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Construction Division

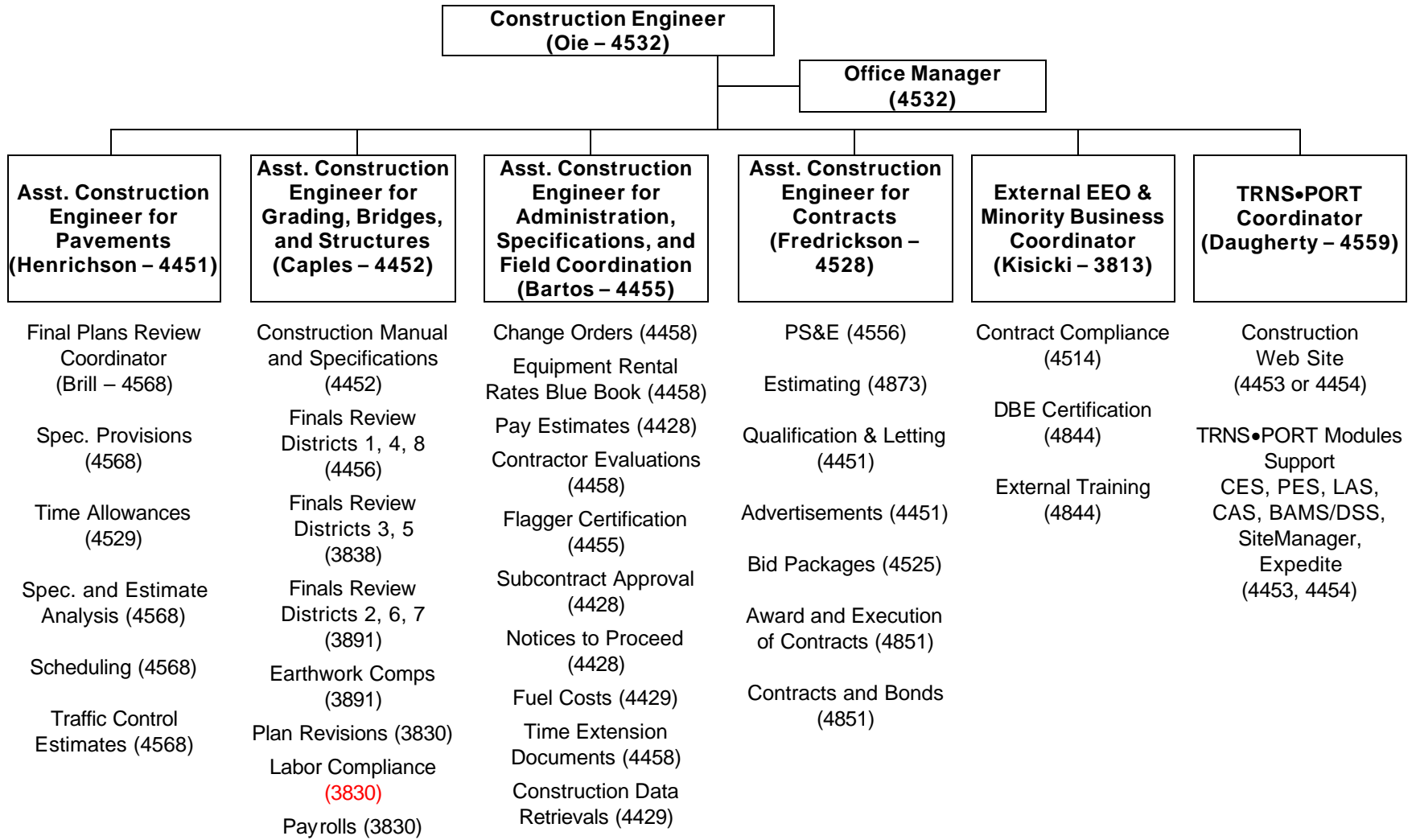
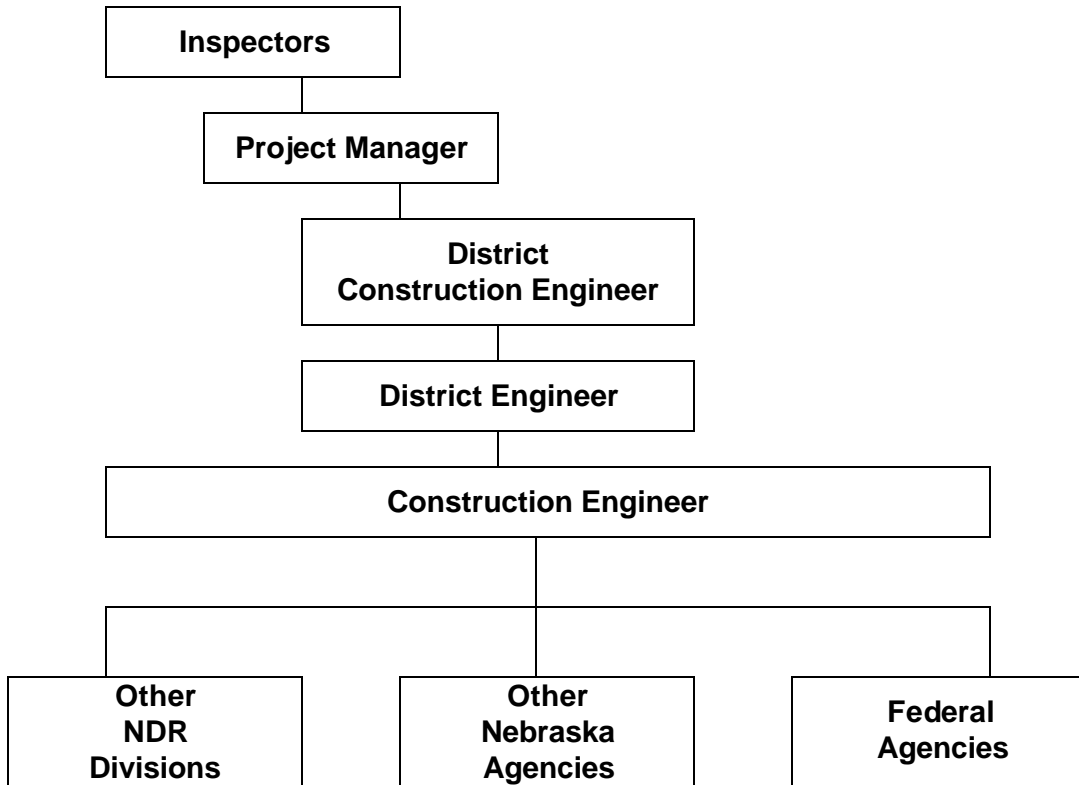


Figure 101.

101.04 CHAIN OF COMMAND

The normal chain of command for questions and business operations is as follows:



101.05 CONSTRUCTION ENGINEER

The Construction Engineer provides guidance to District Construction Offices to insure compliance with Specifications and established policies and procedures in the timely completion of NDR projects. The District Engineer, through the Project Manager, has direct responsibility for construction projects. The Construction Engineer is the next level of authority on approval of substantial change orders and the resolution of contract disputes when District Engineer decisions are appealed.

@

Interpretation of Specifications

The Construction Division provides consultation and advice on construction problems concerning the application and interpretation of Specifications and other contract requirements. Providing this guidance on a statewide basis is intended to insure uniform and fair contract administration.

@

102.09 CONTRACTOR (PARTNERING) RELATIONSHIPS (SSHC Section 113)

Under the contract system used in highway construction, contractors aim to perform the work contracted and NDR Engineers see that the work performed is done according to project plans and Specifications. Since these aims are essentially the same, Engineer-contractor relations should be conducted in a spirit of mutual cooperation within the framework of the Specifications and with the best interest of both contracting parties. Establishing a cooperative and collaborative working relationship with contractors may result in improved quality and fewer unresolved contract issues. This is the goal of "Partnering."

Contractors should do no less than required by contract, nor should they expect compensation for work done that was not required.

Good contractor relations can be promoted by keeping an open line of communication and advising contractors when they are doing unacceptable work before such work is completed.

- Good Project Managers know how the contractor should construct the project. They go out of their way to make sure the contractor starts each phase of construction using proper methods and the correct materials.
- It is 1,000 times easier to correct a subgrade problem with the grading crew than with the paving crew.

The most common construction problem is the contractor being notified after the fact that the work was not done according to the Specifications.

In general, relations with the contractor should be fair, firm, courteous, and based on sound judgment under the guidance of specification requirements.

102.10 FHWA & OTHER OUTSIDE AGENCIES RELATIONSHIPS

FHWA has oversight authority only. FHWA representatives have the right to examine any phase of work, including methods of testings, project records, material reports, etc., to review performance of State inspection personnel assigned to the project, and to check work for compliance with plans and specifications. Their responsibility or authority does not extend to supervising or directing Project Managers or contractor forces.

Reports covering their inspections are forwarded to the Construction Division and then are made available to the District Engineer and Project Manager.

Relations with FHWA personnel should be conducted in a spirit of cooperation and courtesy, extending any assistance or facilities available. The FHWA Engineer should be informed of anticipated plan changes or extra work when the value exceeds \$50,000.00, on full oversight projects (usually Interstate System with a contract value of \$1,000,000 or great).

@

Inquiries from other state or government agencies should be given prompt and courteous consideration.

102.11 EMPLOYMENT OF CONSULTANTS FOR CONSTRUCTION ENGINEERING AND INSPECTION

From time to time, and with increasing frequency, various governing bodies hire consultant services. Governing bodies could be cities, counties, or the State.

Agreement Responsibilities

Responsibilities of a consultant may be limited to providing professional advice to the governing body on the best means of satisfactorily accomplishing the work or may include specific project level engineering and/or inspection responsibilities. These guidelines will address engineering and/or inspection responsibilities. The consultant's contract should define respective authorities and responsibilities of the full-time publicly employed project administrator in charge of the project and consultant's staff.

Under federal-aid regulations, however, prime responsibility for general supervision of construction remains with the governing body. The state (county or city under agreement with state) cannot be relieved of its responsibility to insure that work is performed in accordance with project plans and specifications, even when we hire a consultant to do the inspection or design.

Project Manager

When a consultant has been engaged to provide engineering and inspection services, a Project Manager designated by the Department should also maintain working knowledge of the project.

The designated Project Manager is responsible for being thoroughly knowledgeable of day-to-day operations of both contractors and consultants providing the construction inspection/engineering services. Knowledge of day-to-day operations is construed to mean:

- Knowledge of current project status.
- Involvement in decisions relative to conditions which require change orders or supplemental agreements.
- Involvement in authorization of progress payments even though the consultant may furnish measurements or computation of quantities.
- Making periodic inspections, visits, or on-site reviews of the project; frequency dependent upon the magnitude and complexity of the project.
- The PM must verify that the consultant understands what records are required, how to record the data, and who can sign/verify each document. This is also true when a city or county does the project engineering.

102.12 PERSONNEL

102.13 EMPLOYEE POLICIES

Some of the personnel references that employees should read and follow include:

- Classified System Personnel Rules & Regulations
- Nebraska Association of Public Employees Labor Contract
- Employee Safety Manual
- Nebraska Department of Roads' Operating Instructions
- Davis-Bacon Act

102.14 STAFF REQUIREMENTS

A definite need exists to develop and maintain procedures to properly manage engineering staff requirements necessary for highway construction projects. Proper planning and staffing procedures provide the means to estimate staffing needs based on anticipated workloads.

Field Estimates

@ District Construction Engineers provide an estimate of staffing needs to the Deputy Director for each construction season. Each Project Manager analyzes their particular workload according to the production schedule, and District Construction Engineers collect and combine the data to determine minimum staffing for the upcoming construction season. These figures provide a guide for temporary employee hires (usually submitted in January or February each year).

Adjustments

@ As necessary throughout the year, the District Construction Engineers review their personnel requirements with the Deputy Director.

Field Personnel Duties & Staff Requirements

The District Engineer and District Construction Engineer are responsible for providing the Project Manager with a sufficient number of engineers and construction technicians to adequately and properly supervise and inspect the construction operations. The personnel furnished will have such education and experience, which, together with instruction, training, or direction by the Project Manager, will qualify them for the proper performance of the inspection or other duties assigned to them. It is the responsibility of the Project Manager to assign and utilize such personnel effectively and economically to obtain completed work of good quality and meeting the requirements of the plans and specifications.

102.15 SUBCONTRACTS

Subcontract Request And Approval

All subcontracts are subject to the requirements of *SSHC Subsection 108.01*, and FHWA 1273 (when included in the contract documents), and approval of contracting authority before they are recognized as valid. Subcontracts are required for independent trucking companies when hauling is covered by the provisions of Davis-Bacon wages (*Construction Manual 102.26*). Field forces shall not allow work to proceed without prior approval of the District Construction Engineer or District Engineer. Contractors are expected to make their application for subcontractor approval sufficiently in advance to allow time for processing and approval. On rare occasions, this may not be possible. Under these circumstances, a Project Manager may provide verbal approval provided the contractor has submitted a written application for approval of the subcontract. **If the contract has a DBE goal on it, you shouldn't assume the DBE subcontract has been approved just because their name appears in the subcontract area. One way to tell is to open up the subcontract record. If no approval date has been entered, the subcontract has not been approved.**

@

A. Contractor's Requirements

The prime contractor must initiate a letter requesting to sublet items in the contract. This letter must be sent to the Construction Engineer and shall include the following information:

1. Subcontractor's name, mailing address, and telephone number.
2. Prime contractor's identification number (used on employer's quarterly federal tax return, U.S. Treasury Department Form 941).
3. A check off indicating whether or not the subcontractor is registered with the Division of Labor.
4. Estimated starting and completion dates of the subcontractor's work.
5. Items to be subcontracted with descriptions, quantities, unit prices, and amounts of non-specialty and/or specialty items. Unit prices shown must be the contract unit prices except when "labor only" or "place only" items are subcontracted. In such cases, indicate that the "item unit price" is approximate.

When a subcontracted item is used to satisfy a DBE goal, the amount paid to a DBE must be shown and verified with signatures of the prime contractor and the subcontractor. These signatures will document the agreement for payment between a prime contractor and their subcontractor and eliminate the need for a copy of a DBE subcontract/agreement. Note the additional guidelines on the administration of DBE subcontracts that follow.

6. It has been common practice for subcontractors to include appropriate mobilization costs in their unit bid prices. Prime contractors may have encouraged this practice. However, adjustments in unit prices due to overruns or underruns will have to meet the test of "significant change".

To reduce the risk resulting from changes in quantities which are not subject to price renegotiation, appropriate use of the mobilization item for subcontractors is encouraged. On all subcontract requests, mobilization must be listed for the item even if the dollar amount listed/subcontracted is zero.

7. The Subcontract Request and Approval letter shall include the following statement: **"It is clearly understood by both the prime contractor and the subcontractor that all terms of the prime contract shall apply."** When "Required Contract Provisions" (Form FHWA-1273) are part of the contract documents, the prime contractor is responsible to see that a copy of this form is physically attached to the subcontractor's copy of all subcontracts. The prime contractor is responsible for fulfilling terms of the contract, including construction work completed by approved subcontractors, plus completing all required forms or reports. Refer to *SSHC Subsection 108.01* for requirements and limitations on contract subletting.

B. Project Manager Involvement

If a Subcontract Request is received by the Project Manager, it should be forwarded immediately to the Construction Division.

The Project Manager is responsible to make sure a subcontractor performs the kinds of work described in the approved subcontract.

Occasionally, contractors may have to rent additional equipment and hire extra employees to complete their work. However, when the entire crew and equipment of another contractor is used to complete the work, the prime contractor is violating the intent of *SSHC Subsection 108.01* and is considered brokering a project. If the District Engineer or the Project Manager observe work performed by anyone other than the approved subcontractors, the Construction Division should be notified. Assistance will be provided to investigate the circumstances.

At the preconstruction conference, it will be beneficial to discuss methods of keeping subcontractors informed of the work status. Although the prime contractor is responsible to make progress payments to a subcontractor, numerous incidents in the past have indicated a lack of timely progress payments from the prime contractor to the subcontractor. Subcontractors may review a copy of the "Contract Construction Progress Estimate" in the District office.

@

- C. Field Approval of Subcontract WorkThe **District Engineers** can approve a subcontract request for work up to a maximum amount of \$50,000 for each occasion. This is done on DR Form 42, "Field Approval of Subcontract Work.

There are some specific items that need to be kept in mind at all times when considering a request of the prime contractor to have certain work performed by subcontract. These are as follows:

1. The contractor being considered to do the subcontract work must have been approved by the Department to perform as a subcontractor. A contractor is considered approved if he/she is prequalified to bid work; or is presently a prime contractor on a current project; or is an approved subcontractor on a current project; or has performed subcontract work in the past under the same company name. This information is available on CICS-3.
2. The subcontractor being considered must have current insurance. This information is available on CICS-3.
3. The aggregate total of all work to be subcontracted cannot exceed 70 percent of the contract amount.

If you are not able to determine the status of any of the above or have a question concerning the completion of the form, please contact Steve Bartos or Sharron Magnuson (402-479-4455) in the Construction Division.

D. Exemptions from Subcontract Requirements

The following items of work may be exempted from the normal subcontracting requirements: (It should be noted, however, that these exemptions do not prohibit the contractor from executing a subcontract if he/she chooses to do so.)

Materials

1. Small amounts of asphaltic concrete. When small amounts of material are needed to complete the work, such as for wedges at bridge ends, tying into existing surfaces, etc., the contractor will be permitted to obtain asphaltic material (and placement) from another contractor's portable (or commercial) plant without the need for a subcontract.
2. Tack or prime oil. When small quantities and/or irregular areas are involved, the contractor may obtain this material from another contractor without the need for a subcontract. This exemption in no way relieves the contractor from furnishing material which meets the requirements of the specifications.

Equipment

1. Tree spading
2. Concrete pumping
3. Bump grinding. Equipment used for corrective grinding on asphaltic or portland cement concrete pavement may be hired without the need for a

Plan revisions will be mailed to the contractor as soon as they are issued. Contractors will be responsible for keeping their field representatives informed and supplied with such revisions. If contractors feel such revisions require extra work, they should immediately advise the Project Manager.

C. Wage Rates (Federal Aid Projects)

All wages paid must conform to wage and hour provisions prescribed in the contract. Crafts must be listed exactly as shown in the wage decision. Crafts not listed but needed shall be requested by the contractor through the Project Manager. Required payrolls must be submitted weekly and within seven days after the last day covered by the payroll.

It is suggested that the prime contractor collect, sign, and submit all payrolls of approved subcontractors, as a group, to the Project Manager.

The Project Manager may withhold progress estimates if payrolls are more than two weeks behind schedule.

D. Postings

The contractor shall be responsible for erecting and maintaining required postings as outlined in *Construction Manual* Subsections 103.21 to 103.24.

E. Stockpiled Material

If contractors want payment for stockpiled material, they should provide receipted bills showing the actual cost of the material stockpiled. For payment of stockpiled material, refer to *Construction Manual* 105.06.

F. All plants shall be labeled.

The information on each plant's label shall describe the plant's:

- (1) Botanical genus.
- (2) Species.
- (3) Common name.
- (4) Size or age.

Legible labels shall be attached by the nursery grower to individual plants, boxes, bundles, bales, or other containers to insure that all species and varieties are identified.

G. Subcontracting

1. On all projects, prime contractors must submit their subcontract requests to the Construction Division in a letter or FAX.
2. The prime contractor is responsible for EEO and minimum wage compliance by all subcontractors.
3. All subcontractors must be approved by the Construction Division prior to the subcontractor starting work.
4. In the event a prime contractor elects not to subcontract and instead "carry the people on the payroll", the District Engineer and/or his/her authorized representative may perform the following checks:
 - a. Request to see on a random basis and before distributing the payroll checks of the people in question.
 - b. Request a copy of the lease agreement on equipment to verify that compensation is on a time period basis rather than the amount of work accomplished.
 - c. Check material supplier invoices or billings to insure that the prime contractor is or will make payment for the materials used in the work in question.
 - d. Check the prime contractor's payrolls to determine if the people in question and their supervisor(s) are included on the payrolls.

H. Project Supervision

The prime contractor shall submit in writing, to the Project Manager in charge, the name of an authorized representative on the project. Representative will be empowered to coordinate with all operations of subcontractors and negotiate with the Project Manager any questions concerning extra work, including extra work performed by a subcontractor. If the prime contractor wishes, this representative may be a subcontractor's employee that is present when work on the project is being performed.

I. Weekly Report of Working Days

When working time is being charged, the Project Manager will prepare and furnish the contractor the "Weekly Progress/Working Day Report" showing working days charged that week. Objections to days charged must be made in writing by the contractor within ten calendar days after receipt of the report. Objections based on delays due to unavailability of materials should be accompanied by copies of orders placed, acceptance of orders, and promised dates of delivery. All other objections must be accompanied with documentation of the reason for objection. The Project Manager will respond to the objection, indicating acceptance of the claim or reasons for rejection.

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J. Right-of-Way

All parties are reminded that highway right-of-way abuts upon private property. Any infringement or trespassing upon such private property could cause damage that would become a liability to the person or organization involved. Maintaining good relations with the public (especially private property owners) is very important.

K. Safety

Contractor must comply with provisions of the Federal and State Occupational Safety and Health Acts.

L. Nebraska One Call Notification System shall be explained by the Project Manager. The Diggers Hotline of Nebraska phone number is 1-800-331-5666.

M. Contractor has 48 hours to file notice with county sheriff when burial sites are discovered.

N. Water Pollution & Wetlands

The contractor's schedule and methods for control of water pollution and protection of wetlands should be reviewed. For more information, refer to Construction Manual Division 1100.

All disposal sites require NDR approval.

O. EEO Requirements (Federal Aid Projects)

1. Forms PR-1391, Manpower reports required. (Distribute sample form)

A. The Contractor (prime and subs) shall send two copies to State Contract Compliance Officer.

B. Submit by 10th of August.

@ C. Needed for the week of July 15th only.

D. If no minorities or women employed - explain why.

E. Required of subcontractors, also, with subcontract of \$10,000 or more.

2. All subcontract and purchase agreements must include E.E.O. provisions.

A. All sections of Form PR-1273 must be attached to these agreements.

3. Not allowed to maintain segregated facilities of any kind.

4. Must pay comparable wages.

- B. Use newspapers and other media likely to yield minority and female applicants.
11. When hiring, the contractor should show some active recruitment in local commuting area of job site.
- A. Make personal recruitment visits to organizations, agencies, etc. in the commuting area of the job site.
 - B. Write letters of recruitment to organizations and agencies in the local commuting area.
 - C. Keep records of all recruitment activity (diary notes are acceptable for personal visits).
12. Must show that some attempt is made to analyze the labor market where the job is located.
- A. Determine number of minorities and women in the commuting area of job site.
 - B. Analyze staffing pattern of crew at job site.
 - C. Set up some type of goal or objective for utilizing minorities and women on that particular job. If minorities and women will not be utilized, be prepared to explain why. Keep records of this analysis activity.
13. Will need to show that personnel actions are reviewed by top management for discriminatory effects.
- A. If a minority or women is discharged at the job site, make sure that the home office knows about it and that the company E.E.O. Officer gives the facts surrounding that discharge.
 - B. If a minority or women is transferred or promoted, the E.E.O. Officer should know about it.
- We are not advocating that contractors establish a highly formal procedure for this, because in some cases, it would not be practical or feasible. However, it is the contractor's responsibility to show that this is being done regardless of the method used.
14. Must show some type of training activity. Must advise employees about training opportunities available and encourage minorities and females to participate.

- A. Document progress of trainees.

When training is given on an informal basis, the contractor will need to show that it is given. Records of case histories should be kept, subject to being verified by interviewing the trainee involved. Keep records of all training activity.

15. Letters must be sent to known minority contractors regarding any subcontract work. Documentation must be kept on the efforts made to solicit minority businesses.
16. Keep records of the following:
- A. Number of minority and women applicants referred and where they come from.
- B. Number of minorities and women hired - if not hired, reasons why.
- C. Number of minorities and women transferred, terminated, promoted, etc.
17. Identify minority and women employee files after hire.

Note: Each Federal-Aid project will stand by itself when being evaluated for affirmative action. In other words, affirmative action on one project will not satisfy the requirement of affirmative action on another project. The contractor should satisfy himself/herself that the foregoing actions are taken and that records are kept for each and every project under his/her control.

103.03 PROJECT DETAILS

- A. On many projects it may be necessary for the Project Manager to prepare and present an enlarged plan or map for showing:
- Location.
 - Terminal points.
 - Type of construction involved.
 - Special areas of concern, including installation of public utilities to be fenced or marked if hazardous or sensitive.
 - Restrictions due to lack of right-of-way or defined by right-of-way agreements.
 - Detours and staging of construction for traffic.
- B. Contractor must present his/her detailed construction schedule, or else postpone preconstruction conference.
1. Starting Date _____ Completion Date _____

Any date before Notice to Proceed must be approved in writing by the **Construction Division.**

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- 2. Staging Schedule and/or Sequence of Operation.
- 3. Items to be sublet and names of subcontractors.
- C. Sampling and material testing requirements shall be discussed.
- D. Contractor Insurance requirements shall be verified.
- E. Railroad Protective Insurance

The contractor must have appropriate insurance in force when working on the railroad right-of-way.

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The Controller Division will enter the effective dates of railroad insurance policies in SiteManager. However, the Project Manager must, in the Key Dates area of SiteManager, record the date that construction started and the date when construction in the railroad right-of-way is complete. **Check to make sure that Railroad Protective coverage is in force.** If not, do not allow the contractor on the right-of-way and do give Controller Division (402-479-4631) a call so that they can verify that insurance has, in fact, not been received. When work has been completed on the railroad right-of-way, the same procedure should be used to record the ending date.

F. Utilities and Law Enforcement Attendance

At major project preconstruction meetings, attendance of utilities and law enforcement personnel is highly beneficial to all concerned. The Project Manager should expend extra effort to assure attendance or open communication with utilities and appropriate law enforcement agencies.

Relocation of utilities is of extreme interest to all concerned in the progress of the project. For safe control of traffic, the ability to discuss traffic control with both contractors and law enforcement could be highly beneficial. The State Patrol, local sheriff, or police should be invited to attend preconstruction meetings when appropriate. The State Patrol can be contacted through the State Patrol District Office charged with responsibility for the area of the project being discussed.

It is beneficial to discuss utilities relocation, project staging, and/or traffic control early in the meeting before more detailed and time consuming construction matters are approached. You may excuse utility companies early.

G. Plan and specification omissions must be discussed.

H. Traffic Control (PM shall present the NDOR Traffic Control Plan.)

In addition, the following must be verified:

1. Brand and model of barricade light proposed to be used are on the Approved Products List.
2. Maintaining spare parts on project.
3. Checking barricades and signs at frequent intervals daily.
4. Phone number of person to call at night if barricades, or signs or devices are down or not working.

Name and Number _____ - _____

Name and Number _____ - _____

5. Notify Project Manager before picking up signs and also at first notice of damaged or stolen signs.

I. Prompt Submittal of Certificates of Compliance, Certified Analysis etc. to insure payments.

J. Location of Field Laboratory and Field Offices

K. Subcontractors must be approved before they can begin working on project. We need to be notified when they are going to be working on project.

L. Contractor's Borrow Pits – Approval

M. Payrolls – Prime Contractor needs to check subcontractors

N. Welding on girders not allowed without written permission.

O. Labor, Payrolls, Wage Rates, Training & E.E.O.

E.E.O. Officer _____

Safety Officer _____

103.20 CONTRACT ADMINISTRATION (SEPARATE HANDOUT FOR ALL CONTRACTORS)

This section provides instructions and guidance to contractors and Project Managers for administration of construction contracts. Instructions include information on required reports or forms, equal employment opportunity, wage reports, training program, minority recruitment, and subcontracting. Copies of all NDR forms mentioned in the *Construction Manual* are included in *Appendix 1* -- NDR forms or *Appendix 2* -- Federal Forms) and can be copied as needed. (However, use stock forms when possible to cut reproduction costs.)

103.21 NEBRASKA & FHWA FORMS & REPORTS - PREPARED BY CONTRACTOR

Form No.	Title	Reference Section	Office Where Forms are Available
DR 298	Special Training Provision Monthly On-Job-Training Report	102.24	DBE Office
DR 439	EEO Contractor's Self-Analysis	102.23	DBE Office
FHWA-1391	Annual EEO Report (July)	102.23	DBE Office
FHWA-47	Statement of Material & Labor	102.25	Construction
WH 348	Statement of Compliance	102.25	District Const. Office
Standard Form 1444	Request for Authorization, Additional Classification and Rate	102.26	Construction

Postings

At the preconstruction conference, the Project Manager will supply copies of the posters listed below:

a. Federal-Aid Contracts

Federal Poster - Equal Employment Opportunity is the Law
State Poster - Equal Opportunity Commission
WH-1420 - Your Rights under the Family and Medical Leave Act 1993
WH-1462 - Notice: Employee Polygraph Protection Act
FHWA-1022 - False Statements Notice
FHWA-1495 - Wage Rate Information

b. State Funded Contracts

State Poster - Equal Opportunity Commission
WH-1420 - Your Rights under the Family and Medical Leave Act 1993
WH-1462 - Notice: Employee Polygraph Protection Act
USDOL-1088 - Your Rights - Federal Minimum Wage

Examples are included in *Appendix 2*. Additional copies, if needed, can be obtained from the Project Manager or the Construction Division (Mr. Dan Necas, 4453). In addition to postings noted above, a copy of the Policy Statement shall be posted.

All required site postings shall be in a location that is easily accessible to all employees. They may be fastened to a bulletin board, tool shed, or job office trailer and protected from weather by glass or clear plastic. Postings that become soiled, faded, or otherwise illegible should be replaced. More than one posting may be necessary if there are multiple locations where workers report for work. Such cases typically occur on complex or long projects involving several different crews and/or subcontractors.

103.22 OCCUPATIONAL SAFETY AND HEALTH

Occupational Safety and Health Act (OSHA) regulations (federal and state) apply to all construction projects. (Federal OSHA regulations are codified in *29 CFR, Sections 1910 and 1926*.) Contractors are responsible for compliance with OSHA regulations and shall maintain a safe work site. Therefore, contractors and their employees must be familiar with the health and safety requirements of the act.

- As an employer, contractors are required to keep employee occupational injury and illness records at the location where their employees usually report for work. The "Log and Summary of Occupational Injuries and Illnesses" (OSHA Form 200) must be completed within six days following a recordable occupational illness or injury. A copy of the completed form must be maintained at the work site. In addition, OSHA Form 200 is to be completed at the end of each calendar year and posted at job sites before February 1. Detailed instructions are printed on the back of each form.
- A poster entitled "Safety and Health Protection on the Job" must be displayed in a prominent place at all times.

Contractors can obtain OSHA forms and posters from:

Regional Director-OSHA
Federal Office Building
Lincoln

or Administrative Safety & Labor Standards
Division
Department of Labor
Lincoln

103.23 EQUAL EMPLOYMENT OPPORTUNITY (EEO) (SSHC Subsection 102.09)

A Contractor's Responsibility

Contractors and their staff who are authorized to hire, supervise, promote, and discharge employees or recommend such action must understand the requirements of applicable EEO specifications including "Required Contract Provision", Form FHWA 1273, and Executive Order 11246 in the Special Provisions.

Policy Statement and Compliance Letter

All contractors must formally adopt an Equal Employment Opportunity Policy Statement which:

- Prohibits discrimination of any kind or for any reason.
- Encourages employment of minorities and women.

Examples of minimum acceptable policy statements for both federal and nonfederal aid projects appear in *Appendix 2*. When posted, these policy statements must be on company letterhead.

A sample of an EEO proof of compliance letter, which lists the EEO requirements and postings, is in *Appendix 2*. Written proof of compliance will not be required for material suppliers, manufacturers, truckers, and surveyors.

B. Project Manager Involvement

Responsibility for complying with EEO requirements is solely the contractor's. However, the Project Manager has oversight involvement to ensure that contractors comply with these requirements and that proper forms and/or letters have been received. When a contractor is not in compliance with EEO requirements, the Project Manager shall advise the contractor, in writing, and make a diary entry, that continued negligence in EEO requirements will result in the withholding of progress payments. **The Project Manager will also inform the Contract Compliance Officer of the contractor's noncompliance. The Contract Compliance Officer will investigate all reports of noncompliance and make a recommendation as to what the contractor must do to be in compliance.** If the contractor still fails to take corrective action relative to EEO noncompliance, the Project Manager may, with concurrence from the Construction Engineer (Lincoln), suspend work. All suspensions shall be documented in writing and sent to the contractor.

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1. Contracts and Subcontracts Over \$10,000
 - a. Site Inspections

As soon as a major part of contract work is underway, an EEO project site inspection must be completed by the EEO Office relative to work in progress. A representative of each affected company shall be present and accompany the inspector during an EEO inspection.

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b. Training Program

Contractor training special provisions requires the contractor to have a formal employee training program. During an EEO inspection, the training program should also be checked.

c. Required Posting

During the inspection, all required postings should be checked. Project Managers shall check to see that correct names and addresses appear in the boxes on posters entitled "Wage Rate Information Federal-Aid Highway Project" (FHWA-1495) and "Notice" (FHWA-1022). Copies of these forms are provided in *Appendix 2*.

d. Reports

- "Federal-Aid Highway Construction Contractors Annual EEO Report"

Contractors and subcontractors (with contracts over \$10,000) shall provide the Contract Compliance Officer in the Construction Division two copies of "Federal-Aid Highway Construction Contractors Annual EEO Report" (FHWA-1391). A blank copy is provided in *Appendix 2*. **1391's can also be obtained off the NDOR website under Contractor's Corner – DBE Information.** These forms are to be completed for all federal-aid contracts for which work was performed **during the week of July 15th**.

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NOTE: If Prime or Sub submit the 1391 to the Project Manager, return them and tell the Prime or Sub that the 1391's must be submitted directly to the Contract Compliance Officer to avoid double counting.

A copy of Form FHWA-1391 is provided in *Appendix 2*. Copies can be ordered from:

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Construction Division
Nebraska Department of Roads
1500 Hwy. 2
P.O. Box 94759
Lincoln, Nebraska 68509-4759

Instructions for completing this form are provided by the Construction Division on a yearly basis. Contractors are cautioned to be sure they have the CURRENT instructions. If there is any question about revision dates, contact the Construction Division in Lincoln (402) 479-4514.

Distribution: Route one copy to the Construction Division, Lincoln, and retain one copy in project file.

2. Construction Contracts and Subcontracts \$10,000 and Less

An EEO project site inspection is not necessary for these construction contracts.

3. Maintenance Contracts

On maintenance contracts, an EEO project site inspection is not necessary regardless of contracted amount.

4. Complaints of EEO Violations

The Project Manager will report all complaints of EEO violations to the Construction Division's EEO section for investigation.

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103.24 TRAINING & TRAINEE PROGRAMS

Contractor's Responsibility

1. Training Program

All prime contractors and subcontractors (with contracts over \$10,000) must develop, or have, an approved training program in accordance with the *Specifications*. The Contracts Office (EEO Section) approves these programs and can be contacted [(402) 479-4514] for answers to questions or assistance in developing an approved program.

Shortly after a contract is awarded, the Contracts Office will verify that the successful bidder has an approved training program on file. If not, the contractor will be advised that a formal training program must be approved by the Contracts Office within 30 days. Failure to submit a training program will be considered noncompliance with the Specifications. A contractor who does not comply may be refused bidding proposals for future lettings until requirements for a training program are met. (Typically, contractors adopt and use the Associated General Contractors' (AGC) training program. It is acceptable in Nebraska.)

An acceptable training program shall include information covering:

- Method of trainee recruitment.
- Crafts to be trained and upgraded.
- Number of expected trainees per year and what part of total will be female, minority, and disadvantaged.
- Training procedures, including approximate training time.
- Commitment for keeping up-to-date records to summarize total time each trainee is trained in each classification.

- Other training deficiencies are noted during the inspection.

It is the Construction Division's responsibility to work with the Project Manager and contractor to rectify noted discrepancies. If after a reasonable time a contractor fails to meet training requirements or ignores requests for corrective actions, the Construction Division, working through the Project Manager, may request suspension of work until corrective action(s) are implemented. Suspending work will be used as a last resort. However, the offending contractor's bidding ability on future contracts could be restricted until such time that compliance with training is demonstrated.

2. Wage Rates

Wage rate interviews may also be completed during the EEO inspection.

- Interviews should be conducted a minimum of every six months for each contractor and subcontractor.
- Projects whose duration is less than six months should have one interview with each contractor and subcontractor.
- Each District must keep interviews on file for three years.

3. Reports

a. "Reimbursable Trainee Training Record"

Shortly after a letting, the Contracts Office (EEO Section) will prepare and forward a letter listing projects that require a "Special Training Provision Monthly On-Job-Training Report" (Form 298) along with a supply of these forms. **Additional forms can be obtained off of the NDOR website under Contractor's Corner – DBE Information.**

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Monthly, the contractor will be sending one completed Form 298 for each trainee employee until training for that employee is completed or terminated. The Project Manager will review, initial, copy, and forward the original Form 298 to the Construction Division, EEO Section. The copy will be placed and retained in the project file.

- b. Occasionally, contractors train employees on contracts that do not have a line number for trainee reimbursement. In this case, Project Managers are not responsible for monitoring that program and Form 298 is not required.

103.25 WAGES AND EMPLOYMENT

- A. In order to comply with the requirements of the Freedom of Information Act regarding protection of personal privacy, all requests for access to certified payroll records shall be forwarded to the Construction Division. Requests must be in writing, and if not made on behalf of an individual, the request must indicate the name of the organization making the request.
- B. Access to or copies of payrolls shall not be permitted until authorization has been received from the Construction Division. (Adherence to these procedures during investigation by the Department of Labor or FHWA is not required.)

- C. All contracts for highway construction work have certain requirements on wages and conditions of employment. These requirements vary between Federal-aid and State-funded contracts.
- D. Some laws or regulations provide specific requirements in the contract documents, while others may be cited by reference. Section 107 of the Standard Specifications requires compliance with all laws and applicable regulations, and accordingly, compliance is required whether or not specific listing or reference is made in the contract.
- E. Labor Laws Cited
 - 1. Section 107 of the Specifications calls attention to certain State laws and provides that additional regulations and restrictions will be set forth in the special provisions in the contract. These additional regulations are normally included in the required provisions or the special provisions. The enforcement of contract provisions such as these cannot be ignored. However, the inspection, reporting, and enforcement requirements vary between contracts. A basic knowledge of the laws and the exercise of good judgement and diplomacy are required when any enforcement action is taken. Project Managers are advised to contact the Construction Division for decisions on labor complaints for which answers are not readily available. Knowledge concerning these problems is to be handled in confidence, and complete records are a necessity. Certain standard requirements are made a part of all contract provisions. These are as follows:
 - a. A minimum employment age of sixteen years and the restricting of employment of persons whose age or physical condition is such as to make his/her employment dangerous to themselves or others.
 - b. A provision prohibiting the employment of anyone currently serving sentence to a penal or correction institution (this shall not be interpreted to prohibit the use of persons on a bona fide work release program).
 - c. A provision prohibiting discrimination on any grounds against workers who are qualified for the work by training or experience, and who are not disqualified by Paragraphs a. and b.

2. These regulations are required by State law, but often are duplicated or made more restrictive by Federal laws.
3. *SSHC Section 110* refers to State law restrictions of hours and labor. This would include the State Fair Labor Standards Law which is cited in the Special Provisions in each State-funded project and requires the contractors to comply with such a scale of wages and conditions of employment as are paid and maintained by at least 50 percent of the contractors in the same business or field of endeavor. Contracts for State-funded projects do not contain an established scale of minimum wage rates; however, no wages paid can be below the minimum wage of the Fair Labor Standards Act. Questions which arise concerning the payment of proper rate should be referred to the District Office, or to the Construction Division (Mr. Dan Necas, 4453).

103.26 DAVIS-BACON AND RELATED ACTS REQUIREMENTS (Payrolls)

A. General Information

1. On selected contracts containing Federal-aid funds, Federal laws (Davis-Bacon Act) and regulations require the Secretary of Labor to issue a determination for minimum wage schedules to be included in each of these Federal-aid contracts. Special instructions to the contractors are issued by the Construction Engineer prior to the construction operations. A copy of the current instructions are available in *Appendix 2* (FHWA Forms) under Form WH 348, "STATEMENT OF COMPLIANCE."
2. Project Managers or their assistants shall conduct wage rate interviews (Report of Labor Compliance Interviews DR Form 98) on the selected Federal-aid projects in order to determine whether contractors and subcontractors are properly classifying employees and are complying with the minimum wage rate requirements of the Special Provisions.
3. The Project Manager is to make systematic spot interviews with the contractor's or subcontractor's employees when he/she feels it is necessary. As a matter of courtesy, the contractor's superintendent or foreman should be advised that personal interviews with employees will be made. The Project Manager shall select the employees to be interviewed and these should be of different payroll classifications if possible.
4. The number of different employees and classifications to be interviewed shall be at the discretion of the Project Manager to ascertain compliance with these requirements. If violations are discovered, the frequency and number to be interviewed shall be increased and corrective action taken until such violations have been eliminated. Depending on the size of the crews, an attempt should be made to avoid repeating interviews with the same individuals.

5. Employees should be privately interviewed; that is, without the presence of other employees or their supervisor. The employee being interviewed must not be informed of wage rates reported by fellow employees, but is entitled to know the minimum rates specified for his/her classification.
6. Any apparent violations of labor classification or wage rates are to be called to the attention of and discussed with the contractor's or subcontractor's superintendent. In such cases, the Project Manager and the superintendent, considering all the facts and conditions involved, must reach agreement on the proper labor classification. The wage rate paid must be at least the minimum specified for that classification. If a violation in either proper classification or minimum specified wage rate is involved, the contractor or subcontractor shall be directed to correct the classification and/or wage rate being paid and to make any retroactive payment necessary to provide strict compliance with the requirements.
7. In all cases of apparent violations of proper classification or minimum wage rates paid, and the Project Manager and superintendent having reached agreement on the proper classification or minimum wage rate specified, the employee shall then be contacted and notified as to his/her proper classification and the minimum wage rate specified for that classification.
8. In unusual cases involving apparent violations, the Project Manager and the superintendent may not be able to agree on the proper classification of work performed by the employee. In such cases, the matter may be submitted to higher authority, through proper channels, for decision. The current Standard Labor Classifications and Descriptions for Highway Construction shall be used in determining the proper classifications. (See *Appendix 2*, Form WH 348, "STATEMENT OF COMPLIANCE").
9. The interviews shall be recorded on DR Form 98, "Report of Labor Compliance Interviews" and transmitted to the District Engineer for review and distribution. The report should be submitted regularly, showing the interview information as found, indicating any apparent existing discrepancies. Information concerning the handling of such discrepancies shall be shown, by means of an appropriate note, on that report or in the subsequent report.
10. Any classification not covered by the wage determination included in the contract will require the Project Manager to initiate Standard Form 1444, "Request for Authorization of Additional Classification and Rate."
11. The Construction Division (**ext: 3830**) will supply each District Office with current applicable wage rates to be posted for each individual Federal-aid contract and labor and E.E.O. posters.
12. Regardless of the source of funds, highway construction is associated with interstate commerce and, therefore, is covered by the Federal Fair Labor Standards Act. It has specific requirements for payment of a

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6. The contractor and subcontractor payrolls are to be retained until three years after the District Engineer is notified by Controller Division that the final vouchers have been submitted to the Federal Highway Administration.

(Each District should establish a central location for storing payrolls.)

C. Interpretation

1. The interpretation is taken from the U.S. Department of Labor Field Operations Handbook dated June 1, 1987. (A copy of this manual is available at each permanent field headquarters.)
2. Application of labor laws often becomes a matter of interpretation, such as may be involved in instances when furnishing materials must be classified as subcontracting and subject to highway contract labor regulations. This usually applies to labor involved in producing materials from local pits but is not necessarily limited to that operation. The following are examples of elementary rules that may be used in this determination. It is requested that these rules be followed in enforcing the minimum wage requirements of the Special Provisions.
 - a. The contract labor standards provisions are not normally applicable to employees of "established material suppliers" engaged in the production and delivery of aggregates or materials to the contractor, either to stockpiles or on the road. An "established material supplier" is normally considered to be an aggregate production plant, quarry, concrete plant, or asphalt plant which has been established for commercial production not making more than token amounts of sales to other Federal-aid projects.
 - b. When a contractor produces and hauls aggregates for his/her own use from a previously established pit or quarry from which he/she had been producing and selling aggregates immediately prior to the award of the contract, his/her production and hauling operations will be considered to be as an "established material supplier" and the minimum wage rates will not apply.
 - c. When a new pit or quarry is opened or production equipment is moved into a previously opened pit or quarry for the purpose of producing material for a specific contract, none of the operations will be considered to be commercial and the minimum wage rates and conditions of employment shall apply to all labor employed in producing and hauling the aggregate to the work.
 - d. The work of producing or loading material from a local pit shown in the plans, or from a source substituted by the contractor for a local pit shown in the plans, and the work of hauling materials from such sources is considered to be part of the work

contemplated in the contract. As such, the minimum wage rates shall apply to all operations performed by the contractor or his/her subcontractor in processing, loading, and hauling the materials.

- e. The minimum wage rate requirements do not apply to bona fide owner-operators of trucks who are independent contractors. The certified payrolls including the names of such owner-operators need not show hours worked nor rates allegedly paid, but only the notation "owner-operator".
- f. The contractor is required to pay the minimum wage rates to drivers which he/she employs to operate trucks which he/she owns or leases from another party.

D. Apprentices

- 1. The contractor is not required to submit the Standard Form 1444 "Request for Authorization of Classification and Rate" for apprentices if verification is received that the employee is registered in a bona fide apprenticeship program.

E. Various outside agencies may request copies of payrolls under The Freedom of Information Act. The FHWA processes these requests. If you receive a request for copies of payrolls, have the person who is requesting a payroll contact the FHWA. The FHWA will request the payrolls from the Construction Division. The Construction Division will tell the PM to forward requested payrolls to the FHWA. The FHWA will remove any personal information such as name and Social Security Number before forwarding the information to the requesting agency.

103.27 DISADVANTAGED BUSINESS ENTERPRISE (DBE) SUBCONTRACTOR

A. Contract Award

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On Federal-aid projects with predetermined **DBE participation** goals, all bidders will be required to submit a required DBE Participation Form (see bid proposal package) with their bid. This form identifies DBE subcontractors, suppliers, transporters, and/or manufacturers that will be used to satisfy the DBE goal. The DBE Participation Form shall also include work or items to be subcontracted, and dollar amount committed to each DBE.

Upon execution of a contract, the prime contractor becomes committed to those DBEs goals listed on the form. This commitment is therefore a contractual arrangement between the State and the prime contractor with the same enforcement as any other provision specified in the contract documents. A prime contractor is required to enter into a contractual arrangement with each DBE listed by formally executing a written subcontract agreement specifying the work to be performed and appropriate compensation for that work. This two-tier process, which contractually obligates the prime contractor to both the State and each participating DBE, formalizes implementation of all DBE contract provisions.

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The DBE Office will review the low bidder's "Required DBE Participation Form" to assure that certified DBEs are being used.

@ The successful bidder must then submit a letter and copy of the DBE Subcontract to the Construction Division to get subcontractors approved.

B. Commercially Useful Function

@ (1) A DBE performs a commercially useful function when it is responsible for execution of the work of the contract and is carrying out its responsibilities by actually performing, managing and supervising the work involved. To perform a commercially useful function, the DBE must also be responsible, with respect to materials and supplies used on the contract, for negotiating price, determining quality and quantity, ordering the material, and installing (where applicable) and paying for the material itself. To determine whether a DBE is performing a commercially useful function, you must evaluate the amount of work subcontracted, industry practices, whether the amount the firm is to be paid under the contract is commensurate with the work it is actually performing and the DBE credit claimed for its performance of the work, and other relevant factors.

To meet commercially useful function requirements of the regulations and contract, the following statements are applicable:

- DBE firm must manage the work contracted. Management shall include scheduling work operations, ordering equipment and materials (if materials are part of the contract), preparing and submitting payrolls and all other required reports and forms, as well as hiring and firing employees, including supervisory employees.
- DBE shall perform work with employees normally employed by and under the DBE's control. In all instances, the DBE shall be responsible for payroll and labor compliance requirements concerning all workers under their control. DBEs may use other means to perform work on a limited basis when the contract requires specialized knowledge, skills, or equipment. A DBE may be allowed to augment their work force with personnel which normally work for another firm. If the request can be approved prior to commencing work.

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NOTE: All arrangements must be presented in writing and pre-approved by the DBE Office.

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- DBE must supervise daily operations of their portion of contracted work. The only two acceptable ways for a DBE to supervise daily operations are:
 - 1) The DBE owner may act as the superintendent and directly supervise work, or
 - 2) A skilled and knowledgeable superintendent employed and paid wages by the DBE must directly supervise that work.

If the latter is used, the DBE owner must be actively involved in making operational and managerial decisions of the firm. Basically, this means that all administrative functions shall be performed by personnel responsible to, or employed by, the DBE at facilities or locations under the DBE's control.

- DBEs shall supervise and perform contracted work with workers on their payroll and under their direct supervision. The DBE and the superintendent must, on a full-time basis, supervise and control contracted work. Supervision of contract work by personnel normally employed by another contractor or by personnel not under the DBE's control constitutes failure to perform a commercially useful function.

(Responsibilities include minimum requirements for DBE manufacturers, dealers, transportation services, and subcontractors.) DBE subcontractors that indicate work which will be performed by employees

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@ of another firm or with leased equipment should be questioned. The DBE Office shall be notified in all cases where there is a question regarding "commercially useful function".

3. Partial Subcontract of an Item

It is not unusual for DBE subcontractors to be involved in only part of a contract item.

For conditions where a subcontract does not exist but a DBE firm is manufacturing, supplying, or trucking materials to the job site, this dollar value will not be used to determine the percent subcontracted as specified in the *Specifications*.

Inspection staff must monitor work performed and periodically inform the Project Manager as to which individuals and equipment actually worked so payrolls can be spot-checked.

C. Construction Period

@ The Project Manager and inspectors must review work subcontracted to DBE subcontractors to assure work is being performed and that DBEs are performing a commercially useful function. Where work is performed by any other contractor or with equipment not owned by the DBE, the inspector shall issue a noncompliance notice citing violation of *Supplemental Specifications for Specific Affirmative Action Responsibilities*. This noncompliance shall be immediately reported to the Project Manager, who will in turn immediately notify the DBE Office.

Prime contractors will be given credit toward the DBE contract goal only when a DBE performs a commercially useful function. The requirements for a commercially useful function are outlined in the previous section "Subcontract Approval."

@ A DBE may lease equipment consistent with standard industry practice provided a rental agreement specifying the terms of the lease arrangement is approved prior to a DBE starting work. If equipment is of a specialized nature, the lease may include an equipment operator. No credit will be given for the cost of equipment leased or rented from the prime contractor.

DBEs shall negotiate cost, arrange for delivery, and pay for materials and supplies required for their portion of the contract work. Invoices for materials shall be invoiced to the DBE firm and not to a prime contractor.

@ A prime contractor may occasionally find it necessary to ensure that payments are made to suppliers for materials used by subcontractors. When such a **joint check** payment arrangement is pre-approved by the **Highway Civil Rights Coordinator**, counting the cost of materials actually incorporated into the project by a DBE subcontractor toward DBE participation will be allowable provided the DBE:

- orders and schedules the delivery of materials, and
- is fully responsible for ensuring that materials meet Specifications.

@ **When the DBE office approves** such payments **to be** made by the prime contractor, payments must be made by preparing jointly endorsed checks signed by the DBE and supplier.

No credit shall be allowed toward the DBE goal for cost of materials placed by a DBE subcontractor when payment is made by deducting this payment from the prime contractor's payment to the DBE.

@ Project Managers must evaluate and document performance of the DBE's activity on all projects as part of the normal project contract compliance monitoring. On-site project monitoring by field personnel shall include employee assignments, equipment used, and supervision of the work. All irregularities must be documented in the field books and immediately reported to the prime contractor, and the **Contract Compliance Officer in the DBE Office**.

@ **Project Managers shall not allow a prime contractor or another contractor to perform work that has been committed to a DBE subcontractor without prior written approval from the DBE Office.**

@ In situations where a DBE subcontractor cannot (or is not) performing, the prime contractor must follow all steps described in *Supplemental Specification for Specific Affirmative Action Responsibilities*. Upon receipt of a signed statement from the DBE and documentation where the prime contractor will satisfy the goal with other items or DBEs, the Project Manager may recommend to the **DBE Office** that the commitment be waived and the required goal adjusted. The **DBE Office** must provide written approval of all substitutions before any changes in subcontracted work are performed.

D. Post Construction

@ Prime contractors shall submit a completed "Identification of DBE Goal Achievement" (DR Form 441) with the final project documents **to the DBE office**. The subcontractor submits DR Form 442 "Identification of Work Performed." Blank forms are provided in *Appendix 1 and at the website*. These forms certify the dollar amount paid to each DBE. **DBE Office** must compare the dollar amounts on Forms 441 and 442 to dollar amounts committed to a DBE on "Required DBE Participation Form." The prime contractor will be assessed a penalty by change order for failure to satisfy the DBE commitments. This penalty may be reduced when conditions described in

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Supplemental Specification for Affirmative Action Responsibilities are satisfied. Project Managers must include a written explanation describing situations, background, and findings which resulted in reductions or adjustments.

Unique problems have been noted with the goals and variables of the DBE program. Documentation of any activity related to the program is important and must not be overlooked. Record all telephone or personal contacts noting time, place, and details.

The DR Form 440 Contractor EEO Compliance Record has been eliminated. These records are no longer to be maintained.

103.28 LEASE OF PROPERTY BEYOND THE HIGHWAY RIGHT-OF-WAY

The NDR has found that it is more cost effective and quicker to have the contractor make most land use agreements for areas outside the highway right-of-way. This means borrow sites, plant sites, storage areas, parking lots, and so forth are the contractor's responsibility to lease.

103.29 CONTRACTOR'S USE OF HIGHWAY RIGHT-OF-WAY

Occasionally a contractor requests permission to establish a plant site or a material stockpile on highway right-of-way. In reviewing these requests, the District Engineer must consider the impact of vehicles (trucks or equipment) entering and leaving these sites on public traffic. In situations where these vehicles must enter an open ramp or lane at a point where access is not allowed to the general public, the request shall normally be denied. On two-lane roads if an access permit can be obtained and public convenience and safety is not adversely affected, the request may be approved. On closed sections of the highway, right-of-way may be used as long as trucks can enter and leave the closed road safely.

Many times a contractor will have to exit a controlled-access facility to deliver materials such as mulch, subdrain, guardrail, etc. These stockpiles may be allowed as long as the material is to be used in the general vicinity where stockpiled and is stored beyond the "clear zone".

NOTE: In these situations, the contractor will be responsible to initiate and provide a storm water permit for their operations in that area.

103.30 "CONTRACT QUANTITIES"

The Project Manager and the contractor may agree to a final payment for an item based on contract quantities, i.e., plan quantity. The Project Manager shall verify that the plan quantities are reasonably accurate. If the contractor concurs with the final quantities as shown on the PM Final Estimate, the Project Manager will forward this concurrence to the Construction Division with a copy to the contractor for information.

Final review corrections should be limited to errors of \$150.00 or more per pay item. Do not waste time and money making small corrections.

103.31 CONTRACTOR'S SALES TAX EXEMPTION

When a NDR contract is awarded, the Contracts Section of the Construction Division will issue the prime contractor a "Purchasing Agent Appointment" (DR Form 2-A) and an "Exempt Sale Certificate for Contracts" (DR Form 2-B). These forms allow the contractor to purchase materials that are to be incorporated into a highway project without paying any sales tax. The prime contractor is allowed to make copies of both forms and provide them to the project subcontractors for their use. The prime contractor must contact the Contracts Section [(402) 479-4851] to obtain an extension. The Contracts Section completes the extension by issuing a new "Purchasing Agent Appointment" (DR Form 2-A).

103.32 LOTUS NOTES – NOTIFICATION

Field personnel are strongly encouraged to open their electronic mail daily. The Construction Division (and others) use it regularly and expect messages sent to be messages read.

Any time a plan error/omission is discovered or if for any reason the contract must be changed, the PM should send a Lotus note with appropriate details to the designer (Bridge or Roadway), Construction Division, and if necessary, to Materials & Research.

103.33 PRIME CONTRACTORS/SUBCONTRACTORS

Project Managers should be reminded that correspondence pertaining to a subcontractor should be directed to the prime contractor.

Notification should be made to:

Bernard Hauber, Industrial Hygienist
Occupational Safety and Health Administration
Overland-Wolfe Building, Suite 100
6910 Pacific Street
Omaha, NE 68106

After the original notification has been made, it will be OSHA's responsibility to determine if and when they choose or desire to make an on-site inspection.

104.00 -- CONSTRUCTION INSPECTION

104.01 CONTRACT TIME DETERMINATION (*SSHC Subsection 108.02*)

Tentative Beginning Date - The proposal will show a tentative date on which it is anticipated that the contractor may begin operations.

In most cases, the tentative beginning dates are established several weeks in advance of the letting date by determining the latest possible date the Department would like to see the work completed and backing out the estimated number of days required to complete the work. Consequently, any requests to delay the start of work on a project are examined very carefully before being approved. Additionally, the approval to delay the start of work on a project may be made contingent upon certain concessions by the contractor (such as the imposition of a disincentive payment for a late completion).

In the case of contracts involving multiple time allowances, extensive utility relocation, or work to be performed by others (e.g., railroads, cities, counties), it may be necessary to delay the start of work for several weeks after the tentative starting dates shown in the proposal.

If the tentative beginning date shown in the proposal appears to be earlier or later than believed possible or practical due to job, weather, traffic, or other conditions relevant to the project, the Construction Engineer should be notified promptly.

Notice to Proceed - The contractor will be given a Notice to Proceed by the Construction Division, and work should not begin until the notice has been issued (or at least verbally acknowledged) by the Construction Division.

Normally, the Notice to Proceed date will coincide with the tentative beginning date shown in the proposal; and the Notice to Proceed will automatically be issued after the contract is in place, usually a week or two prior to the starting date. In some cases, however, such as for seeding or landscaping projects, the Construction Division will check with the District Construction Engineer to verify that the site is ready for work to proceed before issuing the notice. The issuance of the Notice will also be delayed when a project is let far in advance of the tentative starting date -- almost always resulting in a request for an early start by the contractor.

It should be noted that in SiteManager, the Notice to Proceed date is recorded in SiteManager under "Key Dates" as the "Notice to Begin Work" date. SiteManager's "Notice to Proceed" date is actually the contract execution date.

Some contracts contain an "early start provision". For those projects, the contractor may begin work prior to the tentative starting date by notifying the District Engineer of his/her intent to begin work early. The notice must be given two weeks prior to the intended starting date and is not subject to review by the Department. When such notice is given, the District should notify the Construction Division of the need to issue the notice and the date for which it should be issued.

For those contracts which do not contain the "early start provision", requests to begin work prior to the tentative starting date should be made by the contractor directly to the Construction Engineer in Lincoln. In many cases, such requests are made following issuance of the original Notice to Proceed. If the request is approved, a revised notice will be issued.

104.08 CHANGE ORDER - SUPPLEMENTAL AGREEMENTS
(SSHHC Subsection 104.02)

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Change Orders are used to:

- Change the authorized quantity of a contract item. This includes increases, decreases, or deletions to contract quantities.
- Add a new item or material to an existing contract. Often this is a result of plan revisions or a change in scope from what was originally envisioned at time of letting.
- Serve as a source document for the Controller Office.
- Officially document changes to the contract documents. CO/SAs and work orders are written orders to a prime contractor which are initiated and prepared by the Project Manager. Once signed by all parties, these documents become a legally binding part of the contract ordering a specific change to the original contract.

Policy for Change Orders

A. Contractor Markup

Subcontracted Items. Extra work performed by a subcontractor entitles a prime contractor an allowance to cover administration expenses. This markup is not to apply to incentive payments. The percentage allowed for administration expense is discussed in *SSHHC Subsection 109.05*.

Contract Unit Price. Change orders covering an overrun/underrun (*SSHHC Subsection 104.02*) of items at contract unit prices are NOT eligible for any additive like an allowance for administration expenses. This includes work which was done by a subcontractor. The contract unit price should have already considered any necessary additives for administrative expenses.

The contractor may request a change order when additional work differs materially in kind or nature from the work included in the originally proposed construction.

A major item of work is defined as an item whose total original contract cost exceeds 10 percent of its original group total amount. The price for a pay item may require adjustment when a major item is increased in excess of 125 percent or decreased below 75 percent of the original contract quantity. Any allowance for an increase in quantity shall apply only to that portion in excess of 125 percent of the original contract item quantity, or in case of a decrease below 75 percent, to the actual amount of work performed.

A contractor may request a price adjustment to recover lost administration expense for underruns amounting to more than 25 percent of the bid amount for a major item of work. A contractor is allowed to recover only that portion of lost administration expense represented by the underrun.

By the same reasoning, a like price adjustment may be made to reduce the cost of major items of work which overrun by more than 25 percent, since the contractor should have already included overhead expenses in their bid. Overrun price adjustments apply to only that portion/quantity which is more than 125 percent.

Agreed Unit Price. Extra work orders based on an agreed price or lump sum should have overhead considered as a part of the negotiation. The agreed unit price may include the cost of overhead for handling subcontracted items. It may be included in lump sum items if justified. However, if negotiations specifically excluded markup, the item may be shown as a separate entry on a cost work up sheet.

Force Account. (*SSHC Subsection 109.05*) Specified force account percentages for labor and material are intended to cover all costs that a contractor may incur due to the work, regardless of who does that work (prime or subcontractor). Force account work to a subcontractor will be authorized for additional administration percentage to a prime.

Plan Revisions

Often, plan revisions result in Change Orders having to be negotiated. Processing Change Orders resulting from plan revisions is sometimes delayed due to disagreement on prices, lack of success in obtaining qualified subcontractor(s), or various other reasons.

It is imperative that Project Managers actively pursue Change Order negotiations to an early conclusion, especially if proposed work involves public safety (guardrail, safety enhancement, etc.) or work related to a prolonged detour. Obviously, agreement on unit prices is desirable. However, there are times that work will have to proceed on a Force Account basis. In all cases, documented agreements on the Method of Measurement and Basis of Payment for extra work items must be obtained before the Change Order is written. NOTE: No work can begin until the contractor has either agreed to a Change Order or agreed to a basis of computing force account costs.

Change Order Approval Limits

Contracts are awarded for a specific dollar amount. Overruns or change orders expend additional funds and can only be authorized by specific people.

FHWA/Certification Acceptance

FHWA projects that have full oversight have "FHWA" stamped in red on the front page of the proposal. The Contracts Section makes the determination and affixes the red stamp.

@ On FHWA oversight projects, current rules require that expenditures in excess of \$50,000 be discussed with the FHWA.

The following table shows the Department's approval limits:

APPROVAL LIMITS	
Deputy Director	Over \$150,000.00
Construction Engineer	\$50,000.00 to \$150,000.00
District Engineer & DCE	\$0 to \$50,000.00

Preparation of Change Order

The following instructions are applicable in the preparation of a Change Order-Supplemental Agreement:

- Create a brief description of the work not in the contract.
- Show reasons for the change; or, if the document is a combination change order-supplemental agreement, show purpose of the agreement. When the work to be performed is not covered in the specifications, the name of the items shall be worded to define the work to be performed. References should be made to similar items in the specifications or plans and the method of measurement and basis of payment definitely established.
- Show the basis of the unit prices established, such as comparison with unit prices for similar contract items or the previous year's average contract unit prices.
- Include statement as to the determination of a change in the contract time allowance.
- @ • Show the name of the FHWA engineer and date of discussion with him/her when the Change Order is for more than \$50,000.00 and the federal-aid contract is for more than \$1,000,000 and on the Interstate.
- Enter estimated increased and decreased changes in quantities of items of work. Use standard item numbers and standard specification/contract wording, when applicable, for the new item description you define.

All Change Orders (CO) and Change Order-Supplemental Agreements (CO/SA) shall address the subject of additional working days or calendar days, if any, to be added to the contract time allowance.

The original working day or calendar day allowance is calculated by assigning some average rates of progress to the various items of work and then making some assumptions as to which items might tend to overlap during the actual performance of

the work. The system is not perfect; but, regardless of the result, it does provide all bidders with a time frame upon which they can estimate a schedule for completion of the work and prepare a bid.

The performance of extra work should not be cause to suspend the working day or calendar day count. Working days or calendar days should be assessed for all extra and originally contracted work according to the guidelines for doing so, and then any relief to which the contractor might be entitled should be granted by issuing a time extension document or addressing the time in a CO or CO/SA.

@ In SiteManager under Reference Tables/Standard Definitions there several option clauses to be added to the Change Order. Four of the options pertain to working/calendar days. They are further described below:

1. No additional working days or calendar days to the contract time allowance are being granted. Additional working day or calendar day consideration is not applicable to this change.
2. “_____” additional working days or calendar days to the contract time allowance are being granted.
3. Additional working days or calendar days to the contract time allowance shall be granted on the basis of the actual working days or calendar days charged for performing the work under this agreement, provided that said work is judged to be the controlling operation.
4. Additional working days or calendar days to the contract time allowance, if any, shall be granted on the monetary value in accordance with Paragraph 10. of Subsection 108.02 of the Standard Specifications.

The writer of the CO or CO/SA must use some judgment when determining which note is appropriate. In fact, there may be instances when it will be necessary to write more than one CO/SA because the items to be added to the contract do not all subject themselves to the same rule. A little extra work, perhaps; but the right thing to do. The discussion that follows should be helpful in determining which note to select.

Note 1 - No additional days

No additional working days or calendar days to the contract time allowance are being granted. Additional working day or calendar day consideration is not applicable to this change.

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This note could be used on any CO/SA which addresses subjects which are not financial in nature. An example would be an early starting date coupled with the conditional addition of the winter work special provision to the contract. A condition might be that the contractor not make any claims for delays due to utilities not being out of the way --- thus the need for a supplemental agreement requiring the contractor's signature. The work remains the same, however; and no change would be made in the contract time allowance.

This note should also be used on any CO/SA that increases the value of the contract but does not necessarily require additional time to perform the work. An example might be the substitution of one type of asphaltic concrete for another. The concrete actually used might be more expensive; but the time to mix, haul, lay, and roll it remains the same. (This does not, however, preclude the granting of some additional time due to an overrun of the final quantities.)

In general, this note could also be used on a CO/SA that has a negative financial impact on the project. An example might be the substitution of an 18" culvert pipe for a 24" pipe. The cost of the pipe and excavation is probably going to result in a savings to the project, but it is not the Department's policy to reduce the contract time allowance.

Note 2 - Specified number of days

“ _____ ” additional working days or calendar days to the contract time allowance are being granted.

This note is the preferred note in many cases and should be utilized whenever possible. The Construction Division will rarely question the number of days granted, no calculations are required by the Final Reviewers, and the fact that the CO/SA is signed by the contractor leaves little opportunity for it to be contested. Obviously, the use of this note is restricted to situations where the supplemental agreement is created after the work is performed and the number of days required is known.

This note can appropriately be used in cases where the extra work is determined to be the controlling operation when it was performed. It definitely should be used when the time required to perform the work is grossly disproportionate to its monetary value. As an extreme example, it may take just one day to add a million-dollar traffic controller on a fifty-thousand-dollar project. Determination of an additional time allowance on the basis of cost would obviously not be correct.

This note can also be used on a CO/SA that is more administrative in nature. As an example, the contractor and the Department may negotiate some changes to the contract for which a time adjustment is a condition of the agreement. This note is a proper method to document the adjustment to the contract time allowance. It functions in the same way as would a Time Extension Document.

Note 3 - Unspecified number of days (controlling operation)

Additional working days or calendar days to the contract time allowance shall be granted on the basis of the actual working days or calendar days charged for performing the work under this agreement, provided that said work is judged to be the controlling operation.

This note should be used in situations similar to those described for Note 2 when the CO/SA is completed prior to the work being performed. When it can be anticipated that the additional work will be the controlling operation or the value of the work is disproportionate to the time required to perform it (especially when the work takes a long time to complete but is not very expensive), this note should be used. In some cases, it may be appropriate to grant some additional time on the basis of monetary value for extra work performed when the work is not the controlling operation for the entire time required to complete it.

The Project Manager should closely monitor the work when choosing this method of calculating an increase to the contract time allowance. The completion of other work is certainly not discouraged or prohibited, but the contractor should not be allowed to intentionally slow the progress of the extra work to gain the advantage of allowing other contract work to be completed concurrently during the time period being added.

Note 4 - Unspecified number of days (monetary value)

Additional working days or calendar days to the contract time allowance, if any, shall be granted on the monetary value in accordance with Paragraph 10. of Subsection 108.02 of the Standard Specifications.

This note serves to cover those situations not addressed by Notes 1, 2, or 3. It is an inexact method, but is usually a fair way to provide additional time to the contract time allowance when the methods associated with Notes 1, 2, and 3 are clearly not more appropriate.

It should be used to address those additional items of work which are similar in nature to other items of work in the contract but for which it is difficult to determine or monitor the actual amount of time required to complete. An example might be additional work performed sporadically over a long period of time or the addition of more work of a type already in the contract --- such as may be added by a plan revision.

The use of this note does require the Finals Reviewers to calculate the amount of extra time to be granted. The calculation should be done on the basis of the monetary value alone, and no consideration should be given to whether or not working days or calendar days were charged during the performance of the work. If the extra work to be added by the CO/SA could have been anticipated prior to the letting, time certainly would have been allowed for it; and it is only fair that an additional time allowance be considered after the fact.

The Project Manager should have the best feel for the type of working day or calendar day consideration that is most appropriate. He/she is encouraged to make a fair

evaluation of the situation and select the method that fits. As indicated in the discussion above, the use of Note 2 is encouraged.

The approved rental rates shall only apply to equipment used under the following conditions:

The contractor's equipment that is available on the project. If equipment not available on the project is needed only for the extra work, it may be necessary to pay rates in excess of the approved rates or to pay compensation for the cost of moving in the equipment. (Mobilization is explained in *Construction Manual Section 104.07.*)

If it is necessary for the contractor to rent equipment for the extra work from a third party, the rate established shall be the actual rental cost plus fifteen percent for overhead and profit.

Equipment used on extra or additional work performed under normal working conditions on a force account or contingent item basis.

If the equipment is to be used under working conditions involving abnormal expenditures for maintenance, fuel, or service, it may be necessary to pay rates in excess of the approved rates.

If major quantities or extended amounts of work are involved, it may be equitable and necessary to negotiate rates at less than those indicated above.

The approved rates shall be paid only for the time actually used in the performance of the work ordered by the Project Manager. Standby time, time involved moving to and from the work and repairing and greasing time shall not normally be included for payment.

If the contractor is required to hold equipment which he/she has brought in specifically for the extra or additional work "on standby" because of circumstances beyond his/her control, consideration may be given to payment for normal schedule "standby time". In such cases, it will be necessary to negotiate lower hourly rates with the contractor which will not include compensation for fuel, oil, grease, repairs and other costs which would not be incurred on the equipment "standing by".

The Project Manager should be careful to obtain the correct name, model size, series number, and type of the equipment and major attachments - (loader or dragline bucket, etc.) involved for each item of equipment for which a rental rate is to be established. This information should be furnished to the District Office and they may then determine the approved rate from the "Rental Rate Blue Book". Complete information is needed to determine the proper rate since the rates vary considerably depending on the model, series, etc. The name of the established item should be descriptive but brief, for example, "Crawler Tractor Loader, 1 Cu. Yd." The body of the force account or supplemental agreement should then include all of the information necessary to determine and verify the correct rate, for example "Caterpillar, Model 955 'H', 100 horsepower, 1 Cu. Yd."

If fully operated rates, including operators' wages are to be established, the rate paid the operator shall be increased by 50 percent to cover insurance, social

security taxes and profit and added to the approved rental rate, rounding to the nearest five cents. When such rates are established, the words "fully operated" shall be included in the equipment rental item.

The Project Manager should call or write to the general office of the contractor advising him/her of the nature of the proposed work to be performed on a force account basis and request that they advise by letter regarding their insurance premium rates for workmen's compensation, public liability, and property damage. Request that the contractor send copies of his/her letter to the District and Construction Engineers. The letter stating the insurance rates should be attached to the force account agreement to be filed as a part of the permanent records. The agreement may also be prepared without the insurance rates and sent to the contractor's office for signature with instructions that the contractor place the rates on the agreement.

The reverse side of the agreement form must contain the "Estimate of Cost". This itemized estimate of the cost of the work shall include an item for each class of labor or piece of equipment for which a rate is established in the agreement. The estimated number of hours that it is contemplated that each item of labor and equipment will be employed shall be shown, extended at the established rates, and totaled. Allowances for insurance, social security taxes, and profit shall be shown and included in the total cost. In the event that the contractor will be required to furnish materials in performing the work, the quantity and estimated cost of each item of material should be shown and included in the totals.

The hourly labor rates to be used in the itemized estimate shall be the average rates that would be earned, including overtime, if the laborer worked a full week. Such rates shall be referenced with asterisks to the following note to be entered below the estimate:

"Average rates earned at the established basic rates in a 40 hour week."

The heading of the "Estimate of Cost" on the reverse side should be on the same end of the sheet as the signatures on the face of the form so that it will not be obscured when it is placed in the Lincoln Office file.

Force Account Statements - A force account statement, signed by both the Project Manager and the contractor's representative, is required for each calendar week during which work is performed. These reports should be prepared and signed weekly. In the event that overtime payment is involved and the agreement requires that reimbursement be made at the average hourly rate earned during the week, the statement shall be prepared and signed on the Monday following the week in which the work is performed.

@ A daily record of labor, equipment and materials used on force account work shall be kept in **SiteManager**. Work on force account and contract items will often occur at the same place at the same time. It will be the duty of the Project Manager or inspector to record his/her estimate of the force account labor and equipment hours and check with the contractor's foreman each day.

A receipted invoice is required for all items of expense incurred by the contractor except insurance, social security taxes, and the items for which rates are established in the force account agreement. The quantity or amount of such services furnished or materials used during each week may be included in the statement for that week, or the total quantity or amount for all materials or other expense covered by the same agreement may be included for payment on a later statement, substantiated by receipted invoice. Payment cannot be made for such items until the receipted invoices are received.

The contractor shall furnish the Project Manager with a copy of his/her weekly labor payroll which contains the names of those personnel working on force account items. The hours worked and the rates paid to labor on force account work shall be compared with this transcript. Any discrepancies should be investigated and corrected to insure the accuracy of the force account statements. See Pages 492 through 497 for instructions and examples of force account agreements and statements.

Alterations of Plans or Character of Work (*SSHC Subsection 104.02*)

This subsection in the specifications authorizes the Department (Project Manager) to increase or decrease quantities of contract items for which there are unit prices included in the contract, if changes in plans or alterations of construction make such increases or decreases necessary or desirable.

A CO/SA may be necessary when there is a significant change in the character of the work. A "significant change" is defined in Subsection 104.02. A CO/SA will not be required if the Project Manager and contractor agree that the additional work can be done at the bid price. Such agreement, preferably including the contractor's initials or signature, should be documented in **SiteManager and** in the Project Manager's diary.

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Sign Deductions

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The change order for sign deductions must indicate that "State Funds Only" shall be used.

104.09 VALUE ENGINEERING (*SSHC Subsection 104.03*)

In accordance with *SSHC Subsection 104.03* a contractor may submit a value engineering proposal to the Project Manager with copies to the District and Construction Division. The purpose of value engineering is to encourage alternative, cost effective measures which produce equal or better quality end products.

Value Engineering proposals will not be accepted for:

- Changes in basic design of a bridge or pavement type. For example: Value engineering a project from PCC to ACC will not be acceptable. Changing a designed bridge to a box culvert is not acceptable.
- Changes which the contracting authority may already be considering.
- Basing a value engineering proposal on, or similar to, existing standard Specifications, Special Provisions, or design plans and standards adopted by the contracting authority. For example: A plan was let using 15 foot (4.6 m) PCC joint spacing. A value engineering proposal would not be accepted changing this to 20 feet (6 m) because Roadway Design Division standards have included this spacing as an acceptable standard.

The written proposal shall have sufficient detail to be evaluated for compliance with the requirements. The detail provided must also allow for reviewing how a proposal impacts the entire project. It shall include:

- A description of existing requirements and proposed changes
- All affected contract items, including new, extra work items and supporting justification for that extra work
- Unit prices requested for the work
- Effects on crew, equipment, and production needs for the project
- Impact on the construction period
- Schedule for obtaining all required materials

It is very important to pursue these requests quickly to maximize potential savings. Once a proposal is received, the Project Manager should (a) discuss the merits of the VE proposal with the District Engineer, and (b) initiate an office review and forward review comments to the Construction Division within a week. The Construction Division will coordinate the review with other offices, including selected section leaders (Design and/or Bridge) and the FHWA, if appropriate. Following this review, the Construction Division will notify the District and Project Manager of approval or disapproval and any special considerations or requirements. Following notification from the Construction Division, the Project Manager will prepare a written notification to the contractor outlining the review and conclusions of that review.

104.11 PLANT REPORTS

The Project Manager should make arrangements with the contractor's plant inspector for timely receipt of plant reports. The original and all copies of the plant report shall be kept at the plant until all documentation is completed. Normally, this will be the day following the end of the reporting period. Review and distribution of the reports will be made by the Project Manager. This distribution will include a copy to be returned to the contractor's plant inspector. Prompt consultation between the plant inspector and the NDR plant monitor shall follow any significant error or omission.

Documentation

- @ A separate field book **entry in SiteManager** should be set up on each project to document plant inspection. Some flexibility in the suggested format may be necessary depending on project size, type of plant, and if the QA/QC Specification applies. It is important to document discrepancies and corrective action taken by the contractor.

104.20 FIELD TESTS

104.21 FIELD TESTING ON CONSTRUCTION PROJECTS

Materials

All sampling, measuring, and testing for construction project quality control shall be performed as prescribed in the NDR Materials Sampling Guide and the NDR Standard Method of Tests.

Project Acceptance Sampling and Testing

Both construction inspection personnel and the contractor are responsible for the field sampling and testing portion of project acceptance tests. The Project Manager must review inspector assignments and maintain a program of continuing training for personnel and training of additional employees if required. Samples taken by inspectors and submitted to District or Central materials laboratories must be properly and completely identified on "Sample Identification Form" (DR Form 12) or other appropriate forms as required.

The *Materials Sampling Guide* shows the minimum required frequency of tests for various types of work. Additional tests should be made as necessary for adequate project control. Reports showing test results must include all tests made.

Reports do not need to be included in field books or diaries.

Assurance Sampling and Testing

SSHC Section 1028 discusses the requirements related to asphalt assurance sampling and testing, most of which are Materials and Research Office responsibilities. Occasionally, assurance samples have not been taken on some projects because timely notification of ongoing work was not made. This has been more common with test cylinders from bridge deck pours and culvert projects.

While the actual taking of assurance samples remains the responsibility of Materials and Research personnel, it is of equal importance that project inspectors provide timely notification regarding available dates for testing.

104.70 ACCIDENTS

Whenever a traffic accident occurs in a construction zone, the Attorney General suggests that the Project Manager immediately video tape, photograph, and/or document the area to verify the position of signage, obstructions, traffic control devices, and other pertinent features.

Use the publication *Collecting of Accident Data* as an aid when reporting accidents.

105.00 -- MEASUREMENT AND PAYMENT

105.01 GENERAL

The Project Manager may elect to pay the plan quantity for items like pavement when the item is built to plan geometrics. Measurements are not always required when the item is constructed to plan and specification requirements.

If the item of work does not conform to the specification requirements, a new item of work must be added as extra work. Example: On guard rail, if it is necessary to leave out a post because of a drainage structure and use a double safety beam section, this section of guard rail must be paid for as extra work as it does not conform to the specification requirements for guard rail.

105.02 MEASUREMENT OF QUANTITIES AND COMPENSATION FOR ALTERED QUANTITIES

@ All standard items of work listed in the contract are to be measured for payment using **English (metric)** System of measurement. A list of standard contract items and their units of measurement is available at each field headquarters and on Lotus Notes or the NDR Web Page. Inspectors or survey parties concerned with measuring and/or recording contract items will need to be informed of proper procedures to be followed.

The contractor may request that materials hauled to the project and paid for by the cubic meter (cubic yard) be measured and a mass conversion factor be used for determining the cubic meters (cubic yards) of material delivered. When the Project Manager approves this procedure, the mass of the material must be obtained on approved scales, the material must be hauled approximately the average haul to the point of delivery, and then the volume of the material must be determined. The mass of the material in kilograms (tons) divided by the volume of the material in cubic meters (cubic yards) will be the mass conversion factor. The cubic meters (cubic yards) of material used may be determined by dividing the total mass delivered by the mass conversion factor.

The Project Manager will determine the frequency for establishing mass conversion factors. The frequency will be dependent on the quantity of material delivered, on variations in the material's characteristics (moisture content, gradation, etc.), and on variations in the length of haul.

The final record for the contracted work must include all records and computations used in determining the mass conversion factors.

If provision is made that payment of any contract item is to be made as an "established quantity", payment will be made on the established quantity listed unless authorized alterations are made. Established quantities are often listed with prescribed tolerances set forth to allow for minor construction changes without requiring that final measurement be made. Authorized alterations are considered to be substantial changes in construction items which would usually be authorized by revised plans or

specifications, and may be listed in two categories. (See *SSHC Subsections 104.02, 109.01 and 109.04.*)

- The first type would be an alteration of a minor item and does not involve supplemental agreements. In this case, payment will be made at the contract unit price for the actual total.
- The second type is an alteration of a major item involving an increase or decrease of more than 25 percent of the item. This situation may involve a supplemental agreement stipulating changes in the actual quantities of the work and establishing (if necessary) a new price per unit price for such work. If there is an overrun, the original contract quantity plus 25% is paid for at the bid price. The extra quantity above 125% is paid for at the new negotiated cost. If there is an underrun, the entire quantity is paid for at the new negotiated price per unit. Payment would then be made at the new unit price for the increased orders and quantity.

105.03 CANCELLED ITEMS (MATERIALS FURNISHED BY CONTRACTOR AND NOT USED DUE TO CHANGES IN PLANS)

The Department will, if the contractor desires, take over unused material at the cost delivered to the location at which it is accepted by the Department.

It will be necessary for the District Engineer or the Project Manager to initiate a change order providing for payment for such materials. The item included in this agreement shall include the phrase, "delivered but not incorporated in the work", in order to specifically identify such materials. The unit price established for items of material furnished by the contractor and not used because of a change in plans will usually be based on the actual cost of the materials, plus 10 percent to cover overhead, handling, other costs and profit. To substantiate the unit price established, the Project Manager should obtain a copy of the receipted invoice for the material and attach it to the supplemental agreement.

@ **Change Order/Supplemental Agreement must be created to pay this.** It will also be necessary for the Project Manager to include an explanation of the transaction in **the Change Order / Supplemental Agreement**. Complete information regarding the disposal made of the material, such as the supply base to which it is delivered or the project on which it is used, is essential. The party to whom it is delivered should prepare a DR Form 329, "Imprest Inventory", providing for the proper transfer of the charges for the material.

Payment for such materials must be included in the final estimate as a nonparticipating contingency.

105.04 PARTIAL PAYMENT

The contractor is to be paid once a month for satisfactory progress on the basis of work completed during that month. The Project Manager prepares a contractor's estimate in the computer stating the estimated quantities for items of completed work to date. This document is forwarded to Lincoln through the District Engineer's office for processing and payment via E-mail.

When the value of the work completed during the first half of the contractor's pay month exceeds the amount stipulated in the specifications (usually \$10,000.00), a semi-monthly contractor's estimate is prepared. All partial payments are made on satisfactory work and materials only, as evidenced by complete certifications or test results as required. Defective work or material shall not be included for payment until the defect has been remedied.

105.05 FIELD MEASUREMENT AND PAYMENT

Photographs and Video Tapes - Documentation on film can save many questions and provide critical answers. Take a picture any time it may be helpful.

Field Records - General - Payment for most contract items is based on the plan quantities. Final measurements should be avoided as long as the specifications permit and the contractor does not dispute the quantities. Their construction should, however, be documented as described under "Inspection Notebooks" with the statement (if applicable) "Constructed as per plans" and substantiating data or measurements, if necessary, also entered in the record.

Field records must be properly kept to substantiate that the contractor has conformed to the requirements of the plans, specifications, and Special Provisions both as to quantity, usually involving measurements, and quality, usually involving tests, of the work or material items used on the project.

Instructions and examples of preparation of specific records may be found in this manual in *Appendix 3*.

- @ **Field SiteManager Entries or SiteManager Item Documentation** - Field measurements made for pay items of work and records of placement of materials shall be entered directly in SiteManager.
- @ Field and lab test results on quality of materials will be entered into SiteManager. Record and document tests using approved Material Sampling Guide and SiteManager procedures.
- @ The item documentation records should indicate the stationing used, date placed or constructed, and sketches with dimensions if necessary to give clear understanding of the placement and material used. The names of the party or engineer making the measurements and dates performed must be entered in SiteManager or included with the supporting documentation. Materials used in the construction of the project for which no direct payment is made but are considered subsidiary to other pay items should also be documented in SiteManager, Materials Management Section.

@ **SiteManager** should contain a detailed summary of all shipments received for the project, including the kind of material, the identification number, net mass, date received, delivery point and, if possible, the point of origin. Include distribution to the proper group of the contract and information on material received but not used on the project.

@ The laydown inspector shall **enter in SiteManager** the activities required in the performance of his/her job. This would normally include such items as types of equipment being used, equipment checks, tonnage checks, thickness checks, temperature checks of mixture, etc. **All entries are to be dated**. Also, we would like to bring to your attention that the inspectors are to sign the scale ticket on receipt and acceptance of the material. Base all entries on facts, not opinions.

@ Final computations shall be entered directly into **SiteManager or other approved recording and documentation methods used in conjunction with SiteManager**. Operations of performing computations and checking computations shall be identified on each page of computations by operation, date, and the name or initials of the individual.

@ Plans, tables, and sketches provide supplementary details necessary to clarify **SiteManager entries** for pay items. Any such plan or sketch shall be **saved electronically in the project files**. Supplementary plans and sketches are sometimes necessary to define the extent of a pay item sufficiently enough to remove any doubt as to its limits.

@

- A good technique is to build the sketch or table in the computer and then **save it electronically**.

Supplementary sketches are sometimes necessary to show measurements of irregular areas for both pavement removal and the construction of new pavement.

@ Computation **spreadsheets should be** used where detailed computations are necessary to determine pay quantities. These computations are made from **SiteManager**, cross section, or sketch information and should be fully referenced in **SiteManager**. It is necessary that all computations **be referenced in SiteManager or saved electronically in a project folder (Read Only Access)** so that the computations can be checked for correctness of method and accuracy.

Scale Tickets - Scale tickets are used to substantiate quantities of materials which are paid for by mass. The original copies (white) should be submitted with the final records of the project to the District Final Reviewer. Preparation of scale tickets and distribution is discussed in the section pertaining to asphaltic concrete inspection (Subsection 507.12 in this manual)

105.06 CONTRACTOR'S ESTIMATES

SSHC Subsection 109.07 allows payments to the contractor if satisfactory progress is being made. These contractor's estimates will include quantities and amounts for items of work completed to the date of the estimate.

@ Progress estimates are completed in **SiteManager** by the Project Manager and signed electronically. It is the District Engineer's responsibility to review and approve the estimate in a timely manner, sign it electronically, and forward it electronically to the Controller.

Upon receipt by the Controller, the estimate is processed further by the Construction and Controller Divisions before it is released for payment.

@ On all Federal-Aid projects, it is necessary to separate participating and nonparticipating items of work on the progress estimate form by dividing them into separate summaries for each project in a contract. Each line is properly divided by the Controller Division when the item is loaded in **SiteManager**. This procedure is done to comply with our agreement with the Federal Highway Administration regarding procedures for current billing and current audits. Items which are added to the contract should be included in the proper group in the participating or nonparticipating summary as applicable. Items added by change order-supplemental agreement should be considered as participating unless the agreement form is marked "nonparticipating" when returned from the Lincoln Office. The District Office should be consulted for further information on any item for which there is some uncertainty regarding its status.

For contracts which include wage rates, progress estimates shall not be released by the Project Manager until the contractor and subcontractor have submitted all delinquent payrolls and Forms WH-348. These reports shall be considered delinquent when they are not in the Project Manager's hands by the seventh day after the date on which the employees are paid. Notify the contractor by letter, with a copy to the Construction Division, of any delinquent payrolls and WH-348's in advance of the estimate date. The estimate should be prepared at the regular time and forwarded immediately upon the receipt of the payrolls.

Estimate Preparation

Please remember to update Line 2 (current quantity) on the estimate for all items added by plan revision or supplemental agreement. This adjustment should be made as soon as you receive the plan revision or supplemental agreement.

The Controller Division depends on Line 2 being accurate so they can allocate sufficient funding to each project.

DISTRICT ESTIMATE SCHEDULE		
District No.	Regular Estimate Date (Only if money due contractor)	Alternate Estimate Date (\$10,000 or more must be paid)
*1	1st Saturday of Month	3rd Saturday of Month
2	2nd Saturday of Month	4th Saturday of Month
*3	1st Saturday of Month	3rd Saturday of Month
4	2nd Saturday of Month	4th Saturday of Month
5	4th Saturday of Month	2nd Saturday of Month
6	3rd Saturday of Month	1st Saturday of Month
7	4th Saturday of Month	2nd Saturday of Month
8	4th Saturday of Month	2nd Saturday of Month

* Districts 1 and 3 use the 5th Saturday of the month instead of the 1st Saturday of the future month as Primary Cutoff day when there are 5 Saturdays in a month.

Stockpiling:

SSHC Subsection 109.07, Paragraph 4. provides that estimates may also be allowed for acceptable nonperishable materials meeting the requirements of the plans and specifications and delivered in the vicinity of the project or stored in acceptable storage places. This will generally apply to aggregates, structural and reinforcing steel, metal specialty items delivered but not incorporated in the work, and other materials which cannot be used for extended periods of time because of delays beyond the contractor's control. The amount included in the estimate will be determined by the PM, but in no case shall it exceed 100-percent of the value of the materials as shown by copies of receipted invoices or costs. Partial payments shall be listed under the stockpiling category with an "800" series number.

As the material is used, the payment for this material should be reduced accordingly in the stockpile item on the estimate.

Payment for stockpiled material is "permissive", and it should not be interpreted to be a requirement in cases where the material will remain in storage a comparatively short time (less than one month). When there is a question as to the inclusion of a material for payment, the District Construction Engineer should be consulted for instructions.

SSHC Subsection 106.02 states that:

All materials are subject to and will be inspected, tested, and accepted by the Project Manager before incorporation in the work.

SSHC Subsection 1001.02 requires:

Materials which must be documented by a certificate of compliance, certified test, or test reports shall not be incorporated into the work until such certificates have been delivered to the Department and verified for compliance.

@

It follows from the above that material items which have not been tested and accepted, or for which appropriate certification, as defined in the Materials and Research Manual, has not been delivered to the State, should not be included on an estimate for payment. Likewise, no material item which has been stored in accordance with Paragraph 4. of Subsection 109.07 of the Specifications should be included on an estimate for payment unless the appropriate test data or certifications for compliance with the specified requirements are in the files of the Project Manager **and documented in SiteManager.**

The Project Manager shall maintain documentation of progress estimate quantities.

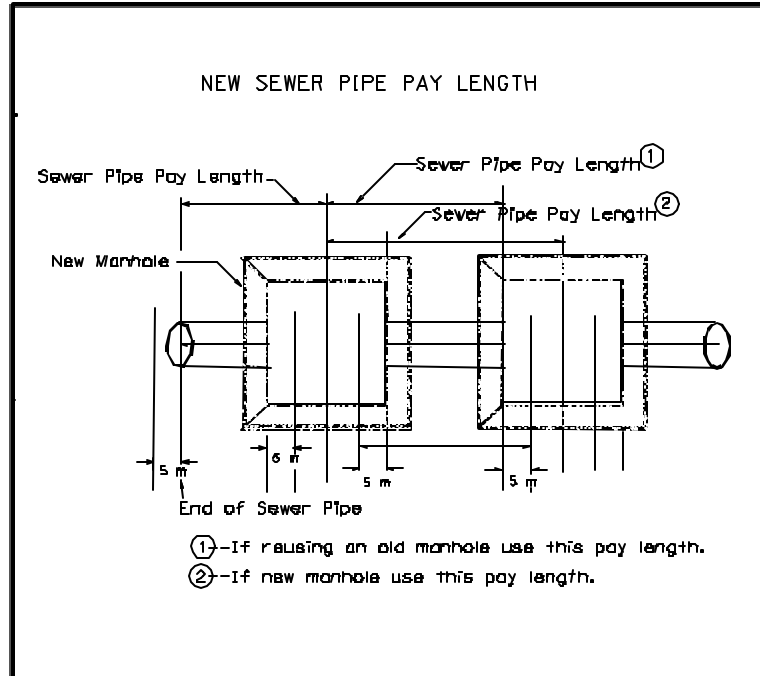
Types of Contractor Estimates – SiteManager has only three types of estimates:

- **Progress** – all estimates prior to the “Final Estimate.”
- **Final** – generated once District has completed its review and is ready to forward the project to Lincoln for “Finaling.”
- **Supplemental** – all estimates generated to change the “Final Estimate.” Additional estimates are obsolete in SiteManager. However, the PM must notify the Construction Division when a project is complete – which used to be the purpose of the additional estimate. In SiteManager, the PM must send a Lotus note to “DOR-CONST-COMPLETION NOTIFICATION.” The Finaling Manual explains what must be included in the “note.”

Processing Estimates – Each District should direct a copy of signed estimates to the Construction Division printer (CON1) as soon as possible after affixing the electronic signature.

Each District is encouraged to sign and print estimates as often as possible. The uniform and steady arrival of estimates in Lincoln is encouraged and appreciated by both the Construction Office and the Controller Division.

Contractor's Statement of Compliance (Form WH-348) - Form WH-348 shall be submitted for each weekly payroll period by each contractor and subcontractor on all projects financed by Federal Funds. (Form WH-348 is not required on other than Federal-Aid projects.) The WH-348 form should be attached to and submitted to the



Guardrail - The contractor shall be allowed payment for linear meters (linear feet) of guardrail complete in place measured from center to center of end posts (*SSHC Section 902*).

Seeding and Slope Protection - Example field book records for Cover Crop Seeding, Seeding, and Slope Protection are in *Appendix 3*.

105.08 BORROW AND LOCAL PIT MATERIALS OBTAINED BY THE CONTRACTOR

Under State Option - All amounts to be paid by the contractor for royalty and borrow costs, to comply with the terms listed in the option block shown in the plans, will be deducted from the payment due on the final estimate. Such amounts will also be included in the retention in the additional estimate. This Department will make payment directly to the owner. Before such payment can be made, it will be necessary to obtain concurrence from the contractor as to the quantities and amounts in order to eliminate the possibility of overpayment to the owner. For this purpose, the Project Manager shall

@ prepare and forward a letter to the contractor, substantially in accordance with the example included in *Appendix 2*.

The receipt of such letters from the Project Manager and contractor, plus the required releases from the pit owners, will complete the records required by the Right of Way Division to enable them to make payment to the owners of local pits. In the case of borrow, taken on an acreage basis, sketches are to be prepared showing the dimensions of the individual pits, the name of the owner, the description of the land subdivision, ties with the project centerline and computations for the acreage included in the letter to the contractor. Such sketches shall be forwarded to the Right of Way Division together with their copy of the letter to the contractor.

When the option block in the plans for the local pit includes payment for incidental items such as temporary fencing, reseeding, crop damage, payment for haul road, etc., the consideration for such incidental items will normally be on a lump sum basis and the lump sum payment for such items shall be included in the letter to the contractor. If payment is stipulated in the option block, for such incidental items, on other than a lump sum basis, the Project Manager shall request the Right of Way Division to advise the proper method of handling the item.

When work is to be suspended for the winter season, or for any other reason, for a considerable length of time and it is desirable to make partial payment to the landowners, the necessary information to authorize partial payment shall be forwarded to the Right of Way Division and, in such cases, it is not necessary to advise the contractor. In the event that a section of the project, involving optional borrow pits, is completed or the work is completed on some of the local pits, the normal letter to the contractor should be prepared in which it shall be noted that information will be forwarded at a later date for the remaining borrow or material pits.

In order to complete the records and eliminate any questions, the Project Manager's letter to the contractor must cover all optional borrow and local pits shown in the plans, regardless of whether they are actually used.

There have been some cases where a pit under state option does not appear on the plans for a particular project but does on an adjacent project. The contractor, if he/she uses this pit, must still be responsible for royalty payments.

Royalty payments for local pit material will normally be made on a cubic meter (cubic yard) basis and such quantities may be determined by preconstruction and final cross sections. In cases where payment to the contractor is based on truck measurement the royalty payment may be based on the same measurement, or by using weight conversion factors where payment to the contractor is based on units of mass.

Borrow and Local Pit Materials Furnished by the State or County and Not Involving the Contractor - When borrow or local pit materials are purchased from the owner directly by the Department or County, and no option requirements involving the contractor are included in the plans, substantially the same information must be forwarded to the Right of Way Division. However, no letter need be written to the contractor. The PM must obtain a site release from the landowner on these Department obtained borrow sites.

@

105.09 SUMMARY OF FINAL QUANTITIES

Project Managers are required to use only black lead pencils in the original preparation and checking of all field records and final computations in the field offices. The District Office review should be indicated by red check marks, initials and dates. Corrections shall be made with red pencil. If any further changes or corrections are found necessary in the Lincoln Office, they will be made in blue or green pencil. This method will eliminate any question at some future date as to where changes or corrections in the records originated.

@ **Each pay item in the contract must be summarized in [SiteManager](#).**

105.10 MOBILIZATION (SSHC Section 112)

Method of Measurement and Basis of Payment

The percent of payment for mobilization under a group of work is based on the percent of work completed on the original contract group amount. Accordingly, when two or more projects are included in the contract and work has been performed on only one project the quantity for mobilization should be paid to all projects based on the percent of work completed on the original contract group amount. In this case mobilization may be paid on a project when no work has been performed on the project.

105.11 SALVAGED PROJECT MATERIALS REPORTING

Many project plans indicate that some removal items shall be stockpiled or salvaged to a nearby maintenance facility. To accomplish documentation of these times, a DR 147a, "Stock Returned for Credit" form has been developed.

The form shall be completely filled out any time project materials are salvaged to a maintenance facility. The form needs the signature and initials of the project inspector and the maintenance employee who received the material.

@ Distribute a copy of the completed form to the Project Manager, District Maintenance Superintendent, [Logistics Division](#), project file, and the contractor. Purchasing & Supply will add the salvaged items to the appropriate stock inventory for the maintenance facility that received these materials. Include a copy of the completed form in the final payment packet for the project.

106.00 -- PROJECT FINALIZATION

106.01 FINAL PAYMENT TO CONTRACTOR

NDR policy is to retain one percent. This retainage is specifically withheld to cover:

- The amount of any possible overpayments or adjustments to contract items and change orders discovered during an audit (State and/or FHWA).
- Any assessed liquidated damages.

Nebraska Code also requires payment of interest on retained contract funds. The interest shall begin to accrue on retained funds on the 61st day after the project is complete provided all of the contractor's documents are on file with the Department.

On projects involving different fundings such as Federal, Interstate, County, State and City, the Project manager must review the project funding agreement and make sure costs are properly recorded on the DR Form 44, "Summary and Distribution of Cost".

106.02 PRICE ADJUSTMENT CHANGE ORDERS

Price adjustment deductions are processed by change orders. If additional price adjustments come up later, a second change order must be prepared; but such increases or decreases are processed as separate change numbers.

106.03 EQUIPMENT PURCHASED BY CONSTRUCTION CONTRACTS

Occasionally, items of equipment are shown as contract items and then taken into the Department's inventory when their use on the project is no longer required (variable message boards, for example). It is required that the contractor be given written confirmation when such equipment is ultimately received and title transferred to the Department.

In order to provide an adequate audit trail, it is required that the letter of confirmation should include detailed information regarding brand, model, serial number, date of transfer, current location and a statement indicating the condition of the equipment when title was transferred.

@ A copy of the letter of confirmation should be forwarded to the **Logistics** Division (in addition to your normal distribution of project correspondence) so that it may initiate the appropriate paperwork reflecting addition of the equipment to the Department's inventory.

106.04 PROJECT ACCEPTANCE AND AUTHORIZATION FOR FINAL PAYMENT

The Final Estimate when signed by the Construction Engineer is authorization to the Controller's Office to release the final payment to the contractor.

The schedule will be revised periodically. Any questions or comments should be referred to the Property Management Section, (402) 479-4770.

Conversion of Existing Direct Measurement Earthwork Pay Items to Established Quantity Pay Items

Certain earthwork items may be converted from being direct-measured for final payment to being paid as established quantities. This policy is to expedite the release of final payment to the contractor, reduce possible interest payments to the contractor, and relieve a portion of the workload performed by field personnel.

The following items of work will be eligible for conversion:

1. Excavation
2. Excavation, Borrow
3. Other earthwork-related items when approved by the Construction Engineer

Direct-measurement items may be converted to established quantities when the following requirements are met:

1. The project has been staked and built according to plan, or the plan quantity has been adjusted to account for field changes.
2. The plan quantity has been adjusted for any obvious errors, and the contractor has been notified of the adjustment.
3. The Project Manager has made written notification to the contractor of the proposed change in the method of measurement, and the contractor has agreed to the proposal in writing.
4. **If the contractor has agreed in writing to accept plan quantity including field adjustments and revisions, it is not necessary to create a new “established quantity” pay item. Payment will be made under the original contract item.**

@

Sample Letter

1997

CROP DAMAGE PAYMENT AFFIDAVIT

Project:

Tract:

This is to certify that I, the undersigned, agree on the amount of \$_____ which is being paid for _____ (acres) of _____ damaged during construction, based on the schedule prepared by the State of Nebraska, Department of Roads.

Owner/Tenant

Social Security #
Federal Identification #

THE CROP PRICES HAVE BEEN COMPILED USING DEPARTMENT OF AGRICULTURE AND UNIVERSITY OF NEBRASKA STATISTICS. THE PRICE REFLECTS AVERAGE YIELDS AND MARKET PRICES LESS THE COST OF HARVESTING AND MARKETING.

CROP	1/4 Acre	1/2 Acre	3/4 Acre	1 Acre
Irrigated corn	\$75.00	\$150.00	\$225.00	\$300.00
Dry corn	\$40.00	\$ 80.00	\$120.00	\$160.00
Irrigated soybeans	\$62.00	\$124.00	\$186.00	\$248.00
Dry soybeans	\$48.00	\$ 96.00	\$144.00	\$192.00
Wheat	\$31.00	\$ 62.00	\$ 93.00	\$124.00
Oats	\$21.00	\$ 42.00	\$ 63.00	\$ 84.00
Milo	\$32.00	\$ 64.00	\$ 96.00	\$128.00

Project Manager

Date

106.09 STATEMENT OF MATERIALS AND LABOR

A "Statement of Materials and Labor" (Form FHWA-47) is required for federal-aid projects that have contract cost (including change order adjustments) of \$1,000,000 or more. Detailed instructions for completing Form FHWA-47 are on the back of the form. Blank forms are available from the Construction Division. A blank copy is provided in *Appendix 2*.

Upon contract completion, each subcontractor must submit a completed Form FHWA-47 (Part "B") to the prime contractor. Subcontractors shall include their name and the word "sub" in the blank space at the top of the form.

The prime contractor shall combine the data from each subcontractor with their own data on one form. Prime contractors shall include their name in the top margin of the "combined" form, note the form is "combined", and attach a listing of all subcontractors involved.

When completing Part "B," contractors shall:

- Report only use of material items that are listed on the form.
- Pay attention to the "units" being requested. "Quantity" entries must correspond to the form's "units."
- Enter required information in the correct column(s).

Prime contractors are responsible to furnish the Construction Division Headquarters (Lincoln) three completed FHWA-47 "packets" before a final pay voucher can be processed. (One packet shall be the original and two packets may be photocopies of the original.) Each FHWA-47 "packet" shall include:

- The prime contractor's combined contract information
- All FHWA-47 forms and any relevant supporting documents furnished by subcontractors.
- Composite of all subcontractors listed on subcontractor request form(s)

Upon receipt of FHWA-47 forms, the Construction Division shall complete Part "A" and verify that:

- An item of material used by a contractor has not been omitted.
- All "starred" line items have received a response or entry.
- Costs reported are reasonable and do not have obvious errors.
- The prime contractor has included required information from all subcontractors on the "combined" form.

106.10 AS BUILT PLANS

An extra set of full size plans will be furnished the Project Manager for use as as-built plans. The Project Manager may request an additional set of plans from the Construction Division for as-builts if needed. The as-built plans shall be an exact representation of the completed work. Any revised plan sheets must be included and the sheets they replace should be discarded. All special plan sheets must be included. The S1 sheets need to be corrected to show the Final Quantities including additional items of work.

@

In preparation of these plans, only black pen shall be used. Lines, dimensions and notations shown in the original plans which have been eliminated or corrected shall be "X ed" (crossed out) and boxed with solid lines. Dashed lines shall be used to indicate any as-built lines, dimensions, or tie points which do not conform to the original plans. For example, a 2' x 65' 8" (600 mm x 20.0 m) pipe culvert is constructed at Station 103+50, whereas the plans called for a 2' x 63' 3" (600 mm x 19.25 m) pipe culvert at Station 101+50. The outline of the culvert at Station 101+50 shall be boxed and the notations describing the work "X ed" within the box with solid lines. The outline of the as-built culvert, in dashed lines, and corrected description notation should be shown at Station 103+50. In striking out figures and notations, care should be used to avoid obliterating the original figures.

Surfacing:

1. Beginning and ending stationing of each type and width of surfacing constructed.
2. Location of all option pits used in connection with the construction of the project. If any plan pits are not used, designate by the words "Not Used".

Processing As Built Plans

1. Project personnel will prepare one (1) full-size set of As Builts.
2. Cities, counties, etc. that have money involved or a special interest in the project will be asked by the Project Manager if they need/want a complete copy of the As Builts or only specified sheets.
3. The As Builts will be submitted to the Construction Division with the final records for finaling with notification of the number of complete copies or specified sheets desired.
4. The final review will be performed.
5. After the final review is completed, the specified sheets or complete copies, as requested by the District, will be copied in half-size sets. The copies will be returned to the District within three (3) to four (4) weeks after submittal to the Construction Division.
6. The full-size set of As Builts will be submitted to the Communication Division for microfilming after the final review is complete and the half-size copies of the As Builts are made.
7. After the As Builts have been microfilmed, the Communication Division will submit the As Builts to the Transportation Planning Division for their use.
8. Upon completion of their work, the Transportation Planning Division will periodically return the full-size As Builts to the District, via truck.

Lighting and Signals - On all roadway lighting and signal projects, a set of "as-builts" will be prepared, pertinent to the wiring alignment, showing the exact location of conduit or cable runs, pull boxes, and any other information which would be beneficial in case of maintenance problems or construction activities in the area. When "as-builts" are submitted to the agency at the time the agency is notified by letter of the acceptance of the installation and to assume the maintenance.

Clearance Letter

The Project Manager shall submit a letter to the Construction Division (with copies to Motor Carrier Permits & Facilities Maintenance) indicating clearance on bridges, sign trusses, and other structures that create a clearance limit.

106.11 OVERRUNS AND UNDERRUNS LETTER

The summary of overruns and underruns letter, which used to be submitted when a contract is finalized, is no longer required. However, a DR Form 74, Cost Overrun/Underrun Notification is required whenever contract quantities overrun/underrun by \$50,000.00 or more. This letter must go to the Construction Division and the Controller Division so that appropriate redistribution of funds is made as soon as possible. This letter is sent as soon as the change in contract quantities is known. The Controller Division will obtain appropriate approvals.

@ 106.12 CONTRACTOR EVALUATIONS

The intent of the Contractor Evaluation is to report strengths and/or weaknesses of a contractor's project-related activities, including paperwork, material documentation, attitude, cooperation, and the actual contracted work. It is suggested that remarks be included to substantiate or help explain significantly high or low ratings or other unusual circumstances on the project. The Construction Division maintains a file of the completed forms, reacts to low evaluations, and seeks to improve the performance and project administration of contractors doing work for us.

The project manager should make note of significant events occurring throughout the life of the project to assist in the preparation of the evaluation when the work is complete. In so doing, perhaps problems can be discussed and resolved as they occur. At a minimum, significant problems reported on a contractor's evaluation should be discussed with him or her when the evaluation is presented.

Evaluations are used as a factor in determining the amount of work on which a contractor may bid. Therefore, it is extremely important that contractors are evaluated realistically, factually, and without bias. In this regard, it is equally important that evaluations are completed promptly. To be at all meaningful, data from the EOC's must be current - - and **ALL** of it must be in the system.

The EOC should be completed and submitted to the Construction Division within 30 days of completion of work. For subcontractors, the EOC should be submitted within 30 days of the time you are relatively certain that the subcontractor's work is complete. For a prime contractor, the EOC should be submitted within 30 days of the project completion date established in the District Engineer's letter of tentative acceptance to the contractor. (In other words, the prime contractor's EOC will always be the last EOC to be completed. The performance of all subcontractors reflects on the prime contractor's overall rating, so it is only proper that the prime contractor's overall rating, so it is only proper that the prime's EOC not be completed until the project is entirely complete.)

The Contractor Evaluation is to be completed on every contractor and subcontractor - - except "trucking" subcontracts. (Trucking subcontractors may receive an optional evaluation at the PM's discretion.) SiteManager identifies whether or not a subcontract is

@ for trucking. An evaluation should also be completed on all bridge painting jobs regardless of size.

Contractor evaluations are required for subcontractors at **any** level - - 2nd tier subcontract, for example.

Project Managers shall prepare and sign the evaluation and forward the original to the Construction Office in Lincoln. For projects inspected and managed by consultants, it is appropriate to have the evaluation signed by the local entity's project manager. (The document itself, however, must be prepared on the **RUG** so the results are posted to the database.)

A copy of the complete evaluation must also be furnished to the contractor or subcontractor being rated. Prime contractors deserve to see their ratings as well as those of their subcontractors, so make sure that both get a copy.

All contractor evaluations shall be prepared using the checklist system provided in **RUG**. The use of this system automatically enters the required data into the database.

For evaluations of subcontractors, report type of work done by that subcontractor.

Contractor evaluations are required for subcontractors at **any** level, including 2nd tier subcontractors.

The intent of an evaluation is to report strength and/or weakness of a contractor's project related activities including paperwork, material documentation, attitude, and cooperation. Special attention should be given to contractor ratings of "poor" and "unsatisfactory." Remarks should be included for any individual item(s) that is rated less than fair. Also good remarks should be included when a contractor is given a high rating or deserving recognition.

The Construction Division maintains a file of the completed form, reacts to low evaluations, and seeks to improve contractor project administration. Evaluations are also used as a factor to establish bidder qualifications. Therefore, it is very important that contractors are evaluated realistically, factually, and without bias. The rating system developed is intended to produce a rating of "good" when the minimum acceptable performance requirements are met.

A series of less than satisfactory evaluations may be grounds for disqualifying bidders from further contracts or reducing their bidding qualifications.

It is anticipated that lower than average ratings would have been discussed at a meeting between the Project Manager and contractor representatives prior to form submittal. A contractor should have an opportunity to discuss and understand why a low rating was given. Further, a contractor should be given (if requested) a critique of corrective actions which would prevent reoccurrence of low rating(s).

The RDP Form 344, Evaluation of Contractor, is available on the computer or you can use paper copies.

To provide a broader evaluation of the contractor's performance of his/her work with reference to his/her equipment, personnel and prosecution of work, RDP Form 344 "Evaluation of Contractor" has been devised. This report is to be completed by the Project Manager for the prime contractor and subcontractor(s) for each separate time allowance under a contract and submitted with the final computations.

The contract value for the prime contractor shall be the original contract value (not final value). The subcontract value used shall be that authorized by the subcontract approval letter. All subcontract approval letters will show the value of the work being subcontracted.

The working days allowed shall reflect all time extensions approved either by letter from the Construction Division during the progress of the work or by supplemental agreements. If a time extension is forthcoming due to "extra work" a correction in the field entry will be made by the Construction Division. However, extra work should be a consideration taken into account in evaluating the prosecution of the work. When this is the case, an explanation to this effect should be made on the reverse side of the form.

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@ **106.13 LETTER OF TRANSMITTAL – FINALIZED PROJECTS**

The Project Manager shall complete a letter of transmittal with project documents when they are forwarded to the District Reviewer. The District Reviewer will also create a letter of transmittal when he/she forwards the records to the Construction Division. The transmittal letter shall include an itemized list of all field notebooks, cross sections, computation sheets, forms, letters, statements, temperature charts, etc., which are being transmitted, so that the shipment can be checked to determine whether it is complete when received. When overhaul or additional haul computations were made in the Lincoln Office, attention should be directed to that fact. If there is any question regarding the accuracy of any of the computations, or there is any item which should be given special attention in the District Office, the items in question should be explained in the letter of transmittal. If the project was completed within the working day time allowance, a working day resume is not required. The transmittal letter should contain a statement indicating whether or not the work was completed within the contract time allowance and/or any internal time limits. A copy of the Project Manager's transmittal letter shall accompany the project records and final estimate when they are forwarded to the Lincoln Office.

When submitting final records, please label all computation and summary sheets with the item numbers for which documentation is being provided.

106.14 FINALING PROCEDURES

See Construction Division's Final Review Process Manual for detailed steps to finalize a project.

106.15 UNAUTHORIZED WORK

The contractor should not be permitted to perform work without line and grades established by the Project Manager.

The contractor should not be permitted to perform any work prior to the execution of the contract by the Construction Engineer. The Project Manager can request to be advised by telephone when the contract has been executed, if the contractor is "standing by" awaiting such execution to begin work.

106.16 USE OF ADJACENT LAND UNDER CONTRACT OR LEASE

We no longer require the contractor to provide a release letter. The contractor is responsible to the landowner and the Department will stay out of the agreement unless the Department acquires the access rights.

Option pits obtained by the Department will require a site release. The Project Manager shall contact the landowner and obtain the site release. The release should be obtained as soon as possible while the contractor is still on site with equipment to make corrections.

106.17 FINAL CLEANING UP

The importance of timely cleanup of cast-in-place concrete structures should be discussed at the pre-construction conference. It is the Department's policy to request the contractors to perform the necessary cleanup in flood plains at the earliest possible time to prevent scrap lumber, nails, form ties, etc., from being flushed out on adjacent landowners.

If this material is deposited on adjacent landowners, the contractor must satisfactorily gather and dispose of it before final acceptance of the work involved. It is in the contractor's and the Department's best interests to keep this cleanup work "current".

The District Engineer should be advised if the contractor refuses to perform this work in accordance with this policy and a field book entry made each time the contractor was contacted. Progress payments can be withheld until the area is cleaned.

The contractor shall make a final cleanup of the highway, borrow pits and all ground (off or on the project) occupied by him/her in connection with the work, leaving it in a neat and presentable condition.

- 6. All contract pay items will be properly documented.
- Safety Areas:
- 1. Maintained Traffic
 - a. Contractor's cars and trucks must adhere to project traffic control procedures.
 - b. Flaggers must be certified and use proper procedures.
 - 2. The contractor should be told to stop all unsafe activities such as:
 - a. Speeding trucks and other equipment.
 - b. Inoperable back-up alarms.
 - c. Inoperable or nonfunctional strobe lights.
 - 3. Contractor vehicles shall be parked beyond the lateral obstacle clearance.
 - 4. Worker protection barriers should be placed as shown in the plans.
 - 5. Traffic markings should clearly indicate traffic flow.
- NDR Tests:
- 1. Nuclear Density NDR T 238
 - 2. NDR T 99 Soil Density (See Earthwork)
 - 3. Soil Type NDR T 87
 - 4. NDR T 2 Sampling Aggregate from Stockpiles
 - 5. Moisture: NDR T 217, T 205, or Nuclear Density Gauge AASHTO T 238/ASTM D 2922.
- Sampling Requirement/
Freq.:
- 1. See Materials Sampling Guide
- Inspector's Records &
Forms
- 1. Grading diary
 - 2. Water application notebook
 - 3. Field book
 - 4. DR Form 8, Water Applied Haul Sheet
 - 5. DR Form 86, Weekly Report of Moisture-Density Tests or Nuclear Density Machine Output
- NDR Point of Contact
- 1. Materials & Tests Soil Mechanics Engineer
479-4678

202.00 GENERAL GRADING INSTRUCTIONS

Grading Inspection

A grading inspector should devote the majority of his/her time to observing and checking the contractor's excavating, drying, moistening, spreading and compacting operations, and securing samples, vary the balance of his/her time in testing samples and making neat and accurate records. The grade inspector will need to check moisture (if control is required) and density at the rate shown in the Materials Sampling Guide (usually check moisture and density once for each 2,500 cubic yards (2000 m³) placed and once for each 1000 feet (300 m) of shoulder or subgrade).

Blue Tops

After the roadway excavation and roadway embankment has been constructed substantially to grade elevations, the construction survey party will set finish grade stakes for finishing the grade or subgrade to the lines and grades shown in the plans. The blue top book elevations must be checked to insure they conform to the information shown on the plan cross-sections.

Rounding of Hinge Points

The Department has determined that the rounding of "hinge points" in the cross-sectional elements can significantly reduce their potential as hazards. Rounded slopes reduce the chances of an errant vehicle becoming airborne, reduce the hazards of encroachment, and afford drivers more control over their vehicles.

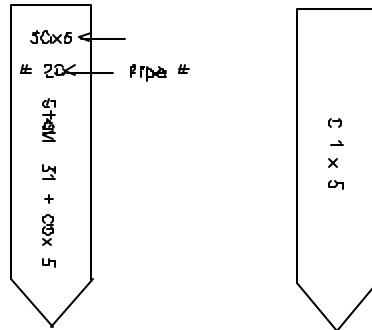
The Construction Division suggests that finish grading and ground preparation activities that result in the rounding of hinge points be permitted, if not encouraged. For example, an 8' disc that "hangs over" a 6' shoulder will provide the desired effect and should not be ruled unacceptable. However, this suggestion is not meant to imply that the cuts and embankments may be built to other than the cross-sections shown in the plans.

Erosion Control

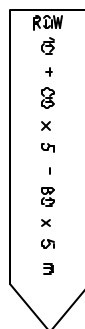
The contractor must have as a minimum silt fence or other erosion control measures as shown in the plans installed to keep silt on our ROW before any grading is allowed.

CULVERT STAKES

Offset



ROW STAKES



Green-yellow flag for easements

Orange flag ROW

203.00 CLEARING AND GRUBBING (SSHC Section 202)

203.01 CONSTRUCTION METHODS

There may be considerable elapsed time between an estimate of clearing and grubbing and the actual work. If actual site conditions are different than those shown in the contract documents, the following suggested resolutions are provided:

- @ • If the pay item is "General Clearing and Grubbing" then no action is necessary because tree removal is subsidiary **for trees with circumference of 80 inches or less at 40 inches above ground level.**
- If the pay item is "Large Tree Removal" then a new tree count should be taken and recorded before the contractor starts work.
- @ • If **a** tree has been cut, leaving branches and the stump, payment is covered under "Clearing and Grubbing" or "Large Tree Removal." If the stumps is the only item remaining and payment method is large tree removal, you would count just the stump as a tree.
- If a fence is partially removed or in poor condition but requires an identifiable removal operation, full price for fence removal may be made.
- @ • Where brush and/or junk has recently (**After the letting was** announced) been deposited within the right-of-way, a price agreeable to both the contractor and the Project Manager may be negotiated or a force account extra work order may be used.

Disposal of Waste

Disposal of the clearing and grubbing waste is restricted according to applicable federal, state, and local laws. Disposal options include:

- Open Burning
- @ • Contractor must obtain necessary permits. In locations where burning is allowed, the burning of the waste must be located at least **1/4 mile (400 m)** from any inhabited building.
- Chipping
Chipping of the down timber for mulching material.
- Firewood
Salvage of the logs for firewood.
- Landfill

Disposal at a "yard waste" landfill.

204.00 REMOVAL OF STRUCTURES AND OBSTRUCTIONS

204.01 CONSTRUCTION METHODS

Removal and Disposal of Old Pavement

@ Pavement is removed from all cuts and fills with less than **3 feet (1 m)** of cover. The removed concrete is to be broken into pieces with an area of **2 square feet (0.2 m²)** or less if placed in fills. (*SSHC Section 203*)

@ Where existing PCC pavement would be located more than **3 feet (1 m)** under the proposed profile grade, the PCC pavement will be required to be broken into surface areas that will not exceed **4 square feet (0.4 m²)** when left in place. If the existing pavement has been resurfaced, the asphalt resurfacing will be removed if the PCC pavement is to be used as slope protection or in a waterway. (*SSHC Subsection 205.03*)

Disposal of Asphaltic Concrete Pavement

The contractor shall manage the material in accordance with all current federal and state rules and regulations. (*SSHC Subsection 107.01*)

@ Salvaged asphaltic cement concrete pavement may be used as special backfill material. When intended for special backfill material, the ACC pavement is normally removed by scarification. Removed bituminous materials may be placed in the outer slopes of embankments, **12 inches (300 mm)** below the finished shoulders and foreslopes. (See *SSHC Subsection 205.03*)

Hazardous Material (Wells, Asbestos Fibers in ACC, Building Removal, Underground Storage Tanks, Archeological Remains)

Appropriate federal, state and local regulations must be followed. (See *Construction Manual Division 1100* for further guidance).

205.00 EXCAVATION (SSHC Section 205)

205.01 DESCRIPTION

The importance of being able to identify soil types cannot be overemphasized. Some soil types have to be placed in the proper location. The inspector must be sure that the work is performed according to the plans.

The balance factor is the change in quantity from cut to fill and includes subsidence, change from borrow density to the final compacted density, incidental loss, and all other factors changing density.

205.02 MATERIAL REQUIREMENTS

Embankment and Excavation Soils Criteria (SSHC Section 206)

There are four basic categories of earthwork.

- Excavation
 - ◆ Usually final cross sections determine pay quantity.
 - ◆ No off-site borrow is required.
- Excavation (Established Quantity)
 - ◆ Payment is based on the plan quantities.
 - ◆ No off-site borrow is required.
- Excavation Borrow
 - ◆ Usually final cross sections determine pay quantities.
 - ◆ Borrow will be needed from off-site source(s).
- Earthwork-Measured-in-Embankment (SSHC Subsections 205.04/205.05)
 - ◆ Plan quantities of the proposed embankment are used to determine the payment quantity.
 - ◆ Contractor must forecast shrinkage. (A change from borrow density to compacted density.)
 - ◆ Borrow from off-site sources.

"Excavation" and "Excavation Borrow" are paid based on final cross sections. The Project Manager may forego the final cross sections when the contractor agrees, **in writing**, that the plan quantities, **including field adjustments and revisions**, accurately reflect the work done. **Payment will be made under the original contract items. It is not necessary to eliminate the original contract item and establish a new "E. Q." item. Refer to Page 129.**

- Within 15 m (50 feet) of traveled way on interstate highways
- On foreslopes
- On outside of sharp horizontal curves

Other storage locations may be approved by Project Manager when it is not practical to satisfy the above criteria.

@ Storage behind guardrail must provide for partial collapse of rail upon impact. For beam guardrail this is normally a minimum of **12 feet (3.6 m)** on bull noses and a minimum of **5 feet (1.4 m)** on parallel sections of rail. A minimum of 3.6 m (12 feet) should be allowed behind cable guardrail.

404.08 CONSTRUCTION WORK ZONE SIGNING DURING WINTER SHUTDOWN

Responsibilities of the District Construction Engineer (DCE), District Maintenance Superintendent, and the contractor for highway projects not fully completed by winter shutdown are reviewed below.

Unless contract documents identify signing responsibilities different than stated herein, the following guidelines will apply. Unusual circumstances will be handled on a project specific basis with approval of the Construction Division.

Uncompleted Projects

This category of projects includes contracts having some carry-over work into the next year or intended by plan to be multi-year contracts.

- Prior to winter shutdown, the DCE, PM and Maintenance should field review the project to identify access, signing, and safety features needed to be completed before the contractor suspends work. The DCE and Maintenance will decide which items are contractors responsibilities and what is best accomplished by NDR Maintenance forces. Cost of traffic control devices furnished by NDR Maintenance can be charged against the project.
- During the winter shutdown period, traffic operation services become the responsibility of the NDR Maintenance. This includes routine surveillance and sign maintenance.
- Snow removal for through traffic and local accesses, if needed, is the responsibility of Maintenance.

Multi-Contract Projects

Some projects are phased so a series of contracts are awarded over several years. The most common examples are separate grading and paving projects. Unless contract documents identify responsibility for traffic signing between completion of one project and start of the next project, the Project Manager should evaluate and resolve each specific situation.

Special Concerns

When temporary traffic signals are involved, the contractor shall arrange for emergency maintenance services. No payment will be made to contractor.

On urban projects, DCE will need to coordinate with the city to determine who is responsible for access, signing, and safety features.

404.09 **FLAGGERS & PILOT CARS** (*SSHC Section 422*)

The Department, in conjunction with the AGC, has made the Flagger Certificate quiz, the Flagger Training video, and a Flagger Training audio cassette available in Spanish.

The availability of this material in Spanish in no way is meant to void the specification that requires that flaggers read and speak English clearly. However, in recent years the number of Hispanic workers on our construction projects has increased. The intent is to provide better education to those whose native language is Spanish, realizing that while they may be able to speak English clearly they may have difficulty learning and taking a test in English. You could relate it to learning metrics. While we know and talk metric, few of us really think in metric.

The flagger on a construction project is the first line player in communicating with the driving public. It is imperative that the flagger be able to speak English clearly with the drivers in a work zone. The contractor is responsible for insuring that anyone performing flagging can meet these requirements.

Flaggers may wear the company's hard hat no matter what color it is.

Flagger Bid Item

@ If the contractor's flagging crew works four hours or less, then ½ flagger day is charged. If the crew works more than four hours, then one flagger day is charged.

Slow/Slow Paddles

@ The Flagger Handbook indicates that when a flagger is used near the lane-line to warn public traffic of workers and equipment close to the open lane, then these flaggers are only allowed to use a "slow/slow" paddle. This paddle shall be **24 inches (0.6 m)** diamond shaped with the word "slow" in black letters on orange background on both sign faces. The standard stop/slow paddle shall never be used on a multi-lane highway, since through traffic should never be forced to stop on these roadways.

Permanent & Temporary Pavement Marking

Pavement moisture can be measured by placing and holding a two square foot piece of clear plastic on the existing pavement for a period of 15 to 20 minutes. Remove and hold the plastic in a vertical position. If water drips from the underside of the plastic sheet, the pavement has excess moisture.

404.17 INERTIAL BARRIER SYSTEMS

There seems to be some misunderstanding among the contractors about the proper installation of the Type I object marker on the inertial barrier systems. The object marker @ must be placed directly on the front of the first 440 lb (200 kg) module, either by adhesive or rivet, etc. The marker is not to be placed on a separate post in front of the module. The presence of a post in front of the system could effect the crash characteristics of the inertial barrier system.

404.18 BARRICADES/PLASTIC DRUMS

Due to increased usage of plastic drums and Type II barricades on resurfacing projects, and the considerable amount of time involved in testing one of every five devices, we are making the following changes in the minimum tests required:

- When less than 50 are furnished, test one of every five furnished, or a minimum of two each, whichever is greater.
- When 50 or more of any one device are furnished, test one of every ten furnished of that device.

@ **405.00 SIGNS**

405.01 DEDUCTION FOR SIGNS

Use DR Form 502 "Construction Signs and Posts" to document signs supplied and returned by the contractor.

@ Itemize those signs not returned or damaged by the contractor in the Sign Deduction Computation Letter to the Construction Division, Finals Section. The itemized list, as prescribed in the Finaling Manual should show the number of signs, sign number, message, sign size, cost per sign and total deduction. The list should also indicate which signs were damaged and which were not returned.

The Project Manager shall determine if the value of damaged or missing signs are to be deducted from the Contractor's payments. Assessment for broken, damaged or unreturned signing materials is to be made for losses or damages which is due to the contractor's actions. The contractor will be assessed the total value of a sign and a salvage value will no longer be allowed for damaged signs.

The Project Manager will compute the assessment and enter it on a project estimate.

405.02 SIGN MAINTENANCE

When a permanent sign has been destroyed or damaged due to the actions of the public, either by accident or by vandalism, the work of repairing or replacing the sign shall be considered to be part of the item, "Maintenance of Permanent Signs". The Department will furnish a new sign and post, if required, at the permanent maintenance headquarters from which the signs were originally obtained.

The Project Manager must have documentation of the following:

1. Performance Graded Binder
2. Aggregates
3. Asphaltic mix taken behind the paving machine but in front of the rolling operation.
4. Asphalt in-place density.

Performance graded binder suppliers are grouped into two categories (levels).

1. Level-1 suppliers are certified suppliers who have submitted documentation to the Department and as part of the certification process, the Department has inspected the supplier's plant.
2. Level-2 suppliers are approved suppliers that are not certified.

The difference between being level-1 and 2 is that level-1 suppliers are only verified every other day while level-2 suppliers must be verified each day. This verification is between the lab and the supplier and the PM is not involved.

Hot-In-Place asphalt work may require support from the lab. Make sure you notify the lab at least 2-3 days in advance so they can plan to be on-site when the work begins.

Density of the in-place mix can be tested with the nuclear density gauge or by taking cores and measuring the density of the cores. Do not use the contractor's random sampling tables. Use the Department's tables and keep location secret.

@

unable to be made promptly after they occur, the inspector shall require the finishing machine to be stopped until workers catch up with making corrections.

When constructing handworked areas such as driveway returns and bridge approach tapers, edge alignment may become irregular during rolling because small, high, and low spots in handworked surface tend to extend in width unevenly. Edge alignment of handworked areas can be made true by first rolling the surface with a steel roller, then immediately trimming the edge with hand tools while the mixture is still hot and workable.

502.40.3 LONGITUDINAL JOINTS

To obtain adequate compaction at longitudinal joints, the contractor shall place sufficient thickness of mix to compensate for 20 to 25 percent reduction in thickness that normally occurs from rolling. If thickness is insufficient prior to rolling, joint will usually be smooth in appearance but lack density because of inadequate compaction. **Make sure density is checked along the joints.**

The vertical face of exposed, longitudinal joints must be tacked before the adjacent lane is placed. This treatment is very important to insure a seal at the joint. No tack coat shall be sprayed on the surface of lane being matched. Shields on distributor spray bar will help protect adjacent lanes (*SSHC Subsection 503.04*).

@ If overlap is maintained at approximately **1 inch (25 mm)** and thickness of joint is correct, brooming or raking may not be necessary to obtain a good joint. However, occasional corrections with hand tools may be necessary. When hand work is completed, excess material should be wasted as opposed to scattered on lane being constructed.

@

502.40.5 DENSITY CONTROLS FOR ASPHALTIC CONCRETE CONSTRUCTION (SSHC Subsection 503.06)

Specifications for asphaltic construction require each layer to be compacted to a density not less than a given percentage of the Rice voidless density.

Density of pavement is determined from cores cut by the contractor or by nuclear density gauges, normally on the working day following construction. The method of mix density determinations will be determined by the contractor, and any disputes will be resolved with cores.

@ One hot box sample per subplot [750 tons (680 Mg)] will be obtained from the roadway surface by the contractor and transported to the field lab for testing. The lab will determine the voidless density. The location of the sample shall be a secret and it must be random.

An average of the voidless densities for a day's production will be used to determine the degree of field density.

@ Five samples shall be cut from each 3750 tons (3400 Mg) or use Nuclear Density Gauge to determine density.

@ The 1,000 ton test strip (and smaller test strips in earlier contracts) is independent of the tonnage listed in the random sampling schedule provided to the PM. The random sampling schedule becomes active following the placement of the 1,000th ton of an approved test strip.

The Specifications also describe a procedure for field density evaluation together with a schedule for payment adjustments when noncompliance occurs. Project inspection personnel shall observe the following:

- @ The contractor is required to take a prescribed number of samples at locations selected and marked out by the project inspector. The project inspector will witness the core sampling. A circle approximately **16 inches (400 mm)** in diameter is adequate for identification of sampling location. The core should be taken from within the area identified. It is not appropriate for the contractor to use a nuclear device to "hunt" for a particular spot to sample; coring locations are no longer random when a nuclear device is used in this fashion.
- @ Sample locations are identified in the random sampling schedule which will be provided by Materials & Research. Keep the location a secret. A core will not be taken less than **12 inches (300 mm)** from the edge of a given pass of the finishing machine. Procedure for identifying random locations should provide for the potential to obtain a core sample at any distance **12 inches (300 mm)** or greater from the edge.
- If the layer being sampled adheres to a lower layer, it may be necessary to sample through two or more layers or full depth. The contractor will need to remove the extra depth by sawing the sample with a masonry saw. It may be necessary to cool the sample by refrigeration or ice to prevent damage during sawing. It is important that core drill bits be kept sharp.
- Each sample shall be inspected carefully by the contractor and inspector prior to testing. Be sure each core sample is representative of the density of the mixture placed and not damaged. If damage is noticeable, discard without testing and take another to replace it.
- If tests indicate that density is less than the specified percentage, the sample shall be retested to insure accuracy. The contractor can request another random sample be taken. (See *SSHC Subsection 1024.02.*)
- Tests on density samples give lower results if samples are damaged during handling. Contractors and project inspectors are advised to use extreme care when taking, transporting, and preparing cores for testing.
- Samples should be transported on hard flat surfaces to avoid loss of density by distortion. If necessary, samples should be stored in a cool place and on a hard flat surface.
- Specifications also require the contractor to take density samples as promptly as practical as prescribed by NDR T 168. Samples should be taken no later than the working day following placement. If the contractor is unable to comply with this timing, the project inspector shall stop construction until the contractor is able to do so.
- NDR personnel shall be responsible for performing density tests as prescribed by NDR T 166 using the contractor provided samples.

- Any failures should be reported to the Project Manager and to the contractor on the day tests are performed.
- When rerolling is performed, insure the area that is rerolled is the complete area of low density, not just the area of the sample.

Asphalt Compaction

@

Many Superpave mixes exhibit what is called a “Tender Zone” during compaction. You will have to confirm the contractor has determined the “Tender Zone” for the mix. Normally the “Tender Zone” is between 230° and 160°F. **When the asphalt is between 230° and 160°F stop compaction rolling.** Do the finish rolling below 160°F and make sure heavy and intense compaction rolling is done above 230°F.

Procedures for Construction of Test Strips (*SSHC Subsection 503.04*)

SSHC Subsection 503.04 requires the contractor to construct a control (test) strip for all mixture types except S.P.S. Test strips are used to evaluate properties of asphalt mixture and identify an effective roller pattern.

Proper construction and documentation of the test strip is the responsibility of the contractor and shall be provided by the contractor to the NDR inspector.

Document the procedure that was followed to construct the test strip.

Resolving Density - Void Conflicts

The project inspector should be aware that the field laboratory and compacted voids are to be tightly controlled. This may require more compactive effort for compliance. Become familiar with other controls by reading the *Materials Sampling Guide* and asking questions of Materials & Research personnel.

For the case where specified density is met, but field laboratory voids are outside designated limits for two moving average points, the production will cease. The Project Manager may allow production to start following agreement on corrective action to be taken. The contractor will select the combination of rollers to be used and preliminary rolling pattern. Nuclear gauge readings would normally be taken after each pass or series of passes.

The inspector shall only observe and document this process. Documentation of type and amount of compactive effort shall be recorded. Inspector will then select and mark out five random core sites within the test site. Density cores taken by contractor will be tested and results reported as soon as possible.

Cooperation between the project inspector, Materials & Research, and the contractor is essential to reach a timely solution. If all anticipated results are not met, further experimenting with a different combination of rollers and operation should be performed. Changes in gradation may be one of the first items looked at by Materials & Research. Changes in performance graded binder content would be one of the last items. Relief from minimum laboratory voids specified may only be approved by Materials & Research.

502.40.6 LAYING WIDTHS FOR ASPHALT

Plans for asphalt projects will show the overall dimensions of finished pavement.

- @ When spreading layers of asphalt **1½ inches to 2 inches (38 to 50 mm)** in thickness, a typical **24 foot (7.2 m)** pavement may broaden **2 to 4 inches (50 to 100 mm)** in width during rolling. Therefore, laydown width before rolling might require **3 inches (75 mm)** less than final design width. An intended lap of **1 inch (25 mm)** at the longitudinal joint is best for proper joint construction but seldom seen these days because the contractor has to have someone “set up” the inch overlap. Use of a cutoff shoe when matching a longitudinal joint is not acceptable.

When using finishing machines that spread the pavement full width, the inspectors shall insure that contractors adjust the spreading width so the final dimensions conform to the dimensions specified in the project documents.

- @ The finishing machine screed extensions are usually available in **6 inches (150 mm)** increments. Where standard screed extensions are utilized to increase the paver width by more than **12 inches (300 mm)**, the paver auger must also be extended. Many new pavers are equipped with automatic screed extensions which can be adjusted to conform to the required width for most resurfacing situations. Some paver models have automatic auger extensions as well.

502.40.6a POLICY FOR PLACEMENT OF TEMPLATE CORRECTION ON OVERLAY PROJECTS

- @ **Effective immediately**, the following shall be Department of Roads policy for placement of asphaltic concrete template correction quantities. **This policy shall be applicable to all new and existing contracts.**

- (1) When constructed under traffic maintained conditions and the **design thickness is greater than 2 inches (50 mm)** for the asphaltic concrete type and nominal aggregate size to be used on the surface layer, the asphaltic concrete shall be placed in **more than one layer. The proposed compacted placement thickness of the top layer shall not exceed 2 inches (50 mm).** Asphaltic concrete provided for template correction shall be placed with the lower layer or with the leveling course, if shown in the plans.
- (2) When constructed under traffic maintained conditions and the plans indicate that template correction is provided with a **designed** asphaltic concrete **thickness of 2 inches (50 mm) or less**, the total asphaltic concrete thickness, including template correction, shall be placed as a **single layer.**

@

502.40.7 PLACEMENT RATES FOR HOT MIX ASPHALT BASES, BINDER, AND SURFACE COURSES

The inspector shall check contract quantities for accuracy.

In general, placement rates for hot mix asphalt shall be determined using the contract asphalt mass. The estimated unit mass from design standards used to calculate contract quantities will provide sufficient material for construction of design thickness for most mixtures used.

If the contract quantity is not sufficient to construct the required thickness, notify the Construction Division.

For lower layers on resurfacing projects, automatic controls should not be adjusted repeatedly based on megagram yields taken at short intervals. Automatic controls should be allowed to correct for irregularities in underlying base without frequent adjustments. Accordingly, the placement rate for individual truckloads will sometimes vary substantially from contract rate because of irregularities in old base. However, over longer distances, **1650 feet (500 m)** or more, taking both sides of the pavement into account, inspectors should select a general spread rate that compares as closely as possible with contract quantities.

For paved shoulders or other construction where dimensions are controlled by specified elevations, existing structures, or other unusual requirements, spread rates shall be adjusted as necessary.

@

502.40.8 COLD WEATHER ASPHALT CONSTRUCTION (*SSHC Section 501*)

SSHC Subsection 501.01 contains limitations for placement of asphalt and liquid bitumen under cold weather conditions. These restrictions apply to pavement surface temperature and time of year, and vary according to whether layer is surface course, lower binder, or base course, and nominal lift thickness.

Cold weather construction problems may show up in the form of increased roughness on profilograph, mat raveling, low density, high voids, segregation, slippage, or failure of tack coat to break. The Project Manager and inspector should be aware of other weather related conditions which may further limit placement.

After September 15, it is appropriate to require tarping and insulation of truck bodies, especially if hauls exceed 3 miles (5 km) (*SSHC Subsection 503.04*). However, if the contractor can demonstrate that the asphalt temperature is not adversely affected by hauling, the tarp and insulation requirements should be waived.

Base temperature is the single greatest factor in the rate of cool down for freshly placed asphalt mat. Consequently, base temperature has direct affect on recommended minimum laydown temperature and rolling time available to obtain specified density.

Wind velocity, air temperature, and cloud cover are additional factors that affect the cooling rate of hot mix asphalt.

For fall work, a cutback asphalt may be used at the Project Manager's option. Cold surface temperatures cause emulsions to lose tackiness and increase breakage time resulting in higher risk of mat slippage.

502.40.9 RUMBLE STRIPS IN ASPHALT SHOULDERS

(The paragraph below moved from Page 247)

Rumble strips will be milled into shoulder on future projects. Department will no longer accept rolled-in rumble strips.

@ **507.00 TACK COATS USING EMULSIONS**

For Dilution

SS-1, SS-1H, CSS-1, and CSS-1H grades are specified. Dilution of emulsion is required if nonuniform tack applications are experienced. Dilute at 1:1 ratio, i.e., 1 gallon emulsion to 1 gallon water.

Application Rate for Diluted Emulsion

For diluted material, double the rates of undiluted material application. Example: 0.03 to .06 gal/yd² (0.14 to 0.28 L/m²) undiluted increased to .064 gal/yd² to .12 gal/yd² (.28 to .56 L/m²) dilute emulsion.

Sample for Compliance

Sample emulsion at spray bar of distributor with bar valve in a circulating position, prior to dilution.

Measurement for Pay

Net liters of diluted emulsion.

Keep in mind, diluted emulsion as supplied normally contains 60% asphalt residue, therefore, a 1:1 field diluted emulsion will contain the minimum of 30% residue (*SSHC Subsection 504.03*).

Settlement of Diluted Emulsions

Varying residue rates of diluted emulsion may be related to blending of original emulsion or settlement while in storage. To minimize this problem, the following steps are recommended:

- Contractor emulsion delivered to storage should be gently circulated prior to pumping into distributor truck.
- If contractor obtains emulsion directly from terminal, the emulsion should be gently circulated prior to use each day.

Material in a storage tank can be circulated with a large diameter, slow turning propeller, or by pumping from top to bottom. Only a small amount of agitation is necessary.

Forced air should not be used for agitation since it may cause the emulsion to break.

@

602.00 PORTLAND CEMENT CONCRETE (PCC) PAVEMENT (SSHHC Section 603)

602.10 DESCRIPTION

Concrete pavement is a surface course composed of portland cement concrete. It may be constructed on a prepared subgrade, a stabilized fill or a granular foundation course.

The production of high quality concrete pavement requires a very close control of all phases of the work. The Project Manager and inspectors assigned to concrete pavement projects should become thoroughly familiar with the construction details outlined in *SSHHC Subsection 105.13, Division 600*, and the material details given in *Sections 1002 to 1027*.

The essentials to observe in this type of pavement construction are:

1. Accurate proportioning of aggregate and cement.
2. Absolute control of the water and admixture content of the mix.
3. Prevention of segregation in the concrete.
4. Adequate amount and proper spacing of finishing equipment to handle the production of the mixer or mixers.
5. Properly trained equipment operators and finishers.
6. Proper curing.
- 7. Timely sawing of joints.**

602.20 PCC PAVEMENT MATERIAL REQUIREMENTS

602.201 Composition of Concrete (SSHC Section 1002)

The plans or special provisions may offer the contractor a choice of various classes of concrete. *SSHC Section 1002* lists the classes of concrete used in Nebraska road construction. If a choice is allowed, the contractor is required to advise the Project Manager of the class of concrete to be used. This notification must be given prior to construction. The Materials and Research Division should be consulted in regard to problems of concrete composition. Table 1002.02 shows authorized mix proportions for the classes of concrete.

Material Inspection - The production of a high quality concrete requires careful control over concrete materials at the batch plant. The inspector must be prompt and accurate to insure quality concrete.

SSHC Sections 601, 602, and 603 contains requirements for concrete pavement construction. The Project Manager and inspectors must familiarize themselves with these requirements and insist that materials be tested and approved before being incorporated in the work. The frequency of sampling, testing or submitting of material samples to the Central Laboratory and the procedures to be followed are covered by the *Materials & Research Materials Sampling Guide*.

Field Testing Laboratory - *SSHC Subsection 105.03* requires the contractor to furnish a field laboratory building meeting certain specific requirements for the type required in the contract. The project manager should document compliance for the laboratory's condition in the Field Book and notify contractor of any problems.

Admixtures - *SSHC Section 1002* states that "only admixtures authorized by the contract documents will be permitted for use in portland cement concrete". Since the various materials constituting admixtures can have a profound effect on the characteristics of the hardened concrete, extreme caution is justified. (See *SSHC Section 1007* for more information on admixtures.)

602.202 Concrete Strength

Currently, four test cylinders are to be fabricated for each placement (generally four cylinders are required for each lot of concrete). These test cylinders are then tested at ages of 7, 10, 14, and 28 days.

@ If the 7-day cylinder tests **3500 psi (25 MPa)** or above, the 10 and 14-day cylinders need not be tested and can be discarded. If the 7-day cylinder should test less than **3500 psi (25 Mpa)**, the 10 and 14-day cylinders must be retained and the above policy applied to the 10-day cylinder. In any case, the 28-day cylinder must be retained and tested.

@ **A 5th cylinder is required if the contractor wants an early break.**

203 Concrete Sampling Locations

Concrete samples shall be collected from at least three different portions of a batch after it is discharged, whether mixed on site or central mixed. Sample location point shall be after plastic concrete has been placed on the grade, either by direct depositing from a batch truck or by use of a placer/spreader and slipform paver machines. Care should be taken to avoid sampling concrete that has been vibrated manually or mechanically. Samples should be taken at locations within the batch that appear to be representative.

Should a voided surface occur during finishing and finishers experience difficulty in closing an open pavement surface, fresh mix or mortar should be obtained from in front of paving train and added to surface to facilitate finishing and produce a tight, closed pavement surface.

602.5022 Tining (SSHC Subsection 603.03)

The plans indicate those pavements that shall receive tining.

Tining impressions are made in plastic concrete while grooves are made once concrete has hardened.

@ The Department has changed tining requirements. Mainline pavement will now be longitudinally tined instead of transversely tined. Transverse tining shall be done with a rake, not a bull float. Ramps and other irregular areas that cannot be properly tined longitudinally shall be transverse tined.

@ The primary goal is to tine longitudinally to reduce noise levels.

@ Proper timing is critical. Longitudinal or transverse tining of the surface too early may result in grooves filling up with mortar or surface tearing. Tining too late results in a reduced groove depth.

To obtain a uniform transversely grooved pavement inspector should check the following items:

- Texture machine operating properly and all control devices functioning correctly.
- Pad line maintained in smooth and stable condition.
- @ • Tining rake carrier rails set to pavement crown, so uniform down pressure on tines maintained as comb sweeps down or across the slab.
- Four springs attached to carrier frame and to broom channel with a tension adjusting chain are identical and adjusted to obtain proper groove depth.
- Tines of comb parallel. A bent tine, which narrows spacing at tips, undercuts adjoining groove.
- No build up of dry mortar near tips of tines. A build up of mortar widens groove at surface and may cause tearing or displacement of larger aggregate particles.
- Steel tines not worn and comb in good condition, to ensure sufficient groove depth.

@ Should an unsatisfactory tined surface result for any reason, stop the paving operation and do not allow resumption until the problem is corrected.

Tine Determination

Depth of the grooves may be determined by using a standard commercial tire tread depth gauge, but normally a visual inspection without measurements is adequate.

Guidelines for Tining Concrete Pavement

@

1. Tine mainline pavement longitudinally.
2. Ramps and small irregular areas can be transverse tined with a tining rake.
3. Tine all concrete pavements where posted speed limit will be 40 mph or greater. When a mainline is tined, include tining in intersections, acceleration lanes, deceleration lanes, left-turn lanes and ramps.
4. Do not tine concrete shoulders.
5. On pavement built without curb, stop tining 6 inches (150 mm) from edge of pavement (for edge of pavement painted line.)
6. On pavement built with curb, stop tining 2 feet (600 mm) from back of curb.

602.5023 Pavement Depression

A pavement depression prevents proper drainage of slab during periods of rain and may cause maintenance problems during the winter. This may be due to one or more of the following reasons:

- Screed not set correctly
- Poor workmanship by finishers in manipulating straightedge
- Improper tension between ends of trailing forms
- Improper adjustment of edges attached to trailing forms

@

Check this deficiency by placing a 10 ft (3 m) straightedge or 4 ft (1.2 m) carpenter's level transversely on pavement surface and noting trueness of surface with bottom of straightedge.

602.5024 Pavement Station Stamping

@

Station location of all PCC pavement shall be stamped in plastic concrete at every station (100 ft/100 m) by the NDR inspector.

@

Permanent Station Numbers - Each station number shall be marked permanently in the surface of the concrete slab by the use of metal dies furnished by the department. The numbers should be stamped neatly in the concrete just before it takes its initial set. They should be placed about 6 inches (150 mm) in from the right-hand edge of the slab so that they can be read from the right roadway shoulder.

DIVISION 700

BRIDGES, CULVERTS, AND RELATED CONSTRUCTION

@

DIVISION 700

701.00 CHECKLISTS

701.01 PILES AND PILE DRIVING CHECKLIST

SSHHC References

Section 703 -- *Piles and Pile Driving*
 705 -- *Precast/Prestressed*

Concrete Structural Units

1002 -- *Portland Cement Concrete*
 1004 -- *Portland Cement*
 1025 -- *Steel Wire for Prestressed
 Concrete Units*

Inspection Crew

Project Manager (PM)
 Construction Technician

Equipment

Saximeter

Material Procedures

Check that all piling is acceptable for driving.

Material certifications and/or reports should be given to
 Project Manager and evaluated before use.

Steel Piling

Steel bearing and sheet piling must be stored on
 suitable skids [6 inch (150 mm)] ground clearance
 recommended) and should be kept clean. Don't allow
 weeds and foreign material in storage sites.

Concrete Piling

Piling must be adequately supported when stored and
 handled to prevent excess deflection. The surface
 finish of concrete piling that will be exposed at the
 completion of driving (bent piles in concrete slab
 bridges) shall not be damaged or discolored.

Cast-in-Place Concrete
Piles Procedures

Check shells immediately before placing any
 concrete (shape and accumulation of water). Use a
 drop cord.

Treated Timber

Notify Materials & Research if timber piling appears
 damaged. The Project Manager or inspector must
 obtain approval to reject timber piling.

Piling certification procedures are found in the *Materials
 Sampling Guide*.

Pile Driving Procedures

The contractor should build a frame (sometimes called
 a checkerboard) to hold each pile in the exact position
 for driving.

Before driving any piles, the inspector should perform the following duties:

1. Verify that piles will be driven exactly as shown in the plan pile layout.
2. Check pile spacing, and record heat numbers (steel pile), code identification (concrete pile) and other pertinent information. Document points and splices.
3. Verify cut-off elevations against a permanent reference.

Confirm that the Project Manager, inspector and contractor understand:

1. How to check penetration depth at any point.
2. How to take and record bearing tests data with saximeter.
3. How to determine the cut-off elevation for individual piles.

SSHC Subsection 703.03, Paragraph 2. allows bearing piling to be driven with a gravity hammer for the first half of the penetration when bearing does not exceed one-third of the design bearing.

Concrete sheet piling shall be driven with a preapproved hammer.

Do not allow pilot holes or preliminary jetting to be greater than 10 ft (3 m).

Gravity hammers used to drive piling to final cut-off elevation shall be preapproved. The fall of gravity hammers shall be regulated so as to avoid damage to the piles. Hammer fall shall not exceed 15 ft (5 m) for wood and steel bearing piles, or 8 ft (2.4 m) for precast concrete piles and shells for cast-in-place piles.

Do not allow hammer fall to damage piles.

Leads are required on all driven piles. Leads shall be held in proper alignment.

Swinging leads are permitted with steam, air or diesel hammers.

Bearing and Sheet Piles
Procedures

Guyed, braced, or fixed leads are required with gravity hammers.

1. Frequently check the pile for plumbness or for required batter. Do not allow a variation of more than 1-inch/50 inches (1 mm/50 mm) of pile during driving.
2. Tops shall not be out of line more than 3 inches (75 mm).
3. Adjacent sheets shall be in line within a ½ inch (12 mm) tolerance.
4. The inspector should observe the pile carefully while it is being driven. A sudden increase in the penetration may indicate a broken or collapsed pile.
5. Remove and replace all broken, split, or misplaced piles. If removal is impractical, contact the Construction Division for instructions on the procedure to be followed.
6. Lead with the tongue or ball end of sheet piles to keep the groove or socket clean.
7. The options when a pile is at cut-off elevation, and not at design bearing are:
 - a. If less than 10% of the piles in any group fail to reach bearing, the average pile bearing may be adequate to support the structure.
 - b. Additional piling may be added to the group.
 - c. Extend the piling and drive to obtain design bearing.
 - d. Determine a soil set up factor and then drive to cut-off elevation.
 - e. Use pile-driving analyzer to determine bearing.
 - f. Run a load test to check if bearing capacity is obtained.

Notify the Construction Division when two or three consecutive piling do not attain design bearing.

8. a. Record pile data on the M&R spreadsheet.

b. E-mail a copy of the spreadsheet to M&R (O. Qudus) and to Construction Division (B. Caples).

c. Do not use contractor provided charts for determining bearing.

Soil Setup Factor

1. Two representative piles shall be driven to 2 ft (600 mm) above cut-off elevation (see SSHC 703.07 para 4.f.).
2. The piling at cut-off+2 ft (600 mm), will be rested for 36 hours and then driven to cut-off elevation with a "warm" hammer.
3. The Project Manager will record the penetration for each ten blows of the hammer until cut-off is reached.
4. Record data and call it in to the Construction Division.
5. The factor and a decision on what action to take will be sent back to the Project Manager.
6. Construction Division recommendations shall be recorded under the Remarks Section of the pile driving record.

Bearing Capacity Procedure

1. Determine bearing at or just prior to the pile reaching final penetration.
2. When determining bearing, the inspector shall be certain that all of the following conditions exist:
 - a. For single action, the hammer shall have a free fall.
 - b. The head of the pile shall be free from crushed or broomed fibers.
 - c. The penetration of the pile shall be at a reasonably quick and uniform rate.
 - d. There is not excessive bounce of the hammer. Deduct twice the height of the bounce from "H" pile for gravity or stream hammers. No deduction is made for diesel hammers.

- e. If the driving is stopped for more than 2 hours, the pile shall be driven at least 1 ft (300 mm) before the bearing capacity is determined.
 - f. For batter piles driven with gravity hammers, see *SSHC Subsection 703.03*, Paragraph 4 for bearing determination.
3. The energy values for common diesel hammers presently in use are listed in *SSHC Subsection 703.03*, Paragraph 4. If the contractor intends to use a hammer not listed, the Construction Office should be contacted to obtain the appropriate energy value.
 4. For bearing capacity computations the mass of the driving cap may be taken from the manufacturer's freight bill or measured. The mass of the pile shall be determined as follows:
 - a. Mass per foot (meter) times length at time bearing is determined.
 - b. Volume of pile times 44 lb/ft³ (703 kg/m³).
 - c. Volume times 150 lb/ft³ (2400 kg/m³).
 5. The reference point should be an object with a fixed elevation or horizontal distance from the pile. Mark the point where the reference intersects the pile. After the required number of blows, mark another line at reference intersection and the distance between the two lines is penetration. Average penetrations can be computed from several measurements.
- Steel "H"
- Timber
- Concrete
- Reference Points
- Pile Driving Analyzer Procedures
- Static Pile Load Test Procedures
1. Contact the Construction Division to schedule personnel and equipment.
 1. The Department will furnish the equipment and personnel for conducting the test. The contractor shall unload, erect, dismantle and reload the testing equipment. Payment for this work shall be by the each for each test.
 2. If a temporary anchor pile is required. It will be paid for as extra work.

Method of Measurement
Procedures

1. If required bearing is obtained at minimum penetration and this is shorter than the order length, the contractor should be encouraged to continue driving until the order length has been driven. Usually he/she will want to drive this extra length to avoid payment deduction. Discontinue driving beyond minimum penetration when:
 - a. Practical refusal is reached.
 - b. Further driving may result in damage to the pile.
2. If practical refusal is reached before minimum penetration, discontinue driving and notify the District Construction Engineer or the Construction Division and do not cut off the pile without their approval.
3. No payment will be made for pile length driven beyond the order length without PM approval.
4. When steel "H" pile and steel pile shells are driven to the exact cut-off elevation without crimping or damage to the top of the pile, they need not be cut off. Length of pile cut-off (measured as provided in *SSHC Subsection 703.05*) shall be paid at 60% of the piles unit price.
5. It will be necessary to pay for pile cut-off only under the following conditions:
 - a. When practical refusal is reached before minimum penetration and the pile cannot be driven or jetted further.
 - b. The contractor elects to stop driving after reaching bearing and minimum penetration but before the order length is driven.

6. MASS FOR PRESTRESSED CONCRETE BEARING PILE

For computing bearing capacity required on M&R Pile Bearing spreadsheet.

Pile Type	Constant Section	
	Mass Per Meter of Pile (Kilogram) (lb)	
I	220	(485)
II	298	(657)
IV	315	(694)

(See Appendix 1. DR97-Pile Driving Record)

Critical Construction Areas

1. Proper placement and length.
2. Permanent reference point.
3. Removal of broken/collapsed piles.
4. Achieving design bearing capacity.

NDR Tests

1. Test pile.
2. Bearing capacity.
3. Pile Driving Analyzer.

Inspector's Records and Forms

1. Pile Record M&R spreadsheet
2. Hammer Data Sheet

701.02

CONCRETE CONSTRUCTION CHECKLIST

SSHC References: Section 704 Concrete Construction
Section 1002 Portland Cement Concrete
Section 1010 White Opaque Polyethylene Film and
Burlap--Polyethylene Sheeting For Curing
Concrete
Section 1011 Burlap For Curing Concrete
Section 1014 Joint Sealing Filler
Section 1015 Preformed Joint Filler
Section 1016 Preformed Polychloroprene
Elastomeric Joint Seals
Section 1033 Aggregates

Inspection Crew: Lead Inspector
Inspection Equipment: Slump Cone
Air Meter (pressure)
Cylinder Molds and Lids
Rod
Mallet
Strike Off Bar
Ruler

- Placement Procedures:
1. Preplacement check of equipment.
 2. Check condition and placement of steel.
 3. Check Form setting and alignment. Verify location coordinates and orientation.
 4. Have contractor wet grade and forms before concrete placement.
 5. Test concrete for air content, slump, and make cylinders when mix changes, as a minimum according to Sampling Guide.
 6. Watch concrete placement for compliance with specifications. Do not allow free fall greater than 5 ft (1.5 m).
 7. Do not use water as a finishing aid; use an approved chemical finishing aid/evaporation retardant.
 8. Check curing operation.

- Construction Critical Area:
1. Take pictures of any pavement under bridge before work begins.
 2. Achievement of concrete consolidation without segregation.
 3. The time between loads of concrete.
 4. Trucks that segregate concrete or have cement balls must not be used.

- NDR Tests:
1. NDR T 23 Making and Curing concrete test specimens.
 2. NDR T 119 Slump of Portland Cement Concrete.
 3. NDR T 141 Sampling of Fresh Concrete.
 4. NDR T 152 Air Content of Freshly Mixed Concrete by the Pressure Method.

701.03 CONCRETE BRIDGE FLOORS CHECKLIST

SSHC References:

Section 706 Concrete Bridge Floors
Section 1002 Portland Cement Concrete
Section 1010 White Opaque Polyethylene Film and
Burlap--Polyethylene Sheeting For
Curing Concrete
Section 1011 Burlap For Curing Concrete
Section 1014 Joint Sealing Filler
Section 1015 Preformed Joint Filler
Section 1016 Preformed Polychloroprene
Elastomeric Joint Seals
Section 1033 Aggregates

Inspection Crew:

Project Manager
Placement Inspector
Plant Inspector

Inspection Equipment:

Slump Cone
Air Meter (pressure)
Cylinder Molds and Lids
Rod
Mallet
Strike Off Bar
Ruler
10 ft (3 m) straightedge
Anemometer
Thermometer
Hygrometer

Placement Procedures:

1. Preplacement check of equipment.
2. Check condition and placement of steel. Enter in SiteManager the date steel was verified.
3. Check Form setting and alignment.
4. Check slab thickness.
5. Check deck for cleanliness
6. Have contractor wet deck forms and grade under approach slabs before concrete placement.

(Note: It's best to place deck and approach slabs at the same time.)

7. Test concrete for air content and make cylinders when mix changes, as a minimum according to Sampling Guide.
8. Watch concrete placement for compliance with specifications.
9. Do not use water as a finishing aid; use an approved chemical finishing aid/evaporation retardant.
10. Check surface with straightedge. Remove depressions and irregularities.
11. Check tining operation.
12. Check cure operation.
13. Make sure a water service and tanks are available to soak burlap.

Construction Critical
Area:

1. Take pictures of any pavement under the deck before work begins.
2. Maintain a uniform roll, of about 4 inches (100 mm), of concrete ahead of the front screed and a minimum of a 2 inch (50 mm) roll ahead of the rear screed.
3. The time between loads of concrete.
4. Trucks that segregate concrete or have cement balls must not be used.
5. Avoiding placement when temperatures and wind velocities may cause plastic shrinkage cracking. (*SSHC Table 706.01*)
6. Vibrate concrete uniformly. Establish good pattern and adjust as necessary.
7. The timing of cure application.

Safety Areas:

NDR Tests:

1. NDR T 23 Making and Curing concrete test specimens.
2. NDR T 119 Slump of Portland Cement Concrete.
3. NDR T 141 Sampling of Fresh Concrete.
4. NDR T 152 Air Content of Freshly Mixed Concrete by the Pressure Method.

701.04 STEEL STRUCTURES CHECKLIST

SSHHC References:	See SSHC Table 708.01
Other References:	AWS Standard Specifications. (ANSI/AASHTO/AWS D1.5 Bridge Welding Code)
Inspection Crew:	Fabrication Inspector Project Manager (PM) Lab Inspector
Inspection Equipment:	Skidmore-Wilhem Calibrator
Shop Procedures:	<ol style="list-style-type: none">1. Check Fabricators QC Plan.2. Make sure QC Plan is followed.3. The mill order list or the Certified Mill Test Reports must be furnished before fabrication begins.4. Document all actions not in compliance with the QC Plan or Standard AWS procedures.5. Welding symbols are shown in Section 708.
Field Construction Procedures:	<ol style="list-style-type: none">1. Confirm steel was inspected on site and in shop. Enter date in SiteManager.2. Sample bolts and send to M&R.3. Heavy hexhead bolts require heavy hexhead nuts and a hardened washer under the element that is turned.4. Check all bolts, washers, and nuts to make sure there is proper and correct marking on each. (See CM Subsection 704.03)5. M&R personnel will calibrate the contractor's wrenches but they need at least 7-days advance notice.6. Before the contractor begins steel erection, the Project Manager will make a final check of span lengths, skew angles, and bearing point elevations.7. Also, take pictures of pavement under any structure where equipment will be lifting members.8. Lead sheets [? inch (3 mm) thick] shall be placed between steel and concrete at all bearing points.9. Rockers, rollers, expansion devices, etc., shall be set according to the temperature at time of installation. (See Plans.)10. Check matchmarks on all girders, separators, angle braces, etc.11. Verify that drift pins do not enlarge holes or distort the metal.12. Stop the contractor from hammering if it appears the metal will be damaged or injured.13. The Construction Division will be notified of all major misfits and determine what procedures will be allowed.

701.05 CONCRETE BRIDGE DECK REPAIR WITH SILICA FUME CONCRETE

SSHC References:

Section 710 -- Concrete Bridge Deck With Silica Fume Concrete
Section 1002 -- Portland Cement Concrete
Section 1010 -- White Opaque Polyethylene Film and White Burlap—Polyethylene Sheeting For Curing Concrete
Section 1011 -- Burlap For Curing Concrete
Section 1014 -- Joint Sealing Filler
Section 1015 -- Preformed Joint Filler
Section 1016 -- Preformed Polychloroprene Elastomeric Joint Seals
Section 1033 -- Aggregates

Inspection Crew:

Placement Inspector
Plant Inspector

Inspection Equipment:

Slump Cone
Air Meter (pressure)
Cylinder Molds and Lids
Rod
Mallet
Strike Off Bar
Ruler
10 ft (3 m) straightedge
Anemometer
Thermometer
Hygrometer

Placement Procedures:

1. Preplacement check of equipment.
2. Check condition and placement of steel.
3. Check Form setting and alignment.
4. Check slab thickness.
5. Check deck for cleanliness.
6. Have contractor wet deck and forms before concrete placement.
7. Test concrete for air content and make cylinders when mix changes, as a minimum according to Sampling Guide.
8. Watch concrete placement for compliance with specifications.
9. Do not use water as a finishing aid; use an approved chemical finishing aid/evaporation retardant.
10. Check surface with straightedge. Remove depressions and irregularities.
11. Check tining for conformance to specification.
12. Check cure operation.

Construction Critical
Area:

1. Check finish machine (template & rails).
2. Check repair areas.
3. Deck shall be uniformly wet, without puddles prior to placement.
4. Bonding grout shall not be allowed to dry out.
5. Maintain a uniform roll, of about 4 inches (100 mm), of concrete ahead of the front screed and a minimum of a 2 inch (50 mm) roll ahead of the rear screed.
6. The time between loads of concrete.
7. Trucks that segregate concrete or have cement balls must not be used.
8. Avoiding placement when temperatures and wind velocities may cause plastic shrinkage cracking (see SSHC Figure 710.01).
9. Fogging system should be operating from time concrete is finished until wet burlap is in place.
10. Check tining operation.
11. The timing of wet burlap application.

Safety Areas:

NDR Tests:

1. NDR T 23 Making and Curing concrete test specimens.
2. NDR T 119 Slump of Portland Cement Concrete.
3. NDR T 141 Sampling of Fresh Concrete.
4. NDR T 152 Air Content of Freshly Mixed Concrete by the Pressure Method.

702.00 EXCAVATION FOR STRUCTURES (SSHHC Section 702)

702.01 DESCRIPTION

- A. All excavation should be done as shown in the plans. Excavation is very dangerous work and appropriate OSHA regulations must always be observed (see SSHC Figure 701.01).
- B. Inspector should be present when an area is being backfilled. The inspector should check to see that the backfill materials are as specified. The materials shall be placed as prescribed in the *SSHHC Subsection 205.03 or 702.03* as appropriate.
- C. Structure excavation includes all excavation, removal of obstruction, bailing, draining, pumping, sheathing, construction and removal of cofferdams, backfilling, compacting and disposal of any excess material necessary to construct the structure in question.

702.02 MATERIAL REQUIREMENTS

- A. Unsuitable Material Excavation (*SSHHC Subsection 702.05*)
 - 1. When unstable material is encountered it shall be removed and backfilled with approved material. The material shall be measured in cubic yds (meters) before it is placed. Payment for the extra work material and all work involved will be made at 10% of the contact unit price for box culvert concrete (when gravel or rock is used). The inspector should make an inspection of all structure footings as they are being excavated by the contractor.
 - 2. Pier footings should not be constructed on unsuitable material. It is true that if the footing is supported by piles, the rock placed at the bottom of the footing serves a limited structural purpose. We should provide for a solid base to hold the concrete in the forms. However, the contractor is not entitled to a rock surface on which to work at the Department's expense.

702.03 CONSTRUCTION METHODS

- A. Culvert Excavation (*SSHHC Subsection 702.03*)
 - 1. All culverts should be constructed with a minimum of approximately 12 inches (300 mm) of cover exclusive of surfacing. An accepted method for obtaining specified bedding for these culverts is to require the contractor to furnish a template conforming to the dimensions of the culvert pipe. This template is then used for shaping the trench to the specified depth.
 - 2. The inspector must be knowledgeable of the Occupational Safety and Health Act (OSHA) requirements concerning excavation and trenching. Pipe culvert excavation by OSHA definition would normally be considered a trench.
 - 3. Never allow any part of a pipe culvert to rest on rock or other unyielding materials. When rock is encountered in the bottom of the trench, it shall be removed to a depth of at least 6 inches (150 mm) below the subgrade and back filled with suitable earth or sand.

4. The Specifications provide that where unstable subgrades are encountered under pipes or pipe-arch culverts, the unsuitable material shall be removed and the excavated area refilled with gravel, crushed rock, or other suitable material. When crushed rock is used, care should be taken to place the fine rock immediately beneath all metal pipe to prevent abrasion of the spelter coating. When gravel or crushed rock is used in place of unsuitable material, it will be measured in cubic meters before it is placed. Payment for furnishing, hauling and placing this material will be made at 10% of the contract unit price for concrete for box culverts. When box culverts are not included in the contract, the average unit price for box culvert concrete shall be used. (*SSHC Subsection 702.05*)

B. General Structure Backfilling (*SSHC Subsection 702.03*)

1. This operation may involve *SSHC Sections 205, 702, and Table 702.01*. The inspector should insure that all applicable sections are followed. The compaction of backfill material close to structures must given special attention. Mechanical tampers should be operated carefully in such a manner as to obtain the required density without damaging the structure.
2. Before any material is placed, the area to be backfilled should be inspected for trash or perishable matter. The materials to be used for backfill should be given careful consideration. Only those that will produce a dense, well-compacted backfill should be used. Granular materials are desirable as much less effort is needed to compact them than clay.
3. When abutments are tied to an anchor or deadman by means of tie rods, care should be taken in the back filling operation. The backfill should be placed in layers, starting at the anchor or deadman and working toward the abutment. Hand tamping may be required around the tie rods, abutment and anchors.
4. Backfilling must not be started without the permission of the Project Manager and in the case of concrete structures not until test cylinders show a minimum strength of at least 80% of the design strength.
5. Backfill should be brought up evenly to the elevation shown in the plans. Granular material must be placed in not more than 8 inches (200 mm) layers (lifts) and should have sufficient moisture to facilitate compaction. Do not allow dumping of granular material directly from the truck into the excavation if this will result in lifts/layers greater than 8 inches.
6. Special attention should be given to culvert wingwalls and flumes to insure proper compaction to prevent erosion and possible washout. The soil should be brought up even with these walls so the surface water will flow over these walls and not along them. Heavy equipment should be kept 3 feet (1 m) or more away from these wingwalls. Compaction within 3 ft (1 m) of the wingwall shall be with pneumatic hand tampers or small hand operated vibratory plate compactors.
7. Backfill for Bridges - Moisture and density requirements for backfill which is to provide support for subsequent construction will be shown in the plans. Backfill which is not to support later construction shall be compacted to 95% of maximum density without definite moisture limits.

8. Backfill for Culverts - When backfilling pipe culverts, the lifts shall be deposited and compacted alternately on opposite sides of the pipe to avoid lateral displacement. The inspector should also watch for vertical displacement. This may occur when tamping adjacent to the lowest 90 degrees of the pipe and should be checked from the grade stakes as backfilling progresses. The pipe should be tied down if any uplift is noted.
 9. Necessary precautions should be taken against washing under the pipe in case of rain. Compacted dikes or temporary earth headwalls at the inlet end will often save removing and relaying the pipe after a heavy rain. All drainage structures in the process of construction should be carefully inspected for washouts at the sides and beneath the structures after rains.
 10. Flowable fill is sometimes included in the plans for backfilling culverts. The plans will identify the locations and show the details for using the flowable fill. *SSHC Section 1003* defines Flowable Fill requirements.
- C. Concrete Seal Course (*SSHC Subsection 702.03*)
1. When it is impossible to dewater the foundation bed or box culvert footing or if live springs develop within the area, a seal course should be constructed below the elevation of the bottom of the footing. Concrete for seals constructed underwater shall contain 10% excess cement and be placed in accordance with *SSHC Subsection 704.03*. The concrete shall be allowed to harden a minimum of 72 hours after completing the final pour before dewatering and continuing work on the structure. Seepage through inadequate or poorly constructed cofferdams shall not be justification for placing a seal course.
- D. Foundations
1. Staking and Checking Locations of Structures - -Check and Double Check
 - a. All measurements and skew angles must be independently checked. From past practice, "independently checked" meant having a second survey party come in, setup, and completely resurvey (verify) original staking. This method is still the most desirable; however, with our upgrading to total station equipment it is acceptable to either setup off to the side and recheck or "back into" the bridge starting up station after clearing the total station.
 - b. Stakes used should be substantial and protected from disturbance. Offset stakes for each pier and abutment must be placed outside the area of contemplated work.
 - c. Any checks suggested by the contractor should be considered, since the site superintendent usually has a good idea of the structure layout in relation to existing features such as trees, old structures, etc. Each stake must be clearly marked to denote its function. Pier numbers must correspond with plan designations.

2. Documentation
 - a. A staking diagram for each structure must be recorded in a permanent survey field book. This sketch must show the exact location of each hub and the markings made on each guard stake. **IT IS NOT COMPLETE UNLESS IT SHOWS THE MEASUREMENTS MADE AS CHECKS ON THE ACCURACY OF THE STAKING LAYOUT.** Names of those in the staking party should be entered as well as the date, design and project numbers, location, type of structure, and any other pertinent information.

- E. Common Survey Errors to Avoid
 1. Turning the wrong skew angle.
 2. Errors in measuring from piers to abutments (This should be detected by an overall check from abutment to abutment.)
 3. The centerline of the bridge is not always on centerline of the road (This is quite common on interstate bridges.) A bridge with a sidewalk may not be centered on its pier(s).

- F. Encountering Old Substructures (*SSHC Subsection 104.06*)
 1. *SSHC Section 203* describes the removal requirements when structures interfere with the new work. Existing substructures are usually shown on the plans. If the designer intended to miss some of these old substructures and the contractor later encounters them, payment will be made to the contractor by change order to remove that portion in conflict. Payment will "NOT" be made if plans indicate the new substructure would hit the old structure. See *SSHC Subsection 104.06* for a list of approved unforeseen obstructions.

- G. Bridge Deck Removal
 1. Contractors generally can be expected to be able to remove the deck without damaging the girders. However, the contractor must use some caution. The contractor cannot use the same force directly over a girder as would be applied over the "free/open" space between girders.
 2. Sometimes a contractor will start the removal work properly with heavy blows only in the "free" space. However, either from impatience, changes to the equipment operator or for some other reason, we have seen the contractor at some point begin to apply too much force directly over the girders. This is very bad because the girders are damaged.
 3. Forewarn the contractor and monitor their operation to make sure girders are not damaged. This is covered in the contract but is still important to monitor in the field.

703.00 PILING AND PILE DRIVING (SSHC Section 703)

A. The Department's Geotechnical Section in the Materials and Research Division provides guidance and geotechnical designs for our projects. Some county bridge projects are completely designed by consultants including pile foundations. When a consultant design fails, i.e., bearing cannot be achieved, the consultant that designed the bridge should be the first point of contact to determine how to correct a failed design.

703.01 EQUIPMENT

A. Diesel Hammers

1. Generally, single acting diesel hammers are the mainstay of contractors for pile driving. Occasionally however, a contractor will request the use of an "air" or "hydraulic" operated hammer. In addition there are a few "double acting" hammers in use. A wave equation analysis will be required for approval of these hammers.
2. One manufacturer of hammers uses one size hammer barrel and places different sized rams inside. Therefore, the MKT "DE" series hammers need to be field verified for ram mass (weight). A check is accomplished by having the contractor stand the hammer upright (in the driving position) and measuring down from top of the barrel to top of the ram. Verify the ram mass (weight) shown on the Hammer Data sheet as follows:

Ram Mass (kg)	Ram Distance (meter)	Ram Mass (tons)	Ram Distance (ft)
907	1.9	1	6.25
1270	1.2	1.4	4.0
1497	0.7	1.65	2.3
1814	180 mm	2.0	0.6

B. Bearing and Penetration

1. Penetration Requirements
 - a. Design pile length is a calculated value based on design bearing and soil conditions. One factor which enters into the calculation is the potential for scour. Obviously, any soil which is eroded during a flood event represents a loss in bearing capacity and foundation stability. **For this reason "minimum penetration" is extremely important.**
 - b. A depth of expected scour is typically shown on the Bridge Geology sheet in the plans. In general, streams with large drainage areas and sand or gravel stream beds are quite susceptible to scour while streams with small drainage areas and heavy clay stream beds are less susceptible to scour.
 - c. When doubt exists concerning the amount of probable scour or minimum pile penetration required, the Construction Division should be consulted. If greater penetration is required, it will be achieved either by boring holes to receive the piles or by jetting. If penetration achieved is satisfactory, piles will be cut off.

C. Dynamic Pile Analyzer

1. The Materials & Research Division has a pile analyzer available for driving evaluations. The pile analyzer will evaluate the bearing, based on energy delivered to a pile as it is being driven.
2. There are two situations where the analyzer should be used:
 - Case 1. Contract documents require pile to be driven with the analyzer.
 - Case 2. Pile do not achieve bearing and there are unresolvable questions or conditions observed during driving.

703.02 CONSTRUCTION METHODS

A. Pile Driving Constraints

1. Piles shall not be driven within 50 ft (15 m) of freshly placed concrete. Normally piles may not be driven near new concrete until three days after the concrete was placed.

B. Splicing Pile--Welding Steel Pile

1. *SSHC Section 708* requires that all welds conform to the Structural Welding Code ANSI/AASHTO/AWS D1.5 of the American Welding Society.
2. Only Shielded Metal Arc Welding (SMAW) will be permitted for welding steel piles.
3. The welding electrode must be on the NDR Approved Products List.

C. Steel Pile Cutoffs

1. If the contractor feels the cutoff is long enough that they may use it on some future project, the Heat number should be placed on the cutoff and a number to indicate the project it came from.

D. Pile Groups/Categories

1. Selecting the type of pile to be used and estimating its necessary length are fairly difficult tasks that require good judgment.
2. Piles can be divided into two major groups, depending on their length and the mechanisms of load transfer to the soil:
 - a. Point Bearing Piles
 - (1) If bedrock is within a reasonable depth, then piles can be extended to the rock and achieve the ultimate bearing capacity.
 - b. Friction Piles

(1) The ultimate bearing capacity is achieved through the skin friction. The length of friction piles depends on the shear strength of the soil, the applied load and pile size. In clayey soils, the resistance to applied load is caused by adhesion.

(2) Piles are also divided into two different categories depending on their interaction with the soil:

c. Displacement Pile:

(1) The effect of displacement pile on the soil is, it increases the lateral ground stress. It displaces cohesion-less soils, remolds and weakens cohesive soils temporarily. If displacement piles are used for cohesive soil, setup time in sensitive clays may be up to six months.

(2) Typical types of displacement piles are closed end steel pipe pile and concrete pile.

d. Non-displacement Pile:

(1) Opposite of the displacement pile, it minimizes disturbance to the soil.

(2) Typical types of non-displacement piles are open-end steel pile and steel H pile. It should be mentioned open steel pipe is not suited for friction piles in coarse granular soils.

(3) It has low driving resistance and this makes field capacity verification difficult, which result in excessive pile length.

Weights of Prestressed Concrete Bearing Piling

For computing bearing capacity required on M&R Pile Record spreadsheet

Pile Type	Constant Section	Tapered Section
	Wt. per Lin. Ft. (Pounds)	Total Weight (Pounds)
I	148	None
II	200	None
III	173	None
IV	212	None
V	124	1740
VI	169	2500
VII	221	2950

This table is based on and is for use only with Standard Plan 1720-C-R2.

Steel Pipe Pile Data

	ARMCO		Union Metal
Size O.D. (ins)	12	12¾	12 (Nominal)
Wall T. (ins.)	.188	.188	7 Ga.
Wt. per Lin. Ft. (lbs.)	23.72	25.16	25.3
Conc. per Lin. Ft. (C.Y.)	.0273	.0309	.0255

Union Metal 30' tapered Sec. Type F Total Wt. 589 Lbs. Conc. 0.55 Cu. Yd.

Size O.D. (ins)	14	14 (Nominal)
Wall T. (ins.)	.188	7 Ga.
Wt. per Lin. Ft. (lbs.)	27.66	29.5
Conc. per Lin. Ft. (C.Y.)	.0375	.0350

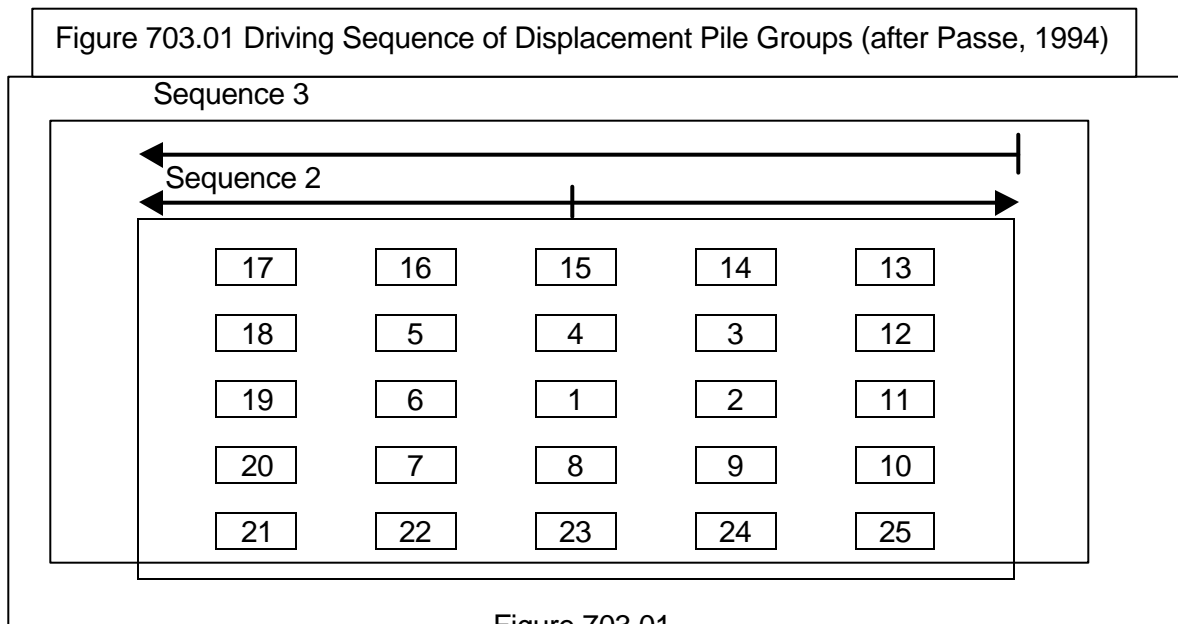
Union Metal 40' tapered Sec. Type F Total Wt. 895 Lbs. Conc. 0.95 Cu. Yd.

For Raymond step tapered pile, contact Geotechnical Section, Materials & Research.

Driving Sequence of Piles

The driving sequence of piles in a pier or bent can be important. The driving sequence can affect the way piles drive as well as the influence the new construction has on adjacent structures. This is especially true for displacement piles. For non-displacement piles, the driving sequence is generally not as critical.

The driving sequence of displacement pile groups should be from the center of the group outward or from one side to the other side. The preferred driving sequence of the displacement pile group shown in Figure 24.16 would be (a) by the pile number shown, (sequence 1), (b) by driving each row starting in the center and working outward (sequence 2), or (c) by driving each row starting on one side of the group and working to the other side (sequence 3).



The following guidelines for Single Acting Diesel Hammer are provided to assist you. If there is a need for a different type of hammer inspection guideline, please contact the Geotechnical Section.

It is very important to field check the hammer systems provided by the contractor to the hammer data sheets after they are approved by the Geotechnical Section. Prior to pile driving, please verify cap weight and size and condition of the hammer cushion material as shown on the hammer data sheets.

E. Inspection of Piles Prior to and During Installation

1. The inspection will be different for each type of pile. Shop plans are required for sheet piles, but usually are not required for H-piles, concrete-piles or pipe-piles.
2. When MSE walls are being constructed, at times the soil conditions may require additional considerations. A note is sometimes included on our plans that states the MSE Wall Must Be Built Before Piles Are Driven. This note is usually applicable when the embankment behind the MSE wall is constructed as a fill. The note also usually specifies that the MSE wall cannot be constructed until the embankment has reached 95+% of its anticipated settlement. The concern here is that the granular backfill material will settle further and the embankment is also able to settle some additional amount due to the granular backfill load. The combined effect on the piling is to cause a downward load on the piling that will reduce the piling's capacity to resist the live and dead loads from the roadway.
3. Battered piles are driven at 1 ft. offset per 12 ft. of length or 3.33 ft. offset in 40 ft.

F. Precast Concrete Piles

1. The following is a list of items for prestressed concrete piles to be inspected at the construction site:
 - a. The piles should be of the specified length and section. The inspector must be assured that a minimum concrete strength has been obtained. If the piles are to be spliced on the site, the splices should meet the specified requirements (type, alignment, etc.).
 - b. Piles should be inspected for cracks or spalling. There should be no evidence that any pile has been damaged during shipping to the site, or during unloading of piles at the site. Lifting hooks are generally cast into the piling at pick-up points. Piles should be unloaded by properly sized and tensioned slings attached to each lifting hook.
 - c. The piles should be stored properly. When piles are being placed in storage, they should be stored above ground on adequate blocking in a manner which keeps them straight and prevents undue bending stresses.
 - d. The contractor should lift the piles into the leads properly and safely. Cables looped around the pile are satisfactory for lifting. Chain slings should never be permitted. Cables should be of sufficient strength and be in good condition. Frayed cables are unacceptable and should be replaced. For shorter piles, a

single pick-up point may be acceptable. The pick-up point locations should be as specified by the casting yard. For longer piles, two or more pick-up points at designated locations may be required.

- e. The pile should be free to twist and move laterally in the helmet.
 - f. Piles should have no noticeable cracks when placed in leads or during installation. Spalling of the concrete at the top or near splices should not be evident.
 - g. Steel H-Piles
1. The following should be inspected at the construction site:
 - a. The piles being driven must be oriented with flanges in the correct direction as shown on the plans. Because the lateral resistance to bending of H-piles is considerably more in the direction perpendicular to flanges, the correct orientation of H-piles is very important.
 - b. The piles should be of the specified steel grade, length, or section/weight.
 - c. Pile points, if required for pile toe protection, should be as specified.
 - d. Splices should be either proprietary splices or full penetration groove welds as specified. The top and bottom pile sections should be in good alignment before splicing.
 - e. Pile point attachments and splices must be welded properly.
 - f. There should be no observable pile damage, including deformations at the pile head.

G. Steel Pipe Piles

1. The following should be inspected at the construction site:
 - a. The piles should be of specified steel grade, length, or minimum section/weight (wall thickness) and either seamless or spiral welded as specified.
 - b. Piles should be driven either open-ended or closed-ended. Closed-ended pipe piles should have bottom closure plates or conical points of the correct size (diameter and thickness) and be welded on properly, as specified. Open-end pipe piles should have cutting shoes that are welded on properly.
 - c. The top and bottom pile sections should be in good alignment before splicing. Splices or full penetration groove welds should be installed as specified.
 - d. There should be no observable pile damage, including deformations at the pile head. After installation, closed-end pipes should be visually inspected for damage or water prior to filling with concrete.

H. Steel Sheet Piles

1. The sheet piles must meet thickness, section models, steel grade, length and width requirements as shown in our plans.
2. Sheet pile length should be measured so that analysis of obstructions to driving can be properly accomplished.
3. Sheet piles should be driven plumb or at the angle shown in the plans.

I. Inspection of Driving Equipment

A typical driving system consists of crane, leads, hammer, hammer cushion, helmet, and in the case of concrete piles, a pile cushion. Each component of the drive system has a specific function and plays an important role in the pile installation. The project plans and specifications may specify or restrict certain items of driving equipment. The Geotechnical Section will approve the contractor's driving equipment and determine conformity with the plans and specifications. The inspector must be sure the equipment used is what was approved.

1. The following checklist will be useful in the inspection of driving equipment before driving:
 - a. The pile driving hammer should be the specified type/size.
 - (1) The inspector should make sure for single acting air/steam or hydraulic hammers that the contractor uses the proper size external power source and that, for adjustable stroke hammers, the stroke necessary for the required energy be obtained. For double acting or differential air/steam or hydraulic hammers, the contractor must again obtain the proper size external power source and the operating pressure and volume must meet the hammer manufacturer's specification.
 - b. The hammer cushion being used should be checked to confirm it is of the approved material type, size and thickness.
 - (1) The main function of the hammer cushion is to protect the hammer itself from fatigue and high frequency accelerations which would result from steel to steel impact with the helmet and/or pile. The hammer cushion should have the proper material and same shape/area to snugly fit inside the helmet (drive cap). If the cushion diameter is too small, the cushion will break or badly deform during hammer blows and become ineffective. The hammer cushion must not be excessively deformed or compressed. Some air/steam hammers rely upon a certain total thickness (of cushion plus striker plate) for proper valve timing. Hammers with incorrect hammer cushion thickness may not operate, or will have improper kinetic energy at impact. Since it is difficult to inspect this item once the driving operation begins, it should be checked before the contractor starts pile driving on a project as well as periodically during production driving on larger projects.

- c. The helmet (drive cap) should properly fit the pile.
 - (1) The purpose of the helmet is to hold the pile head in alignment and transfer the impact concentrically from the hammer to the pile. The helmet also houses the hammer cushion, and must accommodate the pile cushion thickness for concrete piles. The helmet should fit loosely to avoid transmission of torsion or bending forces, but not so loosely as to prevent the proper alignment of hammer and pile. Helmets should ideally be of roughly similar size to the pile diameter. Although generally discouraged, spacers may be used to adapt an oversize helmet, provided the pile will still be held concentrically with the hammer. A properly fitting helmet is important for all pile types, but is particularly critical for precast concrete piles. A poorly fitting helmet often results in pile head damage. Check and record the helmet weight for conformance to wave equation analysis or for future wave equation analysis. Larger weights will reduce the energy transfer to the pile.
- d. The pile cushion should be of correct type material and thickness for concrete piles.
 - (1) The purpose of the pile cushion is to reduce high compression stresses, to evenly distribute the applied forces to protect the concrete pile head from damage, and to reduce the tension stresses in easy driving. Pile cushions for concrete piles should have the required thickness determined from a wave equation analysis but not less than 4 inches (100 mm). A new plywood, hardwood, or composite wood pile cushion, which is not water soaked, should be used for every pile. The cushion material should be checked periodically for damage and replaced before excessive compression (more than half the original thickness), burning or charring occurs. Wood cushions may take only about 1,000 to 2,000 blows before they deteriorate. During hard driving, more than one cushion may be necessary for a single pile. Longer piles or piles driven with larger hammers may require thicker pile cushions.
- e. Predrilling, jetting or spudding equipment, if specified or permitted, should be available for use and meet the requirements. The depth of predrilling, jetting or spudding should be very carefully controlled so that it does not exceed the allowable limits, usually 10 feet (1 m). Predrilling, jetting, or spudding below the allowed depths will generally result in a reduced pile capacity, and the pile acceptance may become questionable.
- f. A lead system must be used.
 - (1) The leads perform the very important function of holding the hammer and pile in good alignment with each other. Poor alignment reduces energy transfer as some energy is then imparted into horizontal motion. Poor alignment also generally results in higher bending stresses and higher local contact stresses which can cause pile damage. This is particularly important at end of driving when driving resistance is highest and driving stresses are generally increased.

J. Inspection of Driving Equipment During Installation

1. The main purpose of inspection is to assure that piles are installed so that they meet the driving criteria and the pile remains undamaged. The driving criteria is often defined as a minimum driving resistance as measured by the blow count in blows per inch. The driving criteria is to assure that piles have the desired capacity. However, the driving resistance is also dependent upon the performance of the pile driving hammer. The driving resistance will generally be lower when the hammer imparts higher energy and force to the pile, and the driving resistance will be higher if the hammer imparts lower energy and force to the pile. High driving resistances can be due either to soil resistance or to a poorly performing hammer. Thus, for the inspector to assure that the minimum driving criteria has been met and, therefore, the capacity is adequate, the inspector must evaluate if the hammer is performing properly.
2. Each hammer has its own operating characteristics; the inspector should not blindly assume that the hammer on the project is in good working condition. In fact, two different types of hammers with identical energy rating will not drive the same pile in the same soil with the same driving resistance. In fact, two supposedly identical hammers (same make and model) may not have similar driving capability due to several factors including differing friction losses, valve timing, air supply hose type-length-condition, fuel type and intake amount, and other maintenance status items. The inspector should become familiar with the proper operation of the hammer(s) used on site. The inspector may wish to contact the hammer manufacturer or supplier who generally will welcome the opportunity to supply further information.

K. Single Acting Diesel Hammers

1. Determine/confirm that the hammer is the correct make and model. Check for and record any identifying labels as to hammer make, model and serial number.
2. Make sure all exhaust ports are open with all plugs removed.
3. Inspect the recoil dampener for condition and thickness. If excessively worn or improper thickness (consult manufacturer) it should be replaced. If the recoil dampener is too thin, the stroke will be reduced. If it is too thick, or if cylinder does not rest on dampener between blows, the ram could blow out the hammer top and become a safety hazard.
4. Check that lubrication of all grease nipples is regularly made. Most manufacturers recommend the impact block be greased every half-hour of operation.
5. As the ram is visible between blows, check the ram for signs of uniform lubrication and ram rotation. Poor lubrication will increase friction and reduce energy to the pile.

6. Determine the hammer stroke, especially at end of driving or beginning of restrrike. A “jump stick” attached to the cylinder is a safety hazard and should not be used. The stroke can be determined by a saximeter which measures the time between blows and then calculates the stroke. The hammer stroke can also be calculated from this formula if the number of blows per minute (bpm) is manually recorded.

$$h \text{ [meters]} = (4400/[\text{bpm}^2]) - 0.90$$

- a. The calculated stroke may require correction for batter or inclined piles. The inspector should always observe the ram rings and visually estimate the stroke using the manufacturer’s chart.
7. As the driving resistance increases, the stroke should also increase. At the end of driving, if the ram fails to achieve the correct stroke (part of the driving criteria from a wave equation analysis), the cause could be lack of fuel. Most hammers have adjustable fuel pumps. Some have distinct fuel settings, others are continuously variable, and some use a pressure pump. Make sure the pump is on the correct fuel setting or pressure necessary to develop the required stroke. The fuel and fuel line should be free of dirt or other contaminants. A clogged or defective fuel injector will also reduce the stroke and should be replaced if needed.
8. Low strokes could be due to poor compression caused by worn or defective piston or anvil rings. Check compression by raising the ram, and with the fuel turned off, allowing the ram to fall. The ram should bounce several times if the piston and anvil rings are satisfactory.
9. Watch for signs of preignition. When a hammer preignites, the fuel burns before impact, requiring extra energy to compress gas and leaving less energy to transfer to the pile. In long sustained periods of driving, or if the wrong fuel with a low flash point is used, the hammer could overheat and preignite. When preignition occurs, less energy is transferred and the driving resistance rises, giving a false indication of high pile capacity. If piles driven with a cold hammer drive deeper or with less hammer blows, or if the driving resistances decrease after short breaks, preignition could be the cause and should be investigated. Dynamic testing is the preferable method to check for preignition.
10. For some diesel hammers, the total thickness of hammer cushion and striker plate must match the hammer manufacturer’s recommendation and the hammer cushion cavity in the helmet for proper fuel injection and hammer operation. This total thickness must be maintained.
11. Make sure the helmet stays properly seated on the pile and that the hammer and pile maintain alignment during operation.
12. The hammer hoist line should always be slack, with the hammer’s weight fully carried by the pile. Excessive tension in the hammer hoist line is a safety hazard and will reduce energy to the pile. Leads should always be used.

13. Some manufacturers void their warranty if the hammer is consistently operated above 100 blows per 250 mm of penetration beyond short periods, such as those required when toe bearing piles are driven to rock. Therefore, in prolonged hard driving situations, it may be more desirable to use a larger hammer or stiffer pile section.

14. Common problems and problem indicators for single acting diesel hammers are presented in the following table.

COMMON PROBLEMS AND PROBLEM INDICATORS FOR SINGLE ACTING DIESEL HAMMERS (from Williams Earth Sciences, 1995)	
Common Problems	Indicators
Water in fuel.	Hollow sound, white smoke.
Fuel lines clogged.	No smoke or little gray smoke.
Fuel pump malfunctioning.	Inconsistent ram strokes, little gray smoke or black smoke.
Fuel injectors malfunctioning.	Inconsistent ram strokes, little gray smoke or black smoke.
Oil low.	Blows per minute rate is lower than specified.
Oil pump malfunctioning.	Blows per minute rate is lower than specified.
Water in combustion chamber.	Hollow sound, white smoke.
Piston rings worn.	Low strokes.
Tripping device broken.	Pawl or pin used to lift piston does not engage piston. Pawl engages but does not lift piston.
Overheating.	Paint and oil on cooling fins start to burn/sound changes.

L. Field Driving Problem

In the following table, there is a list of common field problems and possible solutions.

COMMON PILE INSTALLATION PROBLEMS & POSSIBLE SOLUTIONS	
Problem	Possible Solutions
Piles encountering refusal driving resistance (blow count) above minimum pile penetration requirements.	Have wave equation analysis performed and check the pile has sufficient drivability and that the driving system is matched to the pile. If the pile and driving system are suitably matched, check driving system operation for compliance with manufacturer's guidelines. If no obvious problems are found, dynamic measurements should be made to determine if the problem is driving system or soil behavior related. Driving system problems could include preignition, preadmission, low hammer efficiency, or soft cushion. Soil problems could include greater soil strength than anticipated, temporarily increased soil resistance with later relaxation (required restrike to check), large soil quakes, or high soil damping.
Piles driving significantly deeper than estimated pile penetration depths.	Soil resistance at the time of driving probably is lower than anticipated or driving system performance is better than anticipated. Have wave equation analysis performed to assess ultimate pile capacity based on the blow count at the time of driving. Perform restrike tests after an appropriate waiting period to evaluate soil strength changes with time. If the ultimate capacity based on restrike blow count is still low, check drive system performance and restrike capacity with dynamic measurements. If drive system performance is as assumed and restrike capacity low, the soil conditions are weaker than anticipated. Foundation piles will probably need to be driven deeper than originally estimated or additional piles will be required to support the load. Contact the structural engineer/designer for recommended change.
Abrupt change or decrease in driving resistance (blow count) for bearing piles.	If borings do not indicate weathered profile above bedrock/bearing layer, then pile toe damage is likely. Have wave equation analysis performed and evaluate pile toe stress. If calculated toe stress is high and blow counts are low, a reduced hammer energy (stroke) and higher blow count could be used to achieve capacity with a lower toe stress. If calculated toe stress is high at high blow counts, a different hammer or pile section may be required. For piles that allow internal inspection, reflect light to the pile toe and tape the length inside the pile for indications of toe damage. For piles that cannot be internally inspected, dynamic measurements could be made to evaluate problem or pile extraction could be considered for confirmation of a damage problem.
Driving resistance (blow count) significantly lower than expected during driving.	Review soil borings. If soil borings do not indicate soft layers, pile may be damaged below grade. Have wave equation analysis performed and investigate both tensile stresses along pile and compressive stresses at tie. If calculated stresses are within allowable limits, investigate possibility of obstructions/uneven toe contact on hard layer or other reasons for pile toe damage. If pile was spliced, re-evaluate splice detail and field splicing procedures for possible splice failure.
Vertical (heave) or lateral movement of previously installed piles when driving new piles.	Pile movements likely due to soil displacement from adjacent pile driving. Contact geotechnical engineer for recommended action. Possible solutions include re-driving of installed piles, change in sequence of pile installation, or predrilling of pile locations to reduce ground movements. Lateral pile movements could also result from adjacent slope failure in applicable conditions.

COMMON PILE INSTALLATION PROBLEMS & POSSIBLE SOLUTIONS	
Problem	Possible Solutions
Piles driving out of alignment tolerance.	Piles may be moving out of alignment tolerance due to hammer-pile alignment control or due to soil conditions. If due to poor hammer-pile alignment control, a pile gate, template or fixed lead system may improve the ability to maintain alignment tolerance. Soil conditions such as near surface obstructions (see subsequent section) or steeply sloping bedrock having minimal overburden material (pile point detail is important) may prevent tolerance from being met even with good alignment control. In these cases, survey the as-built condition and contact the Geotechnical engineer for recommended action.
Piles driving out of location tolerance.	Piles may be moving out of location tolerance due to hammer-pile alignment control or due to soil conditions. If due to poor hammer-pile alignment control, a pile gate, template or fixed lead system may improve the ability to maintain location tolerance. Soil conditions such as near surface obstructions (see subsequent section) or steeply sloping bedrock having minimal overburden material (pile point detail is important) may prevent tolerances from being met even with good alignment control. In these cases, survey the as-built condition and contact the Geotechnical engineer for recommended action.
Piles encountering shallow obstructions.	If obstructions are within 3 feet of working grade, obstruction excavation and removal is probably feasible. If obstructions are at deeper depth, are below the water table, or the soil is contaminated, excavation may not be feasible. Spudding or predrilling of pile locations may provide a solution with method selection based on the type of obstructions and soil conditions.
Pile encountering obstructions at depth.	If deep obstructions are encountered that prevent reaching the desired pile penetration depth, contact the structural engineer/designer for remedial design. Ultimate capacity of piles hitting obstructions should be reduced based upon pile damage potential and soil matrix support characteristics. Additional foundation piles may be necessary.
Concrete piles develop partial horizontal cracks in easy driving.	Check hammer-pile alignment since bending may be causing the problem. If the alignment appears to be normal, tension and bending combined may be too high. The possible solution is as above with complete cracks.
Concrete pile spalling or slabbing near pile head.	Have Geotechnical Section determine pile head stress for observed blow count and compare with allowable stresses. If high calculated stress, add pile cushioning. If low calculated stress, investigate pile quality, hammer performance, hammer-pile alignment.
Concrete piles develop complete horizontal cracks in easy driving.	Have Geotechnical Section determine tension stresses along pile for observed blow counts. If high calculated tension stresses, add cushioning or reduce stroke. If low calculated tension stresses, check hammer performance and/or perform measurements.
Concrete piles develop complete horizontal cracks in hard driving.	Have Geotechnical Section determine tension stresses along pile. If high calculated tension stresses, consider heavier ram. If low calculated tension stresses, take measurements and determine quakes which are probably higher than anticipated.
Concrete piles develop partial horizontal cracks in easy driving.	Check hammer-pile alignment since bending may be the problem. If alignment appears to be normal, tension and bending combined may be too high; solution will then be the same as for complete cracks above.
Steel pile head deforms, timber pile top mushrooms.	Check helmet size/shape; check steel strength; check evenness of pile head, banding of timber pile head. If okay, have Geotechnical Section determine pile head stress. If calculated stress is high, reduce hammer energy (stroke) for low blow counts; for high blow counts, different hammer or pile type may be required.
Unexpectedly low blow counts during pile driving.	Investigate soil borings; if soil borings do not indicate soft layers, pile may be damaged below grade. Have Geotechnical Section investigate both tensile stresses along pile and compressive stresses at toe. If calculated stresses are acceptable, investigate possibility of obstructions/uneven toe contact on hard layer or other reasons for pile toe damage.

COMMON PILE INSTALLATION PROBLEMS & POSSIBLE SOLUTIONS	
Problem	Possible Solutions
Higher blow count than expected.	Have the Geotechnical Section review the wave equation analysis and check that all parameters were reasonably considered. Check hammer and driving system. If no obvious defects are found in driving system, field measurements should be taken. Problem could be preignition, preadmission, low hammer efficiency, soft cushion, large quakes, high damping, greater soil strengths, or temporarily increased soil resistance with later relaxation.
Lower blow count than expected.	Probably soil resistance is lower than anticipated. Have the Geotechnical Section assess soil resistance. Perform restrrike testing (soil resistance may have been lot during driving), establish setup factor and drive to lower capacity. Hammer performance may also be better than anticipated, check, by measurement.
Diesel hammer stroke (bounce chamber pressure) higher than calculated.	The field observed stroke exceeds the calculated stroke by more than 10%. Compare calculated and observed blow counts. If observed are higher, soil resistance is probably higher than anticipated. If blow counts are comparable, have the Geotechnical Section reanalyze with higher combustion pressure to match observed stroke and assure that preignition is not a problem, e.g., by measurements.
Diesel hammer stroke (bounce chamber pressure) lower than calculated.	The field observed stroke is less than 90% of the calculated stroke. Check that ram friction is not a problem (ram surface should have well lubricated appearance). Compare calculated and observed blow count. If observed one is lower, soil resistance is probably lower than anticipated. If blow counts are comparable, reanalyze with lower combustion pressure to match observed hammer stroke.
Cannot find hammer in data file.	See if there is a hammer of same type, similar ram weight and energy rating and modify its data.
Cannot find an acceptable hammer to drive pile within driving stress and driving resistance limits.	Both calculated stresses and blow counts are too high. Increase pile impedance or material strength or redesign for lower capacities. Alternatively, check whether soil has potential for setup. If soil is fine grained or known to exhibit setup gains after driving, then end of driving capacity may be chosen lower than required. Capacity should be confirmed by restrrike testing or static load testing.

SINGLE ACTING HAMMER INSPECTION CHECKLIST (For PM Use Only)

Project/Pile: _____

Hammer Name: _____

Date: _____

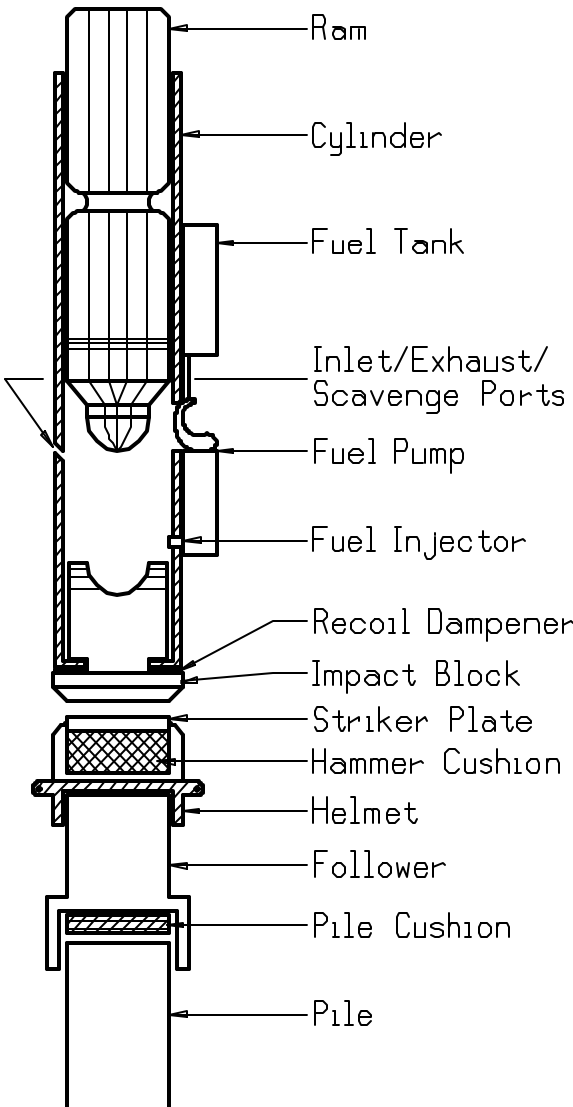
Serial No: _____

Conditions: _____

OBJECT

REQUIREMENTS

OBSERVATIONS



Ram Lubricated?	Yes / No
Exhaust Ports Open?	Yes / No
Fuel Pump	Hammer Setting _____
Recoil Dampener Undamaged?	Yes / No
Impact Block Lubricated?	Yes / No
Striker Plate	t= _____ D= _____
Hammer Cushion	t= _____ D= _____ Material _____
	How long in use? _____
Helmet	Type or Weight? _____
Pile Cushion	Material _____ t= _____ Size _____ How long in use? _____

704.00 BRIDGES (STEEL STRUCTURES) (SSHC Section 708)

704.01 DESCRIPTION

- A. This work includes the furnishing, preparing and erecting of all riveted, bolted or welded structures in which the main members spanning the supports are composed of steel.

704.02 MATERIAL REQUIREMENTS

- A. Members of steel structures that are fabricated in the shop are inspected by NDR personnel before they are shipped to the job site. In some cases, when the fabrication is done outside of the state, the inspection will take place after delivery to the site of work. The Project Manager should have a copy of the shop inspection report and the mill test report before allowing the erection of any portion of the structure. Miscellaneous parts of the superstructure such as high tensile steel bolts will require field inspection and sampling according to the "*Materials Sampling Guide*".
- B. Field welding may require the use of special welding electrodes as designated in the plans, specifications, or special provisions. Some of these welding electrodes may require special care and handling before their use will be permitted. (See *SSHC Section 708*.) Enter date steel is verified in SiteManager. Occasionally wrong size is delivered.
- C. Concrete Industries rebar shipments will be documented to show bending details, heat numbers, quantity and project location by stationing.

704.03 CONSTRUCTION METHODS

- A. Falsework (*SSHC Subsection 704.03*)
1. Girders should be blocked so that the weight of any deck overhang does not bend the girder, which will ripple the deck.
- B. Temporary Fastenings
1. Contractors often request permission to use anchor supports for face forms, concrete curbs, Jersey barriers, raised medians on bridges. Any contractor desiring to use a temporary floor fastening may be allowed to use only some form of weakened section bolt or tie, cast in the floor. The weakened section must be so positioned that when broken off the break will be recessed below the surface. The resulting void must be patched with mortar.
 2. NOTE:
 - a. No bolt without a weakened section may be used.
 - b. No holddown device shot into the floor will be allowed.
 - (1) Concrete arch bridges.
 - (2) Support of girders or other large structural elements when required.

- (3) Unusual or complicated work indicated in the plans.
- (4) Support of girders over or under active railroad tracks.
- (5) Support of girders carrying traffic or extending over highways or streets carrying traffic.

C. Submitting Plans

NOTE: Submission of falsework plans does not imply that OSHA regulations are satisfied, that the NDR, or the Project Manager assumes any liability for the falsework. Inspectors should not give the contractors advice on how to construct the falsework.

D. Bridges-Steel Beam

1. On bridges using weathering steel (A 588) for steel structures, the contractor shall:
 - a. Use "high strength," A325M Type III bolts, A563 Grade DH3 nuts, and F463 Type III washers.
 - b. Limit shop painting to only areas under expansion joints and all bearings. Shop painting will be with a Zinc-rich primer and a colored topcoat. Field touch-up will be required for paint that is damaged and to fasteners in these areas and it will be done with same color and type of paint as the original painting.
 - c. Require special care to assure concrete slobbers are eliminated (or at least removed) from steel surfaces before the concrete hardens. Washing with water is the preferred method of removing concrete slobbers.

E. Structural Joints Using High Tensile Steel

BOLT DIAMETER (INCHES) D	HEAVY HEX STRUCTURAL BOLTS BOLT DIMENSIONS (INCHES)			HEAVY HEX NUTS NUT DIMENSIONS (INCHES)	
	WIDTH ACROSS FLATS F	HEIGHT H	THREAD LENGTH	WIDTH ACROSS FLATS W	HEIGHT H
1/2	7/8	5/8	1	7/8	5/8
3/8	1 1/8	25/64	1 1/4	1 1/8	39/64
3/4	1 3/4	3/4	1 3/4	1 3/4	41/64
5/8	1 7/8	35/64	1 3/2	1 7/8	55/64
1	1 5/8	39/64	1 3/4	1 5/8	59/64
1 1/8	1 7/8	7/8	2	1 7/8	1 1/64
1 1/4	2	15/8	2	2	1 1/2
1 3/8	2 1/8	17/8	2 1/4	2 1/8	1 7/8
1 1/2	2 3/8	9/8	2 1/2	2 3/8	1 7/8

TYPE 2
 TYPE 1
 TYPE 1
 TYPE 5 (NUT)

Manufacturer's Identification Symbol
 Standard Nut Marking
 Manufacturer's Identification Symbol for "F" and "H" dia.
 Nut Marking
 All 3 or 6 mm surface marking should be visible.

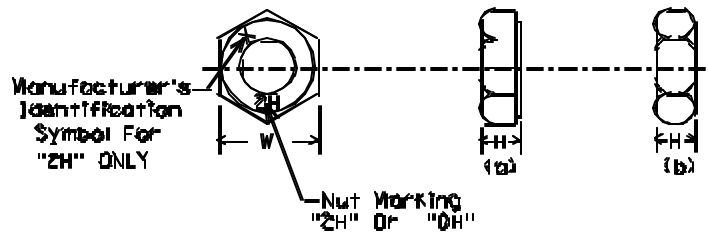
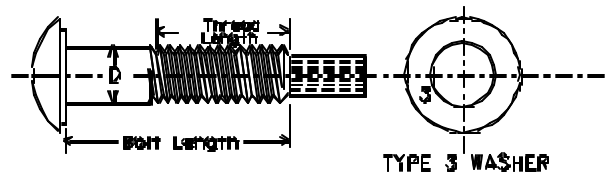
Nut Marking
 Manufacturer's Identification Symbol for "F" dia.
 Nut Marking "H" or "F"
 Mark only on Washer: Patent as in (a) or double threaded as in (b).

Nut Marking
 Manufacturer's Identification Symbol for "F" dia.
 Nut Marking "H" or "F"
 Mark only on Washer: Patent as in (a) or double threaded as in (b).

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Bolts

DIRECT TENSION BOLTS



Nuts may be washer faced as in (a) or double chamfered as in (b)

1. Must obtain Construction Division permission to use these bolts.
2. Special impact wrench that will hold bolt & tighten the nut must be used.
3. End of bolt will separate at proper torque.

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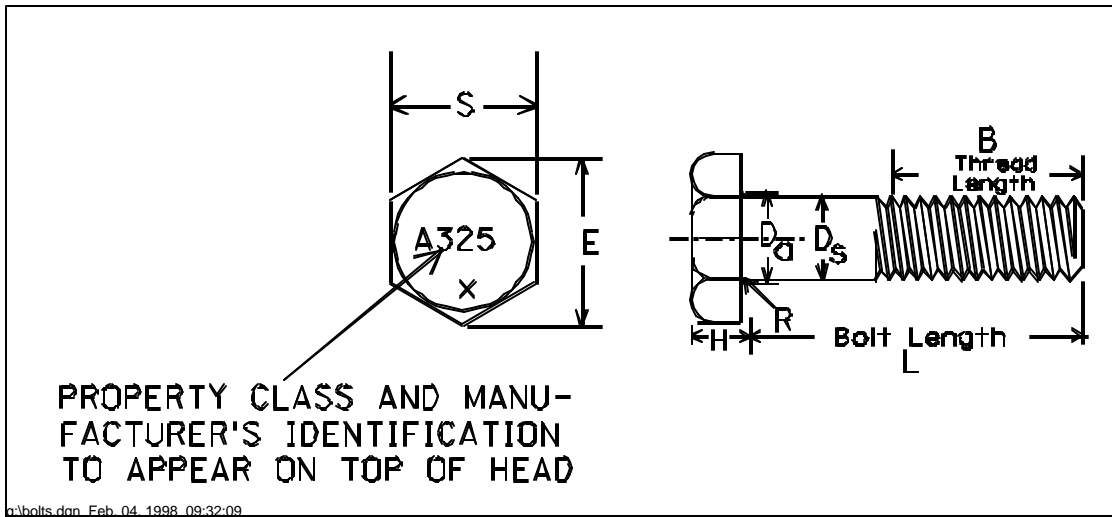
1. *SSHC Section 1058* requires high tensile steel bolt, nut and washer material for structural steel joints to meet the requirements of ASTM Designation A 325/A 325M.
2. When heavy hexhead structural bolts and heavy hexagon nuts are used, a hardened washer is required only under the bolt head, or nut, whichever is the element being turned. Bolts and nuts may be washer faced, but these faces do not take the place of a hardened washer.
3. Heavy hexhead structural bolts manufactured to ASTM A 325/A 325M, Types 1, 2 and 3, the dimensions for which are shown in the ASTM tables, are identified on the top of the head by the legend "A 325", and the manufacturer's symbol.
4. Type 1 bolts, at the option of the manufacturer, may be marked with three radial lines 120 degrees apart.
5. Type 2 bolts shall be marked with three radial lines 60 degrees apart. Type 3 bolts shall have the "A 325" underlined and the manufacturer may add other distinguishing marks indicating that the bolt is of a weathering type.
6. Heavy hex nuts for A 325 bolts are identified on at least one face by the manufacturer's mark and the number "2" or "2H", by three equally spaced circumferential lines, or by the legend "D" or "DH". Heavy hex nuts for A 325 Type 3 bolts shall be marked on one face with three circumferential marks and the numeral "3", in addition to any other distinguishing marks the manufacturer may elect to use.
7. Washers for A 325 Type 3 bolts shall be marked on one face near the outer edge with the numeral "3", or other distinguishing marks indicating that the washer is of a weathering type.
8. The marking on bearing surfaces of nuts and washers shall be depressed.
9. According to the specifications, high strength steel bolts may be installed by the turn of the nut method. It should be noted that the equivalent torque values given in SSHC Table 708.03 are experimental approximations and that the footnote to this table required that the torque-tension ratio be determined under actual conditions of the application. Wrenches will be calibrated and the torque-tension ratio will be determined at the site by Materials and Research Division personnel. The Construction Engineer should be notified as early as possible as to the time when the wrench and representative bolts will be present at the site in order that arrangements may be made to have appropriate personnel travel to the site and calibrate the wrench and establish the torque-tension ratio.
10. When Materials and Research Division personnel have calibrated the wrench and determined the torque-tension ratio, the bolt tension calibrator will be left with the project personnel so that the wrench calibration may be checked as the work goes on. Impact wrenches should be checked on a daily basis and manual torque wrenches at any time that, in the opinion of the Project Manager, conditions have varied from those present during the initial calibration.
11. Impact wrenches should be calibrated under the same conditions, such as length of hose and power supply, that were present during actual installation of the bolts.

12. SSHC Subsection 708.03 requires that the structure shall be adjusted to the requirements of blocking diagram before placing permanent bolts in field connections. This should be checked by the contractor and verified by the inspector prior to completing final phase of bolt tightening.

13. All splice plates and contact surfaces shall be clean.

F. High Strength Fasteners (SSH Section 1058)

METRIC HEAVY HEX BOLTS



D Nominal Bolt Size & Thread Pitch	D _s		S		E		H		D _a	R	B (Ref.) Thread Length (Basic)			
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Fillet Transition Dia.	Radius of Fillet	Bolt Lengths <125	Bolt Lengths >125 and <200		Bolt Lengths >200
												Max.	Min.	
M12x1.75	12.70	11.30	21.00	20.16	24.25	22.78	7.95	7.24	13.7	0.67	30	36	49	
M14x2	14.70	13.30	24.00	23.16	27.71	26.17	9.25	8.51	15.7	0.6	34	40	53	
M16x2	16.70	15.30	27.00	26.16	31.18	29.56	10.75	9.68	17.7	0.6	38	44	57	
M20x2.5	20.84	19.16	34.00	33.00	39.26	37.29	13.40	12.12	22.4	0.8	46	52	65	
M24x3	24.84	23.16	41.00	40.00	47.34	45.20	15.90	14.56	26.4	0.8	54	60	73	
M30x3.5	30.84	29.16	50.00	49.00	57.74	55.37	19.75	17.92	33.4	1.0	66	72	85	
M36x4	37.00	35.00	60.00	58.80	69.28	66.44	23.55	21.72	39.4	1.0	78	84	97	

1. *SSHC Subsection 708.03, Paragraph 10.h.* Turn-of-Nut method shall be followed for tightening all high strength fasteners.
2. High Strength bolts and nuts, which have been torqued as outlined below, shall not be reused. This includes both black and galvanized bolts and nuts.
 - a. Bolting
 - (1) Receiving Shipments
 - (a) Prior to installation, check shipping certifications and compare these to bolting kegs on site. Check for size, length, heat numbers, and general fastener condition i.e., rusted black bolts or non-lubricated galvanized nuts. Rotational-Capacity (RC) lots will need to be checked.
 - b. Installation Checklist
 - (1) A pre-bolting meeting is strongly recommended/encouraged. Bolting procedures, Turn-of-Nut process described below, and the inspection process need to be discussed.
 - (2) Site storage of fasteners is important. Storage should be in a sealed container within a sheltered storage shed.
 - (3) Black bolts and nuts shall be oily to the touch when delivered and installed.
 - (4) Galvanized nuts shall be checked to verify lubrication. A uniform dye color indicates lubricant has not been damaged. If there is no color, or color is not uniform, bolts and nuts shall be field lubricated with bees wax, stick wax, or other approved dry wax prior to installation.
 - (5) Rusted or dirty bolts or nuts shall be cleaned and relubricated prior to installation.
 - (6) Faying surfaces shall be free of burrs and foreign material; and bolted faying surfaces are to be painted with zinc rich paint.
 - (7) All fasteners shall be free of dirt, moisture, rust, and be "well" lubricated.
 - (8) Washers (when required) are to be placed under the **"turned element."**
 - (9) Often contract documents will specify which way a bolt is to be installed. If there is no specific guidance, threaded ends of bolts will be turned inside and away from normal exposure to pedestrian and/or vehicular traffic for aesthetic reasons.

- (10) During installation, particular care should be exercised so a snug-tight condition is achieved.

c. Rotational-Capacity

- (1) The plans and specifications may eventually require a Rotational-Capacity (RC) test for all "high strength" fasteners. This test confirms component compatibility and the presence of adequate lubrication. Currently, it is only required when the Project Manager determines it is necessary.
- (2) There are two separate Rotational-Capacity requirements:
 - (a). Fasteners (bolts, nuts, and washers) received at the project shall have been RC tested by the supplier or manufacturer prior to shipment. Therefore, each combination of production lots must have a unique RC lot number. This number must be readily identifiable on each container of fasteners.
 - (b). Prior to installation, the contractor shall field test all RC lots as supplied. Field tests are not intended to match the values provided by the supplier, but as a separate and added acceptance test.
 - (c) Field testing procedures are given in *SSHC Subsection 708.03, paragraph 10.h.*

d. Turn-of-Nut Method

- (1) "Turn-of-Nut" method involves the following simple steps. Adherence to this procedure will assure a properly fitted and clamped connection. (*Refer to SSHC Subsection 708.03.*)
 - (a) Adequate number of bolts and pins shall be installed to bring a joint in tight contact and alignment. These bolts shall be brought to a snug-tight condition to insure that the joint is maintained in good contact during installation of remaining bolts. A washer shall be placed under the element to be turned.
 - (b) Remaining bolts in a connection shall be installed and brought to a snug-tight condition.
 - (c) Check initially installed bolts to assure they remained in a snug-tight condition.
 - (d) Tighten all bolts by the applicable Turn-of-Nut amount specified in *SSHC Subsection 708.03*. Additional rotation depends on the bolt length to diameter ratio and shape of connected pieces. For MOST installations (both faces normal to bolt Axis) the following table can be used to determine additional rotation for Turn-of-Nut.

NOTE: The following table is currently printed in English units only. When Standard diameter, lengths, and additional rotation values are developed for metric fasteners, another table will be prepared.

Turn of the Nut			
3/4" Dia. Bolts		7/8" Dia. Bolts	
Bolt Length	Additional Rotation	Bolt Length	Additional Rotation
0-3"	1/3 turn	0-3.5"	1/3 turn
>3"-6"	1/2 turn	>3.5-7"	1/2 turn
>6" -9"	2/3 turn	>7" - 10.5"	2/3 turn
NOTE: All additional rotations have a \pm tolerance. Refer to <i>SSHC Section 708</i> .			
1" Dia. Bolts		1 1/8" Dia. Bolts	
Bolt Length	Additional Rotation	Bolt Length	Additional Rotation
0-4"	1/3 turn	0-4.5"	1/3 turn
>4"-8"	1/2 turn	>4.5"-9"	1/2 turn
>8" -12"	2/3 turn	>9" - 13.5"	2/3 turn
NOTE: All additional rotations have a \pm tolerance. Refer to <i>SSHC Subsection 708.03</i> .			

e. Snug Tight

- (1) Snug tight is defined as the tightness that exists when all plies of a joint are in "firm" contact with each other. There shall not be air gaps between metal to metal or metal to bolt surfaces. For properly fitting surfaces, snug tight can usually be accomplished by:
 - (a) The full effort of a person using an ordinary spud wrench.
 - (b) A "few impacts" of an impact wrench. To quantify "few impacts," tighten a few bolts using the full effort method on a spud wrench. Then apply the job impact wrench, and roughly check how many impacts it takes to develop at least the same effort.
- (2) After **ALL** bolts in the connection are snug tight:
 - (a) **ALL** nuts shall be match-marked with bolt point nut and base steel using paint crayon, or other means to provide a straight reference line for determining final relative rotation of parts during tightening.

- (b) All bolts in a connection shall then be tightened additionally by an applicable amount of nut rotation specified above. Tightening should progress from the most rigid part of the joint to its free edges. On our normal web and flange splices, this would mean beginning at the centerline of a splice and progressing away (in each direction) from the centerline of splice.
 - (3) Inspectors should observe this operation at intervals to make certain the match-marking is done correctly, and that the opposite bolt head or nut does not turn during the tightening process. Inspectors also should check to see if proper rotation has been made considering tolerances given at the bottom of the nut rotation chart.
- f. Inspection Wrench Calibration
- (1) Tension Measuring Calibrated Devices
 - (a) Tension measuring calibrated devices (typically Skidmore-Wilhelm Calibrator) are calibrated to a high degree of accuracy, but can lose some of this accuracy after an extended period of time. Contractors can have the devices calibrated by the Materials & Research Laboratory.
 - (b) When each device is calibrated, a calibration sheet will be issued indicating the date the test was performed. Contractors must keep the calibration sheet with the tension-measuring device.
 - (c) Attentiveness needs to be exercised when using this Calibration Sheet. The inspector needs to check the sheet and compare the "Indicated Load on Gauge" column to those values listed in the "AVG" column under "Actual Load on Testing Machine." These are usually **NOT** the same.

NOTE: Be sure to take any difference (INDICATED versus ACTUAL) into account when calibrating the Job Torque Wrench!

- (2) Torque Wrench Calibration
 - (a) At least once a day, three bolts of the same grade, size, and condition as those used in the structure shall be placed individually in a calibration device capable of indicating bolt tension. A washer shall be used under the part to be turned.

NOTE: There must be 3-5 threads exposed behind the nut. Check and add washers if required. For longer bolts, steel shim plates should be used.

- (i) Tension bolt to 100 percent of "Minimum Bolt Tension" listed for a particular bolt diameter. Tension is read directly from the tension measuring calibrated device as corrected by accounting for differences between INDICATED versus ACTUAL. (Refer to *SSHC Subsection 708.03* for "Minimum Bolt Tension.")
- (ii) Apply inspection torque wrench, rotate nut or bolt and increase tension by an additional 5%. Remember, a dial type wrench must be set to zero before checking torque. Record the inspection wrench's "TORQUE" when 105% of the tension is achieved.

NOTE: The turned element must be moving to indicate the correct torque.

- (iii) **EXAMPLE:** (English units)

Assume:

- 1. 7/8" Diameter bolt
- 2. Skidmore Calibration

Minimum Bolt Tension
39,250 lbs-force

Skidmore Calibration
Gauge Reading 40,000 lbs-force
Actual Ave. at 40,000 = **38,800 lbs-force**

Calculations

- For 100% tension, corrected Skidmore gauge should read:

$$39,250 + (40,000 - 38,800) = \mathbf{40,450 \text{ lbs-force}}$$

- For 105% tension, corrected Skidmore gauge should read:

$$40,450 \times 1.05 = \mathbf{42,473 \text{ lbs-force}}$$

- (vi) torque reading on Inspection Wrench at 42,470± lbs-force is recorded.
- (a) Repeat this process for a total of three fasteners.
- (b) The inspector notes the torque for three fasteners, averages this torque, and that becomes the Job Inspection Torque Value until the wrench is recalibrated the next day, or another size or length of bolt is to be inspected.

The Inspector shall record:

- The job inspection torque.
- The Tension Measuring device's calibration "date reported," serial and model number, and calibration lab number.

g. Turn-of-Nut Inspection (*SSHC Subsection 708.03*)

- (1) After all fasteners in a joint are properly tightened by the Turn-of-Nut method, they shall be inspected as indicated:
 - (a) Installed fasteners shall be inspected the same day as installed by the contractor with the inspector present.
 - (b) The contractor shall use a calibrated torque wrench for the inspection operation.
 - (c) Ten percent of the bolts which have been tightened in the structure shall be tested with the inspection wrench the same day as installed. At least two bolts, selected at random, in each connection shall be tested. If no rotation (nut or bolt head) is noted by job inspecting torque wrench and the faying surfaces are in tight contact the connection shall be accepted as properly tightened. If any nut or bolt head is turned, all bolts in the connection shall be checked, and all bolts whose nut or head is turned shall be tightened and reinspected.
 - (d) Bolts tightened by the Turn-of-Nut method may reach tensions substantially above minimum torque values specified, but this shall not be cause for rejection.
 - (e) Care should be taken, however, to not overstress the bolts. If most of the bolts exceed 20% of minimum bolt tension, the contractor's procedures should be reviewed to determine:
 - (i) Is the snug-tight procedure correct?
 - (ii) Are there nicks or burrs on the threads?
 - (iii) Are the nuts or bolts rusty or dirty?
 - (iv) Check for residual lubrication. All threaded fasteners (black and galvanized) are required to be lubricated. Black bolts and nuts need to have a water soluble oil, and galvanized nuts are to be lubricated as per ASTM A 563. Prelubricated galvanized nuts will be dyed typically to a blue color. If there is no indication of color OR if the color is faded, the bolts shall be field lubricated with bees wax, stick wax, or some other dry lubricant.

- (v) Is calibrating device correct?
- (4) Bolts and nuts must always be inspected prior to installation. Items of major concern are:
 - (a) Nicks or burrs in the threads
 - (b) Rust
 - (c) Presence of dirt or other foreign material
 - (d) Fastener lubrication
 - (e) All dirt, foreign material, and rust must be removed prior to use. Black bolts may require reoiling to remove rust etc. If reoiling is required, excess oil must be removed prior to installation. When rust cannot be removed by oiling, the bolt or nut must be rejected. Bolts or nuts with nicks or burrs on threads must be rejected. Relubrication will necessitate rechecking fasteners in the lot for Rotational-Capacity.
- (5) Plan ahead before girder splices have been fully tightened. Make necessary adjustments prior to tightening the bolts in a connection. The best way to assure that beam lines are straight and true is to:
 - (a) Scribe a line at the center of each bearing on all masonry plates or concrete.
 - (b) Set beams and make snug tight connections proceeding to the forward pier. Then go back and straighten the beam line, checking to be sure bearings remain centered on their seats. Once the previous span is aligned and tightened, proceed to the next forward span.
 - (c) Check to be sure beam ends are aligned prior to tightening the splice.
 - (d) This will require coordination between survey and inspection crews and the contractor.
- h. Galvanized Bolts
 - (1) *When using galvanized hardware, a lubricant approved by ASTM A 563 shall be applied to the nuts.* Galvanized nuts "typically" are delivered to the project pre-lubricated. Usually, pre-lubricated nuts are stained and have a distinguishing color. If a lubricant has been applied at the fabrication shop, a field reapplication is not necessary provided original lubrication has not been removed in some manner. For situations where fabrication shop lubricant is in question, field application of bees wax, stick wax, or some other dry lubrication shall be required. Rotational-Capacity requires the test to be conducted with fasteners in the same condition as they will be during installation.

(2) A WORD OF CAUTION:

- (a) Lubrication is required to minimize galling during installation. Since nuts are lubricated (both threads and faces), it is important that nuts be rotated during tightening.
- (b) Fasteners (bolts and nuts of any type) shall not be tightened, then removed, reinstalled, and retightened.

G. Welding (*SSHC Subsection 708.03*)

- 1. Contractors may be allowed to tack weld form hardware to the shear connectors on steel girders. (The intent is to eliminate the request procedure.)
- 2. This policy does not apply to the rebar stirrups which extend out of the top of prestressed girders.

H. Shear Connectors

- 1. OSHA has made a determination that shear connectors on steel girders are a tripping hazard. However, OSHA, after receiving petitions from FHWA, AASHTO, and other organizations, issued relief from the field welding requirements. The Department and other transportation agencies were concerned that field welded shear connectors created a bridge that would not be as safe as a bridge with shop welded shear connectors.
- 2. Girders may arrive on-site with all the shear connectors shop welded and this will not be a citable violation of the OSHA shear connector requirements. It will be considered a “de minimis” violation, or in other words, a minor concern that has a very low probability of occurrence and where expenditure of resources is not warranted to ensure compliance.
- 3. 100 percent conventional fall protection is required for all workers working overhead (6 feet or higher).
- 4. Shear connectors may either be shop welded or field welded.
 - If they are field welded then the inspector needs to realize that welding shear connectors is a critical operation. The bridge may fail if the shear connectors are not welded properly.
 - **Use a “big” hammer to check field welded shear connectors.**

Table 708.01
Shear Connector Checklist

1.	An arc shield (ferrule) of heat-resistant ceramic or other suitable shall be furnished with each stud. The material shall not be detrimental to the welds or cause excessive slag and shall have sufficient strength so as not to crumble or break due to thermal or structural shock before the weld is completed.
2.	Only approved studs shall be used. The arc shield used in production shall be the same as used in qualification tests.
3.	Before installation of the studs, the contractor shall submit to the inspector for approval information on the studs to be furnished as follows:
a.	The name of the manufacturer.
b.	A detailed description of the stud and arc shield.
c.	A certification from the manufacturer that the stud is qualified as specified in the contract.
d.	A copy of the qualification test report as certified by the testing laboratory.
4.	The studs, after welding, shall be free from any defect or substance which would interfere with their function.
5.	Studs shall be end welded to steel with automatically timed stud welding equipment connected to a suitable power source.
6.	If two or more stud welding guns are to be operated from the same power source, they shall be interlocked so that only one gun can operate at a time and so the power source has fully recovered from making one weld before another weld is started.
7.	At the time of welding studs shall be free from any rust, rust pits, scale, oil or other deleterious matter which would effect the welding operation.
8.	Welding shall not be done when the base metal temperature is below 0 degrees or when the surface is wet or exposed to rain or snow.
9.	When necessary to obtain satisfactory welds, the areas on the beam or girder to which the studs are to be welded shall be brushed or ground free of mill scale or rust.
10.	The arc shields or ferrules shall be kept dry. Any arc shield which shows signs of surface moisture from dew or rain shall be oven-dried at 250 degrees for two hours before use.
11.	The first two studs welded on each beam or girder, after being allowed to cool to a temperature of 150 degrees or less, shall be bent 30 degrees by either striking the studs on the head with a hammer or placing a pipe or other suitable hollow device over the stud and manually or mechanically bending the stud.
12.	When the temperature of the base metal is below 32 degrees, tow studs in each 100 studs welded, shall be bent in addition to the first two bent as specified in paragraph 11 above.
13.	Studs on which a full 360 degree weld is not obtained shall be repaired by adding a 3/16 inch fillet weld in place of the lack of weld as ling as the repair weld extends 3/8 of an inch beyond the area on each end of where the lack of weld was. The shielded metal-arc process with 7018 or 8018 low hydrogen electrodes shall be used.
14.	Longitudinal and lateral spacing of studs with respect to each other and to edges of the beam or girder flanges may vary a maximum of one inch from the location shown on the drawings. The clear distance between the studs shall not be less than one inch unless approved by the engineer. The minimum distance from the edge of the stud base to the edge of the flange shall be the diameter of the stud plus 1/8 inch, but preferably not less than 1-1/2 inch.
15.	Prequalification. Studs which are field applied in the flat (down hand) position to a planar and horizontal surface are deemed prequalified by virtue of the manufacturer's stud-base qualification tests and no further application testing is required. The limit of flat position is defined as 0-15 degree slope on the surface to which the stud is applied.

Table 708.02
Shear Connector Welder Qualifications

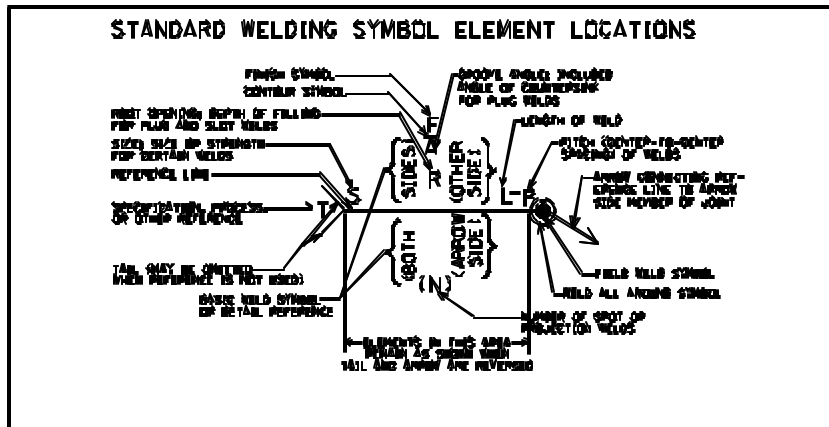
1.	Before any production studs are welded by an operator, they must first shoot two studs on a piece of material similar to the production member in thickness and properties. If the actual thickness is not available, the thickness may vary plus or minus 25%. All test studs shall be welded in the same general position as required on the production member.
2.	The test studs shall be visually examined. They shall exhibit a full 360-degree flash.
3.	In addition to the visual examination, the test shall consist of bending the studs after they are allowed to cool, to an angle of approximately 30 degrees from their original axes by either striking the studs on the head with a hammer or placing a pipe or other suitable hollow device over the stud and manually or mechanically bending the stud.
4.	If on visual examination the test studs do not exhibit 360 degree flash, or if on testing, failure occurs in the weld zone of either stud, the procedure shall be corrected, and two more studs shall be welded to separate material and tested again.
5.	If either of the second two studs fails, additional welding shall be continued on separate plates until two consecutive studs are tested and found to be satisfactory before any production welding begins.

WELDING SYMBOLS

FILLET	PLUG OR SLOT	SPOT OR PROJECTION	SEAM	SPOUFE								BACK OR BACKING	TOP-FACING	FLANGE	
				SQUARE	V	BEVEL	U	J	FLARE-V	FLARE BEVEL	FLARE			CONVEX	

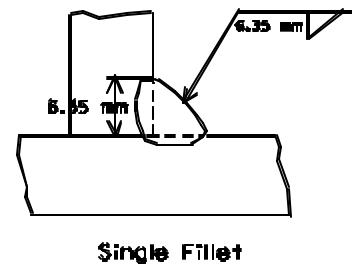
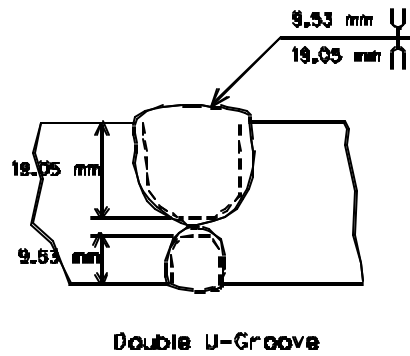
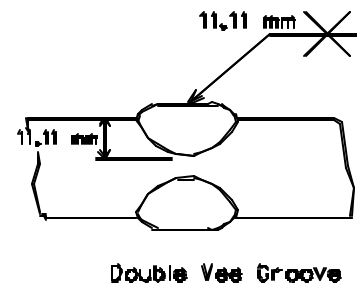
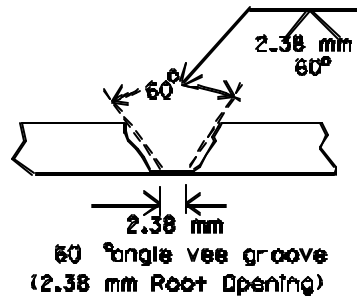
ARC-BEAM OR ARC-SPOT	REINFORCEMENT SPOT	POWER-TIGHT	RESISTANCE SEAM	FLASH OR UPSET

WELD ALL AROUND	FIELD WELD	MULTI-THROAT	CONTOUR		
			FLUSH	CONVEX	CONCAVE



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WELDING DETAILS



Notes: The number above the weld arrow line refers to the depth of weld at the lower surface.
 The number below the line refers to the weld on the top surface.
 Refer to welding charts for descriptions of welds not shown here.
 Field welding must be specifically approved.

I. Trouble Shooting

1. Many operating variables can affect the quality and appearance of the weld. Methods for correcting undesirable characteristics are discussed in the following paragraphs.

J. Weld Spatter

1. Spatter does not affect weld strength but does produce a poor appearance and increases cleaning costs.
 - (a) Be sure to control excessive splatter. Try lowering the current. Be sure the current is within the recommended range for the and size electrode (see attached Table).
 - (b) Be sure the polarity is correct for the electrode type.
 - (c) Try a shorter arc length.
 - (d) If the molten metal is running in front of the arc, change the electrode angle.
 - (e) Watch for arc blow.
 - (f) The electrode is not too wet.

K. Undercut

1. Generally, the only harm from undercutting is impaired appearance. However, undercutting may also impair weld strength, particularly when the weld is loaded in tension or subjected to fatigue. To minimize undercut:
 - (a) Reduce current, travel speed, or electrode size until the puddle is manageable.
 - (b) Change electrode angle so the arc force holds the metal in the corners. Use a uniform travel speed and avoid excessive weaving.

L. Rough Welding

1. If polarity and current are within the electrode manufacturer's recommendations but the arc action is rough and erratic, the electrodes may be wet. Try electrodes from a fresh container. If the problem occurs frequently, store open containers of electrodes in a heated cabinet.

M. Porosity and Surface Holes

1. Most porosity is not visible. But severe porosity can weaken the weld. The following practices minimize porosity:
 - (a) Remove scale, rust, paint, moisture, or dirt from the joint. Generally use an E6010 or E6011 electrode for dirty steel.
 - (b) Keep the puddle molten for a long time, so that gases may boil out before the metal freezes.

- (c) Steels very low in carbon or manganese or those high in sulfur or phosphorus should be welded with a low-hydrogen electrode. Minimize admixture of base metal with weld metal by using low currents and fast travel speeds for less penetration.
- (d) Try using a short arc length; short arcs are required for low-hydrogen electrodes.

2. Surface holes can be avoided by many of the practices used to minimize porosity.

N. Poor Fusion

- 1. Proper fusion exists when the weld bonds to both walls of the joint and forms a solid bead across the joint. Lack of fusion is often visible and must be avoided for a sound weld. To correct poor fusion:
 - (a) Try a higher current and a stringer-bead technique.
 - (b) Be sure the edges of the joint are clean, or use an E6010 or E6011 electrode.
 - (c) If gap is excessive, provide better fitup or use a weave technique to fill the gap.

O. Shallow Penetration

- 1. Penetration refers to the depth the weld enters into the base metal. For full-strength welds, penetration to the bottom of the joint is required. To overcome shallow penetration:
 - (a) Try higher currents or slower travel.
 - (b) Use small electrodes to reach into deep, narrow grooves.
 - (c) Allow some gap (free space) at the bottom of the joint.

P. Cracking

- 1. Many different types of cracks may occur throughout a weld. Some are visible and some are not. However, all cracks are potentially serious, because they can lead to complete failure of the weld. The following suggestions may help control potential cracking.
- 2. Most cracking is attributed to high-carbon or alloy content or high-sulfur content in the base metal. To control this type of cracking:
 - (a) Use low-hydrogen electrodes.
 - (b) Preheat. Use high preheat for heavier plate and rigid joints.
 - (c) Reduce penetration by using low currents and small electrodes. This reduces the amount of alloy added to the weld from melted base metal.

- (d) To control crater cracking, fill each crater before breaking the arc. Use a back-stepping technique so as to end each weld on the crater of the previous weld.
- 3. On multiple-pass or fillet welds, be sure the first bead is of sufficient size and of flat or convex shape to resist cracking until the later beads can be added for support. To increase bead size, use slower travel speed, a short arc, or weld 5° uphill. Always continue welding while the plate is hot.
- 4. Rigid parts are more prone to cracking. If possible, weld toward the unrestrained ends. Leave a 1/32 inch (0.8 mm) gap between plates for free shrinkage movement as the weld cools. Peen each bead while it is still hot to relieve stresses.

Q. How to Reduce Arc Blow

- 1. All arc blow is not detrimental. In fact, a small amount of arc blow can sometimes be used beneficially to help form the bead shape, control molten slag, and control penetration.
- 2. When arc blow is causing or contributing to such defects as undercut, inconsistent penetration, crooked beads, beads of irregular width, porosity, wavy beads, and excessive spatter, it must be controlled. Possible corrective measures have already been suggested in the preceding text. In general, here are some methods that might be considered:
 - a. If DC current is being used with the shielded metal-arc process - especially at rates above 250 amperes - a change to AC current may eliminate problems.
 - b. Hold as short an arc as possible to help the arc force counteract the arc blow.
 - c. Reduce the welding current - which may require a reduction in arc speed.
 - d. Angle the electrode with the work opposite the direction of arc blow.
 - e. Make a heavy tack weld on both ends of the seam; apply frequent tack welds along the seam, especially if the fitup is not tight.
 - f. Weld toward a heavy tack or toward a weld already made.
 - g. Use a back-step welding technique.
 - h. Weld away from the ground to reduce back blow; weld toward the ground to reduce forward blow.
 - i. With processes where a heavy slag is involved, a small amount of back blow may be desirable; to get this, weld toward the ground.
 - j. Wrap ground cable around the work piece and pass ground current through it in such a direction that the magnetic field set up will tend to neutralize the magnetic field causing the arc blow.

3. The direction of the arc blow can be observed with an open-arc process, but with the submerged arc process must be determined by the type of weld defect.
4. Back blow is indicated by the following:
 - a. Spatter.
 - b. Undercut, either continuous or intermittent.
 - c. Narrow, high bead, usually with undercut.
 - d. An increase in penetration.
 - e. Surface porosity at the finish end of weld on sheet metal.
5. Forward blow is indicated by:
 - a. A wide bead, irregular in width.
 - b. Wavy bead.
 - c. Undercut, usually intermittent.
 - d. A decrease in penetration.

R. The Effects of Fixturing on Arc Blow

1. Steel fixtures for holding the work pieces may have an effect on the magnetic field around the arc and, thus, on arc blow. Usually, the fixturing causes no problem with stick-electrode welding when the current does not exceed 250 amperes. Fixtures for use with higher currents and with mechanized welding should be designed with precautions taken so that an arc-blow-promoting situation is not built into the fixture.
2. Each fixturing device may require special study to ascertain the best way to prevent the fixture from interfering deleteriously with the magnetic fields. The following are some points to note:
 - a. Fabricate the fixture from low-carbon steel. This is to prevent the buildup of permanent magnetism in the fixture.
 - b. Welding toward the closed end of "horn type" fixtures reduces back blow.
 - c. Design the fixture long enough so that end tabs can be used if necessary.
 - d. Do not use a copper strip inserted in a steel bar for a backing. The steel part of the backup bar will increase arc blow.
 - e. Provide for continuous or close clamping of parts to be seam-welded. Wide, intermittent clamping may cause seams to gap between clamping points, resulting in arc blow over the gaps.

- f. Do not build into the fixture large masses of steel on one side of the seam only. Counterbalance with a similar mass on the other side.

704.04 METHOD OF MEASUREMENT

- A. Structural steel is usually measured by the pound (kg). Structural steel for handrail is also measured by the pound. Ornamental handrails are measured by the lineal feet of rail between end posts. These values are listed on the plans and may be used in the final computation for payment.

704.05 BASIS OF PAYMENT

- A. PMs are authorized to pay for steel plates and shapes as soon as the material arrives at the fabricator.
- B. The Nebraska Department of Roads had determined that it may be possible to improve inspection procedures and to lower construction costs on bridges and other structures where significant quantities of steel are required if stockpiled materials are paid for upon receipt by the fabricator. Therefore, the Department will allow partial payments for stockpiled steel plates and shapes prior to fabrication. The procedure that must be followed before partial payment will be made is as follows:
 - 1. The prime contractor must request partial payment from the Department's Project Manager for the specific project where payment is requested.
 - 2. The Bridge Divisions, Fabrication Inspector [(402)-479-4763] will be responsible for verifying fabricators' invoices and forwarding them to the project managers; for verifying manufacturer's Certified Mill Test Report and forwarding copies to the PM and M&R Division; and for inspection of the steel.
 - 3. The fabricator must provide the Department's Fabrication Inspector the steel manufacturer's paid invoice for the material. The Project Manager will make the payment for the amount shown on the invoice, which directly is attributed to the project for which payment is being considered. The invoice should be annotated to show:
 - (a) the project number
 - (b) steel quantity in pounds applicable to the project
 - (c) material grade
 - (d) material heat number
 - 4. There must be identifying marks placed on each piece for which payment will be made.

5. Steel must be stored in orderly fashion to readily facilitate identification of specific materials to specific projects. Project materials cannot be commingled with other projects – each project’s materials must have a separate location.
6. The Manufacturer’s Certified Mill Test Reports must be provided to and approved by the Bridge Division before payment will be authorized. The Bridge Division will notify the Project Manager when payment is authorized.
7. The Department will verify that the material is properly stored before payment will be made.
8. The Prime Contractor will make payment to the fabricator within 20 days after the Department has paid for the material.
9. Payment is only authorized for materials that are stored within Nebraska as specified in Subsection 109.07 of the Nebraska *Standard Specifications for Highway Construction*.

705.00 REINFORCEMENT (SSHC Section 707)

705.01 DESCRIPTION

- A. The reinforcement of concrete for structures consists of furnishing and placing deformed metal reinforcing bars or welded-wire fabric in the concrete as required by the plans and specifications.

705.02 MATERIAL REQUIREMENTS (SSHC Subsection 707.02)

- A. Samples of reinforcing steel and welded-wire fabric are required by the Central Laboratory unless these materials are shipped from tested stock. Generally reinforcing steel has been sampled and tested before shipment to the project, and will arrive with acceptance tags attached. At the time this steel is placed in the work, the structure inspector should collect, record in field book, and submit the tags to the Project Manager. Steel arriving untagged should not be incorporated in the work until approved by the Materials Engineer. See the "*Materials Sampling Guide*".
- B. The Materials and Research Division requires that two 6 ft (2.0 m) sample lengths of epoxy-coated reinforcing steel be submitted for testing purposes, and a special provision to that effect will be included in future contracts.
- C. Similarly, the *Materials Sampling Guide* requires two 6 ft (2.0 m) sample lengths for uncoated reinforcement bars be provided (unless shipped from tested and approved stock). Enter the date resteel is verified on-site in SiteManager.

705.03 CONSTRUCTION METHODS (SSHC Subsection 707.03)

A. Placement and Checking (Bridge Deck)

1. Bridge plans specify nominal slab thickness and nominal clearance of reinforcing bars from face of the concrete. This section will establish acceptable deviations from nominal plan dimensions.
2. Four dimensions must be given special attention when checking placement of bridge slab reinforcing:
 - (a) Slab thickness.
 - (b) Clearance of bottom reinforcement from bottom of slab.
 - (c) Distance from bottom of slab to top of top mat of reinforcement.
 - (d) Cover over top mat of reinforcement

B. Slab Thickness

1. This shall be the nominal slab thickness shown on the plans with a tolerance of minus zero and plus ½ inch (13 mm).

C. Clearance of Slab Reinforcement

1. The reinforcing steel shall be placed to monitor the nominal clearances shown in the plans $\pm \frac{1}{4}$ inch (5 mm). Contractors must provide an adequate number of bolsters and/or bar chairs of suitable height and strength to maintain clearance within this range.
2. Contractors must provide an adequate (sag shall be minimal, see *SSHC Figure 707.01*) number of bar chairs of suitable height and strength to maintain the distance within this range of tolerance.

D. Protection of Material (*SSHC Subsection 707.03*)

1. The Specifications provide that steel reinforcement shall be protected at all times from damage. When placed in the work, it shall be free of dirt, loose scale, detrimental rust, paint, oil or any foreign material. Detrimental rust is defined as heavy reddish coating formed on iron or steel when chemically attached by moist air. This must be removed by wire brushing. However, a light layer of rust or mill scale that is not readily removed with a wire brush is acceptable.

E. Placing and Fastening (*SSHC Subsection 707.03*)

1. Positioning - It is essential that inspectors give special attention to the placement of reinforcing steel in all structures. Reinforcement shall be placed in the exact position shown in the plans and held securely in that position to preclude movement or shifting during placement of the concrete. On a 7 inch (175 mm) thick bridge floor, designed with the top steel $1 \frac{3}{4}$ inch (45 mm) below the surface, a sag or displacement in the top steel of only $\frac{1}{2}$ inch (13 mm) will reduce the strength of the floor 19 percent. The reduction in strength of thinner sections such as culvert slabs and walls is even more critical.
2. Present policy is to tie all bar intersections except when the bar spacing is less than 12 inches (300 mm) in both directions in which case alternate intersections may be tied. This requirement is enforceable through *SSHC Subsection 707.03* in that it specifically defines the frequency of tying. The Project Manager should thoroughly study the project documents in order to be aware of this requirement as well as any change which might occur in this revision.
3. Horizontal reinforcement in slabs shall be spaced vertically by means of approved metal chairs. The type and adequacy of bar support systems which includes the spacing of bar supports shall be in accordance with the Concrete Reinforcing Steel Institute's "Manual of Standard Practice", unless other stipulations are provided in the contract provisions. A copy of this manual may be obtained from the District Construction Engineer. Bar supports which are located at exposed concrete surfaces shall be galvanized, plastic coated or stainless steel to a depth of $\frac{1}{2}$ inch (13 mm) minimum from the concrete surface. Chairs may also be used to keep vertical columns and wall steel from contacting the form.

4. Field welding will be permitted only when shown on the plans or with written permission of the Construction Engineer. Reinforcement can best be checked as the work progresses rather than waiting until the contractor has enclosed the reinforcement with forms. In the case of walls and columns it is virtually impossible to do the checking after the forms are in place. When bent bars are used, a check should be made that there are no cracks or splits at the bends. Stirrup hooks should be rotated to different positions in order that the hooks do not fall in the same location when a series of stirrups are used in beams or columns.
5. No welding will be allowed on the main vertical steel of high mast lighting tower foundations except at the very top and bottom where the end loops may be tack welded. If a more rigid cage is desired, additional vertical steel will be required to act as the frame and lifting points for the cage. The required loops may be tack welded to this additional vertical steel. The required vertical steel will then need to be wire tied to the tack welded loops.
6. Welding of all loops, other than the top and bottom loop, to the required vertical steel will not be allowed. Additional bracing may be tack welded to the added vertical bars, if required. The added vertical bars should be sized to support the required load.
7. *SSHC Subsection 704.03* requires the contractor to give the Project Manager sufficient advance notice before starting concrete operations in any unit of a structure, to permit the inspection of forms and reinforcing bars. The Project Manager shall require all reinforcing steel to be accurately placed and firmly held in position.

F. Special Attention Areas

1. Tie-Downs and Supports
 - a. *SSHC Subsection 707.03* require that the top mat of reinforcing steel is to be tied down at not greater than 4 feet (1.2 m) spacing measured in each direction. This requirement can partially be met by wiring the top mat down to shear lugs at 4 feet (1.2 m) spacing along the beam. Regardless of beam spacing, the top mat must be tied to the forms or the bottom reinforcing mat at 4 feet (1.2 m) spacing. Likewise, the top reinforcing mat is to be tied to the bottom reinforcing mat on a 4 feet (1.2 m) grid in floors of concrete slab bridges. Tying should include bars near the ends of the bridge and bars near the curbs. **At least 50 percent of the bar contacts must be tied unless the spacing is more than 1 ft (300 mm) and then every bar contact must be tied.**
2. Epoxy Coated Bar
 - a. Epoxy coated reinforcing steel requires the use of epoxy or plastic coated bar supports and tie wires (*SSHC Subsection 707.03*). Epoxy coated tie wires may tend to slide or break. If this occurs, they should be double tied or stronger ties used.

3. Clearance Check
 - b. The specified clear distance from surface to reinforcing steel must be maintained. To check this, a clearance guide $\frac{1}{4}$ inch (5 mm) less in thickness than the specified clearance to top steel should be temporarily fastened to the bottom of the finishing machine screed. The finishing machine should then be operated along the bridge to insure that proper clearance is obtained. It will be necessary to bend all tie wire loops down to permit the clearance gauge to pass. Any steel not properly placed must be corrected.
 4. Checks During Placement
 - a. Checks of slab thickness and cover over top reinforcement must be made in the finished concrete directly behind the finish machine. A thickness and cover check should be made at the same location of an approximate grid of 10 ft (3 m) transverse and 20 ft (6 m) longitudinal. These checks must be documented in the field book. When the slab is of deficient thickness or cover checks indicate incorrect rebar placement corrections must be made immediately.
 5. Cleaning Forms and Steel
 - a. Mud and other foreign material must be removed from the steel and forms prior to placement. Remove any trapped/ponded water before placing the concrete.
- G. Epoxy-Coated Reinforcement (*SSHC Section 1021*)
1. Epoxy coatings are applied to reinforcing bars by a fusion-bonded process. This means the coating achieves adhesion to the bar as a result of a heat-catalyzed reaction. Besides chemical adhesion, there is also physical adhesion of the coating to the bar.
- H. Care and Handling
1. Epoxy coated bars are subjected to many quality control tests and inspections prior to leaving the supplier's facility. However, from that point forward, careless handling and construction practices can cause excessive coating damage. Contractors should be strongly encouraged to exercise care in handling, storage, and placing of epoxy coated bars. If problems are noted after delivery, the inspector is to contact the Materials and Research Division.
 2. Handling
 - a. During unloading epoxy coated bars from the truck, care must be exercised to minimize scraping of the bundles or bar-to-bar abrasion from sags in the bundles. Skidding bundles from the truck onto the ground should not be allowed. Use of power hoisting equipment for unloading and handling is strongly encouraged. Further, equipment for handling the bars should have

protective contact areas. Specifically, nylon slings or padded wire rope slings should be used and bundles should be lifted at multiple pick-points.

3. Storage

- a. Epoxy coated bars should be stored on timbers or other suitable protective cribbing. All types of reinforcing bars should be stored off the ground as close as possible to the area where they will be used. The following storage practices are suggested to prevent damage:
- b. Store bars above the ground on timbers, cribbing, or dunnage placed close enough together to prevent sags in the bundles.
- c. If a large quantity of bars has to be stored in a small area, bundles can be stacked if adequate blocking is placed between the layers.
- d. While fading of the coating's color is not specifically detrimental, it should be avoided to the fullest extent possible. One recommended method is to cover exposed bundles with burlap or dark plastic.

NOTE: If plastic or other nonporous material is used for covering, the ends must be left open to allow air movement. Without this, condensation under the cover could cause damage.

- e. Long-term site storage (from one year to the next) of epoxy coated bars is not recommended.

4. Placing

- a. Placing of epoxy coated bars is done similar to uncoated bars. The KEY exception is that coated bars require more careful handling and placing. Once bundles have been opened, dragging one bar over another or over any abrasive surface MUST be avoided.
- b. After epoxy coated bars are placed, walking on the bars by construction personnel should be held to a minimum. Bars in high traffic areas or runways for concrete placement should be protected with plywood or other suitable material. Concrete placement equipment shall not be placed on, or supported by, any reinforcing steel.
- c. Bar supports and tie wires for epoxy coated reinforcement shall be coated with epoxy, nylon, or plastic.

I. Field Inspection

1. Epoxy coated bars should be inspected for damaged coating:
 - a. when received at the job site, and
 - b. after they are placed in the structure.

2. Damage Evaluation and Repair

- a. Damaged coating shall be evaluated as outlined below. The "holiday detector" should be used to determine coating flaws.
- b. Bent Bars
 - (1) Examination of physical coating condition on the outside radii of hooks and other bends might reveal cracks in the coating. When cracking of the coating is evident, the contractor must remove loose coating, clean the area, and repair.
- c. Fading of Color
 - (1) When epoxy coated bars are exposed to sunlight over a period of time, fading of the color may occur. Since discoloration does not harm the coating nor affect its corrosion protection properties, such fading will not be cause for rejection.
- d. Damaged Ends
 - (1) Damage to ends because of field shearing, dragging or whatever must be repaired in the field.

J. Repair of Damaged Coating

- 1. When a damaged coating must be repaired, the patching or touch-up material should be applied in strict accordance with the instructions furnished by the manufacturer. Generally, surface preparation consists of a **THOROUGH** manual cleaning of damaged areas, including complete removal of: (1) unbonded epoxy and (2) all rust. Cleaning is usually accomplished with a power driven wire brush, hand steel brush, and/or emery paper. Care should be exercised during preparation so that excessive sound epoxy is not damaged. Acceptance criteria for epoxy repair and touchup materials is in accordance with the original epoxy resin manufacturer's recommendations.
- 2. Epoxy coated reinforcing steel is used in concrete bridge decks to prevent spalling of the concrete which is, in turn, caused by the corrosion of the reinforcing steel. The epoxy coating prevents the corrosion of the reinforcing steel. Two factors influence the capability of the coating to prevent corrosion. One of these factors is the thickness of the coating. The other factor is the integrity of the coating, i.e., the absence or presence of defects in the coating which would allow moisture and de-icing chemicals to reach the metal itself.
- 3. The epoxy coating on the rebars may have three types of defects when the bars arrive at the site. One of these is defined in the Specifications as a "holiday." A holiday is a small hole in the coating which is not visible to the naked eye. This type of defect is the result of some inadequacy in the application process. Holidays can be detected only with an electronic detector and the Specifications permit two holidays per 1 foot (300 mm).

4. The second type of defect, which may be present in the epoxy coating when the bar arrives at the site, is defined as handling damage. Handling damage may take the form of scuffs, scars, scratches or any other wound to the coating caused by rough handling. The Specifications permit a "reasonable" amount of handling damage. Handling damage is generally visible to the naked eye since rust will form over the damaged spot after a sufficient amount of time passes. A fresh cut or scar in the coating would probably be difficult to locate visually, but would be readily picked up with an electronic detector.
5. The third type of defect, which may be present in the epoxy coating when the bar arrives at the site, is due to what may be considered as an "uncoatable" bar. During the rolling process, some bars are formed with very sharp edges on the deformations and ribs.
6. These edges are very difficult to coat adequately, and coating applicators usually avoid coating bars so formed. The defect in coating on these edges may or may not be visible to the naked eye. This particular defect can be detected with an electronic detector. When this defect is present, the detector will indicate this flaw by a constant 'beeping' when run along a rib. In most instances, the thickness of the epoxy coating will be very low in these areas or there may be no coating at all where the sharp edges are present.
7. Materials and Research Division personnel will inspect epoxy coated rebars at the coating applicator's plant in some, but not, all cases. In cases where inspection is made at the applicator's plant, the bars will have a maximum of two holidays per meter, plus handling damage, is allowed, when they arrive at the site. In addition, the coating thickness, on bars inspected at the applicator's plant, must meet the specification requirements for thickness of coating. Bars not so inspected at the applicator's plant will have an unknown number of holidays and possibly uncoated sharp edges plus handling damage when they arrive at the site and, in addition, the coating thickness will not have been checked. Bars that contain rolling defects or have uncoated sharp edges that are found during the inspection shall be rejected.
8. The basis for acceptance will be the total of defects per 1 foot (300 mm) of bar, i.e., holidays plus handling defects as located with the electronic detector.
9. A total of six defects in any 1 foot (300 mm) of the bar will be permitted. As an example, in a bar of given length, if any 1 foot (300 mm) section of that bar has no more than the two allowable holidays and four handling defects, the bar is acceptable, providing none of the four handling defects has an area greater than 0.0025 ft.^2 (225 mm^2). [A square measuring $0.05 \text{ ft} \times 0.05 \text{ ft}$ ($15 \text{ mm} \times 15 \text{ mm}$) has an area of 0.0025 ft.^2 (225 mm^2)]. All handling defects having an area greater than 225 mm^2 must be repaired.
10. The following points may be helpful in the inspection and repair of epoxy coated rebars in the field.
 - a. Inspect bars for coating defects, using the electronic detector, as they come out of the bundle.

- b. It may not be necessary to check all bars in each bundle, but enough bars out of each bundle should be checked in order to determine the quality of coating on all bars in the bundle.
 - c. When the number of defects per 1 foot (300 mm) section exceeds six, only the number of defects necessary to bring the bar into compliance need be repaired. Only exception is that all defects greater than .00005 in² (.035 mm²) must be repaired.
 - d. Repair of defects is accomplished with an approved two component epoxy compound supplied by the coating manufacturer.
 - e. Epoxy compounds used for repair have a minimum temperature at which they may be used and a limited pot life, as recommended by the manufacturer.
 - f. Any rust showing through the defect must be removed before applying the epoxy compound. A file or grinding wheel may be used provided no substantial reduction in the area of the bar occurs.
 - g. Coating thickness of the painted repair area must be as specified for the factory applied coating.
 - h. Coating on bars may be damaged during placement at the site. Such damage to the bars must be repaired when the bars are in place, if the six defects per 1 foot (300 mm) section limitation is exceeded.
 - i. Check coating thickness if bars were not inspected at the coating applicator's plant. This should be done as they come out of the bundle. Coating thickness is checked with a magnetic thickness gage.
 - j. To obtain a holiday detector, contact the nearest branch laboratory or the Construction Division. "Electrometer" magnetic thickness gages may be obtained by requisition from the Engineering Equipment Section, "Inspector" or "Microtest" thickness gages which are used for checking paint film thickness cannot be used for checking epoxy coating thickness on reinforcing steel.
11. For situations where there is no information available as to what type of touch-up material should be used, 3M Corporation has two products available:
- a. SCOTCHKOTE 213 is often used to repair minor nicks and gouges.
 - b. SCOTCHKOTE 312 is a two component epoxy that has been used to repair both small and large areas of damage.

NOTE: Repaired areas do not have as much corrosion or abrasion resistance as factory-applied coatings.

K. Bar Designation System

1. You must be very careful when you review a bar list. Currently, steel bar in the USA is usually measured in English units. Do not assume anything; measure to be sure you are getting the correct size. In general, the mark number for reinforcing bars as shown in the plans generally uses the following designation system. The first letter or letters identify the general location of the bar such as abutment, pier, or slab bar.

<u>Location</u>	<u>Code</u>
Abutment	A
Pier	P
Slab	S

2. The first number or numbers indicate the size of the bar and the last two numbers indicate whether the bar is bent or straight. (Even numbers are straight bars and odd numbers are bent bars.)
3. For example, P1002 would be a straight No. 10 bar located in the pier; A415 would be a bent No. 4 bar located in the abutment. The last two numbers also indicate the approximate length of the bar. The lower the number the longer the bar; for example, a S602 bar would indicate the longest, straight, No. 6 bar used in the slab, whereas a S612 bar would indicate that there are five groups of straight, No. 6 bars that are longer than the S612 in the slab. The reinforcing steel table in *Appendix 4* lists pertinent information concerning the standard bar designation system.

L. Splicing

1. All reinforcement shall be furnished in the full lengths indicated in the plans. Splices, not shown in the plan, shall not be allowed without approval of the Project Manager. Welding shall be allowed only if shown in the plans or authorized by the Construction Engineer in writing.
2. When splices are required, they should be staggered as far as possible in order that a plane of weakness is not caused in the member. The laps should be at least as long as is shown in the plans and if no lap is shown, the bars should be lapped as required in *SSHC Subsection 707.03*. Splices should preferably be made in areas of low stress concentration. The bars in the top of a slab or beam should be spliced in a positive moment section (bottom of slab or beam in tension) and the bars in the bottom of a slab or beam should be spliced in a negative moment section (top of slab or beam in tension). For example, the longitudinal bars in the top of a slab should be spliced near the center of the span rather than over a pier and the longitudinal bars in the bottom of the slab should be spliced near the pier rather than in the middle of a span. Following is a tabulation of 24 and 36 diameter lap requirements for the various sizes of rebars.

ASTM Standard Reinforcing Bars				
		Nominal Dimensions - Round Sections		
Bar Size Designation	Weight Pounds per Foot	Diameter Inches	Cross-Sectional Area - Sq. Inches	Perimeter Inches
#3	.376	.375	.11	1.178
#4	.668	.500	.20	1.571
#5	1.043	.625	.31	1.963
#6	1.502	.750	.44	2.356
#7	2.044	.875	.60	2.749
#8	2.670	1.000	.79	3.142
#9	3.400	1.128	1.00	3.544
#10	4.303	1.270	1.27	3.990
#11	5.313	1.410	1.56	4.430
#14	7.650	1.693	2.25	5.320
#18	13.600	2.257	4.00	7.090

LAP REQUIREMENTS			
Metric Bar Size	English Bar Size	24 Diameter Lap Grade 40 Steel	36 Diameter Lap Grade 60 Steel
10	2	6 in (150 mm)	9 in (225 mm)
10	3	9 in (225 mm)	14 in (350 mm)
10	4	12 in (300 mm)	18 in (450 mm)
15	5	15 in (375 mm)	23 in (575 mm)
15	6	18 in (450 mm)	27 in (675 mm)
25	7	21 in (525 mm)	32 in (800 mm)
25	8	24 in (600 mm)	36 in (900 mm)
30	9	27 in (675 mm)	41 in (1025 mm)
30	10	30 in (750 mm)	44 in (1100 mm)
35	11	33 in (825 mm)	49 in (1225 mm)

3. There are times when splicing of rebar in a manner other than lapping is necessary. Examples include:
 - a. Complicated placement where the cage could be tied off site, in sections, and set in place.
 - b. Reinforcement cages for drilled shafts.
 - c. Situations where an existing rebar is not long enough to develop strengths by lapping.

4. Example: During removal of an existing curb on a bridge deck widening project existing rebar is either cut with the saw or broken during concrete demolition. In this case additional demolition is needed to provide a lap development length.

5. Mechanical splices are only authorized where shown in the plans and materials must be in the NDR Approved Products List. Currently, several couplers are manufactured which can be used to mechanically splice rebar. Mechanical splices, for field approval, shall develop 125% of the rebar's yield strength. Consideration for splice usage must be initiated by the contractor. The Project Manager is to forward that request to the Construction Division for review.

705.04 METHOD OF MEASUREMENT (*SSHC Subsection 707.04*)

- A. Reinforcing steel for concrete structures is measured by the pound. Quantities to be paid for are computed from the theoretical mass of bars and wire mesh. The mass of steel reinforcement required for structures of varying sizes is usually given in tables on standard and special plans. The quantities contained therein may be used for computing final payment for structures except bridges. Plan quantity may be used for final quantity reinforcing steel for bridges.

706.00 CONCRETE CONSTRUCTION (SSHC Section 704)

706.01 DESCRIPTION

- A. This section of the Specifications deals with the construction of structures composed of portland cement concrete. This work includes constructing, setting and supporting the forms, and handling, placing, finishing and curing the concrete for bridges, box culverts, arch culverts, headwalls, retaining walls and steps, and the miscellaneous structures listed in the incidental construction portion of the Specifications.

706.02 MATERIAL REQUIREMENTS

A. Composition of Concrete

1. The class of concrete to be used in the work is specified in the plans or special provisions and shall be one of those described in *SSHC Subsection 1002.02*. In the event that the contractor has a choice of several classes, he/she is required to advise the Project Manager by letter of the one to be used. This information should be obtained prior to any concrete construction to allow engineering personnel to make provisions for necessary inspection and testing. The contractor may not change classes of concrete during construction without the written permission of the Project Manager.
2. *SSHC Subsection 1002.03* prescribes requirements for concrete materials. The Contractor's responsibility for material requirements may be summarized as follows:
 - a. Check with Materials & Research as to the approval of cement, coarse aggregate, fine aggregate, air-entraining agent and curing compound.
 - b. Submit samples of non-approved materials to the Central Testing Laboratory in sufficient time before use to allow time to receive results. The size and frequency of samples are provided in the "*Materials Sampling Guide*".
 - c. Materials for which approval has not been received must not be used in the work.
3. The inspector is concerned not only with the approval of materials but also with the storage of materials. Bag cement shall be stored in a dry location. If stacked more than 8 bags high for a period of time the lower layers take on a "warehouse set" and should not be used. Cement stored over 90 days must be retested before use.

B. Admixtures

1. Admixtures are those ingredients in concrete other than portland cement, water, and aggregates, that are added to the mixture immediately before or during mixing. Admixtures typically encountered on our jobs can be classified by function as follows:
 - a. Air entraining admixtures (optional)
 - b. Water reducing admixtures (optional)

- c. Set retarding admixtures (required)
 - d. Set accelerating admixtures (optional)
 - e. Finely divided and permeability mineral admixtures (Fly Ash & Silica Fume) (optional)
 - f. Coloring agents (normally not used for NDR work) (optional)
2. The amount of any admixture used in a mix should be as recommended by the manufacturer. Effectiveness of an admixture depends upon such factors as type, brand, and amount of cement; water content; aggregate shape; gradation and proportions; mixing time; slump; and temperatures of concrete and air.
 3. Concrete with a low air content shall not be incorporated into work. One addition of air entraining admixture is allowed at the site according to specification.
 4. Concrete with a high air content should not be incorporated into work except under extreme circumstances. If low compressive strengths result, the concrete may be required to be removed and replaced. (*SSHC Subsection 106.05*)

C. Air Entraining Admixtures

1. Air entraining admixtures are used to purposely entrain microscopic air bubbles in concrete. Air entrainment will dramatically improve the durability of concrete exposed to moisture during cycles of freezing and thawing. Entrained air greatly improves concrete's resistance to surface scaling caused by chemical deicers.
2. Rules-of-Thumb
 - a. As cement content increases, air agent must increase to maintain equal entrained air.
 - b. As cement fineness increases, the amount of air agent must increase to maintain equal entrained air.
 - c. As coarse aggregate size decreases, the air content increases for a given amount of air agent.
 - d. As fine aggregate volume increases, the air content increases for a given amount of air agent.
 - e. As mixing water increases, the air content increases for a given amount of air agent.
 - f. Air entraining admixtures should be introduced into mix at the plant, but additional may be added at the site to adjust mix for correct air content.
 - g. Air entraining admixtures should (usually) be added to the front of the truck at the plant. If corrosion inhibiting admixture is used, air entraining agents should be added to the back of the truck.

D. Water Reducing Admixtures (Type A) (optional)

1. Water reducing admixtures are used to reduce the quantity of mixing water required to produce concrete of a certain slump or reduce the water/cement ratio. Regular water reducers reduce water content by about 5% to 10%.
2. Adding a water reducing admixture to a mix without reducing water content can produce a mixture with a much higher slump.
 - a. Rules-of-Thumb
 - (1) Typically, water reducing admixtures do not reduce the rate of slump loss; in most cases, it is increased. Rapid slump loss results in reduced workability and less time to place concrete at the higher slump.
 - (2) Typically, water reducing admixtures decrease on bleed water because less water is available.
 - (3) Certain types of sulfate starved portland cements may cause false set with certain brands of water reducers. Typically, water reducers contain lignosulfonates and these sulfates are easily attracted by sulfate starved cements. This action may cause early false set.
 - (4) Despite reduction in water content, water reducing admixtures can cause a significant increase in drying shrinkage.

E. High Range Water Reducing Admixtures (Type F) (optional)

1. They are added to concrete with low-to-normal slump and water content to make high slump "flowable" concrete. Flowable concrete is a highly fluid, but workable concrete that can be placed with little or no vibration and can still be free of excessive bleeding or segregation. Flowable concrete has applications:
 - a. In areas of closely spaced and congested reinforcing steel.
 - b. In tremied concrete where "self consolidation" is desirable.
 - c. In pumped concrete to reduce pump pressure.
 - d. To produce low water/cement ratio - high strength concrete. High-range "super plasticizers" can reduce water content by about 12% to 30%.
2. Rules-of-Thumb
 - a. The effect of most super plasticizers in increasing workability or flowable concrete is short lived. Typically, maximum is 30 to 60 minutes followed by a very rapid loss in workability.

- b. Typically, super plasticizers are added as split treatments (part at the plant part at the site). Sometimes the addition is totally at the site.
- c. Setting time may be affected depending on the brand used, dosage rate, and interaction with other admixtures.
- d. Excessively high slumps of 10 inches (250 mm) or more may cause segregation.
- e. High-slump, low water/cement super plasticized concrete has less dry-shrinkage than does high-slump high water/cement conventional concrete.
- f. Effectiveness of super plasticizer is increased with an increased amount of cement and/or increased fineness of cement.
- g. Effectiveness of water reducers on concrete is a function of their chemical composition, cement composition and fineness, cement content concrete temperature, and other admixtures being used.
- h. Some water reducing admixtures, such as lignosulfonates, may also entrain some air in the mix.

F. Retarding Admixtures (required)

- 1. Retarding admixtures (retarders) are used to delay the initial set of concrete. High temperatures of fresh concrete 85°F (30°C) and up often cause an increased rate of hardening. Since retarders do not decrease the initial temperature of concrete, other methods of counteracting the effect of temperature must be used.
- 2. Rules-of-Thumb
 - a. Retarders are sometimes used to delay initial set of concrete when difficult, long placement times, or unusual placement conditions exist.
 - b. Retarders offset the set acceleration effect of hot weather.
 - c. Retarders can be added at the site.
 - d. In general, some reduction in strength at early ages (one to two days) accompanies the use of retarders.
 - e. Use of retarders must be closely monitored, because there is probably no single admixture which has caused more field problems.
 - f. If too much retarder has been used in a mix:
 - (1) Time will usually counter the effects.
 - (2) Be sure to maintain the cure during the added time.

G. Accelerating Admixtures (optional)

1. Accelerating admixtures (accelerators) are used to accelerate the setting time and strength development of concrete at an early age. Strength development can also be accelerated by using:
 - a. Type III "high-early" cement
 - b. Lowering water/cement ratio
 - c. Curing at controlled higher temperatures
 2. Calcium Chloride (CaCl_2) is the material most commonly used in accelerating admixtures. Besides accelerating strength gain, calcium chloride also causes an increase in drying shrinkage, potential reinforcement corrosion, discoloration, and potential scaling.
 - a. Rules-of-Thumb
 - (1) Always add calcium chloride in solution form as part of the mixing water.
 - (2) Calcium chloride is not an antifreeze agent. When used in allowable amounts, it will only reduce the freezing point of concrete by a few degrees (may cause deck cracks).
- H. Finely Divided Mineral Admixtures
1. These admixtures are powdered or pulverized materials added to concrete to improve or change the properties (plastic or hardened) of concrete. Based on the mineral's chemical or physical properties, they are classified as: (1) Cementitious, (2) Pozzolans, (3) Pozzolanic and Cementitious, and (4) Nominally inert. Typical PCC mix designs use pozzolanic and cementitious minerals.
 2. Pozzolanic Materials
 - a. A pozzolan is a siliceous or aluminosiliceous material that in itself possesses little or no cementitious value but will, in finely divided form and in the presence of water, chemically react with the calcium hydroxide released by the hydration of portland cement to form compounds possessing cementitious properties. Pozzolans include fly ash and silica fume.
 3. Fly Ash (Class C & F)
 - a. Fly ash is a finely divided residue that results from the combustion of pulverized coal in electric power plants.
 4. Silica Fume
 - a. Silica fume, also referred to as micro-silica or condensed silica fume, is another material that is used as a pozzolanic admixture. This light to dark gray powdery product is a result of the reduction of high-purity quartz with coal in an electric arc furnace.

- b. Fly ash and silica fume have a spherical shape. Silica fume has an extremely small particle size (about 100 times smaller than the average cement particle). Although silica fume is normally in powder form, because of its small size and increased ease of handling the product is commonly available in liquid form.

- c. Rules-of-Thumb
 - (1) Mixes containing fly ash will generally require less water (about 1% to 10%) for a given slump. Silica fume concrete requires more water for a given slump.
 - (2) The amount of air-entraining admixture required to obtain a specified air content is normally greater when fly ash or silica fume is used. The amount of air-entraining admixture for a certain air content is a function of the fineness, carbon content and alkali content.
 - (3) Fly ash will generally improve the workability of concretes of equal slump. However, fly ash in low slump concrete will tend to tear and have reduced workability. Silica fume tends to reduce workability, thus high-range water reducers are usually added to maintain workability.
 - (4) Concrete using fly ash or silica fume generally shows less segregation and bleeding than plain concrete.
 - (5) Use of fly ash will reduce the amount of heat buildup in concrete. Silica fume most likely will not reduce the heat of hydration, because typically high-range water reducers are used and they increase mass temperatures.
 - (6) Use of fly ash will tend to generally retard the setting time of concrete. Silica fume alone will accelerate the setting time, however, high-range water reducers tend to offset this.
 - (7) Use of fly ash generally aids the pumpability of concrete. With adequate and correct curing, fly ash generally reduces the permeability. Silica fume is especially effective in this regard.
 - (8) With adequate and correct curing, fly ash generally reduces for permeability. Silica fume is especially effective in this regard.

I. Concrete Temperatures

1. Recommended Concrete Temperatures

- a. Concrete should be between 45°F and 80°F (7°C and 27°C) when placed. To ensure a concrete temperature of at least 50°F (10°C) for 72 hours after placement the concrete for thin sections such as culvert walls, end posts, piling encasements, etc. should be 65°F (18°C) or higher, since the only additional heat source is the heat of hydration. Concrete for massive sections such as abutments, heavy piers, and footings should be in the 55° to 65°F (13° to 18°C) range.
- b. Since only dry insulation is effective, any insulation that has a propensity to absorb water or become saturated must be protected with a waterproof membrane. The insulation system must provide complete coverage and be secured to provide maximum protection during the full curing period.
- c. For typical protection applications, insulated forms must be left undisturbed for 96 hours before being removed.

2. Checking Temperature of Concrete

- a. For checking compliance with minimum temperature requirements during the 48-hour period after placement thermometer wells should be cast in the concrete during the pour. The following procedure for checking temperature is suggested:
 - (1) Drill a 5/16 inch (8 mm) hole through the form at one or more locations where temperature checks will be made.
 - (2) Grease the thermometer probe and insert it through the hole about 4 inches (100 mm) into the plastic concrete.
 - (3) Remove probe after the concrete is set and cover hole with insulating material.
 - (4) Further checks can be made by inserting the thermometer through the insulation into the well developed in step 2. Leave thermometer in place if desired, but protect from damage or theft.

NOTE: The thermometer stem should be inserted about 3 inches (75 mm) into the concrete because the sensitive portion of the stem is about 1¾ inch (44 mm) below the groove.

- b. Record the temperature daily for 5 days following the pour. Temperature readings below 50°F (10°C) during the first 48 hours should be entered in the Field Book and reported to the District Construction Engineer for evaluation of possible damage or price adjustment.
- c. A thermocouple - - with recorder can also be used to document temperatures during curing.

3. Deck Concrete Temperature and Curing
 - a. Subsection 706.03 identifies requirements for placing and curing concrete bridge floors. Of importance for this section are:
 - (1) Plastic concrete, when placed, shall not exceed 86°F (30°C).
 - (2) The curing method requires "wet" burlap cure for four (4) days.
 - (3) If the forecast high outside air temperature for the day is predicted to be above 80°F (26°C) the contractor should cast the deck starting at 5:00pm.
 - b. The placing of concrete will require close monitoring to comply with the specifications. Obtain a weather report to determine predicted air temperature, wind velocity, and relative humidity for the pour day.
 - c. The above information should be discussed by the inspector, contractor, and ready mix plant operator before a deck pour. The pour should not be attempted if concrete temperature is predicted at 86°F (30°C) or higher and predicted air temperature is above 86°F (30°C).
4. Temperature Field Documentation
 - a. The temperature of concrete should be taken as soon as concrete is placed. It should be taken when the first load is placed. Additional checking is warranted if the temperature is running at or near maximum. Air temperature should also be taken about the same time as the concrete temperature.
5. Maximum Air Temperature--No continuous placement is to be attempted when temperature forecast is above 86°F (30°C).
 - a. Working time of concrete varies with the temperature of concrete, and concrete temperature varies with the temperature of different materials used in the mix. In order to determine the dosage rate of retarder, an estimate of the mix temperature must be made. The following are suggested estimating methods:
 - (1) The temperature of concrete from previous placements could be taken.
 - (2) If a ready mix producer is placing concrete the day before a deck placement, this concrete could be checked for concrete temperature.
 - b. Regardless of the method used, make the best estimate of what the concrete temperature will be during the warmest part of the day. Remember, concrete shall not be placed in new decks if the concrete temperature is above 85°F (30°C).

706.03 CONSTRUCTION METHODS

A. Prepour Meeting

1. It is very important to use the prepour meeting to discuss the specifics of placement, establish communication, and resolve potential "sticky" issues prior to placement. Generally it is recommended to discuss:
 - a. Chain-of-command. Who is in charge for the contractor? Who needs to be notified if material tests do not comply with specifications? Establish prior to placement how test results are reported (i.e., does the Contractor want to be notified verbally, or in writing each time?).
 - b. More cement paste will cause more cracks and less paste means fewer cracks.
 - c. Material requirements and admixtures needed for the placement (Examples: Single cement source, concrete temperature and methods used to cool the mix, source and amount of any admixtures, specific mixes required for bridge decks, etc.)
 - d. Vibration can make a stiff mix workable with better results than adding water.
 - e. Procedures for introducing admixtures during mixing operations need to be discussed and formalized. For example: How and where will the air entraining agent be introduced? There is a growing concern that placement location of admixtures is causing significant variability in mixes. The plant monitor must watch and document how admixtures are introduced during mixing.
 - f. Method and frequency of acceptance testing during any placement. Inform the Contractor what is expected if non-acceptable material is found during placement.
 - g. Scheduling, truck availability, placement method, and required placement rates.
 - h. Establish an acceptable source of preplacement weather forecasting. Agree on weather parameters which will be used for "go" or "no-go" decisions both "prior to" and during the placement activity.
 - i. Larger limestone aggregate will reduce deck cracks. The gradation tables all have tolerances. Make sure we get as large of limestone aggregate as is available.
2. Adequate Labor Force
 - a. At preplacement meetings talk about and, before starting a placement be sure the contractor has:
 - (1) Proper and adequate materials to protect the placement.

- (2) Adequate numbers of sufficiently skilled laborers available.
 - (3) Proper tools on the job.
 - (4) Arranged for the rate of delivery of concrete to make the placement operation efficient.
- b. 25 cy (20 cubic meters) per hour should be a minimum placement rate. Any method of delivery to the deck should be checked to see that rate of placement can be such that finishing operations can proceed at a steady pace, with final finishing completed before the concrete starts its initial set.

B. Concrete Plant Inspector's Checklist

1. Specifications regarding plant inspection, equipment approval, and batching operations should be reviewed for familiarity. **In addition to proper plant calibration, the inspector should verify that each truck mixer used on the job has a current certification as required by SSHC Section 1002.** It is good practice to inspect a random sample of ready mix trucks that will be used on the job, verifying that the certification accurately reflects the truck's condition. Truck certification numbers should be recorded in the inspector's diary and will need to be reverified at least every 30 days.
2. Batching and mixing should be limited to the lead truck until slump and air content have been tested for conformance with specifications. **Contractors may make preliminary tests at the plant but project acceptance is based on job site tests.** It is intended that the ready mix plant supply concrete to the construction site that conforms to all applicable specifications at the point where the acceptance sample is taken.
 - a. *SSHC Table 1002.02, Concrete Proportions*, lists slump and air content requirements.
 - b. If concrete is being delivered which deviates much from these target values, the contractor is responsible for taking corrective action to bring the mix to within target values. Even if the current mix is within specified limits. The intent of the tolerance is to provide latitude during placement for unforeseen changes in materials, mixes, and placement methods. Placing concrete "consistently" near a tolerance limit is not desirable and warrants additional sampling.
 - c. What is important, is the contractor's response to test results approaching tolerance limits. Continually having to add water and/or air agent to each load at the site will not be permitted. If such practice is occurring, the inspector shall notify the contractor (or whomever was designated as "the" responsible individual in charge of the concrete at the site.) Ultimately, it is the contractor's responsibility to initiate immediate corrective action.
3. Non-responsiveness on the contractor's part is reason to initiate sampling and testing of each truck or halt placement. The purpose for additional testing is to ensure that no noncomplying materials are incorporated into the project.

4. In some cases admixtures, such as water reducers, are required to be added in split doses or sometimes totally at the site.
5. All Structural Concrete
 - a. At the start of each day's placement, no concrete is to be placed in the forms or on the deck until the first truck has been sampled, tested, and approved. Incorporation of materials from this truck will not be permitted unless desired slump and air content are within specified limits. Continuous placement shall not begin until after test results indicate the material meets specified requirements.
 - b. If the first load is close to a limit value, it is recommended to sample and test the second load unless site experience indicates it is not necessary.
 - c. Initial start up test results (if taken from the truck chute) must account for method of placement. For example: If placement will be through a pump, air values should be on the high side of target to account for loss during pumping. Again, site/project experience should be factored in this decision.
 - d. Routine acceptance testing will be at a minimum frequency of one sample per 100 yd³ (100 m³). This frequency may be changed for large, continuous placement where placement rates warrant a lesser frequency. Minimum quantity placed between routine acceptance tests is 100 yd³ (100 m³). This rate of testing may be increased (made more frequent) if the inspector has a concern that target values are not being met.

NOTE: Only the Materials and Research Division has authority to approve decreasing (less frequent) testing frequencies from those listed in *Materials Sampling Guide*. PLAN AHEAD and obtain approval for those cases where a variance would be reasonable.

- (1) For routine acceptance testing, obtain a representative sample at the last practical point before incorporation, but prior to consolidation.

NOTE: When concrete is placed by means other than directly from the back of the truck the sample shall be taken after the concrete has passed through the conveyance method being used. (This includes placement by bucket, belt, pumps, power buggies, etc.)

- (2) Routine acceptance sampling and testing does not require holding a truck until results are available. However, if there are obvious deficiencies, the inspector has the authority to hold that truck until test results are available.
- (3) Inspectors should be alert to obvious visual changes in consistency, with routine acceptance air and slump tests being made as noted above. Any load having questionable consistency should be checked for slump, and air content.
- (4) If noncomplying test results are found during routine acceptance sampling, no more material (from that truck or others) shall be incorporated until complying test results are obtained. When test results indicate noncomplying material:

- (a) The rest of that load shall be rejected and not incorporated, unless adjustments can be made to bring it back into compliance.
 - (i) In an attempt to bring noncomplying concrete into compliance, the supplier may make field adjustments (i.e., add air entraining agent, or rotate the drum). Such "field" adjustments shall be an EXCEPTION and not the general rule and the 90 minute time restriction shall not be waived for any situation.
 - (b) For all noncomplying test results the inspector shall immediately notify the contractor or their representative in charge of the concrete. This notification shall also inform the Contractor if noncomplying materials have been incorporated into the structure.
 - (c) If test results indicated noncomplying materials have been incorporated, the inspector shall make a note in the diary indicating the test results, approximate volume incorporated, location the material was placed, and to whom the notification was given. The inspector should also note a noncomplying event on that particular truck's delivery ticket.
 - (d) When noncomplying materials are found, the inspector will:
 - a) hold each truck, and
 - b) initiate sampling and testing of each truck until two consecutive loads meet specifications. At this point sampling and testing may return to normal project acceptance frequency.
6. Specifications spell out requirements that materials must meet to be acceptable. Further, the *Materials Sampling Guide* identifies a frequency for sampling/testing and whether the test is an acceptance or assurance test.
- a. Authority for initially rejecting noncomplying materials and poor quality work performance is given to the inspector in *SSHC Subsection 106.05*. This rejection authority is only superseded by the Project Manager. There is an old saying to the effect "*We shall not knowingly incorporate noncomplying material into a project.*" This means exactly what it says and there is ample support in the specifications for this position.
7. During placements, the inspector should alternate sampling among the various trucks involved in the operation.
8. If there is a specific truck which is identified as causing a problem with consistency, that truck shall be rejected from further use.

9. Transit mixers shall be completely emptied of wash water before reloading. If the truck's top fill hopper is washed after loading, no wash water shall be allowed to enter the mixer.
10. The inspectors will need to satisfy themselves regarding compliance with the specifications for the number of drum revolutions at mixing speed.
11. If water, air entrainment or other admixtures are added at the project site, acceptance testing will not be performed until all additions have been made AND required mixing has been completed following the change.

C. Falsework

1. General: *SSHC Subsection 704.03*, paragraph 7.f. requires the contractor to submit 6 copies of falsework plans when required or when certain conditions apply. These plans shall be prepared by an Engineer registered in the State of Nebraska. The contractor shall prepare falsework plans, as called for in plans or in the special provisions, and for:
 - Support of plastic concrete for concrete slab bridges with spans greater than 50 ft (15.25 m) in length.
 - Cast-in-place concrete girders
 - Slab bridge false work should allow for ? inch (3 mm) of deflection for each 10 feet (3 m) of span. This means that on an 80 foot simple span bridge the falsework should be 1 inch high at midpoint.
2. Falsework Inspection
 - a. Contract requirements governing falsework construction are contained in *SSHC Subsection 704.03, paragraph 7*.
 - b. The Project Manager should observe the falsework as it is erected to ensure that:
 - (1) Only sound materials are used.
 - (2) Quality work is used.
 - (3) During concrete pour, the falsework will carry the load. (More than ½" movement is bad.)

NOTE: Any inspection and/or acceptance by the Project Manager is not intended to relieve a contractor of responsibility under the contract for falsework design and construction.

- c. By specification, a contractor is responsible for proper evaluation of the quality of their falsework materials. However, the Project Manager should not permit use of any material, when there is doubt as to the materials ability to safely

carry the load. If there is any question, the contractor should be required to perform a load test or furnish other evidence of structural adequacy.

- d. Timely inspection is essential. Falsework deficiencies should be brought to the contractor's attention at once. Deficiencies include:

- (1) Poor quality work.
- (2) Use of unsound or poor quality materials.
- (3) Construction which does not conform to the contractor's falsework drawings.

- e. If the contractor fails to take corrective action, a noncompliance letter shall be issued. Corrective action will be required prior to placement of any additional dead or live load to the support structure.

3. Falsework Foundations

- a. Falsework piling should be driven to adequate bearing unless mudsills or spread footings can be founded on rock, shale, compact gravel, coarse sand, firm clays in natural beds, or well compacted fill.

- (1) Falsework Piles

- (a) If requested, pile bearing values will be determined by the wave equation. Otherwise, the contractor is responsible for adequate foundation support.
- (b) The pile bearing value required to support the design load must be shown on falsework drawings, and the pile driving operation must be inspected sufficiently to ensure that falsework piles attain required bearing.

- b. Mudsills and Spread Footings

- (1) Foundation material should be inspected before the footings are placed.
- (2) To ensure uniform soil bearing, falsework pads must be set on material that provides a firm even surface, free of bumps or depressions within the pad bearing area. If necessary to obtain uniform bearing, a thin layer of sand may be used to fill in surface irregularities.
- (3) Continuous pads must be analyzed differently than individual pads, and the two should not be considered equivalent. A change from one to the other requires resubmittal in the Construction Division for review by the Bridge Division.

- (4) Falsework pads should be level. Benches in fill slopes should be cut into firm material, with the pad set well back from the edge of the bench.
- (5) Many soils lose their supporting capacity when saturated. Adequate falsework construction must provide for drainage and protect pads from being undermined or ponded in water.

c. Soil Load Test

- (1) Project Managers should require the contractor to perform a soil bearing test if there is any doubt as to the ability of foundation material to support the falsework load without appreciable settlement. One method to evaluate in-situ bearing capacity is to perform a plate bearing test as per ASTM D-1 194. (The above referenced method is not the only such test procedure, but is included to provide one method of determining in-situ capacity.)

4. Falsework Materials

- a. One aspect of a falsework design and review is based on the use of undamaged, high-quality materials. Material strength values must be reduced if lower quality materials are to be used. Obviously, evaluation of the quality of materials actually furnished is an important, and essential, part of the falsework inspection procedure.

(1) Timber

- (a) Inspecting falsework materials is necessary to prevent the use of materials which obviously do not meet the "undamaged high-quality" design criteria.
- (b) Falsework materials delivered to the job site, should be equal to or greater than the grade, or type of material, assumed in the design review. Timber having large shakes, checks or knots, or which are warped or split should not be used at critical locations. Abused timber, although stress graded, may no longer be capable of withstanding the original allowable stress.
- (c) Rough sawn timbers should be measured to determine their actual dimensions. Unlike surfaced/finished material, the dimensions of roughcut timber are not uniform from piece to piece. The variation may be appreciable, particularly in the larger sizes commonly used for falsework posts and stringers. If actual dimensions are smaller than the dimension assumed in design, the member may not be capable of carrying the imposed load without overstress. Therefore, undersized material should not be incorporated into the falsework, unless the design is reevaluated using smaller dimensions.

(2) Structural Steel

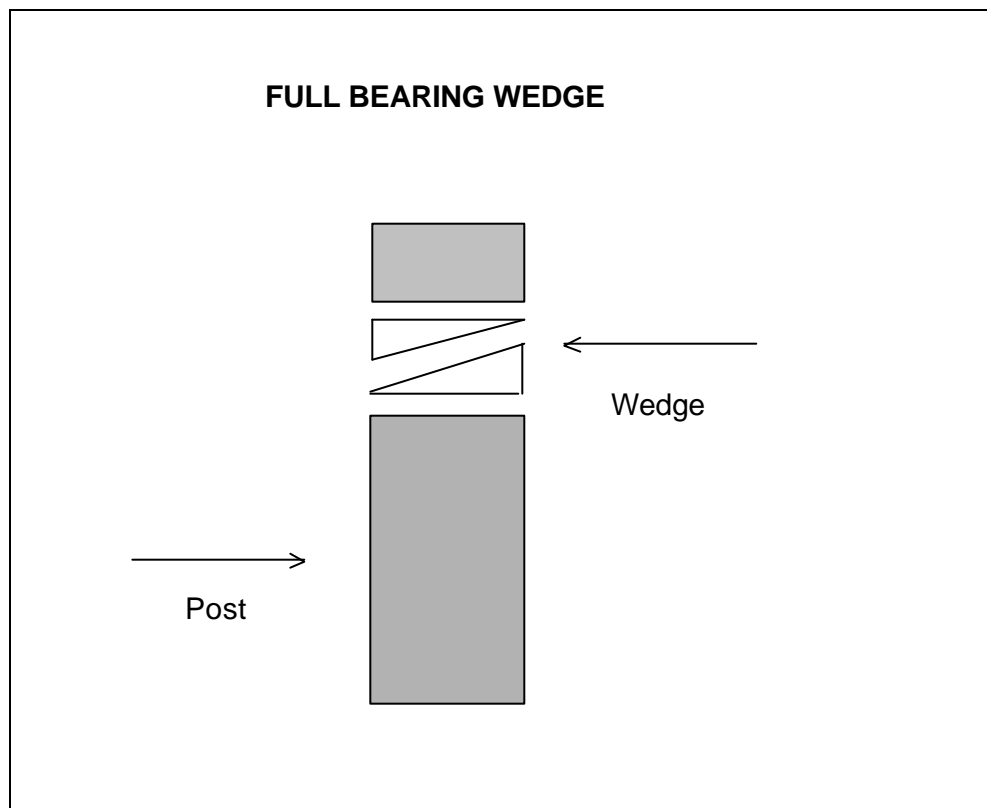
- (a) Used beams, particularly beams salvaged from a previous commercial use, should be examined carefully for loss of section due to welding, rivet or bolt holes, or web openings which may adversely affect the ability of the beam to safely carry the load imposed by the falsework design.
 - (b) Welded splices should be inspected visually for obvious defects. Radiographic inspection or other methods of nondestructive testing will not be required as a means of determining the quality of the splices unless the Project Manager has reason to believe the welds are defective.
 - (3) Manufactured Products
 - (a) Manufacturer's ratings are based on the use of new material or used material in good condition. The determination as to whether a manufactured product is in good condition is highly subjective and requires experience and judgment.
 - (b) When manufactured assemblies are used in falsework, they shall be shown on the falsework plans along with their identification number. The actual assembly shall be clearly and permanently marked with the identification number.
 - b. Identification numbers will allow field inspectors to verify the capacity and proper application of various devices.
 - c. Identification by the contractor applies not only to jacks, beam hangers, overhang brackets, and similar devices, but to all vertical steel shoring systems as well.
 - d. Manufactured products such as tubular steel shoring and steel overhang brackets are particularly vulnerable to damage by continual reuse. Fabricated units in which individual members are bent, twisted, or broken will have a substantial reduction in load carrying capacity. Steel shoring materials should be examined carefully prior to use. Shoring components should not be used if they are heavily rusted, bent, dented, or have broken/damaged welds or other defects. Connections, in particular, should be examined for evidence of cracked or broken welds. Miscellaneous components such as screw jack extensions, clamps, and adjusting pins should be inspected as well.
 - e. Proprietary scaffolding must be used as intended and not subjected to additional stresses or conditions for which it was not originally designed and tested.
- (1) Cable Bracing
 - (a) Cable bracing systems must be carefully inspected to ensure that field installation conforms to details shown on the falsework drawings. This is particularly important with respect to the location and method of cable attachment to any falsework.

- (b) Prior to installation, each cable should be inspected to verify that the type, size, and condition (new or used) are consistent with design assumptions. Used cable should be inspected for strength-reducing flaws. Use of obviously worn, frayed, kinked, or corroded cable should not be permitted.
- (c) Particular attention should be paid to cable clamp fasteners. Improperly installed clamps will reduce the safe working load by as much as 90 percent. Also, the omission of the thimble in a loop connection will reduce the safe working load by approximately 50 percent. After installation, clamps should be inspected periodically and tightened as necessary to ensure their effectiveness.
- (d) A cable clamp has two parts - the "U-Bolt" and the "Saddle." Also a cable has two parts, the wrapped non-continuous end (dead end) and the continuous portion which supports the load (live side). Always put the cable clamp's "saddle" on the live side and the "U-bolt" over the "dead end."

5. Falsework Quality

- a. High quality work, particularly in such details as wedges, fasteners, bracing, friction collars, jack extensions, etc., is critical to the proper performance of falsework. Accordingly, construction details should receive close attention from the project inspector.
 - (1) Timber Construction
 - (a) The following checklist is included as a guide to points which require special consideration:
 - (i) Diagonal bracing, including connections, must conform to details shown on the falsework drawings.
 - (ii) Diagonal bracing should be inspected after any falsework has been adjusted to grade. Connections must be securely fastened to ensure their effectiveness in resisting horizontal forces. Bolted connections may need retightening.
 - (iii) Timber posts may be wedged at either the top or bottom for grade adjustments, but not at both locations. Large posts may require two or more sets of wedges (side by side) to reduce compression stresses perpendicular to the grain.
 - (iv) Blocking and wedging should be kept to a minimum. It is poor workmanship to extend a short post by piling up blocks and wedges. This practice should not be permitted.

- (v) Particular attention should be given to falsework bents where grade adjustment is provided at the bottom of the posts. Differential grade adjustment of posts within a particular bent may induce undesirable stresses in the diagonal bracing.
- (vi) Splicing of wood posts will not be allowed unless shown on approved falsework plans.
- (vii) The ends of spliced posts must be cut square. The need for a post splice should have been anticipated by the contractor and the splice detail shown on falsework drawings. If this is not the case, the contractor must submit a detail for approval.
- (viii) Posts must be plumb and centered over the falsework pad or corbel.
- (ix) Abutting edges of soffit plywood should be set parallel to the joists and continuously supported on a common joist.
- (x) A sufficient number of telltales must be installed to accurately determine the amount of joint take-up and settlement. Telltales should be attached to the joists as close as possible to the supporting post or bent.
- (xi) Full bearing must be obtained between all members in contact. Deficiencies in this respect may be improved by feather wedging. If the joint requires more than a single shim or wedge, extra care should be taken to ensure that full bearing is obtained.



When using wedges, it is a good practice to use wedges inserted from both sides rather than deeply setting a single wedge. Using only one wedge increases the twisting effect on the member.

- When using wedges, it is good practice to install them parallel to and with the flat (nontapered) side against the main member. This improves contact with the main member and decreases the chance of a wedge "backing out" from vibration.
- Nail or clamp the wedge in place after installation.

(2) Steel Shoring (Scaffolding)

a. This checklist may be used as a guide by inspectors when inspecting falsework constructed of steel shoring.

- (1) Shoring components should be inspected prior to erection. Any component that is heavily rusted, bent dented or rewelded, or which is otherwise defective, should be rejected. Fabricated units having individual members that are bent twisted, broken, or where welded connections are cracked or show evidence of rewelding should be rejected.
- (2) A base plate, shore head, or screw jack extension device should be used at the top and bottom of all vertical components.

- (3) All base plates, shore heads, and extension devices must be in firm contact with the footing at the bottom and the cap or stringer at the top.
- (4) Shoring components should fit together evenly, without any gap between the upper end of one unit and the lower end of the other unit. Any component which cannot be brought into proper contact with the component it is intended to fit, should not be used.
- (5) Shore heads, extension devices, and similar components must be axially loaded. Eccentric loads are not permitted on any shoring component.
- (6) All locking devices on frames and braces must be in good working order, coupling pins must align the frame or panel legs, and pivoted cross-braces must have the center pivot in place.
- (7) Shoring should be plumb in both directions. Maximum deviation from true vertical should not exceed 3 inches per 1000 inches (3 mm per meter).

6. Miscellaneous Falsework Items

- a. This checklist covers items that may be used in either type of support system.
 - (1) New high strength bolts shall be used on any item that requires bolts to be torqued.
 - (2) Friction collar bolts and concrete anchors should be torqued initially and checked again just prior to concrete placement.
 - (3) Permanently deflected stringers should be placed with the crown turned upward.
 - (4) Jacks should be plumb and not overextended.

7. Falsework Adjacent to Traffic

- a. This will be an unusual situation in Nebraska. If it occurs, the Construction Division should be notified.

8. Falsework Field Changes

- a. If supplemental calculations are necessary to verify compliance with contract requirements, the change will be considered substantial. In this case, the proposed change must be submitted for review and approval in the same manner as the original drawings.
- b. The following are examples of changes considered substantial and must be shown on revised falsework drawings, regardless of other considerations:
 - (1) A change in size or spacing of any primary load-carrying member.

- (2) A change in method of providing lateral or longitudinal stability.
- (3) Any change, however minor, which affects the falsework to be constructed over or adjacent to a traffic opening.
- (4) A revised concrete placing sequence, if it significantly affects the stresses in load-carrying members.
- (5) When revised drawings are required, they must be submitted for review in the same manner as the original falsework drawings. The Department does not approve falsework! Time shall be allowed for review of revised falsework drawings. Typically this is the same as required for the original submittal.
- (6) The PM should be alert to and document any field changes to falsework plans.

9. Falsework Inspection During Concrete Placement

- a. As concrete is being placed, the falsework should be inspected at frequent intervals. In particular, look for the following indications of potential failure:
 - (1) Excessive compression at the tops and bottoms of posts and under the ends of stringers.
 - (2) Pulling of nails in lateral bracing.
 - (3) Movement or deflection of braces.
 - (4) Excessive deflection of stringers.
 - (5) Tilting or rotating of joists or stringers.
 - (6) Excessive settlement of tell-tales.
 - (7) Posts or towers that are moving out of plumb.
 - (8) Sounds of falling concrete or breaking timbers.
 - (9) If any member deflects unduly or shows evidence of distress, such as splintering on the bottom of stringers, crushing of joints or wedges, etc., placement work in the affected area should be stopped immediately and the falsework strengthened by addition of members, installation of supplementary supports, or some other means.

- (10) Settlement of the falsework should be limited to a maximum of ? inch (10 mm) deviation from the anticipated settlement. Should actual settlement exceed the anticipated settlement by more than the ? inch (10 mm) allowable, and if it appears that a serious problem is developing, concrete placing should be temporarily discontinued in affected areas until the contractor provides satisfactory corrective measures. Concrete placing should not be resumed until the Project Manager is satisfied that further settlement will not occur.
- (11) If it is apparent that satisfactory corrective measures cannot be provided prior to initial setting of the concrete, the Project Manager shall stop placing of concrete and contact the Construction Division.
- (12) One important and often overlooked point is the danger of curing water softening the falsework foundation. Some means should be provided to prevent curing water from reaching and soaking the foundation material beneath the falsework bearing pads.
- (13) The contractor should provide the drainage for any water that accumulates in box-girder cells. Such accumulated water could easily overstress the falsework.

b. Falsework and Centering

- (1) It is the contractor's responsibility to provide form work adequate to support the dead load of the fresh concrete. However, the inspector shall consult with the contractor and the Project Manager concerning any form work which he/she has reason to believe is inadequate to support the load capacity. In calculating the strength of centering, a mass of 150 lb/ft³ (2400 kg/m³) shall be assumed for fresh concrete.
- (2) All falsework shall be rigidly braced and cross braced. Timber piling shall be free from defects with at least a 7 inch (175 mm) butt and a 5 inch (125 mm) tip, measured under the bark. The contractor shall provide jacks or suitable wedges to take up any settlement in the form work during the placing of the concrete. When setting grades for falsework or structure forms, allow 1/16 inch (1.5 mm) settlement or "take-up" for each lap in the falsework timbers.
- (3) Build falsework for slab bridges with ? inch camber for each 10' of span. Deflection after forms are removed should bring deck back to the proper elevation.
- (4) Settlement caused by the concrete loads may be checked as placing of the concrete progresses by means of vertical "telltale" fastened to the bottom of the floor form. When this settlement has reached the amount allowed for "take-up" in the falsework timbers, any further settlement should be prevented by means of the wedges or jacks previously noted. Any adjustments that have to be made must be completed before the concrete has taken its initial set. If adjustments are made after the concrete has set, the concrete may be damaged

irreparably. (In general, if falsework settles more than ½ inch, the PM must investigate and determine the damage.)

10. Removal of Falsework (SSHC Table 704.02)
 - a. Specifications and applicable special provisions, contain specific criteria which must be met before falsework may be removed. Project Managers and inspectors should review these sections prior to falsework removal operations.
 - b. The Project Manager should discuss falsework removal methods and procedures at the preconstruction and/or prepour meeting. The need to provide for employee and public safety is of particular concern.
 - c. In general, all elements of the falsework bracing system must remain in place for the specified time period or until concrete attains the specific strength. In the case of cast-in-place, post tensioned construction, falsework elements must not be removed until stressing is completed.

D. Forms

- a. The inspector shall check the lines, grades and dimensions on all structural form work before allowing the contractor to place concrete. On walls and columns this is best done as the form work progresses.
- b. Forms shall be made of wood, metal or other approved materials. The forms shall be substantial, unyielding and mortar tight. All forms for exterior exposed surfaces, except those locations requiring a specific texture finish as listed in *SSHC Subsection 704.03* shall be lined with pressed wood, plywood or other approved materials used in the largest practicable panels. Forms shall be coated with a colorless oil to prevent sticking to the concrete. The forms should be oiled before placing the reinforcing steel to avoid splattering of oil on the steel. Forms for walls and columns, or wherever else required, may be constructed with the bottom board removable for cleaning out wood chips, dirt, etc., before placing the concrete. Metal tie rods or anchors within the forms shall be constructed so as to permit their removal to a depth of one inch below the surface of the finished concrete. All tie rod and tie-wire holes shall be filled with cement mortar as soon as possible to insure proper bond with the structure concrete.
- c. Pier columns may be constructed using a laminated fiber form which is moisture resistant and seamless. These forms must be capable of withstanding the hydraulic pressure of fresh concrete. Any questions concerning the acceptability of a proposed fiber form should be referred to the Construction Engineer through the District Construction Engineer.
- d. Removal of Forms and Falsework
 - (1) Specific requirements concerning the time limitations for form removal are listed in *SSHC Subsection 704.03*. Proper inspection includes both the monitoring of this time and the method of removing forms. Stresses in concrete due to its own weight must be introduced slowly and carefully during form removal operations to prevent concrete failures. For instance, the removing of falsework from under a cantilevered element, must begin at the point furthest from the support and proceed toward the support. In removing the falsework from under a structure that is continuous over its supports, removal should begin near the areas of maximum dead load positive moment and proceed in both directions towards the supports. In general, all

falsework should be removed before placing any surcharge, such as sidewalks and railings, on the superstructures.

- (2) The requirements listed in the Specifications are based on sound engineering principals and the structures inspector should be thoroughly familiar with and rigidly enforce these requirements.

12. Use of Insulated Forms for Protection

- a. Commercial insulation may be used for protecting concrete during cold weather, or when the contract documents require controlling the heat of hydration. This technique is the contractor's option and could be used in lieu of housing and heating. The contractor must furnish housing and heating and/or insulation of sufficient quality and thickness to maintain concrete at a temperature of not less than 50°F (10°C) for the first 72 hours after placing, and above 41°F (5°C) for the next 48 hours.

E. Placing Concrete

1. Concrete shall be proportioned, mixed and handled in accordance with the requirements of *SSHC Section 1002*. The inspector should also refer to the Materials and Research Manual which outlines the method of proportioning, sampling and field testing the materials necessary for the production of concrete. The contractor shall organize his/her work so that the maximum interval between batches shall not exceed 30 minutes.
2. Concrete should not be placed in footings, columns, etc, until all pile driving within a radius of 50 feet has been completed. If concrete pours must be made within this area prior to the completion of pile driving, such concrete shall set at least three days before further driving is permitted within this radius. Concrete shall not be placed without special permission in steel pile shells for cast-in-place concrete piles for each bent, pier, or abutment until all the shells for that bent pier or abutment have been driven (*SSHC Section 703*).
3. When depositing concrete in the forms, segregation must be avoided. The mass of concrete should be generally free of surface cavities resulting from the trapping of air and water along the forms. Careful spading of concrete along vertical forms and tapping of the forms will usually release the air and water bubbles. Forms which are not mortar tight will leak cement paste and result in "sand streaking." Forms should be mortar tight to the maximum extent possible. Chutes shall be of metal or metal lined and of sufficient number to preclude the necessity of shifting the chutes. If necessary, the contractor shall leave holes in the forms for the entry of the chutes or pipes. Concrete must be deposited within 8 ft (2.5 m) horizontally of the place of its final location. Concrete shall not be dropped vertically more than 5 feet (1.5 m). Concrete in walls, footings, columns, etc, shall be placed in continuous horizontal layers not more than 18 inches (450 mm) thick and vibrated to a monolithic mass. Do not allow dried concrete to collect on forms or reinforcing bars where it will fall into the work.
4. See Section 1003.06 Concrete Cylinder Policy for cylinder requirement.

F. Placement Considerations

1. If there is any doubt about the concrete temperature exceeding 86°F (30°C), the contractor needs to identify measures which will be implemented to keep mix temperatures within specifications. If the contractor is not prepared to maintain a mix temperature below specifications, the pour should be postponed.
2. There are several ways concrete temperatures may be kept within specifications. They are:
 - a. Scheduling placements during cooler times of the day.
 - b. Wetting the aggregate stockpiles.
 - c. Covering/shading the aggregate stockpiles.
 - d. Maintaining a supply of portland cement on hand to preclude getting hot material from the supplier.
 - e. Chilling the mixing water is one of the most effective ways to lower mix temperatures.
 - f. Shaved ice can be used, however, the ready mix operator must submit a proposal for this to the Project Manager for review by the Construction Division.

NOTE:

- No payment will be made for methods taken to keep concrete temperatures within specifications.
 - If pour has to be delayed because of temperature, and pouring is the controlling operation, no working days will be charged.
 - Location of permissible headers should be discussed with the contractor during the pour, it appears the temperature may exceed 86°F (30°C).
 - When casting deck on Phased Construction under traffic make sure potholes in the driving lanes are filled.
3. General - The wind velocity temperature relationships stated in the specifications should be enforced to avoid loss of water from the concrete surface faster than it can be replaced by normal bleeding and to avoid the resultant formation of plastic shrinkage cracks. Anemometers and thermometers must be available on site to measure wind velocity and temperature.
 4. Concrete in bridge floors shall be placed uniformly on both sides of the centerline and shall be placed continuously between specified joints. The sequence of placing shall be in accordance with the pouring diagram shown in the plans. If no pouring diagram is shown in the plans, concrete shall be placed as directed by the Project Manager.

5. Wet the deck forms and approach slab grade before placing the concrete. Concrete shall be adequately vibrated to encase the lower bars of the reinforcing mat where these are near the deck form.
6. Special attention shall be given to finishing the riding surface on the bridge floors. *SSHC* Subsections 706.03, 710.03, and 711.03 explain concrete bridge floor finish.
7. It has been the policy to permit the contractor to use mechanical finishing machines of an approved type whether or not they are required by the plans or special provisions.
8. Method of Finish - When the hand method is employed, the concrete surface shall be struck off with a strike board which conforms to the cross section shown in the plans. If this is pulled by hand, care shall be taken not to displace the reinforcing steel by the workmen doing the pulling. A small air winch anchored to a girder outside of the day's pour will pull the strike off at a slow, uniform rate, giving a truer surface with no displacement of the reinforcing steel. The strike board shall be operated with a combined longitudinal and transverse motion, always carrying a small roll of concrete in front of the cutting edge. The strike off shall be pulled a sufficient number of times to properly distribute the concrete. A longitudinal float generally is required and is described in *SSHC Section 704*. The longitudinal float shall be lapped 1/2 its length when moved to a new position and shall be operated across the surface a sufficient number of times to produce a uniform, smooth riding surface. Occasionally during the finishing operation, conditions may require the use of the long-handled transverse float, which require extreme care in its use to preserve the desired cross-section and a smooth riding surface.
9. Regardless of whether hand or machine finishing methods are used, the floor surface shall be tested for trueness with a straightedge 10 foot (3 m). The bridge contractor is required to furnish a 3 m master straightedge for use in trueing and checking the working straightedges.
10. A burlap drag is required and this operation should be performed as soon as the surface will support the drag. A tined surface is also required by the specifications.
11. Templates used to support the strike off should be in short sections [(10 to 14 ft) (3 m to 4 m)] so they may be removed as the finishing operation advances, allowing the final floating and surface testing to take place, and the wet burlap to be applied immediately. Decks should be cast after the afternoon high temperature is reached. (In summer, this can be as late as 7:00 p.m.) Protection of the aggregates from the sun is also helpful.
12. When mechanical self-propelled finishing machines are used, they shall be capable of obtaining a finish equal to or better than that obtained by the hand method. The screeds of the finishing machine should be set to the exact cross section shown in the plans. Elevation shots will be required for the setting of the riding rails. The usual procedure is to give a fill to grade at the locations where girder shots were taken. The contractor will then set the rail to the correct height to accommodate the machine. An "eyeball" check of the rail for smoothness should always be made. On girder bridges the rail will follow a line that should be smooth after the girders have deflected from the dead load. Correct elevations of the rail can be checked by measuring the distance from the screed to the formwork which should give the correct thickness of slab.

13. Careful attention should be given to the depth of cover over the top steel. With the extensive use of salt, the service life of the steel is reduced if the concrete cover is less than that shown in the plan. (The finishing machine must be dry run to check the minimum clearance of the reinforcing steel and to check the grade of the expansion devices.)
 14. If the finishing machine is used when there is a transition between regular crown and full superelevation, a system should be worked out well in advance of pouring to insure that the screed can be changed rapidly and correctly at intermediate points of the transition. This is important in order that there are no long delays caused by screed adjustments while pouring the transition.
 15. Retarders – Retarders shall be used to delay the setting time of the bridge floor concrete. If the temperature is 60°F (15°C) and rising, retarders must be used. A good goal is to be finishing at the next pier before the concrete is setting-up at the previous pier. Acceptable retarders are Pozzolith 300R and Doratard-17. Water reducing admixtures like WRDA-82, Procrete-N, and Masterpave-N are not acceptable retarders.
 16. When a retarder is required the rate of placing concrete for any positive moment section will be within two-thirds of the initial setting up time of the retarded concrete after the previous negative moment section has been poured. For example, if the initial set takes place in 6 hours, the pouring of a positive moment section must be completed within 4 hours after the completion of the previous negative moment section. This same procedure should be required regardless of whether or not retarders are used.
 17. Calibration of Concrete Proportioning Equipment - Calibration of this equipment should be as described in the National Ready Mixed Concrete Associations' Quality Control Manual.
- G. Placement Methods (Pumping, Belting, And Crane Bucket) (*SSHC Subsection 704.03*)
1. Much concern has been expressed about the method of concrete placement because of lost entrained air. Rough handling of plastic concrete during placement has, at times, reduced entrained air to less than 2% not to mention potential segregation problems. While testing at the point of placement "should" identify such problems, varying placement conditions during the pour can affect concrete conditions significantly.
 2. General conditions which must be avoided (Points to watch for), or at least severely minimized, are explained for each delivery system that follows: If one of the following cannot be avoided, at least be aware of the condition, and be sure to conduct additional testing should any of the conditions present themselves.
 3. Crane and Bucket
 - a. In the past it was felt the crane and bucket placement method did not adversely affect concrete. This is now in question when viewed from loss of air and potential segregation. Therefore, this method will now also require testing at the placement location, if practical.

b. Points-to-Watch For

- (1) Free fall of unrestrained concrete shall not exceed 5 ft (1.5 m.) Avoid exceeding a 5-ft. free fall by removing a section of form work for intermediate placement or by use of a tremie.
- (2) Discharge from the bucket must be controllable.
- (3) Cross section of the drop chute should allow it to be inserted into the form work without interfering with reinforcing steel.

4. Belt Placement

a. Belt equipment is typically used to convey concrete to a: (1) lower, (2) horizontal, or (3) somewhat higher level.

b. Points-to-Watch For

- (1) Keep the number and distance of drops between belts to an absolute minimum. Drops tend to encourage segregation and reduce entrained air.
- (2) As belt conveyors are removed from the line (i.e., as on deck pours), recheck the "as placed" air content.
- (3) Be sure all mortar is being removed at the discharge. (No mortar should be on the return belt.)
- (4) Check discharge for potential segregation problems.
- (5) In adverse weather (hot and/or windy conditions), long belt runs need to be covered.

H. Pump Placement

1. The modern mobile pump with hydraulic placing boom is economical to use in placing both large and small quantities of concrete. These units are used to convey concrete directly from a truck unloading point to the concrete placement area.

2. Points-to-Watch For

- a. Typically, pumps are initially flushed with a thin water/cement paste mixture to coat the lines. This slurry must be wasted and the lines charged with the project mix before beginning. Observe, and be sure initial pump charge is thoroughly removed from the pipelines.
- b. Always pump at a constant rate and keep pipelines full of concrete. High air loss can occur when concrete is allowed to free-fall inside pump lines.

- c. Avoid, if at all possible, having steep angles in the pump pipelines. Steep angles and slow placement rates are probably the worst conditions for minimizing air loss and segregation. If this condition occurs:
 - (1) Attempt to relocate the pumper, thereby minimizing lift angle.
 - (2) If discharge is not maintaining a constant flow with the partial concrete head in the pipe, request the pump operator to place a reducer and short section of hose at the discharge end. The purpose is to avoid free falling concrete from impacting the deck or forms at high velocity.
 - (3) If the above condition is unavoidable, watch and test the discharge frequently for loss in air and potential segregation.

3. Rule-of-Thumb for Pumping

- a. Pump concrete with pipelines as flat as possible (or at least with minimal down angle).
- b. Minimize (or eliminate) free falling concrete in the pipelines. To do this, maintain some amount of concrete head in the pipelines.
- c. Pump concrete through as few elbows and restrictions as possible.
- d. Pump concrete at "some" constant rate.
- e. Watch and test the air content frequently, when drop may exceed 5 feet.

I. Consolidation of Concrete

- 1. The contractor must establish a pattern for vibrating the concrete and ensure the pattern is followed across the entire deck.
- 2. Consolidation of concrete should be accomplished by the use of a sufficient number of vibrators of a type approved by the Project Manager. The vibrators must be of such an intensity as to visibly affect one-inch slump concrete over a radius of 18 inches (450 mm). The contractor is required to furnish a tachometer for the purpose of checking the speed of the vibrator elements.
- 3. Lateral movement of the concrete by means of a vibrators shall be avoided. Over vibration is harmful and is evidenced by grout appearing in the concrete around the vibrator head. Insert and withdraw the vibrator slowly. It should not come in contact with reinforcing steel which extends into previously placed concrete nor should the vibrator head be placed in concrete which is taking its initial set.

J. Reinforcement Bar Cover

- 1. Reinforcement bar cover has contributed to shadow effect. This occurs when reinforcing cage is not rigid or has only a minimum of cover and too much vibration was used. The remedy:

- a. Increase bar cover to 2 ½ inches (65 mm) from minimum of 2 inches (50 mm).
 - b. Maintain uniformity of bar cover.
 - c. Build in rigidity to the reinforcing bar cage by placing diagonal braces as described above.
 - d. Reduce slump and do not over vibrate the concrete.
 - e. Require a dry run to check alignment and uniform spacing between the edge of the mule and rebar cage.
2. Shadowing occurs when slip forming a radius because of nonuniform form pressures inside the mule. The problem manifests as repetitious surface bumps, not depressions as one might think. This problem is inherent with slipforming a radius and is especially noticeable as the radius becomes smaller. In order to minimize shadowing effects, the contractor needs to have finishers work out the bumps by hand.
- K. Use of Finishing Machine (*SSHC Subsections 710.03 and 711.03*)
1. The finishing machine shall be approved before use. Care must be taken to adjust the screeds to proper crown. Support rails must extend beyond the bridge at both ends at proper grade and sufficient distance to accommodate the machine. This permits finishing to begin promptly at the start of the run and also permits the required straightening to proceed on schedule at the end of the run.
- L. Straightedging
1. Following the finishing machine, straightedging should be completed to check for longitudinal smoothness. Straightedges, 10 ft (3 m) in length, need to be operated parallel to centerline of roadway. Each pass should overlap the previous one by a half length. If bull-floating (mopping) is needed to close up the surface, it should always be followed by straightedging.
- M. Tining (Transverse Grooving)
1. Tine bridge decks with a rake. No longer use a bull-float.
 2. After straightedging, and as soon as practical following finishing, the entire traffic surface, except areas within approximately 2 ft (600 mm) from the curbs, shall be given a suitable tining with corrugated tining rake.
 3. Tine all bridge decks where posted speed limit will be 40 mph or greater, except for county road bridges 100 feet (30 m) or less in length that have gravel approaches and no plans exist for future hard surfacing.
 4. On bridge decks, stop the tining 2 ft (600 mm) from the face of the bridge curb.
 5. **Do not overlap the grooving.**

N. Curing

1. The Bridge Deck Curing Special Provision defines how to cure the deck.
2. The surface must be covered with wet burlap as soon as possible. (Slight surface marring and removal of tining is acceptable.) Burlap must be wet before placing. In hot dry weather, it is better to be a little early than late with burlap cover.
3. Since shrinkage cracks are due to rapid loss of mix water before the concrete has attained adequate strength, it is imperative that curing protection be initiated before much evaporation can occur.

O. Ways to Avoid Deck Cracks

1. Verify falsework is stable.
 - (a) Temporary piles need to have significant bearing – practical refusal is best.
 - (b) Wood crush needs to be minimized. Avoid gaps between layers of timbers – be careful to shim the entire length of support timbers.
2. Avoid unnecessary vibrations.
 - (a) Use shooflys where possible to keep traffic away from the bridge.
 - (b) Do not rest falsework on active bridge during phased construction unless there is no other alternative.
 - (c) However, when it comes to intentional consolidation – the contractor should be very careful to establish a fix pattern for vibration and make sure it is achieved along the entire length of the deck and approaches.
3. Check the temperature of the concrete as it arrives on site. It should not be greater than 86°F.
4. Check the slump and if the slump is less than 3.5 inches, confirm that the mix is not too dry – especially if retarders or water reducers are used. Low slump measurements are a good indicator that mix is too dry especially on hot days. Also, with a low slump, it will be hard to get the mix around and in between rebars and tining with the tining rake is much more difficult.
5. Verify camber on girders is correct.
6. Avoid skewed construction of approach sections. If there must be a skew, limit it to 20 degrees. If skew is above 20 degrees, then reinforce the area near the obtuse angles because the stress is significantly increased in this region.
7. Cover the concrete with saturated wet burlap 1 ½ hours after the concrete leaves the truck or pump chute.

8. If the outside air temperature is predicted to be above 80°F (26°C) then start casting the deck at 5:00 pm and finish before dawn.
9. Check the outside air temperature during casting. It should be less than 86°F.
10. If the evaporation rate during casting exceeds .15 lbs/sf/hr, then fogging as prescribed in the Nebraska Fogging Special Provision will replace the evaporating water, keep the deck cool, and slow the setting time.

P. Seal Bridge Deck Cracks

1. Bridge deck cracks should be sealed before de-icing salt is ever applied on or near the deck.
2. High molecular weight methacrylate is the best sealant and is squeegeed into cracks.

Q. Cold Weather Placement

1. On account of the high incidence of shrinkage cracks due to artificial heat during the protection period, no bridge floors will be constructed during cold weather except with the special written permission of the Construction Division.

R. Floor Drains

1. Check floor drain locations against floor grades to be sure deck surface will drain. Adjustments of drain height may be advantageous on every flat grade surface. Also, at this time, study the discharge area from the floor drain for potential damage to features under the structure such as shoulders, railroads, or berm slopes. Major problems foreseen should be brought to the attention of the Construction Division.

S. Flowable Fill (*SSHC Section 1003*)

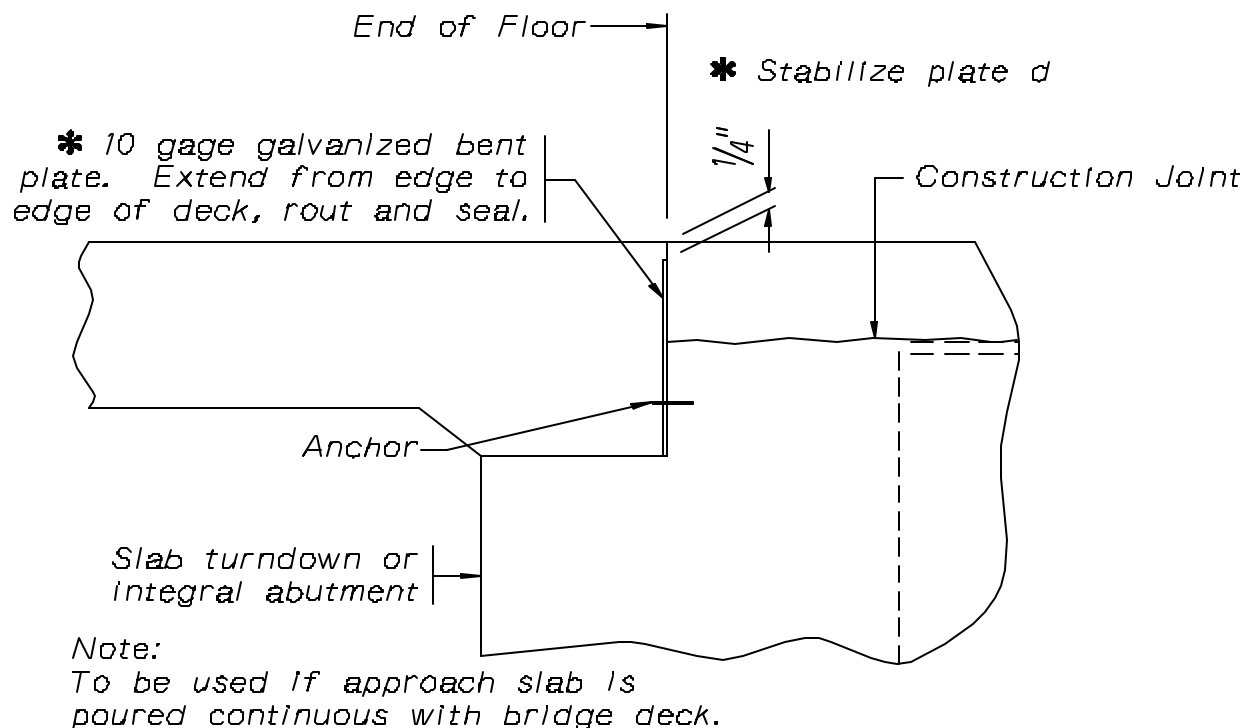
1. The inspector shall make daily entries in the field book on all concrete placed for each project. Record concrete placement location, all results of sieve analysis tests, all data on test beams made and tested and all quantities placed.
2. Flowable fill can be used for the following purposes:
 - a. Backfilling culverts.
 - b. Backfilling culverts constructed under bridges.
 - c. Filling void between culvert and culvert liner.
 - d. Plugging culverts.
 - e. Slope stabilization.
3. Free water in the sand pile must be considered as mix water because a mix design uses oven dried sand.

4. The plans may call for a sewer pipe to receive a gasket, otherwise, see *SSHC Section 722*.
 5. If the contractor uses crushed limestone for granular backfill, it shall meet the requirements for Granular Backfill. (Refer to *SSHC Section 1033*.)
 6. Remember flowable fill is a liquid until the water has dissipated. Bulkheads should be strong enough to withstand the hydraulic pressures.
 7. Under normal conditions, flowable mortar should be set-up sufficiently within 24 to 48 hours for placement of the final lift of either earthfill or special backfill. If "set-up" does not occur or if it seems slow, typically the problem relates directly to drainage of the granular backfill. Often contamination or "dirty" granular backfill is the culprit. Check to be sure it is draining. If not, additional time will help.
 8. Placement of 2 ft (0.6 m) of flowable mortar.
- T. Installation of Joints (*SSHC Subsection 704.03*)
1. Reinforcement
 - a. Reinforcement must be accurately placed and rigidly fastened. If cages are not rigid and braced diagonally in both transverse and longitudinal directions, problems can occur. The remedy:
 - (1) Recommended Procedure:
 - (a) Epoxy coated smooth bar, about ¼ inch (6 mm) in diameter can be placed diagonally from the top of a leading cage to the bottom of the second trailing cage. (Description is referenced to direction of paver's travel.)
 - (2) Alternate Procedure:
 - (a) Welding of diagonal braces to provide longitudinal rigidity is possible, but material would need to be epoxy coated and repair of weld location is necessary.
 2. Preformed Neoprene Joints
 - a. Preformed neoprene expansion joints are used on a large number of bridges.
 - (1) Inspection Checklist

- (a) Neoprene cellular joints, if properly installed, provide a leak-proof joint capable of functioning within expansion limits of the bridge. To insure that a joint will function properly, there are a number of precautions that should be noted regarding the installation of this type of joint. Precautions:
 - (i) A neoprene seal can be placed in two positions, one correct and one incorrect. Make sure that the seal is not installed upside down or sideways.
 - (ii) Position of the $\frac{1}{2} \times \frac{1}{4}$ inch (13 x 6 mm) keeper bars on vertical face of the expansion plate angles has to be consistent with the recommendations of the manufacturer of the neoprene seal. The depth that a seal is set varies greatly with the different manufacturers.
 - (iii) The neoprene seal has to be installed so bottom of the seal touches top of the $\frac{1}{2} \times \frac{1}{4}$ inch (13 x 6 mm) keeper bars, but should not be forced past the keeper bars.
 - (iv) Make sure expansion opening between angles of the expansion device are consistent with the expansion setting shown on design plans and that the same expansion opening is maintained from gutter to gutter.
 - (v) The neoprene seal must project beyond the outside edge of slab as shown on the plans.

b. Summary

- (1) When uncertain as to which side of the seal is top, or when the position of keeper bars is in question, the contractor must be required to submit drawings prepared by the manufacturer which indicate correct position of installation.



OPTIONAL JOINT DETAIL

U. Curing Concrete

1. The structure inspector should give careful attention to the curing, since proper curing is essential to good quality concrete.
2. When the evaporation rate exceeds 0.15 lb/sf/hr, the contractor must either fog the entire deck while placing the concrete; cover the concrete with wet burlap 1 ½ hours after the concrete leaves the truck; or take some action which will lower the evaporation rate on the entire deck below the 0.15 lb/sf/hr limit.
3. Applying wet burlap as soon as possible is essential – limited removal of tining is acceptable. The wet burlap should always be on the deck by 1½ hours after that portion is finished.

V. Concreting in Cold Weather (*SSHC Subsections 704.03 and 1002.02*)

1. As colder weather approaches each fall, the Department experiences a series of problems connected with concrete construction in cold weather. The first indication of the problem usually shows up as a low test result on a 7 day cylinder. At that stage, it is not known if the problem is an improperly fabricated cylinder.

2. A cylinder which has been exposed to colder conditions than the structure, or if the low strength actually represents the concrete in the structure. Sometimes the later cylinder tests show satisfactory results, but in other cases, low strengths are found in these tests also.
3. In some cases, definite information regarding the true condition of the concrete in the structure can only be obtained by coring the material and carrying out a series of special tests.
4. The best fogging system may be the simplest. Hand held fogging nozzles that mix compressed air and water to form a fog are some of the best fogging systems observed. (One nozzle that works very effectively is called a Hydro-Air Washer made by Power Systems Inc. of Lancaster, TX.)

W. Simultaneous Casting of Deck and Approach Slabs

1. Casting the approach slabs and the deck simultaneously creates a smoother transition and ride. However, to avoid maintenance and to preserve the integrity of the deck and the approach slabs, a metal bond breaker should be placed over the abutment across the entire width and depth of the deck. This will ensure that a random crack does not occur before the joint can be cut. At the grade beam, the joint is usually blocked out with styrofoam.
2. The rail that the finishing machine rides on must be uniformly rigid. Unfortunately, where the rail passes over the grade beam and abutment, the rail is frequently more rigid than either side of these substructures. This can cause a dip either side of the abutment and the grade beam, which can result in a "bump" over the abutment, and grade beam.
3. Another problem can result when the deck overhangs the outside girder. Typically, the deck forms are supported by outrigger jacks braced against the outside girder. The weight of the concrete and the finishing machine can momentarily bend the outside girder as the placing operation progresses. Temporary construction braces (usually wood blocks) between all girders can prevent girder movement.

X. Surface Checking (Not in Spec)

1. A 10 ft (3 m) straightedge surface check shall be conducted on all bridges and deck overlays not covered by the Smoothness Specification. Surface areas inaccessible to profilometer shall also be checked.
2. On some projects only one wheel path may be included in the placement width. For price adjustment or incentive pay, only the portion within the traveled lane shall apply. Variable width sections for on and off ramps, which are outside the through traveled lane, will be checked with the surface checker.

Y. Test Procedure for Smoothness

1. A Special Provision entitled "Bridge Deck and Approach Slab Smoothness" will usually be included in the contract proposal. This Provision deals with the method of testing for smoothness and the method for correcting surfaces outside of the smoothness limits. The contractor is responsible for scheduling the testing, which will be performed by Materials and Research Division personnel. The contractor must give the Project Manager seven days notice prior to the date he requests that testing be done. The Project Manager shall contact the Materials and Research Division and arrange for testing on the requested date. Evaluation
2. Materials and Research Division will furnish a profile index to the contractor within 72 hours of the completion of the tests.

Z. Smoothness of Bridge Decks

1. Checklist - The following items should be checked and procedures followed prior to, during, and after the overlay is placed to insure a smooth riding deck surface:
 - a. Guide rails are used to support and guide the finishing machine. Check for rail deflection during passage of finish machine. Any vertical or horizontal movement could compromise smoothness and rideability. Request that the contractor readjust anchor legs and/or tie-downs.
 - b. Check that all propulsion and control equipment are fully operational prior to placing concrete. The contractor shall traverse the finishing machine over the entire length of section to be placed. This not only serves to verify that equipment and control systems are functioning properly, but also provides a check to assure that screeds are adjusted for proper crown and height above existing surface.
 - c. Sufficient materials (water, cement aggregate, and admixtures) are available on site to complete the intended placement in a continuous operation.
 - d. The contractor may have to limit size of placement or provide additional mixers (HD-LS only).
 - (1) If a mobile mixer is not large enough to provide adequate volume for the placement, or
 - (2) If there is no provision for recharging.
 - e. Ensure that adequate number of vehicles are available at the work site to transport mix from mixer to the placement area at a volume necessary to provide a uniform rate of forward progress. Any equipment working on the deck should be checked for oil and hydraulic fluid leaks.
 - f. Contractor must provide sufficient, trained personnel to carry out the various phases of deck placement. Timeliness is of utmost importance during placement operations. Be sure specialized crafts, such as finishers, are

adequately represented and preferably have only one task during the placement.

- g. Check concrete for smoothness with the 10 ft (3 m) straightedge. The straightedge should be placed on the surface from a vertical position, not pushed over the surface. Irregularities can be detected by comparing deck surface with a straightedge. Irregularities noted at this time should be corrected.

2. Surface Correction

- a. Corrective work shall be done in the presence of the Engineer with a diamond bladed grinder at least one meter wide. Grinding residue must be controlled. After the deck is ground, a second test will be made to determine if the deck now meets the smoothness requirements. This second test will also be performed by Materials and Research personnel and it is anticipated they will be on-site at the time of grinding, in order that they may perform the retest while the grinding equipment is on-site.

3. Acceptance

- a. Materials and Research personnel will notify the Project Manager whether or not the corrective work has resulted in an acceptable deck surface. If grinding cannot correct the surface profile, the Specification requires removal and an overlay with high-density low slump concrete.
- b. Troubles and expense of this sort could virtually be eliminated by careful and detailed inspection by project personnel during construction and proper handling of test cylinders.

4. Missed Texturing

- a. There will be times, due to various reasons, when texturing will have to be omitted from a pour. One such event could be when inclement weather catches a pour and covering prevents texturing. Obviously this condition is **NOT** desirable.
- b. After full cure time has expired, grind in the required texture.

AA. Approach Sections--Bridge Approach Tapers

- 1. On deck overlay construction, normally some treatment of the approach is necessary and will be indicated on the plans. Watch the contract documents for bid items for ACC material. For projects where asphalt tapers are proposed and no quantity for ACC is given, an extra work order will be required.
 - a. Shoulder Maintenance - When temporary concrete barrier rails are used on deck repair and overlay jobs, traffic is constricted into a narrower lane. This in turn could cause a rapid deterioration of shoulders at bridge approaches and require the following corrective measures:

- (1) Ruts developing in earth and granular shoulders should be repaired as necessary with a granular surfacing material. This is extra work order and a change order will be issued for this work.
- (2) Ruts and loss of asphaltic cement concrete surfacing on Interstate shoulders should be repaired using an asphalt cement concrete pre-mix, hot mix, or some similar treatment to minimize the development of holes or ruts. A change order may be needed for this work unless there is an ACC contract item for shoulder maintenance and even then it may have to be extended.
- (3) When shoulder strengthening was not included as a bid item, but is needed for the project, the change order must consider:
 - (a) Present shoulder construction and experience with shoulder stability in the immediate area.
 - (b) Traffic volumes, percent of trucks, and duration of potential problem.

BB. Setting Beams

1. The following should be used as a guide in conjunction with *SSHC Section 704*:
 - a. On diaphragm piers, beams may be set as soon as doing so will not mar or chip the concrete. It is recommended that 24 hours be considered a minimum cure time. (In cooler weather, ambient temperatures below 40°F (5°C), the minimum time indicated should be increased to 48 hours.)
 - b. No beams may be set on piers until the cap concrete is at least 7 days old and has its design compressive strength.
 - c. On stub abutments, steel beams and girders may be set as under A above. Concrete beams on stub abutments, same as A above. On full abutments (solid and continuous from spread footing), same as A above.

706.04 METHOD OF MEASUREMENT

- A. The cubic yards of concrete for structures of varying sizes are computed from dimensions shown in the plans and placed in tables in the plans. All structures using the same type of concrete are lumped together.

707.00 BRIDGE DECKS AND OVERLAYS (*SSHC Sections 710 and 711*)

707.01 DESCRIPTION

- A. The concrete bridge floor is the wearing surface of the bridge superstructure and is commonly referred to as the bridge "deck". This work consists of forming, reinforcing, and placing concrete to the lines, grades, and typical cross sections shown in the plans.

707.02 MATERIAL REQUIREMENTS

- A. See Subsection 706.02

B. Density Testing

1. Durable, low maintenance bridge decks require impermeable (very dense) concrete. Therefore, checking density during placement is an essential part of deck surfacing and overlay inspection. Test frequencies for determining the density of bridge deck surfacing and overlays are listed in *SSHC Subsection 711.04*. A test should be taken at 5 ft (1.5 m), 10 ft (3 m), 15 ft (4.5 m), and every 50 ft (15 m) thereafter per placement width per bridge. Density tests will not be required for overlaying approach paving areas.
2. It is always desirable to take more than the minimum nuclear density tests per length of overlay placed. If densities are at or near the lower specification limits, additional testing will need to be performed.
3. Vibrating Mix at Test Well Location
 - a. On some projects, contractors have been vibrating the concrete mix in the test well with a hand-held vibrator prior to passage of the finishing machine. This practice will not be permitted.
 - b. If the oscillating screed vibrators are functioning properly, complying density of the concrete mix in the test well will be obtained without any difficulty. Obtaining required density at test well locations, without supplemental vibration, assures us that the contractors' equipment and placement procedures are capable of producing the desired results throughout the overlay being placed.
4. Density Test Wells on Bridge Deck Repair Projects
 - a. Follow guidelines in *SSHC Subsection 710.04, para. 7.b*.

707.03 CONSTRUCTION METHODS

- A. General – The wind velocity-temperature relationships stated in the specifications should be enforced to avoid loss of water from the concrete surface faster than it can be replaced by normal bleeding and to avoid the resultant formation of plastic shrinkage cracks. Anemometers and thermometers must be available on site to measure wind velocity and temperature.

1. Concrete in bridge floors shall be placed uniformly on both sides of the centerline and shall be placed continuously between specified joints. The sequence of placing shall be in accordance with the pouring diagram shown in the plans. If no pouring diagram is shown in the plans, concrete shall be placed as directed by the Project Manager.
2. The deck forms shall be dry when using HD-LS but must be wet when using silica fume concrete before placing the concrete. Concrete shall be adequately vibrated to encase the lower bars of the reinforcing mat where these are near the deck form.
3. Special attention shall be given to finishing the riding surface on the bridge floors. *SSHC* Subsections 706.03, 710.03, and 711.03 explain concrete bridge floor finish.
4. It has been the policy to permit the contractor to use mechanical finishing machines of an approved type whether or not they are required by the plans or special provisions.
5. Method of Finish - When the hand method described in Section 704 is employed, the concrete surface shall be struck off with a strike board which conforms to the cross section shown in the plans. If this is pulled by hand, care shall be taken not to displace the reinforcing steel by the workmen doing the pulling. A small air winch anchored to a girder outside of the day's pour will pull the strike off at a slow, uniform rate, giving a truer surface with no displacement of the reinforcing steel. The strike board shall be operated with a combined longitudinal and transverse motion, always carrying a small roll of concrete in front of the cutting edge. The strike off shall be pulled a sufficient number of times to properly distribute the concrete. A longitudinal float generally is required and is described in
6. *SSHC Section 704*. The longitudinal float shall be lapped 1/2 its length when moved to a new position and shall be operated across the surface a sufficient number of times to produce a uniform, smooth riding surface. Occasionally during the finishing operation, conditions may require the use of the long-handled transverse float, which require extreme care in its use to preserve the desired cross-section and a smooth riding surface.
7. Regardless of whether hand or machine finishing methods are used, the floor surface shall be tested for trueness with a 10 ft (3 m) straightedge. The bridge contractor is required to furnish a 10 ft (3 m) master straightedge for use in trueing and checking the working straightedges.
8. Phased construction of a bridge deck usually requires a form longitudinally down the bridge deck near the center of the bridge. The location of the form is shown in the plans. Sometimes it is more efficient to move the location of the longitudinal phasing joint. On bridges with concrete girders it is nice if the joint can be lined up to use the notched lip in the girder flange. However, the resulting lane widths must be checked to confirm there is adequate clearance for vehicles.

B. Bridge Deck Curing

1. When the high temperature for the day that the deck will be cast is expected to exceed 80°F the deck should be cast at night. The Contractor should contact the concrete plant and schedule the concrete deliveries to the bridge deck to begin at 5:00 pm. The Contractor must also confirm that the concrete will have a 1-hour set delay when it arrives on the deck.

C. Bridge Deck Joints

1. If a joint compound is not specified the Contractor may use hot tar to seal bridge deck joints.

E. Deck Overlay Preparation

1. Securing an adequate bond at the interface of the existing prepared deck surface and proposed overlay course is essential in obtaining a durable and maintenance free bridge deck system. General surface preparation requires milling, shotblasting, and/or sandblasting depending on the surface condition or amount of existing surface material to be removed. Any reinforcing bar which is exposed must be sandblasted to remove all rust contaminants, and unsound concrete. Also, prior to placing the grout the surface must receive an air blast to remove dust and other foreign particles from the prepared surface.
2. The surface, once cleaned, must remain clean until the grout and concrete is placed. There have been cases where the prepared deck surface has become contaminated during the decking operations by concentrated traffic of vehicles transporting the concrete. This is especially true when the skid-steer type loaders are used to transport mix. The deck surface is contaminated by the abrasive action between the concrete surface and the rubber tires, and also from oil and other foreign material tracked in from off the bridge. Contamination can be recognized by discoloration or oil on the deck surface. Contamination is especially noticeable in the wheel paths used by the vehicles.
3. Core specimens taken and tested for bond strength from areas as mentioned above showed a marked decrease in bond strength between the interfaces.
4. To prevent the cleaned deck surface from being contaminated by traffic, the contractor shall cover any prepared surface with sheets of plywood, multiple layers of plastic, or other suitable material. To ensure a clean surface prior to placement of the overlay system, areas which become contaminated shall be resandblasted followed by an air blast.

F. Class I Floor Repair (*SSHC Sections 710 and 711*)

1. Follow guidance in SSHC Subsections 710.04, para. 1 and 711.04, para. 1.

G. Work on Adjacent Lanes

1. *SSHC Section 423* prescribes traffic provisions when traffic is present.

708.00 Bridge Diaphragms

- A. Steel diaphragms, if allowed, are shown in the plans for prestressed beam structures. Shop drawings are required for steel diaphragms showing details of beam layouts, location of the diaphragms, and location of mounting holes.
1. High strength bolts for steel diaphragms shall be tightened by Turn-of-Nut method. (Refer to *SSHC Subsection 708.03* for information on proper bolt inspection and installation.) Inspection and field installation acceptance will be based on observing proper Turn-of-Nut procedures. (A tensioning device and inspection torque wrench is recommended, but will not be required.)
 2. Concrete diaphragms at piers of prestressed concrete girder bridges should be cast to 2/3 of their intended depth. The final 1/3 and the deck are then placed at the same time. However, there are instances where allowance has been given for specific diaphragms to be placed prior to slab placement. If there is a construction option shown in the plans, the diaphragm can be poured separate from the deck. Note the construction joint detail will show how to strike-off the surface. Consult with the Construction Division in situations where the contractor requests to place concrete diaphragms other than as shown in the plans.
 3. Phased bridge decks which have inverted "T" girders should not have the portion of the diaphragms cast between the two girders on each side of the longitudinal phasing construction joint until the second phase deck is cast. If the girder diaphragms for the gap between the two girders which are on each side of the phasing joint are cast before the second phase deck is cast, the diaphragms will lock the girders under the second phase deck at a position higher than the phase 1 girders. Cast the diaphragms between the two girders that are on each side of the phasing construction joint at the time the second phase deck is cast. The remaining girder diaphragms in the second phase should be cast before the deck is cast.
 - a. Casting the intermediate (midspan) diaphragms before the deck is cast removes some of the girder camber and will make the structure more stable for the deck casting.

709.00 Girder Shims

A. Definition

1. A girder shim is defined as the distance measured from top of girder to top of finished slab. There are three different types of bridges which we build that have girder shims. The first type is a steel girder bridge, either a rolled beam section or a plate girder section. The second type is a prestressed girder (NU Girder Section). The third type is a prestressed twin tee girder. When taking shim shots on a prestressed twin tee girder, they should be taken at the edges of the twin tee. Take shim shot on steel girders or NU girders along the girder centerline.
2. For each type, the definition of the girder shim is the same; girder shim is the distance measured from the top of girder to top of finished slab.
3. Stages of the Girder Shim Process The Bridge Division, upon completion of the design, will prepare the shim input forms. After the project has been let, we send these forms to the Project Manager. After the girders are erected and prior to forming the deck for the slab, shim shots are required to be taken. These shim shots should be taken at the bearings, field splices, and at 3 m intervals along the length of the girder. The shim shots can be recorded on the input forms.
4. The H.I. Elevation needs to be recorded by the inspector at the time the shim shots are taken.
5. The rod readings at each location are recorded on RDP Form 50a. This information is normally sent by computer to the Bridge Division. The Bridge Division will run a computer program which uses the grade of the roadway, crown of roadway, the dead load deflection of the girder, and your rod readings to determine the amount of shim at each location.
6. The Bridge Division will look at the shims to see if they are too large or too small. The final shim information will be sent to the Project Manager along with solutions to any problems which may have occurred.
7. The proper girder shims are critical to ensure that construction of the bridge is in accordance with the intended design.
8. Composite Girders
 - a. There are two methods of designing girders. One method is a non-composite design and the other method is a composite design. The non-composite design is basically the slab sitting on top of the girders. By providing shear connectors on the top of the top flange, we can tie the slab to the girders into what we call a composite section. On prestressed girders, the stirrups extending out of the girder into the slab provide the composite action. The composite section produces a more economical design. The Bridge Division designs the girders as a composite section.
 - b. AASHTO Specifications

- (1) In order for this composite action to actually take place, it is critical that these shear connectors extend into the slab the proper amount. For steel girders, AASHTO specifications require that the shear connectors penetrate at least 2 inches (50 mm) above the bottom of the slab.
- (2) The AASHTO specifications also state that the clear depth of concrete over the tops of the shear connectors for steel girders shall not be less than 2 inches (50 mm). So this gives the Bridge Division a range for the location for the top of the shear connectors.
- (3) Proper vs. Improper Shims
- (4) When you are inspecting a job, a visual inspection of the relationship of the shear connectors to the slab reinforcement will help you determine if something is wrong. Based on the slab thicknesses that we normally use [7.5 inches (190 mm) or 8 inches (205 mm)] thick, the length of stud that we normally use [5 inches (125 mm long)] and if the slab is reinforced, the end of the sheer connector should be located somewhere between the top and bottom transverse slab reinforcing steel.
- (5) We specify 1 inch (25 mm) of clearance between the bottom of the slab and the bottom transverse reinforcing steel. A $\frac{3}{4}$ inch (20 mm) bar is the largest bar specified. Therefore, knowing that we need 2 inches (50 mm) of penetration for the shear connectors, the top of the shear connector should always be above the transverse bar in the bottom of the slab.

3. Problems and Solutions

- a. When we have the problem of too large of a shim, there are a couple of things we can do to solve this problem. One solution is to provide some reinforcing bars at each shear connector location that properly extend into the slab. Another solution is to weld a plate onto the top of the shear connectors to gain the proper penetration length.
- b. Where we have the problem of too small of a shim (top flange extending into the slab) there is only basically one thing you can do. That is to raise the grade of the roadway.

4. Critical Item - Proper Girder Seat Elevations

- a. The most important thing that our inspectors can do to insure proper shims is to make sure that the girder seats are poured to the proper elevations. If the girder seat elevations are wrong, you can almost be sure that you will have problems with your shims. If your girder seats are correct, more than likely your shims will also be correct.

5. Critical Item - To Ensure Proper Shim

- a. Steel girders must be set on substructure by following the blocking diagram shown on the plans.

Example Computer Print

IDENT	PROB. NO.	GIRD. NO.	DIST. CL PROJ. TO CL ROADWAY	E FROM BASELINE	H.I. ELEV.			
7018	1	1	O.C.	10.0000 LT.	1719.24			
Girder No.	Station	Centerline Grade	Crown Correction	Girder Elevation	Dead Load Deflection	Rod Reading	X Distance	Shim
1	22+10.77	1715.662	-0.150	1714.920	0.0	4.32	0.0	0.592
1	22+20.77	1715.753	-0.150	1715.020	0.015	4.22	10.00	0.598
1	22+30.77	1715.840	-0.150	1715.100	0.023	4.14	20.00	0.613
1	22+40.77	1715.925	-0.150	1715.180	0.021	4.06	30.00	0.616
1	22+50.77	1716.006	-0.150	1715.260	0.011	3.98	40.00	0.607
1	22+60.77	1716.084	-0.150	1715.320	0.001	3.92	50.00	0.616
1	22+65.77	1716.122	-0.150	1715.350	0.0	3.89	55.00	0.622
1	22+70.77	1716.189	-0.150	1715.370	0.004	3.87	60.00	0.644
1	22+80.77	1716.281	-0.150	1715.470	0.019	3.77	70.00	0.630
1	22+90.77	1716.300	-0.150	1715.490	0.033	3.75	80.00	0.693
1	23+ 0.77	1716.365	-0.150	1715.550	0.040	8.69	90.00	0.705
1	23+10.77	1716.427	-0.150	1715.610	0.033	3.63	100.00	0.701
1	23+20.77	1716.486	-0.150	1715.700	0.019	3.54	110.00	0.655
1	23+30.77	1716.342	-0.150	1715.730	0.004	3.51	120.00	0.666
1	23+35.77	1716.588	-0.150	1715.770	0.0	3.47	125.00	0.648
1	23+40.77	1716.594	-0.150	1715.810	0.001	3.43	130.00	0.636
1	23+50.77	1716.644	-0.150	1715.860	0.011	3.38	140.00	0.645
1	23+60.77	1716.690	-0.150	1715.900	0.021	3.34	150.00	0.661
1	23+70.77	1716.733	-0.150	1715.950	0.023	3.29	160.00	0.656
1	23+80.77	1716.773	-0.150	1715.980	0.015	3.26	170.00	0.658
1	23+90.77	1716.809	-0.150	1716.010	0.0	3.23	180.00	0.649

710.00 Pot Bearings

- A. The Materials and Research Division inspects pot bearings at the site. In order to facilitate the work, we request that the Materials and Research Division be notified immediately when the pot bearings arrive at the site. This will permit Materials and Research personnel to inspect the bearings in a timely manner.

- B. The person to notify is Mr. Mark Burham at Materials and Research. His phone number is (402) 479-4746.

711.00 Barrier Rails

711.01 Description

A. Fixed Form Jersey & Retrofit Rail

1. Before cast-in-place barrier rail is constructed on the existing bridge curb section, *SSHC Subsection 704.03* requires that old concrete which is to be in contact with the new concrete be cleaned of all laitance (loose particles of concrete, dirt, or other foreign materials).
2. Structurally, the existing curb surface need not be roughened, but must be clean. To assure a clean surface and to obtain maximum bond at the interface, sandblasting the old curb surface shall be required. Other methods of cleaning may be approved by the Project Manager.
3. Surface preparation, such as sandblasting, should be completed prior to setting the epoxy coated dowels.
4. When retrofit is part of a deck overlay, the contractor may request permission to place the finish machine on the retrofit rail. Construction's policy will be:
 - (a) A minimum cure time of at least 48 hours prior to placing the mass of a finish machine on the rail, AND
 - (b) Finish machine rail support feet must be spaced less than 1'-9" (550 mm) apart.
 - (1) If these conditions are unacceptable to the contractor, a minimum cure time of 72 hours will be required. After 72 hours there are no special conditions for placing a finishing machine on the barrier rail.

B. Cast-In-Place (Retrofit) Barrier Rail

1. This work is routinely combined with a deck repair project and includes an overlay. Often contractors will place the new rail prior to placing overlay. In these situations, the contractor intends to place the finish machine's rail on top of the new barrier rail. Question: How long must the new rail cure before allowing the deck finishing machine to be placed on it?
 - a. 48 hours must expire prior to placing the weight of a finishing machine on the rail.
 - b. Rail supports (legs) must be placed at a spacing of no greater than 18 inches (500 mm).
 - c. Rail supports and rail cannot be placed until the surface has sufficiently cured to prevent scuffing and/or marring.
 - d. Care must be taken to prevent damage to the face or back of the barrier rail.

C. Slip Form Barrier Rail

1. Slip form rails have at times displayed transverse cracks, longitudinal cracks, reinforcing steel shadows, and nonuniformity of top elevations. Consideration of the following construction problems and solutions will help to eliminate problems:
2. Longitudinal Cracks
 - (a) Longitudinal cracks and vertical cracks near posts can be prevented with proper construction techniques. (Consolidate uniformly, obtain proper rebar clearance and wet cure.)

711.02 Material Requirements (See Section 706)

711.03 Construction Methods

A. Concrete Surface Finish (Rail and Beams)

1. Ordinary surface finish is required for rails. Beams need only have "popcorns" filed.

B. Surface Finish

1. The type of surface finish required for concrete structures is governed by the special provisions, the plans and *SSHC Subsection 704.03*. A pre-construction study of these sources will bring to light any possible differences of opinion concerning requirements and allow time for their solution.
2. For either ordinary surface finish, rubbed finish, grout cleaned finish, or floated surface finishes, the contractor should be required to perform the work as promptly as practical after the removal of the forms. If this work is started promptly, and the surface finishing work performed before the concrete becomes excessively hardened, a much better surface finish will be obtained. Also, this better finish will be obtained with less work and consequently at lower cost.
3. If the required finish is a rubbed finish, then *SSHC Subsection 704.03* does not authorize plastering an excess of mortar on the surface of the concrete. The mortar is to be applied, as stated in the Specifications.
4. Note that proper rubbing is a sequence of three steps:
 - a. The surface is thoroughly saturated and then rubbed with the medium coarse stone faced with mortar. The paste (rubbed up from the surface of the concrete, and not applied as a plaster) is left on.
 - b. The surface is wetted and rubbed with a fine carborundum stone. The paste is left to dry on the surface.

- c. The dried paste is rubbed off completely with burlap. Some laborers will not distinguish between coarse and fine stones, or the contractor may originally furnish only one grade. Check with the Project Manager as to the proper degree of fineness of the stones being used, on the basis of the finished results. Request the Project Manager's inspection of the first finishing work done in order that he/she can set standards for methods and results in subsequent work. Ordinary surface finish, rubbed finish, grout cleaned finish, and floated surface finishes include leaving all chamfer lines and all plane surfaces intersection lines cut clean and straight.
- 5. Special provisions currently allow the use of a special surface coating as an alternate to a rubbed surface finish.
- 6. Special attention and inspection should be given to the close tolerance required in finishing of the concrete at the bearing plate areas on abutment and pier caps. Promptly after the concrete has hardened sufficiently, remove the anchor-bolt templates and finish the bearing area to a true surface. A small carpenter's level is very helpful to level the area. Prompt and efficient performance of this work will save much grinding of the hardened concrete at the time the bearing plates are set, and will yield better, more uniform bearing areas.

NOTE: To enhance the ability to hand finish slipped rail, CONFILM is recommended. CONFILM is a Master Builders product and should be used per manufacturer's recommendations.

712.00 HAND RAILS (SSHC Section 716)

712.01 DESCRIPTION

- A. This work shall consist of furnishing and erecting all steel or ornamental handrail and all miscellaneous hardware such as anchor bolts, capacity plates, and splices.

712.02 MATERIAL REQUIREMENTS

- A. Handrails shall conform to the horizontal and vertical curves specified in the plans. Posts shall be set normal to the top of the curb, except when otherwise noted in the plans or special provisions.

712.03 CONSTRUCTION METHODS

- A. Ornamental Handrail
 1. Care must be taken in storing, handling, and erecting ornamental handrail so as not to permanently mar or injure the finish on the post and rail elements. Aluminum ornamental handrail which is to be stored in the open should be removed from the cardboard cartons since cartons may stain the handrail when they become wet and considerable effort is required to remove these stains.
 2. Ornamental handrail inspection is not generally waived at the fabrication plant even if small quantities are involved. If the Project Manager does not have a copy of a shop inspection report on file indicating inspected material, the material should be inspected by Materials and Research Division. If there is a question of whether the material has been inspected or not, the Materials and Research Division should be contacted for clarification.
 3. The Project Manager should make a visual check of the handrail before placing it in the structure. In the case of aluminum tubing, "carbon streaks" that develop in the manufacturing process are not cause for rejection. However, the carbon streaks should be limited to one 90-degree segment of the surface of any rail. Particular attention is necessary at the time of erection. Tubing should be placed in the bridge railing in such a manner that the carbon streaks are not visible to traffic.

713.00 PAINTING (SSHC Section 709)

713.01 DESCRIPTION - The painting of metal structures has a dual purpose. The primary function of paint application is to preserve the life of the metal. A second function, especially important in highway grade separations, is to produce and maintain an improved appearance. Painting includes the preparation of the surface and the application of the paint coatings.

A. Painting (SSHC Section 709)

1. New Non-Weathering Structural Steel

- a. Shop applied paint system shall be used for non-weathering steel bridges.
- b. A field applied "top coat" is usually required. A top coat will also be required when it is deemed necessary due to aesthetics.
- c. The contractor will be required to touch-up any damaged areas after erection. Touch-up with top coat paint system shall be the same paint as the shop coat.

2. New Weathering (ASTM A 588) Structural Steel

- a. The plans require shop applied prime paint to selected areas on the structure. They also require:
- b. The approved paint system.
- c. Only paint where shown in the plans with approved paint system.
- d. The contractor to touch-up any damage to primed areas after erection prior to top coating. This includes bolts in those areas. Touch-up paint shall be the same paint as the shop coat.

3. Field Painting

- a. Field painting of structural steel shall be done as shown in the plans and special provisions.

713.02 MATERIAL REQUIREMENTS - Paint sampling should be done according to the "*Materials Sampling Guide*" unless the paint to be used is from tested stock in which case it will be tagged to show acceptance.

A. Mixing Paint

- 1. Follow the manufacturers recommended mixing and thinning procedures.

713.03 CONSTRUCTION METHODS

A. Painting Structural Steel

1. Paint which has been applied on rust, or dirty surfaces will peel and crack. If rust blisters form under the paint film, they can, in time, seriously reduce the effective cross section of structural shapes. The specifications require that all erection work be completed before the cleaning process is started. The cleaning should be done in a systematic manner, with the painters cleaning a given area or member before painting it.
2. Paint shall be applied as prescribed by contract specifications or the manufacturer's recommendations, whichever is most demanding. The Project Manager shall determine the correct procedure if the contract specifications differ from the manufacturer's recommendations.
3. The Project Manager or inspector should insist that the painting be done systematically, with painters working in groups on a given coat. The practice of having cleaners and painters spread out all over a bridge, with the inspector not knowing what men are working on each operation, nor which members have been cleaned and painted, should not be permitted. Painting should, in general, be started with the highest bridge members and progress downward, in order to cover areas where paint has dripped from the work above. Painting operations below deck level, should be permitted only after the deck slab concrete has been placed. Girders painted prior to the concrete placement are likely to be spattered by form leakage and may be badly scarred by form removal, necessitating considerable recleaning and repainting of all coats.
4. The plans and specifications require different paint film thickness depending on the type of paint specified. The Project Manager should check the plans and specifications to determine the types of paint required to verify that the correct system has been certified and should check for the required dry film thickness.
 - a. County bridges usually only get one coat.
 - b. New state structures usually get two coats.
 - c. Repainting an existing structure usually means adding a third coat.
5. The Project Manager or inspector should check the dry film thickness of the shop and field coats of paint applied on structural steel in accordance with the following instructions:
6. Shop Coat - The shop coat of paint may or may not have been checked in the fabricator's shop; nevertheless the shop coat should always be checked in the field, and any deficiency in paint film thickness corrected, before the second coat is started. When the dry film thickness of the shop coat is found to be inadequate, the Materials and Research Engineer should be notified in order that the particular fabricator involved may be made aware of the situation.
7. Second and Third Coats - Checking the thickness of the second and third coat with the magnetic gauge is accomplished by measuring the cumulative thickness of the first (or shop coat) and the additional coats. The dry film thickness of the second coat should always be checked and any deficiency in paint film thickness corrected before the third coat is started. Any deficiency in paint film thickness must be corrected before the work can be considered complete and consideration of acceptance given.

8. The equipment used to check the dry film paint thickness is called a magnetic dry film thickness gauge. One or two of these gauges are being furnished to each District Office for use in the District in checking the painting of steel structures. These gauges are expensive, delicate instruments and must be carefully handled and always kept in the carrying case when not in use. The procedure for using the gauge is as follows:
 - a. Turn dial to maximum reading.
 - b. Place pole on the surface to be measured.
 - c. Be sure the magnetic contact is touching the painted surface.
 - d. Slowly and as continuously as possible, rotate the dial clockwise until magnetic contact breaks. A click will be heard when the pin breaks contact. At this point the coating thickness can be read on the dial indicator. The reading will remain on the dial when the gauge is removed from the surface being checked. The gauge can also be held in any position to take a reading. The magnetic gauge reads directly in mils. A reading of 2 on the dial indicates that the thickness of the paint film is 2 mils or .002 inch.
9. The frequency of testing for paint thickness should be as follows:
 - a. Girders - Each line of girders should be checked at a maximum interval of 50 ft (15 m) and at each check point, 3 or 4 tests should be made. For example, on a 200 ft (60 m) bridge each line of girders should be checked at the abutments and at 3 intermediate points. At each one of these points three or four places should be checked such as a point on the web, a point on each flange, and a point on a stiffener.
 - b. Separators, Cross-frames and Floor Beams - Alternate lines of separators, cross-frames and floor beams should be checked two times at one location. For example, the top and bottom angle should both be checked for every other line of cross-frames.
 - c. Lateral Bracing - Lateral bracing should be checked at about 50 foot intervals.
 - d. Miscellaneous Material - Material such as expansion devices, tie rods, bearing plates and drainage systems should be spot checked for required paint film thickness.
10. Additional tests should be made, as required, to determine the extent and location of any areas deficient in paint film thickness.
11. The bridge notebook or diary should verify that the paint film thickness on each structure meets the thickness requirement specified, and the entry should include the signature of the inspector and date of inspection.

714.00 **CULVERTS** (*SSHC Sections 717 to 726*)

714.01 **GENERAL**

- A. The backfill near a pipe or box culvert is more expensive than excavation in the surrounding area. Therefore, in the *SSHC Subsection 702.03*, limits are placed on the quantities “Excavation for Box Culvert” and “Excavation for Pipe, Pipe-Arch Culverts, and Headwalls.”

715.00 CONCRETE BOX CULVERTS (SSHC Section 717)

715.01 DESCRIPTION

- A. A culvert may be defined as a structure to convey water under a roadway. Concrete box or arch culverts are used when drainage areas are too large for the conventional culvert pipe or when cattle passes under the roadway are desired. These structures are cast-in-place according to standard or special plans under *SSHC Sections 702, 704, 705 and 717*.
- B. The contractor may request that culverts be built to the nearest whole English units. Any material savings will be deducted from the payments due the contractor.

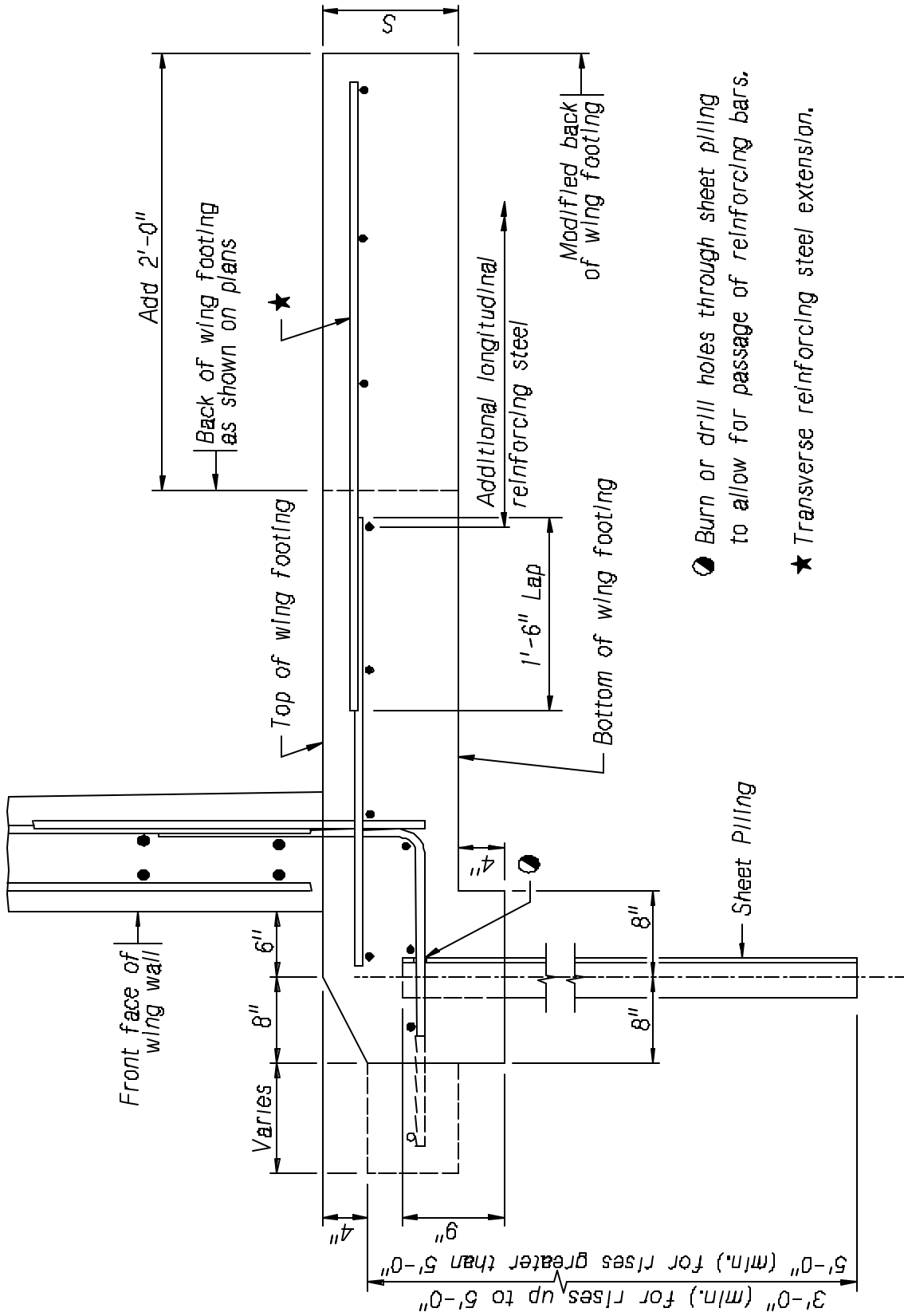
715.02 MATERIAL REQUIREMENTS

- A. See Section 706.02. Note in SiteManager the date the reinforcing steel is verified on-site.

715.03 CONSTRUCTION METHODS

- A. General - The concrete placement for box and arch culverts is discussed in Section 706 of this manual. *SSHC Subsection 717.04* further provides that foundation excavations shall be "as dry as practicable before concrete is poured". This requirement recognizes the necessity of an adequate foundation for roadway structures. When the excavation for a footing is completed, the project manager or his/her representative should be contacted for his/her approval of the footing subgrade before any concrete is placed. In the event that unsuitable foundation subgrades are encountered, suitable ones composed of sand, gravel, concrete aggregates or a concrete seal course must be constructed (see *SSHC Subsections 702* of this manual).
 - 1. Construction of curtain walls on culvert footings usually is quite a problem because of the difficulty in maintaining the excavation in proper condition while placing concrete.
 - 2. If material to be excavated is of such nature that neat lines for the curtain wall cannot be maintained, the Project Manager may allow forming and placing the curtain wall to the bottom of the footing. Mud must be prevented from working up into the concrete.
 - 3. Currently, the plans for box culverts show the backside of the wing battered 3/8" in 12", which results in a varying wall thickness. Contractors may be permitted to construct walls using the wall's base thickness, thus eliminating the batter. A plan revision or change order will not be required to effect this change.
- B. Placing Concrete and Form Removal
- C. Placing Concrete
 - 1. Placing Concrete in Walls and Top Slab. *SSHC Subsection 704.03* states that culvert, sidewalls, and top of slab may be constructed as:
 - a. A monolith unit or,
 - b. Concrete in sidewalls may be placed and allowed to harden before the top slab is placed.

2. If the contractor chooses to use the hardened concrete method, keyways will have to be installed to anchor the cover slab.
- D. Sheet Pile Turndown. Option to Use Steel Sheet Piling in Lieu of the Planned Turndowns at Box Culvert Ends.



● Burn or drill holes through sheet piling to allow for passage of reinforcing bars.

★ Transverse reinforcing steel extension.

OPTIONAL SHEET PILING TURNDOWN AT WING FOOTING

(For concrete box culvert wings)

E. Removal of Wall Forms

1. On large culvert jobs, it is a distinct advantage for the contractor to remove wall forms before the top slab has attained sufficient age to remove supporting forms. This will be permitted under the following conditions:
 - a. Vertical forms may be removed as provided in *SSHC Subsection 704.03*.
 - b. Slab forms must be supported independently of the wall forms.
 - c. Vertical supports for the slab forms must be capped with timbers. Longitudinal spacing of supports with 4x6 inch (100 x 150 mm) caps on edge should not exceed 4.5 ft (1.4 m). With 4x8 inch (100 x 200 mm) caps, spacing should not exceed 6 ft (1.8 m). Rows of supports must not be over 4 ft (1.2 m) apart. There must be at least two rows of support, with the outside rows not more than 2 ft (0.6 m) from walls. Variance from the above suggested spacing should be reviewed by the Project Manager.
 - d. Vertical posts shall not be smaller than 4x4 inches (100 x 100 mm), but may be built up of two 2x4 inches (50 x 100 mm) pieces of lumber. Lateral bracing will be required. A vertical clearance of ¼ inch (6 mm) must be provided between the wall form studs and the slab form joists.

NOTE: Lumber may be sized in metrics using actual, not the conventional nominal sizes.

- e. The slab form must remain in place as provided in *SSHC Subsection 704.03*.
- f. The interior walls of the culvert must be coated with white pigmented curing compound as provided in *SSHC Subsection 704.03*.

F. Flume Reinforcement

1. Regarding Type I, II, IV, and V Flumes, welded wire fabric reinforcing is now required on the Special Plan C (4341, 4342, 4344, 4345 – both E & M) for the flume and spillway areas. This wire can be awkward to place and keep in position. Contractors may place **intersecting No. 3 rebar at 12” centers** as an alternative to the welded wire fabric.

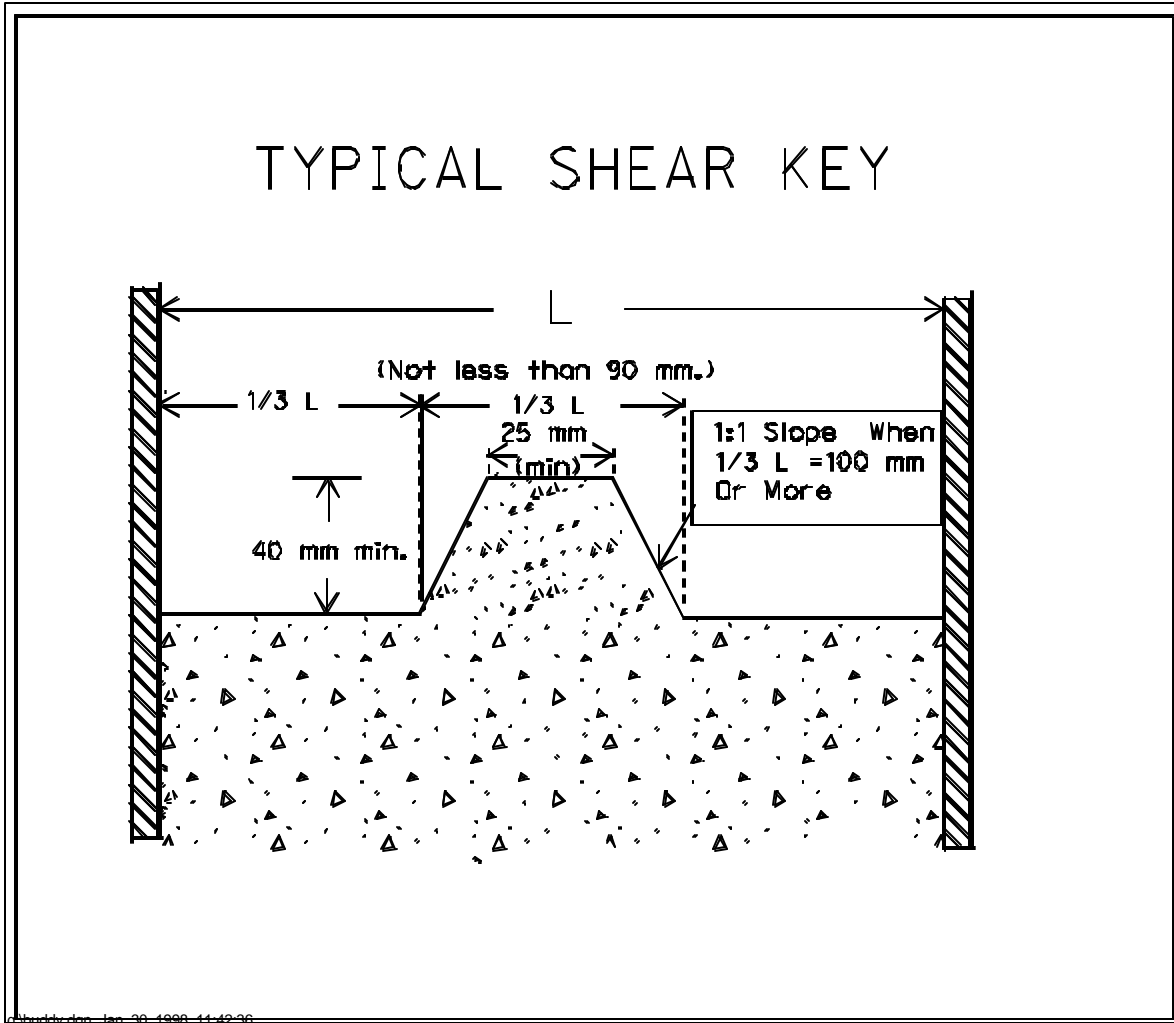
G. Backfilling Culverts – Typical Grading

1. The plans define the area used to calculate plan quantities for flowable mortar and granular backfill. (Flowable mortar plan quantities should include 30% additional for anticipated consolidation of the granular backfill and shrink due to loss of water.) If the Contractor opts to excavate a larger area than assumed for plan quantity, additional excavation, backfill, and flowable mortar will not be considered for pay. We will however, require additional excavation to be backfilled in a manner as identified by the plans or typicals.
2. Placement of flowable mortar shall always be computed from "top down." This means allow for:

- a. Pavement thickness.
- b. 1 foot (0.3 m) of special backfill, if required.
- c. Variable thickness of earth fill where cover heights are over 8 ft (2.5 m).

H. Joints (*SSHC Subsection 704.03*)

1. The location and dimensions for construction joints will generally be shown on the plans.
2. In cases where the pour is larger than can be accomplished at one time, or for some other reason it is necessary to make a construction joint not shown on the plans, approval should come from the Construction Engineer.
3. When an emergency arises, construction joints shall be placed as directed by the Project Manager. If there is some doubt as to the proper location of the joint, the District Construction Engineer should be contacted.
4. Construction joints shall be paid for as outlined in SSHC 704.04.
5. Where it is necessary to transfer shear, shear keys or inclined reinforcement shall be used. It should be pointed out that in practically all cases, shear transfer is essential and therefore shear keys or inclined reinforcement will usually be required. When inclined reinforcement is used as a means of shear transfer No. 5 bars at 1 foot (300 mm) centers should be considered a minimum. The angle of inclination should be approximately 15 degrees from the direction of shear and the length of bar should be at least 2'-3" (685 mm) in order that 20 bar diameters can be placed in both sections of the pour.
6. Shear keys should be formed with beveled strips or boards at right angles to the direction of shear. Typical dimensions for a shear key are shown in the following sketch.
7. If the volume of concrete culvert pour is greater than can be placed in a normal day's operation, or in case of emergency, construction joints located in accordance with the details shown in the drawing "Construction Joints for Box Culverts" may be constructed. Construction joints between roadway shoulder lines are not shown in this drawing since they are not to be so constructed unless authorized by the Construction Engineer.
8. Construction joints in box culverts should be located as follows: Vertical floor joints, wall joints and top slab joints should be constructed in accordance with the sketches in this article and should be staggered by approximately 3 ft (1.0 m). When the walls and top slab are placed simultaneously, the top slab should be stopped and jointed approximately 3 ft (1.0 m) before ending the wall. (Refer to sketch "Construction Joint for Box Culverts".)



[The side slopes of the key will be less than one to one until the widest dimension of the key reaches 4 inches (100 mm).]

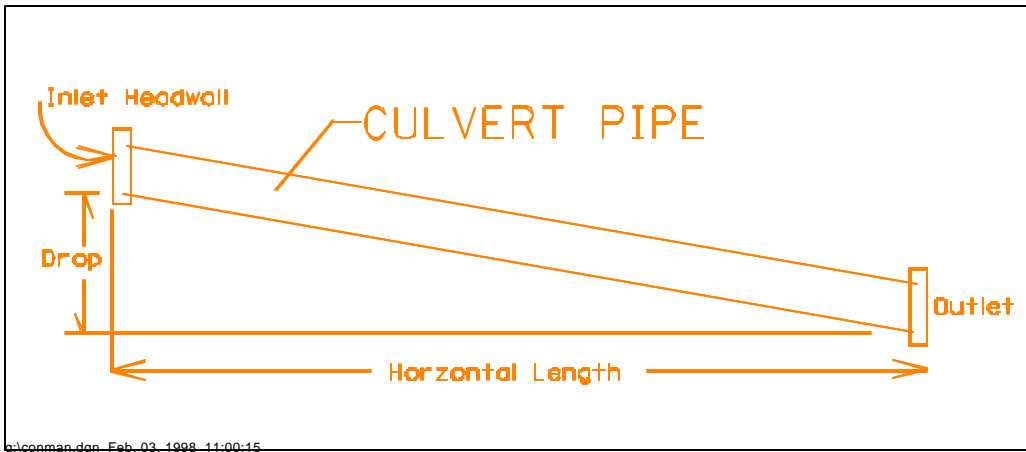
716.00 CULVERT PIPE (SSHC Section 718)

716.01 DESCRIPTION

A. This work shall consist of furnishing and installing culvert pipe. The contractor has the option to furnish any of the types of culvert pipe listed in the specifications.

716.02 CONSTRUCTION METHODS

A. Culvert List. The contractor is not permitted to order or deliver culvert pipe until a "culvert list" listing the correct sizes and lengths of pipe is furnished to him/her by the Project Manager.



B. Pipe Bedding

1. Pipe bedding is explained in the special plan for "Pipe Policy".
2. The following soil classifications are necessary to use the pipe special plans to determine correct bedding materials.

ASTM D 2487 Description and Identification of Soils			
		SIEVE RANGE	
GRAVEL	COURSE	Passes 3-inch	Retained on ¾-inch
	FINE	passes ¾-inch	Retained on No. 4
SAND	COURSE	Passes No. 4	Retained on No. 10
	MEDIUM	Passes No. 10	Retained on No. 40
	FINE	Passes No. 40	Retained on No. 200

C. Temporary Culvert Pipe

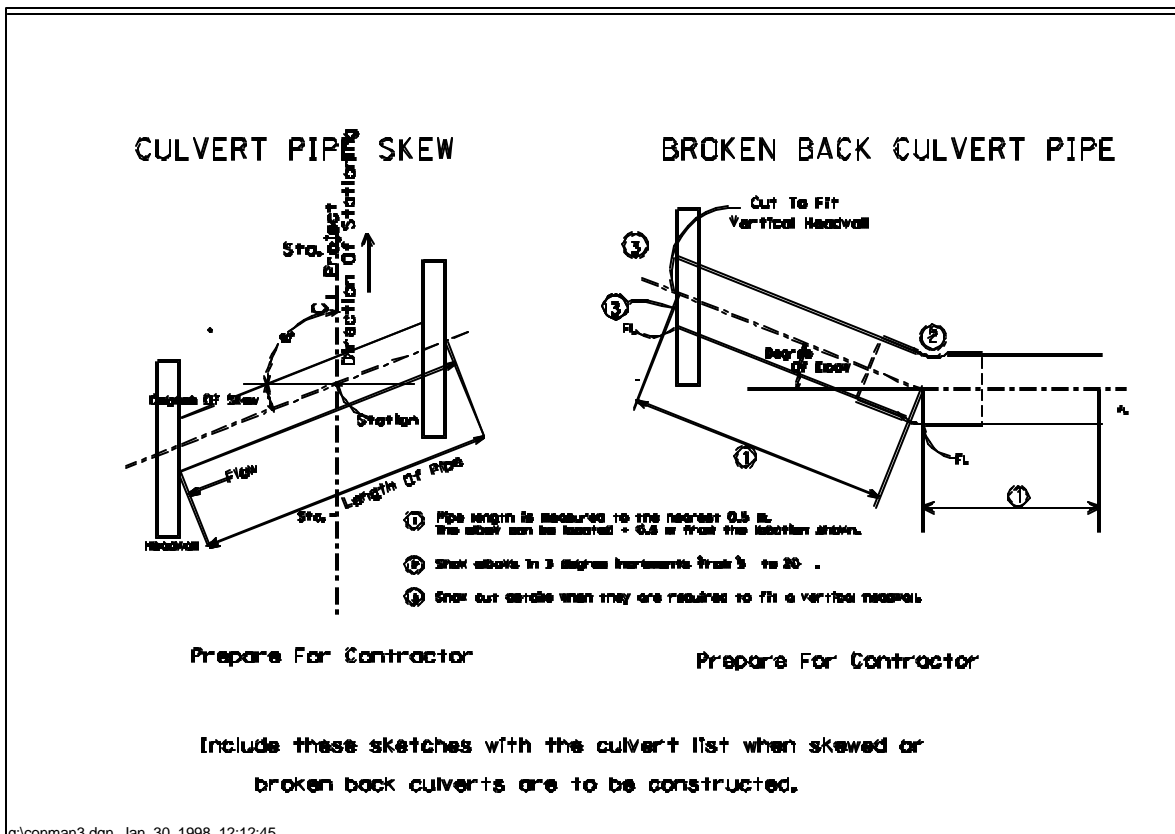
1. The Districts will be responsible for making a determination (presumably during the plan-in-hand inspection) regarding whether or not to ask for new pipe.
 2. Logistics Division maintains a list of pipe values which can be used to determine damages to the Department when pipe is not returned to us in usable condition.
- D. Salvaged Culvert Pipe. The following listed examples and rules are given to help clarify removal and salvage of culvert pipe.
1. Rules
 - a. The decision to salvage or not to salvage the culvert pipe at each location must be made by the Inspector or Project Manager prior to beginning removal work on the culvert pipe, and the contractor must be advised of your decision prior to his/her commencing work on the removal.
 - b. Culvert pipe ordered salvaged and carefully removed by the contractor will be paid for as per the specifications even though after removal it is apparent that the removed pipe has no salvage value.
 - c. The contractor must carefully remove the culvert pipe to prevent damage to the culvert pipe.
 2. Examples
 - a. The contractor is ordered to salvage the culvert pipe. The contractor carefully removes the culvert pipe. The culvert pipe has almost rusted through from the outside and really has no salvage value. The length of pipe removed will be included for payment.
 - b. The contractor is ordered to salvage the culvert pipe. After the pipe has been uncovered, it is apparent that it has very little salvage value. If the contractor is agreeable, the Inspector or Project Manager can rescind their salvage order and the contractor can complete the removal any way possible. The length of pipe removed under these conditions will not be included for payment.
 - c. The contractor is ordered to salvage the culvert pipe. The contractor is careless in removing the culvert pipe and damages it. The length of pipe removed less the damage length may be included for payment, or the Inspector or Project Manager may determine that there is no salvage value left in the culvert pipe and no payment will be made for salvaging the culvert pipe at this location.
 - d. The contractor is ordered to not salvage the culvert pipe. The contractor removes the culvert pipe and disposes of part of it. The contractor advises that the remaining removed pipe may be picked up by the Department. The Department may refuse to pick it up, inasmuch as all such material is the property of the contractor and it is his/her responsibility to properly dispose of such material. If the Department picks it up the lengths may be included for payment as salvaging culvert pipe or they may be picked up without payment

being made. The Inspector or Project Manager shall determine what is fair and just.

3. Decisions and Documentation

a. There will undoubtedly be conditions arising which are not entirely covered by these rules or examples but the Inspector or Project Manager should be able to make the proper decision within the spirit of these guidelines.

4. The project records must include pertinent notes explaining and detailing decisions made on salvaging culvert pipe.



**ADDITIONAL EXCAVATION FOR EMBANKMENT OR BACKFILL
(Left in English Units for Your Convenience)**

The following charts may be used for computing Additional Excavation for Embankment or Backfill for circular culvert pipe, arch culvert pipe or elliptical culvert pipe (pages 450C, D, E, F). "Y" is the distance from natural ground to the center of the pipe or in the case of arch pipe to the widest part of the pipe. The numbers in the columns under the different size pipe diameters are the end area in square feet of the backfill required by the specification.

Example: A 24" circular culvert pipe is laid at Station 17+30 with Flowline Lt. 2416.60 at 47' and Flowline Rt. 2415.00 at 51'. The field design cross-section is 16.6 at 50' Lt., 16.3 at 35' Lt., 16.2 at

Culvert Pipe

18' Lt., 16.2 at CL, 16.0 at 5' Rt., 16.0 at 10' Rt., 15.3 at 15' Rt., 15.0 at 27' Rt., 15.7 at 42' Rt. and 15.5 at 55' Rt.

16.6 at 50'		
16.5 at 47'	FL = 16.6 at 47'	Y = 1.1
16.3 at 35'	FL = 16.4 at 35'	Y = 1.1
16.2 at 18'	FL = 16.1 at 18'	Y = 0.9
16.2 at CL	FL = 15.8 at CL	Y = 0.6
16.0 at 5'	FL = 15.8 at 5'	Y = 0.8
16.0 at 10'	FL = 15.7 at 10'	Y = 0.7
15.3 at 15'	FL = 15.6 at 15'	Y = 1.3
15.0 at 27'	FL = 15.4 at 27'	Y = 1.4
15.7 at 42'	FL = 15.1 at 42'	Y = 0.4
15.6 at 51'		
15.5 at 55'	FL = 15.0 at 51'	Y = 0.4

24"x98' Culvert Pipe

Circular Culvert Pipe Embankment Areas
 (Y=Height, TC = Center of Pipe)
 Pipe Diagram

Y	12"	15"	18"	24"	30"	36"	42"	48"	54"	60"	72"
0.1	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
0.2	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
0.3	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
0.4	2.0	2.0	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
0.5	2.6	2.6	2.6	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
0.6	3.3	3.3	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.1	3.1
0.7	4.1	4.0	4.0	3.9	3.9	3.9	3.8	3.8	3.8	3.8	3.8
0.8	4.9	4.9	4.8	4.7	4.6	4.6	4.6	4.6	4.6	4.5	4.5
0.9	5.7	5.7	5.7	5.5	5.4	5.4	5.4	5.3	5.3	5.3	5.3
1.0	6.6	6.6	6.6	6.4	6.3	6.2	6.2	6.2	6.2	6.1	6.1
1.1	7.5	7.6	7.6	7.4	7.2	7.1	7.1	7.1	7.0	7.0	7.0
1.2	8.5	8.6	8.6	8.5	8.2	8.1	8.0	8.0	7.9	7.9	7.9
1.3	9.5	9.6	9.6	9.4	9.4	9.1	9.0	9.0	8.9	8.9	8.8
1.4	10.5	10.7	10.7	10.7	10.6	10.3	10.1	10.0	10.0	9.9	9.8
1.5	11.6	11.8	11.9	11.9	11.8	11.5	11.2	11.1	11.0	11.0	10.9
1.6	12.7	12.9	13.0	13.1	13.1	12.8	12.5	12.3	12.2	12.1	12.0
1.7	13.9	14.1	14.2	14.4	14.4	14.1	13.7	13.5	13.4	13.3	13.2
1.8	15.1	15.3	15.5	15.7	15.7	15.5	15.2	14.8	14.7	14.5	14.4
1.9	16.3	16.6	16.8	17.0	17.1	17.0	16.7	16.2	16.0	15.8	15.6
2.0	17.6	17.9	18.1	18.4	18.5	18.5	18.2	17.7	17.4	17.2	17.0
2.1	18.9	19.2	19.5	19.8	20.0	20.0	19.8	19.3	18.9	18.6	18.3
2.2	20.3	20.6	20.9	21.3	21.5	21.5	21.4	21.0	20.5	20.1	19.8
2.3	21.7	22.0	22.3	22.8	23.1	23.1	23.0	22.7	22.2	21.7	21.3
2.4	23.1	23.5	23.8	24.3	24.7	24.8	24.7	24.4	24.0	23.4	22.9
2.5	24.6	25.0	25.4	25.9	26.3	26.5	26.4	26.2	25.8	25.2	24.5
2.6	26.1	26.6	26.9	27.5	28.0	28.2	28.2	28.0	27.7	27.1	26.2
2.7	27.7	28.1	28.5	29.2	29.7	29.9	30.0	29.9	29.6	29.1	28.0
2.8	29.3	29.8	30.2	30.9	31.4	31.7	31.9	31.8	31.5	31.1	29.8
2.9	30.9	31.4	31.9	32.6	33.2	33.6	33.8	33.7	33.5	33.1	31.8
3.0	32.6	33.1	33.6	34.4	35.0	35.5	35.7	35.7	35.5	35.2	33.9
3.1	34.3	34.9	35.4	36.2	36.9	37.4	37.7	37.7	37.6	37.3	36.1
3.2	36.1	36.7	37.2	38.1	38.8	39.3	39.7	39.8	39.7	39.5	38.3
3.3	37.9	38.5	39.0	40.0	40.8	41.3	41.7	41.9	41.9	41.7	40.6
3.4	39.7	40.4	40.9	41.9	42.8	43.4	43.8	44.0	44.1	43.9	43.0
3.5	41.6	42.3	42.9	43.9	44.8	45.5	45.9	46.2	46.3	46.2	45.4
3.6	43.5	44.2	44.8	45.9	46.9	47.6	48.1	48.4	48.6	48.5	47.8
3.7	45.5	46.2	46.8	48.0	49.0	49.7	50.3	50.7	50.9	50.9	50.2
3.8	47.5	48.2	48.9	50.1	51.1	51.9	52.6	53.0	53.2	53.3	52.7
3.9	49.5	50.3	51.0	52.2	53.3	54.2	54.9	55.3	55.6	55.7	55.3
4.0	51.6	52.4	53.1	54.4	55.5	56.5	57.2	57.7	58.0	58.2	57.9
4.1	53.7	54.5	55.3	56.6	57.8	58.8	59.6	60.1	60.5	60.7	60.5
4.2	55.9	56.7	57.5	58.9	60.1	61.1	62.0	62.6	63.0	63.3	63.1
4.3	58.1	58.9	59.7	61.2	62.5	63.5	64.4	65.1	65.6	65.9	65.8
4.4	60.3	61.2	62.0	63.5	64.9	66.0	66.9	67.6	68.2	68.5	68.6
4.5	62.6	63.5	64.4	65.9	67.3	68.5	69.4	70.2	70.8	71.2	71.4
4.6	64.9	65.9	66.7	68.3	69.8	71.0	72.0	72.8	73.	73.9	74.2
4.7	67.3	68.2	69.1	70.8	72.3	73.5	74.6	75.5	76.2	76.7	77.0
4.8	69.7	70.7	71.6	73.3	74.8	76.1	77.3	78.2	78.9	79.5	79.9
4.9	72.1	73.1	74.1	75.8	77.4	78.8	80.0	80.9	81.7	82.3	82.9
5.0	74.6	75.6	76.6	78.4	80.0	81.5	82.7	83.7	84.5	85.2	85.9

Culvert Pipe-Arch Embankment Areas
(Y=Height to Widest Section of Pipe)
Equivalent Round Size

Y	12"	30"	36"	42"	48"	54"	60"	66"	72"
0.1	0.6	0.6	0.7	0.7	0.8	0.9	1.0	1.2	1.3
0.2	1.1	1.1	1.1	1.2	1.3	1.4	1.5	1.7	1.8
0.3	1.6	1.6	1.6	1.7	1.8	1.9	2.1	2.2	2.4
0.4	2.0	2.2	2.2	2.2	2.24	2.5	2.6	2.8	2.9
0.5	2.8	2.7	2.7	2.7	2.9	3.1	3.2	3.4	3.5
0.6	3.7	3.6	3.5	3.4	3.4	3.7	3.8	4.0	4.2
0.7	4.6	4.6	4.5	4.4	4.2	4.1	4.5	4.7	4.9
0.8	5.5	5.6	5.6	5.5	5.3	5.0	4.9	5.4	5.6
0.9	6.5	6.6	6.7	6.7	6.5	6.2	5.9	5.8	5.7
1.0	7.5	7.7	7.8	7.9	7.8	7.5	7.1	6.8	6.7
1.1	8.6	8.8	9.0	9.1	9.1	8.9	8.6	8.1	7.8
1.2	9.7	10.0	10.2	10.4	10.4	10.3	10.0	9.6	9.2
1.3	10.8	11.2	11.5	11.7	11.8	11.7	11.5	11.2	10.8
1.4	12.0	12.4	12.8	13.1	13.2	13.2	13.1	12.8	12.4
1.5	13.2	13.7	14.1	14.5	14.7	14.7	14.6	14.4	14.1
1.6	14.5	15.0	15.5	15.9	16.2	16.3	16.3	16.1	15.8
1.7	15.8	16.4	16.9	17.4	17.7	17.9	17.9	17.8	17.6
1.8	17.1	17.8	18.4	18.9	19.3	19.5	19.6	19.6	19.4
1.9	18.5	19.2	19.9	20.4	20.9	21.2	21.4	21.4	21.3
2.0	19.9	20.7	21.4	22.0	22.6	22.9	23.1	23.2	23.2
2.1	21.4	22.2	23.0	23.7	24.3	24.7	25.0	25.1	25.1
2.2	22.9	23.8	24.6	25.4	26.0	26.5	26.8	27.0	27.0
2.3	24.4	25.4	26.3	27.1	27.8	28.3	28.7	29.0	29.1
2.4	26.0	27.0	28.0	28.8	29.6	30.2	30.7	31.0	31.1
2.5	27.6	28.7	29.7	30.6	31.5	32.1	32.6	33.0	33.2
2.6	29.3	30.4	31.5	32.5	33.4	34.1	34.7	35.1	35.3
2.7	31.0	32.2	33.3	34.3	35.3	36.1	36.7	37.2	37.5
2.8	32.7	34.0	35.2	36.3	37.3	38.1	38.8	39.3	39.7
2.9	34.5	35.8	37.1	38.2	39.4	40.2	41.0	41.5	41.9
3.0	36.3	37.7	39.0	40.2	41.4	42.3	43.1	43.8	44.2
3.1	38.2	39.6	41.0	42.2	43.5	44.5	45.4	46.1	46.6
3.2	40.1	41.6	43.0	44.3	45.7	46.7	47.6	48.4	48.9

Culvert Pipe-Arch Embankment Areas
(Y=Height to Widest Section of Pipe)
Equivalent Round Size

Y	24"	30"	36"	42"	48"	54"	60"	66"	72"
3.3	42.0	43.6	45.1	46.4	47.8	48.9	49.9	50.7	51.3
3.4	44.0	45.6	47.2	48.6	50.1	51.2	52.3	53.1	53.8
3.5	46.0	47.7	49.3	50.8	52.3	53.5	54.6	55.6	56.3
3.6	48.1	49.8	51.5	53.0	54.6	55.9	57.1	58.1	58.8
3.7	50.2	52.0	53.7	55.3	57.0	58.3	59.5	60.6	61.4
3.8	52.3	54.2	56.0	57.6	59.4	60.7	62.0	63.1	64.0
3.9	54.5	56.4	58.3	60.0	61.8	63.2	64.6	65.7	66.6
4.0	56.8	58.7	60.6	62.4	64.3	65.7	67.1	68.4	69.3
4.1	59.0	61.0	63.0	64.8	66.8	68.3	69.8	71.0	72.0
4.2	61.3	63.4	65.4	67.3	69.3	70.9	72.4	73.8	74.8
4.3	63.7	65.8	67.8	69.8	71.9	73.6	75.1	76.5	77.6
4.4	66.0	68.2	70.3	72.4	74.5	76.2	77.9	79.3	80.5
4.5	68.5	70.7	72.9	75.0	77.2	79.0	80.6	82.2	83.4
4.6	70.9	73.2	75.5	77.6	79.9	81.7	83.5	85.0	86.3
4.7	73.4	75.8	78.1	80.3	82.6	84.5	86.3	88.0	89.3
4.8	76.0	78.4	80.7	83.0	85.4	87.4	89.2	90.9	92.3
4.9	78.5	81.0	83.4	85.1	88.2	90.2	92.2	93.9	95.3
5.0	81.2	83.7	86.2	88.5	91.1	93.2	95.1	97.0	98.4

Elliptical Culvert Pipe Embankment Areas
(Y = Height to Center of Pipe)
Equivalent Round Size

0.1	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
0.2	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.0	0.9
0.3	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
0.4	2.0	2.0	1.9	1.9	1.9	1.9	1.9	1.9	1.9
0.5	2.6	2.6	2.6	2.5	2.5	2.5	2.5	2.5	2.5
0.6	3.3	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2
0.7	4.0	4.0	3.9	3.9	3.9	3.9	3.9	3.9	3.9
0.8	4.9	4.8	4.7	4.7	4.7	4.6	4.6	4.6	4.6
0.9	5.9	5.7	5.6	5.5	5.5	5.4	5.4	5.4	5.4
1.0	6.9	8.7	6.5	6.4	6.4	6.3	6.3	6.2	6.2
1.1	8.0	7.8	7.5	7.4	7.3	7.2	7.2	7.1	7.1
1.2	9.1	9.0	8.6	8.4	8.3	8.2	8.2	8.1	8.1
1.3	10.3	10.2	5.9	9.5	9.4	9.3	9.2	9.1	9.1
1.4	11.5	11.5	11.2	10.8	10.6	10.4	10.3	10.2	10.1
1.5	12.7	12.8	12.6	12.2	11.9	11.6	11.5	11.4	11.3
1.6	14.0	14.1	14.0	13.7	13.3	12.9	12.7	12.6	12.5
1.7	15.3	15.5	15.4	15.2	14.9	14.3	14.1	13.9	13.7
1.8	16.6	16.9	16.9	16.7	16.3	15.9	15.5	15.2	15.1
1.9	18.0	18.3	18.4	18.3	18.1	17.6	17.0	18.7	16.5
2.0	19.4	19.8	19.9	19.9	19.8	19.4	18.7	18.2	18.0
2.1	20.9	21.4	21.5	21.6	21.5	21.1	20.6	19.9	19.6
2.2	22.4	23.0	23.2	23.3	23.3	23.0	22.5	21.7	21.2
2.3	24.0	24.6	24.8	25.0	25.1	24.8	24.4	23.7	23.0
2.4	25.6	26.2	26.0	26.8	26.9	26.7	26.4	25.7	24.9
2.5	27.2	27.9	28.3	28.6	28.8	28.7	28.4	27.9	27.1
2.6	28.9	29.7	30.1	30.5	30.7	30.7	30.4	29.9	29.2
2.7	30.6	31.4	31.9	32.4	32.7	32.7	32.5	32.1	31.5
2.8	32.3	33.3	33.8	34.3	34.7	34.8	34.7	34.3	33.7
2.9	34.1	35.1	35.7	36.3	36.7	36.9	36.8	36.5	36.0
3.0	35.9	37.0	37.7	38.3	38.8	39.0	39.1	38.8	38.4
3.1	37.8	38.9	39.7	40.4	40.9	41.2	41.3	41.1	40.7
3.2	39.7	40.9	41.7	42.5	43.1	43.6	43.6	43.4	43.2
3.3	41.7	42.9	43.8	44.6	45.3	45.7	45.9	45.8	45.6
3.4	43.7	45.0	45.9	46.8	47.5	38.0	48.3	48.2	48.1
3.5	45.7	47.1	48.1	49.0	49.8	50.4	50.7	50.7	50.6
3.6	47.8	49.2	50.3	51.3	52.1	52.7	53.2	53.2	53.2
3.7	49.9	51.4	52.5	53.6	54.5	55.2	55.7	55.8	55.8
3.8	52.0	53.6	54.8	55.9	56.9	57.6	58.2	58.4	58.5
3.9	54.2	55.9	57.1	58.3	59.3	60.1	60.8	61.0	61.2
4.0	56.4	58.2	59.4	60.8	61.8	62.7	63.4	63.7	63.9
4.1	58.7	60.5	61.8	63.2	64.3	65.3	66.0	66.4	66.7
4.2	61.0	62.9	64.3	65.7	66.9	67.9	68.7	69.1	69.5
4.3	63.4	65.3	66.7	68.3	69.5	70.6	71.8	71.9	72.4
4.4	65.8	67.8	69.3	70.8	72.1	73.3	74.2	74.8	75.3
4.5	68.2	70.3	71.8	73.5	74.8	76.0	77.1	77.6	76.2
4.6	70.7	72.8	74.4	76.1	77.5	78.8	79.9	80.5	81.2
4.7	73.2	75.4	77.0	78.8	80.3	81.6	82.8	83.5	84.2
4.8	75.7	78.0	79.7	81.6	83.1	84.5	85.7	86.5	87.3
4.9	78.3	80.6	82.4	86.3	85.9	87.4	89.7	89.5	90.4
5.0	80.9	83.3	85.2	87.2	88.8	90.4	91.7	92.6	93.5

Cu. Yds. of Concrete to be deducted from one Headwall because of skew.**Corrugated Pipe 8" Headwalls**

Size/Skew	5"	10"	15"	20"	25"	30"	35"	40"	45"	50"	55"	60"
18" Pipe	.000	.001	.002	.003	.005	.007	.010	.013	.018	.024	.032	.044
24" Pipe	.000	.001	.003	.005	.008	.012	.017	.024	.032	.043	.058	.078
30" Pipe	.000	.002	.004	.008	.013	.019	.027	.037	.050	.067	.090	.121
30" Pipe	.001	.003	.006	.011	.018	.027	.039	.053	.072	.097	.130	.174
42" Pipe	.001	.004	.008	.015	.025	.037	.052	.073	.098	.132	.177	.238
48" Pipe	.001	.005	.011	.020	.032	.048	.068	.095	.128	.172	.231	.310
54" Pipe	.001	.006	.014	.025	.041	.061	.087	.120	.163	.218	.292	.393
60" Pipe	.002	.007	.017	.031	.050	.075	.107	.148	.201	.269	.360	.485
72" Pipe	.003	.011	.025	.045	.072	.108	.154	.213	.289	.388	.519	.698
84" Pipe	.004	.015	.034	.061	.098	.147	.210	.290	.394	.528	.706	.950

Corrugated Pipe 6" Headwalls

Size/Skew	5"	10"	15"	20"	25"	30"	35"	40"	45"	50"	55"	60"
18" Pipe	.000	.001	.001	.002	.003	.005	.007	.010	.014	.018	.024	.033
24" Pipe	.000	.001	.002	.004	.006	.009	.013	.018	.024	.052	.043	.058
30" Pipe	.000	.001	.003	.006	.009	.014	.020	.028	.038	.051	.068	.091
36" Pipe	.001	.002	.005	.008	.014	.020	.029	.040	.054	.073	.097	.131
42" Pipe	.001	.003	.006	.011	.018	.028	.039	.054	.074	.099	.132	.178
48" Pipe	.001	.004	.008	.015	.024	.036	.051	.071	.096	.129	.173	.233
54" Pipe	.001	.005	.010	.019	.030	.046	.065	.090	.122	.164	.219	.294
60" Pipe	.001	.006	.013	.023	.038	.056	.080	.111	.151	.202	.270	.364
72" Pipe	.002	.008	.018	.034	.054	.081	.116	.160	.217	.291	.389	.523
84" Pipe	.003	.011	.025	.046	.074	.110	.157	.218	.295	.398	.530	.713

Concrete Pipe 8" Headwalls

Size	T	5"	10"	15"	20"	25"	30"	35"	40"	45"	50"	55"	60"
18" Pipe	2½	.000	.001	.003	.005	.007	.011	.016	.022	.030	.040	.053	.071
24" Pipe	2¾	.000	.002	.004	.008	.012	.018	.026	.036	.049	.065	.087	.117
30" Pipe	3	.001	.003	.006	.011	.018	.027	.039	.053	.072	.097	.130	.174
36" Pipe	3½	.001	.004	.009	.016	.026	.039	.055	.076	.103	.138	.185	.249
42" Pipe	4¼	.001	.005	.012	.022	.035	.053	.076	.105	.142	.191	.255	.343
48" Pipe	5	.002	.007	.016	.029	.047	.070	.100	.138	.188	.252	.337	.453
54" Pipe	5"	.002	.009	.019	.035	.057	.085	.122	.168	.228	.306	.410	.551
54" Pipe	5½	.002	.009	.020	.037	.059	.088	.126	.14	.236	.316	.423	.569
60" Pipe	5½	.003	.010	.024	.044	.070	.105	.150	.207	.281	.377	.505	.579
60" Pipe	6"	.003	.011	.025	.045	.072	.108	.154	.213	.289	.388	.519	.698
72" Pipe	7"	.004	.015	.035	.064	.130	.154	.220	.304	.412	.553	.740	.996
84" Pipe	8"	.005	.021	.048	.086	.139	.208	.297	.411	.558	.748	1001	1346

Concrete Pipe 6" Headwalls

Size	T	5"	10"	15"	20"	25"	30"	35"	40"	45"	50"	55"	60"
18" Pipe	2½	.000	.001	.002	.003	.005	.008	.012	.016	.022	.030	.040	.053
24" Pipe	2¼	.000	.001	.003	.006	.009	.014	.019	.027	.036	.049	.065	.088
30" Pipe	3"	.001	.002	.005	.008	.014	.020	.029	.040	.054	.073	.097	.131
36" Pipe	3½	.001	.003	.007	.012	.019	.029	.041	.057	.077	.104	.139	.187
42" Pipe	4¼	.001	.004	.009	.017	.027	.040	.057	.079	.107	.143	.191	.258
48" Pipe	5"	.001	.005	.012	.022	.035	.053	.075	.104	.141	.189	.253	.340
54" Pipe	5"	.002	.006	.015	.027	.043	.064	.091	.126	.171	.230	.307	.414
54" Pipe	5½	.002	.007	.015	.027	.044	.055	.094	.130	.177	.237	.317	.427
60" Pipe	5½	.002	.008	.018	.033	.053	.079	.112	.155	.211	.283	.378	.509
60" Pipe	6"	.002	.008	.018	.034	.054	.081	.116	.160	.217	.291	.389	.523
72" Pipe	7"	.003	.012	.026	.048	.077	.116	.165	.228	.309	.415	.555	.747
84" Pipe	8"	.004	.016	.036	.065	.104	.156	.223	.308	.418	.561	.751	1.010

717.00 CONCRETE PIPE CULVERTS (SSHC Section 720)

717.01 DESCRIPTION

- A. This work shall consist of furnishing and installing new reinforced concrete culvert pipe (round, pipe-arch and elliptical), reinforced concrete slotted pipe and the relaying of existing reinforced concrete pipe.

717.02 MATERIAL REQUIREMENTS

- A. Pipe Marking. Each section of pipe used should be marked with the fabrication inspector's initial and the class of pipe, when it arrives at the site. The culvert inspector should not permit the laying of any section that does not have these markings. The project manager will receive a copy of the "Report of Shipment of Reinforced Concrete Pipe" (Form DR-420), listing the size, class, length, number of sections of pipe, the inspector's identification mark and stock report number. The inspector will use the information contained in this report to verify approval of reinforced concrete pipe received on the project. The diameter, class, length, number of sections and the pipe identification number shall be recorded in the culvert notebook. Each section of pipe should be examined for damaged ends, cracks and evidence of poor manufacture. All irregularities should be referred to the Project Manager before using of the pipe.
- B. Ordering Material
1. The contractor is **not permitted to order or deliver** culvert pipe until a "culvert list" listing the correct sizes and lengths of pipe is furnished by the Project Manager.
 2. The Project Manager shall furnish a pipe list for driveway and sewer requirements.
 3. The District Construction Engineer, and the Project Manager should go over the drainage situation and features in the field to confirm that the structures shown in the plans are adequate to handle the drainage. The cross sections taken at each culvert site should be plotted, the roadway cross section template and the structure plotted thereon at the proper flow line elevations, and the length of the structure thus determined. If the Project Manager includes either a larger drainage structure, or an additional drainage structure in the culvert list, he/she should, if possible, specify the same type of structure, or the same kind of pipe (culvert pipe, concrete pipe or corrugated metal pipe) as is shown in the approved plans for the project for the other structures.
 4. In detailing and ordering the pipe culverts, the following rules should be followed for all kinds of culvert pipe (concrete pipe, corrugated metal pipe or culvert pipe):
 - a. The overall length of culvert pipe should be given to the closest 2 ft (600 mm).
 - b. The minimum distance from either end of the pipe to the break point of a broken back pipe culvert shall be 10 ft (3 m).

- c. The dimensions from ends of the pipe to break points, or between break points of a broken-back pipe culvert should be given to the closest 2 ft (600 mm) along the centerline of the pipe. The fabricator will be permitted to locate the elbows 1 foot (300 mm) in either direction from the locations shown in the culvert sketch.
- d. Generally, pipe culverts should not be designed or constructed with elbows of less than 5 degrees.
- e. Prepare a sketch for each broken-back pipe culvert, designing and detailing the structure using the chart "Slope Data for Pipe Culvert" as a guide, and including dimensions, details and elevations as shown in the sample culvert sketch shown in this Subsection.
- f. Pipe arch culverts are to be detailed and dimensioned the same as round pipe culverts. Broken-back pipe arch culverts should be avoided.
- g. If flared end sections are to be installed, the pay length shall be the order length shown in the culvert list and sketch. A note should be made as part of the list indicating that order lengths do not indicate the "Y" distances shown in the applicable Standard Plan in the case of metal pipe.
- h. The condition, kind of pipe, diameter and lengths right and left of centerline should be carefully checked before ordering extensions for an existing pipe culvert. Careful checking will eliminate ordering extensions which are improper as to length, diameter, kind of pipe, etc.
- i. The maximum discharge of the average pipe culvert without head on the inlet will be provided when such pipe are given a slope of between one percent and two percent. Slopes steeper than this will not increase the water carrying capacity of the culvert. The Project Manager should make every effort to use such slopes when they are compatible with other drainage requirements at the individual culvert site. In choosing between a straight and a broken-back culvert pipe, the Project Manager should realize that little, if any, value is gained by installing elbows of less than 5 degrees.
- j. If settlement or subsidence is anticipated under higher fills, pipe culverts and box culverts should be cambered. The plans will usually include a "Camber Note" which will state that the pipe culverts should be laid and box culverts constructed on parabolic camber grade as shown in the applicable standard plan, and will state the proportion of fill height which the foundation soil is expected to settle. Settlement or subsidence is generally zero at the toe of the slope, and at a maximum at the shoulder line.

717.03 CONSTRUCTION METHODS

- A. Excavation and Backfilling
 - 1. See Section 702 of this manual.

B. Installation

1. Begin laying concrete pipe at the downstream end of the culvert with the groove or bell portion of each section upstream.
2. Irrigation culverts shall be constructed of concrete pipe and must have approved gaskets at the joints. These gaskets shall be installed as per the manufacturer's recommendations and standards. Here is example of how to calculate payment for excavation.

EXAMPLE CALCULATION

Area for 1.25 m depth:

1a

Area for 2.75 m depth:

1b + 2b + 3b

Area for 4.25 m depth:

1c + 2c + 3c

Area for 5.75 m depth:

1d + 2d + 3d

Area for greater than 5.75 m depth:

1e + 2e + 3e

718.00 CORRUGATED METAL PIPE CULVERTS (SSHC Section 719)

718.01 DESCRIPTION

- A. This work shall consist of furnishing and installing new corrugated galvanized metal pipes and pipe arches and the relaying of existing corrugated metal pipe and pipe arches.

718.02 MATERIAL REQUIREMENTS

- A. Pipe Marking. SSHC Tables 1035.01 & 1036.01 contain the required minimum gage or sheet thickness for the various pipe diameters. The "Materials and Sampling Guide" provides that the necessary tests for acceptance will be handled by the Materials and Research Division. Material samples need not be taken by project personnel unless a special request is made for samples. The diameter of the pipe and number of sections of pipe covered by each heat number and delivered to each culvert location should be recorded in the culvert notebook. The pipe shipment should be checked against the shipment report and any discrepancy should be reported to the Project Manager. The pipe shipment should also be checked for shipping damage and any damage noted should also be reported to the Project Manager.
- B. Ordering Material
1. **The contractor is not permitted to order or deliver corrugated metal pipe or pipe arches until a "culvert list" listing the correct sizes and lengths of pipe is furnished to him/her by the Project Manager.**

718.03 CONSTRUCTION METHODS

- A. Excavating and Backfilling
1. Refer to Section 702 of this manual.
- B. Installation
1. The culvert inspector should insist on careful handling of the corrugated metal pipes or pipe arches. Corrugated metal pipes or pipe arches should be lifted and moved with a rope sling or similar device which will not damage the galvanized surfaces of the pipes or pipe arches. The contractor should not be allowed to drag the pipes or pipe arches over abrasive surfaces as this will also damage the galvanized surfaces.
 2. Corrugated metal pipes and pipe arches shall be laid with the inside circumferential laps lapped downstream so that the water will flow over the lap. The pipe shall be rotated so that the longitudinal laps are horizontal. When joining sections of pipe, the connecting bands should be pulled up as tight as possible. The band should be tapped with a wooden mallet as the bolts are tightened. Excessive pressure on the bolts should be avoided to keep from pulling the steel angle loose from the band. A gap of about 1 inch (25mm) should be allowed between the pipe ends being joined,

CHAPTER NOTES:

807.00 EROSION CONTROL

807.01 EROSION CONTROL CHECKLIST

SSHC Reference: Section 807 -- Erosion Control & Special Provisions

Other References: Approved Products List

Inspection Crew: Construction Technician

Inspection Equipment: NA

- General Comments:*
1. Has the finish grade been accepted for this area? (*SSHC Subsection 807.03, Para. 1*)
 2. Is the material on the approved products list? (*SSHC Subsection 807.02, Para. 1*)
 3. Does the contractor have the right pins? (*SSHC Subsection 807.02, Para. 2*)
 4. Does the contractor have the right fertilizer? (*Special Provisions*)
 5. Is the seed bed properly prepared? (*SSHC Subsection 807.03, Para. 4*)
 6. Does the seed have the department tags for this project? (*SSHC Subsection 803.02, Paragraphs 3 & 4*)
 7. Usual work sequence:
 - a. Soil preparation including the slots for the erosion checks
 - b. Fertilize
 - c. Install filter fabric for check slots and soil fill
 - d. Seed and rake the seed into the soil
 - e. Install erosion control material
 - f. Some erosion control materials come with the filter fabric attached. When this material is used, direct seed into the erosion control material and then soil is spread over the seed
 8. Questions -- call 402-479-4537, Roadside Development.

807.02 FILTER FABRIC

@

Cut the fabric so that the excess material lies under the outlet so that the water falls on a double layer. This is shown on the plans.

The filter fabric detail should show the fabric covering the area above a box culvert opening and the boxes wings.

The bale check includes the necessary filter fabric so do not include this quantity when calculating the pay quantity for filter fabric. Pay limits will be added to the plan detail.

@

808.00 EROSION CHECKS

808.01 EROSION CHECKS CHECKLIST

SSHC Reference: *Section 808 -- Erosion Checks & Special Provisions*

Other References: Approved Products List

Inspection Crew: Construction Technician

Inspection Equipment: NA

- General Comments:
1. Work generally performed in conjunction with erosion control after an area is final graded.
 2. Make sure that the center bale is lower than the outside bales
 3. The erosion control material for the erosion checks must match the erosion control material used in the ditch. Is the material on the approved products list?
 4. Work performed similar to erosion control
 5. Seed is never to be placed under the filter fabric - only on top of the filter fabric
 6. Some erosion control materials have the filter fabric attached. When this occurs, the seed is directly seeded onto the erosion control material and then soil is spread over the seed
 7.
 - a. "Temporary Silt Checks" (TSC) are to be installed as soon as rough grading begins. TSC should be placed as shown in the plans or as directed by the engineer.
 - b. Temporary Silt Checks (TSC) have to be removed in order for final grading to be completed. However, once final grading is complete, the TSC's need to be reinstalled.
 - c. The contractor does not have to reinstall TSC if instead the permanent erosion checks are available and will be installed immediately after finish grading.
 8. Roadside Development (402) 479-4537 Questions -- call 402-479-4537, Roadside Development

808.02 PLACEMENT

The suggested sequence of work for special ditch control is as follows:

Shape

@ Shape the ditch and prepare the seed bed approximately **3/4 inch (20 mm)** deep. If ditches are unstable and equipment leaves them in a rough condition, the seed bed must be prepared by hand. The ditches should be shaped so that the ditch drains without water ponding and has a minimum depth of **6 inches (150 mm)**. Minor irregularities in ditch alignment must be corrected so the completed ditch will follow the ditch line constructed during the grading operation. This may not be possible in cases of severe washing of the ditch bottom. All rocks and clods more than **1½ inch (40 mm)** in diameter, and all sticks and other materials, which prevent contact of the special ditch control materials with the seed bed, shall be removed.

@ The vegetation on new slopes may take more than one construction season to be effectively established and bale checks and silt fence should not be removed until they are no longer needed. It would be unacceptable to hold the contract open until the vegetation was established.

The only time that steel rebar should be used is when the stake must penetrate shale – then the PM needs to let Maintenance know this was allowed.

@

10. Q. - We did everything like we should and we still had some silt get away.

A. - Hari-kari is not required. The erosion process is a natural one. We are just trying to slow it down and keep our "dirt" at home. Take photographs of what did and did not work and send them in. We will pass on the good and redesign the bad.

809.01 SILT FENCING CHECKLIST

SSHC Reference: *Section 809 -- Silt Fencing & Special Provisions*

Other References: Silt Fence Guideline & Approved Products List

Inspection Crew: Construction Technician

Inspection Equipment: None

Silt Fencing Procedures:

- General Comments:
1. Silt fencing is a first item of business -- before any soil is disturbed.
 2. Does the contractor have the right material? (SSHC Subsection 809.02, Para. 1.)
 3. Is the material on the approved products list?
 4. Does the silt fence location need to be adjusted to function better?
 5. Silt fences only work when they are:
 - a. installed correctly
 - b. kept clean
 - c. kept repaired
 6. Questions -- call 402-479-4537, Roadside Development
- Roadside Development (402) 479-4537:

809.02 SILT FENCE

@

At bridge approaches and on other steep slopes, the contractor should place extra rows of silt fence if necessary. The Plan requirements are only a guide and should be adjusted by the project manager to fit the actual field circumstances.

The bay portion of the silt fence is shown partially buried on some details is not correct. The silt fence should be shown on top of the slope.

@ The objective is to place the silt fence so that silt will not leave our ROW. Design depends on site visits and preliminary survey data. However, erosion control has not been the focus in past surveys. Therefore placement of silt fence and other erosion control items may have not been optimal. If there is a better place – site the fence there; if more is needed, get it placed; the bottom line is do whatever is necessary to provide erosion control – in the long run it is really cheaper.

The District should remove silt fences and bail checks when the ground cover is established.

If the silt fence is properly installed and some subsequent construction activity damages the silt fence, is additional payment authorized?

It will depend on the circumstances. If the fence had to be installed at a location where subsequent activity was necessary and caused the fence to be removed and replaced, then additional payment is justified. However, if the contractor was negligent and did not use reasonable caution and his neglect resulted in damage to the silt fence, then no additional payment is authorized to replace the fence.

@

810.00 SLOPE PROTECTION

810.01 SLOPE PROTECTION CHECKLIST

SSHC Reference: *Section 810 -- Slope Protection & the Special Provision*

Other References: None

Inspection Crew: Construction Technician

Inspection Equipment: Yard stick, meter stick and small balance scale

Procedures and General Comments:

1. The mulch must be prairie hay and certified as noxious weed free (*SSHC Subsection 810.02*)
2. The seed will be mixed at the seed company and tagged with department supplied tags
3. All areas possible are to have the seed drilled. The drilled seed will establish much faster than broadcast seed. The percentage of the area to be drilled is given in the Special Provisions.
4. Hay buster machines have proven to be satisfactory for the mechanical application of the mulch
- @ 5. Sampling for the proper weight of mulch per **yd² or m²**. Use the meter stick or yard stick -- which ever applies -- and gather all the hay in a square before crimping -- and weigh this on the scale -- the results are approximate. Use them as a guide and not as an absolute
6. Best hay information -- Establish a test plot with the exact amount of hay per yd² or m² -- crimp -- and use this plot for a visual comparison
7. Questions -- call 402-479-4537, Roadside Development

Roadside Development
(402) 479-4537

DIVISION 900 INCIDENTAL CONSTRUCTION

901.00 FIELD LABORATORIES AND SCALE HOUSES

901.01 GENERAL REQUIREMENTS

The Project Manager shall determine if the field laboratories or scale houses furnished by the contractor conform to the requirements of the specifications, supplemental specifications and/or the special provisions. Inspection report forms for the laboratories are available at the district offices.

The Project Manager shall require the contractor to furnish, relocate when necessary and maintain the field laboratory or scale house as specified.

The personnel using the contractor furnished facility shall use due care in performing their required duties to prevent unnecessary wear and tear on the facility.

901.02 METHOD OF MEASUREMENT

Appendix 3 of this manual has an example of the field book records required for a field laboratory.

901.03 BASIS OF PAYMENT

Payment of 100 percent will be made for the field laboratory after it is inspected and approved by the Project Manager. When two or more projects are included in the same contract the cost for the field laboratories may be prorated to the projects on the contractor's estimate forms furnished the Project Manager. When preparing the form for submittal, the Project Manager will use the same decimal quantities, shown under contract quantities on the form, for each project on the first estimate that payment is made for this item even though work has started on only one of the projects involved. Payment for the field laboratory will not be related to the percent of work performed by the contractor.

902.00 GUARDRAIL CHECKLIST

		YES	NO
@	1. Before construction of the guardrail, is the slope from the shoulder line 2 ft. (600 mm) past the guardrail post 10:1 or flatter?	_____	_____
	2. Are offsets correct? [$\pm 1"$ (25mm)].	_____	_____
	3. Is rail height above ground, 27 to 27.5 inches (686 to 702 mm) is OK, but 27 $\frac{3}{4}$ " to 30" (702 to 762 mm) preferred for W-beam; 32? inches (810 mm) for thrie-beam including the bull-nose; cable is at 30 inches.	_____	_____
	4. Is rail alignment good?	_____	_____
	5. Are laps to specified case in direction of traffic?	_____	_____
@	6. Is post spacing correct?	_____	_____
	7. Are plate washers on post bolts according to plans?	_____	_____
	8. Is 8x8 inches (200 mm x 200 mm) plate washer installed correctly (nails)?	_____	_____
	9. Are washers in correct location on all connections?	_____	_____
	10. Is surfacing/pavement around timber guardrail posts removed and backfilled properly [7" (180 mm) behind post.]?	_____	_____
@	11. Are high strength bolts used in bridge end connection? (See 903.03)	_____	_____
	12. Are object markers and new hardware in correct location?	_____	_____
	13. Are delineators in correct locations?	_____	_____
	14. If 6x8 inch (150 mm x 200 mm) posts are used, are they installed properly?	_____	_____
	15. Is end anchorage cable tightened? (Remove all slack)	_____	_____
	16. Are the vertical steel tubes at the correct elevation [less than 4" (100 mm) above soil]?	_____	_____
	17. Are the horizontal steel struts between the end post and the 2 nd posts resting on the ground?	_____	_____
	18. Is the horizontal steel strut below the hole in the wood post?	_____	_____

@ 903.00 W-BEAM/THRIE-BEAM GUARDRAIL

903.01 DESCRIPTION

The construction inspection for this work includes:

1. Checking the plan information with actual field conditions to assure plan information is correct or to modify it as necessary to more closely fit field conditions.
2. Preparing a field checked order list for the contractor's use in ordering the necessary materials. This order list should be prepared in letter form to the contractor and include the following listed items.
 - a. List stations of guardrail.
 - b. Side of project.
 - c. Build, remove, reset, etc.
 - d. Lineal feet (meters) of rail.
 - e. Type of rail.
 - f. Type of end treatment.
 - g. Number, type and dimensions for special posts.
 - h. Special and/or standard plan numbers.

This field checked order list should be prepared and submitted to the district office for their review. The district office will distribute the original and copies of the order list after they have reviewed it.

3. This field checked order list should be prepared and submitted as soon as possible to allow the contractor ample time to obtain the necessary materials prior to the date established for beginning the work.
4. All build items will be staked by the field personnel. Stakes will be set at the ends of guard rail locations. Nails (red heads with wire flags as guards) should be set at each post location. The location of end treatments, bridge approach sections, etc. should be marked with stakes.
5. The field book record for this work should include:
 - a. Plan data.
 - b. Construction data.
 - c. Staking information.
 - d. Inspection information.

- e. Quantities and summary of quantities.
- @ f. **End treatment.**
- 6. Usually guardrail contract work cannot be started until other contract work on the project is completed. Therefore, the Project Manager must keep the district office, the contractor and the construction office informed as to the date the work site will become available.
- @ 7. **The Contractor must submit to the Construction Division shop plans on the type of "end treatment" that will be installed. Approved shop plans will be distributed to Maintenance so that future repair work has good reference documents. The PM must indicate on the "As-Built" Plans the types of "end treatments" that were installed.**

GENERAL INSTRUCTIONS

- @ Safety implications make it very important that the Project Manager, inspector, and contractor know the plans **and** specifications that apply to this work.

A guardrail inspection checklist is provided at the beginning of this Division. This checklist may be helpful in preparation and inspection for guardrail work. Inspection and material acceptance requirements are identified in the Plans and Specifications.

Guardrail installations are dependent on correct location of shoulder or bridge approach paving and 10:1 (or flatter) approach slope to guardrail. Prior to the start of guardrail installations, these need to be reviewed and verified.

- @ Slope on finished surface between shoulder and a point at least **2 feet (600 mm)** behind back of posts should be 10:1 or flatter. This provides a slope which will keep vehicle wheels in contact with the ground and adequate soil support for the posts.

If the inspector or the Project Manager observe a variance from plans or specifications, then the contractor should be advised immediately. When situations arise that are not covered by specifications, plans, standard plans, or this instruction, contact the Construction Division.

903.02 MATERIAL REQUIREMENTS

The plans, special provisions and specifications will include the material requirements. The Materials and Research Manual includes the inspection and test requirements for the materials. The field personnel must insure that all materials used in the work conform to these requirements.

903.03 CONSTRUCTION METHODS

- @ Standard plan **for** Traffic Control Devices for Construction and Maintenance, is a part of all guardrail project plans. Field personnel shall insure that project traffic (whether local only or traffic maintained condition are in effect) is controlled and workmen protected so this work is performed under safe conditions for all involved. Generally, guardrail work would be considered to require traffic control procedures similar to the situation sketches for minor maintenance of short duration or road repair.

- @ The specifications are very detailed on construction methods and the field personnel must insure that these methods are used. All connections must be tightened, etc. Cables that are anchored in concrete cannot be tightened until the concrete has attained **2000 psi (14 Mpa)**. The work is not complete until the contractor has tightened all turnbuckles, **cables, nuts**, etc.

W-BEAM AND THRIE-BEAM GUARDRAIL INSTALLATION

Rail Alignment

Rail shall be installed with reasonably smooth vertical and horizontal lines. Kinks in both straight and shop curved sections shall be avoided. Face of rail shall have no protrusions that could catch a vehicle sliding along the rail. The project plans will show how to install the guardrail. Minor adjustments may be made to meet plan requirements.

Guardrail Posts

- @ Posts shall be installed at prepunched holes and at intervals shown on the correct plan. Post details on the plans show required backfill materials and correct hole sizes.

Where longitudinal obstructions (electric cables, curbs, etc.) are encountered, 2 or 3 posts may have a maximum of 2 blockouts to provide an offset. If this cannot be done, obstruction shall be removed or relocated. We could also use a 25 ft (7.62 m) section of **nested guardrail** over one or two posts and avoid using post in obstructed locations. Plans will show **these** details.

- @

Rail Section Location

All prepunched rail sections should be in proper location within each guardrail assembly.

- @ This involves sections with **3 feet-1½ inch** post spacing, sections with **6 feet- 3 inch (1.905 m)** post spacing, and appropriate **end treatments** section as shown in the plans.

Rail Height

Guardrail installations are constructed with W beam and thrie-beam rail. The Standard

- @ Plans indicate the mounting height is measured from surface of ground at the face of rail to the top of rail. Target height is **27¾ (705 mm)** for W-beam and **32 ? inch (829 mm)** for thrie-beam.

On a project where all new guardrail is installed or existing guardrail is being removed and reinstalled, tolerance will be.

Lapping of Guardrail

Lapping of rail must be accomplished in a uniform manner. Details shown in the plans will achieve uniformity statewide. However, clarification may be helpful in obtaining this uniformity in specific instances.

- @ Plans indicate guardrail shall normally be lapped in direction of traffic flow. Following this general rule, most installations will be lapped correctly. Plans provide a lapping procedure detail for each type of guardrail installation except:
 - Where guardrail alignment is curved away from centerline (bridge ends or end sections), lap should protect approach vehicles.

Keep in mind that the basic principle of lapping has to do with favoring the traffic for which the guardrail is being installed.

- @ All laps of rail shall take place at a post. The 5/8 inch (16 mm) x 1 ¼ inch (32 mm) splice bolts at these laps should not have washers.

BRIDGE CONNECTIONS

- @ All end treatments including bridge approach sections shall be installed so that the end post sleeve is not more than 4 inches above ground level so that the undercarriage of a vehicle cannot be snagged. Exception to this is on trailing end of a one-way bridge where Type "J" terminal section shall be installed on outside of rail.

On guardrail attachments to concrete which require a bolt longer than 2 ft (600 mm), 7/8 inch (22 mm) bolt anchors may be grouted into concrete using threaded insert anchors with epoxy.

All bolts on bridge end connections shall be high strength, galvanized hex bolts. Surface of bolt head should be marked A-325, A449 or have three radial marks at 120° intervals.

GUARDRAIL POST

- @ W-beam and thrie beam guardrail posts – wood and steel – must be able to rotate if the beam rail is to work properly. Care must be taken to insure compliance with the details shown on the plans regarding “space” and density of material behind the posts.

END TREATMENTS

- @ There are two general types of end treatments (Type I & II). Future plans will no longer provide “end treatment” details. Contractors will be required to submit shop plans for the “end treatment” they want to use. The plans will indicate where the end treatment is to be installed and whether Type I or Type II end treatment is required and also the acceptable styles for each “Type” (such as Best, ET-2000, etc).

End treatment Type I is dimensioned as 50 feet (15.2 m) so that ET-2000, Best and SKT-350 can be bid competitively. The ET-2000 is only 37 feet- 6 inches (11.4 m) and the extra

12 feet-6 inches (3.8 m) split will be standard W-beam, either placed parallel or 25:1 as shown on the guardrail layout special plan.

End treatment Type I is generally used on expressways and interstates where the speed limit will be at or above 65 mph. "Type I" will be on a guardrail which is set on a 25:1 taper.

End treatment and Type II is used at locations where the posted speed is under 65 mph. Type II will be on guardrail which is on a 15:1 taper.

The PM must indicate the type of end treatment that was installed in the "As-Builts".

END ANCHORAGE

@ To insure that concrete does not become attached to bottom and sides of breakaway end anchorage post a small amount [1 or 2 inch (25 or 50 mm)] of soil may be tamped around post bottom or bottom 6 inches (150 mm) of post may be wrapped with expanded polystyrene foam sheets in place as shown on the plans. If steel tubes are used, grease the bottom 12 inches (300 mm) of the wood post and the inside of the sleeve generously. This is done so that it would be easy to remove the damaged ones.

Soil removed from all end anchorage holes should be disposed of away from the hole to insure proper installation height.

To remove post a small quantity of diesel fuel can be poured on expanded polystyrene foam. This will dissolve foam for easy removal.

903.04 METHOD OF MEASUREMENT

Final field measurement will not be required when the guardrail is constructed as ordered.

904.00 SUBDRAIN EARTHWORK

904.01 SUBDRAINS

Subdrains are constructed on grading, paving, and structures contracts. Refer to *SSHC Sections 914 and 915*.

Subdrains are used for tile relocations, backslope drains, longitudinal and cross drains under the roadway area.

Subdrains are also used with granular blankets to develop a drainage layer in areas where the soil has a high moisture content and poor stability.

904.02 BACKSLOPE DRAINS

Backslope drains are used in areas where seepage and/or a slide is possible. Where a water table is perched on a very dense layer, a subdrain is installed at or below the surface of the very dense layer. The flow line is very important in this case. A backslope drain may also be used to drain a sand pocket, again plan flow line is important.

904.03 LONGITUDINAL DRAINS

Longitudinal drains are usually installed at the pavement edge to remove any water that accumulates under the pavement.

Inspection considerations must include:

- **Trench Excavation**

The trenching equipment must be adjusted and maintained so the trench is excavated to the specified depth. It is important that all of the loose excavated material is removed from the bottom of the trench to minimize settlement of the trench backfill. Trenchers have a metal device on the end of the trencher's boom called a "cumber." The "cumber" is to be adjusted so the loose material is scraped off of the bottom and removed.

- **Outlets**

All outlets should be inspected prior to backfilling. The pipe coupling should be inspected to assure proper installation. The flow line of the outlet should be checked for uniform downward grade toward the ditch. All outlets are to be marked with an orange fence post.

Some projects require that existing subdrain outlets be extended, for example, on a shoulder widening project. On these projects, the contractor must remove the existing rodent guard before extending the pipe.

DIVISION 1000

MATERIAL DETAILS

1001.00 GENERAL

Specification Division 1000 provides detailed descriptions of the materials specified for highway construction. (Refer to the *Standard Specification for Highway Construction Manual Division 100* for further material information.)

1001.01 MATERIAL CERTIFICATIONS

Construction materials may required certificates of compliance, certified tests, or reports of inspection from an outside agency for their use and acceptance. These materials will not be incorporated into the work until such information has been received by State Personnel.

After the material information has been received, the following course of action will be taken:

- A. The information will be reviewed by State Personnel to insure that it conforms with the material requirements.
- B. The information will be dated when it is received from the contractor. This can either be initialed and dated or date stamped.
- C. The original copy of the information will be forwarded to the Materials & Research Division immediately. A copy will be kept in the Project Manager's project file.

Material inadvertently incorporated in the work without the required material documentation should not be included for payment on the progress estimate. If an item is on the estimate, it should be removed until proper documentation is received.

1001.02 MATERIAL CERTIFICATION RECEIPT & INTEREST DATE DETERMINATION

The interest beginning date is normally the sixty first day following tentative acceptance.

If the certifications are not received in a timely manner, then the interest date will be adjusted to the date that the documentation is in NDR possession. This is why it is extremely important to date the information when it is received from the contractor.

1002.00 APPROVED PRODUCTS LIST

1002.01 DESCRIPTION

Many material items are not described in detail in the plans and specifications but are authorized for use as shown on the NDR Approved Products List. The NDR Approved Products List is on file on the NDOR web page and is updated when a new product is added to the list or when a product is dropped from the list.

@

1002.02 ACCESS COMMANDS

Moved following paragraph from page 479 and deleted text.

Contact Terry Masters in the NDR Materials and Research Division at (402) 479-4754 if there are any questions concerning the viewing or printing of the Approved Products List.

1002.03 ADDITIONS/DELETIONS TO THE APPROVED PRODUCTS LIST

The Approved Products List is normally updated on Friday. Materials that meet NDR's *Standard Specifications for Highway Construction* may be added to the list at any time. Materials may also be deleted from the list at any time.

Contact the Physical Testing Section in the NDR Materials and Research Division at (402) 479-4746 to obtain information on required certification and documentation that is necessary for a specific product.

SSHC Subsection 1001.03 identifies details relating to the use of the Approved Products List and the procedure for using a material that is not included on the Approved Products List.

1003.00 WHITE PIGMENTED CURING COMPOUND AND HOT-POUR JOINT SEALER

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1003.01 DESCRIPTION

White pigmented curing compound and hot-pour joint sealer are sampled at the manufacturer's plant and tested in the Lincoln laboratory before being shipped to Nebraska. Test results for curing compound and joint sealer are on file on the computer. When either of these materials arrive at the construction site, it is necessary to identify the manufacturer and lot number of the material, then check the [Approved Products List on the Department's web-site](#) to verify that the material has been tested and approved for use on the project. The possibility always exists that untested material may be shipped to the construction site.

@

1003.02 REPORTING MATERIAL USAGE

If you use white pigmented curing compound and/or hot-pour joint sealer, Materials and Research needs to know. Send Terry Masters an e-mail note with product name, manufacturer, lot number, approval date and the quantity used.

@

@

@ **1004.00 PCC REQUIREMENTS**

1004.01 CEMENT CERTIFICATIONS

Note 7 in the Materials Sampling Guide, Volume II, requires that the pink copy of the cement certificate of compliance, DR Form 228 or a copy of the mill's own certification form be mailed to the Materials & Research Division. However, Materials & Research does not need the pink copy of the certification mailed to them anymore. The copy at the concrete production facility is enough for Materials & Research records.

The certificate of compliance is needed both for mills that require sampling and those that do not. When a sample is required, normal procedure has been to submit the pink copy with the sample. This is acceptable. For those mills which do not require sampling, please collect and submit the certifications on a routine basis but at a minimum of once each week.

1004.02 CONCRETE STRENGTH

The following English and Metric unit “Concrete Strength Variation” table is provided to define the different strengths that may be specified. The specified strength has varied as the Department has converted from English to Metric units and then back to English units. In the following table, the standard strengths are given in pounds per square inch (psi) and the various equivalent units that have been used in the past 5 years to specify this strength are shown. **However, the strength that a contractor is held-to can only be what is contained in the contract. So if the contract calls for 2900-psi, we cannot reject or deduct if he does not provide 3000-psi.**

Concrete Strength Variation

Current Standard Strength (psi)	Actual Specified Strength (psi)	Actual Specified Strength (Mpa)
3000	3000, 2900	20, 20.7, 21
3500	3500, 3625	25, 24.3, 24
4000	4000, 4350	30, 27.6, 27

1004.03 CONCRETE CYLINDER POLICY

@

Cylinders

All concrete cylinders applicable to this policy will be 6 inches by 12 inches. All cylinders shall be cast by currently certified technicians, or by new or temporary employees trained and approved by qualified Materials and Research personnel in accordance with the NDR technician training program.

Structures

A set of three cylinders will be made for the first 100 cubic yards placed and an additional set of three cylinders will be made for the remainder of the concrete placed for each day provided at least 50 cubic yards more is placed. A minimum of three cylinders will be made for each day's placement. One cylinder from each set will be tested at 28 days. The other two cores from each set will be tested at the intervals designated by the engineer. If no intervals are designated, the cylinders will be tested at 7 days and 14 days respectively.

Pavements

A set of four cylinders will be made for each day's placement. These cylinders will be tested at the intervals designated by the engineer unless the pavement does not need to be cored. If the pavement will not be cored, at least one cylinder must be tested at 28 days. The other cylinders will be tested at the intervals designated by the engineer.

If the pavement must be cored and no intervals are designated, the cylinders will be tested at 7, 10, and 14 days or until the specified strength is attained. If needed, the fourth cylinder will also be tested at 14 days and the average strength of the two cylinders reported. If the pavement will not be cored and no intervals are designated, the cylinders will be tested at 7, 10, 14, and 28 days or until the specified strength is attained.

Miscellaneous Concrete

Concrete placements requiring five cubic yards or less and which are noncritical, may be accepted by the engineer without testing. Noncritical refers to placements that will not sustain traffic loading and for which failure is not likely to disrupt traffic or pose a threat of harm to the traveling public.

CONCRETE CYLINDER REQUIREMENTS SUMMARY						
CONCRETE PRODUCT	REQUIRED NUMBER OF CYLINDERS	REQUIRED BREAK DATE				
		7-DAYS	10-DAYS	14-DAYS	28-DAYS	OTHER
STRUCTURES*	3				2	2
PAVEMENTS**	4	1	1	1	1	
MISCELLANEOUS CONCRETE	Concrete placements requiring 5-cubic yards or less which are noncritical, may be accepted without testing.					
*3-cylinders are required for the first 100-yd ³ each day and another set of 3-cylinders is required if a total of at least 150-yd ³ is required in one day. The Engineer may set the date of the third cylinder break as necessary.						
**Four cylinders are required for each day's placement. The Engineer may designate the date the cylinders are to be broken; if the pavement will not be cored at least one cylinder will be broke at 28-days; if the pavement will be cored then cylinders are broke at dates designated by the Engineer or as shown above.						

@

1005.00 MATERIALS & RESEARCH DIVISION'S FINAL REVIEW PROCEDURES

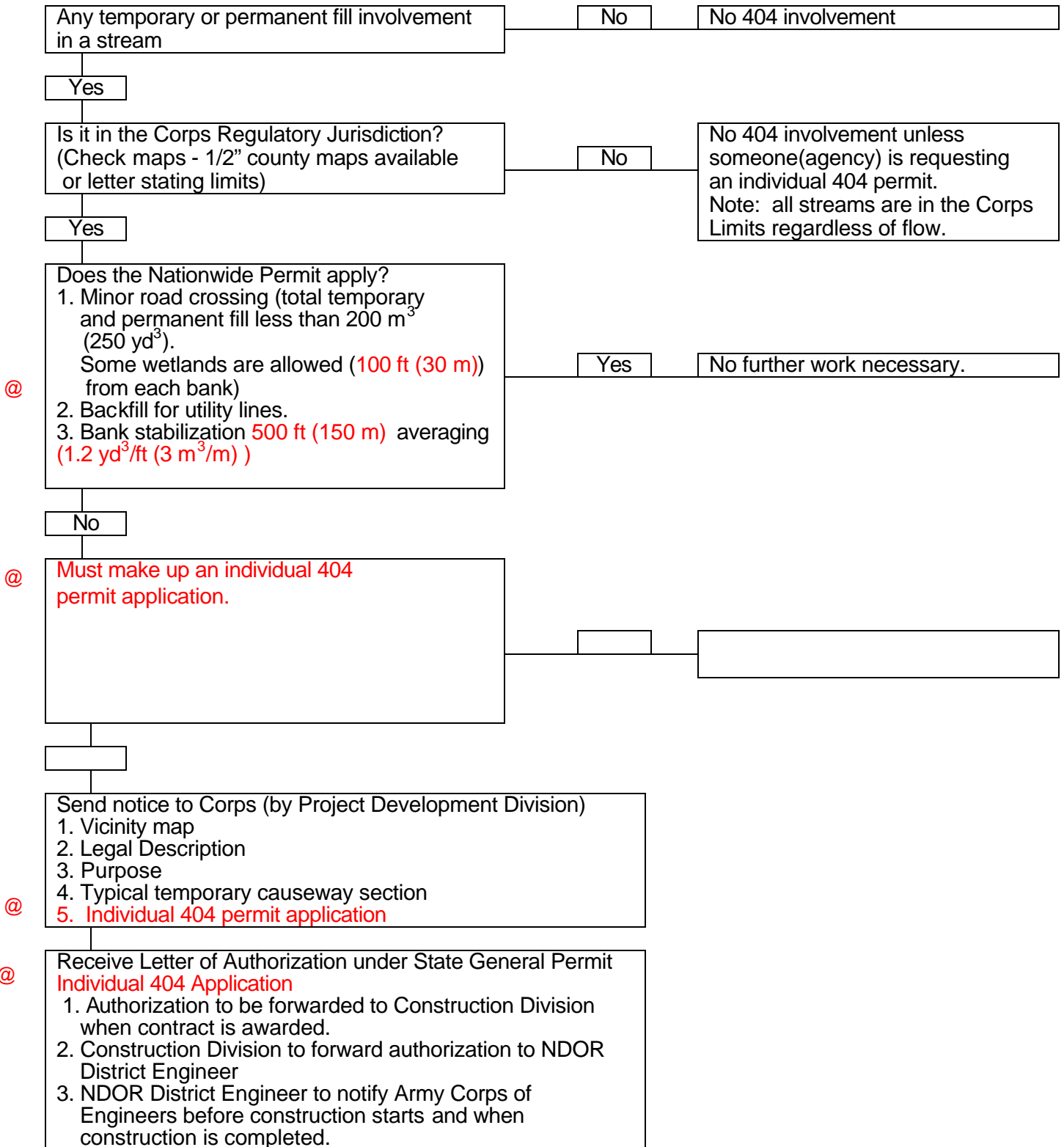
The Materials and Research Division's Final Review Section will perform the following steps:

- The Materials and Research Division will receive notification from the Project Manager that the project is complete and ready for the material review.
- The Materials and Research Division's Final Review Section will make a listing of all materials that need to be reviewed.
- This listing will be routed through the various laboratories in the Materials and Research Division. The individual laboratories will review their areas and note if the material is satisfactory or a deficiency exists (i.e.: required samples or certifications not received, materials not meeting specification requirements, deductions in compensation for failing materials).
- When complete this listing will be returned to the Materials and Research Division's Final Review Section.
- The Materials and Research Division will determine which materials are deemed critical and non-critical.
- Non-Critical Materials will be accepted by a blanket letter of acceptance. This letter will be generated by the Materials and Research Division's Final Review Section and sent to the Project Manager by e-mail or fax. By signing this letter the Project Manager is stating that all of the materials met specification requirements and that the necessary documentation is in their files. The Project Manager can fax or mail the signed letter to the Materials and Research Division (fax number 402-479-3975).
- Critical Materials will require that the necessary certifications and samples are on file in the Materials and Research Division. The Materials and Research Division's Final Review Section will send an e-mail to the Project Manager listing these materials and requesting that the required documentation be submitted.
- Once all of the necessary information is received in the Materials and Research Division a letter will be sent to the Project Manager stating that the material review is complete. (There is the possibility that another material shortage could occur if a subsequent estimate adds an item or increases a quantity. If this happens the Project Manager will be notified).

- The Construction Division will contact the Materials and Research Division when a final estimate is ready for our approval. When all necessary documentation has been received we will release this estimate for final payment. A letter will be sent to the Project Manager stating that the Materials and Research Division has released the final estimate.
- @ ➤ If you have any questions regarding this procedure please contact Rhonda DeButts @ 402-479-4760 or Dave Hall @ 402-479-4837.

CHAPTER NOTES:

404 Determination Checklist



- I. Corps of Engineers (C.O.E.) Wetland Regulatory Authority
 - A. Rivers and Harbors Act - 1890 - Navigable Waters
 - B. Federal Water Pollution Control Act - 1972
 1. Section 404 Permits - Regulate discharge of dredged or fill material from or into waters of the United States.
 2. Act amended in 1977 and given common name "Clean Water Act" (C.W.A.).
 3. Wetlands are under the jurisdiction of Clean Water Act through 1985 court case. Those wetlands covered by the Clean Water Act are called jurisdictional wetlands.
- II. C.O.E. Changes Jurisdictional Wetland Policy
 - A. Regulatory Guidance Letter - November, 1995 - in some cases, wetlands are no longer under the jurisdiction of the C.W.A. - no Corps regulation.
 1. Former Policy - Wetlands in roadside ditches were under the jurisdiction of the Clean Water Act, thus regulated by C.O.E. - possible mitigation.
 2. Current Policy
 - (a) Wetlands occurring in typical ditches, in upland areas are nonjurisdictional. Therefore, not under the jurisdiction of C.W.A. No Corps authority. No mitigation for impacts.
 - (b) If ditch was constructed in a wetland, then the ditch would be under the jurisdiction of C.W.A. Corps has regulatory authority. Possible mitigation for impacts.
 - (c) Borrow pits which exhibit wetland characteristics are under the jurisdiction of the C.W.A. Corps has regulatory authority. Possible mitigation for impacts.
 - B. Overall mitigation requirements will lessen which will result in lower costs.
- III. C.O.E. Concerns
 - A. C.O.E. perceives there to be a problem with:
 1. Disposal of road materials in waterways and wetlands.
 - (a) Section 404 of the Clean Water Act
 - (1) Dredge and fill activities require permit from C.O.E.

- (b) Violation of Section 404 - Work done without a permit. Up to \$25,000 fine per day that the violation is in place. Examples - filling wetland or dumping old bridge in waterway.
 - (c) Noncompliance with Section 404 - Not following permit conditions. Up to \$10,000 per violation plus remedial costs. Examples - using asphalt or allowing concrete with exposed rebar for bank stabilization.
- 2. Impacting wetlands not cross hatched on plans. Examples - storing equipment in wetland areas or rock in ditched jurisdictional wetland to prevent the accumulation of mud on the road.
 - 3. Failure to utilize silt fences.

The wetlands point of contact is:

Wetlands Program Manager
Project Development Division
(402) 479-4418

1100.15 WASTE GENERATED

"Solid Waste" means garbage, refuse, rubbish, and other similar discarded solid or semisolid materials, including but not limited to such materials resulting from industrial, commercial, agricultural, and domestic activities. This shall not prohibit the use of dirt, stone, brick, or similar inorganic material for fill, landscaping, excavation, or grading at places other than a sanitary disposal site. It shall be unlawful for any private or public agency to dump or dispose or permit the dumping or depositing of any solid waste at any place other than an approved sanitary landfill.

"Open Dumping" means the depositing of solid wastes on the surface of the ground or into a stream or body of water.

"Toxic and Hazardous Wastes" means waste materials including, but not limited to poisons, pesticides, herbicides, acids, caustics, pathological wastes, flammable or explosive materials, and similar harmful wastes which require special handling. These items must be disposed of in such a manner as to conserve the environment and be protective of public health and safety.

"Free Liquids" or wastes containing free liquids shall not be disposed of in a sanitary landfill. This includes industrial sludge and toxic or hazardous wastes.

1100.16 WATER WELLS

Occasionally contractors request permission to drill water wells on state property in order to secure water to use in the construction of a project. A written agreement should be executed between the state (DEQ) and any contractor who wants to develop a well on state property in order to assure that the contractor assumes responsibility and liability for use of the well.

@

@

1100.17 ARCHEOLOGICAL AND PALEONTOLOGICAL DISCOVERIES

If Indian relics, fossils, meteorites or other articles of historical or geological interest are encountered in highway excavation operations, such operations shall be suspended in the area involved "until such times as arrangements are made for their removal and preservation".

Under present procedures, the department is cooperating with the Nebraska State Historical Society and the University of Nebraska State Museum. Preliminary plans for highway improvements are made available to these agencies as far in advance of construction as practical. Their archeologists examine the plan locations and correlate any findings with their records and information. If any known historical relics or Indian habitations or relics are involved with the construction, arrangements are then made cooperatively with the department to remove and preserve such items in advance of the construction of the project.

It is expected that only rarely will such items be encountered during construction. However, if such articles are encountered, the Project Manager will have work suspended in the area involved, and immediately notify the Construction Division. Arrangements will then be made from that office for the removal and preservation of the articles.

Project Managers or their representatives should make a periodic inspection of the work site or sites on all archeological or paleontological work. This inspection is to determine that the work called for in the agreement is being performed. This periodic inspection should be made at least once a week. The Project Manager should keep himself advised of the progress so that no unnecessary delays to the contractor will occur. Confirmation that the contractor can resume work at the site will come from the Construction Division.

1100.20 UNDERGROUND TANKS

@ NDEQ has a website (www.deq.state.ne.us) which is an excellent environmental and underground storage tank reference.

Underground Storage Tanks (USTs) represent one of the more common environmental problems encountered. USTs may have been (or may currently be) used to store almost any kind of viscous material including petroleum products, chemicals, and discarded wastes (some of which could be classified as hazardous). Leaks from these tanks or their auxiliary components (i.e., piping, couplings, pumps, and valves) are not uncommon.

An Underground Storage Tank (UST) is defined as a tank and associated piping with 10% or more of its volume below the ground which has stored or is storing a regulated substance. Regulated substances include petroleum based substances (motor fuels, motor oil, home heating fuels, solvents, etc.) and any other substance which, if released into the environment may present substantial danger to public health, welfare, or the environment.

1100.21 REGISTRATION

EPA established a program for regulating Leaking Underground Storage Tanks (LUSTs). Under this program the design, installation, maintenance, monitoring, and failures of LUSTs are regulated. In Nebraska, this federal program is administrated by DEQ. All underground storage tanks are required to be registered with the State Fire Marshal Office. Tanks that have been registered should have a metal tag affixed to the fill pipe. Owners (including NDR) of underground storage tanks must:

- A. Register existing tanks, previously removed tanks, and abandoned tanks. (The "registration" of a tank includes "any" tank from a tank at a gas station to one located in the middle of Timbuktu.)

In Nebraska, the registration includes attaching a numbered metal tag to the fill pipe of any underground tank. The lack of a tag does not necessarily mean the tank is not registered, but obviously the presence of a tag indicates it is registered. If there is a question about registration, contact the Construction Division. This office has access to the registration file at State Fire Marshal Office via computer, and can look up any registered tank with minimal basic information.

NOTE: Currently in Nebraska, there is a registration exclusion for tanks:

- @ • Farm tanks holding 835 gal (3164 L) or less.
 - Tanks on or above the floor of underground areas such as basements.
 - Tanks storing home heating oils used on the premises where it is stored.
 - @ • Tanks holding 110 gal (416 L) or less.
- B. Meet tank performance standards for new installations.
- C. Make tanks leak proof for their entire life.
- D. Install leak detection systems.

- E. Keep operational records.

1100.22 REMOVAL OF USTs

@ The following procedure for removing underground tanks is based on **State Fire Marshall (SFM)** regulations. For clarity, the following has been divided into known tank locations and unknown tank locations. (The law considers both the same. But because of bid items, contract administration requires them to be treated differently.) For all removals of underground tanks, follow appropriate Supplemental Specification.

Removal of Known Tanks

These tanks are the ones identified on the project plans and will be noted for removal.

A. Removal Process

IMMEDIATELY upon starting any project requiring UST removal, check the tankfill pipes for a metal Registration Tag.

- If tank has a registration tag, note its number in the inspectors daily diary.
- If the tank does not have a registration tag, the Project Manager must notify the Construction Division immediately. This notification will allow the Construction Division to check Fire Marshal records for a valid registration. Also, it will allow time for registration should the tank not be listed with the Fire Marshal.

@ Note: Nonregistered tanks cannot be removed until after they have been registered, and that process can take a couple of weeks to complete. In addition, the Construction Division must submit a closure notification to **SFM and Closure Assessment Report (CAR)** as specified on the permit to close.

B. Closure Notification

- The Project Manager must initiate and submit a "Notification of Tank Closure or Change-in-Service" to the Construction Division 35 days prior to removal.
- @ • After the form has been submitted and processed, **SFM** will send removal information and instructions directly to the Project Manager.

C. Tank Removal

@ Contractor's consultant is required to **have certified Closure Individual** with the **SFM on site during the entire removal process. The contractor shall provide the NDOR Project Manager a photocopy of the individual's card and also Contractor's license to close tanks.**

- Tanks must have ALL liquids **and** any explosive vapors REMOVED prior to extracting the tank.
 1. All removed liquids must be disposed in accordance with DEQ regulations.

@ 2. Vapors are typically evacuated by placing dry ice into the tank. As the ice evaporates, carbon dioxide is released and the fuel vapors are displaced.

- State Fire Marshal may be on site to inspect the removal.
- Removed tank must be stenciled according to SFM requirements.
- Any registration tags must be removed and retained by the project inspector. These tags are to be submitted to (SFM) when the closure report is filed.
- Any extracted tanks should be removed from the site on the day of removal.
- A "Certificate of Destruction" must be completed for each tank at the time the tank is disposed.

D. Sampling

- @
- All removals require soil and/or water samples to be taken by the contractor's consultant and analyzed for potential contamination.
 - DEQ requires samples collected from tank sites to be analyzed using specific laboratory methods.
 - Soil sampling locations are identified in the removal information and instructions furnished by DEQ. **Soil samples may be required below the Static groundwater table. The water shall be sampled if water is encountered during excavation.**
- @

E. Contamination

- If contamination is found or suspected during the tank extraction, contact the Construction Division immediately. If appropriate Construction Division personnel are not available, the Project Manager shall notify DEQ directly. The telephone number for DEQ's tank section is (402) 471-4230. (The contractor's consultant will provide site information based on air monitoring if there are any questions.)
 - The NDR has 24 hours to report this contamination unless an immediate threat exists. In that case, reporting times are reduced to 6 hours.
 - Immediate threat means a potential exists for explosive conditions, immediate danger to life or health, or an immediate threat to water supplies.
- @

- F. Site Safety

1. If, based on site conditions and situations, the inspector or contractor feels there is an immediate threat for **explosion**, the contractor shall:

- Immediately shut-off all operating equipment, extinguish all sources of ignition (i.e., cigarettes etc.), and evacuate the area. This includes all personnel.
- After the site is evacuated, establish controls to prevent site access and contact local **and state** authorities.

@

- **No smoking signs must be in place. (No smoking within 50 feet).**

The inspector shall contact the Construction Division.

2. If, based on site conditions and situations, the inspector or contractor feels there is an **immediate** danger to life or health **other than** by explosion, the contractor shall:

- Immediately evacuate the area. This includes all personnel and could include equipment.
- After the site is evacuated, establish controls to prevent site access.

The inspector shall contact the Construction Division.

3. If, based on site conditions and situations, the inspector or contractor feels there is an immediate danger to a water supply, the contractor shall:

- Using whatever means are available, immediately establish positive restrictions to limit or prevent migration of contamination to a water supply. **(If threats to life or health from explosion are not present).**
- Watch for changing conditions which could present threats due to explosion and/or danger to life or health. If site conditions change, implement the appropriate response as noted above.

@

The inspector shall contact the Construction Division.

G. Removal of Contaminated Soil

If the site is determined to be contaminated, one method of remediation is to overexcavate. Contaminated soil which has been over-excavated must be "properly" disposed. **(DEQ may provide approval to over-excavation--see pages 3-5 of the DEQ "Petroleum Contaminated Soils Guidance for Leaking USTs".)**

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H. Disposal Options

There are several approved methods for disposal, however, DEQ must preapprove any disposal option. Some options which have been successfully used include:

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1. Removal of soil and disposing in a **licensed** landfill. This not only requires prior approval by DEQ, but also approval from the local receiving landfill.

@ Typical costs for this option range from \$15 to \$40/yd³ (\$15 to \$40/m³) plus trucking.

2. Another option which is limited by physical location is that of "soil burning." The process involves treating petroleum contaminated soil by passing it through a rotating drum where there is high heat and flame. (It is a converted asphalt drum dryer.) During "treatment," soil moisture is driven off, combustible products in the soil are first volatilized and then flashed off. The result is dry "petroleum" free soil.

@ While the remedial concept is reasonably sound, the cost for this remediation is very expensive (costs range from \$30 to \$70 per Ton (Megagram)) not to mention trucking costs to the plant. However, if a project is in that area, "soil burning" is one option available for remediation.

For completeness, a word of caution must be included about this process. The process, if properly operated, removes petroleum contamination, however, it does not remove other potential contaminants (i.e., heavy metals, pesticides/herbicides, etc.) Often the plant requests anyone bringing soil to the plant to back haul "processed" soil. Obviously, clean/remediated soil is a by-product of this operation. **DO NOT AGREE TO BACK HAUL ANY "REMEDiated" SOIL FROM THIS OPERATION WITHOUT FIRST CONTACTING THE CONSTRUCTION DIVISION.** This does not mean the facility should not be used, or that the remediated soil is not clean. DEQ needs to be sure there are adequate and quantifiable analytical results to assure back-hauled soils are not contaminated with other substances.

3. Another option is to remove the soil (over-excavate) and spread it out on the surface. This method is called Land Application and also requires preapproved permit from DEQ. The land application of petroleum contaminated soil provides an effective means of treatment through volatilization and biodegradation. Land application has been used successfully in situations where NDR owns (not by temporary easement) a parcel of excess right-of-way.

In situations where contaminated soil must be remediated, the Project Manager should look for and identify suitable locations to the Construction Division. Criteria for land application are:

- @ • Maximum application rate is 4 inches (100 mm) thick **OR** 500 tons/acre(1.12 Gg/hectare). Based on an estimated excavation volume, the inspector can calculate approximate remediation area.
- Petroleum saturated soil cannot be land applied. (The KEY is "petroleum saturated" not "moisture saturated." Soil excavated below the water table may be land applied, as long as it does contain free (decantable) petroleum products.
- Petroleum contaminated soil cannot be applied any closer than:
 - @ a. 525 ft (160 m) from a well.

- b. 200 ft (61 m) from an occupied residence.
 - c. 200 ft (61 m) from a stream, river, lake, pond, sinkhole, or down gradient intake for a tile line or culvert.
- Slopes must be less than 5%.
- Potential land farming areas with sandy, sandy loamy, and high silty soils are not acceptable. There also must be at least 6 ft (2 m) of existing topsoil over bedrock.
 - Obviously the site must be accessible to trucks or hauling equipment and have no other planned traffic or activity during the remediation time.
 - Soil for remediation will have to be leveled and disced at least two times during the course of remediation. One discing needs to be soon after placement and leveling, the other about 2 months later. Once the soil has been tested and analytical results indicate it is clean, the area should be fertilized and seeded with a suitable stabilization crop.

I. Closure Report

- Contractor and/or the contractor's environmental consultant are responsible to complete the closure report.
- The report shall locate all removed tank locations by station and offset.
- Closure reports are to be submitted to the Project Manager within 20 days of completion of sample analysis. The Project Manager shall keep a copy of all reports in the project files and forward original to the Construction Division within 5 days of receipt. The State Fire Marshall's Office must receive a copy of the closure report before the deadline listed in the permit to close, usually 45 days from date of tank removal.

Closure reports are to contain:

1. Completed preprinted SFM closure forms. Check to be sure the following information is included:
 - a. All lab reports.
 - b. Construction details.
 - c. Scale dimensional site drawing showing location and depth, location and depth of all piping, location and depth of all sampling and monitoring well locations. NOTE: All locations are to be referenced by station and offset from mainline or side road survey.
2. Tank registration tags.

Removal/Discovery of Unknown Tanks ("Orphan" Tanks)

For the purposes of this chapter, "unknown" tanks should be considered those tanks not identified on the plans but encountered during a project. Most likely the discovery of an unknown tank will come at the worst time. For example, machinery running, work time in a crunch, and "any" appreciable delay will work a severe hardship on the contractor. Therefore, timeliness and notification become critical in dealing with the issues.

Upon finding a previously unknown tank, follow these guidelines:

FIRST: Immediately stop all work in and around the tank.

SECOND: Determine the site conditions. For example:

A. Note tank condition and damage. Is liquid leaking from the tank? If so:

1. If fuel is released, call:

- NDEQ at (402) 471-4230 during office hours or (402) 471-4545 NSP (State Patrol) afterhours. [Leaking Underground Storage Tank/Release Assessment Section \(LUST/RA\)](#).
- State Fire Marshal's Office (SFM)
Flammable Liquid Storage Tank Division
(402) 471-9465 Clark Conklin
- Construction Division (402) 479-4532

@

2. If, based on site conditions and situations, the inspector or contractor feels there is an immediate threat for **explosion**, the contractor shall:

- Immediately shut-off all operating equipment extinguish all sources of ignition (i.e., cigarettes etc.) and evacuate the area. This includes all personnel.
- After the site is evacuated, establish controls to prevent site access and contact local authorities.

The inspector shall contact the Construction Division.

3. If, based on site conditions and situations, the inspector or contractor feels there is an immediate danger to life or health other than by explosion, the Contractor shall:

- Immediately evacuate the area. This includes all personnel and could include equipment.
- After the site is evacuated, establish controls to prevent site access.

The inspector shall contact the Construction Division.

4. If, based on site conditions and situations, the inspector feels there is an immediate danger to a water supply, the contractor shall: **(Threats to life or health and explosion are not present.)**

- Using whatever means are available, immediately establish positive restrictions to limit or prevent migration of contamination to a water supply.
- Watch for changing conditions which could present threats due to explosion and/or danger to life or health. If site conditions change, implement the appropriate response as noted above.

The inspector shall contact the Construction Division.

B. If leakage is not apparent determine if any liquid is in the tank.

C. Attempt to determine the size of the tank (volumetric and/or dimensional size estimation).

@ D. Is there any indication of past leakage? (Stained (discolored) soil or smell of fuel are indicators.)

E. Establish tank location by station, offset and approximate depth. Also indicate approximate street address if available.

THIRD: Begin to establish some positive control to eliminate access to the immediate area. (Silt fence, snow fence, or orange safety fencing set on fence posts are examples of temporary restraints.)

FOURTH: Notify the Project Manager or supervisor of the discovery and provide site conditions to them. If the Project Manager will not be available for some time (3 to 5 hours), the inspector shall contact the Construction Division directly.

FIFTH: The Project Manager shall notify the Construction Division. (NDOR has a legal responsibility, and time limit, to report finding previously unknown USTs.)

1. For Reference: Time expired since first discovering the tank shall not be more than 5 hours before contacting the Construction Division.

2. Leave tank in place.

@ 3. Post "No Smoking Within 50 ft (15m)" signs near tank and secure from general public. Use snow fence.

4. The Logistics Division will apply for a permit to remove tanks as soon as possible. Permit required from Fire Marshal's Office.

5. Removal by licensed contractor (State or private company) will be scheduled as soon as possible.

@ 6. The firm or person in charge of tank removal must notify the Fire Marshal's Office 72 hours before taking out the tank and give the DEQ a minimum of 24 hours advance notice. If NDOR completes a Closure Assessment Report, DEQ advance notice is not needed.

7. Tanks removed from the ground shall be stored in a secure location inaccessible to the general public.
8. A licensed certified closure individual must be present during excavation and tank removal.
9. If contamination is present in the excavation, the State Fire Marshal and the Department of Environmental **Quality** must be notified within 24 hours if they are not present during the scheduled time of tank removal.
- @ 10. Soils will be disposed of as directed by the **NDEQ**. Land farming may be required. Contact **Waste Management Section of NDEQ** (402) 471-4210.
11. The excavated area should be backfilled with clean soil and compacted as required by the Project Manager.
12. For more information, refer to Title 159, Rules and Regulations for Underground Storage Tanks. A copy is available in the Lincoln **Logistics Division** Office.
13. If fuel contaminated soils are encountered during normal construction activities, notify the Lincoln **Construction** Office even if no tank is found. The Lincoln Office will notify the **NDEQ LUST/RA Section and Waste Management Section**.

Recap:

- All construction activity around the area of the tank shall be halted, and remain that way, pending further investigation.
- Preliminary site assessment shall be completed. Included in this assessment shall be an evaluation for imminent dangers.
- Site "SPILL CONTROL" measures should be implemented if needed.
- Positive constraints shall be in place to prevent free public access of the site.
- The Construction Division shall be notified of the discovery.

What Happens Next?

- Construction Division notifies **NDEQ and SFM** about finding an unknown UST.
 - **DEQ does not need to be notified about an unknown UST unless there has been a release or unless DOR will not be completing a Closure Assessment Report.**
- Construction Division will determine if the UST is registered. If not, a registration process will be initiated. (An unregistered UST cannot be removed until after it is registered.)
- The Construction Division will request **SFM's** approval to remove the tank, once registration status is resolved.

- The Project Manager needs to use this time to negotiate an Change Order for tank removals.

@ Once SFM authorizes removal, a notice will be provided to the Project Manager. Removal from this point forward is outlined in SFM approval documents.

1100.30 STORM WATER DISCHARGE (NOT YET FULLY IMPLEMENTED)

All NDR construction projects which disturb 2 ha (5 acres) or more are required to have a STORM WATER PERMIT. (The rules also apply to cities and counties with populations of 100,000 or more.)

A Storm Water Permit requires specific actions intended to reduce and/or eliminate the problems associated with runoff, soil erosion, and siltation. To comply with this environmental regulation, the NDR has developed the following procedure:

- Projects which disturb 2 ha (5 acres) or more are identified by Project Development.
- When projects are turned in, Project Development tabulates projects with PPPs and sends NOIs and newspaper notices to the Construction Division.
- The Construction Division forwards required notices to appropriate newspapers for publication. Once publication verification is returned, the Construction Division assembles all parts for NOIs and forwards copies to DEQ and the Project Manager.
- At this point, the Project Manager administering a particular project is notified that a Storm Water Permit is in place. (The contractor may begin work any time after that notification.)

Project Manager shall check to assure that projects requiring a Storm Water Permit have a Pollution Prevention Plan (PPP). Along with a PPP there should be bid items for pollution control items such as silt fence, stabilizing crops, ditch checks, etc. As always, it is important to check preliminary plans whenever possible to be sure all needed contract items have been included. Obviously, if a contract is let without erosion control items, the Project Manager will have to change order those items.

1100.31 NOTICE OF INTENT (NOI)

NOIs are NDR's official notification to DEQ that there is a project located at "xxxxxxxxxxxxxxxx," and the project will be disturbing at least 2 ha (5 acres) or more are required to have a STORM WATER PERMIT. (The rules also apply to cities and counties with populations of 100,000 or more.)

1100.32 CONSTRUCTION DIVISION POLICIES

- Project Managers shall have a copy of all contractor NOIs (noncommercial sources) on file in the project documents before allowing a contractor to produce or provide material for the project.
- *SSHC Subsection 204.02* restricts exposing erodible soil to less than $75000 \pm \text{m}^2$ (90,000 sy) without prior approval of the Project Manager. Criteria for approving a variance to the maximum exposure limit will be based on:
 - A. Having current exposed area protected with erosion control measures. Minimum measures would include silt fence around the perimeter of the area, ditch checks, and additional silt fence where sediments may leave the project.

This includes all disturbed areas (i.e., borrows, areas within temporary and permanent easements.)

- B. The contractor has demonstrated ability and willingness to keep erosion control measures current and maintained within existing work areas.
- C. Consideration must be given for the time of year before exposing additional areas. For example: It would not be unreasonable to deny a request for additional working area in a situation where it is late in the grading season and the contractor is falling behind in finishing, applying mulch, or temporary seeding.

Also, it would not be unreasonable to place a condition on approving an additional spread. For example: "Contractor, you may open area "X" as soon as you have finished and stabilized up to Station "Y.""

- D. The contractor has successfully followed their erosion control work plan. The Project Manager has not noted storm water violations, and has every reason to believe additional open areas will **not** over-extend the contractor's ability to comply with our Storm Water Pollution Permit.

It is strongly recommended that the Project Manager approve additional area on a case-by-case basis and consider approval on the contractor's previous work experience as well as site conditions.

- Contractors have been told it is their responsibility to maintain the project within storm water compliance. They have also been told about the need to be prepared to complete requirements of **their** Pollution Prevention Plan should a subcontractor not be able to perform.

Pollution prevention is necessary even through most of the erosion control work is subcontracted to DBEs. However, compliance is a must and project administrators **MUST** be sure the project is maintained within storm water requirements and that the Pollution Prevention Plan is followed.

1100.33 QUESTIONS OFTEN ASKED

The weather is not favorable to establish temporary seeding or silt fences. What do we do?

- A. Stabilization

Regulations say if an area will not have any activity for 21 days; by the 14th day, some form of stabilization will be required. There is very little latitude in that statement even if it is wet or freezing.

To be in compliance with storm water regulations, something needs to be done. For example, incorporating mulch, using HydroMulch or Soil Binders which are comprised of wood fiber and paper mulch. Both work, but tend to be expensive knowing it is less than temporary and we will have to ultimately seed.

Best solution is to conduct temporary seeding in a timely manner and not let the contractor get so much open that it cannot be stabilized by seeding. At the least keep it to a minimum so if one of the other alternates is necessary, costs can be kept to a minimum.

B. Localized Soil Erosion (Ditch Check and Slit Fences)

Bale checks used as ditch checks are most likely not as effective as "properly" installed silt fence. However, in situations where you are unable to properly install silt fence, bale checks are far superior to nothing at all. For example:

- It is wet and muddy, a trencher cannot get in to place silt fence. Interim ditch check should be bale checks.
- The ground is frozen to a point where a trencher will not work. Winter is coming. Rather than do nothing, bale checks should be installed. At least there is protection in place during the spring thaw. If an "Indian Summer" comes along and silt fence can be installed, by all means replace the bale check.

Bottom Line: Bale checks are very good interim erosion control measures when used in emergency situations. (Check the Road Standards as Roadside Development is resurrecting a standard for bale checks.)

How are borrows evaluated for Storm Water compliance?

All project specified borrows are included in the calculation for a Pollution Prevention Plan (PPP).

A. Pond Borrows

- All pond borrows (wet or dry) during construction must have at least the perimeter protected by erosion control measures. Plus, site specific considerations must be included if there is any dredging involved during construction.
- Temporary stabilization and mulching will not be required on concave slopes within the borrow. However, channels (in-flow and/or out-flow) will require stabilization or erosion control measures.
- Seeding for pond borrows will be required on any disturbed area above normal design pool or ground water elevation.

B. Wetland Mitigation Areas

- Seeding for wet land areas typically does not require special attention. Usually these areas are seeded with the same vegetation crop as any other disturbed segment on a project. Check the contract documents for non-standard situations where special aquatic plants such as cattails, wild rice, etc. may be required.
- Refer to Pond Borrows (Section A, above) for guidance in areas of standing water and selected sections in Normal Borrows (Section C, below) for those areas which are dry during seeding. In either case, all "normal" erosion control practices are required for wet land areas.

C. Normal (Dry) Borrowes

- All normal borrowes must be protected by perimeter erosion control measures, and are included for temporary erosion control measures if work is halted at that site for more than 21 days.
- All normal borrowes, purchased by fee title, shall be included in the area which is permanently seeded.
- Normal borrowes obtained by temporary easement:
 1. That require replacement of topsoil **AND** are used for agricultural row crops. The Project Manager needs to ask the property owner if they want the area permanently seeded.
 - a. If the property owner requests permanent seeding, provide that seeding.
 - b. If the property owner does not want permanent seeding, shape and place temporary seeding on the area. In this case, because the property will be returned to agricultural row crop use, consider temporary seeding as complying with storm water requirements. Note: Other temporary erosion control measures in that area will have to be maintained until the project is accepted.
 2. For temporary easements NOT used for agricultural row crops, permanent seeding will be required. (Examples of this situation would be permanent pastures, timber land, non-farmed land, etc.)

Is snow considered temporary cover in the Storm Water regulations? YES.

Storm water regulations are written recognizing that snow is a "**temporary**" preventive measure. However, just because it snows may or may not fulfill a winter long stabilization and definitely will not comply as spring thaws begin. As soon as the snow is gone, some other means of stabilization is required. ("Gone" could be by melting, wind, or snow plow.) Best advice is to keep working on some form of soil stabilization until it absolutely freezes so hard that work from then on will not be practical.

EXAMPLE: If snow comes in late October and is blown off the site by mid December, then some other form of temporary stabilization is required from that point forward.

Plan notes have designated a plant site within NDR right-of-way. Further, the contractor is told it is their responsibility to provide a permit for this activity. Who is ultimately responsible?

@ The contractor is responsible for that portion of area designated as the "plant site." When this situation occurs, **the contractor should** modify the project PPP by note to exclude the plant site when the contractor's NOI becomes effective.

Often "negative air" is a term used to describe air exhausting systems. For our purposes, this term will be used to signify that the exhaust system is withdrawing at least as much air as:

- Is being supplied by the blasting nozzle(s) and
- The combined effects of all leakage in the containment.

Obviously in situations described above, "**NO NOTICEABLE DUST**" can escape the containment.

While the exhaust system capacity is important it is only as effective as the system's filtering ability. All exhausted air must be filtered to remove suspended dust and particulate. Typically, a dust collection system (i.e., bag house) is attached to the discharge or exhaust equipment.

Rules-of-Thumb:

Good field checks on the effectiveness of any containment are to:

- Watch for signs of dust escaping the containment and/or dust being discharged from exhaust system.
- Containments with proper air handling systems should appear concave along the walls during blast operations. They should **NEVER** appear to bulge during blasting.
- Containments with proper air handling systems should not be so dusty inside that visibility is severely limited.

1100.43 PAINT WASTE DISPOSAL

Toxic Characteristic Leaching Procedure Testing

All waste generated during removal operations SHALL BE sampled and analyzed by the contractor. The waste sample shall be submitted to a laboratory for a TCLP heavy metals analysis. This analysis is for eight environmentally regulated metals typically found in paint and abrasive wastes.

Hazardous Waste Designation

Paint debris is classified as hazardous due to the characteristic of toxicity, if after testing by TCLP, the leachate contains any of the elements in the concentrations equal to or greater than those listed below.

REGULATED LEVELS *	
METAL	mg/L
Arsenic	5.0
Barium	100.0
Cadmium	1.0
Chromium	5.0
Lead	5.0
Mercury	0.2
Selenium	1.0
Silver	5.0
* All regulated levels are "AS OF" spring 1994.	

The Construction Division will attempt to issue a timely memo to all field Construction Divisions when changes occur.

NOTE: Other elements, chemicals, and characteristics can cause a material to be hazardous as defined in *40 CFR 261*. It is for this reason the *Supplemental Specifications* require that no other waste be mixed with paint waste generated during the cleaning process.

If any analysis indicates the presence of metals in levels close to (or above) those listed, contact the Construction Division **BEFORE** issuing a notice for transporting the waste.

Notice for Transfer of Nonhazardous Paint Waste

For all projects involving the removal of paint wastes, some form of manifesting is required. For "nonhazardous" paint wastes (waste with leachable levels below those listed above), *Supplemental Specifications* states:

@ "Accumulated wastes shall not be removed from the temporary storage area without **proper documentation**."

This **notice of disposition** has been standardized and is used as NDR's internal manifest of material being shipped.

The contract documents will identify an NDR facility which has been designated as the "RECEIVING FACILITY." Currently, for construction projects only (not maintenance projects) this is the central complex at Lincoln, Nebraska. There has been a fenced facility designated for storage of nonhazardous paint, which is located at the NDR Maintenance Facility in Lincoln.

Prior to shipping any waste:

1. Waste analysis results shall have been reviewed and determined that the waste is **NOT** hazardous.
- @ 2. A "Notice for Transfer of Nonhazardous Paint Waste" form shall be completed by the **contractor**. (Instructions for completing the form are printed on the form.)
3. The completed form, with required copies, is given to the contractor as their **"notice of disposition."** At this time, the contractor and Project Manager will sign the form "and,"
- @

1100.50 DISPOSAL OF CONSTRUCTION WASTES

1100.51 ASBESTOS

Asbestos is the name for a group of natural minerals that separate into strong, fine fibers. The fibers are heat-resistant and extremely durable. There are a number of different types of asbestos including Chrysotile, Amosite, Crocidolite, Anthophyllite, Actinolite, and Tremolite. The typical size of asbestos fibers is from 0.1 to 10 micrometers. This makes them usually invisible to the human eye. Because of their fine size, they can remain suspended in air for hours when disturbed. This increases the possibility of human exposure via inhalation.

Health Concerns

Medical studies have shown that the primary exposure route for asbestos is through inhalation. The following diseases can result from inhalation of asbestos fibers:

- Asbestosis - A noncancerous respiratory disease that consists of scarring of lung tissue
- Lung Cancer
- Mesothelioma - A rare cancer of the thin membrane lining of the chest and abdomen
- Other Cancers - Some studies have suggested that exposure to asbestos is responsible for some cancers of internal organs such as esophagus, larynx, stomach, colon, and kidney.

Asbestos Removal

U.S. EPA regulates the removal of asbestos containing material from facilities which are being demolished or renovated. EPA regulations for removal, and subsequent disposal, are set forth in 40 CFR 61. Generally speaking, the following procedures must be followed:

- For all facilities, U.S. EPA must be notified prior to renovation or demolition. This notification must include an estimate of the approximate amount of regulated asbestos containing material to be handled. For the NDR, this notification is handled through the Project Development Office.
- Regulated Asbestos-Containing Material (RACM) must be removed prior to any activities that would disturb the materials or prevent future access to them for removal.
- When RACM has been removed, it must be contained in a leak-proof wrapping or bag and properly labeled for disposal.
- All asbestos removal and handling operations must be performed under the supervision of an individual trained and certified in asbestos handling.
- U.S. DOT regulates the transportation of asbestos and identifies it as a hazardous material. Before accepting RACM for transportation, a transporter must ensure that

DIVISION 1200 -- SITEMANAGER

1200.01 INTRODUCTION

@ SiteManager™ is one of the most powerful software support systems available to transportation agencies. It seamlessly integrates field-based data collection, administration of contract records, contractor payments, project-oriented civil rights monitoring, and materials management. All this is combined with a state-of-the-art, client/server environment and is available to field, project, district, laboratory and central office personnel.

1200.02 INFORMATIONAL GUIDANCE

Each lap top that is used for Construction Inspection and management has the SiteManager documentation installed on the hard drive. This is the official source for guidance and use of SiteManager. In addition, supplemental help files are available on DORSRV81/runtime/how_to.chm.

1200.03 SITEMANAGER SUPPORT LIST**System Administration**

	Lee Burbach	Information Systems	(402) 479-3982
	Shirley Daugherty	Construction Division	(402) 479-4559
	Jim Ferguson	Construction Division	(402) 479-4454
	Mitch Hendricks	Information Systems	(402) 479-3616
	Bill Hitzeman	Construction Division	(402) 479-4456
@	Jill Danburg	Construction Division	(402) 479-4453

District Trainers

	Jeff Kisicki	District 1	(402) 471-0850, Ext. 1910
	Jodie Domenge	District 2	(402) 595-2534, Ext. 223
	Bill Mainquist	District 3	(402) 370-3470
	Terry O'Neel	District 4	(308) 385-6265
@	Scott Clinger	District 5	(308) 262-1920
	Russ Frickey	District 5	(308) 262-1929, Ext. 201
	Ronda Lewis	District 6	(308) 535-8031
	Kelly Doyle	District 7	(308) 345-8490
	Linda Jackson	District 8	(402) 376-1126
	Rhonda DeButts	Materials & Research	(402) 479-4760

Resident Trainers

	Craig Washburn	District 1	(402) 471-0850, Ext. 1138
	Jeff Kisicki	District 1	(402) 471-0850, Ext. 1910
	Bill Jasa	District 1	(402) 335-4131
	Russ Eltiste	District 1	(402) 335-4131
	Mel Kuper	District 1	(402) 729-3489
	Bob McClure	District 1	(402) 729-3489
	Karl Burns	District 2	(402) 595-2534, Ext. 269
	Micky Jacobs	District 2	(402) 727-3292
	Gary Mangen	District 2	(402) 595-2534, Ext. 268
@	Darin Brown	District 2	(402) 727-3292
	Lynette Norman	District 3	(402) 370-3474
	Lisa Sudbeck	District 3	(402) 254-6552
	Gary Schmid	District 3	(402) 564-5751
	Lyle Kohmetscher	District 4	(402) 462-4996
	W. T. Farber	District 4	(308) 462-1996
	Richard Kwiatkowski	District 4	(308) 754-5411
	Tom Anderson	District 4	(402) 362-5934
	Arlen Zaruba	District 4	(308) 728-5655
	Scott Griepenstroh	District 4	(308) 385-6265
	Calvin Splattstoesser	District 4	(308) 385-6265

Resident Trainers		
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Duane Katen	District 5	(308) 432-6144
Sylvia Hilderbrand	District 5	(308) 262-1920
Darryl Steinwart	District 5	(308) 632-1429
Kerri Lewandowski	District 6	(308) 535-8031
Bill Teahon	District 6	(308) 872-6733
Duane Collins	District 7	(308) 345-8490
Gene Colfack	District 8	(402) 336-2051
Mike Freeman	District 8	(402) 387-2471
Dean DeButts	Materials & Research	(402) 479-4809
Chris Dowding	Materials & Research	(402) 479-4753

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DIVISION 1300

PROJECT SURVEYS

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DIVISION 1300 -- PROJECT SURVEYS

1300.01 GENERAL REQUIREMENTS

- A. General. Horizontal and Vertical Control. *SSHC Section 114*, Construction Surveying, requires that certain vertical and horizontal control stakes be set for the various items of work to be constructed. This is interpreted to mean the Department will provide the contractor with sufficient intermediate grade and alignment points or stakes, so the contractor can construct the work according to contract documents. Remember the contract plans were created from the preliminary survey which may be several years old by the time construction starts.
- B. Grade And Alignment Stakes. When grade and alignment stakes, including intermediate points, are set by an NDR survey crew, the Department will be responsible for correctness of staking. The contractor shall be responsible for the correct transposing of data from the construction stakes to the work.
- C. Staking. Refer to NDR training book "Introductory Surveying" for instructions on construction staking for the various types of work (Use the stock control number "70-79600" to obtain the manual from Logistics.). District 4 has a written a "Preliminary Survey Manual" that is available on the "Network Neighborhood". There is also a GeoPak Course Guide "NDOR Survey with GeoPak Survey 98" available from Roadway Design.
- D. The Department's ROW Line. The Department's ROW line is not usually placed by registered land surveyors. Therefore it is not usually a legal description of our boundary. Use of rebar to mark the Department's ROW can be misleading. Our NDOR caps should be treated as "temporary" monuments.
- E. Consultant Survey Data. Consultant survey data must be electronically compatible with GeoPak.
- F. Consultant Surveyors. Consultant Surveyors must provide reports of all on site survey activity either in advance of the activity or immediately following the activity so the Department can readily check all stake locations and other survey information provided.
- G. Survey Accuracy
 - 1. The required accuracy for construction survey staking are as shown in Table 1300.1a.
 - 2. The required accuracy for construction survey closures are as shown in Table 1300.1b
 - 3. Bench levels, control points, and any significant location should be checked against two known locations.
 - 4. All computations should be checked by someone on the survey crew, other than the person who did the initial computation. The check should be done in the field while still on site.

Table 1300.1A Survey Staking Accuracy Requirements*		
Description	Metric (m)	English (ft.)
Alignment (Project) PI's, PT's, etc. and CP's/BM's	0.003	0.01
Farmstead Drives	0.3	1
Field Entrances	0.3	1
County Roads	0.03	0.1
Intersecting Highways	0.003	0.01
Telephone Poles/Power Poles (offset)	0.3	1
Drainage Pipes (Stationing)	0.3	1
Length of Pipe	0.3	1
Box Culverts (Stationing)	0.3	1
Length of Pipe	0.03	0.1
Bridges (Stationing)	0.003	0.01
Wells (Stationing/offset)	0.3	1
Cross-Section Slope Stakes; Rough Grading Stakes; Hub Line	.03	.1
Final Grading (Blue Tops)	.015	.05
Paving Hubs	.0063	.01
POT, PI, PC, PT, ETC	0.003	0.01

***All locations are to be based on a known location and checked against another known location.**

Table 1300.1B		
Maximum Closure Allowance For Survey Tasks And Activities*.		
(Checking In At A Known Bench Or Other Control Point)		
Activity	Conventional Survey Methods. (Differential Leveling)	Modern Survey Methods (Total Station Type, Trigonometric Level, Survey)
Paving Hubs	< or = 0.05' vertically. (Always adjust out any error encountered on paving grades) Horizontally hubs should always be set sighting thru to the next point, eliminating any error.	It's not recommended that you set paving hubs using this method. As vertical control is not as accurate using trigonometric methods.
Blue Tops	< or = .07' vertically. (Always adjust out any error encountered on blue top grades) Horizontally hubs should always be set sighting thru to the next point eliminating any error in the alignment. Outside hubs should be set pulling a tape perpendicular to centerline.	< or = .07' for vertical closure. < or = to .15' for horizontal closure
Slope Staking	< or = 0.10' vertically. Horizontal alignment is established pulling a tape perpendicular to centerline.	< or = 0.10' vertically. < or = .50' horizontally
Bridges:	< or = .01' horizontally and vertically	It's not recommended that you stake bridges using this method. . As vertical control is not as accurate using trigonometric methods.
Culverts	< or = 0.10' vertically. < Or = to 0.5' horizontally	< or = .10' vertically. < or = 0.5' horizontally
Cross-Sections & Borrow Pits	< or = .15' vertically. < or = 1.0' horizontally	< or = .15 vertically. < or = 1.0' horizontally
Bench Levels	Use formula- .05' multiplied by square root of miles. Any error should be adjusted out thru the entire level run. Use .035' for preliminary bench levels.	It's not recommended that you established benches using this method. . As vertical control is not as accurate using trigonometric methods.
Alignment	< or = .05' horizontally	< or = .05' horizontally
Storm Sewer Systems	< or = 0.05' vertically. < or = to 0.1' horizontally. NOTE: Inlets need to be accurate within a couple of hundreds from centerline to insure proper placement of wall, back of curb and inlet throat.	< or = 0.05' vertically. < or = to 0.1' horizontally.

*All units are represented in feet.

*Note: Under no circumstance should accuracy be compromised. This chart is only to be used as a guide to help you understand the closure tolerance that may be allowed before you need to take the time reviewing your work. These numbers may not fit all situations. If you have any questions it's best to consult with your project manager.

1300.02 CONSTRUCTION STAKES

A. General - Construction Staking

1. Construction surveying represents a large proportion of the construction engineering cost and, therefore, requires study to eliminate all needless refinements. The goal to be reached is a satisfactory project constructed according to the approved plans with a minimum of cost. Centerlines, right-of-way monuments and benchmarks should be established within recognized limits. Other stakes should be established to standards commensurate with their use.
 - Rt or Lt is relative to stationing – align yourself looking up to next higher station number to determine left or right.
 - The Department usually stakes the ROW as needed for the relocation and location of utilities before the contract is awarded. Utility companies need references to determine how to move their property before the project begins.
 - Utilities may damage stakes—communicate the Departments desire to maintain stakes and require utilities to relocate damaged stakes where possible.
 - The project manager needs to communicate with the contractor to determine where the contractor plans to start work. With good communication, the Project Manager should be able to accommodate the contractor's need for stakes within time requirements specified in the contract.
 - Today the centerline is generally defined by coordinates however, it is still significant in the majority of the construction staking.
 - The survey crew should set the construction stakes as far ahead of the contractor as practicable. The Project Manager must have the area staked sufficiently in advance to avoid construction delays.
 - The stakes provide the contractor the construction lines and grades and also serve as an inspection guide.
 - Stakes must be accurate.
 - Keep communication with the contractor open so if a change is necessary, staking will not delay the project.
 - The contractor shall be responsible for the protection and integrity of the stakes after placement. The contractor shall take the necessary measures to achieve this.

- All preliminary survey results go to Ken Hartwig, Geodetic Survey Section. Ken checks the data then passes the data onto both Kurt Svoboda, Right-of-Way, and to the Roadway designer responsible for the project.
 - ROW surveys are generally done as part of the Preliminary survey. However, Gene Thomsen does many of the ROW surveys.
 - Hydraulic surveys are also part of the Preliminary survey and the data is provided to Don Jisa,
- The Geodetic Survey Section does Photogrammetric surveys. The Photogrammetry Section plots/maps the survey data.
- GPS Pairs are permanent monuments.
 - On each project the Geodetic Survey Section will provide a GPS pair at the beginning, end and every 2-3 miles along the project.
 - Usually the monuments are offset 500-1,000' left and right of the centerline.
- The GPS establishes the state coordinate system.
 - HARN was created in 1995 with the help of a National Geodetic Survey, which established a grid of accurate points across Nebraska based on GPS sightings.
 - Contact the Bridge or Roadway Design Division if you need the coordinates of any point.
- Geodetic surveys are expensive.
 - Preliminary surveys are estimated at 200 hours per mile in rural areas \pm correction factors.
 - Preliminary surveys are estimated at 800 hours per mile in urban areas \pm correction factors.
 - If a contract survey is estimated above in-house time allocations, try to find a way to do the work in-house.

B. Minimum Survey Requirements

Each project is unique and has different survey requirements. Table 1300.2 describes the common stakes. Table 1300.3 explains the minimum stakes necessary and their appropriate location in normal conditions for the item listed. Table 1300.4 shows the minimum placement intervals for stakes. Finally Table 1300.5 shows how to stake structures (Bridges & culverts).

Table 1300.2 STAKE DESCRIPTION*	
STAKE	DESCRIPTION
Hub (Right of Way)	1" x 2" x 18" (oak)
Hub (Blue Tops)	2" x 2" x 9" (oak) or 1" x 2" x 18"
Hub (Paving Hubs)	2" x 2" x 9" (oak)
Guard Stakes for Marking/Describing Hubs	1/2 " x 2" X18"
Information Stakes For Use in Right of Way, Structures	1" x 2" x 18" (pine)
Slope Stakes	1/2" x 2" x 18" (pine)
Lath (marks hub/guard sites)	1/2" x 2" x 48"
Pink Ribbon	Delineates lath or other objects for visual locating.
Wire Flags – Pink	Marks Bluetops, Paving Hubs, ROW, Structure Stakes, etc.
Rebar	5/8" x 36" Used in establishing control points, ROW breaks.
Aluminum Caps	Placed on rebar to accurately establish a given survey point and stamp point information.

*Ground conditions may require other sizes and or types of stakes, than those indicated.

STAKE DEFINITIONS		
Table 1300.3		
	DESCRIPTION	PURPOSE
HUB LINE	1" x 2" x 18" oak/pine hub stake set usually at 100' intervals or at plan cross section locations between ROW breaks on the ROW boundary. The hub is protected with a 1" x 2" x 18" guard stake with station/offset information, and a ½" x 2" x 48" pine lath.	Establishes the boundary of the Department property, shows the offset location of the centerline and shows stationing. Also may be used to define rough grading. May also be used to mark temporary and permanent easements.
ROW	½" x 2" x 18" hub or 5/8" or ¾" x 36" rebar rods set at points in the Hub Line where the ROW changes directions (Deflections). Set on PC's, PT's of curves, in Hub Line where tangent sections are over 1,000 feet in length and on hills so ROW may be viewed.	Establishes the boundary breaks of the Department property. Right of Way markers are normally installed on these points by the contractor. (Confirm control points before staking ROW.) Or at ROW hub (See example at Subsection 1300.02 C.)
SLOPE STAKES	½" x 2" x 18" pine stake with lath (optional) and guard stake (optional) with information describing the limits of rough grading. Set on the extreme outside points of the designed cross section where the grading work and natural ground intersect. Usually set at 100-foot intervals and where changes in slopes, roadway width, sharp curves or ditch dimension change. Slope stakes are protected by a wire flag or lath for visibility.	Defines rough grading requirements – cut/fill, slope, offset from centerline, toe of backslope distance, hinge point/shoulder distance and ditch dimensions. A cut or fill to centerline may be written on the back of the stake.
BLUE TOPS (A Subgrade Lath is sometimes used instead of a Blue Top in cases of extreme subgrade overfill or deficiency with the PM's approval)	2" x 2" x 9" or 1" x 2" x 18" oak/pine Hub stake depending on soil conditions with plain, blue or white colored top. Set the stake at finished subgrade elevation and place another stake (short lath) or wire flag near it for protection. Sometimes colored fiber tail ("chaser") is placed atop the stake to aid grader. Generally the Department will not color the top of the hub or place a fiber tail chaser – that is the responsibility of the contractor.	Used to establish the final subgrade elevations and final grading slopes. These stakes are set centerline; edge of mainline roadway (¼ points), & edge of shoulder transversely across the roadway. (Additional stakes are needed on multilane highways.) Bluetops are usually set at 100' intervals longitudinally. Additional blue tops may be set at 50' intervals in cases such as vertical curves, sharp horizontal curves, or slope transition areas. Set Blue tops at the exact finish grade elevation—the contractor must make any adjustment.
PAVING HUBS	2" x 2" x 9" oak/pine hub with a tack set at a contractor specified offset distance from the pavement centerline/edge of pavement. A ½" x 2" x 18" pine stake is driven beside the paving hub which explains offset, grade (cut/fill) and station of the paving hub. Usually set at 50' intervals on both sides of the mainline. In cases of sharp vertical curves, horizontal curves over 1 degree, or transition areas, hubs are set at 25-foot longitudinal increments.	Used to set the string line to guide the trimming and pavement-finishing machines. Grade (cut/fill) is indicated on the stake. Need to determine with the contractor whether the offset is level from the edge of pavement or is the projected slope.
DRAINAGE, PIPE, CULVERT, BRIDGE, WALL, DRIVEWAY, CURB, SIDEWALK AND OTHER STRUCTURE STAKES.	1" x 2" x 18" oak/pine Hub set at a specified offset from the structure being staked. A (1" x 2" x 18") pine guard stake which explains offset, grade (cut/fill) and station of the paving hub and a ½" x 2" x 48" lath stake is driven beside the hub for visibility and protection. On long pipe runs usually for storm sewers, offset stakes are set at 50' intervals.	Shows the location of structures in terms of project stationing and offset distances.
SHIM SHOTS	Points on a girder. At locations directed by the Bridge Division. Use a paint mark to mark location.)	Used to determine the final grade of the bridge deck. (Make sure all the Bridge Division knows where on the girder the points were taken.) The actual shim amount is shown with a black marker on steel girders and with paint on concrete girders.
STATIONING LATHS	½" x 2" x 48" pine stake (lath). Usually only needed on asphalt overlay projects.	Defines the project stationing. Usually placed before the subgrade is set to help define/establish pavement quantities. Offset near edge of shoulder.
PAVEMENT STAMP	Imprinted station number on pavement. (3" brass number stamps imprints in plastic concrete). Place stamp every 100-feet or 20-meters. Normally place on the right side, progressing up stationing so the stamp can be read from the shoulder. Avoid rumble strip location.	Defines the project stationing.
ALIGNMENT POINTS OR CONTROL POINTS	May be ¾" or ½" x 36" rebar for permanent points; a 60d spike for a less permanent point; or frequently a 1" x 2" x 18" oak/pine hub with a tack. ½" x 2" x 48" pine stake (lath) is used to protect the hub.	Defines the centerline alignment. Such as the beginning or ending of a curve, or the point of deflection of two tangent segments. Control points may also be offset from the centerline at various locations and are tied to the highway with coordinates.

MINIMUM SURVEY REQUIREMENTS

Table 1300.4

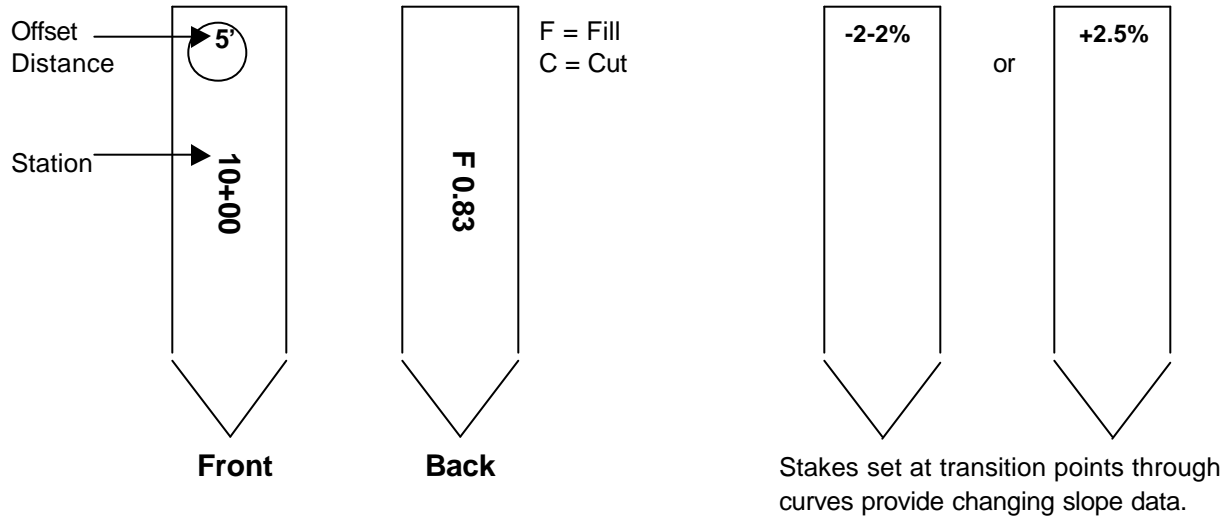
MAJOR CONSTRUCTION						
TYPE OF STAKE	LOCATIONS	LEVEL GRADE (feet)	HORIZ. CURVES >2 degree (r≤2865') (feet)	HOR. CURVES <2 degree (r≥2865') (feet)	SHARP VERT. CURVES (feet)	OTHER REQUIREMENTS
Hub Line	Hub, guard and Lath set between ROW Breaks on the ROW boundary	HL(100')	HL(100')	HL(100')	HL(100')	Hubs may be "graded" to centerline for use by the grading contractor.
ROW	Hubs or Rebar rods, guard and lath set at points in the hub line where the ROW changes direction (deflects).					Set a stake at each break point; on level ground every 1000-feet; at Control points; and at the top of hills to provide Line of Sight and at other locations described in Subsection 1300.02. .
Slope Stakes	Slope stake and wire flag or lath to be set at the extreme outside points of the designed cross section where the grading work and the natural ground intersect.	SS(100')	SS(100')	SS(100')	SS(100')	Changes in roadway width, slopes, ditch dimensions or sharp curves may require additional slope stakes.
Blue Tops	White or blue topped hubs with wire flag or colored fiber tail (chaser) set to final grade elevations across subgrade template. Bluetops may be replaced by subgrade lath if approved by the Project Manager. Only a short lath with cut/fill marked on them is placed on subgrade template.	BT(100')	BT(50')	BT(100')	BT(50')	Blue Tops establish the final grading limits. These stakes are set at centerline; ¼ points; & subgrade/foreslope intersection (edge of shoulder). (Additional stakes may be necessary on multilane roads.)
Paving Hubs	Hubs with guard stakes are set at specified offset distance from edge of pavement.	PH(50')	PH(25')	PH(50')	PH(25')	Offset needed for their equipment. Graded to top of proposed pavement surface. (Level or projected grades as required by the contractor.)
Radius Points and Other Control Points	Locate and verify control points and benchmarks from preliminary survey.	As necessary	As necessary	As necessary	As necessary	Add construction benchmarks and roadway alignment as necessary.

PH=Paving Hubs
HL=Hub Line
BT=Blue Tops-Final Grading
SS=Slope Stakes

SURVEY REQUIREMENTS		
Table 1300.5		
STRUCTURES (BRIDGES AND CULVERTS)		
	STAKES LOCATION	
ABUTMENT CENTERLINE	BS (8 each)	Normally two stakes are placed on each side of the bridge at specified distances from centerline of the bridge at each abutment.
WING ENDS	BS (8 each)	Two stakes are placed at specified distances from the end of the wing. These stakes are on the same azimuth as the wing.
PILE LOCATIONS AND ELEVATIONS		Contractor measures from existing stakes to pile locations. Elevations should be verified by the inspector.
PIER CENTERLINE	BS (4 each/pier)	Two stakes are placed on each side of the pier at specified distances from the center of the bridge pier.
GRADE BEAM CENTERLINE	BS (8 each)	Two stakes are placed on each side of the grade beam at specified distances from the center of the bridge.
SHIM SHOTS ON EACH GIRDER	SSR – As Directed By The Bridge Division.	Used to determine the final grade of the bridge deck. (Make sure all the Bridge Division knows where on the girder the points were taken.) The actual shim amount is shown with a black marker on steel girders and with paint on concrete girders.
PIPE CULVERTS	CS (2 each) @ each end of pipe offset as required.	Hub, guard and lath should be placed at a specified offset from the end of the floor on centerline of the pipe, at each end. Any broken back or horizontal break should also be referenced on the end stakes or staked separately.
BOX CULVERTS	CS (2 each) @ each end of pipe offset as required	Hub, guard and lath should be placed at a specified offset from the end of the floor on centerline of the box, at each end. Some contractors may require parapet stakes and wing stakes (mostly on skewed boxes). These should be set at a specified distance to the centerline of the box or end of wing, on the parapet line or wing line. Any broken back or horizontal break should also be referenced on the end stakes or staked separately.
CS=culvert stakes require a hub, guard and lath. BS=bridge stakes may require a hub with nail, information guard and lathe. SSR=shim shot reading		

C. Survey Stake Minimum Requirement Examples—Suggested Format

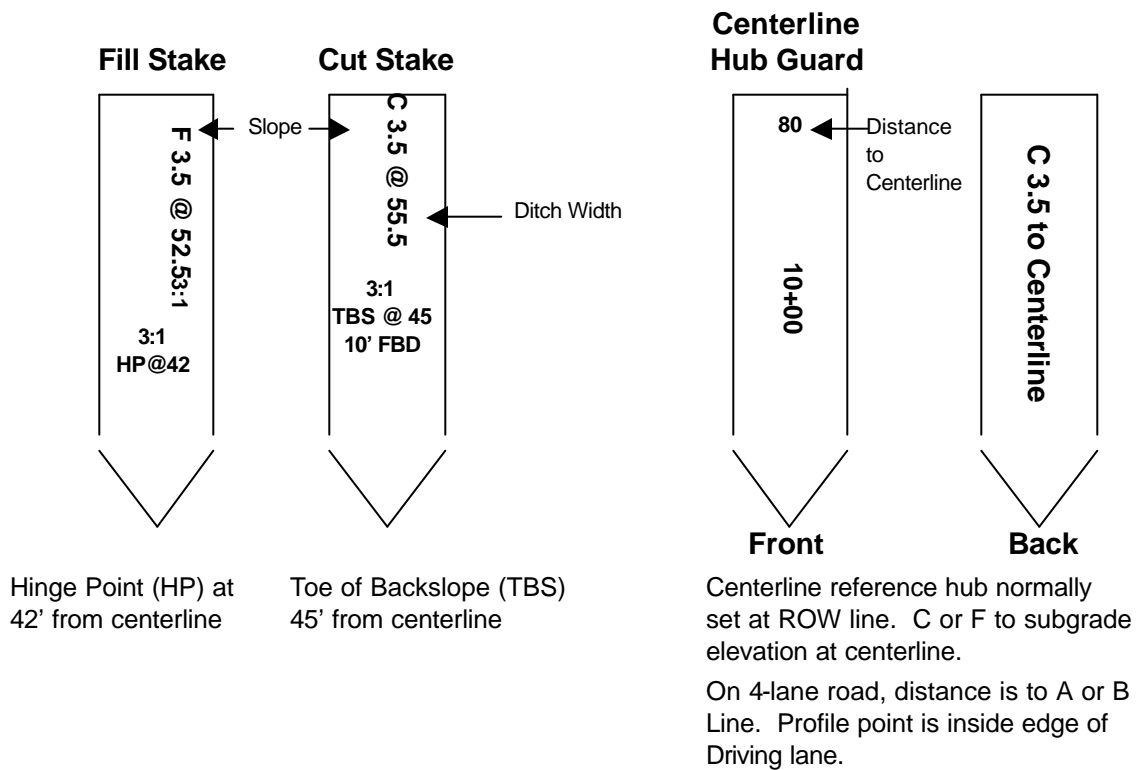
PAVING STAKES



Fill (cut) is to the top of the pavement at outside edge.

Pavement grades may be computed flat from edge of pavement to paving hub, or on projected slope of pavement out to paving hub. Coordinate with contractor for method preferred.

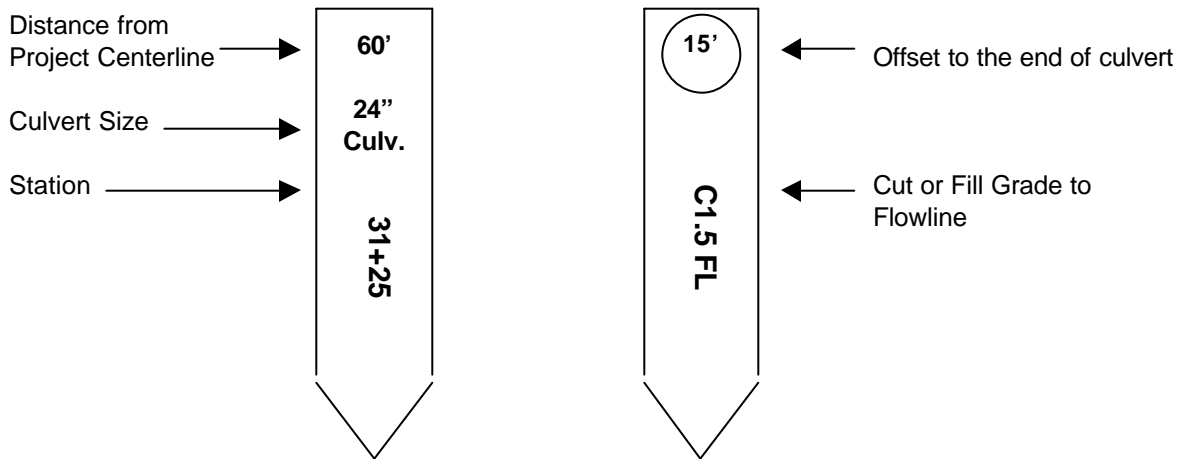
SLOPE STAKES



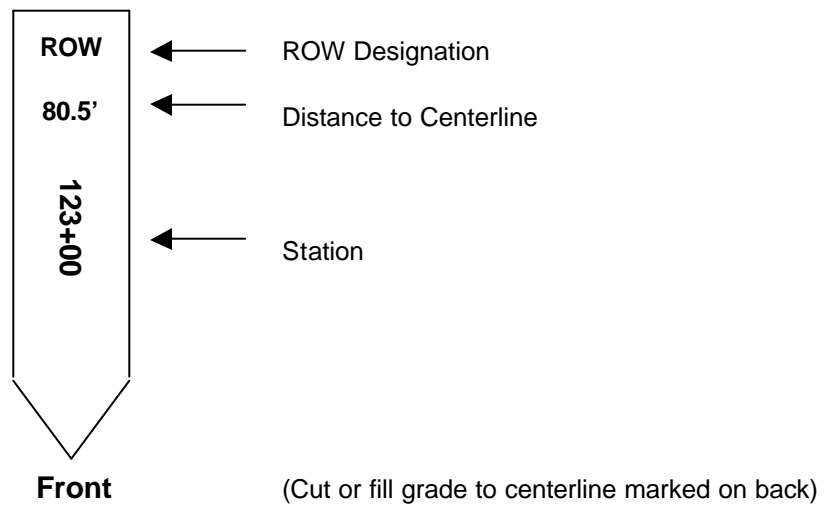
Hinge Point (HP) at 42' from centerline

Toe of Backslope (TBS) 45' from centerline

CULVERT STAKES



ROW STAKES



Hub Flags: Green-Yellow flag for easements.
Orange flag for ROW.

1300.03 CONSTRUCTION SURVEY BASIC REQUIREMENTS

A. GeoPak Guidance (Not All Projects Are Available In This Format)

1. GeoPak New Project Instructions:

- a. Create a new folder on your C: drive under C:\geoprjs\11111; Name this folder with the 5-digit control number for this project. In this example the control number is 11111.
- b. Open microstation. The microstation manager window will be on the screen.
 - Set the path on the right to C:\geoprjs\11111.
 - Then click file – new. At the bottom of the window select a seed file. Example – C:\users\data\seed3.dgn. Use seed3.dgn for an English survey or mseed3.dgn for a metric survey.
 - Then type the control number in the window on the left side and click ok. The control number 11111.dgn will appear on the top left side of the microstation manager window. Click ok.
- c. The microstation design screen is now on your screen. The top bar on the screen should read 11111.dgn (3D) – MICROSTATION/J. Click on Applications – GeoPak survey – GeoPak survey tools. The toolbox has four icons.
- d. Click on the Project Manager icon. The Project Manager window opens.
 - Set the path on the right side to C:\geoprjs\11111. The path appears towards the top of the window.
 - Then click project – new. The create new project window opens. Project name: 11111, Working directory: leave blank, Job number: 111, for the job number use the last 3-digits of the control number. Project description: Skyline Dr.- 204th and Dodge.
 - Now click on preferences. GeoPak user preferences window opens. Direction: Azimuth, Coordinate: XY, Unit: English or Metric. Working directory: leave blank.
 - Then click on feature preferences. Select .smd file, Example- C:\GeoPak_Projects\Standards\prelim.smd or mprelim.smd for a metric prelim.
 - Also toggle on the best match feature. Click ok.
 - Then click ok in the GeoPak user preferences window, and click ok in the Create new project window. An alert window appears asking Create Job 111 in directory C:\geoprjs\11111\? Click Yes.
- e. In the Project manager window 11111.prj should appear highlighted on the left side of the window. Click ok. The Project users window opens. Click users – new. Name: your initials, Full name: your full name, Op code: your initials, Description: your title or your titles initials, Click ok. Do you wish to define a password for this user? Click No. Highlite (aa) Click ok.

- f. Click Survey, The Select Run window opens. Click run – new. The run name should correspond with the letter you used for your Sdms project segment. In this example the run is named tra for the traverse segment. The description can be left blank. Highlight tra. Click ok.
- g. The Survey project window opens. The title bar should read, Survey....Project (11111) .. User (aa)..Run (tra).
- h. Highlight Data Source, click Single file. The Select sdms window opens.
 - Set the path on the right side of the window to C:\sdms\prj\11111. On the left side of the window the sdms project segments should appear.
 - Select 11111tra.prj and click ok. Toggle on Remove Sdms tag names from point descriptions.
 - Now click sdms to obs. Click on mapping option.
 - Toggle on draw mapping. The Dgn file should read C:\geoprjs\11111\11111.dgn. The seed file is grayed out.
 - Now click control code. Click open. Click 11111tra.ctl. Click ok. The control file should read C:\geoprjs\11111\11111tra.ctl. Coord fields should now have coordinates.
- i. Now click process survey. The standard unit weight should be 3 or less. A larger number indicates a problem with the process of the observations in the obs file and the control file. The Least squares adjustment takes place when processing the survey and creates the reports for review. These are very useful for checking errors and adjustments. Now press any key to continue. Then click import to gpk. This imports the points and chains to a GeoPak database.
- j. Clicking on the Bentley B and selecting sink can hide the survey project window. You can restore the window by clicking on window – survey project.
- k. To view the project on your screen click fit view. In this example you would see the CP's for this projects traverse.
- l. Continue by opening the survey project window. Click copy run. Select tra. Click ok. Type in the next segment letter and click ok. Proceed with data source as previously explained.
- m. Roadway Design is developing a program to make setup easier and when this is available it will be easier to use GeoPak.

2. Computer Listings Available – For projects developed on the computer, listings will be sent to the Project Manager with the plans or as soon thereafter as they can be printed. If, due to loss or damage, additional listings are needed by the field personnel, they will be supplied upon request. The listings available are discussed under the subsequent paragraphs. GeoPak can reproduce or reformat any of the previous listings/books.
3. **Preliminary Cross Section Listings** – This is a tabulation of the preliminary survey elevations and distance. GeoPak has the capability of projecting cross sections at any location.
4. **Plotted Cross Sections** – Plotted cross sections are available to the Project Manager for all computer designed projects.
 - GeoPak plots both the preliminary and design cross sections. The scale used for both may be modified to any desirable scale. The scale used is printed in the upper left hand corner of each sheet.
5. **Earthwork Computation Listing** – This is a tabulation by stations of areas and volumes.
6. The RDS form is titled “**Earthwork Quantities List for Roadways.**”
7. **Grades and Surfacing Elevations Listing** – This is a tabulation of the finish grades at centerline and at the edge of the surfacing. On horizontal curves all grades have been corrected for transitions and superelevations. GeoPak can furnish grades for any point between the two shoulders.
8. **R.O.W. Limit Listings** – This machine listing is discussed later in this subsection.
9. **Blue Top Book** – This listing is discussed later in this subsection.
10. **Slope Stake Book** – This listing is discussed later in this subsection.
11. **Alignment Book** – This listing gives alignment information and is for use when referencing and relocating centerline.
 - Preliminary alignments are available through Ken Hartwig In Roadway Design [(402)-479-4682].
 - Construction Alignments are available through the Roadway Design, Project Designer [(402)-479-4601].

12. **Locations of “No Passing Zones”** – Vertical curve no passing zones can be obtained from Roadway Design. However, the District can run the two vehicle test method to determine the zones. (Two vehicles follow 1200’ apart and when sight is obstructed that starts the no passing zone one direction and ends the no passing zone the other direction. When sight distance is returned that ends the zone the first direction and begins the zone the other direction. Logistics Division has the equipment for this operation.

B. Checking Bench Levels

1. Good bench levels are one of the important reference features of any construction project.
2. All benchmarks should be thoroughly checked before any other level work is started. If the preliminary survey party has not established benchmarks at proper intervals, intermediate ones should be set. Permanent benchmarks should be established approximately 1000 ft (300 m) apart and also near all major structure locations.
3. In choosing objects for benchmarks, the Project Manager must keep in mind that such objects must be permanent and easily accessible. Nails in fence posts and pole lines should be avoided. A 3 foot “T” post is normally required for a benchmark however, the PM may authorize the use of steel reinforcing rod, at least 1/2 inch (12.7 mm) round and 3 ft (1.0 m) long driven 2 inches (50 mm) below ground level in a location that will not be disturbed. The location should be marked with a guide stake or lath and red cloth, and the “plus” and “distance right or left of centerline” recorded in the levels book.
4. In running levels, the following rules should be followed:
 - a. Equalize sights. In order to eliminate instrumental errors as much as possible, backsight and foresight distances should be of equal length at all turning points.
 - b. Reading the rod. Rod readings at turning points shall be taken to the nearest .005 foot (.00152 meter). The rodperson shall use a rod plumb or if plumb is not available may wave the rod away from and toward the instrument parallel to the plane of collimation.
 - c. Never take down the instrument without checking on a benchmark other than the one used on the setup or turn.
 - d. In establishing benchmarks, it is important to turn on each benchmark.

5. Benchmarks notes may be kept in the alignment notebook. Recorded rod readings shall never be erased. If an error is made, a line should be drawn through the erroneous figure and the correct figure written above. In checking elevations, the plan elevations shall be used unless an error in elevation of **0.05 ft (15 mm)** or more is found. If errors are found they should be corrected and documented—some errors will have to be prorated over the intermediate points by the data collector. The final cross section levels may then be corrected to the preliminary datum at preliminary benchmarks or at established benchmarks.
6. If difficulty is encountered in checking preliminary bench levels or the Project Manager has reason to believe that an error was made in transferring preliminary elevations onto the plans, he/she may obtain the original preliminary notes by writing the Roadway Design Division at Lincoln.

C. Reproducing And Referencing Centerline

1. The construction centerline shall be reestablished using the plan information. It is a good policy to establish the centerline and set the reference stakes for the entire project as early as possible, so that property owners may have ample time to lower pipe lines, remove fences, power and telephone poles, buildings, etc., before the construction crew arrives.
2. In reestablishing the centerline, the work should proceed as follows:
 - a. Locate and “tie out” all plan transit points.
 - b. Establish and “tie out” any additional required control points.
 - c. Reestablish the centerline.
 - d. Set the centerline reference stakes.
3. Transit points that should be located or established and “tied out” are:
 - a. P.O.T. (Point on tangent)
 - b. P.I. (Point of intersection)
 - c. P.C. (Point of curvature)
 - d. P.T. (Point of tangency)
 - e. T.S. (Tangent to spiral)
 - f. S.C. (Spiral to curve)
 - g. C.S. (Curve to spiral)
 - h. S.T. (Spiral to tangent)

i. P.O.C. (Point on curve)

(Reference these points to at least four permanent objects which will not be disturbed during construction or shall have coordinates accurate to ± 0.01 feet. However, in the absence of available "permanent objects", tacked stakes set at right angles to and at known distances from the project centerline will be satisfactory. Reference ties should be measured horizontally to the nearest ? " (3.0 mm) with a steel tape.)

4. After the transit points have been established, proceed to reestablish the centerline markers. The Project Manager should set the centerline markers with an instrument at 100 ft (25 m) intervals, measured horizontally on tangents and horizontal curves up to 9400 ft (2864.789 m) radius. Curves that are less than radius of 9400 ft (2864.789 m) should use 50 ft (15 m) chords. The distance "plumbed up" by the chaining crew should be checked occasionally with a hand level or from the difference in old ground elevations shown on the plans. Intermediate centerline markers on tangents may be set later with a chain stretched between the station markers. Intermediate centerline markers on curves should always be set with the instrument.
5. When obstructions such as fences, etc. are present on the right-of-way and when the removal of such items are not included in the contract items, the appropriate adjacent property owners shall be notified that they must remove such obstructions. Such notification shall be made well in advance of construction operations so that the owners will have sufficient time to make arrangements for performing the work. They should also be advised of the date on which stakes will be set for their information in removing or relocating their property.
6. Provision for the removal of advertisement signs is handled independently by our Right of Way Division. Should any problems arise relative to the removal of advertisement signs, the Construction Division should be contacted.

D. Checking Plan Grade And Calculating Grade Revisions

1. As soon as possible after assignment to the project, all grade elevations shown on the plan-profile sheets of the plans should be thoroughly checked. This includes percent of grade and vertical curve corrections. On structures, it is recommended that all grades be recomputed including pile cutoff, footing, pier cap, abutment seat, and top of girder elevations.
2. It is particularly important to check the profile of the roadway surfacing which connects with the project being constructed. If this elevation is found to differ from that shown on the plans, it is evident that the project grade line will need to be adjusted. This adjustment will cause changes in grade stake elevations and may even affect lengths of proposed culverts in the area.

3. If any appreciable error is found between the preliminary and preconstruction chaining or bench levels, and an equation is introduced, it will be necessary to recalculate the centerline grade from the equation point to the next point of intersection of tangent grades, or if too distant, to some nearer convenient point of the next grade break. This is particularly important on concrete pavement as any equation or correction in levels or distance will be reflected in the pavement form elevation.

E. Staking Right-Of-Way Fence and Right-Of-Way Limit Listing

1. ROW stakes are needed usually before the contract is awarded to provide references for utility relocations.
2. On some projects, right-of-way fence is a contract item and staked and constructed in accordance with the plans or the right-of-way listing. On other projects, fence stakes must be set on the right-of-way line for the guidance of adjacent property owners. The Project Manager should also check the fence setting as it progresses to see that it is set in correct relation to the fence stakes.
3. Right-of-way fence stakes should not be set in borrow pits or channel changes until the contractor has these finished to the landowner's and the District Engineer's satisfaction.
4. Right-of-way limit listings are available for most projects except interstate. Separate listings will be furnished for the left and right sides of centerline of the project. They will give the right-of-way distances at all breaks in the line and at all intermediate full stations. All distances given on the listings are from centerline of the project to the right-of-way line.
5. Right-of-way limit information will not be given for segregated parcels near section corners. The listing will give the station and distance to the point where the normal right-of-way enters the segregated parcel and also at the exit, with a break in the stationing between the two. The section corner will not be given. If right-of-way markers are to be set for segregated parcels, consult the plans or the right-of-way contract for the necessary information.

F. Setting Slope Stakes

1. The "Slope Stake Book" provides the data for locating the slope stakes and this "book"/file is available from the Roadway Design Division, CADD Applications Section, (402) 479-3986.
2. Construction stakes are placed on the project before work begins to outline for the contractor the location and extent of the work. Slope stakes may be set with an instrument on projects having the excavation quantity computed from plotted cross sections. The notes shall be kept in a separate book.

3. For fill sections, slope stakes are set at the toe of the slope and marked to show the vertical distance and slope from the ground at the stake location to the grade elevation at the hinge point and the subgrade shoulder of the fill.
4. For cut sections, slope stakes are set at the top of the backslope and marked to show the vertical distance and slope from the point on the ground where the stake is set to the grade elevation for the bottom of the ditch.
5. Slope stakes are normally set on both sides of the road at every station (100-feet); and every 50 ft (15 m) on horizontal curves having a radius of 2865 feet (873.25 m) or less. Use Type "D" ½" x 2" x 18" (12.5 x 50 x 458 mm) pine stakes.
6. Some intermediate points at which slope stakes should also be set are:
 - a. P.C. and P.T. of horizontal curves.
 - b. Beginning and ending of superelevation.
 - c. Points where shoulder and backslope change.
 - d. Change in width of roadbed.
 - e. Change in width of side ditch or borrow.
 - f. Any other points helpful to the contractor.
7. Balance points shall be well marked on the ground with a lath and red flag. Call the contractor's attention to these points and see that he/she works to them.
8. The plan data pertinent to each station shall be placed in the slope stake notebook. This data gives the trial distance for the first rod reading and also a check between the plan and the stake as actually set in the field. The information from the plans and the staking data should be similar to the example shown in Appendix 3-12. This example also shows the method for setting stakes for high fills when the instrument height (H.I.) is below the new plan grade.
9. The staking party should watch drainage along the toe of fill slopes, intercepting ditches, dikes, etc., as the machine does not now provide for drainage in all cases. Where necessary, special ditch grades must be computed in the field. They should also watch for vertical banks just beyond the limits of construction and correct slope stake locations accordingly.

G. Setting Finishing Stakes

1. The use of a separate notebook is suggested for the finishing stake (blue top) notes. Several satisfactory methods of keeping notes are presently in use. Following is a description of one acceptable method. The left-hand page of the notebook may be used for the plan data; that is, the station number, the centerline grade elevation, the drop to intermediate points and shoulders, the amount of superelevation on curves, etc. The right-hand page of the book can then be used for recording the staking data. The grade rod, for each point on the grading roadway template to be staked, is computed and placed on this page. The actual level rod reading (Read Rod) can be recorded below the corresponding grade rod and the cut or fill from the existing ground to the grade rod computed. Finishing stakes are then driven at these points and "blue-topped". Only in extreme cases should a cut or fill be marked on the finishing stake. If the grade has been built too high, a hole should be dug deep enough to drive the blue top to grade. The contractor can be expected to protect these stakes so that they will not have to be reset at some future date. If many stake holes are necessary or many stakes are appreciably high [0.3 ft (90 mm) and over], additional work should be done by the contractor before stakes are set.
2. Blue top books are available on all projects designed with the computer. The design information is given for each preliminary cross section on one page with a blank page following for construction information. The elevations included in this information may include an allowance for "trimming". The Project Manager or party chief must determine exactly what elevations are given. When a trimming allowance is not included, up to 0.1 ft (30 mm) may be added to the elevation of the finished grade stakes.

H. Setting Trimming Or Paving Form Stakes

1. When the roadway is in condition for the surface structure, trimming or paving stakes may be set. They should be aligned and graded by instrument.
2. The riding quality of the surface structure depends to a large extent on the vertical accuracy of the stakes and the accuracy with which the trimming is performed or the forms are set. The approved method is to set accurate grades to millimeters for each side of the surfacing at a uniform offset (consult the contractor). Grades may be indicated by stakes either driven to grade or driven flush with the ground and marked with a cut or fill. Stakes driven flush are least likely to be disturbed. The alignment shall be given on one side only and indicated by tacks in the top of the stakes. The appearance of the grade may be checked visually from both directions by sighting along the contractor's string line before the trimming or form setting operation begins.
3. On curves, the tack line may be run on the offset line after computing a chord length for the offset radius, or the centerline of the curve may be run and the tack line set by double chaining the offset line, again using the proper chord length for the offset radius.

4. Stakes are normally set at 50 ft (15 m) intervals on tangent alignments and on horizontal curves up to 2° radius which have straight or long vertical curve grades. On horizontal curves over 2° radius and vertical curves having a grade algebraic difference that is more than 1.75 ft (0.532 m) from the tangent grade in 50 ft (15 m), a 25 ft (7.5 m) interval should be used. The ST, CS, SC and TS or PC and PT of all horizontal and the PVC and PVT of all vertical curves should be clearly marked for the contractor. Stake the transitions in and out through the super's of the curves as per the Standard Plan.

I. Contractor's Forms on Large Structures

1. On viaducts and bridges, the staking crew shall give the contractor line and grade on all bents, piers, abutments, walls, etc. This duty will be continuous throughout the duration of the construction. Using the stakes previously set, the Project Manager shall stake or check all pile layouts, centerline, and grade on all footings, columns, caps and anchor bolts before and after the pouring of concrete. Columns, pier caps and anchor bolts should be checked while the concrete is still fresh enough to allow for adjusting the forms or anchor bolts to line and grade. In addition to checking the line from the survey stakes, anchor bolts may also be checked by steel taping form pier to pier. Temperature, force on the tape, and plumbing for elevation must all be considered when this method is used. On steel girder bridges, a final check shall be made on span lengths, pier and abutment angles, and bearing plate seat elevations before attempting to set the girders in place. This should be done as soon as possible to allow time for minor adjustments in the girders should they be necessary. The following steps are used in making this check:
 - a. From a transit setup, mark the centerline of the structure on the pier caps.
 - b. From a setup, turn the pier angles and mark the centerline of the pier at the center of each set of anchor bolts.
 - c. Check the anchor bolts for proper relation to the pier centerlines you have marked.
 - d. Steel tape the distance along each line of girders between the abutments and piers as a check on the span lengths. Temperature, pull force, and plumbing for elevation must be accurately used in the measurement. (See the "Introduction to Surveying" page 51 & 52 for the chaining requirements and temperature corrections.)
 - e. Take elevations on all bearing plate seats. Across any one pier cap the variation from plan elevation between any two bearing seats should not be more than $\frac{1}{4}$ inch (6 mm). For example, if all bearing seats across the pier are $\frac{1}{4}$ inch (6 mm) too high (or low), the floor grade can be adjusted to compensate. However, if one bearing seat is $\frac{1}{4}$ inch (6 mm) high and the adjacent seat is $\frac{1}{4}$ inch (3 mm) low, the variation is more than $\frac{1}{4}$ inch (6 mm) and the bearing seat elevations should be adjusted by grinding. This will assure the proper fit of the separator angle against the girder web.

- J. Checking Culvert Lengths, Culvert Lists, Slope Stakes, Blue Top Stakes, Paving Hubs, etc.
1. General – Another duty of the survey crew is to take cross sections along the centerline of all culvert sites. This includes existing structures which are to be extended as well as proposed structures. The cross section should follow the centerline of the new structure and be taken along the skew line if the structure is not at right angles to centerline. If the inlet or outlet of the proposed structure does not coincide with the flow line of the existing channel or ditch, sufficient rod readings should be taken off-angle [usually extending [200 to 300 ft (60 to 90 m)] in the existing channel to establish the proper flow line design for the new structure. (The pipes off-line distance, change of skew, and length changes should be noted on the cross section sheets.) The elevation of the intersection of the right-of-way line and existing channel should also be determined.
 2. The specifications provide that “the contractor shall not order and deliver the (culvert) pipe until a correct list of sizes and lengths is furnished by the Project Manager.” Also, the contractor should not order and deliver material for box culverts, inlets, junction boxes, manholes and similar appurtenances, until a correct list of sizes and lengths of such structures is furnished by the Project Manager.
 3. The Project Manager should promptly field-check the culvert and drainage structure locations, and prepare the field-checked culvert list. The instructions included herein provide for designing and detailing culvert pipe, reinforced concrete pipe, or corrugated metal pipe in exactly the same manner. This procedure will enable the Project Manager to field check and prepare the “field checked order list” without delaying to determine identity of the contractor and the kind (concrete or metal) of culvert pipe to be furnished. Accordingly, the Project Manager will be able to and should expedite the preparation of the field-checked culvert list to facilitate and provide time for fabrication and delivery of the culvert materials.
 4. Culvert List – Pipe Culverts – The “field-checked list” of pipe culverts and appurtenances should include the following information for each pipe culvert:
 - a. Station locations.
 - b. Diameter and length.
 - c. Kind of pipe culvert (concrete pipe, corrugated metal pipe or culvert pipe).
 - d. Type of headwalls, inlet, manhole, junction box, or other appurtenance, and applicable standard plan number or numbers, if such items are to be constructed.
 - e. Degree of skew if culvert is to be skewed, if skewed on one end only, show direction of flow by sketch.

- f. Sketch for each broken back pipe culvert.
 - g. Direction of flow for all pipe extensions.
5. Do not make any field changes to pipe culverts without approval from the designer.

K. Culvert List – Box Culverts

1. The “field-checked list” of culverts should include all of the following information for each box culvert:
 - a. Station location.
 - b. Span, rise and barrel length.
 - c. Plan number or numbers.
 - d. Height of fill over the box culvert.
 - e. The “field-checked list” should include additional information for each box culvert which is to be constructed on skew, as a broken-back structure, with control joints, or an extension of an existing box culvert, as follows:
 - (1) Skew angle if the box culvert is to be constructed on skew, include a sketch if the ends or parapet walls are not to be constructed as shown in the standard plans.
 - (2) A sketch for each broken-back culvert, showing dimensions between the ends of barrel and break points and between break points measured on the axis of the culvert, and showing flow line elevations at ends and at break points.
 - (3) A sketch for each box culvert which is to be constructed with control joints. The sketch should show the dimensions from the ends of the barrel to the first control joint and the spacing between control joints.
 - (4) When the plans provide for the extension of an existing box culvert, the removal of the endwalls and/or the preparation of the existing structure will usually be performed in accordance with details shown in a standard plan.
 - (5) Special plans may be provided for large or complicated structure remodeling. The standard plan includes details for connecting to old structures having angle or straight wings, structures with or without floors between wings, etc. The standard plans also give the contractor the option of doweling into the wings of the existing structure, or breaking back and exposing 2 feet (600 mm) of reinforcing steel to connect the extended structure, when the individual structure plan note does not specify the method of extension.

- (6) In detailing the extensions or remodeling of existing box culvert structures, the Project Manager must include with the field-checked culvert list (1) an adequate description of the existing structure, and (2) an adequate description of the preparation work and extension. This information is essential to the contractor and the fabricator of the necessary reinforcing steel.
- f. The description of the existing structure should include:
 - (1) Station location, dimensions (span, rise, barrel length) and type of structure.
 - (2) Plan number if known or available.
 - (3) Type of wing, angle or straight; for straight wings include wing dimensions "L", "C" and "H".
 - (4) Whether or not concrete floors are between the wings.
 - (5) Whether the existing box is suitable for doweling.
 - g. The description of the new work should clearly describe the preparation work and the extension, and should include:
 - (1) Span, rise and extension length, right and left.
 - (2) The standard plan numbers both for the removal and preparation and for the extension.
 - (3) An adequate description of the removal of endwalls and/or preparation work on the existing structure. Typical examples of the preparation work:
 - (a) "Remove end walls and prepare structure as shown on the Special Plans (in case of special plans for preparation of old structure)."
 - (b) It will be seen that, depending on the type, suitability for doweling and condition of the old structure, the description of the preparation work may include one or more of the typical examples listed. Include a good sketch, with dimensions, for the contractor's (and fabricator's) use when the plan and condition of the existing structure and the new work are difficult to describe in words.
2. Do not make any field changes to box culverts without approval from the designer.

L. Staking Culverts And Structures

1. The centerline of culverts shall be indicated by hubs driven on the centerline and offset at such distance from the end of the structure as to protect them from disturbance. The elevation of tops of the hubs above or below the flow line grade at the ends of the culvert should be given, as well as the offset distance [usually 5 to 10 ft (1.5 or 3 m)] from the hub to the end of the new culvert. Guide stakes shall be set in all cases, giving the necessary information relative to the hubs.
2. Hubs for the alignment of headwalls may be placed on each side of the culvert on the line of the headwall face with the guide stakes clearly indicating the face staked. If the culvert has angling wingwalls, it is suggested that stakes be set marking such angle.
3. The centerline of bridges and viaducts may be indicated by hubs driven on the centerline at pier or bent locations and also on centerline of the structure, offset each way from the pier or bent locations. Pier angles shall be turned with a transit and hubs driven on their centerline at such distances as to protect them from disturbance. If possible, three hubs shall be driven on each side of each pier line. Type "E" or specially prepared 2 to 4 inch (50 to 100 mm) stakes, depending on the soil conditions, should be used as hubs to provide stable reference points. All hubs shall be tacked for line and at least two hubs on each side for distance. Since the centerline hubs will usually be destroyed during construction, a based line should be staked both right and left of centerline.
4. Permanent benchmarks should be established at each end of the structure and intermediate points as required. All elevations and chaining should be checked and rechecked.
5. The purpose of this letter is to provide the District Construction Engineer and the Construction Division with information with which to cross check culvert lists. It is felt that the letter may also be of value to the Project Manager for future reference.

M. Land Survey Monuments

The Department is required by law to notify the county board before undertaking any work that may disturb or destroy any corners of land surveys. It is essential that notification be given the county surveyor so that he/she will have sufficient time to properly witness all corners before work is begun. In the event that there is no county surveyor, or the county surveyor is not willing to perform the work, the Project Manager is responsible to schedule a registered land surveyor to perpetuate a monument.

N. U.S. Survey Monuments

1. Occasionally, benchmarks, triangulation stations, or other monuments of the U.S. Geological Survey or the National Geodetic Survey are located within the limits of construction and must be relocated. Such monuments must not be disturbed until specific permission is received from the director of the survey involved.
2. As soon as it becomes apparent that a monument of this type must be relocated, a letter shall be sent to the director of the appropriate survey, stating the necessity for moving the monument giving its designation and requesting instructions regarding the procedure to be followed in moving it. The condition of the monument and its location with respect to section, range, township, county and nearest town should also be included in the letter. The designation consists of letters and numbers stamped with dies on the disk. It is desirable that a rubbing of the disk be submitted also. The address to use for benches and landmarks is:
Director, National Geodetic Survey
601 East 12th Street, Room 1436
Kansas City, Missouri 64106

or

Central Region Engineer
U.S. Geological Survey
Rolla, Missouri 65401
3. A rubbing may be made by placing a piece of light or medium weight paper over the disk and then rubbing over the paper with a pencil, preferably a hard one, to bring out the legend case in the disk and any letters or numbers stamped on the disk with dies.
4. Upon receipt of this information, the director will provide for relocation by their forces or will authorize you to move the monument and furnish a new disk to be used in the relocated monument and instruction to be followed in its relocation.
5. The new monument shall be established strictly in accordance with the director's instructions. The old disk and all notes and information requested shall be transmitted to the director immediately after the monument has been relocated. Extreme care and accuracy shall be exercised in all measurements and work performed and reported so that the accuracy of the original monument may be preserved.
6. It is important that the necessity for moving such monuments be reported promptly when it becomes apparent that they must be disturbed so that delays in construction work due to waiting for permission and instructions from the directory may be avoided. The work of relocating such monuments should be performed promptly upon receipt of the necessary authorization so that the survey office may have definite information regarding the status of the monument at the earliest possible date.

O. Preserving, Perpetuating And Witnessing Land Survey Monuments

1. Preserving Land Survey Monuments – In the course of construction operations, it frequently becomes necessary to remove, or cover with embankments or surfacing, section corners or other land subdivision corners. Due to the fact that so few counties maintain county surveyors, considerable expense is incurred by the department each year in locating corners necessary in acquiring right-of-way. In order to preserve all corners and avoid additional expense in relocating the corners when additional improvements are contemplated, Project Managers are requested to take precautionary steps to preserve all existing corners during construction and to establish permanent markers and witnesses after the work is completed.
2. The county board is required by law to “cause to be perpetuated the existing corners of land surveys along the public roads and highways where such corners are liable to destruction, either by public travel or construction or maintenance.”
3. In order to comply with the law and cooperate with the county surveyor or Project Manager, the District Engineer will notify the county board in writing at least 120 days prior to construction, listing locations of land survey monuments which are within the construction limits. This notification shall be given on all construction projects including pavement resurfacing (except gravel). Copies of the notification shall be sent to the Deputy State Surveyor in the Roadway Design Division and the Construction Division.
4. Where corners have been located by the county surveyor or deputy state surveyor and properly witnessed, it shall be the responsibility of the Project Manager to protect the witnesses during the construction of the project. The Project Manager shall cooperate with the county surveyor by furnishing information regarding the proposed limits of construction so that witnesses may be placed in locations that will not be disturbed. The county surveyor should be notified promptly if it becomes necessary to disturb any witnesses or if witnesses are discovered during construction. Prompt notification in such instances may avoid inconvenience to the county surveyor. The land surveyor who witnessed the land corners prior to construction should be notified. Do not notify deputy state surveyors since they will be unable to return to the project.
5. The contractor is required by *SSHC Subsection 107.09* in the specifications to “protect carefully from disturbance or damage all land monuments and property markers until the Project Manager has witnessed or otherwise referenced their location and shall not remove them until directed.” The Project Manager shall cooperate with the contractor and advise of the location of all monuments which have been located and properly witnessed, marking the location of all witnesses by lath or in some other satisfactory manner and advise regarding any other location where monuments have not been located and where particular care should be exercised in excavating to avoid disturbing the monument if it is uncovered.

6. On resurfacing projects, the written notification directed to the county board shall be considered to have fulfilled the Department's obligation unless the county is not willing or cannot perform necessary work and time and personnel are available to perpetuate known monuments.
7. In the event that the county does not have a county surveyor or the county surveyor is not willing to perform the work, the Project Manager is responsible to get a registered surveyor from the Deputy State Surveyor's Office to set a temporary witness to preserve the location of all existing land monuments during construction and record such temporary witnesses in the project records.
8. After construction, permanent corner markers and witnesses can be established to preserve the location of such monuments. Only existing monuments need to be witnessed since lost or obliterated corners have no status unless their location is established by a registered land surveyor. It is anticipated, however, that when right-of-way is acquired, monuments will be found at all land corners since the Right of Way Division is attempting to have the location of all lost or obliterated corners established by the county surveyor or a deputy state surveyor before construction is begun. In order to avoid confusion in the records, it is important that the following instructions be carefully observed.
9. At some time before construction begins, the county surveyor, if available, should be contacted to determine whether all land corners on the project have been located and witnessed by permanent objects which are on record in his/her office. If witnesses are shown in the plans, they should be compared with those on record and any errors in the plans corrected. Information omitted from the plans should be entered thereon. The witnesses can then be inspected in the field. If it is found that any of the witnesses have been disturbed, or are within the limits of construction, or are in locations where they cannot be protected during construction operations, the county surveyor shall be requested to establish additional witnesses in protected locations.
10. If the county surveyor neglects to set adequate witnesses or if a county surveyor is not available and the witnesses shown in the plans have been disturbed or are inadequate, the Project Manager will be responsible to get a registered land surveyor to establish temporary witnesses to preserve the location of all existing corner monuments. These witnesses shall be set in the same manner as that later prescribed for establishing permanent witnesses, except that they may be set in any protected location without specific relation to right-of-way lines.
11. During construction operations, existing stones or monuments shall not be disturbed unless absolutely necessary. Should construction require disturbing a stone or other government survey monument, the deputy state surveyor in the Roadway Design Division should immediately be contacted before the stone is disturbed. The procedure to be followed in this situation will vary with the situation and the circumstances, however, the deputy state surveyor should be consulted before a government land corner is destroyed. Original monuments which will be under proposed embankments shall not be disturbed and every effort shall be made to protect them during construction operations.

12. If more than one monument is discovered for a land survey corner, the county surveyor and the deputy state surveyor should be contacted so that he/she may determine which marks the legal corner. In the event a county surveyor is not available, both monuments should be witnessed and a detailed description of each monument submitted to the Right of Way Division. In such instances, a very careful examination should be made of the surrounding soil for evidence of any deposit originally placed with the monument and charred stakes or pits and mounds which may have existed when the corner was originally established. These descriptions will be submitted to the state surveyor for a ruling as to which monument marks the legal corner.

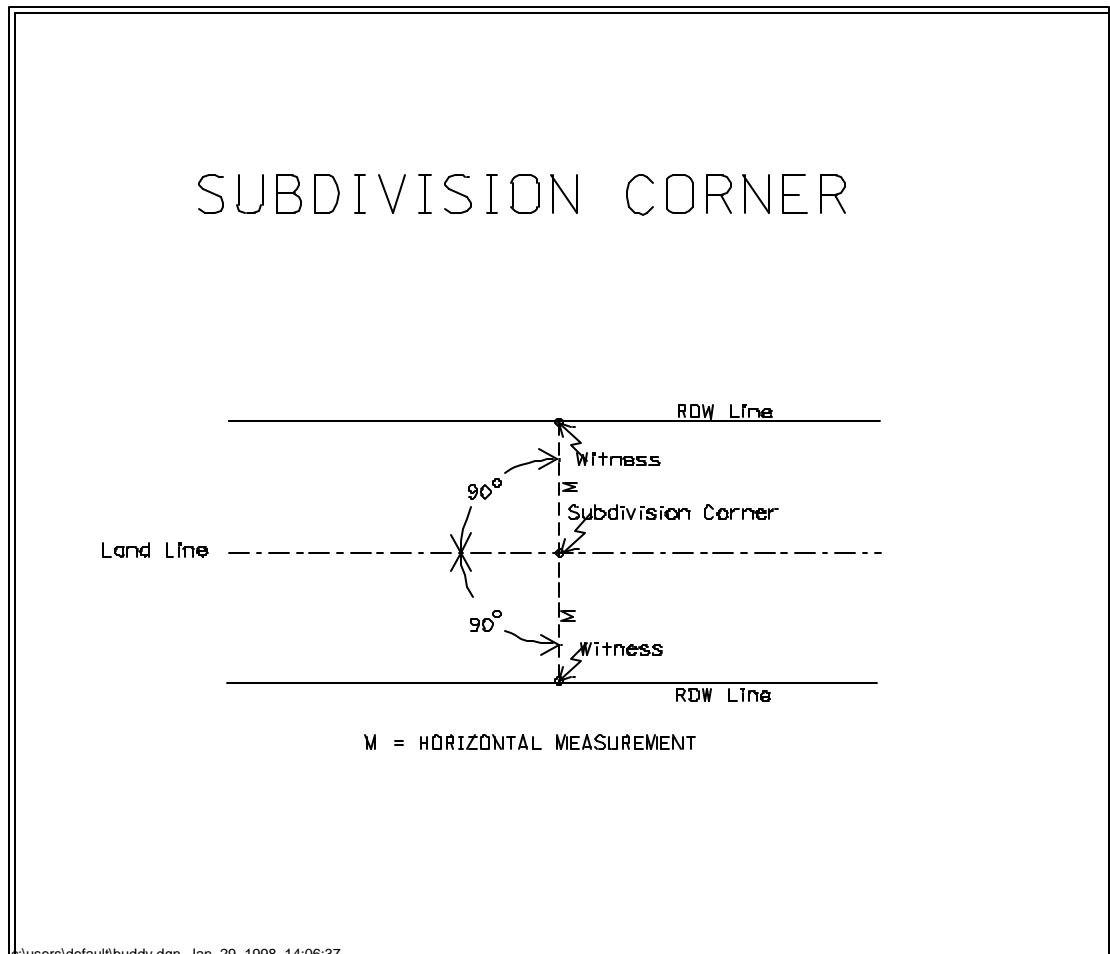
P. Perpetuation Of Section Corner Markers

1. After the work on the project is completed, permanent corner markers shall be established. If a county surveyor has not been handling the work, the Project Manager is responsible to schedule the deputy state surveyor to perpetuate section corners using measurements from the temporary witness corners previously set.
2. Permanent corner markers set by a registered land surveyor shall be $\frac{1}{2}$ inch (12.5 mm) or $\frac{3}{4}$ inch (19 mm) round steel bars at least 2 ft (600 mm) in length. If monuments are set below paved surface, a hole will be dug each time a corner is needed. Angle irons are also suitable. They shall be driven plumb to an elevation 6 inches (150 mm) below the road or ground surface. Corner markers in bituminous pavement shall be driven to an elevation approximately 2 inches (50 mm) below the surface and any depression filled with bituminous material.
3. Corner locations covered by concrete pavement shall be preserved by taking a core and setting the marker in the core hole flush with the surface of the pavement. The hole in the pavement shall be filled with concrete in the same manner as other cores.

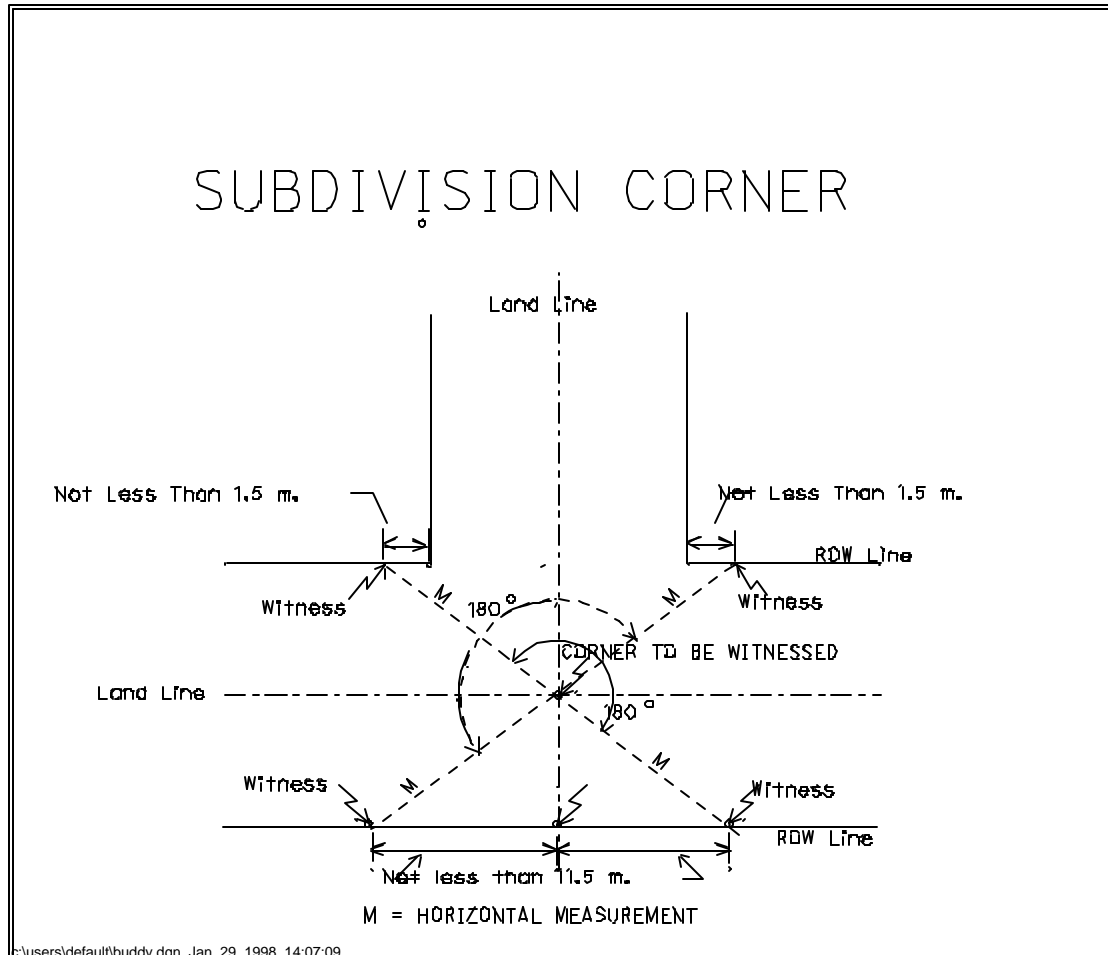
Q. Setting Witness Corners

1. Permanent witness corners to be set by the Project Manager shall be steel bars, angle irons or old grader blades. Steel bars and angle irons shall be driven flush with the ground surface and marked with an oak guide stake. Grader blades shall be approximately 4 ft (1.2 m) in length and set with 2 ft (0.6 m) of the blade below the ground surface. Witness points shall be set with a transit over the corner to be witnessed. The horizontal distance between the corner marker and the witness shall be measured and recorded. If right-of-way markers are in place, they may be used as witness corners and the section corner tied to the near corner of the right-of-way marker.

- Four witnesses shall be set for each section corner and for each subdivision corner located at an intersection of the project and other roads or streets. They shall be set on the Department right-of-way line not less than 5 ft (1.5 m), back of the right-of-way lines of the intersecting roads or streets. Witnesses for section corners not located at an intersection of the project with another road or street shall be set on the Department right-of-way lines not less than 38 ft (11.6 m) (if possible) from the intersecting landline.



- Two witnesses shall be set for each subdivision corner, except those located at an intersection with another road or street. They shall be set on the Department right-of-way lines at right angles to the land.



4. A "Section Corner Tie Sheet" DR-70 shall be prepared for each corner perpetuated by the Project Manager. Three copies shall be submitted to the Deputy State Surveyor by the Deputy State Surveyor employed by this Department. The Deputy State Surveyor shall forward one of these copies to the State Surveyor, and forward one to the county for their records. Signatures and addresses of two local residents observing the perpetuation of the corner markers and establishment of witnesses should be secured as witnesses. In the event local residents are not present, signatures and permanent addresses of other members of the party shall be secured as witnesses.

R. Installation Of Right-Of-Way Markers

The Department's right-of-way marker is international orange reinforced concrete block. See *SSHC Section 913*.

S. Location Of Markers

1. Right-of-way markers shall be set accurately on the following points:
 - At each break in the right-of-way line.
 - At apparent intersections of railroad or county right-of-way line.
 - At beginning and end of each curve plus intermediate points on long curves where necessary
 - At apparent intersection of government land lines.
 - At apparent intersection of street right-of-way lines.
 - At lot line intersections if lot corner was in place prior to construction.
 - Refer to Table 1300.4 for stake placement intervals.
2. Block corners at city street intersections must be referenced out if available. This will simplify setting a pin on the apparent intersecting street right-of-way line and projecting the new right-of-way line from street to street for proper location of sidewalks or retaining walls.

T. Benchmarks

1. During construction of a highway project, many benchmarks may be destroyed and alternate ones must be selected for future use. A permanent benchmark should be established at approximately ½ mile (0.8 km) intervals along the highway route in rural areas. Bridge abutments are good locations for permanent benchmarks. Headwalls of culverts have also been a favorite place for benchmark locations, but a certain amount of settlement may take place during the first year in a new culvert and may result in erroneous benchmark elevations. Best results can usually be obtained by establishing a benchmark circuit after initial settlement has been completed, normally one year after construction. After elevations are established on the new benchmarks, a DR Form 70 should be completed and filed with the survey coordinator or the District office.
2. Utility poles, fence posts, ends of drainage pipes, and railroad rails should all be avoided since these objects tend to be disturbed by frost, wind, and farming operations. Casting of a permanent concrete monument within the right-of-way appears to be the best solution in the absence of some other stable, permanent object.

3. Establishment of permanent benchmarks should be considered near the end of every major grading and paving project. Monument location should be at the direction of the Project Manager. Occasionally, the Project Manager will have cast-in-place concrete monuments placed by contractor and paid by extra work order. Standard brass shall be provided by the Project Manager to be set in plastic concrete.
4. Locations for permanent benchmarks in urban areas include fire hydrants, concrete sign bases, and other permanent objects. Interval of benchmarks should be established at about one per city block.

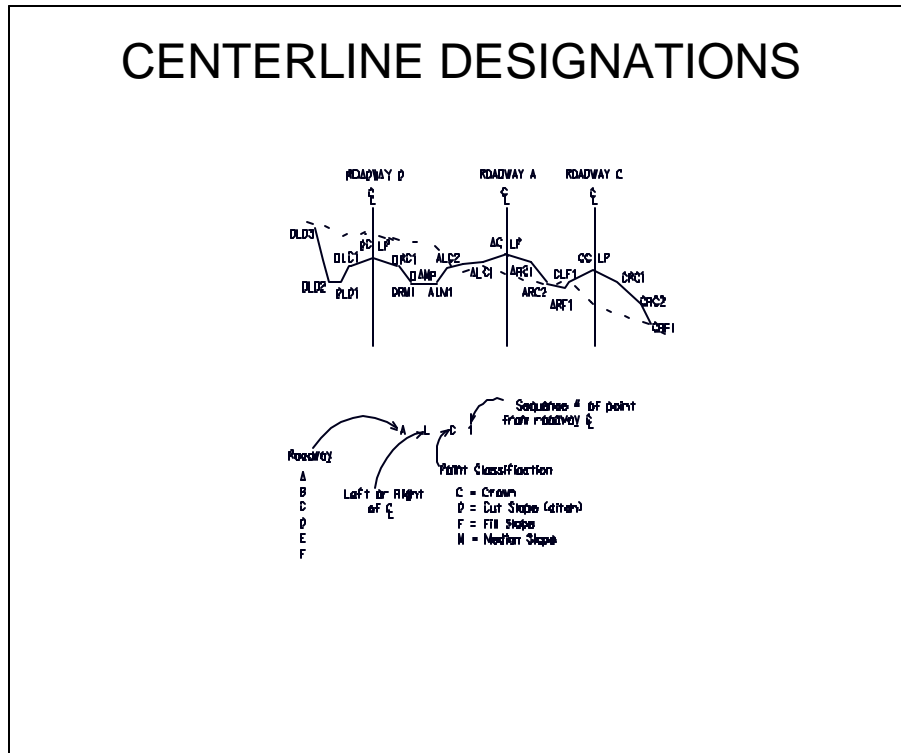
U. Permanent Benchmarks Along Rural Highways

1. Permanent cast-in-place concrete benchmarks should be constructed using the following guidelines. These should be considered minimum dimensions:
 - Excavate a 1 ft (300 mm) diameter hole 5 ft (1.5 m) deep.
 - Insert a #6 English (#20 metric) size diameter reinforcing bar in the center of the excavation.
 - Place concrete around reinforcing bar to a depth of approximately 2 inches (50 mm) below ground elevation.
 - Finish concrete so surface is slightly rounded.
 - Insert a brass cap in center of plastic concrete.
2. Monument shall be tied to construction centerline by station and distance and recorded on "as built" plans.
3. The DR Form 70 is required to report and describe all permanent benchmarks on any construction project. "Bridge Plans" include details for placing benchmarks, (brass caps), at bridge ends. (A district file with copies of these forms is recommended.)
4. All permanent benchmarks must be tied into the highway reference system and this information included on DR Form 70.
5. The benchmark's DR Form 70 shall be sent to:

Nebraska Department of Roads
Roadway Design Division
Mr. Ken Hartwig, Preliminary Surveys
P.O. Box 94759
Lincoln, Nebraska 68509-4759
6. A district file of copies of these forms is also recommended.
7. A computer file of these permanent benchmarks will be maintained and the highway reference post system will be used to identify the benchmarks.

1300.04 TAKING PRECONSTRUCTION CROSS SECTIONS

- A. Preliminary Survey Requirements: The designer and the District will work together to determine the “Preliminary Survey Requirements”. The requirements can vary for each project.
- B. Preliminary Survey with Data Collector/GeoPak – When the preliminary survey is put in a “Husky” or some other Data Collector and loaded in **GeoPak**, then preconstruction cross sections can be taken mathematically at any plane.
- C. Preconstruction Cross Sections. The preconstruction cross sections will, in most cases, consist of additional and extended sections omitted from the preliminary survey. Cross sections must be taken wherever necessary to show the true excavation quality. Some of these points will include:
 - 1. Zero sections between cut and fill.
 - 2. P.C. and P.T. (T.S. and S.T.) of horizontal curves.
 - 3. Points where width of side ditch and borrow changes.
 - 4. Points where backslope changes.
 - 5. Points where width of roadway changes in cut section.
 - 6. Beginning and end of side borrow pits.
 - 7. Extending preliminary cross sections where necessary.
- D. Cross Section Accuracy. Cross sections shall be taken accurately, at right angles to the centerline, at known locations so that final cross sections may be taken at the same stations. Each section shall be an accurate profile of the ground at that location. The rod shall be held vertically and the tape shall be read to the nearest 1 ft (300 mm) from the centerline of the project. The rod shall be read to the nearest 1/10 foot (30 mm). All sections shall be taken both left and right of centerline and shall extend at least 10 ft (3 m) beyond the construction limits.



- E. Preliminary Cross Sections Used to Compute Final Quantities. When final quantities are to be computed in the field office and the preliminary cross sections are to be used as the preconstruction sections, the Project Manager should request the plotted cross sections by letter to the Construction Division. These cross sections should then be carefully checked to determine that they are of sufficient width to cover the construction limits. Preliminary cross sections are sometimes extended arbitrarily beyond the actual cross section limits when the project is designed in the Lincoln Office.
- F. Intersections. The Project Manager should take preconstruction cross sections on intersections occurring in excavation sections. These cross sections shall be taken at right angles to the intersecting road and may begin at the centerline of the project or at the right-way-way line. In either case, they should “close” on a cross section taken at right angles to the centerline of the project on each side of the intersecting road. The notes should include a complete sketch showing the following:
1. The station of the intersecting road or approach road.
 2. The location of the cross sections.
 3. Ties to the project centerline and to the approach road line extended.
 4. Angle of intersection.
 5. North point.

- 6. Station or plus of project cross sections on which intersecting road cross sections are to “close”.

- G. Other Excavation Areas – Channel changes and borrow pits that are not parallel to the centerline of the project shall be cross sectioned separately and tied to the project centerline in a manner similar to that described for intersections. Waste banks shall be cross sectioned if overhaul is involved. They shall be tied to the project centerline and haul routes shown.

- H. Cross Section Notes. Notes on intersections, channels, approaches, etc., are usually kept in a separate notebook. Cross section notes should be kept in a manner similar to the example in Division III. Do not crowd the notes.

1300.05 FINAL CROSS SECTIONS AND FINAL QUANTITIES

A. General

As a general rule, final cross sections are not required as long as the contractor has not disputed the plan quantities and any correction made during construction and agreed to accept the plan quantity as the final pay quantity.

B. Final Cross Section Guidance

When final cross sections must be taken, the following is provided as guidance:

1. Final cross sections may be taken on each 1 mile (1.7 km) as soon as the grading work on that 1 mile (1.7 km) section has been completed and accepted. Final cross sections may be taken while awaiting acceptance if the Project Manager is sure there will be no further work which might change the elevation of any excavation cross section.
2. Final cross sections must be taken at all points where a preconstruction or preliminary cross section was taken, if excavation was made at that point. If it develops that a final cross section must be taken at some plus station which has no preconstruction cross section, a preconstruction section must be interpolated at that point. The final cross section should extend well beyond the construction limits [5 to 10 ft (1.5 to 3 m)]. A rod reading should always be taken on the first definite "natural ground" and this information recorded in the notebook. In addition the surveyor must locate all breaks in each cross section and the maximum distance between shots in each cross section is 20-feet.
3. The excavation involved in undercutting slopes, ditches, borrow pits and shoulders in preparing such areas for the placement of topsoil is not measured for payment and final cross sections shall be taken after the topsoil has been placed.
4. The Project Manager must clearly separate each borrow pit quantity from one another. If the borrow pit is adjacent to the roadway excavation, the final cross section notes must include a rod reading at the R.O.W. line (shear section) and cross sections for the adjacent borrow pit must be separate from the roadway cross sections and computed separately.
5. The option pit block on the plans should be stamped participating and at the end of the detailed estimate breakdown of costs for each such borrow pit will appear. The borrow material costs will be computed in the Lincoln Office. These instructions are in addition to those required in Subsection 109.11, Paragraph V. of this manual.

6. On normal grading contracts, in which no changes in plans are made which would involve overhaul, final cross sections will not be taken for sections which include embankment only. However, when taking the final cross sections for excavation, centerline and shoulder shots should be taken on the embankment at each full station. At locations involving excavation only, or excavation and embankment in the same location, final cross sections shall be taken as necessary to include the excavation.
7. On linear grading contracts where the plans show a grade line elevation (not county agreement projects), the Project Manager shall take a final cross section at each station consisting of shots on centerline and each shoulder of the finished roadway. This may be done at the time the final check is made on the roadway surface to see that it meets the tolerance set forth in the specifications and/or special provisions, and should be submitted as part of the final records. On projects constructed under agreement by county forces, sufficient checks should be made of the finished grade to substantiate conformance with plans, specifications and special provisions.
8. Preconstruction surveys for rebalancing, or additional preconstruction cross sections might be necessary to determine pay quantities. Changes in plan or grade line which might involve overhaul cannot be anticipated during design or at the start of work. It is essential that preconstruction information be complete, so that if necessary, the final cross sections may be adjusted to reflect the existing ground elevations at the start of the project if different from the original preliminary cross sections.
9. When changes in plans involve overhaul, the final cross sections must include all embankment as well as excavation for the balance that the overhaul has occurred in. See Subsection 105.07 of this manual for additional instructions.

C. Earthwork Calculations

1. The final earthwork quantities on all in-house projects can be computed/verified via Microsoft/GeoPak. The Finals Section of the Construction Division can assist with or perform these calculations. However, the specific quantities and their location are necessary to verify or calculate quantities. There are two basic ways that projects are surveyed currently:
 - Total Stationing
 - Conventional Surveying

The Construction Division will convert conventional data to a Microsoft/GeoPak file to accomplish any quantity calculations. The following are required when requesting convention survey verification of quantities:

- a. Final cross section notes
- b. H.I. data

- c. Curve data
 - d. Surfacing data
 - e. Preconstruction cross section notes
 - f. Zero-zero sections
 - g. Interpolated cross sections
 - h. Width of preconstruction (preliminary) cross sections
 - i. Preparation and submittal of records
2. Field Notebooks
- a. Final Cross Section Notes – A special effort should be made to keep the notes clear and legible. Do not crowd the notes. Not more than four single line cross sections should be recorded on each page of a 4½ x 7½ inch (115 x 190 mm) field book. It is suggested that a 3H pencil be used in taking notes.
 - b. Notes should be recorded with the stationing reading from the bottom of the page to the top. If there is insufficient room for all readings on one line, the readings should be completed on the next line. The station of each line shall be shown. All shots must be recorded on the proper side of the centerline. See Division III of this manual for example.
 - c. Rod readings shall be expressed in ± 1/10 foot (30 mm) on dirt. Surfacing shots will be expressed in 1/100 foot (3 mm). Use a slightly elevated decimal figure in lieu of a decimal point. All plus rod readings shall be indicated by a plus symbol (+) preceding the reading. Horizontal distances shall be recorded to the nearest 1 ft (300 mm).
 - d. A cross section shall be taken at all equations.
 - e. Final roadway cross sections may originate on either the right or left side of centerline of the project. The cross section must have a centerline (zero distance) rod reading. This also applies to borrow pits or channels cross sectioned from a base (zero distance) line.
 - f. When it becomes necessary to take the final cross sections after completion of the surfacing work, sufficient room shall be left by the note recorder for inserting calculated rod readings. These rod readings will reflect the elevation of the typical grading section shoulder-subgrade point.

- g. Don't use any harder pencil than 3H. When the final earthwork computation listing sheet is returned to the field, the correction notes are to be reviewed thoroughly. All notes indicating further action are to be addressed at the field office.
- h. H.I. Data – The H.I. shall be shown on each page of notes near the location of the centerline shots. When one cross section has been taken from two or more H.I.'s, the portion of the section represented by each H.I. shall be clearly indicated.
- i. The Project Manager shall check the reduction of all H.I.'s with care. It is essential that the following details be recorded:
- (1) Six digits in the elevation shall be recorded for each H.I. entered in the notes such as 1225.75 or 0925.87.
- (2) If a correction in levels is made when "checking in " or turning on a benchmark, the correction shall be shown in the notes in the following manner.

$$\begin{array}{r} +5.20 \underline{0930.00} \text{ Correct to } - \text{ B.M. Elev. } 0924.80 \\ \wedge \\ -1.00 \qquad \qquad \qquad 0924.75 \\ \\ \underline{0925.75} \\ \wedge \end{array}$$

3. Curve Data – In order to permit the computation of corrections for curvature electronically, it is essential for a cross section to be taken at each P.C. and P.T., for each P.C. and P.T. to be properly identified and the degree of curvature to be shown in the notes for all simple curves. The direction of the curve shall be shown as right or left. The degree of the curve shall be recorded to the nearest hundredth of a degree (not degrees and minutes). The following example shows the proper method of recording information for a 2°25' simple curve to the left.

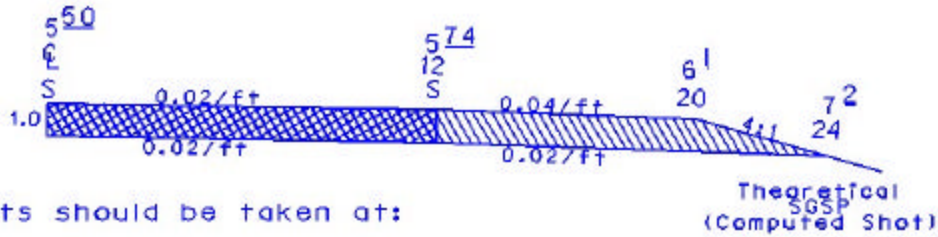
125 + 16.21 P.C. 2° 25'12" Curve	10 ²	10 ⁶	11 ³
Left			
	75	60	53
	OG	OG	

The correction for a spiral curve is applied near the mid-points of the spiral curvature. Accordingly, the cross section nearest the mid-points of spiral curvature for curves with spiral easements shall be designated by the Project Manager as the point to begin the curve correction.

D. Surfacing Data

1. Portland Cement Concrete Pavement – The Project Manager should take complete final cross sections after grading is complete prior to performing any surfacing structure work. If cross sections are taken after the surfacing is complete, the following three examples show where rod readings must be taken to reflect the excavation due the contractor in each instance. The letter “S” which indicates surfacing shall be placed under rod readings as shown in the examples. If pavement thickness, foundation course and surfaced shoulders are constructed other than as shown on the typical cross section of improvement sheet of the plans or the station limits are changed from those shown on this plan sheet, this information shall be shown in the notebook and also in the letter of transmittal.

Sufacing w/ Earth Shoulder English Concrete Pavement



Shots should be taken at:

- Centerline
- Edge of driving surfaces or at lane breaks for multiple lane roadways
- Edge of surfaced shoulders
- Hinge points
- All ground breaks - not to exceed 20' between shots

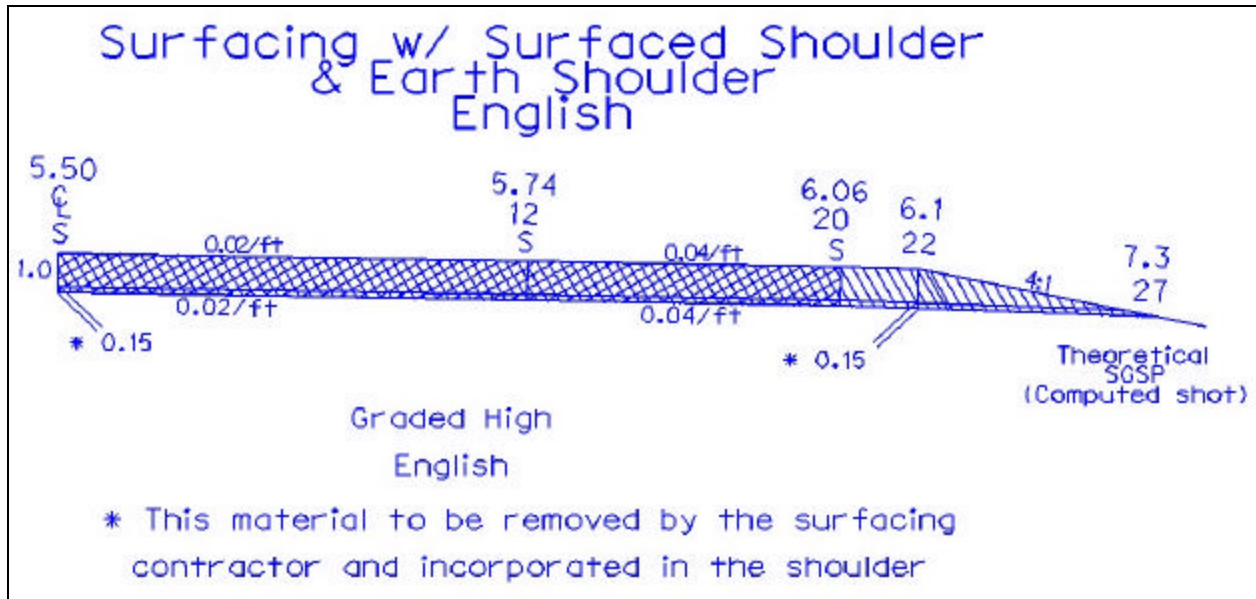
Theoretical Subgrade Shoulder Point (SGSP) should be computed and inserted into the x-section.

English

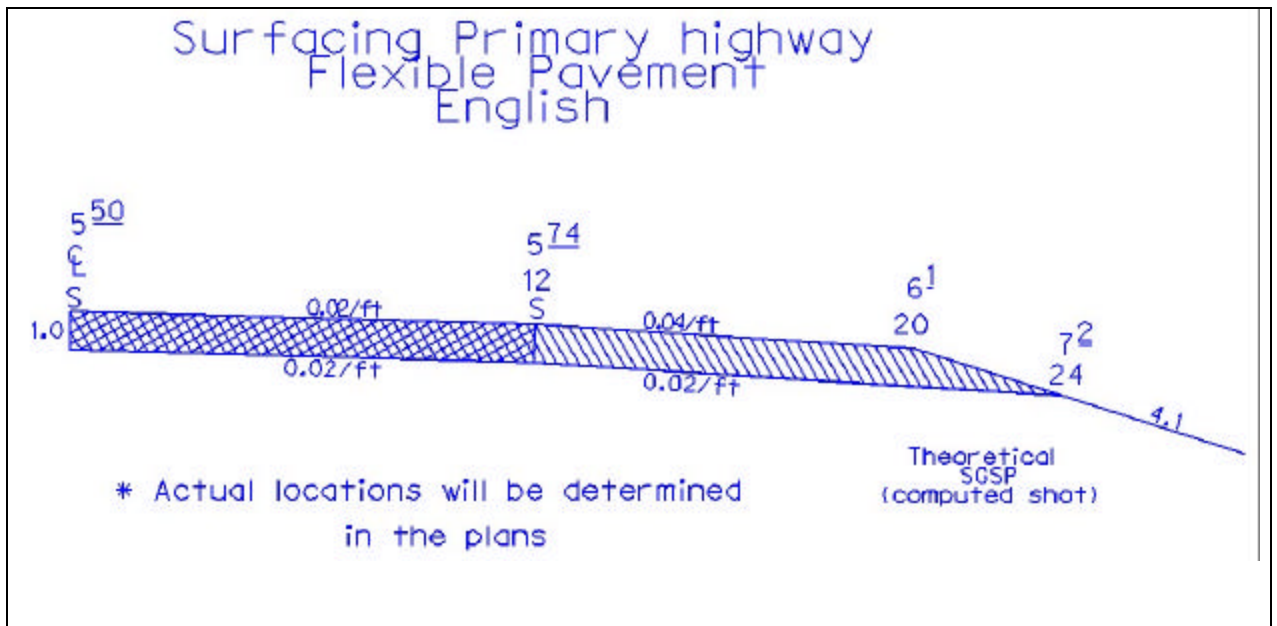
- Surfacing shots read to the nearest hundredth of a foot.
- Ground shots read to the nearest tenth of a foot.

Metric

- Surfacing shots read to the nearest thousandth of a meter.
- Ground shots read to the nearest hundredth of a meter.



2. Flexible Pavements (Asphaltic Concrete, Bituminous, and Base and Armour Coat Surface Courses) – The Project Manager should take complete final cross sections after grading is complete prior to surfacing and shoulder construction. When cross sections are taken after the surfacing is complete, all rod readings taken on the surfacing shall be identified with the letter “S” (indicating surfacing) under the distance. If the surface structure is constructed other than as shown on the typical cross section of the improvement sheet of the plans or the station limits are changed from those shown on this plan sheet, this information shall be shown in the notebook and also in the letter of transmittal. The following sketch shows the rod readings and distances required on the roadway for a 7.3 m (24 ft) asphaltic surface course constructed directly on the subgrade.



3. Any rod readings, other than those shown in the above sketch, necessary to show additional excavation required to be made in constructing variable width surfacing shall be taken, recorded and identified by the letter "s" under the rod reading. One such case would be at channelized intersections.
4. Rod readings beyond the shoulder will not be necessary in embankment sections unless the elevation of the subgrade is below the grade line of the existing embankment prior to grading (locations where the old embankment is lowered or cored out to place a subbase or base course) or it is necessary to accurately determine the quantity of embankment in order to compute overhaul.
5. The Project Manager will be responsible for inserting the shoulder rod readings into the final cross sections.
6. Two (2) methods will be used to determine the shoulder point:
 - a. Slope Stake Data (preferred)
 - b. Theoretical Shoulder Point

(The Project Manager will state, in the transmittal letter, what method(s) was used and where.)

E. Shoulder Construction

1. On both rigid and flexible pavements, the quantity of material required for the earth portion of the shoulder construction will usually be either subsidiary to the subgrade preparation work or measured for payment as "Shoulder Construction". Accordingly, the excavation for the shouldering material is not a pay item. The Project Manager should take complete final cross sections after grading is complete and prior to surfacing and shoulder construction. If final cross sections cannot be taken until shouldering is complete, the quantity of excavation for shoulders should be deducted from the excavation pay quantity. If possible, this deduction should be computed by cross section method of material at the source. When it is not possible to cross section the material at the source, the volume may be computed by using the typical section for shouldering and multiplying by a balance factor of 1.35. If the typical cross section provided for the subgrade to be graded "high" and the material trimmed is to provide the shoulder material, no deduction is required.
2. Topsoil Placement – When the plans provide for topsoil placement as a part of the grading construction, final cross sections should be taken after the topsoil has been placed. This is in accordance with Subsection 929.04 of the specifications which provides no payment for undercutting the topsoil placement.

F. Preconstruction Cross Section Notes

Where preconstruction cross section notes are taken to supplement or replace preliminary cross sections, this fact shall be noted in the letter of transmittal. Give the book and page number location of such notes. The letter of transmittal shall also contain the book and page number location of all extensions to preconstruction and preliminary cross sections.

G. Zero-Zero Sections

The location of zero areas for cut may be shown in the notes without taking a final cross section when there is no cut whatever at the location. Examples: (1) Cut on Lt., C=00 Rt. take final cross section of Lt. (2) Cut on Rt., C=00 Lt. take final cross section on Rt. (3) No Cut Rt. or Lt., C=00 Rt. or Lt., no final cross section is necessary.

H. Interpolated Cross Sections

Final cross sections for which a preliminary or preconstruction cross section is not included in the original notes shall be identified by a note in the final cross section book giving the location in the records where the interpolated cross section may be found. The necessary interpolation shall be made by the Project Manager before submitting the note to the Lincoln Office and shall consist of elevations and distances.

I. Width Of Preliminary And Preconstruction Cross Sections

The Project Manager shall check the preliminary cross section notes, the "Slope Stake Book" and his/her own preconstruction cross section notes to determine whether in all instances these cross sections extend at least as far from centerline as the final cross sections he/she has taken at the same locations. In instances where the preliminary or preconstruction cross sections are not as wide as the final cross section, it will be necessary to extend the preliminary cross section using other available information. This will usually consist of reference hub elevations, slope stake elevations, or as a last resort, the final cross section elevation. The data on which the closure is based shall be entered in the final notes on the left-hand page opposite the inadequate cross section.

J. Example Of Note. The note should show the elevation and the distance from centerline of the point to be used to extend the preliminary (preconstruction) cross section and the manner in which it was established as shown in the following example.

17 Extd. Prelim. to El. 55.6 @ 90 m Lt. S.S. Bk. No. 4
+50 Extd. Prelim. to El. 55.0 @ 90 m Lt. Final Elev.
16 Extd. Prelim. to El. 54.4 @ 100 m Lt. S.S. Bk. No. 4

K. Extension Made Without Note. When no preliminary cross section extension note is given by the Project Manager, the extension will be made by using the last final shot as the last preliminary elevation and distance.

L. Preparation And Submittal of Records

The elevations of all H.I.'s should be reduced and carefully checked to insure their accuracy.

1. The notes should not be reduced to show the elevations of the individual shots on the cross sections except where necessary to check closing shots.
2. The closing shots of all final cross sections in excavated areas shall be checked in the field office to verify closure with the preliminary survey. Cross sections normally will be closed on undisturbed ground. However, this ground often is a plowed field where 6-inch elevation differences are to be expected. Therefore the Department's tolerance on all cross section closures at or near the limits of construction shall be ± 6 inch (150 mm). Cross sections which do not close within these limits shall be field checked or explained by an entry in the final notes. If an error in the preliminary can be substantiated, for example, with slope stake elevations, then an entry correcting the preliminary cross section elevations should be placed in the final notes.
3. Notebooks shall be given a permanent number and completely indexed in the front to show the location of all data included therein. The project number and the name and address of the Project Manager shall be entered on the inside of the front cover.

4. Final cross section notebooks shall be prepared in accordance with these instructions and submitted to the Construction Division. Projects up to approximately 10 km long shall be submitted in their entirety. Projects over 10 km may be submitted in two sections if this will speed up the processing of the final records. If the preliminary notes are at the field office, those stations covered by the final cross sections being submitted shall also be sent to the Construction Division. Final notebooks will not be returned to the field unless specifically requested by the Project Manager. The data submitted to the Construction Division shall be addressed as follows:

Department of Roads
Construction Division – Finals Section
1500 Hwy 2
P.O. Box 94759
Lincoln, Nebraska 68509-4759

M. Plotting Cross Sections

1. Microstation/GeoPak may be used in lieu of hand calculations.
2. Final cross sections need to be plotted only on those projects not designed under the computer program or those portions of projects (channels, borrow pits, intersections, etc.) which are being computed in the field office.
3. For those projects computed in the field office, after checking all H.I.'s, the preconstruction and final cross section notes are reduced and checked. The points are then accurately plotted on cross section paper using a scale of 1 inch=5 ft (25 mm equals 1.5 m) vertically and 5 ft (1.5 m) horizontally, or 5 ft (1.5 m) vertically and 10 ft (3.0 m) horizontally. All plotting should be checked by reading the elevations and distances back from the cross section sheets. Preconstruction cross sections shall not be inked.
4. The final cross sections for excavation only are plotted over the preliminary or the preconstruction cross sections using the same coordinates and drawing in the final with a dashed line.

1300.06 CONTRACTOR FURNISHED CONSTRUCTION SURVEY

- A. Construction Staking And Surveying As Contract Item. On projects with “Construction Staking and Surveying” included as a contract item, the contractor is responsible for construction staking. The prime contractor may subcontract this item.
- B. Additional Survey Work Payment. Additional survey work required because of plan revisions or changes directed by Project Manager shall be paid for as extra work according to *SSHC Subsection 109.05* or be done by the Department.
- C. Contractor’s Responsibilities Include:
- The Contractor’s Surveyor must comply with the minimum requirements in Tables 1300.1 through 1300.5 and all other surveying requirements in this manual.
 - Provide survey data in a format that is compatible with GeoPak.
 - Stake right-of-way, temporary easements, and right-of-entry reference.
 - Preserve and reestablish all centerline control points-point of curve (PC), point of tangent (PT), point of intersection (PI), and point on tangent (POT); and all spirial points (TS, SC, CS, and ST).
 - Establish relocation centerline and related points, including extensions of cross sections, if not established in field by time of advertising for bids.
 - Staking culverts, bridges, sewers and all other structures and pavement requirements.
 - Perform a level circuit to check benchmarks prior to start of construction. Report the results of this survey to the PM immediately upon completion.
 - Stake right-of-way break points.
 - Establish permanent benchmarks and permanent ties to all required points. A copy of all ties must be provided to the Project Manager.
 - Reestablish land corners and section corners. If this is pay item in the contract then this is a contractor requirement.
 - Section corners are usually reestablished by the county.
 - In rural areas the property corners are usually not reestablished by a registered land surveyor.
 - In urban areas property corners are reestablished by a registered land surveyor and this is a separate pay item.

D. Department Responsibilities:

- Take elevation reading of settlement plates.
- Perform work identified in the special provisions of the contract.

E. Special Attention Items

1. The Project Manager should be notified and/or consulted for guidance if the following conditions occur:
 - Proposed culvert is staked and its location does not fit existing ground elevations.
 - Conflicting conditions occur such as existing water line located at same location as the proposed sewer line.
 - Farm subdrains are present. Contractor will determine their location, size, and elevation. The Project Manager will establish final size, location, and elevation for construction of tile line to be staked by the contractor.
 - Slope stakes do not match design cross section.

F. Documentation

1. Field notes are to be kept in the bound field books. After project completion, field books become the property of the Department.

G. Contract Administration

1. By Specification, "construction survey" is identified as a "specialty item."
2. "Construction survey" is considered a professional service, therefore Davis-Bacon requirements do not apply.
3. If survey work is performed by someone other than the contractor, a "Subcontract Request and Approval" form shall be submitted. All requirements of subcontractors are to be fulfilled with the exception of Davis-Bacon requirements.

1300.07 ENGINEERING EQUIPMENT, SUPPLIES AND SERVICES

A. General

Engineering equipment and supplies are a significant annual expenditure of the Department of Roads. It is Department policy to maintain equipment in reliable condition, supplies in adequate amounts, and that expenditures be controlled. All employees are expected to support this policy.

B. Responsibility

1. The employee is charged with full responsibility for the care of all equipment issued to him/her. The employee should instruct assistants in the proper care and handling of all equipment, particularly the more delicate equipment such as transits, levels, balances, etc. When accepting responsibility for an instrument, whether new or old, the person should inspect it carefully and make sure that it is in good conditions and complete when received. When returning an instrument, all missing or damaged parts should be reported.
2. The employee is held directly responsible for the loss or damage of equipment in his/her charge caused by negligence or carelessness and may be required to pay for repair or replacement of this equipment. Equipment when not in use should be stored in a place where it is secure from damage or loss. When equipment is left in an unattended automobile, the vehicle should be locked to prevent theft or damage.

C. Engineering, Surveying And Testing Equipment

A supply of this equipment is maintained at Logistics. Equipment will be issued directly to the employee as ordered and approved by the District Engineer or Division Head. Equipment which is no longer needed should be returned to Logistics.

D. Requisition And Transfer

1. The following example cases are given to explain the procedures to be followed. If your question is not answered, contact the Logistics Division.

Case I - Requests for Engineering, Surveying and Testing Equipment listed in the Department's Statewide Inventory System (SWIS) and included in the Supply Catalog in Class 59, are non-stocked items and must be budgeted by districts and purchased by the Logistics Division, Engineering Equipment Section.

Case II - Requests for Engineering, Surveying and Testing Equipment not listed on the Department's SWIS and included in the Supply Catalog in classes other than Class 59 will be ordered on a DR Form 146, Stock Requisition. Equipment not included in the Supply Catalog will be purchased on a DR Form 151, Purchase Order. It will be coded in the District/Division ONE and Activity 5099.

Case III – Material Sampling and Other Miscellaneous Supplies, sacks, cans, molds, lath, stakes, nails, field books, cloth, etc. included in the Supply Catalog will require a DR Form 146, Stock Requisition. Items not included in the Supply Catalog will require a DR Form 151, Purchase Order. These are “direct purchase” items and are to be charged to specific projects. “O” for participating, “I” for nonparticipating, the OE code for your District/Division and the appropriate activity (Constructing, Design, etc.).

Case IV – Office Supplies, Safety Gear and Medical Supplies included in the Supply Catalog will require a DR Form 146, Stock Requisition. Items not included in the Supply Catalog will require a DR Form 151, Purchase Order. These items are not “direct purchase” items and are to be charged to OE code for your District/Division and Activity 5099. Safety equipment is coded to AFE Y500.

Case V- Transfers of Engineering, Surveying and Testing Equipment listed on the Department’s SWIS between Divisions, Districts or returned to Logistics will be documented on DR Form 332, Furniture and Equipment Issue/Transfer. A DR Form 332 must accompany the equipment transferred. Logistics Division will always receive the original. The transferee, transferor and the Districts or Divisions will all receive copies. The transferee is responsible for submitting this form.

Case VI – Transfer of Engineering, Surveying and Testing Equipment not listed on the Department’s SWIS and in classes other than 59 to Logistics will require a DR Form 147 for cataloged equipment and a DR Form 147a for non-cataloged equipment. A copy of the form will accompany the equipment. OE code for your District/Division and Activity 5099 will be used.

2. All forms except the copies required to accompany the equipment will be routed through the District/Division Office and then to the Logistics Division.

E. Precautions And Maintenance Of Survey Equipment

1. Total Stations (Precautions)
 - a. Never place the Total Stations directly on the ground. Avoid damaging the tripod head and centering screw with sand or dust.
 - b. Do not aim the telescope at the sun. Avoid damaging the LED of the EDM.
 - c. Protect the Total Stations with an umbrella against direct sunlight, precipitation, and humidity.
 - d. Never carry the Total Station on the tripod to another site.
 - e. Handle the Total Stations with care. Avoid heavy shocks or vibration.
 - f. Always switch the power off before removing the standard battery.

- g. Remove the standard battery from the Total Station before putting it in the case.
- h. When the Total Station is placed in the carrying case, follow the layout plan.
- i. Make sure that the Total Stations and the protective lining of the carrying case are dry before closing the case. The case is hermetically sealed and if moisture is trapped inside, damage to the instrument could occur.
- j. Someone should always be near the instruments when it is set up in the roadway or in any other location where it may be disturbed.

F. Total Stations (Maintenance)

- 1. Wipe off moisture completely if the instrument gets wet during survey work.
- 2. Always clean the instrument before returning it to the case. The lens requires special care. Dust it off with the lens brush first, to remove minute particles. Then after providing a little condensation by breathing on this, wipe it with a soft clean cloth or lens tissue.
- 3. Do not wipe the displays and keyboard or carrying case with an organic solvent.
- 4. Store Total Stations in a dry room where the temperature remains fairly constant.
- 5. If the battery is discharged excessively, its life may be shortened. If it is stored, it should have somewhat of a charge in it.
- 6. Check the tripod for loose fit and loose screws.
- 7. When removing the Total Stations from the carrying case, never pull it out by force. The empty carrying case should be closed to protect it from moisture.
- 8. Check the Total Stations for proper adjustment periodically to maintain the instrument accuracy.

G. Electronic Digital Theodolite/Transit (Precautions)

- 1. When the theodolite/transit is not used for a long time, check it at least once every three months.
- 2. Handle the theodolite/transit with care. Avoid heavy shocks or vibration.
- 3. If any problems are found with the rotatable portion, screws or optical parts (e.g., lens) send it in to the Engineering Equipment Shop.

4. After removing the theodolite/transit from the carrying case, close the case to exclude dust and moisture. Never place the theodolite/transit directly on the ground. (Attached dirt may damage the base plate and centering screw.)
5. Never carry the theodolite/transit on the tripod to another site.
6. Protect the theodolite/transit with an umbrella against strong sunlight and precipitation of any kind.
7. When the operator leaves the theodolite/transit, the vinyl cover should be placed over the instrument.
8. Always switch the power off before removing the internal battery on the theodolite.
9. Make sure the theodolite/transit and the protective lining of the carrying case are dry before closing the case. (The case is hermetically sealed; if moisture is trapped inside, damage to the instrument could occur.)
10. Someone should always be near the instrument when it is set up in the roadway or in any other location where it may be disturbed.

H. Electronic Digital Theodolite/Transit (Maintenance)

1. Wipe off any moisture if the instrument gets wet during operation.
2. Always clean the instrument before returning it to its case. The lens requires special care. Dust it off with the lens brush first, to remove minute particles. Then, after providing a little condensation by breathing on the lens, wipe it with a soft, clean cloth or lens tissue. (Theodolite only) when cleaning the display, keyboard and carrying case, never use any organic solvent (e.g., thinners).
3. Store the instrument in a dry room where the temperature remains fairly constant.
4. Check the tripod for loose fitting and loose screws.

I. Survey Levels (General Precautions)

1. Be sure to carry the instrument to the job site in the plastic case.
2. Handle with care.
3. Do not place the instrument directly on the ground.
4. After taking the instrument and accessories out of the plastic case, be sure to close the case cover to keep out dust and dirt.

5. Use both hands to hold the instrument when carrying it at the job site. Remember that when moving the instrument from one job site to another, it must be removed from the tripod for transporting.
6. If the instrument is left mounted on the tripod for any length of time, cap the objective lens and cover the entire instrument with the vinyl cover.
7. Be careful not to expose the instrument to direct sunlight and precipitation. If it gets wet, wipe it with a dry cloth before putting it back in the plastic case.
8. Store the accessories in the specified places in the case.
9. Use neutral cleanser or water to clean up the plastic case.
10. Someone should always be near the instrument when it is set up in the roadway or in any other location where it may be disturbed.

J. Survey Levels (Maintenance)

1. Moisture affects the surveying instrument. Completely wipe off any moisture if the instrument gets wet during surveying work.
2. After use, clean every part of the instrument before putting it back in the case. Breathe on the lens to moisten them and gently clean them with a lens cloth, a clean cloth (preferable, worn out cotton), or soft tissue paper.
3. The tripod shoes may become loose or the legs may become shaky due to faulty wing nuts when used for a long period. Check them periodically.
4. If foreign matter appears to have entered any movable parts or screws or when condensation or fungi appears on the lens, prisms, etc., in the telescope, put on work order and send in to Engineering Equipment Shop.
5. It is recommended to subject the instrument to annual or semi-annual checking and inspection to maintain the high quality necessary for your surveying work.

K. Adjustment Of Instruments

1. All instruments issued to Project Managers should be in proper adjustment when received from the Lincoln Office. They should, however, be checked for accuracy and necessary adjustments made at regular intervals. Adjustments should be made only by the Project Manager or a qualified member of the party who had been authorized by the Project Manager to perform such work. All adjustments should be carefully made strictly in accordance with methods prescribed in surveying handbooks. Any adjustment which requires dismantling must be made in the Lincoln repair shop.
2. All Total Station adjustments should be made in the Lincoln repair shop.

L. Transporting Equipment

1. Surveying equipment should be loaded into cars or trucks in such a manner as to minimize the possibility of damage. Leveling rods, range poles, etc., are easily damaged by rubbing or scratching against other objects. It is suggested that a holder be installed on the car for each of these articles. Level rods should be kept in a canvas case which may be ordered from Logistics.
2. Transits and levels should be carried in their cases when being transported by car or truck over any appreciable distance. It is good practice to provide a special protected holder within the vehicle for these cases. Instruments may be carried out of case over short distances if carefully held in someone's lap.
3. Equipment shall be placed in or on vehicles in the most "safe" position both for the equipment and for the operator and passengers of the vehicle. Employees are encouraged to conceive safe methods of transporting equipment. Any alterations, etc., to the vehicle must be made only with the approval of the District Mechanic.

M. Damaged Equipment

1. All damaged equipment listed in the Department's Statewide Inventory System missing (lost or stolen) is to be reported on DR Form 159.
2. Damaged equipment, especially surveying instruments, should not be used or motions tested to determine the extent of damage until it has been inspected in the Lincoln repair shop. This precaution is necessary for the reason that all damage to the instrument may not be visible. For example, after an instrument has had a fall, the delicate graduated edges of the plates may be seriously damaged by the slightest movement of the plates.
3. All damaged equipment, together with all worn or broken parts, should be promptly shipped to the Logistics Division for repair. Equipment returned to the Logistics Division for repair, adjustment or exchange must be accompanied by DR Form 124, Shop Work Orders. The action desired must be described on this form. The appropriate OE and Activity Coding shall be shown.

N. Shipping

1. If at any time it becomes necessary to ship an instrument, it should be packed securely in its case and arrangements shall be made through the District Construction Engineer for the transfer of the instrument to Lincoln. Total stations and electronic theodolites should be by truck or car and not be shipped.
2. Other equipment shall be carefully packed in the cases provided for that purpose. If cases are not provided, the equipment should be packed in a box or carton of ample strength for protection during shipment. All equipment should be sent to Lincoln in the same manner as transits and levels.

O. Care of Equipment

1. Cloth tapes, pie-tins and other items of similar nature are considered to be expendable equipment for the reason that they depreciate rather rapidly with normal use. The fact that these items are expendable does not relieve the employees of the responsibility for their proper care and conservation.
2. Rods and range poles shall be carried in protective coverings or in holders which prevent marring and scratching. To avoid breakage, they should never be used for any purpose except that for which they are designed.
3. Chains are easily damaged by kinking and by the action of traffic. When practical, a cloth tape should be used instead of a chain, especially if measurements are being made across the line of traffic. When wet or muddy, chains should be cleaned and dried before rolling. They should be cleaned, oiled and inspected occasionally and all kinks removed by hammering on a flat wood surface. Splices are available for use in repairing broken chains.

P. Salvage Of Equipment

1. Marred, broken or worn rods and range poles, badly kinked or broken chains, cut or torn cloth tapes, etc., shall be returned to the Engineering Equipment Repair Section for painting, repair or salvage. Many other items of equipment, usually considered expendable, may often be reconditioned for further use. District Construction Engineers should make periodic checks with Project Managers having such equipment. All broken or salvage equipment should be assembled at the District Headquarters Office and sent to the Engineering Equipment Repair Section using state transportation. The following items of equipment are considered to have salvage value:

Cylinder molds	Paving station numbers
Level rods	Stoves (gasoline and electric)
Range poles	Tapes, 100 ft, 200 ft, 300 ft [30 m, 60m, 90 m] steel
Sieves	Tapes, 50 ft (15 m) filler
	Tapes, 50 ft (15 m) steel, case

2. Also, any other broken or damaged equipment which the Project Manager believes has salvage value.

Q. Supplies

1. The Department policy is to have central procurement of supplies. The Supply Catalog lists the items usually stocked. The Supply Catalog can be accessed via computer terminal. Items not listed in the Supply Catalog may be ordered on DR Form 151, "Purchase Order". Be sure and list adequate description of the item desired.

2. The Project Manager shall prepare a stock requisition DR Form 146 for such office and field supplies as may be required for a reasonable length of time. Additional stock requisitions may be submitted as field supplies are depleted. The carrying of large quantities of supplies in the field office should be avoided.

R. Stakes

Construction stakes are stored at the Department's supply base in Lincoln. The following types of stakes are available and are listed in the Supply Catalog.

Class	Stock No.	Type	Dimensions	Package d	General Use
58	85700	"A" Oak	1" x 2" x 18"	50	Reference Stake; Blue Top
58	85705	"A" Oak	1" x 2" x 12"	50	Reference Stake; Blue Top
58	85712	"B" Oak	2" x 2" x 9"	50	Pavement Hub; Location Hub
58	85740	"C" Pine	1" x 2" x 16"	50	Reference Stake; Blue Top
58	85730	"D" Pine	½" x 2" x 16"	100	Lath; reference, guard and ROW stakes
58	85720	"E" Oak	2" x 2" x 20"	25	Reference Hub
58	09700	Lath	½" x 2" x 36"	50	Reference Stake; Lath

S. Local Purchase Of Services

Local services shall be processed for payment by the Project Manager by coding attachments and by indicating his/her approval signing and dating the bill. Coding attachments are DR Form 160 for all services except telephone bills and DR Form 57 for telephone bills. Chapter 4 of the accounting and DOR-1 80-9 should be reviewed.

T. Equipment Inventory

Equipment listed in the Department's Statewide Inventory System will be inventoried when requested by Logistics. The internal control and inventory of equipment not listed will be established by the District/Division.

U. Non-NDOR Equipment Calibration Policy

1. Highway Construction Work

This policy is applicable to all non-NDOR equipment used for the inspection of highway construction work under the jurisdiction of the Nebraska Department of Roads.

- a. NDOR will not provide calibration services for consultants, contractors, or other testing firms performing inspection work; however, the calibration must be performed by a commercial laboratory or business.

- b. All equipment shall be calibrated at least annually and at any other time when the results of tests are questionable or unreliable. (With the development of Nebraska's Quality Assurance Program for Construction, a set calibration schedule will be implemented for the various types of inspection equipment. This calibration schedule may be other than annual.)
- c. A "Certificate of Calibration" shall be available for inspection by NDOR personnel at any time. The "Certificate of Calibration" shall provide, at a minimum, the following information:
 - Serial number or identification number of the equipment.
 - Date of calibration.
 - Results of the calibration.
 - Name of the laboratory or company performing the calibration.
- d. NDOR inspection personnel have the right to verify the calibration of any inspection equipment owned by a consultant, contractor, or other testing firm by performing an independent calibration check. The decision to perform an independent calibration check rests solely with NDOR personnel and will not be performed on a request basis.

CHAPTER NOTES:

CHAPTER NOTES:

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Construction Division

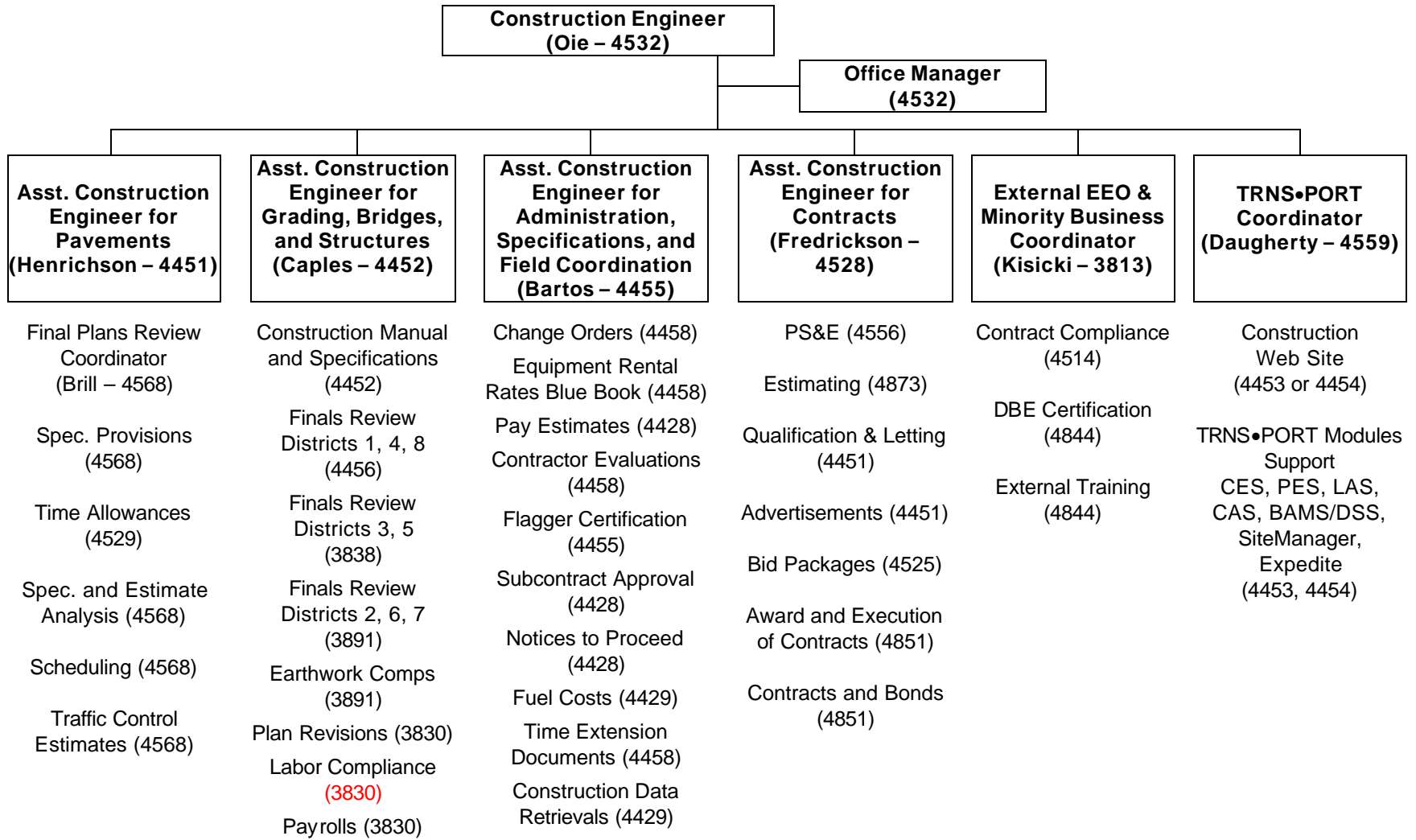
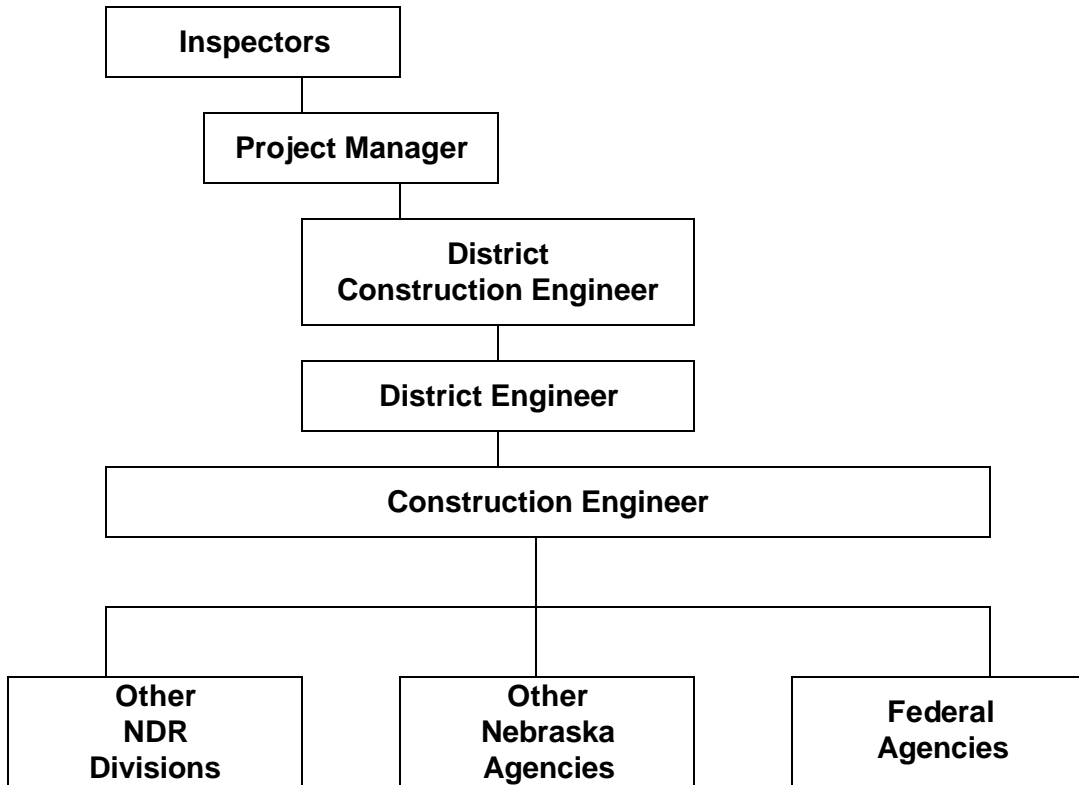


Figure 101.

101.04 CHAIN OF COMMAND

The normal chain of command for questions and business operations is as follows:



101.05 CONSTRUCTION ENGINEER

The Construction Engineer provides guidance to District Construction Offices to insure compliance with Specifications and established policies and procedures in the timely completion of NDR projects. The District Engineer, through the Project Manager, has direct responsibility for construction projects. The Construction Engineer is the next level of authority on approval of substantial change orders and the resolution of contract disputes when District Engineer decisions are appealed.

@

Interpretation of Specifications

The Construction Division provides consultation and advice on construction problems concerning the application and interpretation of Specifications and other contract requirements. Providing this guidance on a statewide basis is intended to insure uniform and fair contract administration.

@

102.09 CONTRACTOR (PARTNERING) RELATIONSHIPS (SSHC Section 113)

Under the contract system used in highway construction, contractors aim to perform the work contracted and NDR Engineers see that the work performed is done according to project plans and Specifications. Since these aims are essentially the same, Engineer-contractor relations should be conducted in a spirit of mutual cooperation within the framework of the Specifications and with the best interest of both contracting parties. Establishing a cooperative and collaborative working relationship with contractors may result in improved quality and fewer unresolved contract issues. This is the goal of "Partnering."

Contractors should do no less than required by contract, nor should they expect compensation for work done that was not required.

Good contractor relations can be promoted by keeping an open line of communication and advising contractors when they are doing unacceptable work before such work is completed.

- Good Project Managers know how the contractor should construct the project. They go out of their way to make sure the contractor starts each phase of construction using proper methods and the correct materials.
- It is 1,000 times easier to correct a subgrade problem with the grading crew than with the paving crew.

The most common construction problem is the contractor being notified after the fact that the work was not done according to the Specifications.

In general, relations with the contractor should be fair, firm, courteous, and based on sound judgment under the guidance of specification requirements.

102.10 FHWA & OTHER OUTSIDE AGENCIES RELATIONSHIPS

FHWA has oversight authority only. FHWA representatives have the right to examine any phase of work, including methods of testings, project records, material reports, etc., to review performance of State inspection personnel assigned to the project, and to check work for compliance with plans and specifications. Their responsibility or authority does not extend to supervising or directing Project Managers or contractor forces.

Reports covering their inspections are forwarded to the Construction Division and then are made available to the District Engineer and Project Manager.

Relations with FHWA personnel should be conducted in a spirit of cooperation and courtesy, extending any assistance or facilities available. The FHWA Engineer should be informed of anticipated plan changes or extra work when the value exceeds \$50,000.00, on full oversight projects (usually Interstate System with a contract value of \$1,000,000 or great).

@

Inquiries from other state or government agencies should be given prompt and courteous consideration.

102.11 EMPLOYMENT OF CONSULTANTS FOR CONSTRUCTION ENGINEERING AND INSPECTION

From time to time, and with increasing frequency, various governing bodies hire consultant services. Governing bodies could be cities, counties, or the State.

Agreement Responsibilities

Responsibilities of a consultant may be limited to providing professional advice to the governing body on the best means of satisfactorily accomplishing the work or may include specific project level engineering and/or inspection responsibilities. These guidelines will address engineering and/or inspection responsibilities. The consultant's contract should define respective authorities and responsibilities of the full-time publicly employed project administrator in charge of the project and consultant's staff.

Under federal-aid regulations, however, prime responsibility for general supervision of construction remains with the governing body. The state (county or city under agreement with state) cannot be relieved of its responsibility to insure that work is performed in accordance with project plans and specifications, even when we hire a consultant to do the inspection or design.

Project Manager

When a consultant has been engaged to provide engineering and inspection services, a Project Manager designated by the Department should also maintain working knowledge of the project.

The designated Project Manager is responsible for being thoroughly knowledgeable of day-to-day operations of both contractors and consultants providing the construction inspection/engineering services. Knowledge of day-to-day operations is construed to mean:

- Knowledge of current project status.
- Involvement in decisions relative to conditions which require change orders or supplemental agreements.
- Involvement in authorization of progress payments even though the consultant may furnish measurements or computation of quantities.
- Making periodic inspections, visits, or on-site reviews of the project; frequency dependent upon the magnitude and complexity of the project.
- The PM must verify that the consultant understands what records are required, how to record the data, and who can sign/verify each document. This is also true when a city or county does the project engineering.

102.12 PERSONNEL

102.13 EMPLOYEE POLICIES

Some of the personnel references that employees should read and follow include:

- Classified System Personnel Rules & Regulations
- Nebraska Association of Public Employees Labor Contract
- Employee Safety Manual
- Nebraska Department of Roads' Operating Instructions
- Davis-Bacon Act

102.14 STAFF REQUIREMENTS

A definite need exists to develop and maintain procedures to properly manage engineering staff requirements necessary for highway construction projects. Proper planning and staffing procedures provide the means to estimate staffing needs based on anticipated workloads.

Field Estimates

@ District Construction Engineers provide an estimate of staffing needs to the Deputy Director for each construction season. Each Project Manager analyzes their particular workload according to the production schedule, and District Construction Engineers collect and combine the data to determine minimum staffing for the upcoming construction season. These figures provide a guide for temporary employee hires (usually submitted in January or February each year).

Adjustments

@ As necessary throughout the year, the District Construction Engineers review their personnel requirements with the Deputy Director.

Field Personnel Duties & Staff Requirements

The District Engineer and District Construction Engineer are responsible for providing the Project Manager with a sufficient number of engineers and construction technicians to adequately and properly supervise and inspect the construction operations. The personnel furnished will have such education and experience, which, together with instruction, training, or direction by the Project Manager, will qualify them for the proper performance of the inspection or other duties assigned to them. It is the responsibility of the Project Manager to assign and utilize such personnel effectively and economically to obtain completed work of good quality and meeting the requirements of the plans and specifications.

102.15 SUBCONTRACTS

Subcontract Request And Approval

All subcontracts are subject to the requirements of *SSHC Subsection 108.01*, and FHWA 1273 (when included in the contract documents), and approval of contracting authority before they are recognized as valid. Subcontracts are required for independent trucking companies when hauling is covered by the provisions of Davis-Bacon wages (*Construction Manual 102.26*). Field forces shall not allow work to proceed without prior approval of the District Construction Engineer or District Engineer. Contractors are expected to make their application for subcontractor approval sufficiently in advance to allow time for processing and approval. On rare occasions, this may not be possible. Under these circumstances, a Project Manager may provide verbal approval provided the contractor has submitted a written application for approval of the subcontract. **If the contract has a DBE goal on it, you shouldn't assume the DBE subcontract has been approved just because their name appears in the subcontract area. One way to tell is to open up the subcontract record. If no approval date has been entered, the subcontract has not been approved.**

@

A. Contractor's Requirements

The prime contractor must initiate a letter requesting to sublet items in the contract. This letter must be sent to the Construction Engineer and shall include the following information:

1. Subcontractor's name, mailing address, and telephone number.
2. Prime contractor's identification number (used on employer's quarterly federal tax return, U.S. Treasury Department Form 941).
3. A check off indicating whether or not the subcontractor is registered with the Division of Labor.
4. Estimated starting and completion dates of the subcontractor's work.
5. Items to be subcontracted with descriptions, quantities, unit prices, and amounts of non-specialty and/or specialty items. Unit prices shown must be the contract unit prices except when "labor only" or "place only" items are subcontracted. In such cases, indicate that the "item unit price" is approximate.

When a subcontracted item is used to satisfy a DBE goal, the amount paid to a DBE must be shown and verified with signatures of the prime contractor and the subcontractor. These signatures will document the agreement for payment between a prime contractor and their subcontractor and eliminate the need for a copy of a DBE subcontract/agreement. Note the additional guidelines on the administration of DBE subcontracts that follow.

6. It has been common practice for subcontractors to include appropriate mobilization costs in their unit bid prices. Prime contractors may have encouraged this practice. However, adjustments in unit prices due to overruns or underruns will have to meet the test of "significant change".

To reduce the risk resulting from changes in quantities which are not subject to price renegotiation, appropriate use of the mobilization item for subcontractors is encouraged. On all subcontract requests, mobilization must be listed for the item even if the dollar amount listed/subcontracted is zero.

7. The Subcontract Request and Approval letter shall include the following statement: **"It is clearly understood by both the prime contractor and the subcontractor that all terms of the prime contract shall apply."** When "Required Contract Provisions" (Form FHWA-1273) are part of the contract documents, the prime contractor is responsible to see that a copy of this form is physically attached to the subcontractor's copy of all subcontracts. The prime contractor is responsible for fulfilling terms of the contract, including construction work completed by approved subcontractors, plus completing all required forms or reports. Refer to *SSHC Subsection 108.01* for requirements and limitations on contract subletting.

B. Project Manager Involvement

If a Subcontract Request is received by the Project Manager, it should be forwarded immediately to the Construction Division.

The Project Manager is responsible to make sure a subcontractor performs the kinds of work described in the approved subcontract.

Occasionally, contractors may have to rent additional equipment and hire extra employees to complete their work. However, when the entire crew and equipment of another contractor is used to complete the work, the prime contractor is violating the intent of *SSHC Subsection 108.01* and is considered brokering a project. If the District Engineer or the Project Manager observe work performed by anyone other than the approved subcontractors, the Construction Division should be notified. Assistance will be provided to investigate the circumstances.

At the preconstruction conference, it will be beneficial to discuss methods of keeping subcontractors informed of the work status. Although the prime contractor is responsible to make progress payments to a subcontractor, numerous incidents in the past have indicated a lack of timely progress payments from the prime contractor to the subcontractor. Subcontractors may review a copy of the "Contract Construction Progress Estimate" in the District office.

@

- C. Field Approval of Subcontract WorkThe **District Engineers** can approve a subcontract request for work up to a maximum amount of \$50,000 for each occasion. This is done on DR Form 42, "Field Approval of Subcontract Work.

There are some specific items that need to be kept in mind at all times when considering a request of the prime contractor to have certain work performed by subcontract. These are as follows:

1. The contractor being considered to do the subcontract work must have been approved by the Department to perform as a subcontractor. A contractor is considered approved if he/she is prequalified to bid work; or is presently a prime contractor on a current project; or is an approved subcontractor on a current project; or has performed subcontract work in the past under the same company name. This information is available on CICS-3.
2. The subcontractor being considered must have current insurance. This information is available on CICS-3.
3. The aggregate total of all work to be subcontracted cannot exceed 70 percent of the contract amount.

If you are not able to determine the status of any of the above or have a question concerning the completion of the form, please contact Steve Bartos or Sharron Magnuson (402-479-4455) in the Construction Division.

D. Exemptions from Subcontract Requirements

The following items of work may be exempted from the normal subcontracting requirements: (It should be noted, however, that these exemptions do not prohibit the contractor from executing a subcontract if he/she chooses to do so.)

Materials

1. Small amounts of asphaltic concrete. When small amounts of material are needed to complete the work, such as for wedges at bridge ends, tying into existing surfaces, etc., the contractor will be permitted to obtain asphaltic material (and placement) from another contractor's portable (or commercial) plant without the need for a subcontract.
2. Tack or prime oil. When small quantities and/or irregular areas are involved, the contractor may obtain this material from another contractor without the need for a subcontract. This exemption in no way relieves the contractor from furnishing material which meets the requirements of the specifications.

Equipment

1. Tree spading
2. Concrete pumping
3. Bump grinding. Equipment used for corrective grinding on asphaltic or portland cement concrete pavement may be hired without the need for a

Plan revisions will be mailed to the contractor as soon as they are issued. Contractors will be responsible for keeping their field representatives informed and supplied with such revisions. If contractors feel such revisions require extra work, they should immediately advise the Project Manager.

C. Wage Rates (Federal Aid Projects)

All wages paid must conform to wage and hour provisions prescribed in the contract. Crafts must be listed exactly as shown in the wage decision. Crafts not listed but needed shall be requested by the contractor through the Project Manager. Required payrolls must be submitted weekly and within seven days after the last day covered by the payroll.

It is suggested that the prime contractor collect, sign, and submit all payrolls of approved subcontractors, as a group, to the Project Manager.

The Project Manager may withhold progress estimates if payrolls are more than two weeks behind schedule.

D. Postings

The contractor shall be responsible for erecting and maintaining required postings as outlined in *Construction Manual* Subsections 103.21 to 103.24.

E. Stockpiled Material

If contractors want payment for stockpiled material, they should provide receipted bills showing the actual cost of the material stockpiled. For payment of stockpiled material, refer to *Construction Manual* 105.06.

F. All plants shall be labeled.

The information on each plant's label shall describe the plant's:

- (1) Botanical genus.
- (2) Species.
- (3) Common name.
- (4) Size or age.

Legible labels shall be attached by the nursery grower to individual plants, boxes, bundles, bales, or other containers to insure that all species and varieties are identified.

G. Subcontracting

1. On all projects, prime contractors must submit their subcontract requests to the Construction Division in a letter or FAX.
2. The prime contractor is responsible for EEO and minimum wage compliance by all subcontractors.
3. All subcontractors must be approved by the Construction Division prior to the subcontractor starting work.
4. In the event a prime contractor elects not to subcontract and instead "carry the people on the payroll", the District Engineer and/or his/her authorized representative may perform the following checks:
 - a. Request to see on a random basis and before distributing the payroll checks of the people in question.
 - b. Request a copy of the lease agreement on equipment to verify that compensation is on a time period basis rather than the amount of work accomplished.
 - c. Check material supplier invoices or billings to insure that the prime contractor is or will make payment for the materials used in the work in question.
 - d. Check the prime contractor's payrolls to determine if the people in question and their supervisor(s) are included on the payrolls.

H. Project Supervision

The prime contractor shall submit in writing, to the Project Manager in charge, the name of an authorized representative on the project. Representative will be empowered to coordinate with all operations of subcontractors and negotiate with the Project Manager any questions concerning extra work, including extra work performed by a subcontractor. If the prime contractor wishes, this representative may be a subcontractor's employee that is present when work on the project is being performed.

I. Weekly Report of Working Days

When working time is being charged, the Project Manager will prepare and furnish the contractor the "Weekly Progress/Working Day Report" showing working days charged that week. Objections to days charged must be made in writing by the contractor within ten calendar days after receipt of the report. Objections based on delays due to unavailability of materials should be accompanied by copies of orders placed, acceptance of orders, and promised dates of delivery. All other objections must be accompanied with documentation of the reason for objection. The Project Manager will respond to the objection, indicating acceptance of the claim or reasons for rejection.

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J. Right-of-Way

All parties are reminded that highway right-of-way abuts upon private property. Any infringement or trespassing upon such private property could cause damage that would become a liability to the person or organization involved. Maintaining good relations with the public (especially private property owners) is very important.

K. Safety

Contractor must comply with provisions of the Federal and State Occupational Safety and Health Acts.

L. Nebraska One Call Notification System shall be explained by the Project Manager. The Diggers Hotline of Nebraska phone number is 1-800-331-5666.

M. Contractor has 48 hours to file notice with county sheriff when burial sites are discovered.

N. Water Pollution & Wetlands

The contractor's schedule and methods for control of water pollution and protection of wetlands should be reviewed. For more information, refer to Construction Manual Division 1100.

All disposal sites require NDR approval.

O. EEO Requirements (Federal Aid Projects)

1. Forms PR-1391, Manpower reports required. (Distribute sample form)

A. The Contractor (prime and subs) shall send two copies to State Contract Compliance Officer.

B. Submit by 10th of August.

@ C. Needed for the week of July 15th only.

D. If no minorities or women employed - explain why.

E. Required of subcontractors, also, with subcontract of \$10,000 or more.

2. All subcontract and purchase agreements must include E.E.O. provisions.

A. All sections of Form PR-1273 must be attached to these agreements.

3. Not allowed to maintain segregated facilities of any kind.

4. Must pay comparable wages.

- B. Use newspapers and other media likely to yield minority and female applicants.
11. When hiring, the contractor should show some active recruitment in local commuting area of job site.
- A. Make personal recruitment visits to organizations, agencies, etc. in the commuting area of the job site.
 - B. Write letters of recruitment to organizations and agencies in the local commuting area.
 - C. Keep records of all recruitment activity (diary notes are acceptable for personal visits).
12. Must show that some attempt is made to analyze the labor market where the job is located.
- A. Determine number of minorities and women in the commuting area of job site.
 - B. Analyze staffing pattern of crew at job site.
 - C. Set up some type of goal or objective for utilizing minorities and women on that particular job. If minorities and women will not be utilized, be prepared to explain why. Keep records of this analysis activity.
13. Will need to show that personnel actions are reviewed by top management for discriminatory effects.
- A. If a minority or women is discharged at the job site, make sure that the home office knows about it and that the company E.E.O. Officer gives the facts surrounding that discharge.
 - B. If a minority or women is transferred or promoted, the E.E.O. Officer should know about it.
- We are not advocating that contractors establish a highly formal procedure for this, because in some cases, it would not be practical or feasible. However, it is the contractor's responsibility to show that this is being done regardless of the method used.
14. Must show some type of training activity. Must advise employees about training opportunities available and encourage minorities and females to participate.

- A. Document progress of trainees.

When training is given on an informal basis, the contractor will need to show that it is given. Records of case histories should be kept, subject to being verified by interviewing the trainee involved. Keep records of all training activity.

15. Letters must be sent to known minority contractors regarding any subcontract work. Documentation must be kept on the efforts made to solicit minority businesses.
16. Keep records of the following:
- A. Number of minority and women applicants referred and where they come from.
- B. Number of minorities and women hired - if not hired, reasons why.
- C. Number of minorities and women transferred, terminated, promoted, etc.
17. Identify minority and women employee files after hire.

Note: Each Federal-Aid project will stand by itself when being evaluated for affirmative action. In other words, affirmative action on one project will not satisfy the requirement of affirmative action on another project. The contractor should satisfy himself/herself that the foregoing actions are taken and that records are kept for each and every project under his/her control.

103.03 PROJECT DETAILS

- A. On many projects it may be necessary for the Project Manager to prepare and present an enlarged plan or map for showing:
- Location.
 - Terminal points.
 - Type of construction involved.
 - Special areas of concern, including installation of public utilities to be fenced or marked if hazardous or sensitive.
 - Restrictions due to lack of right-of-way or defined by right-of-way agreements.
 - Detours and staging of construction for traffic.
- B. Contractor must present his/her detailed construction schedule, or else postpone preconstruction conference.
1. Starting Date _____ Completion Date _____

Any date before Notice to Proceed must be approved in writing by the **Construction Division.**

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- 2. Staging Schedule and/or Sequence of Operation.
- 3. Items to be sublet and names of subcontractors.
- C. Sampling and material testing requirements shall be discussed.
- D. Contractor Insurance requirements shall be verified.
- E. Railroad Protective Insurance

The contractor must have appropriate insurance in force when working on the railroad right-of-way.

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The Controller Division will enter the effective dates of railroad insurance policies in SiteManager. However, the Project Manager must, in the Key Dates area of SiteManager, record the date that construction started and the date when construction in the railroad right-of-way is complete. **Check to make sure that Railroad Protective coverage is in force.** If not, do not allow the contractor on the right-of-way and do give Controller Division (402-479-4631) a call so that they can verify that insurance has, in fact, not been received. When work has been completed on the railroad right-of-way, the same procedure should be used to record the ending date.

F. Utilities and Law Enforcement Attendance

At major project preconstruction meetings, attendance of utilities and law enforcement personnel is highly beneficial to all concerned. The Project Manager should expend extra effort to assure attendance or open communication with utilities and appropriate law enforcement agencies.

Relocation of utilities is of extreme interest to all concerned in the progress of the project. For safe control of traffic, the ability to discuss traffic control with both contractors and law enforcement could be highly beneficial. The State Patrol, local sheriff, or police should be invited to attend preconstruction meetings when appropriate. The State Patrol can be contacted through the State Patrol District Office charged with responsibility for the area of the project being discussed.

It is beneficial to discuss utilities relocation, project staging, and/or traffic control early in the meeting before more detailed and time consuming construction matters are approached. You may excuse utility companies early.

G. Plan and specification omissions must be discussed.

H. Traffic Control (PM shall present the NDOR Traffic Control Plan.)

In addition, the following must be verified:

1. Brand and model of barricade light proposed to be used are on the Approved Products List.
2. Maintaining spare parts on project.
3. Checking barricades and signs at frequent intervals daily.
4. Phone number of person to call at night if barricades, or signs or devices are down or not working.

Name and Number _____ - _____

Name and Number _____ - _____

5. Notify Project Manager before picking up signs and also at first notice of damaged or stolen signs.

I. Prompt Submittal of Certificates of Compliance, Certified Analysis etc. to insure payments.

J. Location of Field Laboratory and Field Offices

K. Subcontractors must be approved before they can begin working on project. We need to be notified when they are going to be working on project.

L. Contractor's Borrow Pits – Approval

M. Payrolls – Prime Contractor needs to check subcontractors

N. Welding on girders not allowed without written permission.

O. Labor, Payrolls, Wage Rates, Training & E.E.O.

E.E.O. Officer _____

Safety Officer _____

103.20 CONTRACT ADMINISTRATION (SEPARATE HANDOUT FOR ALL CONTRACTORS)

This section provides instructions and guidance to contractors and Project Managers for administration of construction contracts. Instructions include information on required reports or forms, equal employment opportunity, wage reports, training program, minority recruitment, and subcontracting. Copies of all NDR forms mentioned in the *Construction Manual* are included in *Appendix 1* -- NDR forms or *Appendix 2* -- Federal Forms) and can be copied as needed. (However, use stock forms when possible to cut reproduction costs.)

103.21 NEBRASKA & FHWA FORMS & REPORTS - PREPARED BY CONTRACTOR

Form No.	Title	Reference Section	Office Where Forms are Available
DR 298	Special Training Provision Monthly On-Job-Training Report	102.24	DBE Office
DR 439	EEO Contractor's Self-Analysis	102.23	DBE Office
FHWA-1391	Annual EEO Report (July)	102.23	DBE Office
FHWA-47	Statement of Material & Labor	102.25	Construction
WH 348	Statement of Compliance	102.25	District Const. Office
Standard Form 1444	Request for Authorization, Additional Classification and Rate	102.26	Construction

Postings

At the preconstruction conference, the Project Manager will supply copies of the posters listed below:

a. Federal-Aid Contracts

Federal Poster - Equal Employment Opportunity is the Law
State Poster - Equal Opportunity Commission
WH-1420 - Your Rights under the Family and Medical Leave Act 1993
WH-1462 - Notice: Employee Polygraph Protection Act
FHWA-1022 - False Statements Notice
FHWA-1495 - Wage Rate Information

b. State Funded Contracts

State Poster - Equal Opportunity Commission
WH-1420 - Your Rights under the Family and Medical Leave Act 1993
WH-1462 - Notice: Employee Polygraph Protection Act
USDOL-1088 - Your Rights - Federal Minimum Wage

Examples are included in *Appendix 2*. Additional copies, if needed, can be obtained from the Project Manager or the Construction Division (Mr. Dan Necas, 4453). In addition to postings noted above, a copy of the Policy Statement shall be posted.

All required site postings shall be in a location that is easily accessible to all employees. They may be fastened to a bulletin board, tool shed, or job office trailer and protected from weather by glass or clear plastic. Postings that become soiled, faded, or otherwise illegible should be replaced. More than one posting may be necessary if there are multiple locations where workers report for work. Such cases typically occur on complex or long projects involving several different crews and/or subcontractors.

103.22 OCCUPATIONAL SAFETY AND HEALTH

Occupational Safety and Health Act (OSHA) regulations (federal and state) apply to all construction projects. (Federal OSHA regulations are codified in *29 CFR, Sections 1910 and 1926*.) Contractors are responsible for compliance with OSHA regulations and shall maintain a safe work site. Therefore, contractors and their employees must be familiar with the health and safety requirements of the act.

- As an employer, contractors are required to keep employee occupational injury and illness records at the location where their employees usually report for work. The "Log and Summary of Occupational Injuries and Illnesses" (OSHA Form 200) must be completed within six days following a recordable occupational illness or injury. A copy of the completed form must be maintained at the work site. In addition, OSHA Form 200 is to be completed at the end of each calendar year and posted at job sites before February 1. Detailed instructions are printed on the back of each form.
- A poster entitled "Safety and Health Protection on the Job" must be displayed in a prominent place at all times.

Contractors can obtain OSHA forms and posters from:

Regional Director-OSHA
Federal Office Building
Lincoln

or Administrative Safety & Labor Standards
Division
Department of Labor
Lincoln

103.23 EQUAL EMPLOYMENT OPPORTUNITY (EEO) (SSHC Subsection 102.09)

A Contractor's Responsibility

Contractors and their staff who are authorized to hire, supervise, promote, and discharge employees or recommend such action must understand the requirements of applicable EEO specifications including "Required Contract Provision", Form FHWA 1273, and Executive Order 11246 in the Special Provisions.

Policy Statement and Compliance Letter

All contractors must formally adopt an Equal Employment Opportunity Policy Statement which:

- Prohibits discrimination of any kind or for any reason.
- Encourages employment of minorities and women.

Examples of minimum acceptable policy statements for both federal and nonfederal aid projects appear in *Appendix 2*. When posted, these policy statements must be on company letterhead.

A sample of an EEO proof of compliance letter, which lists the EEO requirements and postings, is in *Appendix 2*. Written proof of compliance will not be required for material suppliers, manufacturers, truckers, and surveyors.

B. Project Manager Involvement

Responsibility for complying with EEO requirements is solely the contractor's. However, the Project Manager has oversight involvement to ensure that contractors comply with these requirements and that proper forms and/or letters have been received. When a contractor is not in compliance with EEO requirements, the Project Manager shall advise the contractor, in writing, and make a diary entry, that continued negligence in EEO requirements will result in the withholding of progress payments. **The Project Manager will also inform the Contract Compliance Officer of the contractor's noncompliance. The Contract Compliance Officer will investigate all reports of noncompliance and make a recommendation as to what the contractor must do to be in compliance.** If the contractor still fails to take corrective action relative to EEO noncompliance, the Project Manager may, with concurrence from the Construction Engineer (Lincoln), suspend work. All suspensions shall be documented in writing and sent to the contractor.

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1. Contracts and Subcontracts Over \$10,000
 - a. Site Inspections

As soon as a major part of contract work is underway, an EEO project site inspection must be completed by the EEO Office relative to work in progress. A representative of each affected company shall be present and accompany the inspector during an EEO inspection.

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b. Training Program

Contractor training special provisions requires the contractor to have a formal employee training program. During an EEO inspection, the training program should also be checked.

c. Required Posting

During the inspection, all required postings should be checked. Project Managers shall check to see that correct names and addresses appear in the boxes on posters entitled "Wage Rate Information Federal-Aid Highway Project" (FHWA-1495) and "Notice" (FHWA-1022). Copies of these forms are provided in *Appendix 2*.

d. Reports

- "Federal-Aid Highway Construction Contractors Annual EEO Report"

Contractors and subcontractors (with contracts over \$10,000) shall provide the Contract Compliance Officer in the Construction Division two copies of "Federal-Aid Highway Construction Contractors Annual EEO Report" (FHWA-1391). A blank copy is provided in *Appendix 2*. **1391's can also be obtained off the NDOR website under Contractor's Corner – DBE Information.** These forms are to be completed for all federal-aid contracts for which work was performed **during the week of July 15th**.

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NOTE: If Prime or Sub submit the 1391 to the Project Manager, return them and tell the Prime or Sub that the 1391's must be submitted directly to the Contract Compliance Officer to avoid double counting.

A copy of Form FHWA-1391 is provided in *Appendix 2*. Copies can be ordered from:

@

Construction Division
Nebraska Department of Roads
1500 Hwy. 2
P.O. Box 94759
Lincoln, Nebraska 68509-4759

Instructions for completing this form are provided by the Construction Division on a yearly basis. Contractors are cautioned to be sure they have the CURRENT instructions. If there is any question about revision dates, contact the Construction Division in Lincoln (402) 479-4514.

Distribution: Route one copy to the Construction Division, Lincoln, and retain one copy in project file.

2. Construction Contracts and Subcontracts \$10,000 and Less

An EEO project site inspection is not necessary for these construction contracts.

3. Maintenance Contracts

On maintenance contracts, an EEO project site inspection is not necessary regardless of contracted amount.

4. Complaints of EEO Violations

The Project Manager will report all complaints of EEO violations to the Construction Division's EEO section for investigation.

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103.24 TRAINING & TRAINEE PROGRAMS

Contractor's Responsibility

1. Training Program

All prime contractors and subcontractors (with contracts over \$10,000) must develop, or have, an approved training program in accordance with the *Specifications*. The Contracts Office (EEO Section) approves these programs and can be contacted [(402) 479-4514] for answers to questions or assistance in developing an approved program.

Shortly after a contract is awarded, the Contracts Office will verify that the successful bidder has an approved training program on file. If not, the contractor will be advised that a formal training program must be approved by the Contracts Office within 30 days. Failure to submit a training program will be considered noncompliance with the Specifications. A contractor who does not comply may be refused bidding proposals for future lettings until requirements for a training program are met. (Typically, contractors adopt and use the Associated General Contractors' (AGC) training program. It is acceptable in Nebraska.)

An acceptable training program shall include information covering:

- Method of trainee recruitment.
- Crafts to be trained and upgraded.
- Number of expected trainees per year and what part of total will be female, minority, and disadvantaged.
- Training procedures, including approximate training time.
- Commitment for keeping up-to-date records to summarize total time each trainee is trained in each classification.

- Other training deficiencies are noted during the inspection.

It is the Construction Division's responsibility to work with the Project Manager and contractor to rectify noted discrepancies. If after a reasonable time a contractor fails to meet training requirements or ignores requests for corrective actions, the Construction Division, working through the Project Manager, may request suspension of work until corrective action(s) are implemented. Suspending work will be used as a last resort. However, the offending contractor's bidding ability on future contracts could be restricted until such time that compliance with training is demonstrated.

2. Wage Rates

Wage rate interviews may also be completed during the EEO inspection.

- Interviews should be conducted a minimum of every six months for each contractor and subcontractor.
- Projects whose duration is less than six months should have one interview with each contractor and subcontractor.
- Each District must keep interviews on file for three years.

3. Reports

a. "Reimbursable Trainee Training Record"

Shortly after a letting, the Contracts Office (EEO Section) will prepare and forward a letter listing projects that require a "Special Training Provision Monthly On-Job-Training Report" (Form 298) along with a supply of these forms. **Additional forms can be obtained off of the NDOR website under Contractor's Corner – DBE Information.**

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Monthly, the contractor will be sending one completed Form 298 for each trainee employee until training for that employee is completed or terminated. The Project Manager will review, initial, copy, and forward the original Form 298 to the Construction Division, EEO Section. The copy will be placed and retained in the project file.

- b. Occasionally, contractors train employees on contracts that do not have a line number for trainee reimbursement. In this case, Project Managers are not responsible for monitoring that program and Form 298 is not required.

103.25 WAGES AND EMPLOYMENT

- A. In order to comply with the requirements of the Freedom of Information Act regarding protection of personal privacy, all requests for access to certified payroll records shall be forwarded to the Construction Division. Requests must be in writing, and if not made on behalf of an individual, the request must indicate the name of the organization making the request.
- B. Access to or copies of payrolls shall not be permitted until authorization has been received from the Construction Division. (Adherence to these procedures during investigation by the Department of Labor or FHWA is not required.)

- C. All contracts for highway construction work have certain requirements on wages and conditions of employment. These requirements vary between Federal-aid and State-funded contracts.
- D. Some laws or regulations provide specific requirements in the contract documents, while others may be cited by reference. Section 107 of the Standard Specifications requires compliance with all laws and applicable regulations, and accordingly, compliance is required whether or not specific listing or reference is made in the contract.
- E. Labor Laws Cited
 - 1. Section 107 of the Specifications calls attention to certain State laws and provides that additional regulations and restrictions will be set forth in the special provisions in the contract. These additional regulations are normally included in the required provisions or the special provisions. The enforcement of contract provisions such as these cannot be ignored. However, the inspection, reporting, and enforcement requirements vary between contracts. A basic knowledge of the laws and the exercise of good judgement and diplomacy are required when any enforcement action is taken. Project Managers are advised to contact the Construction Division for decisions on labor complaints for which answers are not readily available. Knowledge concerning these problems is to be handled in confidence, and complete records are a necessity. Certain standard requirements are made a part of all contract provisions. These are as follows:
 - a. A minimum employment age of sixteen years and the restricting of employment of persons whose age or physical condition is such as to make his/her employment dangerous to themselves or others.
 - b. A provision prohibiting the employment of anyone currently serving sentence to a penal or correction institution (this shall not be interpreted to prohibit the use of persons on a bona fide work release program).
 - c. A provision prohibiting discrimination on any grounds against workers who are qualified for the work by training or experience, and who are not disqualified by Paragraphs a. and b.

2. These regulations are required by State law, but often are duplicated or made more restrictive by Federal laws.
3. *SSHC Section 110* refers to State law restrictions of hours and labor. This would include the State Fair Labor Standards Law which is cited in the Special Provisions in each State-funded project and requires the contractors to comply with such a scale of wages and conditions of employment as are paid and maintained by at least 50 percent of the contractors in the same business or field of endeavor. Contracts for State-funded projects do not contain an established scale of minimum wage rates; however, no wages paid can be below the minimum wage of the Fair Labor Standards Act. Questions which arise concerning the payment of proper rate should be referred to the District Office, or to the Construction Division (Mr. Dan Necas, 4453).

103.26 DAVIS-BACON AND RELATED ACTS REQUIREMENTS (Payrolls)

A. General Information

1. On selected contracts containing Federal-aid funds, Federal laws (Davis-Bacon Act) and regulations require the Secretary of Labor to issue a determination for minimum wage schedules to be included in each of these Federal-aid contracts. Special instructions to the contractors are issued by the Construction Engineer prior to the construction operations. A copy of the current instructions are available in *Appendix 2* (FHWA Forms) under Form WH 348, "STATEMENT OF COMPLIANCE."
2. Project Managers or their assistants shall conduct wage rate interviews (Report of Labor Compliance Interviews DR Form 98) on the selected Federal-aid projects in order to determine whether contractors and subcontractors are properly classifying employees and are complying with the minimum wage rate requirements of the Special Provisions.
3. The Project Manager is to make systematic spot interviews with the contractor's or subcontractor's employees when he/she feels it is necessary. As a matter of courtesy, the contractor's superintendent or foreman should be advised that personal interviews with employees will be made. The Project Manager shall select the employees to be interviewed and these should be of different payroll classifications if possible.
4. The number of different employees and classifications to be interviewed shall be at the discretion of the Project Manager to ascertain compliance with these requirements. If violations are discovered, the frequency and number to be interviewed shall be increased and corrective action taken until such violations have been eliminated. Depending on the size of the crews, an attempt should be made to avoid repeating interviews with the same individuals.

5. Employees should be privately interviewed; that is, without the presence of other employees or their supervisor. The employee being interviewed must not be informed of wage rates reported by fellow employees, but is entitled to know the minimum rates specified for his/her classification.
6. Any apparent violations of labor classification or wage rates are to be called to the attention of and discussed with the contractor's or subcontractor's superintendent. In such cases, the Project Manager and the superintendent, considering all the facts and conditions involved, must reach agreement on the proper labor classification. The wage rate paid must be at least the minimum specified for that classification. If a violation in either proper classification or minimum specified wage rate is involved, the contractor or subcontractor shall be directed to correct the classification and/or wage rate being paid and to make any retroactive payment necessary to provide strict compliance with the requirements.
7. In all cases of apparent violations of proper classification or minimum wage rates paid, and the Project Manager and superintendent having reached agreement on the proper classification or minimum wage rate specified, the employee shall then be contacted and notified as to his/her proper classification and the minimum wage rate specified for that classification.
8. In unusual cases involving apparent violations, the Project Manager and the superintendent may not be able to agree on the proper classification of work performed by the employee. In such cases, the matter may be submitted to higher authority, through proper channels, for decision. The current Standard Labor Classifications and Descriptions for Highway Construction shall be used in determining the proper classifications. (See *Appendix 2*, Form WH 348, "STATEMENT OF COMPLIANCE").
9. The interviews shall be recorded on DR Form 98, "Report of Labor Compliance Interviews" and transmitted to the District Engineer for review and distribution. The report should be submitted regularly, showing the interview information as found, indicating any apparent existing discrepancies. Information concerning the handling of such discrepancies shall be shown, by means of an appropriate note, on that report or in the subsequent report.
10. Any classification not covered by the wage determination included in the contract will require the Project Manager to initiate Standard Form 1444, "Request for Authorization of Additional Classification and Rate."
11. The Construction Division (**ext: 3830**) will supply each District Office with current applicable wage rates to be posted for each individual Federal-aid contract and labor and E.E.O. posters.
12. Regardless of the source of funds, highway construction is associated with interstate commerce and, therefore, is covered by the Federal Fair Labor Standards Act. It has specific requirements for payment of a

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6. The contractor and subcontractor payrolls are to be retained until three years after the District Engineer is notified by Controller Division that the final vouchers have been submitted to the Federal Highway Administration.

(Each District should establish a central location for storing payrolls.)

C. Interpretation

1. The interpretation is taken from the U.S. Department of Labor Field Operations Handbook dated June 1, 1987. (A copy of this manual is available at each permanent field headquarters.)
2. Application of labor laws often becomes a matter of interpretation, such as may be involved in instances when furnishing materials must be classified as subcontracting and subject to highway contract labor regulations. This usually applies to labor involved in producing materials from local pits but is not necessarily limited to that operation. The following are examples of elementary rules that may be used in this determination. It is requested that these rules be followed in enforcing the minimum wage requirements of the Special Provisions.
 - a. The contract labor standards provisions are not normally applicable to employees of "established material suppliers" engaged in the production and delivery of aggregates or materials to the contractor, either to stockpiles or on the road. An "established material supplier" is normally considered to be an aggregate production plant, quarry, concrete plant, or asphalt plant which has been established for commercial production not making more than token amounts of sales to other Federal-aid projects.
 - b. When a contractor produces and hauls aggregates for his/her own use from a previously established pit or quarry from which he/she had been producing and selling aggregates immediately prior to the award of the contract, his/her production and hauling operations will be considered to be as an "established material supplier" and the minimum wage rates will not apply.
 - c. When a new pit or quarry is opened or production equipment is moved into a previously opened pit or quarry for the purpose of producing material for a specific contract, none of the operations will be considered to be commercial and the minimum wage rates and conditions of employment shall apply to all labor employed in producing and hauling the aggregate to the work.
 - d. The work of producing or loading material from a local pit shown in the plans, or from a source substituted by the contractor for a local pit shown in the plans, and the work of hauling materials from such sources is considered to be part of the work

contemplated in the contract. As such, the minimum wage rates shall apply to all operations performed by the contractor or his/her subcontractor in processing, loading, and hauling the materials.

- e. The minimum wage rate requirements do not apply to bona fide owner-operators of trucks who are independent contractors. The certified payrolls including the names of such owner-operators need not show hours worked nor rates allegedly paid, but only the notation "owner-operator".
- f. The contractor is required to pay the minimum wage rates to drivers which he/she employs to operate trucks which he/she owns or leases from another party.

D. Apprentices

- 1. The contractor is not required to submit the Standard Form 1444 "Request for Authorization of Classification and Rate" for apprentices if verification is received that the employee is registered in a bona fide apprenticeship program.

E. Various outside agencies may request copies of payrolls under The Freedom of Information Act. The FHWA processes these requests. If you receive a request for copies of payrolls, have the person who is requesting a payroll contact the FHWA. The FHWA will request the payrolls from the Construction Division. The Construction Division will tell the PM to forward requested payrolls to the FHWA. The FHWA will remove any personal information such as name and Social Security Number before forwarding the information to the requesting agency.

103.27 DISADVANTAGED BUSINESS ENTERPRISE (DBE) SUBCONTRACTOR

A. Contract Award

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On Federal-aid projects with predetermined **DBE participation** goals, all bidders will be required to submit a required DBE Participation Form (see bid proposal package) with their bid. This form identifies DBE subcontractors, suppliers, transporters, and/or manufacturers that will be used to satisfy the DBE goal. The DBE Participation Form shall also include work or items to be subcontracted, and dollar amount committed to each DBE.

Upon execution of a contract, the prime contractor becomes committed to those DBEs goals listed on the form. This commitment is therefore a contractual arrangement between the State and the prime contractor with the same enforcement as any other provision specified in the contract documents. A prime contractor is required to enter into a contractual arrangement with each DBE listed by formally executing a written subcontract agreement specifying the work to be performed and appropriate compensation for that work. This two-tier process, which contractually obligates the prime contractor to both the State and each participating DBE, formalizes implementation of all DBE contract provisions.

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The DBE Office will review the low bidder's "Required DBE Participation Form" to assure that certified DBEs are being used.

@ The successful bidder must then submit a letter and copy of the DBE Subcontract to the Construction Division to get subcontractors approved.

B. Commercially Useful Function

@ (1) A DBE performs a commercially useful function when it is responsible for execution of the work of the contract and is carrying out its responsibilities by actually performing, managing and supervising the work involved. To perform a commercially useful function, the DBE must also be responsible, with respect to materials and supplies used on the contract, for negotiating price, determining quality and quantity, ordering the material, and installing (where applicable) and paying for the material itself. To determine whether a DBE is performing a commercially useful function, you must evaluate the amount of work subcontracted, industry practices, whether the amount the firm is to be paid under the contract is commensurate with the work it is actually performing and the DBE credit claimed for its performance of the work, and other relevant factors.

To meet commercially useful function requirements of the regulations and contract, the following statements are applicable:

- DBE firm must manage the work contracted. Management shall include scheduling work operations, ordering equipment and materials (if materials are part of the contract), preparing and submitting payrolls and all other required reports and forms, as well as hiring and firing employees, including supervisory employees.
- DBE shall perform work with employees normally employed by and under the DBE's control. In all instances, the DBE shall be responsible for payroll and labor compliance requirements concerning all workers under their control. DBEs may use other means to perform work on a limited basis when the contract requires specialized knowledge, skills, or equipment. A DBE may be allowed to augment their work force with personnel which normally work for another firm. If the request can be approved prior to commencing work.

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NOTE: All arrangements must be presented in writing and pre-approved by the DBE Office.

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- DBE must supervise daily operations of their portion of contracted work. The only two acceptable ways for a DBE to supervise daily operations are:
 - 1) The DBE owner may act as the superintendent and directly supervise work, or
 - 2) A skilled and knowledgeable superintendent employed and paid wages by the DBE must directly supervise that work.

If the latter is used, the DBE owner must be actively involved in making operational and managerial decisions of the firm. Basically, this means that all administrative functions shall be performed by personnel responsible to, or employed by, the DBE at facilities or locations under the DBE's control.

- DBEs shall supervise and perform contracted work with workers on their payroll and under their direct supervision. The DBE and the superintendent must, on a full-time basis, supervise and control contracted work. Supervision of contract work by personnel normally employed by another contractor or by personnel not under the DBE's control constitutes failure to perform a commercially useful function.

(Responsibilities include minimum requirements for DBE manufacturers, dealers, transportation services, and subcontractors.) DBE subcontractors that indicate work which will be performed by employees

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@ of another firm or with leased equipment should be questioned. The DBE Office shall be notified in all cases where there is a question regarding "commercially useful function".

3. Partial Subcontract of an Item

It is not unusual for DBE subcontractors to be involved in only part of a contract item.

For conditions where a subcontract does not exist but a DBE firm is manufacturing, supplying, or trucking materials to the job site, this dollar value will not be used to determine the percent subcontracted as specified in the *Specifications*.

Inspection staff must monitor work performed and periodically inform the Project Manager as to which individuals and equipment actually worked so payrolls can be spot-checked.

C. Construction Period

@ The Project Manager and inspectors must review work subcontracted to DBE subcontractors to assure work is being performed and that DBEs are performing a commercially useful function. Where work is performed by any other contractor or with equipment not owned by the DBE, the inspector shall issue a noncompliance notice citing violation of *Supplemental Specifications for Specific Affirmative Action Responsibilities*. This noncompliance shall be immediately reported to the Project Manager, who will in turn immediately notify the DBE Office.

Prime contractors will be given credit toward the DBE contract goal only when a DBE performs a commercially useful function. The requirements for a commercially useful function are outlined in the previous section "Subcontract Approval."

@ A DBE may lease equipment consistent with standard industry practice provided a rental agreement specifying the terms of the lease arrangement is approved prior to a DBE starting work. If equipment is of a specialized nature, the lease may include an equipment operator. No credit will be given for the cost of equipment leased or rented from the prime contractor.

DBEs shall negotiate cost, arrange for delivery, and pay for materials and supplies required for their portion of the contract work. Invoices for materials shall be invoiced to the DBE firm and not to a prime contractor.

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A prime contractor may occasionally find it necessary to ensure that payments are made to suppliers for materials used by subcontractors. When such a **joint check** payment arrangement is pre-approved by the **Highway Civil Rights Coordinator**, counting the cost of materials actually incorporated into the project by a DBE subcontractor toward DBE participation will be allowable provided the DBE:

- orders and schedules the delivery of materials, and
- is fully responsible for ensuring that materials meet Specifications.

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When the DBE office approves such payments **to be** made by the prime contractor, payments must be made by preparing jointly endorsed checks signed by the DBE and supplier.

No credit shall be allowed toward the DBE goal for cost of materials placed by a DBE subcontractor when payment is made by deducting this payment from the prime contractor's payment to the DBE.

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Project Managers must evaluate and document performance of the DBE's activity on all projects as part of the normal project contract compliance monitoring. On-site project monitoring by field personnel shall include employee assignments, equipment used, and supervision of the work. All irregularities must be documented in the field books and immediately reported to the prime contractor, and the **Contract Compliance Officer in the DBE Office**.

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Project Managers shall not allow a prime contractor or another contractor to perform work that has been committed to a DBE subcontractor without prior written approval from the DBE Office.

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In situations where a DBE subcontractor cannot (or is not) performing, the prime contractor must follow all steps described in *Supplemental Specification for Specific Affirmative Action Responsibilities*. Upon receipt of a signed statement from the DBE and documentation where the prime contractor will satisfy the goal with other items or DBEs, the Project Manager may recommend to the **DBE Office** that the commitment be waived and the required goal adjusted. The **DBE Office** must provide written approval of all substitutions before any changes in subcontracted work are performed.

D. Post Construction

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Prime contractors shall submit a completed "Identification of DBE Goal Achievement" (DR Form 441) with the final project documents **to the DBE office**. The subcontractor submits DR Form 442 "Identification of Work Performed." Blank forms are provided in **Appendix 1 and at the website**. These forms certify the dollar amount paid to each DBE. **DBE Office** must compare the dollar amounts on Forms 441 and 442 to dollar amounts committed to a DBE on "Required DBE Participation Form." The prime contractor will be assessed a penalty by change order for failure to satisfy the DBE commitments. This penalty may be reduced when conditions described in

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Supplemental Specification for Affirmative Action Responsibilities are satisfied. Project Managers must include a written explanation describing situations, background, and findings which resulted in reductions or adjustments.

Unique problems have been noted with the goals and variables of the DBE program. Documentation of any activity related to the program is important and must not be overlooked. Record all telephone or personal contacts noting time, place, and details.

The DR Form 440 Contractor EEO Compliance Record has been eliminated. These records are no longer to be maintained.

103.28 LEASE OF PROPERTY BEYOND THE HIGHWAY RIGHT-OF-WAY

The NDR has found that it is more cost effective and quicker to have the contractor make most land use agreements for areas outside the highway right-of-way. This means borrow sites, plant sites, storage areas, parking lots, and so forth are the contractor's responsibility to lease.

103.29 CONTRACTOR'S USE OF HIGHWAY RIGHT-OF-WAY

Occasionally a contractor requests permission to establish a plant site or a material stockpile on highway right-of-way. In reviewing these requests, the District Engineer must consider the impact of vehicles (trucks or equipment) entering and leaving these sites on public traffic. In situations where these vehicles must enter an open ramp or lane at a point where access is not allowed to the general public, the request shall normally be denied. On two-lane roads if an access permit can be obtained and public convenience and safety is not adversely affected, the request may be approved. On closed sections of the highway, right-of-way may be used as long as trucks can enter and leave the closed road safely.

Many times a contractor will have to exit a controlled-access facility to deliver materials such as mulch, subdrain, guardrail, etc. These stockpiles may be allowed as long as the material is to be used in the general vicinity where stockpiled and is stored beyond the "clear zone".

NOTE: In these situations, the contractor will be responsible to initiate and provide a storm water permit for their operations in that area.

103.30 "CONTRACT QUANTITIES"

The Project Manager and the contractor may agree to a final payment for an item based on contract quantities, i.e., plan quantity. The Project Manager shall verify that the plan quantities are reasonably accurate. If the contractor concurs with the final quantities as shown on the PM Final Estimate, the Project Manager will forward this concurrence to the Construction Division with a copy to the contractor for information.

Final review corrections should be limited to errors of \$150.00 or more per pay item. Do not waste time and money making small corrections.

103.31 CONTRACTOR'S SALES TAX EXEMPTION

When a NDR contract is awarded, the Contracts Section of the Construction Division will issue the prime contractor a "Purchasing Agent Appointment" (DR Form 2-A) and an "Exempt Sale Certificate for Contracts" (DR Form 2-B). These forms allow the contractor to purchase materials that are to be incorporated into a highway project without paying any sales tax. The prime contractor is allowed to make copies of both forms and provide them to the project subcontractors for their use. The prime contractor must contact the Contracts Section [(402) 479-4851] to obtain an extension. The Contracts Section completes the extension by issuing a new "Purchasing Agent Appointment" (DR Form 2-A).

103.32 LOTUS NOTES – NOTIFICATION

Field personnel are strongly encouraged to open their electronic mail daily. The Construction Division (and others) use it regularly and expect messages sent to be messages read.

Any time a plan error/omission is discovered or if for any reason the contract must be changed, the PM should send a Lotus note with appropriate details to the designer (Bridge or Roadway), Construction Division, and if necessary, to Materials & Research.

103.33 PRIME CONTRACTORS/SUBCONTRACTORS

Project Managers should be reminded that correspondence pertaining to a subcontractor should be directed to the prime contractor.

Notification should be made to:

Bernard Hauber, Industrial Hygienist
Occupational Safety and Health Administration
Overland-Wolfe Building, Suite 100
6910 Pacific Street
Omaha, NE 68106

After the original notification has been made, it will be OSHA's responsibility to determine if and when they choose or desire to make an on-site inspection.

104.00 -- CONSTRUCTION INSPECTION

104.01 CONTRACT TIME DETERMINATION (*SSHC Subsection 108.02*)

Tentative Beginning Date - The proposal will show a tentative date on which it is anticipated that the contractor may begin operations.

In most cases, the tentative beginning dates are established several weeks in advance of the letting date by determining the latest possible date the Department would like to see the work completed and backing out the estimated number of days required to complete the work. Consequently, any requests to delay the start of work on a project are examined very carefully before being approved. Additionally, the approval to delay the start of work on a project may be made contingent upon certain concessions by the contractor (such as the imposition of a disincentive payment for a late completion).

In the case of contracts involving multiple time allowances, extensive utility relocation, or work to be performed by others (e.g., railroads, cities, counties), it may be necessary to delay the start of work for several weeks after the tentative starting dates shown in the proposal.

If the tentative beginning date shown in the proposal appears to be earlier or later than believed possible or practical due to job, weather, traffic, or other conditions relevant to the project, the Construction Engineer should be notified promptly.

Notice to Proceed - The contractor will be given a Notice to Proceed by the Construction Division, and work should not begin until the notice has been issued (or at least verbally acknowledged) by the Construction Division.

Normally, the Notice to Proceed date will coincide with the tentative beginning date shown in the proposal; and the Notice to Proceed will automatically be issued after the contract is in place, usually a week or two prior to the starting date. In some cases, however, such as for seeding or landscaping projects, the Construction Division will check with the District Construction Engineer to verify that the site is ready for work to proceed before issuing the notice. The issuance of the Notice will also be delayed when a project is let far in advance of the tentative starting date -- almost always resulting in a request for an early start by the contractor.

It should be noted that in SiteManager, the Notice to Proceed date is recorded in SiteManager under "Key Dates" as the "Notice to Begin Work" date. SiteManager's "Notice to Proceed" date is actually the contract execution date.

Some contracts contain an "early start provision". For those projects, the contractor may begin work prior to the tentative starting date by notifying the District Engineer of his/her intent to begin work early. The notice must be given two weeks prior to the intended starting date and is not subject to review by the Department. When such notice is given, the District should notify the Construction Division of the need to issue the notice and the date for which it should be issued.

For those contracts which do not contain the "early start provision", requests to begin work prior to the tentative starting date should be made by the contractor directly to the Construction Engineer in Lincoln. In many cases, such requests are made following issuance of the original Notice to Proceed. If the request is approved, a revised notice will be issued.

104.08 CHANGE ORDER - SUPPLEMENTAL AGREEMENTS
(SSHHC Subsection 104.02)

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Change Orders are used to:

- Change the authorized quantity of a contract item. This includes increases, decreases, or deletions to contract quantities.
- Add a new item or material to an existing contract. Often this is a result of plan revisions or a change in scope from what was originally envisioned at time of letting.
- Serve as a source document for the Controller Office.
- Officially document changes to the contract documents. CO/SAs and work orders are written orders to a prime contractor which are initiated and prepared by the Project Manager. Once signed by all parties, these documents become a legally binding part of the contract ordering a specific change to the original contract.

Policy for Change Orders

A. Contractor Markup

Subcontracted Items. Extra work performed by a subcontractor entitles a prime contractor an allowance to cover administration expenses. This markup is not to apply to incentive payments. The percentage allowed for administration expense is discussed in *SSHHC Subsection 109.05*.

Contract Unit Price. Change orders covering an overrun/underrun (*SSHHC Subsection 104.02*) of items at contract unit prices are NOT eligible for any additive like an allowance for administration expenses. This includes work which was done by a subcontractor. The contract unit price should have already considered any necessary additives for administrative expenses.

The contractor may request a change order when additional work differs materially in kind or nature from the work included in the originally proposed construction.

A major item of work is defined as an item whose total original contract cost exceeds 10 percent of its original group total amount. The price for a pay item may require adjustment when a major item is increased in excess of 125 percent or decreased below 75 percent of the original contract quantity. Any allowance for an increase in quantity shall apply only to that portion in excess of 125 percent of the original contract item quantity, or in case of a decrease below 75 percent, to the actual amount of work performed.

A contractor may request a price adjustment to recover lost administration expense for underruns amounting to more than 25 percent of the bid amount for a major item of work. A contractor is allowed to recover only that portion of lost administration expense represented by the underrun.

By the same reasoning, a like price adjustment may be made to reduce the cost of major items of work which overrun by more than 25 percent, since the contractor should have already included overhead expenses in their bid. Overrun price adjustments apply to only that portion/quantity which is more than 125 percent.

Agreed Unit Price. Extra work orders based on an agreed price or lump sum should have overhead considered as a part of the negotiation. The agreed unit price may include the cost of overhead for handling subcontracted items. It may be included in lump sum items if justified. However, if negotiations specifically excluded markup, the item may be shown as a separate entry on a cost work up sheet.

Force Account. (*SSHC Subsection 109.05*) Specified force account percentages for labor and material are intended to cover all costs that a contractor may incur due to the work, regardless of who does that work (prime or subcontractor). Force account work to a subcontractor will be authorized for additional administration percentage to a prime.

Plan Revisions

Often, plan revisions result in Change Orders having to be negotiated. Processing Change Orders resulting from plan revisions is sometimes delayed due to disagreement on prices, lack of success in obtaining qualified subcontractor(s), or various other reasons.

It is imperative that Project Managers actively pursue Change Order negotiations to an early conclusion, especially if proposed work involves public safety (guardrail, safety enhancement, etc.) or work related to a prolonged detour. Obviously, agreement on unit prices is desirable. However, there are times that work will have to proceed on a Force Account basis. In all cases, documented agreements on the Method of Measurement and Basis of Payment for extra work items must be obtained before the Change Order is written. NOTE: No work can begin until the contractor has either agreed to a Change Order or agreed to a basis of computing force account costs.

Change Order Approval Limits

Contracts are awarded for a specific dollar amount. Overruns or change orders expend additional funds and can only be authorized by specific people.

FHWA/Certification Acceptance

FHWA projects that have full oversight have "FHWA" stamped in red on the front page of the proposal. The Contracts Section makes the determination and affixes the red stamp.

@ On FHWA oversight projects, current rules require that expenditures in excess of \$50,000 be discussed with the FHWA.

The following table shows the Department's approval limits:

APPROVAL LIMITS	
Deputy Director	Over \$150,000.00
Construction Engineer	\$50,000.00 to \$150,000.00
District Engineer & DCE	\$0 to \$50,000.00

Preparation of Change Order

The following instructions are applicable in the preparation of a Change Order-Supplemental Agreement:

- Create a brief description of the work not in the contract.
- Show reasons for the change; or, if the document is a combination change order-supplemental agreement, show purpose of the agreement. When the work to be performed is not covered in the specifications, the name of the items shall be worded to define the work to be performed. References should be made to similar items in the specifications or plans and the method of measurement and basis of payment definitely established.
- Show the basis of the unit prices established, such as comparison with unit prices for similar contract items or the previous year's average contract unit prices.
- Include statement as to the determination of a change in the contract time allowance.
- @ • Show the name of the FHWA engineer and date of discussion with him/her when the Change Order is for more than \$50,000.00 and the federal-aid contract is for more than \$1,000,000 and on the Interstate.
- Enter estimated increased and decreased changes in quantities of items of work. Use standard item numbers and standard specification/contract wording, when applicable, for the new item description you define.

All Change Orders (CO) and Change Order-Supplemental Agreements (CO/SA) shall address the subject of additional working days or calendar days, if any, to be added to the contract time allowance.

The original working day or calendar day allowance is calculated by assigning some average rates of progress to the various items of work and then making some assumptions as to which items might tend to overlap during the actual performance of

the work. The system is not perfect; but, regardless of the result, it does provide all bidders with a time frame upon which they can estimate a schedule for completion of the work and prepare a bid.

The performance of extra work should not be cause to suspend the working day or calendar day count. Working days or calendar days should be assessed for all extra and originally contracted work according to the guidelines for doing so, and then any relief to which the contractor might be entitled should be granted by issuing a time extension document or addressing the time in a CO or CO/SA.

@ In SiteManager under Reference Tables/Standard Definitions there several option clauses to be added to the Change Order. Four of the options pertain to working/calendar days. They are further described below:

1. No additional working days or calendar days to the contract time allowance are being granted. Additional working day or calendar day consideration is not applicable to this change.
2. “_____” additional working days or calendar days to the contract time allowance are being granted.
3. Additional working days or calendar days to the contract time allowance shall be granted on the basis of the actual working days or calendar days charged for performing the work under this agreement, provided that said work is judged to be the controlling operation.
4. Additional working days or calendar days to the contract time allowance, if any, shall be granted on the monetary value in accordance with Paragraph 10. of Subsection 108.02 of the Standard Specifications.

The writer of the CO or CO/SA must use some judgment when determining which note is appropriate. In fact, there may be instances when it will be necessary to write more than one CO/SA because the items to be added to the contract do not all subject themselves to the same rule. A little extra work, perhaps; but the right thing to do. The discussion that follows should be helpful in determining which note to select.

Note 1 - No additional days

No additional working days or calendar days to the contract time allowance are being granted. Additional working day or calendar day consideration is not applicable to this change.

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This note could be used on any CO/SA which addresses subjects which are not financial in nature. An example would be an early starting date coupled with the conditional addition of the winter work special provision to the contract. A condition might be that the contractor not make any claims for delays due to utilities not being out of the way --- thus the need for a supplemental agreement requiring the contractor's signature. The work remains the same, however; and no change would be made in the contract time allowance.

This note should also be used on any CO/SA that increases the value of the contract but does not necessarily require additional time to perform the work. An example might be the substitution of one type of asphaltic concrete for another. The concrete actually used might be more expensive; but the time to mix, haul, lay, and roll it remains the same. (This does not, however, preclude the granting of some additional time due to an overrun of the final quantities.)

In general, this note could also be used on a CO/SA that has a negative financial impact on the project. An example might be the substitution of an 18" culvert pipe for a 24" pipe. The cost of the pipe and excavation is probably going to result in a savings to the project, but it is not the Department's policy to reduce the contract time allowance.

Note 2 - Specified number of days

“ _____ ” additional working days or calendar days to the contract time allowance are being granted.

This note is the preferred note in many cases and should be utilized whenever possible. The Construction Division will rarely question the number of days granted, no calculations are required by the Final Reviewers, and the fact that the CO/SA is signed by the contractor leaves little opportunity for it to be contested. Obviously, the use of this note is restricted to situations where the supplemental agreement is created after the work is performed and the number of days required is known.

This note can appropriately be used in cases where the extra work is determined to be the controlling operation when it was performed. It definitely should be used when the time required to perform the work is grossly disproportionate to its monetary value. As an extreme example, it may take just one day to add a million-dollar traffic controller on a fifty-thousand-dollar project. Determination of an additional time allowance on the basis of cost would obviously not be correct.

This note can also be used on a CO/SA that is more administrative in nature. As an example, the contractor and the Department may negotiate some changes to the contract for which a time adjustment is a condition of the agreement. This note is a proper method to document the adjustment to the contract time allowance. It functions in the same way as would a Time Extension Document.

Note 3 - Unspecified number of days (controlling operation)

Additional working days or calendar days to the contract time allowance shall be granted on the basis of the actual working days or calendar days charged for performing the work under this agreement, provided that said work is judged to be the controlling operation.

This note should be used in situations similar to those described for Note 2 when the CO/SA is completed prior to the work being performed. When it can be anticipated that the additional work will be the controlling operation or the value of the work is disproportionate to the time required to perform it (especially when the work takes a long time to complete but is not very expensive), this note should be used. In some cases, it may be appropriate to grant some additional time on the basis of monetary value for extra work performed when the work is not the controlling operation for the entire time required to complete it.

The Project Manager should closely monitor the work when choosing this method of calculating an increase to the contract time allowance. The completion of other work is certainly not discouraged or prohibited, but the contractor should not be allowed to intentionally slow the progress of the extra work to gain the advantage of allowing other contract work to be completed concurrently during the time period being added.

Note 4 - Unspecified number of days (monetary value)

Additional working days or calendar days to the contract time allowance, if any, shall be granted on the monetary value in accordance with Paragraph 10. of Subsection 108.02 of the Standard Specifications.

This note serves to cover those situations not addressed by Notes 1, 2, or 3. It is an inexact method, but is usually a fair way to provide additional time to the contract time allowance when the methods associated with Notes 1, 2, and 3 are clearly not more appropriate.

It should be used to address those additional items of work which are similar in nature to other items of work in the contract but for which it is difficult to determine or monitor the actual amount of time required to complete. An example might be additional work performed sporadically over a long period of time or the addition of more work of a type already in the contract --- such as may be added by a plan revision.

The use of this note does require the Finals Reviewers to calculate the amount of extra time to be granted. The calculation should be done on the basis of the monetary value alone, and no consideration should be given to whether or not working days or calendar days were charged during the performance of the work. If the extra work to be added by the CO/SA could have been anticipated prior to the letting, time certainly would have been allowed for it; and it is only fair that an additional time allowance be considered after the fact.

The Project Manager should have the best feel for the type of working day or calendar day consideration that is most appropriate. He/she is encouraged to make a fair

evaluation of the situation and select the method that fits. As indicated in the discussion above, the use of Note 2 is encouraged.

The approved rental rates shall only apply to equipment used under the following conditions:

The contractor's equipment that is available on the project. If equipment not available on the project is needed only for the extra work, it may be necessary to pay rates in excess of the approved rates or to pay compensation for the cost of moving in the equipment. (Mobilization is explained in *Construction Manual Section 104.07.*)

If it is necessary for the contractor to rent equipment for the extra work from a third party, the rate established shall be the actual rental cost plus fifteen percent for overhead and profit.

Equipment used on extra or additional work performed under normal working conditions on a force account or contingent item basis.

If the equipment is to be used under working conditions involving abnormal expenditures for maintenance, fuel, or service, it may be necessary to pay rates in excess of the approved rates.

If major quantities or extended amounts of work are involved, it may be equitable and necessary to negotiate rates at less than those indicated above.

The approved rates shall be paid only for the time actually used in the performance of the work ordered by the Project Manager. Standby time, time involved moving to and from the work and repairing and greasing time shall not normally be included for payment.

If the contractor is required to hold equipment which he/she has brought in specifically for the extra or additional work "on standby" because of circumstances beyond his/her control, consideration may be given to payment for normal schedule "standby time". In such cases, it will be necessary to negotiate lower hourly rates with the contractor which will not include compensation for fuel, oil, grease, repairs and other costs which would not be incurred on the equipment "standing by".

The Project Manager should be careful to obtain the correct name, model size, series number, and type of the equipment and major attachments - (loader or dragline bucket, etc.) involved for each item of equipment for which a rental rate is to be established. This information should be furnished to the District Office and they may then determine the approved rate from the "Rental Rate Blue Book". Complete information is needed to determine the proper rate since the rates vary considerably depending on the model, series, etc. The name of the established item should be descriptive but brief, for example, "Crawler Tractor Loader, 1 Cu. Yd." The body of the force account or supplemental agreement should then include all of the information necessary to determine and verify the correct rate, for example "Caterpillar, Model 955 'H', 100 horsepower, 1 Cu. Yd."

If fully operated rates, including operators' wages are to be established, the rate paid the operator shall be increased by 50 percent to cover insurance, social

security taxes and profit and added to the approved rental rate, rounding to the nearest five cents. When such rates are established, the words "fully operated" shall be included in the equipment rental item.

The Project Manager should call or write to the general office of the contractor advising him/her of the nature of the proposed work to be performed on a force account basis and request that they advise by letter regarding their insurance premium rates for workmen's compensation, public liability, and property damage. Request that the contractor send copies of his/her letter to the District and Construction Engineers. The letter stating the insurance rates should be attached to the force account agreement to be filed as a part of the permanent records. The agreement may also be prepared without the insurance rates and sent to the contractor's office for signature with instructions that the contractor place the rates on the agreement.

The reverse side of the agreement form must contain the "Estimate of Cost". This itemized estimate of the cost of the work shall include an item for each class of labor or piece of equipment for which a rate is established in the agreement. The estimated number of hours that it is contemplated that each item of labor and equipment will be employed shall be shown, extended at the established rates, and totaled. Allowances for insurance, social security taxes, and profit shall be shown and included in the total cost. In the event that the contractor will be required to furnish materials in performing the work, the quantity and estimated cost of each item of material should be shown and included in the totals.

The hourly labor rates to be used in the itemized estimate shall be the average rates that would be earned, including overtime, if the laborer worked a full week. Such rates shall be referenced with asterisks to the following note to be entered below the estimate:

"Average rates earned at the established basic rates in a 40 hour week."

The heading of the "Estimate of Cost" on the reverse side should be on the same end of the sheet as the signatures on the face of the form so that it will not be obscured when it is placed in the Lincoln Office file.

Force Account Statements - A force account statement, signed by both the Project Manager and the contractor's representative, is required for each calendar week during which work is performed. These reports should be prepared and signed weekly. In the event that overtime payment is involved and the agreement requires that reimbursement be made at the average hourly rate earned during the week, the statement shall be prepared and signed on the Monday following the week in which the work is performed.

@ A daily record of labor, equipment and materials used on force account work shall be kept in **SiteManager**. Work on force account and contract items will often occur at the same place at the same time. It will be the duty of the Project Manager or inspector to record his/her estimate of the force account labor and equipment hours and check with the contractor's foreman each day.

A receipted invoice is required for all items of expense incurred by the contractor except insurance, social security taxes, and the items for which rates are established in the force account agreement. The quantity or amount of such services furnished or materials used during each week may be included in the statement for that week, or the total quantity or amount for all materials or other expense covered by the same agreement may be included for payment on a later statement, substantiated by receipted invoice. Payment cannot be made for such items until the receipted invoices are received.

The contractor shall furnish the Project Manager with a copy of his/her weekly labor payroll which contains the names of those personnel working on force account items. The hours worked and the rates paid to labor on force account work shall be compared with this transcript. Any discrepancies should be investigated and corrected to insure the accuracy of the force account statements. See Pages 492 through 497 for instructions and examples of force account agreements and statements.

Alterations of Plans or Character of Work (*SSHC Subsection 104.02*)

This subsection in the specifications authorizes the Department (Project Manager) to increase or decrease quantities of contract items for which there are unit prices included in the contract, if changes in plans or alterations of construction make such increases or decreases necessary or desirable.

A CO/SA may be necessary when there is a significant change in the character of the work. A “significant change” is defined in Subsection 104.02. A CO/SA will not be required if the Project Manager and contractor agree that the additional work can be done at the bid price. Such agreement, preferably including the contractor’s initials or signature, should be documented in **SiteManager and** in the Project Manager’s diary.

@

Sign Deductions

@

The change order for sign deductions must indicate that “State Funds Only” shall be used.

104.09 VALUE ENGINEERING (*SSHC Subsection 104.03*)

In accordance with *SSHC Subsection 104.03* a contractor may submit a value engineering proposal to the Project Manager with copies to the District and Construction Division. The purpose of value engineering is to encourage alternative, cost effective measures which produce equal or better quality end products.

Value Engineering proposals will not be accepted for:

- Changes in basic design of a bridge or pavement type. For example: Value engineering a project from PCC to ACC will not be acceptable. Changing a designed bridge to a box culvert is not acceptable.
- Changes which the contracting authority may already be considering.
- Basing a value engineering proposal on, or similar to, existing standard Specifications, Special Provisions, or design plans and standards adopted by the contracting authority. For example: A plan was let using 15 foot (4.6 m) PCC joint spacing. A value engineering proposal would not be accepted changing this to 20 feet (6 m) because Roadway Design Division standards have included this spacing as an acceptable standard.

The written proposal shall have sufficient detail to be evaluated for compliance with the requirements. The detail provided must also allow for reviewing how a proposal impacts the entire project. It shall include:

- A description of existing requirements and proposed changes
- All affected contract items, including new, extra work items and supporting justification for that extra work
- Unit prices requested for the work
- Effects on crew, equipment, and production needs for the project
- Impact on the construction period
- Schedule for obtaining all required materials

It is very important to pursue these requests quickly to maximize potential savings. Once a proposal is received, the Project Manager should (a) discuss the merits of the VE proposal with the District Engineer, and (b) initiate an office review and forward review comments to the Construction Division within a week. The Construction Division will coordinate the review with other offices, including selected section leaders (Design and/or Bridge) and the FHWA, if appropriate. Following this review, the Construction Division will notify the District and Project Manager of approval or disapproval and any special considerations or requirements. Following notification from the Construction Division, the Project Manager will prepare a written notification to the contractor outlining the review and conclusions of that review.

104.11 PLANT REPORTS

The Project Manager should make arrangements with the contractor's plant inspector for timely receipt of plant reports. The original and all copies of the plant report shall be kept at the plant until all documentation is completed. Normally, this will be the day following the end of the reporting period. Review and distribution of the reports will be made by the Project Manager. This distribution will include a copy to be returned to the contractor's plant inspector. Prompt consultation between the plant inspector and the NDR plant monitor shall follow any significant error or omission.

Documentation

- @ A separate field book **entry in SiteManager** should be set up on each project to document plant inspection. Some flexibility in the suggested format may be necessary depending on project size, type of plant, and if the QA/QC Specification applies. It is important to document discrepancies and corrective action taken by the contractor.

104.20 FIELD TESTS

104.21 FIELD TESTING ON CONSTRUCTION PROJECTS

Materials

All sampling, measuring, and testing for construction project quality control shall be performed as prescribed in the NDR Materials Sampling Guide and the NDR Standard Method of Tests.

Project Acceptance Sampling and Testing

Both construction inspection personnel and the contractor are responsible for the field sampling and testing portion of project acceptance tests. The Project Manager must review inspector assignments and maintain a program of continuing training for personnel and training of additional employees if required. Samples taken by inspectors and submitted to District or Central materials laboratories must be properly and completely identified on "Sample Identification Form" (DR Form 12) or other appropriate forms as required.

The *Materials Sampling Guide* shows the minimum required frequency of tests for various types of work. Additional tests should be made as necessary for adequate project control. Reports showing test results must include all tests made.

Reports do not need to be included in field books or diaries.

Assurance Sampling and Testing

SSHC Section 1028 discusses the requirements related to asphalt assurance sampling and testing, most of which are Materials and Research Office responsibilities. Occasionally, assurance samples have not been taken on some projects because timely notification of ongoing work was not made. This has been more common with test cylinders from bridge deck pours and culvert projects.

While the actual taking of assurance samples remains the responsibility of Materials and Research personnel, it is of equal importance that project inspectors provide timely notification regarding available dates for testing.

104.70 ACCIDENTS

Whenever a traffic accident occurs in a construction zone, the Attorney General suggests that the Project Manager immediately video tape, photograph, and/or document the area to verify the position of signage, obstructions, traffic control devices, and other pertinent features.

Use the publication *Collecting of Accident Data* as an aid when reporting accidents.

105.00 -- MEASUREMENT AND PAYMENT

105.01 GENERAL

The Project Manager may elect to pay the plan quantity for items like pavement when the item is built to plan geometrics. Measurements are not always required when the item is constructed to plan and specification requirements.

If the item of work does not conform to the specification requirements, a new item of work must be added as extra work. Example: On guard rail, if it is necessary to leave out a post because of a drainage structure and use a double safety beam section, this section of guard rail must be paid for as extra work as it does not conform to the specification requirements for guard rail.

105.02 MEASUREMENT OF QUANTITIES AND COMPENSATION FOR ALTERED QUANTITIES

@ All standard items of work listed in the contract are to be measured for payment using **English (metric)** System of measurement. A list of standard contract items and their units of measurement is available at each field headquarters and on Lotus Notes or the NDR Web Page. Inspectors or survey parties concerned with measuring and/or recording contract items will need to be informed of proper procedures to be followed.

The contractor may request that materials hauled to the project and paid for by the cubic meter (cubic yard) be measured and a mass conversion factor be used for determining the cubic meters (cubic yards) of material delivered. When the Project Manager approves this procedure, the mass of the material must be obtained on approved scales, the material must be hauled approximately the average haul to the point of delivery, and then the volume of the material must be determined. The mass of the material in kilograms (tons) divided by the volume of the material in cubic meters (cubic yards) will be the mass conversion factor. The cubic meters (cubic yards) of material used may be determined by dividing the total mass delivered by the mass conversion factor.

The Project Manager will determine the frequency for establishing mass conversion factors. The frequency will be dependent on the quantity of material delivered, on variations in the material's characteristics (moisture content, gradation, etc.), and on variations in the length of haul.

The final record for the contracted work must include all records and computations used in determining the mass conversion factors.

If provision is made that payment of any contract item is to be made as an "established quantity", payment will be made on the established quantity listed unless authorized alterations are made. Established quantities are often listed with prescribed tolerances set forth to allow for minor construction changes without requiring that final measurement be made. Authorized alterations are considered to be substantial changes in construction items which would usually be authorized by revised plans or

specifications, and may be listed in two categories. (See *SSHC Subsections 104.02, 109.01 and 109.04.*)

- The first type would be an alteration of a minor item and does not involve supplemental agreements. In this case, payment will be made at the contract unit price for the actual total.
- The second type is an alteration of a major item involving an increase or decrease of more than 25 percent of the item. This situation may involve a supplemental agreement stipulating changes in the actual quantities of the work and establishing (if necessary) a new price per unit price for such work. If there is an overrun, the original contract quantity plus 25% is paid for at the bid price. The extra quantity above 125% is paid for at the new negotiated cost. If there is an underrun, the entire quantity is paid for at the new negotiated price per unit. Payment would then be made at the new unit price for the increased orders and quantity.

105.03 CANCELLED ITEMS (MATERIALS FURNISHED BY CONTRACTOR AND NOT USED DUE TO CHANGES IN PLANS)

The Department will, if the contractor desires, take over unused material at the cost delivered to the location at which it is accepted by the Department.

It will be necessary for the District Engineer or the Project Manager to initiate a change order providing for payment for such materials. The item included in this agreement shall include the phrase, "delivered but not incorporated in the work", in order to specifically identify such materials. The unit price established for items of material furnished by the contractor and not used because of a change in plans will usually be based on the actual cost of the materials, plus 10 percent to cover overhead, handling, other costs and profit. To substantiate the unit price established, the Project Manager should obtain a copy of the receipted invoice for the material and attach it to the supplemental agreement.

@ **Change Order/Supplemental Agreement must be created to pay this.** It will also be necessary for the Project Manager to include an explanation of the transaction in **the Change Order / Supplemental Agreement**. Complete information regarding the disposal made of the material, such as the supply base to which it is delivered or the project on which it is used, is essential. The party to whom it is delivered should prepare a DR Form 329, "Imprest Inventory", providing for the proper transfer of the charges for the material.

Payment for such materials must be included in the final estimate as a nonparticipating contingency.

105.04 PARTIAL PAYMENT

The contractor is to be paid once a month for satisfactory progress on the basis of work completed during that month. The Project Manager prepares a contractor's estimate in the computer stating the estimated quantities for items of completed work to date. This document is forwarded to Lincoln through the District Engineer's office for processing and payment via E-mail.

When the value of the work completed during the first half of the contractor's pay month exceeds the amount stipulated in the specifications (usually \$10,000.00), a semi-monthly contractor's estimate is prepared. All partial payments are made on satisfactory work and materials only, as evidenced by complete certifications or test results as required. Defective work or material shall not be included for payment until the defect has been remedied.

105.05 FIELD MEASUREMENT AND PAYMENT

Photographs and Video Tapes - Documentation on film can save many questions and provide critical answers. Take a picture any time it may be helpful.

Field Records - General - Payment for most contract items is based on the plan quantities. Final measurements should be avoided as long as the specifications permit and the contractor does not dispute the quantities. Their construction should, however, be documented as described under "Inspection Notebooks" with the statement (if applicable) "Constructed as per plans" and substantiating data or measurements, if necessary, also entered in the record.

Field records must be properly kept to substantiate that the contractor has conformed to the requirements of the plans, specifications, and Special Provisions both as to quantity, usually involving measurements, and quality, usually involving tests, of the work or material items used on the project.

Instructions and examples of preparation of specific records may be found in this manual in *Appendix 3*.

- @ **Field SiteManager Entries or SiteManager Item Documentation** - Field measurements made for pay items of work and records of placement of materials shall be entered directly in SiteManager.
- @ Field **and lab test results** on quality of materials **will be entered into SiteManager. Record and document tests using approved Material Sampling Guide and SiteManager procedures.**
- @ The **item documentation** records should indicate the stationing used, date placed or constructed, and sketches with dimensions if necessary to give clear understanding of the placement and material used. The names of the party or engineer making the measurements and dates performed must be entered in **SiteManager or included with the supporting documentation.** Materials used in the construction of the project for which no direct payment is made but are considered subsidiary to other pay items should also be documented in **SiteManager, Materials Management Section.**

@ **SiteManager** should contain a detailed summary of all shipments received for the project, including the kind of material, the identification number, net mass, date received, delivery point and, if possible, the point of origin. Include distribution to the proper group of the contract and information on material received but not used on the project.

@ The laydown inspector shall **enter in SiteManager** the activities required in the performance of his/her job. This would normally include such items as types of equipment being used, equipment checks, tonnage checks, thickness checks, temperature checks of mixture, etc. **All entries are to be dated**. Also, we would like to bring to your attention that the inspectors are to sign the scale ticket on receipt and acceptance of the material. Base all entries on facts, not opinions.

@ Final computations shall be entered directly into **SiteManager or other approved recording and documentation methods used in conjunction with SiteManager**. Operations of performing computations and checking computations shall be identified on each page of computations by operation, date, and the name or initials of the individual.

@ Plans, tables, and sketches provide supplementary details necessary to clarify **SiteManager entries** for pay items. Any such plan or sketch shall be **saved electronically in the project files**. Supplementary plans and sketches are sometimes necessary to define the extent of a pay item sufficiently enough to remove any doubt as to its limits.

@

- A good technique is to build the sketch or table in the computer and then **save it electronically**.

Supplementary sketches are sometimes necessary to show measurements of irregular areas for both pavement removal and the construction of new pavement.

@ Computation **spreadsheets should be** used where detailed computations are necessary to determine pay quantities. These computations are made from **SiteManager**, cross section, or sketch information and should be fully referenced in **SiteManager**. It is necessary that all computations **be referenced in SiteManager or saved electronically in a project folder (Read Only Access)** so that the computations can be checked for correctness of method and accuracy.

Scale Tickets - Scale tickets are used to substantiate quantities of materials which are paid for by mass. The original copies (white) should be submitted with the final records of the project to the District Final Reviewer. Preparation of scale tickets and distribution is discussed in the section pertaining to asphaltic concrete inspection (Subsection 507.12 in this manual)

105.06 CONTRACTOR'S ESTIMATES

SSHC Subsection 109.07 allows payments to the contractor if satisfactory progress is being made. These contractor's estimates will include quantities and amounts for items of work completed to the date of the estimate.

@ Progress estimates are completed in **SiteManager** by the Project Manager and signed electronically. It is the District Engineer's responsibility to review and approve the estimate in a timely manner, sign it electronically, and forward it electronically to the Controller.

Upon receipt by the Controller, the estimate is processed further by the Construction and Controller Divisions before it is released for payment.

@ On all Federal-Aid projects, it is necessary to separate participating and nonparticipating items of work on the progress estimate form by dividing them into separate summaries for each project in a contract. Each line is properly divided by the Controller Division when the item is loaded in **SiteManager**. This procedure is done to comply with our agreement with the Federal Highway Administration regarding procedures for current billing and current audits. Items which are added to the contract should be included in the proper group in the participating or nonparticipating summary as applicable. Items added by change order-supplemental agreement should be considered as participating unless the agreement form is marked "nonparticipating" when returned from the Lincoln Office. The District Office should be consulted for further information on any item for which there is some uncertainty regarding its status.

For contracts which include wage rates, progress estimates shall not be released by the Project Manager until the contractor and subcontractor have submitted all delinquent payrolls and Forms WH-348. These reports shall be considered delinquent when they are not in the Project Manager's hands by the seventh day after the date on which the employees are paid. Notify the contractor by letter, with a copy to the Construction Division, of any delinquent payrolls and WH-348's in advance of the estimate date. The estimate should be prepared at the regular time and forwarded immediately upon the receipt of the payrolls.

Estimate Preparation

Please remember to update Line 2 (current quantity) on the estimate for all items added by plan revision or supplemental agreement. This adjustment should be made as soon as you receive the plan revision or supplemental agreement.

The Controller Division depends on Line 2 being accurate so they can allocate sufficient funding to each project.

DISTRICT ESTIMATE SCHEDULE		
District No.	Regular Estimate Date (Only if money due contractor)	Alternate Estimate Date (\$10,000 or more must be paid)
*1	1st Saturday of Month	3rd Saturday of Month
2	2nd Saturday of Month	4th Saturday of Month
*3	1st Saturday of Month	3rd Saturday of Month
4	2nd Saturday of Month	4th Saturday of Month
5	4th Saturday of Month	2nd Saturday of Month
6	3rd Saturday of Month	1st Saturday of Month
7	4th Saturday of Month	2nd Saturday of Month
8	4th Saturday of Month	2nd Saturday of Month

* Districts 1 and 3 use the 5th Saturday of the month instead of the 1st Saturday of the future month as Primary Cutoff day when there are 5 Saturdays in a month.

Stockpiling:

SSHC Subsection 109.07, Paragraph 4. provides that estimates may also be allowed for acceptable nonperishable materials meeting the requirements of the plans and specifications and delivered in the vicinity of the project or stored in acceptable storage places. This will generally apply to aggregates, structural and reinforcing steel, metal specialty items delivered but not incorporated in the work, and other materials which cannot be used for extended periods of time because of delays beyond the contractor's control. The amount included in the estimate will be determined by the PM, but in no case shall it exceed 100-percent of the value of the materials as shown by copies of receipted invoices or costs. Partial payments shall be listed under the stockpiling category with an "800" series number.

As the material is used, the payment for this material should be reduced accordingly in the stockpile item on the estimate.

Payment for stockpiled material is "permissive", and it should not be interpreted to be a requirement in cases where the material will remain in storage a comparatively short time (less than one month). When there is a question as to the inclusion of a material for payment, the District Construction Engineer should be consulted for instructions.

SSHC Subsection 106.02 states that:

All materials are subject to and will be inspected, tested, and accepted by the Project Manager before incorporation in the work.

SSHC Subsection 1001.02 requires:

Materials which must be documented by a certificate of compliance, certified test, or test reports shall not be incorporated into the work until such certificates have been delivered to the Department and verified for compliance.

@

It follows from the above that material items which have not been tested and accepted, or for which appropriate certification, as defined in the Materials and Research Manual, has not been delivered to the State, should not be included on an estimate for payment. Likewise, no material item which has been stored in accordance with Paragraph 4. of Subsection 109.07 of the Specifications should be included on an estimate for payment unless the appropriate test data or certifications for compliance with the specified requirements are in the files of the Project Manager **and documented in SiteManager.**

The Project Manager shall maintain documentation of progress estimate quantities.

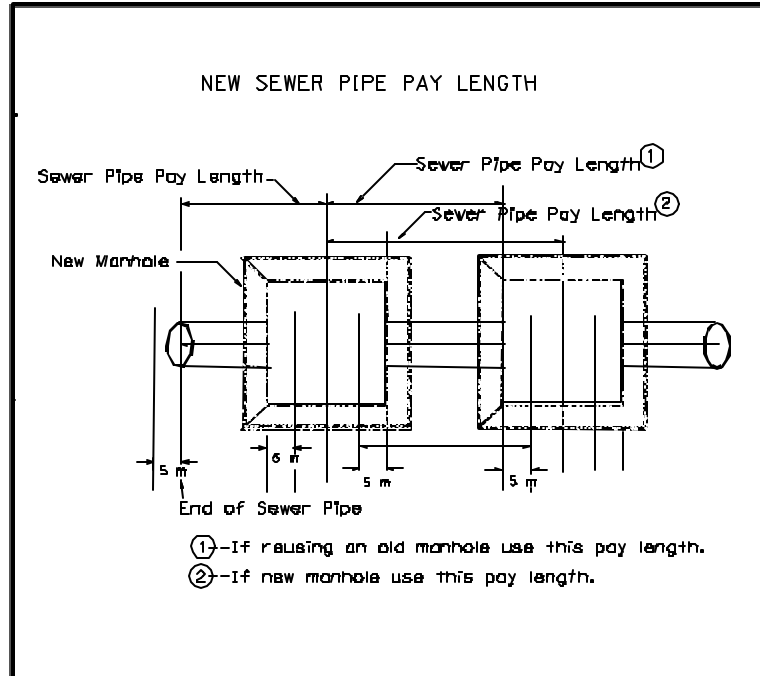
Types of Contractor Estimates – SiteManager has only three types of estimates:

- **Progress** – all estimates prior to the “Final Estimate.”
- **Final** – generated once District has completed its review and is ready to forward the project to Lincoln for “Finaling.”
- **Supplemental** – all estimates generated to change the “Final Estimate.” Additional estimates are obsolete in SiteManager. However, the PM must notify the Construction Division when a project is complete – which used to be the purpose of the additional estimate. In SiteManager, the PM must send a Lotus note to “DOR-CONST-COMPLETION NOTIFICATION.” The Finaling Manual explains what must be included in the “note.”

Processing Estimates – Each District should direct a copy of signed estimates to the Construction Division printer (CON1) as soon as possible after affixing the electronic signature.

Each District is encouraged to sign and print estimates as often as possible. The uniform and steady arrival of estimates in Lincoln is encouraged and appreciated by both the Construction Office and the Controller Division.

Contractor's Statement of Compliance (Form WH-348) - Form WH-348 shall be submitted for each weekly payroll period by each contractor and subcontractor on all projects financed by Federal Funds. (Form WH-348 is not required on other than Federal-Aid projects.) The WH-348 form should be attached to and submitted to the



Guardrail - The contractor shall be allowed payment for linear meters (linear feet) of guardrail complete in place measured from center to center of end posts (SSH Section 902).

Seeding and Slope Protection - Example field book records for Cover Crop Seeding, Seeding, and Slope Protection are in *Appendix 3*.

105.08 BORROW AND LOCAL PIT MATERIALS OBTAINED BY THE CONTRACTOR

Under State Option - All amounts to be paid by the contractor for royalty and borrow costs, to comply with the terms listed in the option block shown in the plans, will be deducted from the payment due on the final estimate. Such amounts will also be included in the retention in the additional estimate. This Department will make payment directly to the owner. Before such payment can be made, it will be necessary to obtain concurrence from the contractor as to the quantities and amounts in order to eliminate the possibility of overpayment to the owner. For this purpose, the Project Manager shall

@ prepare and forward a letter to the contractor, substantially in accordance with the example included in *Appendix 2*.

The receipt of such letters from the Project Manager and contractor, plus the required releases from the pit owners, will complete the records required by the Right of Way Division to enable them to make payment to the owners of local pits. In the case of borrow, taken on an acreage basis, sketches are to be prepared showing the dimensions of the individual pits, the name of the owner, the description of the land subdivision, ties with the project centerline and computations for the acreage included in the letter to the contractor. Such sketches shall be forwarded to the Right of Way Division together with their copy of the letter to the contractor.

When the option block in the plans for the local pit includes payment for incidental items such as temporary fencing, reseeding, crop damage, payment for haul road, etc., the consideration for such incidental items will normally be on a lump sum basis and the lump sum payment for such items shall be included in the letter to the contractor. If payment is stipulated in the option block, for such incidental items, on other than a lump sum basis, the Project Manager shall request the Right of Way Division to advise the proper method of handling the item.

When work is to be suspended for the winter season, or for any other reason, for a considerable length of time and it is desirable to make partial payment to the landowners, the necessary information to authorize partial payment shall be forwarded to the Right of Way Division and, in such cases, it is not necessary to advise the contractor. In the event that a section of the project, involving optional borrow pits, is completed or the work is completed on some of the local pits, the normal letter to the contractor should be prepared in which it shall be noted that information will be forwarded at a later date for the remaining borrow or material pits.

In order to complete the records and eliminate any questions, the Project Manager's letter to the contractor must cover all optional borrow and local pits shown in the plans, regardless of whether they are actually used.

There have been some cases where a pit under state option does not appear on the plans for a particular project but does on an adjacent project. The contractor, if he/she uses this pit, must still be responsible for royalty payments.

Royalty payments for local pit material will normally be made on a cubic meter (cubic yard) basis and such quantities may be determined by preconstruction and final cross sections. In cases where payment to the contractor is based on truck measurement the royalty payment may be based on the same measurement, or by using weight conversion factors where payment to the contractor is based on units of mass.

Borrow and Local Pit Materials Furnished by the State or County and Not Involving the Contractor - When borrow or local pit materials are purchased from the owner directly by the Department or County, and no option requirements involving the contractor are included in the plans, substantially the same information must be forwarded to the Right of Way Division. However, no letter need be written to the contractor. The PM must obtain a site release from the landowner on these Department obtained borrow sites.

@

105.09 SUMMARY OF FINAL QUANTITIES

Project Managers are required to use only black lead pencils in the original preparation and checking of all field records and final computations in the field offices. The District Office review should be indicated by red check marks, initials and dates. Corrections shall be made with red pencil. If any further changes or corrections are found necessary in the Lincoln Office, they will be made in blue or green pencil. This method will eliminate any question at some future date as to where changes or corrections in the records originated.

@ **Each pay item in the contract must be summarized in [SiteManager](#).**

105.10 MOBILIZATION (SSHC Section 112)

Method of Measurement and Basis of Payment

The percent of payment for mobilization under a group of work is based on the percent of work completed on the original contract group amount. Accordingly, when two or more projects are included in the contract and work has been performed on only one project the quantity for mobilization should be paid to all projects based on the percent of work completed on the original contract group amount. In this case mobilization may be paid on a project when no work has been performed on the project.

105.11 SALVAGED PROJECT MATERIALS REPORTING

Many project plans indicate that some removal items shall be stockpiled or salvaged to a nearby maintenance facility. To accomplish documentation of these times, a DR 147a, "Stock Returned for Credit" form has been developed.

The form shall be completely filled out any time project materials are salvaged to a maintenance facility. The form needs the signature and initials of the project inspector and the maintenance employee who received the material.

@ Distribute a copy of the completed form to the Project Manager, District Maintenance Superintendent, [Logistics Division](#), project file, and the contractor. Purchasing & Supply will add the salvaged items to the appropriate stock inventory for the maintenance facility that received these materials. Include a copy of the completed form in the final payment packet for the project.

106.00 -- PROJECT FINALIZATION

106.01 FINAL PAYMENT TO CONTRACTOR

NDR policy is to retain one percent. This retainage is specifically withheld to cover:

- The amount of any possible overpayments or adjustments to contract items and change orders discovered during an audit (State and/or FHWA).
- Any assessed liquidated damages.

Nebraska Code also requires payment of interest on retained contract funds. The interest shall begin to accrue on retained funds on the 61st day after the project is complete provided all of the contractor's documents are on file with the Department.

On projects involving different fundings such as Federal, Interstate, County, State and City, the Project manager must review the project funding agreement and make sure costs are properly recorded on the DR Form 44, "Summary and Distribution of Cost".

106.02 PRICE ADJUSTMENT CHANGE ORDERS

Price adjustment deductions are processed by change orders. If additional price adjustments come up later, a second change order must be prepared; but such increases or decreases are processed as separate change numbers.

106.03 EQUIPMENT PURCHASED BY CONSTRUCTION CONTRACTS

Occasionally, items of equipment are shown as contract items and then taken into the Department's inventory when their use on the project is no longer required (variable message boards, for example). It is required that the contractor be given written confirmation when such equipment is ultimately received and title transferred to the Department.

In order to provide an adequate audit trail, it is required that the letter of confirmation should include detailed information regarding brand, model, serial number, date of transfer, current location and a statement indicating the condition of the equipment when title was transferred.

@ A copy of the letter of confirmation should be forwarded to the **Logistics** Division (in addition to your normal distribution of project correspondence) so that it may initiate the appropriate paperwork reflecting addition of the equipment to the Department's inventory.

106.04 PROJECT ACCEPTANCE AND AUTHORIZATION FOR FINAL PAYMENT

The Final Estimate when signed by the Construction Engineer is authorization to the Controller's Office to release the final payment to the contractor.

The schedule will be revised periodically. Any questions or comments should be referred to the Property Management Section, (402) 479-4770.

Conversion of Existing Direct Measurement Earthwork Pay Items to Established Quantity Pay Items

Certain earthwork items may be converted from being direct-measured for final payment to being paid as established quantities. This policy is to expedite the release of final payment to the contractor, reduce possible interest payments to the contractor, and relieve a portion of the workload performed by field personnel.

The following items of work will be eligible for conversion:

1. Excavation
2. Excavation, Borrow
3. Other earthwork-related items when approved by the Construction Engineer

Direct-measurement items may be converted to established quantities when the following requirements are met:

1. The project has been staked and built according to plan, or the plan quantity has been adjusted to account for field changes.
2. The plan quantity has been adjusted for any obvious errors, and the contractor has been notified of the adjustment.
3. The Project Manager has made written notification to the contractor of the proposed change in the method of measurement, and the contractor has agreed to the proposal in writing.
4. **If the contractor has agreed in writing to accept plan quantity including field adjustments and revisions, it is not necessary to create a new “established quantity” pay item. Payment will be made under the original contract item.**

@

Sample Letter

1997

CROP DAMAGE PAYMENT AFFIDAVIT

Project:

Tract:

This is to certify that I, the undersigned, agree on the amount of \$_____ which is being paid for _____ (acres) of _____ damaged during construction, based on the schedule prepared by the State of Nebraska, Department of Roads.

Owner/Tenant

Social Security #
Federal Identification #

THE CROP PRICES HAVE BEEN COMPILED USING DEPARTMENT OF AGRICULTURE AND UNIVERSITY OF NEBRASKA STATISTICS. THE PRICE REFLECTS AVERAGE YIELDS AND MARKET PRICES LESS THE COST OF HARVESTING AND MARKETING.

CROP	1/4 Acre	1/2 Acre	3/4 Acre	1 Acre
Irrigated corn	\$75.00	\$150.00	\$225.00	\$300.00
Dry corn	\$40.00	\$ 80.00	\$120.00	\$160.00
Irrigated soybeans	\$62.00	\$124.00	\$186.00	\$248.00
Dry soybeans	\$48.00	\$ 96.00	\$144.00	\$192.00
Wheat	\$31.00	\$ 62.00	\$ 93.00	\$124.00
Oats	\$21.00	\$ 42.00	\$ 63.00	\$ 84.00
Milo	\$32.00	\$ 64.00	\$ 96.00	\$128.00

Project Manager

Date

106.09 STATEMENT OF MATERIALS AND LABOR

A "Statement of Materials and Labor" (Form FHWA-47) is required for federal-aid projects that have contract cost (including change order adjustments) of \$1,000,000 or more. Detailed instructions for completing Form FHWA-47 are on the back of the form. Blank forms are available from the Construction Division. A blank copy is provided in *Appendix 2*.

Upon contract completion, each subcontractor must submit a completed Form FHWA-47 (Part "B") to the prime contractor. Subcontractors shall include their name and the word "sub" in the blank space at the top of the form.

The prime contractor shall combine the data from each subcontractor with their own data on one form. Prime contractors shall include their name in the top margin of the "combined" form, note the form is "combined", and attach a listing of all subcontractors involved.

When completing Part "B," contractors shall:

- Report only use of material items that are listed on the form.
- Pay attention to the "units" being requested. "Quantity" entries must correspond to the form's "units."
- Enter required information in the correct column(s).

Prime contractors are responsible to furnish the Construction Division Headquarters (Lincoln) three completed FHWA-47 "packets" before a final pay voucher can be processed. (One packet shall be the original and two packets may be photocopies of the original.) Each FHWA-47 "packet" shall include:

- The prime contractor's combined contract information
- All FHWA-47 forms and any relevant supporting documents furnished by subcontractors.
- Composite of all subcontractors listed on subcontractor request form(s)

Upon receipt of FHWA-47 forms, the Construction Division shall complete Part "A" and verify that:

- An item of material used by a contractor has not been omitted.
- All "starred" line items have received a response or entry.
- Costs reported are reasonable and do not have obvious errors.
- The prime contractor has included required information from all subcontractors on the "combined" form.

106.10 AS BUILT PLANS

An extra set of full size plans will be furnished the Project Manager for use as as-built plans. The Project Manager may request an additional set of plans from the Construction Division for as-builts if needed. The as-built plans shall be an exact representation of the completed work. Any revised plan sheets must be included and the sheets they replace should be discarded. All special plan sheets must be included. The S1 sheets need to be corrected to show the Final Quantities including additional items of work.

@

In preparation of these plans, only black pen shall be used. Lines, dimensions and notations shown in the original plans which have been eliminated or corrected shall be "X ed" (crossed out) and boxed with solid lines. Dashed lines shall be used to indicate any as-built lines, dimensions, or tie points which do not conform to the original plans. For example, a 2' x 65' 8" (600 mm x 20.0 m) pipe culvert is constructed at Station 103+50, whereas the plans called for a 2' x 63' 3" (600 mm x 19.25 m) pipe culvert at Station 101+50. The outline of the culvert at Station 101+50 shall be boxed and the notations describing the work "X ed" within the box with solid lines. The outline of the as-built culvert, in dashed lines, and corrected description notation should be shown at Station 103+50. In striking out figures and notations, care should be used to avoid obliterating the original figures.

Surfacing:

1. Beginning and ending stationing of each type and width of surfacing constructed.
2. Location of all option pits used in connection with the construction of the project. If any plan pits are not used, designate by the words "Not Used".

Processing As Built Plans

1. Project personnel will prepare one (1) full-size set of As Builts.
2. Cities, counties, etc. that have money involved or a special interest in the project will be asked by the Project Manager if they need/want a complete copy of the As Builts or only specified sheets.
3. The As Builts will be submitted to the Construction Division with the final records for finaling with notification of the number of complete copies or specified sheets desired.
4. The final review will be performed.
5. After the final review is completed, the specified sheets or complete copies, as requested by the District, will be copied in half-size sets. The copies will be returned to the District within three (3) to four (4) weeks after submittal to the Construction Division.
6. The full-size set of As Builts will be submitted to the Communication Division for microfilming after the final review is complete and the half-size copies of the As Builts are made.
7. After the As Builts have been microfilmed, the Communication Division will submit the As Builts to the Transportation Planning Division for their use.
8. Upon completion of their work, the Transportation Planning Division will periodically return the full-size As Builts to the District, via truck.

Lighting and Signals - On all roadway lighting and signal projects, a set of "as-builts" will be prepared, pertinent to the wiring alignment, showing the exact location of conduit or cable runs, pull boxes, and any other information which would be beneficial in case of maintenance problems or construction activities in the area. When "as-builts" are submitted to the agency at the time the agency is notified by letter of the acceptance of the installation and to assume the maintenance.

Clearance Letter

The Project Manager shall submit a letter to the Construction Division (with copies to Motor Carrier Permits & Facilities Maintenance) indicating clearance on bridges, sign trusses, and other structures that create a clearance limit.

106.11 OVERRUNS AND UNDERRUNS LETTER

The summary of overruns and underruns letter, which used to be submitted when a contract is finalized, is no longer required. However, a DR Form 74, Cost Overrun/Underrun Notification is required whenever contract quantities overrun/underrun by \$50,000.00 or more. This letter must go to the Construction Division and the Controller Division so that appropriate redistribution of funds is made as soon as possible. This letter is sent as soon as the change in contract quantities is known. The Controller Division will obtain appropriate approvals.

@ 106.12 CONTRACTOR EVALUATIONS

The intent of the Contractor Evaluation is to report strengths and/or weaknesses of a contractor's project-related activities, including paperwork, material documentation, attitude, cooperation, and the actual contracted work. It is suggested that remarks be included to substantiate or help explain significantly high or low ratings or other unusual circumstances on the project. The Construction Division maintains a file of the completed forms, reacts to low evaluations, and seeks to improve the performance and project administration of contractors doing work for us.

The project manager should make note of significant events occurring throughout the life of the project to assist in the preparation of the evaluation when the work is complete. In so doing, perhaps problems can be discussed and resolved as they occur. At a minimum, significant problems reported on a contractor's evaluation should be discussed with him or her when the evaluation is presented.

Evaluations are used as a factor in determining the amount of work on which a contractor may bid. Therefore, it is extremely important that contractors are evaluated realistically, factually, and without bias. In this regard, it is equally important that evaluations are completed promptly. To be at all meaningful, data from the EOC's must be current - - and **ALL** of it must be in the system.

The EOC should be completed and submitted to the Construction Division within 30 days of completion of work. For subcontractors, the EOC should be submitted within 30 days of the time you are relatively certain that the subcontractor's work is complete. For a prime contractor, the EOC should be submitted within 30 days of the project completion date established in the District Engineer's letter of tentative acceptance to the contractor. (In other words, the prime contractor's EOC will always be the last EOC to be completed. The performance of all subcontractors reflects on the prime contractor's overall rating, so it is only proper that the prime contractor's overall rating, so it is only proper that the prime's EOC not be completed until the project is entirely complete.)

The Contractor Evaluation is to be completed on every contractor and subcontractor - - except "trucking" subcontracts. (Trucking subcontractors may receive an optional evaluation at the PM's discretion.) SiteManager identifies whether or not a subcontract is

@ for trucking. An evaluation should also be completed on all bridge painting jobs regardless of size.

Contractor evaluations are required for subcontractors at **any** level - - 2nd tier subcontract, for example.

Project Managers shall prepare and sign the evaluation and forward the original to the Construction Office in Lincoln. For projects inspected and managed by consultants, it is appropriate to have the evaluation signed by the local entity's project manager. (The document itself, however, must be prepared on the **RUG** so the results are posted to the database.)

A copy of the complete evaluation must also be furnished to the contractor or subcontractor being rated. Prime contractors deserve to see their ratings as well as those of their subcontractors, so make sure that both get a copy.

All contractor evaluations shall be prepared using the checklist system provided in **RUG**. The use of this system automatically enters the required data into the database.

For evaluations of subcontractors, report type of work done by that subcontractor.

Contractor evaluations are required for subcontractors at **any** level, including 2nd tier subcontractors.

The intent of an evaluation is to report strength and/or weakness of a contractor's project related activities including paperwork, material documentation, attitude, and cooperation. Special attention should be given to contractor ratings of "poor" and "unsatisfactory." Remarks should be included for any individual item(s) that is rated less than fair. Also good remarks should be included when a contractor is given a high rating or deserving recognition.

The Construction Division maintains a file of the completed form, reacts to low evaluations, and seeks to improve contractor project administration. Evaluations are also used as a factor to establish bidder qualifications. Therefore, it is very important that contractors are evaluated realistically, factually, and without bias. The rating system developed is intended to produce a rating of "good" when the minimum acceptable performance requirements are met.

A series of less than satisfactory evaluations may be grounds for disqualifying bidders from further contracts or reducing their bidding qualifications.

It is anticipated that lower than average ratings would have been discussed at a meeting between the Project Manager and contractor representatives prior to form submittal. A contractor should have an opportunity to discuss and understand why a low rating was given. Further, a contractor should be given (if requested) a critique of corrective actions which would prevent reoccurrence of low rating(s).

The RDP Form 344, Evaluation of Contractor, is available on the computer or you can use paper copies.

To provide a broader evaluation of the contractor's performance of his/her work with reference to his/her equipment, personnel and prosecution of work, RDP Form 344 "Evaluation of Contractor" has been devised. This report is to be completed by the Project Manager for the prime contractor and subcontractor(s) for each separate time allowance under a contract and submitted with the final computations.

The contract value for the prime contractor shall be the original contract value (not final value). The subcontract value used shall be that authorized by the subcontract approval letter. All subcontract approval letters will show the value of the work being subcontracted.

The working days allowed shall reflect all time extensions approved either by letter from the Construction Division during the progress of the work or by supplemental agreements. If a time extension is forthcoming due to "extra work" a correction in the field entry will be made by the Construction Division. However, extra work should be a consideration taken into account in evaluating the prosecution of the work. When this is the case, an explanation to this effect should be made on the reverse side of the form.

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@

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@ **106.13 LETTER OF TRANSMITTAL – FINALIZED PROJECTS**

The Project Manager shall complete a letter of transmittal with project documents when they are forwarded to the District Reviewer. The District Reviewer will also create a letter of transmittal when he/she forwards the records to the Construction Division. The transmittal letter shall include an itemized list of all field notebooks, cross sections, computation sheets, forms, letters, statements, temperature charts, etc., which are being transmitted, so that the shipment can be checked to determine whether it is complete when received. When overhaul or additional haul computations were made in the Lincoln Office, attention should be directed to that fact. If there is any question regarding the accuracy of any of the computations, or there is any item which should be given special attention in the District Office, the items in question should be explained in the letter of transmittal. If the project was completed within the working day time allowance, a working day resume is not required. The transmittal letter should contain a statement indicating whether or not the work was completed within the contract time allowance and/or any internal time limits. A copy of the Project Manager's transmittal letter shall accompany the project records and final estimate when they are forwarded to the Lincoln Office.

When submitting final records, please label all computation and summary sheets with the item numbers for which documentation is being provided.

106.14 FINALING PROCEDURES

See Construction Division's Final Review Process Manual for detailed steps to finalize a project.

106.15 UNAUTHORIZED WORK

The contractor should not be permitted to perform work without line and grades established by the Project Manager.

The contractor should not be permitted to perform any work prior to the execution of the contract by the Construction Engineer. The Project Manager can request to be advised by telephone when the contract has been executed, if the contractor is "standing by" awaiting such execution to begin work.

106.16 USE OF ADJACENT LAND UNDER CONTRACT OR LEASE

We no longer require the contractor to provide a release letter. The contractor is responsible to the landowner and the Department will stay out of the agreement unless the Department acquires the access rights.

Option pits obtained by the Department will require a site release. The Project Manager shall contact the landowner and obtain the site release. The release should be obtained as soon as possible while the contractor is still on site with equipment to make corrections.

106.17 FINAL CLEANING UP

The importance of timely cleanup of cast-in-place concrete structures should be discussed at the pre-construction conference. It is the Department's policy to request the contractors to perform the necessary cleanup in flood plains at the earliest possible time to prevent scrap lumber, nails, form ties, etc., from being flushed out on adjacent landowners.

If this material is deposited on adjacent landowners, the contractor must satisfactorily gather and dispose of it before final acceptance of the work involved. It is in the contractor's and the Department's best interests to keep this cleanup work "current".

The District Engineer should be advised if the contractor refuses to perform this work in accordance with this policy and a field book entry made each time the contractor was contacted. Progress payments can be withheld until the area is cleaned.

The contractor shall make a final cleanup of the highway, borrow pits and all ground (off or on the project) occupied by him/her in connection with the work, leaving it in a neat and presentable condition.

- 6. All contract pay items will be properly documented.
- Safety Areas:
- 1. Maintained Traffic
 - a. Contractor's cars and trucks must adhere to project traffic control procedures.
 - b. Flaggers must be certified and use proper procedures.
 - 2. The contractor should be told to stop all unsafe activities such as:
 - a. Speeding trucks and other equipment.
 - b. Inoperable back-up alarms.
 - c. Inoperable or nonfunctional strobe lights.
 - 3. Contractor vehicles shall be parked beyond the lateral obstacle clearance.
 - 4. Worker protection barriers should be placed as shown in the plans.
 - 5. Traffic markings should clearly indicate traffic flow.
- NDR Tests:
- 1. Nuclear Density NDR T 238
 - 2. NDR T 99 Soil Density (See Earthwork)
 - 3. Soil Type NDR T 87
 - 4. NDR T 2 Sampling Aggregate from Stockpiles
 - 5. Moisture: NDR T 217, T 205, or Nuclear Density Gauge AASHTO T 238/ASTM D 2922.
- Sampling Requirement/
Freq.:
- 1. See Materials Sampling Guide
- Inspector's Records &
Forms
- 1. Grading diary
 - 2. Water application notebook
 - 3. Field book
 - 4. DR Form 8, Water Applied Haul Sheet
 - 5. DR Form 86, Weekly Report of Moisture-Density Tests or Nuclear Density Machine Output
- NDR Point of Contact
- 1. Materials & Tests Soil Mechanics Engineer
479-4678

202.00 GENERAL GRADING INSTRUCTIONS

Grading Inspection

A grading inspector should devote the majority of his/her time to observing and checking the contractor's excavating, drying, moistening, spreading and compacting operations, and securing samples, vary the balance of his/her time in testing samples and making neat and accurate records. The grade inspector will need to check moisture (if control is required) and density at the rate shown in the Materials Sampling Guide (usually check moisture and density once for each 2,500 cubic yards (2000 m³) placed and once for each 1000 feet (300 m) of shoulder or subgrade).

Blue Tops

After the roadway excavation and roadway embankment has been constructed substantially to grade elevations, the construction survey party will set finish grade stakes for finishing the grade or subgrade to the lines and grades shown in the plans. The blue top book elevations must be checked to insure they conform to the information shown on the plan cross-sections.

Rounding of Hinge Points

The Department has determined that the rounding of "hinge points" in the cross-sectional elements can significantly reduce their potential as hazards. Rounded slopes reduce the chances of an errant vehicle becoming airborne, reduce the hazards of encroachment, and afford drivers more control over their vehicles.

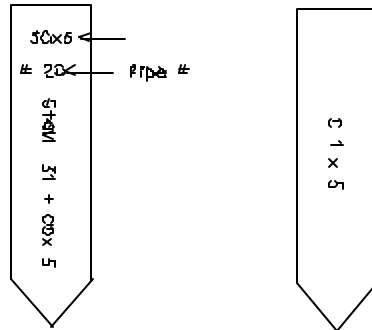
The Construction Division suggests that finish grading and ground preparation activities that result in the rounding of hinge points be permitted, if not encouraged. For example, an 8' disc that "hangs over" a 6' shoulder will provide the desired effect and should not be ruled unacceptable. However, this suggestion is not meant to imply that the cuts and embankments may be built to other than the cross-sections shown in the plans.

Erosion Control

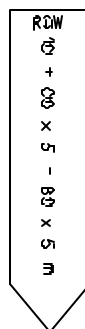
The contractor must have as a minimum silt fence or other erosion control measures as shown in the plans installed to keep silt on our ROW before any grading is allowed.

CULVERT STAKES

Offset



ROW STAKES



Green-yellow flag for easements

Orange flag ROW

203.00 CLEARING AND GRUBBING (SSHC Section 202)

203.01 CONSTRUCTION METHODS

There may be considerable elapsed time between an estimate of clearing and grubbing and the actual work. If actual site conditions are different than those shown in the contract documents, the following suggested resolutions are provided:

- @ • If the pay item is "General Clearing and Grubbing" then no action is necessary because tree removal is subsidiary **for trees with circumference of 80 inches or less at 40 inches above ground level.**
- If the pay item is "Large Tree Removal" then a new tree count should be taken and recorded before the contractor starts work.
- @ • If **a** tree has been cut, leaving branches and the stump, payment is covered under "Clearing and Grubbing" or "Large Tree Removal." If the stumps is the only item remaining and payment method is large tree removal, you would count just the stump as a tree.
- If a fence is partially removed or in poor condition but requires an identifiable removal operation, full price for fence removal may be made.
- @ • Where brush and/or junk has recently (**After the letting was** announced) been deposited within the right-of-way, a price agreeable to both the contractor and the Project Manager may be negotiated or a force account extra work order may be used.

Disposal of Waste

Disposal of the clearing and grubbing waste is restricted according to applicable federal, state, and local laws. Disposal options include:

- Open Burning
- @ • Contractor must obtain necessary permits. In locations where burning is allowed, the burning of the waste must be located at least **1/4 mile (400 m)** from any inhabited building.
- Chipping
Chipping of the down timber for mulching material.
- Firewood
Salvage of the logs for firewood.
- Landfill

Disposal at a "yard waste" landfill.

204.00 REMOVAL OF STRUCTURES AND OBSTRUCTIONS

204.01 CONSTRUCTION METHODS

Removal and Disposal of Old Pavement

@ Pavement is removed from all cuts and fills with less than **3 feet (1 m)** of cover. The removed concrete is to be broken into pieces with an area of **2 square feet (0.2 m²)** or less if placed in fills. (*SSHC Section 203*)

@ Where existing PCC pavement would be located more than **3 feet (1 m)** under the proposed profile grade, the PCC pavement will be required to be broken into surface areas that will not exceed **4 square feet (0.4 m²)** when left in place. If the existing pavement has been resurfaced, the asphalt resurfacing will be removed if the PCC pavement is to be used as slope protection or in a waterway. (*SSHC Subsection 205.03*)

Disposal of Asphaltic Concrete Pavement

The contractor shall manage the material in accordance with all current federal and state rules and regulations. (*SSHC Subsection 107.01*)

@ Salvaged asphaltic cement concrete pavement may be used as special backfill material. When intended for special backfill material, the ACC pavement is normally removed by scarification. Removed bituminous materials may be placed in the outer slopes of embankments, **12 inches (300 mm)** below the finished shoulders and foreslopes. (See *SSHC Subsection 205.03*)

Hazardous Material (Wells, Asbestos Fibers in ACC, Building Removal, Underground Storage Tanks, Archeological Remains)

Appropriate federal, state and local regulations must be followed. (See *Construction Manual Division 1100* for further guidance).

205.00 EXCAVATION (SSHC Section 205)

205.01 DESCRIPTION

The importance of being able to identify soil types cannot be overemphasized. Some soil types have to be placed in the proper location. The inspector must be sure that the work is performed according to the plans.

The balance factor is the change in quantity from cut to fill and includes subsidence, change from borrow density to the final compacted density, incidental loss, and all other factors changing density.

205.02 MATERIAL REQUIREMENTS

Embankment and Excavation Soils Criteria (SSHC Section 206)

There are four basic categories of earthwork.

- Excavation
 - ◆ Usually final cross sections determine pay quantity.
 - ◆ No off-site borrow is required.
- Excavation (Established Quantity)
 - ◆ Payment is based on the plan quantities.
 - ◆ No off-site borrow is required.
- Excavation Borrow
 - ◆ Usually final cross sections determine pay quantities.
 - ◆ Borrow will be needed from off-site source(s).
- Earthwork-Measured-in-Embankment (SSHC Subsections 205.04/205.05)
 - ◆ Plan quantities of the proposed embankment are used to determine the payment quantity.
 - ◆ Contractor must forecast shrinkage. (A change from borrow density to compacted density.)
 - ◆ Borrow from off-site sources.

"Excavation" and "Excavation Borrow" are paid based on final cross sections. The Project Manager may forego the final cross sections when the contractor agrees, **in writing**, that the plan quantities, **including field adjustments and revisions**, accurately reflect the work done. **Payment will be made under the original contract items. It is not necessary to eliminate the original contract item and establish a new "E. Q." item. Refer to Page 129.**

- Within 15 m (50 feet) of traveled way on interstate highways
- On foreslopes
- On outside of sharp horizontal curves

Other storage locations may be approved by Project Manager when it is not practical to satisfy the above criteria.

@ Storage behind guardrail must provide for partial collapse of rail upon impact. For beam guardrail this is normally a minimum of **12 feet (3.6 m)** on bull noses and a minimum of **5 feet (1.4 m)** on parallel sections of rail. A minimum of 3.6 m (12 feet) should be allowed behind cable guardrail.

404.08 CONSTRUCTION WORK ZONE SIGNING DURING WINTER SHUTDOWN

Responsibilities of the District Construction Engineer (DCE), District Maintenance Superintendent, and the contractor for highway projects not fully completed by winter shutdown are reviewed below.

Unless contract documents identify signing responsibilities different than stated herein, the following guidelines will apply. Unusual circumstances will be handled on a project specific basis with approval of the Construction Division.

Uncompleted Projects

This category of projects includes contracts having some carry-over work into the next year or intended by plan to be multi-year contracts.

- Prior to winter shutdown, the DCE, PM and Maintenance should field review the project to identify access, signing, and safety features needed to be completed before the contractor suspends work. The DCE and Maintenance will decide which items are contractors responsibilities and what is best accomplished by NDR Maintenance forces. Cost of traffic control devices furnished by NDR Maintenance can be charged against the project.
- During the winter shutdown period, traffic operation services become the responsibility of the NDR Maintenance. This includes routine surveillance and sign maintenance.
- Snow removal for through traffic and local accesses, if needed, is the responsibility of Maintenance.

Multi-Contract Projects

Some projects are phased so a series of contracts are awarded over several years. The most common examples are separate grading and paving projects. Unless contract documents identify responsibility for traffic signing between completion of one project and start of the next project, the Project Manager should evaluate and resolve each specific situation.

Special Concerns

When temporary traffic signals are involved, the contractor shall arrange for emergency maintenance services. No payment will be made to contractor.

On urban projects, DCE will need to coordinate with the city to determine who is responsible for access, signing, and safety features.

404.09 **FLAGGERS & PILOT CARS** (*SSHC Section 422*)

The Department, in conjunction with the AGC, has made the Flagger Certificate quiz, the Flagger Training video, and a Flagger Training audio cassette available in Spanish.

The availability of this material in Spanish in no way is meant to void the specification that requires that flaggers read and speak English clearly. However, in recent years the number of Hispanic workers on our construction projects has increased. The intent is to provide better education to those whose native language is Spanish, realizing that while they may be able to speak English clearly they may have difficulty learning and taking a test in English. You could relate it to learning metrics. While we know and talk metric, few of us really think in metric.

The flagger on a construction project is the first line player in communicating with the driving public. It is imperative that the flagger be able to speak English clearly with the drivers in a work zone. The contractor is responsible for insuring that anyone performing flagging can meet these requirements.

Flaggers may wear the company's hard hat no matter what color it is.

Flagger Bid Item

@ If the contractor's flagging crew works four hours or less, then ½ flagger day is charged. If the crew works more than four hours, then one flagger day is charged.

Slow/Slow Paddles

@ The Flagger Handbook indicates that when a flagger is used near the lane-line to warn public traffic of workers and equipment close to the open lane, then these flaggers are only allowed to use a "slow/slow" paddle. This paddle shall be **24 inches (0.6 m)** diamond shaped with the word "slow" in black letters on orange background on both sign faces. The standard stop/slow paddle shall never be used on a multi-lane highway, since through traffic should never be forced to stop on these roadways.

Permanent & Temporary Pavement Marking

Pavement moisture can be measured by placing and holding a two square foot piece of clear plastic on the existing pavement for a period of 15 to 20 minutes. Remove and hold the plastic in a vertical position. If water drips from the underside of the plastic sheet, the pavement has excess moisture.

404.17 INERTIAL BARRIER SYSTEMS

There seems to be some misunderstanding among the contractors about the proper installation of the Type I object marker on the inertial barrier systems. The object marker @ must be placed directly on the front of the first 440 lb (200 kg) module, either by adhesive or rivet, etc. The marker is not to be placed on a separate post in front of the module. The presence of a post in front of the system could effect the crash characteristics of the inertial barrier system.

404.18 BARRICADES/PLASTIC DRUMS

Due to increased usage of plastic drums and Type II barricades on resurfacing projects, and the considerable amount of time involved in testing one of every five devices, we are making the following changes in the minimum tests required:

- When less than 50 are furnished, test one of every five furnished, or a minimum of two each, whichever is greater.
- When 50 or more of any one device are furnished, test one of every ten furnished of that device.

@ **405.00** **SIGNS**

405.01 **DEDUCTION FOR SIGNS**

Use DR Form 502 "Construction Signs and Posts" to document signs supplied and returned by the contractor.

@ Itemize those signs not returned or damaged by the contractor in the Sign Deduction Computation Letter to the Construction Division, Finals Section. The itemized list, as prescribed in the Finaling Manual should show the number of signs, sign number, message, sign size, cost per sign and total deduction. The list should also indicate which signs were damaged and which were not returned.

The Project Manager shall determine if the value of damaged or missing signs are to be deducted from the Contractor's payments. Assessment for broken, damaged or unreturned signing materials is to be made for losses or damages which is due to the contractor's actions. The contractor will be assessed the total value of a sign and a salvage value will no longer be allowed for damaged signs.

The Project Manager will compute the assessment and enter it on a project estimate.

405.02 **SIGN MAINTENANCE**

When a permanent sign has been destroyed or damaged due to the actions of the public, either by accident or by vandalism, the work of repairing or replacing the sign shall be considered to be part of the item, "Maintenance of Permanent Signs". The Department will furnish a new sign and post, if required, at the permanent maintenance headquarters from which the signs were originally obtained.

The Project Manager must have documentation of the following:

1. Performance Graded Binder
2. Aggregates
3. Asphaltic mix taken behind the paving machine but in front of the rolling operation.
4. Asphalt in-place density.

Performance graded binder suppliers are grouped into two categories (levels).

1. Level-1 suppliers are certified suppliers who have submitted documentation to the Department and as part of the certification process, the Department has inspected the supplier's plant.
2. Level-2 suppliers are approved suppliers that are not certified.

The difference between being level-1 and 2 is that level-1 suppliers are only verified every other day while level-2 suppliers must be verified each day. This verification is between the lab and the supplier and the PM is not involved.

Hot-In-Place asphalt work may require support from the lab. Make sure you notify the lab at least 2-3 days in advance so they can plan to be on-site when the work begins.

Density of the in-place mix can be tested with the nuclear density gauge or by taking cores and measuring the density of the cores. Do not use the contractor's random sampling tables. Use the Department's tables and keep location secret.

@

unable to be made promptly after they occur, the inspector shall require the finishing machine to be stopped until workers catch up with making corrections.

When constructing handworked areas such as driveway returns and bridge approach tapers, edge alignment may become irregular during rolling because small, high, and low spots in handworked surface tend to extend in width unevenly. Edge alignment of handworked areas can be made true by first rolling the surface with a steel roller, then immediately trimming the edge with hand tools while the mixture is still hot and workable.

502.40.3 LONGITUDINAL JOINTS

To obtain adequate compaction at longitudinal joints, the contractor shall place sufficient thickness of mix to compensate for 20 to 25 percent reduction in thickness that normally occurs from rolling. If thickness is insufficient prior to rolling, joint will usually be smooth in appearance but lack density because of inadequate compaction. **Make sure density is checked along the joints.**

The vertical face of exposed, longitudinal joints must be tacked before the adjacent lane is placed. This treatment is very important to insure a seal at the joint. No tack coat shall be sprayed on the surface of lane being matched. Shields on distributor spray bar will help protect adjacent lanes (*SSHC Subsection 503.04*).

@ If overlap is maintained at approximately **1 inch (25 mm)** and thickness of joint is correct, brooming or raking may not be necessary to obtain a good joint. However, occasional corrections with hand tools may be necessary. When hand work is completed, excess material should be wasted as opposed to scattered on lane being constructed.

@

502.40.5 DENSITY CONTROLS FOR ASPHALTIC CONCRETE CONSTRUCTION (SSHC Subsection 503.06)

Specifications for asphaltic construction require each layer to be compacted to a density not less than a given percentage of the Rice voidless density.

Density of pavement is determined from cores cut by the contractor or by nuclear density gauges, normally on the working day following construction. The method of mix density determinations will be determined by the contractor, and any disputes will be resolved with cores.

@ One hot box sample per subplot [750 tons (680 Mg)] will be obtained from the roadway surface by the contractor and transported to the field lab for testing. The lab will determine the voidless density. The location of the sample shall be a secret and it must be random.

An average of the voidless densities for a day's production will be used to determine the degree of field density.

@ Five samples shall be cut from each 3750 tons (3400 Mg) or use Nuclear Density Gauge to determine density.

@ The 1,000 ton test strip (and smaller test strips in earlier contracts) is independent of the tonnage listed in the random sampling schedule provided to the PM. The random sampling schedule becomes active following the placement of the 1,000th ton of an approved test strip.

The Specifications also describe a procedure for field density evaluation together with a schedule for payment adjustments when noncompliance occurs. Project inspection personnel shall observe the following:

- @ The contractor is required to take a prescribed number of samples at locations selected and marked out by the project inspector. The project inspector will witness the core sampling. A circle approximately **16 inches (400 mm)** in diameter is adequate for identification of sampling location. The core should be taken from within the area identified. It is not appropriate for the contractor to use a nuclear device to "hunt" for a particular spot to sample; coring locations are no longer random when a nuclear device is used in this fashion.
- @ Sample locations are identified in the random sampling schedule which will be provided by Materials & Research. Keep the location a secret. A core will not be taken less than **12 inches (300 mm)** from the edge of a given pass of the finishing machine. Procedure for identifying random locations should provide for the potential to obtain a core sample at any distance **12 inches (300 mm)** or greater from the edge.
- If the layer being sampled adheres to a lower layer, it may be necessary to sample through two or more layers or full depth. The contractor will need to remove the extra depth by sawing the sample with a masonry saw. It may be necessary to cool the sample by refrigeration or ice to prevent damage during sawing. It is important that core drill bits be kept sharp.
- Each sample shall be inspected carefully by the contractor and inspector prior to testing. Be sure each core sample is representative of the density of the mixture placed and not damaged. If damage is noticeable, discard without testing and take another to replace it.
- If tests indicate that density is less than the specified percentage, the sample shall be retested to insure accuracy. The contractor can request another random sample be taken. (See *SSHC Subsection 1024.02.*)
- Tests on density samples give lower results if samples are damaged during handling. Contractors and project inspectors are advised to use extreme care when taking, transporting, and preparing cores for testing.
- Samples should be transported on hard flat surfaces to avoid loss of density by distortion. If necessary, samples should be stored in a cool place and on a hard flat surface.
- Specifications also require the contractor to take density samples as promptly as practical as prescribed by NDR T 168. Samples should be taken no later than the working day following placement. If the contractor is unable to comply with this timing, the project inspector shall stop construction until the contractor is able to do so.
- NDR personnel shall be responsible for performing density tests as prescribed by NDR T 166 using the contractor provided samples.

- Any failures should be reported to the Project Manager and to the contractor on the day tests are performed.
- When rerolling is performed, insure the area that is rerolled is the complete area of low density, not just the area of the sample.

Asphalt Compaction

@

Many Superpave mixes exhibit what is called a “Tender Zone” during compaction. You will have to confirm the contractor has determined the “Tender Zone” for the mix. Normally the “Tender Zone” is between 230° and 160°F. **When the asphalt is between 230° and 160°F stop compaction rolling.** Do the finish rolling below 160°F and make sure heavy and intense compaction rolling is done above 230°F.

Procedures for Construction of Test Strips (*SSHC Subsection 503.04*)

SSHC Subsection 503.04 requires the contractor to construct a control (test) strip for all mixture types except S.P.S. Test strips are used to evaluate properties of asphalt mixture and identify an effective roller pattern.

Proper construction and documentation of the test strip is the responsibility of the contractor and shall be provided by the contractor to the NDR inspector.

Document the procedure that was followed to construct the test strip.

Resolving Density - Void Conflicts

The project inspector should be aware that the field laboratory and compacted voids are to be tightly controlled. This may require more compactive effort for compliance. Become familiar with other controls by reading the *Materials Sampling Guide* and asking questions of Materials & Research personnel.

For the case where specified density is met, but field laboratory voids are outside designated limits for two moving average points, the production will cease. The Project Manager may allow production to start following agreement on corrective action to be taken. The contractor will select the combination of rollers to be used and preliminary rolling pattern. Nuclear gauge readings would normally be taken after each pass or series of passes.

The inspector shall only observe and document this process. Documentation of type and amount of compactive effort shall be recorded. Inspector will then select and mark out five random core sites within the test site. Density cores taken by contractor will be tested and results reported as soon as possible.

Cooperation between the project inspector, Materials & Research, and the contractor is essential to reach a timely solution. If all anticipated results are not met, further experimenting with a different combination of rollers and operation should be performed. Changes in gradation may be one of the first items looked at by Materials & Research. Changes in performance graded binder content would be one of the last items. Relief from minimum laboratory voids specified may only be approved by Materials & Research.

502.40.6 LAYING WIDTHS FOR ASPHALT

Plans for asphalt projects will show the overall dimensions of finished pavement.

- @ When spreading layers of asphalt **1½ inches to 2 inches (38 to 50 mm)** in thickness, a typical **24 foot (7.2 m)** pavement may broaden **2 to 4 inches (50 to 100 mm)** in width during rolling. Therefore, laydown width before rolling might require **3 inches (75 mm)** less than final design width. An intended lap of **1 inch (25 mm)** at the longitudinal joint is best for proper joint construction but seldom seen these days because the contractor has to have someone “set up” the inch overlap. Use of a cutoff shoe when matching a longitudinal joint is not acceptable.

When using finishing machines that spread the pavement full width, the inspectors shall insure that contractors adjust the spreading width so the final dimensions conform to the dimensions specified in the project documents.

- @ The finishing machine screed extensions are usually available in **6 inches (150 mm)** increments. Where standard screed extensions are utilized to increase the paver width by more than **12 inches (300 mm)**, the paver auger must also be extended. Many new pavers are equipped with automatic screed extensions which can be adjusted to conform to the required width for most resurfacing situations. Some paver models have automatic auger extensions as well.

502.40.6a POLICY FOR PLACEMENT OF TEMPLATE CORRECTION ON OVERLAY PROJECTS

- @ **Effective immediately**, the following shall be Department of Roads policy for placement of asphaltic concrete template correction quantities. **This policy shall be applicable to all new and existing contracts.**

- (1) When constructed under traffic maintained conditions and the **design thickness is greater than 2 inches (50 mm)** for the asphaltic concrete type and nominal aggregate size to be used on the surface layer, the asphaltic concrete shall be placed in **more than one layer. The proposed compacted placement thickness of the top layer shall not exceed 2 inches (50 mm).** Asphaltic concrete provided for template correction shall be placed with the lower layer or with the leveling course, if shown in the plans.
- (2) When constructed under traffic maintained conditions and the plans indicate that template correction is provided with a **designed** asphaltic concrete **thickness of 2 inches (50 mm) or less**, the total asphaltic concrete thickness, including template correction, shall be placed as a **single layer.**

@

502.40.7 PLACEMENT RATES FOR HOT MIX ASPHALT BASES, BINDER, AND SURFACE COURSES

The inspector shall check contract quantities for accuracy.

In general, placement rates for hot mix asphalt shall be determined using the contract asphalt mass. The estimated unit mass from design standards used to calculate contract quantities will provide sufficient material for construction of design thickness for most mixtures used.

If the contract quantity is not sufficient to construct the required thickness, notify the Construction Division.

For lower layers on resurfacing projects, automatic controls should not be adjusted repeatedly based on megagram yields taken at short intervals. Automatic controls should be allowed to correct for irregularities in underlying base without frequent adjustments. Accordingly, the placement rate for individual truckloads will sometimes vary substantially from contract rate because of irregularities in old base. However, over longer distances, 1650 feet (500 m) or more, taking both sides of the pavement into account, inspectors should select a general spread rate that compares as closely as possible with contract quantities.

For paved shoulders or other construction where dimensions are controlled by specified elevations, existing structures, or other unusual requirements, spread rates shall be adjusted as necessary.

@

502.40.8 COLD WEATHER ASPHALT CONSTRUCTION (*SSHC Section 501*)

SSHC Subsection 501.01 contains limitations for placement of asphalt and liquid bitumen under cold weather conditions. These restrictions apply to pavement surface temperature and time of year, and vary according to whether layer is surface course, lower binder, or base course, and nominal lift thickness.

Cold weather construction problems may show up in the form of increased roughness on profilograph, mat raveling, low density, high voids, segregation, slippage, or failure of tack coat to break. The Project Manager and inspector should be aware of other weather related conditions which may further limit placement.

After September 15, it is appropriate to require tarping and insulation of truck bodies, especially if hauls exceed 3 miles (5 km) (*SSHC Subsection 503.04*). However, if the contractor can demonstrate that the asphalt temperature is not adversely affected by hauling, the tarp and insulation requirements should be waived.

Base temperature is the single greatest factor in the rate of cool down for freshly placed asphalt mat. Consequently, base temperature has direct affect on recommended minimum laydown temperature and rolling time available to obtain specified density.

Wind velocity, air temperature, and cloud cover are additional factors that affect the cooling rate of hot mix asphalt.

For fall work, a cutback asphalt may be used at the Project Manager's option. Cold surface temperatures cause emulsions to lose tackiness and increase breakage time resulting in higher risk of mat slippage.

502.40.9 RUMBLE STRIPS IN ASPHALT SHOULDERS

(The paragraph below moved from Page 247)

Rumble strips will be milled into shoulder on future projects. Department will no longer accept rolled-in rumble strips.

@ **507.00 TACK COATS USING EMULSIONS**

For Dilution

SS-1, SS-1H, CSS-1, and CSS-1H grades are specified. Dilution of emulsion is required if nonuniform tack applications are experienced. Dilute at 1:1 ratio, i.e., 1 gallon emulsion to 1 gallon water.

Application Rate for Diluted Emulsion

For diluted material, double the rates of undiluted material application. Example: 0.03 to .06 gal/yd² (0.14 to 0.28 L/m²) undiluted increased to .064 gal/yd² to .12 gal/yd² (.28 to .56 L/m²) dilute emulsion.

Sample for Compliance

Sample emulsion at spray bar of distributor with bar valve in a circulating position, prior to dilution.

Measurement for Pay

Net liters of diluted emulsion.

Keep in mind, diluted emulsion as supplied normally contains 60% asphalt residue, therefore, a 1:1 field diluted emulsion will contain the minimum of 30% residue (*SSHC Subsection 504.03*).

Settlement of Diluted Emulsions

Varying residue rates of diluted emulsion may be related to blending of original emulsion or settlement while in storage. To minimize this problem, the following steps are recommended:

- Contractor emulsion delivered to storage should be gently circulated prior to pumping into distributor truck.
- If contractor obtains emulsion directly from terminal, the emulsion should be gently circulated prior to use each day.

Material in a storage tank can be circulated with a large diameter, slow turning propeller, or by pumping from top to bottom. Only a small amount of agitation is necessary.

Forced air should not be used for agitation since it may cause the emulsion to break.

@

602.00 PORTLAND CEMENT CONCRETE (PCC) PAVEMENT (SSHHC Section 603)

602.10 DESCRIPTION

Concrete pavement is a surface course composed of portland cement concrete. It may be constructed on a prepared subgrade, a stabilized fill or a granular foundation course.

The production of high quality concrete pavement requires a very close control of all phases of the work. The Project Manager and inspectors assigned to concrete pavement projects should become thoroughly familiar with the construction details outlined in *SSHHC Subsection 105.13, Division 600*, and the material details given in *Sections 1002 to 1027*.

The essentials to observe in this type of pavement construction are:

1. Accurate proportioning of aggregate and cement.
2. Absolute control of the water and admixture content of the mix.
3. Prevention of segregation in the concrete.
4. Adequate amount and proper spacing of finishing equipment to handle the production of the mixer or mixers.
5. Properly trained equipment operators and finishers.
6. Proper curing.
- 7. Timely sawing of joints.**

602.20 PCC PAVEMENT MATERIAL REQUIREMENTS

602.201 Composition of Concrete (SSHC Section 1002)

The plans or special provisions may offer the contractor a choice of various classes of concrete. SSHC Section 1002 lists the classes of concrete used in Nebraska road construction. If a choice is allowed, the contractor is required to advise the Project Manager of the class of concrete to be used. This notification must be given prior to construction. The Materials and Research Division should be consulted in regard to problems of concrete composition. Table 1002.02 shows authorized mix proportions for the classes of concrete.

Material Inspection - The production of a high quality concrete requires careful control over concrete materials at the batch plant. The inspector must be prompt and accurate to insure quality concrete.

SSHC Sections 601, 602, and 603 contains requirements for concrete pavement construction. The Project Manager and inspectors must familiarize themselves with these requirements and insist that materials be tested and approved before being incorporated in the work. The frequency of sampling, testing or submitting of material samples to the Central Laboratory and the procedures to be followed are covered by the Materials & Research *Materials Sampling Guide*.

Field Testing Laboratory - SSHC Subsection 105.03 requires the contractor to furnish a field laboratory building meeting certain specific requirements for the type required in the contract. The project manager should document compliance for the laboratory's condition in the Field Book and notify contractor of any problems.

Admixtures - SSHC Section 1002 states that "only admixtures authorized by the contract documents will be permitted for use in portland cement concrete". Since the various materials constituting admixtures can have a profound effect on the characteristics of the hardened concrete, extreme caution is justified. (See SSHC Section 1007 for more information on admixtures.)

602.202 Concrete Strength

Currently, four test cylinders are to be fabricated for each placement (generally four cylinders are required for each lot of concrete). These test cylinders are then tested at ages of 7, 10, 14, and 28 days.

@ If the 7-day cylinder tests 3500 psi (25 MPa) or above, the 10 and 14-day cylinders need not be tested and can be discarded. If the 7-day cylinder should test less than 3500 psi (25 Mpa), the 10 and 14-day cylinders must be retained and the above policy applied to the 10-day cylinder. In any case, the 28-day cylinder must be retained and tested.

@ A 5th cylinder is required if the contractor wants an early break.

203 Concrete Sampling Locations

Concrete samples shall be collected from at least three different portions of a batch after it is discharged, whether mixed on site or central mixed. Sample location point shall be after plastic concrete has been placed on the grade, either by direct depositing from a batch truck or by use of a placer/spreader and slipform paver machines. Care should be taken to avoid sampling concrete that has been vibrated manually or mechanically. Samples should be taken at locations within the batch that appear to be representative.

Should a voided surface occur during finishing and finishers experience difficulty in closing an open pavement surface, fresh mix or mortar should be obtained from in front of paving train and added to surface to facilitate finishing and produce a tight, closed pavement surface.

602.5022 Tining (SSHC Subsection 603.03)

The plans indicate those pavements that shall receive tining.

Tining impressions are made in plastic concrete while grooves are made once concrete has hardened.

@ The Department has changed tining requirements. Mainline pavement will now be longitudinally tined instead of transversely tined. Transverse tining shall be done with a rake, not a bull float. Ramps and other irregular areas that cannot be properly tined longitudinally shall be transverse tined.

@ The primary goal is to tine longitudinally to reduce noise levels.

@ Proper timing is critical. Longitudinal or transverse tining of the surface too early may result in grooves filling up with mortar or surface tearing. Tining too late results in a reduced groove depth.

To obtain a uniform transversely grooved pavement inspector should check the following items:

- Texture machine operating properly and all control devices functioning correctly.
- Pad line maintained in smooth and stable condition.
- @ • Tining rake carrier rails set to pavement crown, so uniform down pressure on tines maintained as comb sweeps down or across the slab.
- Four springs attached to carrier frame and to broom channel with a tension adjusting chain are identical and adjusted to obtain proper groove depth.
- Tines of comb parallel. A bent tine, which narrows spacing at tips, undercuts adjoining groove.
- No build up of dry mortar near tips of tines. A build up of mortar widens groove at surface and may cause tearing or displacement of larger aggregate particles.
- Steel tines not worn and comb in good condition, to ensure sufficient groove depth.

@ Should an unsatisfactory tined surface result for any reason, stop the paving operation and do not allow resumption until the problem is corrected.

Tine Determination

Depth of the grooves may be determined by using a standard commercial tire tread depth gauge, but normally a visual inspection without measurements is adequate.

Guidelines for Tining Concrete Pavement

@

1. Tine mainline pavement longitudinally.
2. Ramps and small irregular areas can be transverse tined with a tining rake.
3. Tine all concrete pavements where posted speed limit will be 40 mph or greater. When a mainline is tined, include tining in intersections, acceleration lanes, deceleration lanes, left-turn lanes and ramps.
4. Do not tine concrete shoulders.
5. On pavement built without curb, stop tining 6 inches (150 mm) from edge of pavement (for edge of pavement painted line.)
6. On pavement built with curb, stop tining 2 feet (600 mm) from back of curb.

602.5023 Pavement Depression

A pavement depression prevents proper drainage of slab during periods of rain and may cause maintenance problems during the winter. This may be due to one or more of the following reasons:

- Screed not set correctly
- Poor workmanship by finishers in manipulating straightedge
- Improper tension between ends of trailing forms
- Improper adjustment of edges attached to trailing forms

@

Check this deficiency by placing a **10 ft (3 m)** straightedge or **4 ft (1.2 m)** carpenter's level transversely on pavement surface and noting trueness of surface with bottom of straightedge.

602.5024 Pavement Station Stamping

@

Station location of all PCC pavement shall be stamped in plastic concrete at every station (**100 ft/100 m**) by the NDR inspector.

@

Permanent Station Numbers - Each station number shall be marked permanently in the surface of the concrete slab by the use of metal dies furnished by the department. The numbers should be stamped neatly in the concrete just before it takes its initial set. They should be placed about **6 inches (150 mm)** in from the right-hand edge of the slab so that they can be read from the right roadway shoulder.

DIVISION 700

BRIDGES, CULVERTS, AND RELATED CONSTRUCTION

@

DIVISION 700

701.00 CHECKLISTS

701.01 PILES AND PILE DRIVING CHECKLIST

SSHHC References

Section 703 -- *Piles and Pile Driving*
 705 -- *Precast/Prestressed*

Concrete Structural Units

1002 -- *Portland Cement Concrete*
 1004 -- *Portland Cement*
 1025 -- *Steel Wire for Prestressed
 Concrete Units*

Inspection Crew

Project Manager (PM)
 Construction Technician

Equipment

Saximeter

Material Procedures

Check that all piling is acceptable for driving.

Material certifications and/or reports should be given to
 Project Manager and evaluated before use.

Steel Piling

Steel bearing and sheet piling must be stored on
 suitable skids [6 inch (150 mm)] ground clearance
 recommended) and should be kept clean. Don't allow
 weeds and foreign material in storage sites.

Concrete Piling

Piling must be adequately supported when stored and
 handled to prevent excess deflection. The surface
 finish of concrete piling that will be exposed at the
 completion of driving (bent piles in concrete slab
 bridges) shall not be damaged or discolored.

Cast-in-Place Concrete
Piles Procedures

Check shells immediately before placing any
 concrete (shape and accumulation of water). Use a
 drop cord.

Treated Timber

Notify Materials & Research if timber piling appears
 damaged. The Project Manager or inspector must
 obtain approval to reject timber piling.

Piling certification procedures are found in the *Materials
 Sampling Guide*.

Pile Driving Procedures

The contractor should build a frame (sometimes called
 a checkerboard) to hold each pile in the exact position
 for driving.

Before driving any piles, the inspector should perform the following duties:

1. Verify that piles will be driven exactly as shown in the plan pile layout.
2. Check pile spacing, and record heat numbers (steel pile), code identification (concrete pile) and other pertinent information. Document points and splices.
3. Verify cut-off elevations against a permanent reference.

Confirm that the Project Manager, inspector and contractor understand:

1. How to check penetration depth at any point.
2. How to take and record bearing tests data with saximeter.
3. How to determine the cut-off elevation for individual piles.

SSHC Subsection 703.03, Paragraph 2. allows bearing piling to be driven with a gravity hammer for the first half of the penetration when bearing does not exceed one-third of the design bearing.

Concrete sheet piling shall be driven with a preapproved hammer.

Do not allow pilot holes or preliminary jetting to be greater than 10 ft (3 m).

Gravity hammers used to drive piling to final cut-off elevation shall be preapproved. The fall of gravity hammers shall be regulated so as to avoid damage to the piles. Hammer fall shall not exceed 15 ft (5 m) for wood and steel bearing piles, or 8 ft (2.4 m) for precast concrete piles and shells for cast-in-place piles.

Do not allow hammer fall to damage piles.

Leads are required on all driven piles. Leads shall be held in proper alignment.

Swinging leads are permitted with steam, air or diesel hammers.

Bearing and Sheet Piles
Procedures

Guyed, braced, or fixed leads are required with gravity hammers.

1. Frequently check the pile for plumbness or for required batter. Do not allow a variation of more than 1-inch/50 inches (1 mm/50 mm) of pile during driving.
2. Tops shall not be out of line more than 3 inches (75 mm).
3. Adjacent sheets shall be in line within a ½ inch (12 mm) tolerance.
4. The inspector should observe the pile carefully while it is being driven. A sudden increase in the penetration may indicate a broken or collapsed pile.
5. Remove and replace all broken, split, or misplaced piles. If removal is impractical, contact the Construction Division for instructions on the procedure to be followed.
6. Lead with the tongue or ball end of sheet piles to keep the groove or socket clean.
7. The options when a pile is at cut-off elevation, and not at design bearing are:
 - a. If less than 10% of the piles in any group fail to reach bearing, the average pile bearing may be adequate to support the structure.
 - b. Additional piling may be added to the group.
 - c. Extend the piling and drive to obtain design bearing.
 - d. Determine a soil set up factor and then drive to cut-off elevation.
 - e. Use pile-driving analyzer to determine bearing.
 - f. Run a load test to check if bearing capacity is obtained.

Notify the Construction Division when two or three consecutive piling do not attain design bearing.

8. a. Record pile data on the M&R spreadsheet.

b. E-mail a copy of the spreadsheet to M&R (O. Qudus) and to Construction Division (B. Caples).

c. Do not use contractor provided charts for determining bearing.

Soil Setup Factor

1. Two representative piles shall be driven to 2 ft (600 mm) above cut-off elevation (see SSHC 703.07 para 4.f.).
2. The piling at cut-off+2 ft (600 mm), will be rested for 36 hours and then driven to cut-off elevation with a "warm" hammer.
3. The Project Manager will record the penetration for each ten blows of the hammer until cut-off is reached.
4. Record data and call it in to the Construction Division.
5. The factor and a decision on what action to take will be sent back to the Project Manager.
6. Construction Division recommendations shall be recorded under the Remarks Section of the pile driving record.

Bearing Capacity Procedure

1. Determine bearing at or just prior to the pile reaching final penetration.
2. When determining bearing, the inspector shall be certain that all of the following conditions exist:
 - a. For single action, the hammer shall have a free fall.
 - b. The head of the pile shall be free from crushed or broomed fibers.
 - c. The penetration of the pile shall be at a reasonably quick and uniform rate.
 - d. There is not excessive bounce of the hammer. Deduct twice the height of the bounce from "H" pile for gravity or stream hammers. No deduction is made for diesel hammers.

- e. If the driving is stopped for more than 2 hours, the pile shall be driven at least 1 ft (300 mm) before the bearing capacity is determined.
 - f. For batter piles driven with gravity hammers, see *SSHC Subsection 703.03*, Paragraph 4 for bearing determination.
3. The energy values for common diesel hammers presently in use are listed in *SSHC Subsection 703.03*, Paragraph 4. If the contractor intends to use a hammer not listed, the Construction Office should be contacted to obtain the appropriate energy value.
 4. For bearing capacity computations the mass of the driving cap may be taken from the manufacturer's freight bill or measured. The mass of the pile shall be determined as follows:
 - a. Mass per foot (meter) times length at time bearing is determined.
 - b. Volume of pile times 44 lb/ft³ (703 kg/m³).
 - c. Volume times 150 lb/ft³ (2400 kg/m³).
 5. The reference point should be an object with a fixed elevation or horizontal distance from the pile. Mark the point where the reference intersects the pile. After the required number of blows, mark another line at reference intersection and the distance between the two lines is penetration. Average penetrations can be computed from several measurements.
- Steel "H"
- Timber
- Concrete
- Reference Points
- Pile Driving Analyzer Procedures
- Static Pile Load Test Procedures
1. Contact the Construction Division to schedule personnel and equipment.
 1. The Department will furnish the equipment and personnel for conducting the test. The contractor shall unload, erect, dismantle and reload the testing equipment. Payment for this work shall be by the each for each test.
 2. If a temporary anchor pile is required. It will be paid for as extra work.

Method of Measurement
Procedures

1. If required bearing is obtained at minimum penetration and this is shorter than the order length, the contractor should be encouraged to continue driving until the order length has been driven. Usually he/she will want to drive this extra length to avoid payment deduction. Discontinue driving beyond minimum penetration when:
 - a. Practical refusal is reached.
 - b. Further driving may result in damage to the pile.
2. If practical refusal is reached before minimum penetration, discontinue driving and notify the District Construction Engineer or the Construction Division and do not cut off the pile without their approval.
3. No payment will be made for pile length driven beyond the order length without PM approval.
4. When steel "H" pile and steel pile shells are driven to the exact cut-off elevation without crimping or damage to the top of the pile, they need not be cut off. Length of pile cut-off (measured as provided in *SSHC Subsection 703.05*) shall be paid at 60% of the piles unit price.
5. It will be necessary to pay for pile cut-off only under the following conditions:
 - a. When practical refusal is reached before minimum penetration and the pile cannot be driven or jetted further.
 - b. The contractor elects to stop driving after reaching bearing and minimum penetration but before the order length is driven.

6. MASS FOR PRESTRESSED CONCRETE BEARING PILE

For computing bearing capacity required on M&R Pile Bearing spreadsheet.

Pile Type	Constant Section	
	Mass Per Meter of Pile (Kilogram) (lb)	
I	220	(485)
II	298	(657)
IV	315	(694)

(See Appendix 1. DR97-Pile Driving Record)

Critical Construction Areas

1. Proper placement and length.
2. Permanent reference point.
3. Removal of broken/collapsed piles.
4. Achieving design bearing capacity.

NDR Tests

1. Test pile.
2. Bearing capacity.
3. Pile Driving Analyzer.

Inspector's Records and Forms

1. Pile Record M&R spreadsheet
2. Hammer Data Sheet

701.02

CONCRETE CONSTRUCTION CHECKLIST

SSHC References: Section 704 Concrete Construction
Section 1002 Portland Cement Concrete
Section 1010 White Opaque Polyethylene Film and
Burlap--Polyethylene Sheeting For Curing
Concrete
Section 1011 Burlap For Curing Concrete
Section 1014 Joint Sealing Filler
Section 1015 Preformed Joint Filler
Section 1016 Preformed Polychloroprene
Elastomeric Joint Seals
Section 1033 Aggregates

Inspection Crew: Lead Inspector
Inspection Equipment: Slump Cone
Air Meter (pressure)
Cylinder Molds and Lids
Rod
Mallet
Strike Off Bar
Ruler

- Placement Procedures:
1. Preplacement check of equipment.
 2. Check condition and placement of steel.
 3. Check Form setting and alignment. Verify location coordinates and orientation.
 4. Have contractor wet grade and forms before concrete placement.
 5. Test concrete for air content, slump, and make cylinders when mix changes, as a minimum according to Sampling Guide.
 6. Watch concrete placement for compliance with specifications. Do not allow free fall greater than 5 ft (1.5 m).
 7. Do not use water as a finishing aid; use an approved chemical finishing aid/evaporation retardant.
 8. Check curing operation.

- Construction Critical Area:
1. Take pictures of any pavement under bridge before work begins.
 2. Achievement of concrete consolidation without segregation.
 3. The time between loads of concrete.
 4. Trucks that segregate concrete or have cement balls must not be used.

- NDR Tests:
1. NDR T 23 Making and Curing concrete test specimens.
 2. NDR T 119 Slump of Portland Cement Concrete.
 3. NDR T 141 Sampling of Fresh Concrete.
 4. NDR T 152 Air Content of Freshly Mixed Concrete by the Pressure Method.

701.03 CONCRETE BRIDGE FLOORS CHECKLIST

SSHC References:

Section 706 Concrete Bridge Floors
Section 1002 Portland Cement Concrete
Section 1010 White Opaque Polyethylene Film and
Burlap--Polyethylene Sheeting For
Curing Concrete
Section 1011 Burlap For Curing Concrete
Section 1014 Joint Sealing Filler
Section 1015 Preformed Joint Filler
Section 1016 Preformed Polychloroprene
Elastomeric Joint Seals
Section 1033 Aggregates

Inspection Crew:

Project Manager
Placement Inspector
Plant Inspector

Inspection Equipment:

Slump Cone
Air Meter (pressure)
Cylinder Molds and Lids
Rod
Mallet
Strike Off Bar
Ruler
10 ft (3 m) straightedge
Anemometer
Thermometer
Hygrometer

Placement Procedures:

1. Preplacement check of equipment.
2. Check condition and placement of steel. Enter in SiteManager the date steel was verified.
3. Check Form setting and alignment.
4. Check slab thickness.
5. Check deck for cleanliness
6. Have contractor wet deck forms and grade under approach slabs before concrete placement.

(Note: It's best to place deck and approach slabs at the same time.)

7. Test concrete for air content and make cylinders when mix changes, as a minimum according to Sampling Guide.
8. Watch concrete placement for compliance with specifications.
9. Do not use water as a finishing aid; use an approved chemical finishing aid/evaporation retardant.
10. Check surface with straightedge. Remove depressions and irregularities.
11. Check tining operation.
12. Check cure operation.
13. Make sure a water service and tanks are available to soak burlap.

Construction Critical
Area:

1. Take pictures of any pavement under the deck before work begins.
2. Maintain a uniform roll, of about 4 inches (100 mm), of concrete ahead of the front screed and a minimum of a 2 inch (50 mm) roll ahead of the rear screed.
3. The time between loads of concrete.
4. Trucks that segregate concrete or have cement balls must not be used.
5. Avoiding placement when temperatures and wind velocities may cause plastic shrinkage cracking. (*SSHC Table 706.01*)
6. Vibrate concrete uniformly. Establish good pattern and adjust as necessary.
7. The timing of cure application.

Safety Areas:

NDR Tests:

1. NDR T 23 Making and Curing concrete test specimens.
2. NDR T 119 Slump of Portland Cement Concrete.
3. NDR T 141 Sampling of Fresh Concrete.
4. NDR T 152 Air Content of Freshly Mixed Concrete by the Pressure Method.

701.04 STEEL STRUCTURES CHECKLIST

SSHHC References:	See SSHC Table 708.01
Other References:	AWS Standard Specifications. (ANSI/AASHTO/AWS D1.5 Bridge Welding Code)
Inspection Crew:	Fabrication Inspector Project Manager (PM) Lab Inspector
Inspection Equipment:	Skidmore-Wilhem Calibrator
Shop Procedures:	<ol style="list-style-type: none">1. Check Fabricators QC Plan.2. Make sure QC Plan is followed.3. The mill order list or the Certified Mill Test Reports must be furnished before fabrication begins.4. Document all actions not in compliance with the QC Plan or Standard AWS procedures.5. Welding symbols are shown in Section 708.
Field Construction Procedures:	<ol style="list-style-type: none">1. Confirm steel was inspected on site and in shop. Enter date in SiteManager.2. Sample bolts and send to M&R.3. Heavy hexhead bolts require heavy hexhead nuts and a hardened washer under the element that is turned.4. Check all bolts, washers, and nuts to make sure there is proper and correct marking on each. (See CM Subsection 704.03)5. M&R personnel will calibrate the contractor's wrenches but they need at least 7-days advance notice.6. Before the contractor begins steel erection, the Project Manager will make a final check of span lengths, skew angles, and bearing point elevations.7. Also, take pictures of pavement under any structure where equipment will be lifting members.8. Lead sheets [? inch (3 mm) thick] shall be placed between steel and concrete at all bearing points.9. Rockers, rollers, expansion devices, etc., shall be set according to the temperature at time of installation. (See Plans.)10. Check matchmarks on all girders, separators, angle braces, etc.11. Verify that drift pins do not enlarge holes or distort the metal.12. Stop the contractor from hammering if it appears the metal will be damaged or injured.13. The Construction Division will be notified of all major misfits and determine what procedures will be allowed.

701.05 CONCRETE BRIDGE DECK REPAIR WITH SILICA FUME CONCRETE

SSHC References:

Section 710 -- Concrete Bridge Deck With Silica Fume Concrete
Section 1002 -- Portland Cement Concrete
Section 1010 -- White Opaque Polyethylene Film and White Burlap—Polyethylene Sheeting For Curing Concrete
Section 1011 -- Burlap For Curing Concrete
Section 1014 -- Joint Sealing Filler
Section 1015 -- Preformed Joint Filler
Section 1016 -- Preformed Polychloroprene Elastomeric Joint Seals
Section 1033 -- Aggregates

Inspection Crew:

Placement Inspector
Plant Inspector

Inspection Equipment:

Slump Cone
Air Meter (pressure)
Cylinder Molds and Lids
Rod
Mallet
Strike Off Bar
Ruler
10 ft (3 m) straightedge
Anemometer
Thermometer
Hygrometer

Placement Procedures:

1. Preplacement check of equipment.
2. Check condition and placement of steel.
3. Check Form setting and alignment.
4. Check slab thickness.
5. Check deck for cleanliness.
6. Have contractor wet deck and forms before concrete placement.
7. Test concrete for air content and make cylinders when mix changes, as a minimum according to Sampling Guide.
8. Watch concrete placement for compliance with specifications.
9. Do not use water as a finishing aid; use an approved chemical finishing aid/evaporation retardant.
10. Check surface with straightedge. Remove depressions and irregularities.
11. Check tining for conformance to specification.
12. Check cure operation.

Construction Critical
Area:

1. Check finish machine (template & rails).
2. Check repair areas.
3. Deck shall be uniformly wet, without puddles prior to placement.
4. Bonding grout shall not be allowed to dry out.
5. Maintain a uniform roll, of about 4 inches (100 mm), of concrete ahead of the front screed and a minimum of a 2 inch (50 mm) roll ahead of the rear screed.
6. The time between loads of concrete.
7. Trucks that segregate concrete or have cement balls must not be used.
8. Avoiding placement when temperatures and wind velocities may cause plastic shrinkage cracking (see SSHC Figure 710.01).
9. Fogging system should be operating from time concrete is finished until wet burlap is in place.
10. Check tining operation.
11. The timing of wet burlap application.

Safety Areas:

NDR Tests:

1. NDR T 23 Making and Curing concrete test specimens.
2. NDR T 119 Slump of Portland Cement Concrete.
3. NDR T 141 Sampling of Fresh Concrete.
4. NDR T 152 Air Content of Freshly Mixed Concrete by the Pressure Method.

702.00 EXCAVATION FOR STRUCTURES (SSHC Section 702)

702.01 DESCRIPTION

- A. All excavation should be done as shown in the plans. Excavation is very dangerous work and appropriate OSHA regulations must always be observed (see SSHC Figure 701.01).
- B. Inspector should be present when an area is being backfilled. The inspector should check to see that the backfill materials are as specified. The materials shall be placed as prescribed in the *SSHC Subsection 205.03 or 702.03* as appropriate.
- C. Structure excavation includes all excavation, removal of obstruction, bailing, draining, pumping, sheathing, construction and removal of cofferdams, backfilling, compacting and disposal of any excess material necessary to construct the structure in question.

702.02 MATERIAL REQUIREMENTS

- A. Unsuitable Material Excavation (*SSHC Subsection 702.05*)
 - 1. When unstable material is encountered it shall be removed and backfilled with approved material. The material shall be measured in cubic yds (meters) before it is placed. Payment for the extra work material and all work involved will be made at 10% of the contact unit price for box culvert concrete (when gravel or rock is used). The inspector should make an inspection of all structure footings as they are being excavated by the contractor.
 - 2. Pier footings should not be constructed on unsuitable material. It is true that if the footing is supported by piles, the rock placed at the bottom of the footing serves a limited structural purpose. We should provide for a solid base to hold the concrete in the forms. However, the contractor is not entitled to a rock surface on which to work at the Department's expense.

702.03 CONSTRUCTION METHODS

- A. Culvert Excavation (*SSHC Subsection 702.03*)
 - 1. All culverts should be constructed with a minimum of approximately 12 inches (300 mm) of cover exclusive of surfacing. An accepted method for obtaining specified bedding for these culverts is to require the contractor to furnish a template conforming to the dimensions of the culvert pipe. This template is then used for shaping the trench to the specified depth.
 - 2. The inspector must be knowledgeable of the Occupational Safety and Health Act (OSHA) requirements concerning excavation and trenching. Pipe culvert excavation by OSHA definition would normally be considered a trench.
 - 3. Never allow any part of a pipe culvert to rest on rock or other unyielding materials. When rock is encountered in the bottom of the trench, it shall be removed to a depth of at least 6 inches (150 mm) below the subgrade and back filled with suitable earth or sand.

4. The Specifications provide that where unstable subgrades are encountered under pipes or pipe-arch culverts, the unsuitable material shall be removed and the excavated area refilled with gravel, crushed rock, or other suitable material. When crushed rock is used, care should be taken to place the fine rock immediately beneath all metal pipe to prevent abrasion of the spelter coating. When gravel or crushed rock is used in place of unsuitable material, it will be measured in cubic meters before it is placed. Payment for furnishing, hauling and placing this material will be made at 10% of the contract unit price for concrete for box culverts. When box culverts are not included in the contract, the average unit price for box culvert concrete shall be used. (*SSHC Subsection 702.05*)

B. General Structure Backfilling (*SSHC Subsection 702.03*)

1. This operation may involve *SSHC Sections 205, 702, and Table 702.01*. The inspector should insure that all applicable sections are followed. The compaction of backfill material close to structures must given special attention. Mechanical tampers should be operated carefully in such a manner as to obtain the required density without damaging the structure.
2. Before any material is placed, the area to be backfilled should be inspected for trash or perishable matter. The materials to be used for backfill should be given careful consideration. Only those that will produce a dense, well-compacted backfill should be used. Granular materials are desirable as much less effort is needed to compact them than clay.
3. When abutments are tied to an anchor or deadman by means of tie rods, care should be taken in the back filling operation. The backfill should be placed in layers, starting at the anchor or deadman and working toward the abutment. Hand tamping may be required around the tie rods, abutment and anchors.
4. Backfilling must not be started without the permission of the Project Manager and in the case of concrete structures not until test cylinders show a minimum strength of at least 80% of the design strength.
5. Backfill should be brought up evenly to the elevation shown in the plans. Granular material must be placed in not more than 8 inches (200 mm) layers (lifts) and should have sufficient moisture to facilitate compaction. Do not allow dumping of granular material directly from the truck into the excavation if this will result in lifts/layers greater than 8 inches.
6. Special attention should be given to culvert wingwalls and flumes to insure proper compaction to prevent erosion and possible washout. The soil should be brought up even with these walls so the surface water will flow over these walls and not along them. Heavy equipment should be kept 3 feet (1 m) or more away from these wingwalls. Compaction within 3 ft (1 m) of the wingwall shall be with pneumatic hand tampers or small hand operated vibratory plate compactors.
7. Backfill for Bridges - Moisture and density requirements for backfill which is to provide support for subsequent construction will be shown in the plans. Backfill which is not to support later construction shall be compacted to 95% of maximum density without definite moisture limits.

8. Backfill for Culverts - When backfilling pipe culverts, the lifts shall be deposited and compacted alternately on opposite sides of the pipe to avoid lateral displacement. The inspector should also watch for vertical displacement. This may occur when tamping adjacent to the lowest 90 degrees of the pipe and should be checked from the grade stakes as backfilling progresses. The pipe should be tied down if any uplift is noted.
 9. Necessary precautions should be taken against washing under the pipe in case of rain. Compacted dikes or temporary earth headwalls at the inlet end will often save removing and relaying the pipe after a heavy rain. All drainage structures in the process of construction should be carefully inspected for washouts at the sides and beneath the structures after rains.
 10. Flowable fill is sometimes included in the plans for backfilling culverts. The plans will identify the locations and show the details for using the flowable fill. *SSHC Section 1003* defines Flowable Fill requirements.
- C. Concrete Seal Course (*SSHC Subsection 702.03*)
1. When it is impossible to dewater the foundation bed or box culvert footing or if live springs develop within the area, a seal course should be constructed below the elevation of the bottom of the footing. Concrete for seals constructed underwater shall contain 10% excess cement and be placed in accordance with *SSHC Subsection 704.03*. The concrete shall be allowed to harden a minimum of 72 hours after completing the final pour before dewatering and continuing work on the structure. Seepage through inadequate or poorly constructed cofferdams shall not be justification for placing a seal course.
- D. Foundations
1. Staking and Checking Locations of Structures - -Check and Double Check
 - a. All measurements and skew angles must be independently checked. From past practice, "independently checked" meant having a second survey party come in, setup, and completely resurvey (verify) original staking. This method is still the most desirable; however, with our upgrading to total station equipment it is acceptable to either setup off to the side and recheck or "back into" the bridge starting up station after clearing the total station.
 - b. Stakes used should be substantial and protected from disturbance. Offset stakes for each pier and abutment must be placed outside the area of contemplated work.
 - c. Any checks suggested by the contractor should be considered, since the site superintendent usually has a good idea of the structure layout in relation to existing features such as trees, old structures, etc. Each stake must be clearly marked to denote its function. Pier numbers must correspond with plan designations.

2. Documentation
 - a. A staking diagram for each structure must be recorded in a permanent survey field book. This sketch must show the exact location of each hub and the markings made on each guard stake. **IT IS NOT COMPLETE UNLESS IT SHOWS THE MEASUREMENTS MADE AS CHECKS ON THE ACCURACY OF THE STAKING LAYOUT.** Names of those in the staking party should be entered as well as the date, design and project numbers, location, type of structure, and any other pertinent information.

- E. Common Survey Errors to Avoid
 1. Turning the wrong skew angle.
 2. Errors in measuring from piers to abutments (This should be detected by an overall check from abutment to abutment.)
 3. The centerline of the bridge is not always on centerline of the road (This is quite common on interstate bridges.) A bridge with a sidewalk may not be centered on its pier(s).

- F. Encountering Old Substructures (*SSHC Subsection 104.06*)
 1. *SSHC Section 203* describes the removal requirements when structures interfere with the new work. Existing substructures are usually shown on the plans. If the designer intended to miss some of these old substructures and the contractor later encounters them, payment will be made to the contractor by change order to remove that portion in conflict. Payment will "NOT" be made if plans indicate the new substructure would hit the old structure. See *SSHC Subsection 104.06* for a list of approved unforeseen obstructions.

- G. Bridge Deck Removal
 1. Contractors generally can be expected to be able to remove the deck without damaging the girders. However, the contractor must use some caution. The contractor cannot use the same force directly over a girder as would be applied over the "free/open" space between girders.
 2. Sometimes a contractor will start the removal work properly with heavy blows only in the "free" space. However, either from impatience, changes to the equipment operator or for some other reason, we have seen the contractor at some point begin to apply too much force directly over the girders. This is very bad because the girders are damaged.
 3. Forewarn the contractor and monitor their operation to make sure girders are not damaged. This is covered in the contract but is still important to monitor in the field.

703.00 PILING AND PILE DRIVING (SSHC Section 703)

A. The Department's Geotechnical Section in the Materials and Research Division provides guidance and geotechnical designs for our projects. Some county bridge projects are completely designed by consultants including pile foundations. When a consultant design fails, i.e., bearing cannot be achieved, the consultant that designed the bridge should be the first point of contact to determine how to correct a failed design.

703.01 EQUIPMENT

A. Diesel Hammers

1. Generally, single acting diesel hammers are the mainstay of contractors for pile driving. Occasionally however, a contractor will request the use of an "air" or "hydraulic" operated hammer. In addition there are a few "double acting" hammers in use. A wave equation analysis will be required for approval of these hammers.
2. One manufacturer of hammers uses one size hammer barrel and places different sized rams inside. Therefore, the MKT "DE" series hammers need to be field verified for ram mass (weight). A check is accomplished by having the contractor stand the hammer upright (in the driving position) and measuring down from top of the barrel to top of the ram. Verify the ram mass (weight) shown on the Hammer Data sheet as follows:

Ram Mass (kg)	Ram Distance (meter)	Ram Mass (tons)	Ram Distance (ft)
907	1.9	1	6.25
1270	1.2	1.4	4.0
1497	0.7	1.65	2.3
1814	180 mm	2.0	0.6

B. Bearing and Penetration

1. Penetration Requirements
 - a. Design pile length is a calculated value based on design bearing and soil conditions. One factor which enters into the calculation is the potential for scour. Obviously, any soil which is eroded during a flood event represents a loss in bearing capacity and foundation stability. **For this reason "minimum penetration" is extremely important.**
 - b. A depth of expected scour is typically shown on the Bridge Geology sheet in the plans. In general, streams with large drainage areas and sand or gravel stream beds are quite susceptible to scour while streams with small drainage areas and heavy clay stream beds are less susceptible to scour.
 - c. When doubt exists concerning the amount of probable scour or minimum pile penetration required, the Construction Division should be consulted. If greater penetration is required, it will be achieved either by boring holes to receive the piles or by jetting. If penetration achieved is satisfactory, piles will be cut off.

C. Dynamic Pile Analyzer

1. The Materials & Research Division has a pile analyzer available for driving evaluations. The pile analyzer will evaluate the bearing, based on energy delivered to a pile as it is being driven.
2. There are two situations where the analyzer should be used:
 - Case 1. Contract documents require pile to be driven with the analyzer.
 - Case 2. Pile do not achieve bearing and there are unresolvable questions or conditions observed during driving.

703.02 CONSTRUCTION METHODS

A. Pile Driving Constraints

1. Piles shall not be driven within 50 ft (15 m) of freshly placed concrete. Normally piles may not be driven near new concrete until three days after the concrete was placed.

B. Splicing Pile--Welding Steel Pile

1. *SSHC Section 708* requires that all welds conform to the Structural Welding Code ANSI/AASHTO/AWS D1.5 of the American Welding Society.
2. Only Shielded Metal Arc Welding (SMAW) will be permitted for welding steel piles.
3. The welding electrode must be on the NDR Approved Products List.

C. Steel Pile Cutoffs

1. If the contractor feels the cutoff is long enough that they may use it on some future project, the Heat number should be placed on the cutoff and a number to indicate the project it came from.

D. Pile Groups/Categories

1. Selecting the type of pile to be used and estimating its necessary length are fairly difficult tasks that require good judgment.
2. Piles can be divided into two major groups, depending on their length and the mechanisms of load transfer to the soil:
 - a. Point Bearing Piles
 - (1) If bedrock is within a reasonable depth, then piles can be extended to the rock and achieve the ultimate bearing capacity.
 - b. Friction Piles

(1) The ultimate bearing capacity is achieved through the skin friction. The length of friction piles depends on the shear strength of the soil, the applied load and pile size. In clayey soils, the resistance to applied load is caused by adhesion.

(2) Piles are also divided into two different categories depending on their interaction with the soil:

c. Displacement Pile:

(1) The effect of displacement pile on the soil is, it increases the lateral ground stress. It displaces cohesion-less soils, remolds and weakens cohesive soils temporarily. If displacement piles are used for cohesive soil, setup time in sensitive clays may be up to six months.

(2) Typical types of displacement piles are closed end steel pipe pile and concrete pile.

d. Non-displacement Pile:

(1) Opposite of the displacement pile, it minimizes disturbance to the soil.

(2) Typical types of non-displacement piles are open-end steel pile and steel H pile. It should be mentioned open steel pipe is not suited for friction piles in coarse granular soils.

(3) It has low driving resistance and this makes field capacity verification difficult, which result in excessive pile length.

Weights of Prestressed Concrete Bearing Piling

For computing bearing capacity required on M&R Pile Record spreadsheet

Pile Type	Constant Section	Tapered Section
	Wt. per Lin. Ft. (Pounds)	Total Weight (Pounds)
I	148	None
II	200	None
III	173	None
IV	212	None
V	124	1740
VI	169	2500
VII	221	2950

This table is based on and is for use only with Standard Plan 1720-C-R2.

Steel Pipe Pile Data

	ARMCO		Union Metal
Size O.D. (ins)	12	12¾	12 (Nominal)
Wall T. (ins.)	.188	.188	7 Ga.
Wt. per Lin. Ft. (lbs.)	23.72	25.16	25.3
Conc. per Lin. Ft. (C.Y.)	.0273	.0309	.0255

Union Metal 30' tapered Sec. Type F Total Wt. 589 Lbs. Conc. 0.55 Cu. Yd.

Size O.D. (ins)	14	14 (Nominal)
Wall T. (ins.)	.188	7 Ga.
Wt. per Lin. Ft. (lbs.)	27.66	29.5
Conc. per Lin. Ft. (C.Y.)	.0375	.0350

Union Metal 40' tapered Sec. Type F Total Wt. 895 Lbs. Conc. 0.95 Cu. Yd.

For Raymond step tapered pile, contact Geotechnical Section, Materials & Research.

Driving Sequence of Piles

The driving sequence of piles in a pier or bent can be important. The driving sequence can affect the way piles drive as well as the influence the new construction has on adjacent structures. This is especially true for displacement piles. For non-displacement piles, the driving sequence is generally not as critical.

The driving sequence of displacement pile groups should be from the center of the group outward or from one side to the other side. The preferred driving sequence of the displacement pile group shown in Figure 24.16 would be (a) by the pile number shown, (sequence 1), (b) by driving each row starting in the center and working outward (sequence 2), or (c) by driving each row starting on one side of the group and working to the other side (sequence 3).

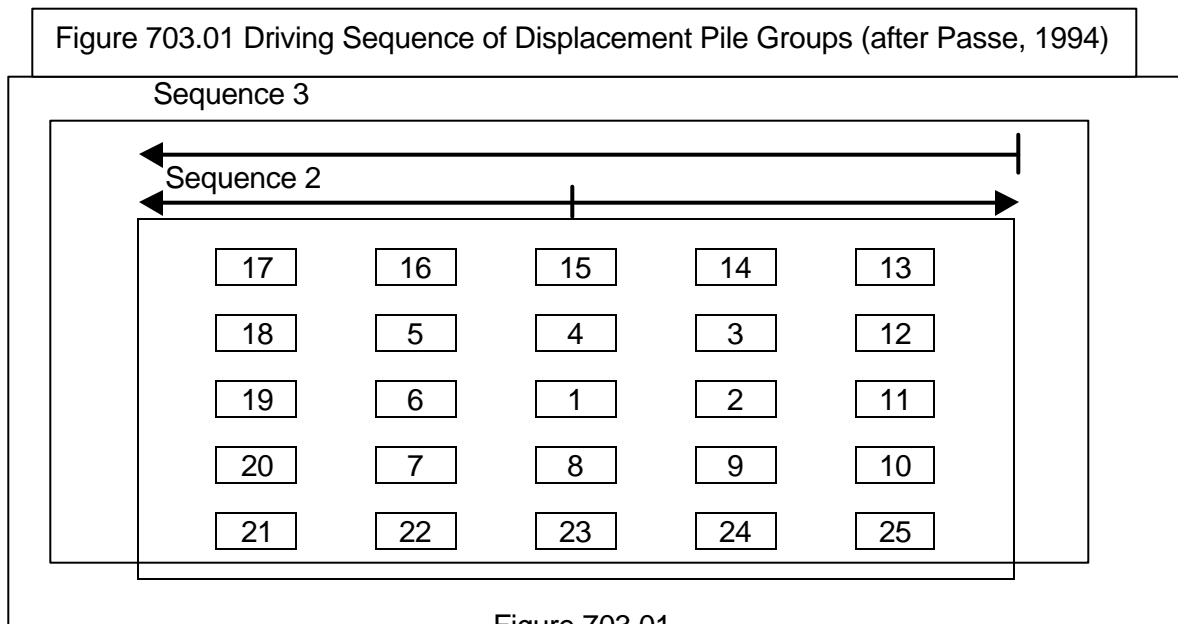


Figure 703.01

The following guidelines for Single Acting Diesel Hammer are provided to assist you. If there is a need for a different type of hammer inspection guideline, please contact the Geotechnical Section.

It is very important to field check the hammer systems provided by the contractor to the hammer data sheets after they are approved by the Geotechnical Section. Prior to pile driving, please verify cap weight and size and condition of the hammer cushion material as shown on the hammer data sheets.

E. Inspection of Piles Prior to and During Installation

1. The inspection will be different for each type of pile. Shop plans are required for sheet piles, but usually are not required for H-piles, concrete-piles or pipe-piles.
2. When MSE walls are being constructed, at times the soil conditions may require additional considerations. A note is sometimes included on our plans that states the MSE Wall Must Be Built Before Piles Are Driven. This note is usually applicable when the embankment behind the MSE wall is constructed as a fill. The note also usually specifies that the MSE wall cannot be constructed until the embankment has reached 95+% of its anticipated settlement. The concern here is that the granular backfill material will settle further and the embankment is also able to settle some additional amount due to the granular backfill load. The combined effect on the piling is to cause a downward load on the piling that will reduce the piling's capacity to resist the live and dead loads from the roadway.
3. Battered piles are driven at 1 ft. offset per 12 ft. of length or 3.33 ft. offset in 40 ft.

F. Precast Concrete Piles

1. The following is a list of items for prestressed concrete piles to be inspected at the construction site:
 - a. The piles should be of the specified length and section. The inspector must be assured that a minimum concrete strength has been obtained. If the piles are to be spliced on the site, the splices should meet the specified requirements (type, alignment, etc.).
 - b. Piles should be inspected for cracks or spalling. There should be no evidence that any pile has been damaged during shipping to the site, or during unloading of piles at the site. Lifting hooks are generally cast into the piling at pick-up points. Piles should be unloaded by properly sized and tensioned slings attached to each lifting hook.
 - c. The piles should be stored properly. When piles are being placed in storage, they should be stored above ground on adequate blocking in a manner which keeps them straight and prevents undue bending stresses.
 - d. The contractor should lift the piles into the leads properly and safely. Cables looped around the pile are satisfactory for lifting. Chain slings should never be permitted. Cables should be of sufficient strength and be in good condition. Frayed cables are unacceptable and should be replaced. For shorter piles, a

single pick-up point may be acceptable. The pick-up point locations should be as specified by the casting yard. For longer piles, two or more pick-up points at designated locations may be required.

- e. The pile should be free to twist and move laterally in the helmet.
 - f. Piles should have no noticeable cracks when placed in leads or during installation. Spalling of the concrete at the top or near splices should not be evident.
 - g. Steel H-Piles
1. The following should be inspected at the construction site:
 - a. The piles being driven must be oriented with flanges in the correct direction as shown on the plans. Because the lateral resistance to bending of H-piles is considerably more in the direction perpendicular to flanges, the correct orientation of H-piles is very important.
 - b. The piles should be of the specified steel grade, length, or section/weight.
 - c. Pile points, if required for pile toe protection, should be as specified.
 - d. Splices should be either proprietary splices or full penetration groove welds as specified. The top and bottom pile sections should be in good alignment before splicing.
 - e. Pile point attachments and splices must be welded properly.
 - f. There should be no observable pile damage, including deformations at the pile head.

G. Steel Pipe Piles

1. The following should be inspected at the construction site:
 - a. The piles should be of specified steel grade, length, or minimum section/weight (wall thickness) and either seamless or spiral welded as specified.
 - b. Piles should be driven either open-ended or closed-ended. Closed-ended pipe piles should have bottom closure plates or conical points of the correct size (diameter and thickness) and be welded on properly, as specified. Open-end pipe piles should have cutting shoes that are welded on properly.
 - c. The top and bottom pile sections should be in good alignment before splicing. Splices or full penetration groove welds should be installed as specified.
 - d. There should be no observable pile damage, including deformations at the pile head. After installation, closed-end pipes should be visually inspected for damage or water prior to filling with concrete.

H. Steel Sheet Piles

1. The sheet piles must meet thickness, section models, steel grade, length and width requirements as shown in our plans.
2. Sheet pile length should be measured so that analysis of obstructions to driving can be properly accomplished.
3. Sheet piles should be driven plumb or at the angle shown in the plans.

I. Inspection of Driving Equipment

A typical driving system consists of crane, leads, hammer, hammer cushion, helmet, and in the case of concrete piles, a pile cushion. Each component of the drive system has a specific function and plays an important role in the pile installation. The project plans and specifications may specify or restrict certain items of driving equipment. The Geotechnical Section will approve the contractor's driving equipment and determine conformity with the plans and specifications. The inspector must be sure the equipment used is what was approved.

1. The following checklist will be useful in the inspection of driving equipment before driving:
 - a. The pile driving hammer should be the specified type/size.
 - (1) The inspector should make sure for single acting air/steam or hydraulic hammers that the contractor uses the proper size external power source and that, for adjustable stroke hammers, the stroke necessary for the required energy be obtained. For double acting or differential air/steam or hydraulic hammers, the contractor must again obtain the proper size external power source and the operating pressure and volume must meet the hammer manufacturer's specification.
 - b. The hammer cushion being used should be checked to confirm it is of the approved material type, size and thickness.
 - (1) The main function of the hammer cushion is to protect the hammer itself from fatigue and high frequency accelerations which would result from steel to steel impact with the helmet and/or pile. The hammer cushion should have the proper material and same shape/area to snugly fit inside the helmet (drive cap). If the cushion diameter is too small, the cushion will break or badly deform during hammer blows and become ineffective. The hammer cushion must not be excessively deformed or compressed. Some air/steam hammers rely upon a certain total thickness (of cushion plus striker plate) for proper valve timing. Hammers with incorrect hammer cushion thickness may not operate, or will have improper kinetic energy at impact. Since it is difficult to inspect this item once the driving operation begins, it should be checked before the contractor starts pile driving on a project as well as periodically during production driving on larger projects.

- c. The helmet (drive cap) should properly fit the pile.
 - (1) The purpose of the helmet is to hold the pile head in alignment and transfer the impact concentrically from the hammer to the pile. The helmet also houses the hammer cushion, and must accommodate the pile cushion thickness for concrete piles. The helmet should fit loosely to avoid transmission of torsion or bending forces, but not so loosely as to prevent the proper alignment of hammer and pile. Helmets should ideally be of roughly similar size to the pile diameter. Although generally discouraged, spacers may be used to adapt an oversize helmet, provided the pile will still be held concentrically with the hammer. A properly fitting helmet is important for all pile types, but is particularly critical for precast concrete piles. A poorly fitting helmet often results in pile head damage. Check and record the helmet weight for conformance to wave equation analysis or for future wave equation analysis. Larger weights will reduce the energy transfer to the pile.
- d. The pile cushion should be of correct type material and thickness for concrete piles.
 - (1) The purpose of the pile cushion is to reduce high compression stresses, to evenly distribute the applied forces to protect the concrete pile head from damage, and to reduce the tension stresses in easy driving. Pile cushions for concrete piles should have the required thickness determined from a wave equation analysis but not less than 4 inches (100 mm). A new plywood, hardwood, or composite wood pile cushion, which is not water soaked, should be used for every pile. The cushion material should be checked periodically for damage and replaced before excessive compression (more than half the original thickness), burning or charring occurs. Wood cushions may take only about 1,000 to 2,000 blows before they deteriorate. During hard driving, more than one cushion may be necessary for a single pile. Longer piles or piles driven with larger hammers may require thicker pile cushions.
- e. Predrilling, jetting or spudding equipment, if specified or permitted, should be available for use and meet the requirements. The depth of predrilling, jetting or spudding should be very carefully controlled so that it does not exceed the allowable limits, usually 10 feet (1 m). Predrilling, jetting, or spudding below the allowed depths will generally result in a reduced pile capacity, and the pile acceptance may become questionable.
- f. A lead system must be used.
 - (1) The leads perform the very important function of holding the hammer and pile in good alignment with each other. Poor alignment reduces energy transfer as some energy is then imparted into horizontal motion. Poor alignment also generally results in higher bending stresses and higher local contact stresses which can cause pile damage. This is particularly important at end of driving when driving resistance is highest and driving stresses are generally increased.

J. Inspection of Driving Equipment During Installation

1. The main purpose of inspection is to assure that piles are installed so that they meet the driving criteria and the pile remains undamaged. The driving criteria is often defined as a minimum driving resistance as measured by the blow count in blows per inch. The driving criteria is to assure that piles have the desired capacity. However, the driving resistance is also dependent upon the performance of the pile driving hammer. The driving resistance will generally be lower when the hammer imparts higher energy and force to the pile, and the driving resistance will be higher if the hammer imparts lower energy and force to the pile. High driving resistances can be due either to soil resistance or to a poorly performing hammer. Thus, for the inspector to assure that the minimum driving criteria has been met and, therefore, the capacity is adequate, the inspector must evaluate if the hammer is performing properly.
2. Each hammer has its own operating characteristics; the inspector should not blindly assume that the hammer on the project is in good working condition. In fact, two different types of hammers with identical energy rating will not drive the same pile in the same soil with the same driving resistance. In fact, two supposedly identical hammers (same make and model) may not have similar driving capability due to several factors including differing friction losses, valve timing, air supply hose type-length-condition, fuel type and intake amount, and other maintenance status items. The inspector should become familiar with the proper operation of the hammer(s) used on site. The inspector may wish to contact the hammer manufacturer or supplier who generally will welcome the opportunity to supply further information.

K. Single Acting Diesel Hammers

1. Determine/confirm that the hammer is the correct make and model. Check for and record any identifying labels as to hammer make, model and serial number.
2. Make sure all exhaust ports are open with all plugs removed.
3. Inspect the recoil dampener for condition and thickness. If excessively worn or improper thickness (consult manufacturer) it should be replaced. If the recoil dampener is too thin, the stroke will be reduced. If it is too thick, or if cylinder does not rest on dampener between blows, the ram could blow out the hammer top and become a safety hazard.
4. Check that lubrication of all grease nipples is regularly made. Most manufacturers recommend the impact block be greased every half-hour of operation.
5. As the ram is visible between blows, check the ram for signs of uniform lubrication and ram rotation. Poor lubrication will increase friction and reduce energy to the pile.

6. Determine the hammer stroke, especially at end of driving or beginning of restrrike. A “jump stick” attached to the cylinder is a safety hazard and should not be used. The stroke can be determined by a saximeter which measures the time between blows and then calculates the stroke. The hammer stroke can also be calculated from this formula if the number of blows per minute (bpm) is manually recorded.

$$h \text{ [meters]} = (4400/[\text{bpm}^2]) - 0.90$$

- a. The calculated stroke may require correction for batter or inclined piles. The inspector should always observe the ram rings and visually estimate the stroke using the manufacturer’s chart.
7. As the driving resistance increases, the stroke should also increase. At the end of driving, if the ram fails to achieve the correct stroke (part of the driving criteria from a wave equation analysis), the cause could be lack of fuel. Most hammers have adjustable fuel pumps. Some have distinct fuel settings, others are continuously variable, and some use a pressure pump. Make sure the pump is on the correct fuel setting or pressure necessary to develop the required stroke. The fuel and fuel line should be free of dirt or other contaminants. A clogged or defective fuel injector will also reduce the stroke and should be replaced if needed.
8. Low strokes could be due to poor compression caused by worn or defective piston or anvil rings. Check compression by raising the ram, and with the fuel turned off, allowing the ram to fall. The ram should bounce several times if the piston and anvil rings are satisfactory.
9. Watch for signs of preignition. When a hammer preignites, the fuel burns before impact, requiring extra energy to compress gas and leaving less energy to transfer to the pile. In long sustained periods of driving, or if the wrong fuel with a low flash point is used, the hammer could overheat and preignite. When preignition occurs, less energy is transferred and the driving resistance rises, giving a false indication of high pile capacity. If piles driven with a cold hammer drive deeper or with less hammer blows, or if the driving resistances decrease after short breaks, preignition could be the cause and should be investigated. Dynamic testing is the preferable method to check for preignition.
10. For some diesel hammers, the total thickness of hammer cushion and striker plate must match the hammer manufacturer’s recommendation and the hammer cushion cavity in the helmet for proper fuel injection and hammer operation. This total thickness must be maintained.
11. Make sure the helmet stays properly seated on the pile and that the hammer and pile maintain alignment during operation.
12. The hammer hoist line should always be slack, with the hammer’s weight fully carried by the pile. Excessive tension in the hammer hoist line is a safety hazard and will reduce energy to the pile. Leads should always be used.

13. Some manufacturers void their warranty if the hammer is consistently operated above 100 blows per 250 mm of penetration beyond short periods, such as those required when toe bearing piles are driven to rock. Therefore, in prolonged hard driving situations, it may be more desirable to use a larger hammer or stiffer pile section.

14. Common problems and problem indicators for single acting diesel hammers are presented in the following table.

COMMON PROBLEMS AND PROBLEM INDICATORS FOR SINGLE ACTING DIESEL HAMMERS (from Williams Earth Sciences, 1995)	
Common Problems	Indicators
Water in fuel.	Hollow sound, white smoke.
Fuel lines clogged.	No smoke or little gray smoke.
Fuel pump malfunctioning.	Inconsistent ram strokes, little gray smoke or black smoke.
Fuel injectors malfunctioning.	Inconsistent ram strokes, little gray smoke or black smoke.
Oil low.	Blows per minute rate is lower than specified.
Oil pump malfunctioning.	Blows per minute rate is lower than specified.
Water in combustion chamber.	Hollow sound, white smoke.
Piston rings worn.	Low strokes.
Tripping device broken.	Pawl or pin used to lift piston does not engage piston. Pawl engages but does not lift piston.
Overheating.	Paint and oil on cooling fins start to burn/sound changes.

L. Field Driving Problem

In the following table, there is a list of common field problems and possible solutions.

COMMON PILE INSTALLATION PROBLEMS & POSSIBLE SOLUTIONS	
Problem	Possible Solutions
Piles encountering refusal driving resistance (blow count) above minimum pile penetration requirements.	Have wave equation analysis performed and check the pile has sufficient drivability and that the driving system is matched to the pile. If the pile and driving system are suitably matched, check driving system operation for compliance with manufacturer's guidelines. If no obvious problems are found, dynamic measurements should be made to determine if the problem is driving system or soil behavior related. Driving system problems could include preignition, preadmission, low hammer efficiency, or soft cushion. Soil problems could include greater soil strength than anticipated, temporarily increased soil resistance with later relaxation (required restrike to check), large soil quakes, or high soil damping.
Piles driving significantly deeper than estimated pile penetration depths.	Soil resistance at the time of driving probably is lower than anticipated or driving system performance is better than anticipated. Have wave equation analysis performed to assess ultimate pile capacity based on the blow count at the time of driving. Perform restrike tests after an appropriate waiting period to evaluate soil strength changes with time. If the ultimate capacity based on restrike blow count is still low, check drive system performance and restrike capacity with dynamic measurements. If drive system performance is as assumed and restrike capacity low, the soil conditions are weaker than anticipated. Foundation piles will probably need to be driven deeper than originally estimated or additional piles will be required to support the load. Contact the structural engineer/designer for recommended change.
Abrupt change or decrease in driving resistance (blow count) for bearing piles.	If borings do not indicate weathered profile above bedrock/bearing layer, then pile toe damage is likely. Have wave equation analysis performed and evaluate pile toe stress. If calculated toe stress is high and blow counts are low, a reduced hammer energy (stroke) and higher blow count could be used to achieve capacity with a lower toe stress. If calculated toe stress is high at high blow counts, a different hammer or pile section may be required. For piles that allow internal inspection, reflect light to the pile toe and tape the length inside the pile for indications of toe damage. For piles that cannot be internally inspected, dynamic measurements could be made to evaluate problem or pile extraction could be considered for confirmation of a damage problem.
Driving resistance (blow count) significantly lower than expected during driving.	Review soil borings. If soil borings do not indicate soft layers, pile may be damaged below grade. Have wave equation analysis performed and investigate both tensile stresses along pile and compressive stresses at tie. If calculated stresses are within allowable limits, investigate possibility of obstructions/uneven toe contact on hard layer or other reasons for pile toe damage. If pile was spliced, re-evaluate splice detail and field splicing procedures for possible splice failure.
Vertical (heave) or lateral movement of previously installed piles when driving new piles.	Pile movements likely due to soil displacement from adjacent pile driving. Contact geotechnical engineer for recommended action. Possible solutions include re-driving of installed piles, change in sequence of pile installation, or predrilling of pile locations to reduce ground movements. Lateral pile movements could also result from adjacent slope failure in applicable conditions.

COMMON PILE INSTALLATION PROBLEMS & POSSIBLE SOLUTIONS	
Problem	Possible Solutions
Piles driving out of alignment tolerance.	Piles may be moving out of alignment tolerance due to hammer-pile alignment control or due to soil conditions. If due to poor hammer-pile alignment control, a pile gate, template or fixed lead system may improve the ability to maintain alignment tolerance. Soil conditions such as near surface obstructions (see subsequent section) or steeply sloping bedrock having minimal overburden material (pile point detail is important) may prevent tolerance from being met even with good alignment control. In these cases, survey the as-built condition and contact the Geotechnical engineer for recommended action.
Piles driving out of location tolerance.	Piles may be moving out of location tolerance due to hammer-pile alignment control or due to soil conditions. If due to poor hammer-pile alignment control, a pile gate, template or fixed lead system may improve the ability to maintain location tolerance. Soil conditions such as near surface obstructions (see subsequent section) or steeply sloping bedrock having minimal overburden material (pile point detail is important) may prevent tolerances from being met even with good alignment control. In these cases, survey the as-built condition and contact the Geotechnical engineer for recommended action.
Piles encountering shallow obstructions.	If obstructions are within 3 feet of working grade, obstruction excavation and removal is probably feasible. If obstructions are at deeper depth, are below the water table, or the soil is contaminated, excavation may not be feasible. Spudding or predrilling of pile locations may provide a solution with method selection based on the type of obstructions and soil conditions.
Pile encountering obstructions at depth.	If deep obstructions are encountered that prevent reaching the desired pile penetration depth, contact the structural engineer/designer for remedial design. Ultimate capacity of piles hitting obstructions should be reduced based upon pile damage potential and soil matrix support characteristics. Additional foundation piles may be necessary.
Concrete piles develop partial horizontal cracks in easy driving.	Check hammer-pile alignment since bending may be causing the problem. If the alignment appears to be normal, tension and bending combined may be too high. The possible solution is as above with complete cracks.
Concrete pile spalling or slabbing near pile head.	Have Geotechnical Section determine pile head stress for observed blow count and compare with allowable stresses. If high calculated stress, add pile cushioning. If low calculated stress, investigate pile quality, hammer performance, hammer-pile alignment.
Concrete piles develop complete horizontal cracks in easy driving.	Have Geotechnical Section determine tension stresses along pile for observed blow counts. If high calculated tension stresses, add cushioning or reduce stroke. If low calculated tension stresses, check hammer performance and/or perform measurements.
Concrete piles develop complete horizontal cracks in hard driving.	Have Geotechnical Section determine tension stresses along pile. If high calculated tension stresses, consider heavier ram. If low calculated tension stresses, take measurements and determine quakes which are probably higher than anticipated.
Concrete piles develop partial horizontal cracks in easy driving.	Check hammer-pile alignment since bending may be the problem. If alignment appears to be normal, tension and bending combined may be too high; solution will then be the same as for complete cracks above.
Steel pile head deforms, timber pile top mushrooms.	Check helmet size/shape; check steel strength; check evenness of pile head, banding of timber pile head. If okay, have Geotechnical Section determine pile head stress. If calculated stress is high, reduce hammer energy (stroke) for low blow counts; for high blow counts, different hammer or pile type may be required.
Unexpectedly low blow counts during pile driving.	Investigate soil borings; if soil borings do not indicate soft layers, pile may be damaged below grade. Have Geotechnical Section investigate both tensile stresses along pile and compressive stresses at toe. If calculated stresses are acceptable, investigate possibility of obstructions/uneven toe contact on hard layer or other reasons for pile toe damage.

COMMON PILE INSTALLATION PROBLEMS & POSSIBLE SOLUTIONS	
Problem	Possible Solutions
Higher blow count than expected.	Have the Geotechnical Section review the wave equation analysis and check that all parameters were reasonably considered. Check hammer and driving system. If no obvious defects are found in driving system, field measurements should be taken. Problem could be preignition, preadmission, low hammer efficiency, soft cushion, large quakes, high damping, greater soil strengths, or temporarily increased soil resistance with later relaxation.
Lower blow count than expected.	Probably soil resistance is lower than anticipated. Have the Geotechnical Section assess soil resistance. Perform restrrike testing (soil resistance may have been lot during driving), establish setup factor and drive to lower capacity. Hammer performance may also be better than anticipated, check, by measurement.
Diesel hammer stroke (bounce chamber pressure) higher than calculated.	The field observed stroke exceeds the calculated stroke by more than 10%. Compare calculated and observed blow counts. If observed are higher, soil resistance is probably higher than anticipated. If blow counts are comparable, have the Geotechnical Section reanalyze with higher combustion pressure to match observed stroke and assure that preignition is not a problem, e.g., by measurements.
Diesel hammer stroke (bounce chamber pressure) lower than calculated.	The field observed stroke is less than 90% of the calculated stroke. Check that ram friction is not a problem (ram surface should have well lubricated appearance). Compare calculated and observed blow count. If observed one is lower, soil resistance is probably lower than anticipated. If blow counts are comparable, reanalyze with lower combustion pressure to match observed hammer stroke.
Cannot find hammer in data file.	See if there is a hammer of same type, similar ram weight and energy rating and modify its data.
Cannot find an acceptable hammer to drive pile within driving stress and driving resistance limits.	Both calculated stresses and blow counts are too high. Increase pile impedance or material strength or redesign for lower capacities. Alternatively, check whether soil has potential for setup. If soil is fine grained or known to exhibit setup gains after driving, then end of driving capacity may be chosen lower than required. Capacity should be confirmed by restrrike testing or static load testing.

SINGLE ACTING HAMMER INSPECTION CHECKLIST (For PM Use Only)

Project/Pile: _____

Hammer Name: _____

Date: _____

Serial No: _____

Conditions: _____

OBJECT	REQUIREMENTS	OBSERVATIONS
<p style="font-size: small;">Labels in diagram: Ram Cylinder Fuel Tank Inlet/Exhaust/Scavenge Ports Fuel Pump Fuel Injector Recoil Dampener Impact Block Striker Plate Hammer Cushion Helmet Follower Pile Cushion Pile</p>	Ram Lubricated?	Yes / No
	Exhaust Ports Open?	Yes / No
	Fuel Pump	Hammer Setting _____
	Recoil Dampener Undamaged?	Yes / No
	Impact Block Lubricated?	Yes / No
	Striker Plate	t= _____ D= _____
	Hammer Cushion	t= _____ D= _____ Material _____
		How long in use? _____
	Helmet	Type or Weight? _____
	Pile Cushion	Material _____ t= _____ Size _____ How long in use? _____

704.00 BRIDGES (STEEL STRUCTURES) (SSHC Section 708)

704.01 DESCRIPTION

- A. This work includes the furnishing, preparing and erecting of all riveted, bolted or welded structures in which the main members spanning the supports are composed of steel.

704.02 MATERIAL REQUIREMENTS

- A. Members of steel structures that are fabricated in the shop are inspected by NDR personnel before they are shipped to the job site. In some cases, when the fabrication is done outside of the state, the inspection will take place after delivery to the site of work. The Project Manager should have a copy of the shop inspection report and the mill test report before allowing the erection of any portion of the structure. Miscellaneous parts of the superstructure such as high tensile steel bolts will require field inspection and sampling according to the "*Materials Sampling Guide*".
- B. Field welding may require the use of special welding electrodes as designated in the plans, specifications, or special provisions. Some of these welding electrodes may require special care and handling before their use will be permitted. (See *SSHC Section 708*.) Enter date steel is verified in SiteManager. Occasionally wrong size is delivered.
- C. Concrete Industries rebar shipments will be documented to show bending details, heat numbers, quantity and project location by stationing.

704.03 CONSTRUCTION METHODS

- A. Falsework (*SSHC Subsection 704.03*)
1. Girders should be blocked so that the weight of any deck overhang does not bend the girder, which will ripple the deck.
- B. Temporary Fastenings
1. Contractors often request permission to use anchor supports for face forms, concrete curbs, Jersey barriers, raised medians on bridges. Any contractor desiring to use a temporary floor fastening may be allowed to use only some form of weakened section bolt or tie, cast in the floor. The weakened section must be so positioned that when broken off the break will be recessed below the surface. The resulting void must be patched with mortar.
 2. NOTE:
 - a. No bolt without a weakened section may be used.
 - b. No holddown device shot into the floor will be allowed.
 - (1) Concrete arch bridges.
 - (2) Support of girders or other large structural elements when required.

- (3) Unusual or complicated work indicated in the plans.
- (4) Support of girders over or under active railroad tracks.
- (5) Support of girders carrying traffic or extending over highways or streets carrying traffic.

C. Submitting Plans

NOTE: Submission of falsework plans does not imply that OSHA regulations are satisfied, that the NDR, or the Project Manager assumes any liability for the falsework. Inspectors should not give the contractors advice on how to construct the falsework.

D. Bridges-Steel Beam

- 1. On bridges using weathering steel (A 588) for steel structures, the contractor shall:
 - a. Use "high strength," A325M Type III bolts, A563 Grade DH3 nuts, and F463 Type III washers.
 - b. Limit shop painting to only areas under expansion joints and all bearings. Shop painting will be with a Zinc-rich primer and a colored topcoat. Field touch-up will be required for paint that is damaged and to fasteners in these areas and it will be done with same color and type of paint as the original painting.
 - c. Require special care to assure concrete slobbers are eliminated (or at least removed) from steel surfaces before the concrete hardens. Washing with water is the preferred method of removing concrete slobbers.

E. Structural Joints Using High Tensile Steel

BOLT DIAMETER (INCHES) D	HEAVY HEX STRUCTURAL BOLTS BOLT DIMENSIONS (INCHES)			HEAVY HEX NUTS NUT DIMENSIONS (INCHES)	
	WIDTH ACROSS FLATS F	HEIGHT H	THREAD LENGTH	WIDTH ACROSS FLATS W	HEIGHT H
1/2	7/8	5/8	1	7/8	5/8
3/8	1 1/8	25/64	1 1/4	1 1/8	39/64
3/4	1 3/4	3/4	1 3/4	1 3/4	41/64
5/8	1 5/8	33/64	1 1/2	1 5/8	35/64
1	1 7/8	39/64	1 3/4	1 7/8	63/64
1 1/8	2 1/8	7/8	2	2 1/8	1 1/8
1 1/4	2	15/8	2	2	1 3/8
1 3/8	2 3/8	7/8	2 1/4	2 3/8	1 7/8
1 1/2	2 7/8	15/8	2 1/2	2 7/8	1 7/8

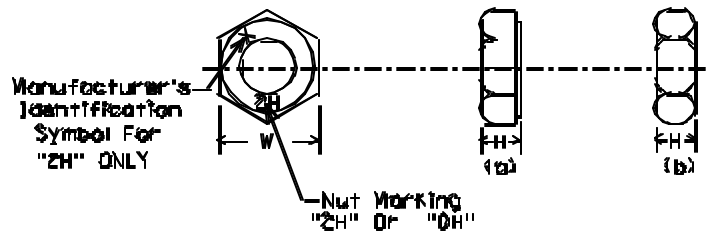
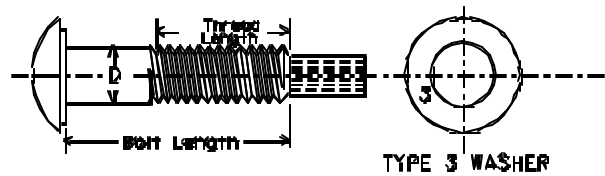
TYPE 2
 TYPE 1
 TYPE 5 (Nut)
 TYPE 3 (Nut)

Manufacturer's Identification Symbol
 Standard Nut Marking
 Nut Marking
 Manufacturer's Identification Symbol for "F" and "H" dia.
 Markings with "F" and "H" and three circumferential marks
 Markings with "F" and "H"

Dimensions: D (Bolt Diameter), F (Width Across Flats), H (Bolt Height), W (Nut Width Across Flats), L (Bolt Thread Length)

Bolts

DIRECT TENSION BOLTS



Nuts may be washer faced as in (a) or double chamfered as in (b)

1. Must obtain Construction Division permission to use these bolts.
2. Special impact wrench that will hold bolt & tighten the nut must be used.
3. End of bolt will separate at proper torque.

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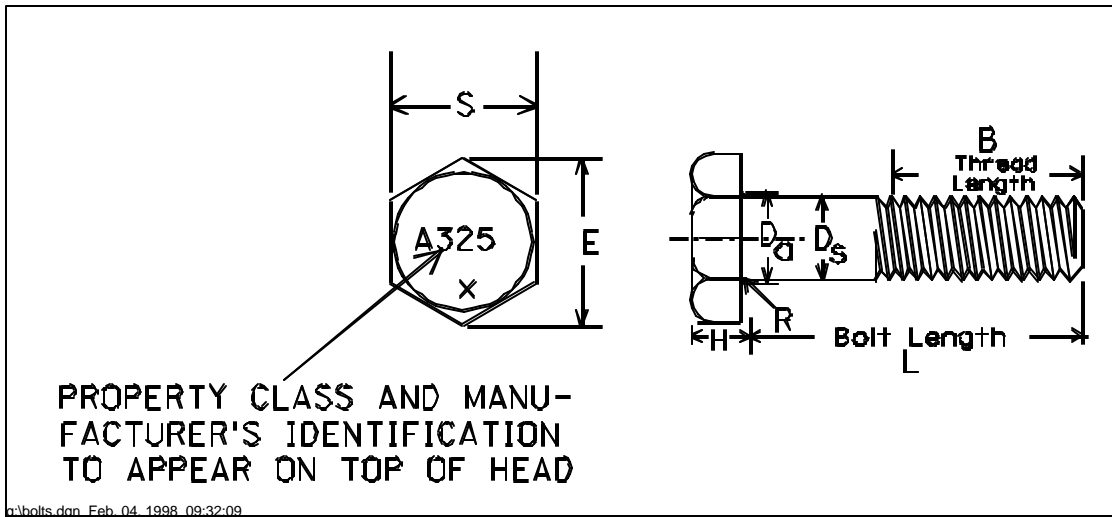
1. *SSHC Section 1058* requires high tensile steel bolt, nut and washer material for structural steel joints to meet the requirements of ASTM Designation A 325/A 325M.
2. When heavy hexhead structural bolts and heavy hexagon nuts are used, a hardened washer is required only under the bolt head, or nut, whichever is the element being turned. Bolts and nuts may be washer faced, but these faces do not take the place of a hardened washer.
3. Heavy hexhead structural bolts manufactured to ASTM A 325/A 325M, Types 1, 2 and 3, the dimensions for which are shown in the ASTM tables, are identified on the top of the head by the legend "A 325", and the manufacturer's symbol.
4. Type 1 bolts, at the option of the manufacturer, may be marked with three radial lines 120 degrees apart.
5. Type 2 bolts shall be marked with three radial lines 60 degrees apart. Type 3 bolts shall have the "A 325" underlined and the manufacturer may add other distinguishing marks indicating that the bolt is of a weathering type.
6. Heavy hex nuts for A 325 bolts are identified on at least one face by the manufacturer's mark and the number "2" or "2H", by three equally spaced circumferential lines, or by the legend "D" or "DH". Heavy hex nuts for A 325 Type 3 bolts shall be marked on one face with three circumferential marks and the numeral "3", in addition to any other distinguishing marks the manufacturer may elect to use.
7. Washers for A 325 Type 3 bolts shall be marked on one face near the outer edge with the numeral "3", or other distinguishing marks indicating that the washer is of a weathering type.
8. The marking on bearing surfaces of nuts and washers shall be depressed.
9. According to the specifications, high strength steel bolts may be installed by the turn of the nut method. It should be noted that the equivalent torque values given in SSHC Table 708.03 are experimental approximations and that the footnote to this table required that the torque-tension ratio be determined under actual conditions of the application. Wrenches will be calibrated and the torque-tension ratio will be determined at the site by Materials and Research Division personnel. The Construction Engineer should be notified as early as possible as to the time when the wrench and representative bolts will be present at the site in order that arrangements may be made to have appropriate personnel travel to the site and calibrate the wrench and establish the torque-tension ratio.
10. When Materials and Research Division personnel have calibrated the wrench and determined the torque-tension ratio, the bolt tension calibrator will be left with the project personnel so that the wrench calibration may be checked as the work goes on. Impact wrenches should be checked on a daily basis and manual torque wrenches at any time that, in the opinion of the Project Manager, conditions have varied from those present during the initial calibration.
11. Impact wrenches should be calibrated under the same conditions, such as length of hose and power supply, that were present during actual installation of the bolts.

12. SSHC Subsection 708.03 requires that the structure shall be adjusted to the requirements of blocking diagram before placing permanent bolts in field connections. This should be checked by the contractor and verified by the inspector prior to completing final phase of bolt tightening.

13. All splice plates and contact surfaces shall be clean.

F. High Strength Fasteners (SSHC Section 1058)

METRIC HEAVY HEX BOLTS



D Nominal Bolt Size & Thread Pitch	D _s		S		E		H		D _a	R	B (Ref.) Thread Length (Basic)			
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Fillet Transition Dia.	Radius of Fillet	Bolt Lengths <125	Bolt Lengths >125 and <200		Bolt Lengths >200
												Body Diameter	Width Across Flats	
M12x1.75	12.70	11.30	21.00	20.16	24.25	22.78	7.95	7.24	13.7	0.67	30	36	49	
M14x2	14.70	13.30	24.00	23.16	27.71	26.17	9.25	8.51	15.7	0.6	34	40	53	
M16x2	16.70	15.30	27.00	26.16	31.18	29.56	10.75	9.68	17.7	0.6	38	44	57	
M20x2.5	20.84	19.16	34.00	33.00	39.26	37.29	13.40	12.12	22.4	0.8	46	52	65	
M24x3	24.84	23.16	41.00	40.00	47.34	45.20	15.90	14.56	26.4	0.8	54	60	73	
M30x3.5	30.84	29.16	50.00	49.00	57.74	55.37	19.75	17.92	33.4	1.0	66	72	85	
M36x4	37.00	35.00	60.00	58.80	69.28	66.44	23.55	21.72	39.4	1.0	78	84	97	

1. *SSHC Subsection 708.03, Paragraph 10.h.* Turn-of-Nut method shall be followed for tightening all high strength fasteners.
2. High Strength bolts and nuts, which have been torqued as outlined below, shall not be reused. This includes both black and galvanized bolts and nuts.
 - a. Bolting
 - (1) Receiving Shipments
 - (a) Prior to installation, check shipping certifications and compare these to bolting kegs on site. Check for size, length, heat numbers, and general fastener condition i.e., rusted black bolts or non-lubricated galvanized nuts. Rotational-Capacity (RC) lots will need to be checked.
 - b. Installation Checklist
 - (1) A pre-bolting meeting is strongly recommended/encouraged. Bolting procedures, Turn-of-Nut process described below, and the inspection process need to be discussed.
 - (2) Site storage of fasteners is important. Storage should be in a sealed container within a sheltered storage shed.
 - (3) Black bolts and nuts shall be oily to the touch when delivered and installed.
 - (4) Galvanized nuts shall be checked to verify lubrication. A uniform dye color indicates lubricant has not been damaged. If there is no color, or color is not uniform, bolts and nuts shall be field lubricated with bees wax, stick wax, or other approved dry wax prior to installation.
 - (5) Rusted or dirty bolts or nuts shall be cleaned and relubricated prior to installation.
 - (6) Faying surfaces shall be free of burrs and foreign material; and bolted faying surfaces are to be painted with zinc rich paint.
 - (7) All fasteners shall be free of dirt, moisture, rust, and be "well" lubricated.
 - (8) Washers (when required) are to be placed under the **"turned element."**
 - (9) Often contract documents will specify which way a bolt is to be installed. If there is no specific guidance, threaded ends of bolts will be turned inside and away from normal exposure to pedestrian and/or vehicular traffic for aesthetic reasons.

- (10) During installation, particular care should be exercised so a snug-tight condition is achieved.

c. Rotational-Capacity

- (1) The plans and specifications may eventually require a Rotational-Capacity (RC) test for all "high strength" fasteners. This test confirms component compatibility and the presence of adequate lubrication. Currently, it is only required when the Project Manager determines it is necessary.
- (2) There are two separate Rotational-Capacity requirements:
 - (a). Fasteners (bolts, nuts, and washers) received at the project shall have been RC tested by the supplier or manufacturer prior to shipment. Therefore, each combination of production lots must have a unique RC lot number. This number must be readily identifiable on each container of fasteners.
 - (b). Prior to installation, the contractor shall field test all RC lots as supplied. Field tests are not intended to match the values provided by the supplier, but as a separate and added acceptance test.
 - (c) Field testing procedures are given in *SSHC Subsection 708.03, paragraph 10.h.*

d. Turn-of-Nut Method

- (1) "Turn-of-Nut" method involves the following simple steps. Adherence to this procedure will assure a properly fitted and clamped connection. (*Refer to SSHC Subsection 708.03.*)
 - (a) Adequate number of bolts and pins shall be installed to bring a joint in tight contact and alignment. These bolts shall be brought to a snug-tight condition to insure that the joint is maintained in good contact during installation of remaining bolts. A washer shall be placed under the element to be turned.
 - (b) Remaining bolts in a connection shall be installed and brought to a snug-tight condition.
 - (c) Check initially installed bolts to assure they remained in a snug-tight condition.
 - (d) Tighten all bolts by the applicable Turn-of-Nut amount specified in *SSHC Subsection 708.03*. Additional rotation depends on the bolt length to diameter ratio and shape of connected pieces. For MOST installations (both faces normal to bolt Axis) the following table can be used to determine additional rotation for Turn-of-Nut.

NOTE: The following table is currently printed in English units only. When Standard diameter, lengths, and additional rotation values are developed for metric fasteners, another table will be prepared.

Turn of the Nut			
3/4" Dia. Bolts		7/8" Dia. Bolts	
Bolt Length	Additional Rotation	Bolt Length	Additional Rotation
0-3"	1/3 turn	0-3.5"	1/3 turn
>3"-6"	1/2 turn	>3.5-7"	1/2 turn
>6" -9"	2/3 turn	>7" - 10.5"	2/3 turn
NOTE: All additional rotations have a \pm tolerance. Refer to <i>SSHC Section 708</i> .			
1" Dia. Bolts		1 1/8" Dia. Bolts	
Bolt Length	Additional Rotation	Bolt Length	Additional Rotation
0-4"	1/3 turn	0-4.5"	1/3 turn
>4"-8"	1/2 turn	>4.5"-9"	1/2 turn
>8" -12"	2/3 turn	>9" - 13.5"	2/3 turn
NOTE: All additional rotations have a \pm tolerance. Refer to <i>SSHC Subsection 708.03</i> .			

e. Snug Tight

- (1) Snug tight is defined as the tightness that exists when all plies of a joint are in "firm" contact with each other. There shall not be air gaps between metal to metal or metal to bolt surfaces. For properly fitting surfaces, snug tight can usually be accomplished by:
 - (a) The full effort of a person using an ordinary spud wrench.
 - (b) A "few impacts" of an impact wrench. To quantify "few impacts," tighten a few bolts using the full effort method on a spud wrench. Then apply the job impact wrench, and roughly check how many impacts it takes to develop at least the same effort.
- (2) After **ALL** bolts in the connection are snug tight:
 - (a) **ALL** nuts shall be match-marked with bolt point nut and base steel using paint crayon, or other means to provide a straight reference line for determining final relative rotation of parts during tightening.

- (b) All bolts in a connection shall then be tightened additionally by an applicable amount of nut rotation specified above. Tightening should progress from the most rigid part of the joint to its free edges. On our normal web and flange splices, this would mean beginning at the centerline of a splice and progressing away (in each direction) from the centerline of splice.
 - (3) Inspectors should observe this operation at intervals to make certain the match-marking is done correctly, and that the opposite bolt head or nut does not turn during the tightening process. Inspectors also should check to see if proper rotation has been made considering tolerances given at the bottom of the nut rotation chart.
- f. Inspection Wrench Calibration
- (1) Tension Measuring Calibrated Devices
 - (a) Tension measuring calibrated devices (typically Skidmore-Wilhelm Calibrator) are calibrated to a high degree of accuracy, but can lose some of this accuracy after an extended period of time. Contractors can have the devices calibrated by the Materials & Research Laboratory.
 - (b) When each device is calibrated, a calibration sheet will be issued indicating the date the test was performed. Contractors must keep the calibration sheet with the tension-measuring device.
 - (c) Attentiveness needs to be exercised when using this Calibration Sheet. The inspector needs to check the sheet and compare the "Indicated Load on Gauge" column to those values listed in the "AVG" column under "Actual Load on Testing Machine." These are usually **NOT** the same.

NOTE: Be sure to take any difference (INDICATED versus ACTUAL) into account when calibrating the Job Torque Wrench!

- (2) Torque Wrench Calibration
 - (a) At least once a day, three bolts of the same grade, size, and condition as those used in the structure shall be placed individually in a calibration device capable of indicating bolt tension. A washer shall be used under the part to be turned.

NOTE: There must be 3-5 threads exposed behind the nut. Check and add washers if required. For longer bolts, steel shim plates should be used.

- (i) Tension bolt to 100 percent of "Minimum Bolt Tension" listed for a particular bolt diameter. Tension is read directly from the tension measuring calibrated device as corrected by accounting for differences between INDICATED versus ACTUAL. (Refer to *SSHC Subsection 708.03* for "Minimum Bolt Tension.")
- (ii) Apply inspection torque wrench, rotate nut or bolt and increase tension by an additional 5%. Remember, a dial type wrench must be set to zero before checking torque. Record the inspection wrench's "TORQUE" when 105% of the tension is achieved.

NOTE: The turned element must be moving to indicate the correct torque.

- (iii) **EXAMPLE:** (English units)

Assume:

1. 7/8" Diameter bolt
2. Skidmore Calibration

Minimum Bolt Tension
39,250 lbs-force

Skidmore Calibration
Gauge Reading 40,000 lbs-force
Actual Ave. at 40,000 = **38,800 lbs-force**

Calculations

- For 100% tension, corrected Skidmore gauge should read:

$$39,250 + (40,000 - 38,800) = \mathbf{40,450 \text{ lbs-force}}$$

- For 105% tension, corrected Skidmore gauge should read:

$$40,450 \times 1.05 = \mathbf{42,473 \text{ lbs-force}}$$

- (vi) torque reading on Inspection Wrench at 42,470± lbs-force is recorded.
- (a) Repeat this process for a total of three fasteners.
- (b) The inspector notes the torque for three fasteners, averages this torque, and that becomes the Job Inspection Torque Value until the wrench is recalibrated the next day, or another size or length of bolt is to be inspected.

The Inspector shall record:

- The job inspection torque.
- The Tension Measuring device's calibration "date reported," serial and model number, and calibration lab number.

g. Turn-of-Nut Inspection (*SSHC Subsection 708.03*)

- (1) After all fasteners in a joint are properly tightened by the Turn-of-Nut method, they shall be inspected as indicated:
 - (a) Installed fasteners shall be inspected the same day as installed by the contractor with the inspector present.
 - (b) The contractor shall use a calibrated torque wrench for the inspection operation.
 - (c) Ten percent of the bolts which have been tightened in the structure shall be tested with the inspection wrench the same day as installed. At least two bolts, selected at random, in each connection shall be tested. If no rotation (nut or bolt head) is noted by job inspecting torque wrench and the faying surfaces are in tight contact the connection shall be accepted as properly tightened. If any nut or bolt head is turned, all bolts in the connection shall be checked, and all bolts whose nut or head is turned shall be tightened and reinspected.
 - (d) Bolts tightened by the Turn-of-Nut method may reach tensions substantially above minimum torque values specified, but this shall not be cause for rejection.
 - (e) Care should be taken, however, to not overstress the bolts. If most of the bolts exceed 20% of minimum bolt tension, the contractor's procedures should be reviewed to determine:
 - (i) Is the snug-tight procedure correct?
 - (ii) Are there nicks or burrs on the threads?
 - (iii) Are the nuts or bolts rusty or dirty?
 - (iv) Check for residual lubrication. All threaded fasteners (black and galvanized) are required to be lubricated. Black bolts and nuts need to have a water soluble oil, and galvanized nuts are to be lubricated as per ASTM A 563. Prelubricated galvanized nuts will be dyed typically to a blue color. If there is no indication of color OR if the color is faded, the bolts shall be field lubricated with bees wax, stick wax, or some other dry lubricant.

- (v) Is calibrating device correct?
- (4) Bolts and nuts must always be inspected prior to installation. Items of major concern are:
 - (a) Nicks or burrs in the threads
 - (b) Rust
 - (c) Presence of dirt or other foreign material
 - (d) Fastener lubrication
 - (e) All dirt, foreign material, and rust must be removed prior to use. Black bolts may require reoiling to remove rust etc. If reoiling is required, excess oil must be removed prior to installation. When rust cannot be removed by oiling, the bolt or nut must be rejected. Bolts or nuts with nicks or burrs on threads must be rejected. Relubrication will necessitate rechecking fasteners in the lot for Rotational-Capacity.
- (5) Plan ahead before girder splices have been fully tightened. Make necessary adjustments prior to tightening the bolts in a connection. The best way to assure that beam lines are straight and true is to:
 - (a) Scribe a line at the center of each bearing on all masonry plates or concrete.
 - (b) Set beams and make snug tight connections proceeding to the forward pier. Then go back and straighten the beam line, checking to be sure bearings remain centered on their seats. Once the previous span is aligned and tightened, proceed to the next forward span.
 - (c) Check to be sure beam ends are aligned prior to tightening the splice.
 - (d) This will require coordination between survey and inspection crews and the contractor.
- h. Galvanized Bolts
 - (1) *When using galvanized hardware, a lubricant approved by ASTM A 563 shall be applied to the nuts.* Galvanized nuts "typically" are delivered to the project pre-lubricated. Usually, pre-lubricated nuts are stained and have a distinguishing color. If a lubricant has been applied at the fabrication shop, a field reapplication is not necessary provided original lubrication has not been removed in some manner. For situations where fabrication shop lubricant is in question, field application of bees wax, stick wax, or some other dry lubrication shall be required. Rotational-Capacity requires the test to be conducted with fasteners in the same condition as they will be during installation.

(2) A WORD OF CAUTION:

- (a) Lubrication is required to minimize galling during installation. Since nuts are lubricated (both threads and faces), it is important that nuts be rotated during tightening.
- (b) Fasteners (bolts and nuts of any type) shall not be tightened, then removed, reinstalled, and retightened.

G. Welding (*SSHC Subsection 708.03*)

1. Contractors may be allowed to tack weld form hardware to the shear connectors on steel girders. (The intent is to eliminate the request procedure.)
2. This policy does not apply to the rebar stirrups which extend out of the top of prestressed girders.

H. Shear Connectors

1. OSHA has made a determination that shear connectors on steel girders are a tripping hazard. However, OSHA, after receiving petitions from FHWA, AASHTO, and other organizations, issued relief from the field welding requirements. The Department and other transportation agencies were concerned that field welded shear connectors created a bridge that would not be as safe as a bridge with shop welded shear connectors.
2. Girders may arrive on-site with all the shear connectors shop welded and this will not be a citable violation of the OSHA shear connector requirements. It will be considered a “de minimis” violation, or in other words, a minor concern that has a very low probability of occurrence and where expenditure of resources is not warranted to ensure compliance.
3. 100 percent conventional fall protection is required for all workers working overhead (6 feet or higher).
4. Shear connectors may either be shop welded or field welded.
 - If they are field welded then the inspector needs to realize that welding shear connectors is a critical operation. The bridge may fail if the shear connectors are not welded properly.
 - **Use a “big” hammer to check field welded shear connectors.**

Table 708.01
Shear Connector Checklist

1.	An arc shield (ferrule) of heat-resistant ceramic or other suitable shall be furnished with each stud. The material shall not be detrimental to the welds or cause excessive slag and shall have sufficient strength so as not to crumble or break due to thermal or structural shock before the weld is completed.
2.	Only approved studs shall be used. The arc shield used in production shall be the same as used in qualification tests.
3.	Before installation of the studs, the contractor shall submit to the inspector for approval information on the studs to be furnished as follows:
a.	The name of the manufacturer.
b.	A detailed description of the stud and arc shield.
c.	A certification from the manufacturer that the stud is qualified as specified in the contract.
d.	A copy of the qualification test report as certified by the testing laboratory.
4.	The studs, after welding, shall be free from any defect or substance which would interfere with their function.
5.	Studs shall be end welded to steel with automatically timed stud welding equipment connected to a suitable power source.
6.	If two or more stud welding guns are to be operated from the same power source, they shall be interlocked so that only one gun can operate at a time and so the power source has fully recovered from making one weld before another weld is started.
7.	At the time of welding studs shall be free from any rust, rust pits, scale, oil or other deleterious matter which would effect the welding operation.
8.	Welding shall not be done when the base metal temperature is below 0 degrees or when the surface is wet or exposed to rain or snow.
9.	When necessary to obtain satisfactory welds, the areas on the beam or girder to which the studs are to be welded shall be brushed or ground free of mill scale or rust.
10.	The arc shields or ferrules shall be kept dry. Any arc shield which shows signs of surface moisture from dew or rain shall be oven-dried at 250 degrees for two hours before use.
11.	The first two studs welded on each beam or girder, after being allowed to cool to a temperature of 150 degrees or less, shall be bent 30 degrees by either striking the studs on the head with a hammer or placing a pipe or other suitable hollow device over the stud and manually or mechanically bending the stud.
12.	When the temperature of the base metal is below 32 degrees, tow studs in each 100 studs welded, shall be bent in addition to the first two bent as specified in paragraph 11 above.
13.	Studs on which a full 360 degree weld is not obtained shall be repaired by adding a 3/16 inch fillet weld in place of the lack of weld as ling as the repair weld extends 3/8 of an inch beyond the area on each end of where the lack of weld was. The shielded metal-arc process with 7018 or 8018 low hydrogen electrodes shall be used.
14.	Longitudinal and lateral spacing of studs with respect to each other and to edges of the beam or girder flanges may vary a maximum of one inch from the location shown on the drawings. The clear distance between the studs shall not be less than one inch unless approved by the engineer. The minimum distance from the edge of the stud base to the edge of the flange shall be the diameter of the stud plus 1/8 inch, but preferably not less than 1-1/2 inch.
15.	Prequalification. Studs which are field applied in the flat (down hand) position to a planar and horizontal surface are deemed prequalified by virtue of the manufacturer's stud-base qualification tests and no further application testing is required. The limit of flat position is defined as 0-15 degree slope on the surface to which the stud is applied.

Table 708.02
Shear Connector Welder Qualifications

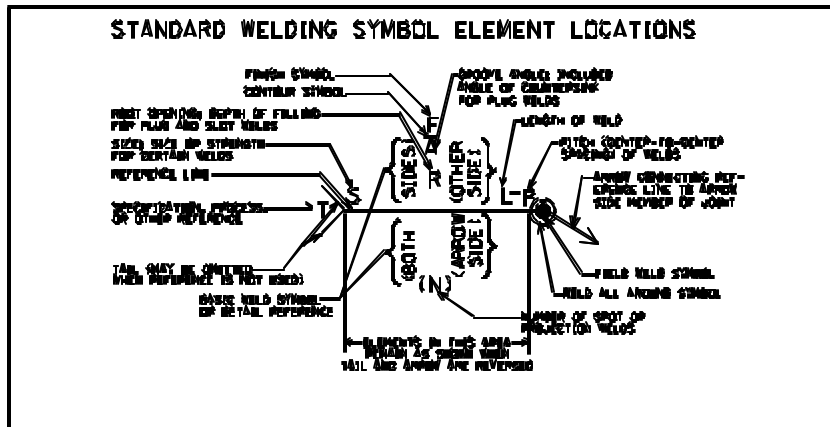
1.	Before any production studs are welded by an operator, they must first shoot two studs on a piece of material similar to the production member in thickness and properties. If the actual thickness is not available, the thickness may vary plus or minus 25%. All test studs shall be welded in the same general position as required on the production member.
2.	The test studs shall be visually examined. They shall exhibit a full 360-degree flash.
3.	In addition to the visual examination, the test shall consist of bending the studs after they are allowed to cool, to an angle of approximately 30 degrees from their original axes by either striking the studs on the head with a hammer or placing a pipe or other suitable hollow device over the stud and manually or mechanically bending the stud.
4.	If on visual examination the test studs do not exhibit 360 degree flash, or if on testing, failure occurs in the weld zone of either stud, the procedure shall be corrected, and two more studs shall be welded to separate material and tested again.
5.	If either of the second two studs fails, additional welding shall be continued on separate plates until two consecutive studs are tested and found to be satisfactory before any production welding begins.

WELDING SYMBOLS

FILLET	PLUG OR SLOT	SPOT OR PROJECTION	SEAM	SPOUFE								BACK OR BACKING	TOP-FACING	FLANGE	
				SQUARE	V	BEVEL	U	J	FLARE-V	FLARE BEVEL	FLARE			COMED	

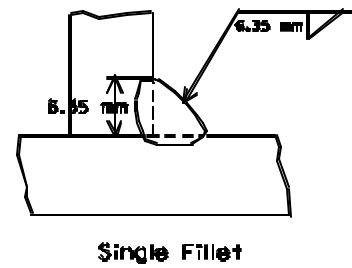
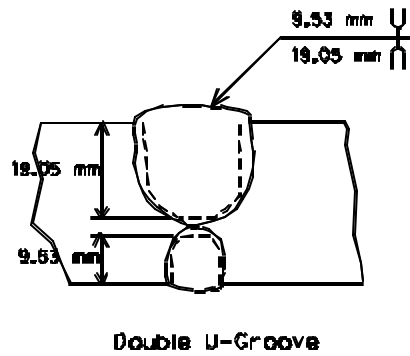
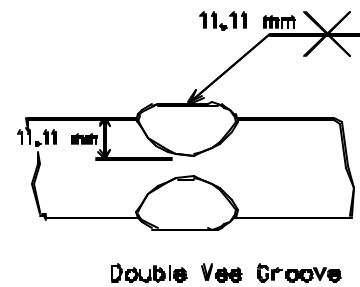
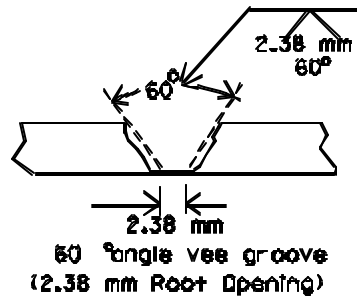
ARC-BEAM OR ARC-SPOT	RESISTANCE SPOT	POWER-TIGH	RESISTANCE SEAM	FLASH OR OFFSET

WELD ALL AROUND	FIELD WELD	MULTI-PASS	CONTOUR		
			FLUSH	CONVEX	CONCAVE



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WELDING DETAILS



Notes: The number above the weld arrow line refers to the depth of weld at the lower surface.
 The number below the line refers to the weld on the top surface.
 Refer to welding charts for descriptions of welds not shown here.
 Field welding must be specifically approved.

I. Trouble Shooting

1. Many operating variables can affect the quality and appearance of the weld. Methods for correcting undesirable characteristics are discussed in the following paragraphs.

J. Weld Spatter

1. Spatter does not affect weld strength but does produce a poor appearance and increases cleaning costs.
 - (a) Be sure to control excessive splatter. Try lowering the current. Be sure the current is within the recommended range for the and size electrode (see attached Table).
 - (b) Be sure the polarity is correct for the electrode type.
 - (c) Try a shorter arc length.
 - (d) If the molten metal is running in front of the arc, change the electrode angle.
 - (e) Watch for arc blow.
 - (f) The electrode is not too wet.

K. Undercut

1. Generally, the only harm from undercutting is impaired appearance. However, undercutting may also impair weld strength, particularly when the weld is loaded in tension or subjected to fatigue. To minimize undercut:
 - (a) Reduce current, travel speed, or electrode size until the puddle is manageable.
 - (b) Change electrode angle so the arc force holds the metal in the corners. Use a uniform travel speed and avoid excessive weaving.

L. Rough Welding

1. If polarity and current are within the electrode manufacturer's recommendations but the arc action is rough and erratic, the electrodes may be wet. Try electrodes from a fresh container. If the problem occurs frequently, store open containers of electrodes in a heated cabinet.

M. Porosity and Surface Holes

1. Most porosity is not visible. But severe porosity can weaken the weld. The following practices minimize porosity:
 - (a) Remove scale, rust, paint, moisture, or dirt from the joint. Generally use an E6010 or E6011 electrode for dirty steel.
 - (b) Keep the puddle molten for a long time, so that gases may boil out before the metal freezes.

- (c) Steels very low in carbon or manganese or those high in sulfur or phosphorus should be welded with a low-hydrogen electrode. Minimize admixture of base metal with weld metal by using low currents and fast travel speeds for less penetration.
- (d) Try using a short arc length; short arcs are required for low-hydrogen electrodes.

2. Surface holes can be avoided by many of the practices used to minimize porosity.

N. Poor Fusion

- 1. Proper fusion exists when the weld bonds to both walls of the joint and forms a solid bead across the joint. Lack of fusion is often visible and must be avoided for a sound weld. To correct poor fusion:
 - (a) Try a higher current and a stringer-bead technique.
 - (b) Be sure the edges of the joint are clean, or use an E6010 or E6011 electrode.
 - (c) If gap is excessive, provide better fitup or use a weave technique to fill the gap.

O. Shallow Penetration

- 1. Penetration refers to the depth the weld enters into the base metal. For full-strength welds, penetration to the bottom of the joint is required. To overcome shallow penetration:
 - (a) Try higher currents or slower travel.
 - (b) Use small electrodes to reach into deep, narrow grooves.
 - (c) Allow some gap (free space) at the bottom of the joint.

P. Cracking

- 1. Many different types of cracks may occur throughout a weld. Some are visible and some are not. However, all cracks are potentially serious, because they can lead to complete failure of the weld. The following suggestions may help control potential cracking.
- 2. Most cracking is attributed to high-carbon or alloy content or high-sulfur content in the base metal. To control this type of cracking:
 - (a) Use low-hydrogen electrodes.
 - (b) Preheat. Use high preheat for heavier plate and rigid joints.
 - (c) Reduce penetration by using low currents and small electrodes. This reduces the amount of alloy added to the weld from melted base metal.

- (d) To control crater cracking, fill each crater before breaking the arc. Use a back-stepping technique so as to end each weld on the crater of the previous weld.
- 3. On multiple-pass or fillet welds, be sure the first bead is of sufficient size and of flat or convex shape to resist cracking until the later beads can be added for support. To increase bead size, use slower travel speed, a short arc, or weld 5° uphill. Always continue welding while the plate is hot.
- 4. Rigid parts are more prone to cracking. If possible, weld toward the unrestrained ends. Leave a 1/32 inch (0.8 mm) gap between plates for free shrinkage movement as the weld cools. Peen each bead while it is still hot to relieve stresses.

Q. How to Reduce Arc Blow

- 1. All arc blow is not detrimental. In fact, a small amount of arc blow can sometimes be used beneficially to help form the bead shape, control molten slag, and control penetration.
- 2. When arc blow is causing or contributing to such defects as undercut, inconsistent penetration, crooked beads, beads of irregular width, porosity, wavy beads, and excessive spatter, it must be controlled. Possible corrective measures have already been suggested in the preceding text. In general, here are some methods that might be considered:
 - a. If DC current is being used with the shielded metal-arc process - especially at rates above 250 amperes - a change to AC current may eliminate problems.
 - b. Hold as short an arc as possible to help the arc force counteract the arc blow.
 - c. Reduce the welding current - which may require a reduction in arc speed.
 - d. Angle the electrode with the work opposite the direction of arc blow.
 - e. Make a heavy tack weld on both ends of the seam; apply frequent tack welds along the seam, especially if the fitup is not tight.
 - f. Weld toward a heavy tack or toward a weld already made.
 - g. Use a back-step welding technique.
 - h. Weld away from the ground to reduce back blow; weld toward the ground to reduce forward blow.
 - i. With processes where a heavy slag is involved, a small amount of back blow may be desirable; to get this, weld toward the ground.
 - j. Wrap ground cable around the work piece and pass ground current through it in such a direction that the magnetic field set up will tend to neutralize the magnetic field causing the arc blow.

3. The direction of the arc blow can be observed with an open-arc process, but with the submerged arc process must be determined by the type of weld defect.
 4. Back blow is indicated by the following:
 - a. Spatter.
 - b. Undercut, either continuous or intermittent.
 - c. Narrow, high bead, usually with undercut.
 - d. An increase in penetration.
 - e. Surface porosity at the finish end of weld on sheet metal.
 5. Forward blow is indicated by:
 - a. A wide bead, irregular in width.
 - b. Wavy bead.
 - c. Undercut, usually intermittent.
 - d. A decrease in penetration.
- R. The Effects of Fixturing on Arc Blow
1. Steel fixtures for holding the work pieces may have an effect on the magnetic field around the arc and, thus, on arc blow. Usually, the fixturing causes no problem with stick-electrode welding when the current does not exceed 250 amperes. Fixtures for use with higher currents and with mechanized welding should be designed with precautions taken so that an arc-blow-promoting situation is not built into the fixture.
 2. Each fixturing device may require special study to ascertain the best way to prevent the fixture from interfering deleteriously with the magnetic fields. The following are some points to note:
 - a. Fabricate the fixture from low-carbon steel. This is to prevent the buildup of permanent magnetism in the fixture.
 - b. Welding toward the closed end of "horn type" fixtures reduces back blow.
 - c. Design the fixture long enough so that end tabs can be used if necessary.
 - d. Do not use a copper strip inserted in a steel bar for a backing. The steel part of the backup bar will increase arc blow.
 - e. Provide for continuous or close clamping of parts to be seam-welded. Wide, intermittent clamping may cause seams to gap between clamping points, resulting in arc blow over the gaps.

- f. Do not build into the fixture large masses of steel on one side of the seam only. Counterbalance with a similar mass on the other side.

704.04 METHOD OF MEASUREMENT

- A. Structural steel is usually measured by the pound (kg). Structural steel for handrail is also measured by the pound. Ornamental handrails are measured by the lineal feet of rail between end posts. These values are listed on the plans and may be used in the final computation for payment.

704.05 BASIS OF PAYMENT

- A. PMs are authorized to pay for steel plates and shapes as soon as the material arrives at the fabricator.
- B. The Nebraska Department of Roads had determined that it may be possible to improve inspection procedures and to lower construction costs on bridges and other structures where significant quantities of steel are required if stockpiled materials are paid for upon receipt by the fabricator. Therefore, the Department will allow partial payments for stockpiled steel plates and shapes prior to fabrication. The procedure that must be followed before partial payment will be made is as follows:
 - 1. The prime contractor must request partial payment from the Department's Project Manager for the specific project where payment is requested.
 - 2. The Bridge Divisions, Fabrication Inspector [(402)-479-4763] will be responsible for verifying fabricators' invoices and forwarding them to the project managers; for verifying manufacturer's Certified Mill Test Report and forwarding copies to the PM and M&R Division; and for inspection of the steel.
 - 3. The fabricator must provide the Department's Fabrication Inspector the steel manufacturer's paid invoice for the material. The Project Manager will make the payment for the amount shown on the invoice, which directly is attributed to the project for which payment is being considered. The invoice should be annotated to show:
 - (a) the project number
 - (b) steel quantity in pounds applicable to the project
 - (c) material grade
 - (d) material heat number
 - 4. There must be identifying marks placed on each piece for which payment will be made.

5. Steel must be stored in orderly fashion to readily facilitate identification of specific materials to specific projects. Project materials cannot be commingled with other projects – each project’s materials must have a separate location.
6. The Manufacturer’s Certified Mill Test Reports must be provided to and approved by the Bridge Division before payment will be authorized. The Bridge Division will notify the Project Manager when payment is authorized.
7. The Department will verify that the material is properly stored before payment will be made.
8. The Prime Contractor will make payment to the fabricator within 20 days after the Department has paid for the material.
9. Payment is only authorized for materials that are stored within Nebraska as specified in Subsection 109.07 of the Nebraska *Standard Specifications for Highway Construction*.

705.00 REINFORCEMENT (SSHC Section 707)

705.01 DESCRIPTION

- A. The reinforcement of concrete for structures consists of furnishing and placing deformed metal reinforcing bars or welded-wire fabric in the concrete as required by the plans and specifications.

705.02 MATERIAL REQUIREMENTS (SSHC Subsection 707.02)

- A. Samples of reinforcing steel and welded-wire fabric are required by the Central Laboratory unless these materials are shipped from tested stock. Generally reinforcing steel has been sampled and tested before shipment to the project, and will arrive with acceptance tags attached. At the time this steel is placed in the work, the structure inspector should collect, record in field book, and submit the tags to the Project Manager. Steel arriving untagged should not be incorporated in the work until approved by the Materials Engineer. See the "*Materials Sampling Guide*".
- B. The Materials and Research Division requires that two 6 ft (2.0 m) sample lengths of epoxy-coated reinforcing steel be submitted for testing purposes, and a special provision to that effect will be included in future contracts.
- C. Similarly, the *Materials Sampling Guide* requires two 6 ft (2.0 m) sample lengths for uncoated reinforcement bars be provided (unless shipped from tested and approved stock). Enter the date resteel is verified on-site in SiteManager.

705.03 CONSTRUCTION METHODS (SSHC Subsection 707.03)

A. Placement and Checking (Bridge Deck)

1. Bridge plans specify nominal slab thickness and nominal clearance of reinforcing bars from face of the concrete. This section will establish acceptable deviations from nominal plan dimensions.
2. Four dimensions must be given special attention when checking placement of bridge slab reinforcing:
 - (a) Slab thickness.
 - (b) Clearance of bottom reinforcement from bottom of slab.
 - (c) Distance from bottom of slab to top of top mat of reinforcement.
 - (d) Cover over top mat of reinforcement

B. Slab Thickness

1. This shall be the nominal slab thickness shown on the plans with a tolerance of minus zero and plus ½ inch (13 mm).

C. Clearance of Slab Reinforcement

1. The reinforcing steel shall be placed to monitor the nominal clearances shown in the plans $\pm \frac{1}{4}$ inch (5 mm). Contractors must provide an adequate number of bolsters and/or bar chairs of suitable height and strength to maintain clearance within this range.
2. Contractors must provide an adequate (sag shall be minimal, see *SSHC Figure 707.01*) number of bar chairs of suitable height and strength to maintain the distance within this range of tolerance.

D. Protection of Material (*SSHC Subsection 707.03*)

1. The Specifications provide that steel reinforcement shall be protected at all times from damage. When placed in the work, it shall be free of dirt, loose scale, detrimental rust, paint, oil or any foreign material. Detrimental rust is defined as heavy reddish coating formed on iron or steel when chemically attached by moist air. This must be removed by wire brushing. However, a light layer of rust or mill scale that is not readily removed with a wire brush is acceptable.

E. Placing and Fastening (*SSHC Subsection 707.03*)

1. Positioning - It is essential that inspectors give special attention to the placement of reinforcing steel in all structures. Reinforcement shall be placed in the exact position shown in the plans and held securely in that position to preclude movement or shifting during placement of the concrete. On a 7 inch (175 mm) thick bridge floor, designed with the top steel $1 \frac{3}{4}$ inch (45 mm) below the surface, a sag or displacement in the top steel of only $\frac{1}{2}$ inch (13 mm) will reduce the strength of the floor 19 percent. The reduction in strength of thinner sections such as culvert slabs and walls is even more critical.
2. Present policy is to tie all bar intersections except when the bar spacing is less than 12 inches (300 mm) in both directions in which case alternate intersections may be tied. This requirement is enforceable through *SSHC Subsection 707.03* in that it specifically defines the frequency of tying. The Project Manager should thoroughly study the project documents in order to be aware of this requirement as well as any change which might occur in this revision.
3. Horizontal reinforcement in slabs shall be spaced vertically by means of approved metal chairs. The type and adequacy of bar support systems which includes the spacing of bar supports shall be in accordance with the Concrete Reinforcing Steel Institute's "Manual of Standard Practice", unless other stipulations are provided in the contract provisions. A copy of this manual may be obtained from the District Construction Engineer. Bar supports which are located at exposed concrete surfaces shall be galvanized, plastic coated or stainless steel to a depth of $\frac{1}{2}$ inch (13 mm) minimum from the concrete surface. Chairs may also be used to keep vertical columns and wall steel from contacting the form.

4. Field welding will be permitted only when shown on the plans or with written permission of the Construction Engineer. Reinforcement can best be checked as the work progresses rather than waiting until the contractor has enclosed the reinforcement with forms. In the case of walls and columns it is virtually impossible to do the checking after the forms are in place. When bent bars are used, a check should be made that there are no cracks or splits at the bends. Stirrup hooks should be rotated to different positions in order that the hooks do not fall in the same location when a series of stirrups are used in beams or columns.
5. No welding will be allowed on the main vertical steel of high mast lighting tower foundations except at the very top and bottom where the end loops may be tack welded. If a more rigid cage is desired, additional vertical steel will be required to act as the frame and lifting points for the cage. The required loops may be tack welded to this additional vertical steel. The required vertical steel will then need to be wire tied to the tack welded loops.
6. Welding of all loops, other than the top and bottom loop, to the required vertical steel will not be allowed. Additional bracing may be tack welded to the added vertical bars, if required. The added vertical bars should be sized to support the required load.
7. *SSHC Subsection 704.03* requires the contractor to give the Project Manager sufficient advance notice before starting concrete operations in any unit of a structure, to permit the inspection of forms and reinforcing bars. The Project Manager shall require all reinforcing steel to be accurately placed and firmly held in position.

F. Special Attention Areas

1. Tie-Downs and Supports
 - a. *SSHC Subsection 707.03* require that the top mat of reinforcing steel is to be tied down at not greater than 4 feet (1.2 m) spacing measured in each direction. This requirement can partially be met by wiring the top mat down to shear lugs at 4 feet (1.2 m) spacing along the beam. Regardless of beam spacing, the top mat must be tied to the forms or the bottom reinforcing mat at 4 feet (1.2 m) spacing. Likewise, the top reinforcing mat is to be tied to the bottom reinforcing mat on a 4 feet (1.2 m) grid in floors of concrete slab bridges. Tying should include bars near the ends of the bridge and bars near the curbs. **At least 50 percent of the bar contacts must be tied unless the spacing is more than 1 ft (300 mm) and then every bar contact must be tied.**
2. Epoxy Coated Bar
 - a. Epoxy coated reinforcing steel requires the use of epoxy or plastic coated bar supports and tie wires (*SSHC Subsection 707.03*). Epoxy coated tie wires may tend to slide or break. If this occurs, they should be double tied or stronger ties used.

3. Clearance Check
 - b. The specified clear distance from surface to reinforcing steel must be maintained. To check this, a clearance guide $\frac{1}{4}$ inch (5 mm) less in thickness than the specified clearance to top steel should be temporarily fastened to the bottom of the finishing machine screed. The finishing machine should then be operated along the bridge to insure that proper clearance is obtained. It will be necessary to bend all tie wire loops down to permit the clearance gauge to pass. Any steel not properly placed must be corrected.
 4. Checks During Placement
 - a. Checks of slab thickness and cover over top reinforcement must be made in the finished concrete directly behind the finish machine. A thickness and cover check should be made at the same location of an approximate grid of 10 ft (3 m) transverse and 20 ft (6 m) longitudinal. These checks must be documented in the field book. When the slab is of deficient thickness or cover checks indicate incorrect rebar placement corrections must be made immediately.
 5. Cleaning Forms and Steel
 - a. Mud and other foreign material must be removed from the steel and forms prior to placement. Remove any trapped/ponded water before placing the concrete.
- G. Epoxy-Coated Reinforcement (*SSHC Section 1021*)
1. Epoxy coatings are applied to reinforcing bars by a fusion-bonded process. This means the coating achieves adhesion to the bar as a result of a heat-catalyzed reaction. Besides chemical adhesion, there is also physical adhesion of the coating to the bar.
- H. Care and Handling
1. Epoxy coated bars are subjected to many quality control tests and inspections prior to leaving the supplier's facility. However, from that point forward, careless handling and construction practices can cause excessive coating damage. Contractors should be strongly encouraged to exercise care in handling, storage, and placing of epoxy coated bars. If problems are noted after delivery, the inspector is to contact the Materials and Research Division.
 2. Handling
 - a. During unloading epoxy coated bars from the truck, care must be exercised to minimize scraping of the bundles or bar-to-bar abrasion from sags in the bundles. Skidding bundles from the truck onto the ground should not be allowed. Use of power hoisting equipment for unloading and handling is strongly encouraged. Further, equipment for handling the bars should have

protective contact areas. Specifically, nylon slings or padded wire rope slings should be used and bundles should be lifted at multiple pick-points.

3. Storage

- a. Epoxy coated bars should be stored on timbers or other suitable protective cribbing. All types of reinforcing bars should be stored off the ground as close as possible to the area where they will be used. The following storage practices are suggested to prevent damage:
- b. Store bars above the ground on timbers, cribbing, or dunnage placed close enough together to prevent sags in the bundles.
- c. If a large quantity of bars has to be stored in a small area, bundles can be stacked if adequate blocking is placed between the layers.
- d. While fading of the coating's color is not specifically detrimental, it should be avoided to the fullest extent possible. One recommended method is to cover exposed bundles with burlap or dark plastic.

NOTE: If plastic or other nonporous material is used for covering, the ends must be left open to allow air movement. Without this, condensation under the cover could cause damage.

- e. Long-term site storage (from one year to the next) of epoxy coated bars is not recommended.

4. Placing

- a. Placing of epoxy coated bars is done similar to uncoated bars. The KEY exception is that coated bars require more careful handling and placing. Once bundles have been opened, dragging one bar over another or over any abrasive surface MUST be avoided.
- b. After epoxy coated bars are placed, walking on the bars by construction personnel should be held to a minimum. Bars in high traffic areas or runways for concrete placement should be protected with plywood or other suitable material. Concrete placement equipment shall not be placed on, or supported by, any reinforcing steel.
- c. Bar supports and tie wires for epoxy coated reinforcement shall be coated with epoxy, nylon, or plastic.

I. Field Inspection

- 1. Epoxy coated bars should be inspected for damaged coating:
 - a. when received at the job site, and
 - b. after they are placed in the structure.

2. Damage Evaluation and Repair

- a. Damaged coating shall be evaluated as outlined below. The "holiday detector" should be used to determine coating flaws.
- b. Bent Bars
 - (1) Examination of physical coating condition on the outside radii of hooks and other bends might reveal cracks in the coating. When cracking of the coating is evident, the contractor must remove loose coating, clean the area, and repair.
- c. Fading of Color
 - (1) When epoxy coated bars are exposed to sunlight over a period of time, fading of the color may occur. Since discoloration does not harm the coating nor affect its corrosion protection properties, such fading will not be cause for rejection.
- d. Damaged Ends
 - (1) Damage to ends because of field shearing, dragging or whatever must be repaired in the field.

J. Repair of Damaged Coating

- 1. When a damaged coating must be repaired, the patching or touch-up material should be applied in strict accordance with the instructions furnished by the manufacturer. Generally, surface preparation consists of a **THOROUGH** manual cleaning of damaged areas, including complete removal of: (1) unbonded epoxy and (2) all rust. Cleaning is usually accomplished with a power driven wire brush, hand steel brush, and/or emery paper. Care should be exercised during preparation so that excessive sound epoxy is not damaged. Acceptance criteria for epoxy repair and touchup materials is in accordance with the original epoxy resin manufacturer's recommendations.
- 2. Epoxy coated reinforcing steel is used in concrete bridge decks to prevent spalling of the concrete which is, in turn, caused by the corrosion of the reinforcing steel. The epoxy coating prevents the corrosion of the reinforcing steel. Two factors influence the capability of the coating to prevent corrosion. One of these factors is the thickness of the coating. The other factor is the integrity of the coating, i.e., the absence or presence of defects in the coating which would allow moisture and de-icing chemicals to reach the metal itself.
- 3. The epoxy coating on the rebars may have three types of defects when the bars arrive at the site. One of these is defined in the Specifications as a "holiday." A holiday is a small hole in the coating which is not visible to the naked eye. This type of defect is the result of some inadequacy in the application process. Holidays can be detected only with an electronic detector and the Specifications permit two holidays per 1 foot (300 mm).

4. The second type of defect, which may be present in the epoxy coating when the bar arrives at the site, is defined as handling damage. Handling damage may take the form of scuffs, scars, scratches or any other wound to the coating caused by rough handling. The Specifications permit a "reasonable" amount of handling damage. Handling damage is generally visible to the naked eye since rust will form over the damaged spot after a sufficient amount of time passes. A fresh cut or scar in the coating would probably be difficult to locate visually, but would be readily picked up with an electronic detector.
5. The third type of defect, which may be present in the epoxy coating when the bar arrives at the site, is due to what may be considered as an "uncoatable" bar. During the rolling process, some bars are formed with very sharp edges on the deformations and ribs.
6. These edges are very difficult to coat adequately, and coating applicators usually avoid coating bars so formed. The defect in coating on these edges may or may not be visible to the naked eye. This particular defect can be detected with an electronic detector. When this defect is present, the detector will indicate this flaw by a constant 'beeping' when run along a rib. In most instances, the thickness of the epoxy coating will be very low in these areas or there may be no coating at all where the sharp edges are present.
7. Materials and Research Division personnel will inspect epoxy coated rebars at the coating applicator's plant in some, but not, all cases. In cases where inspection is made at the applicator's plant, the bars will have a maximum of two holidays per meter, plus handling damage, is allowed, when they arrive at the site. In addition, the coating thickness, on bars inspected at the applicator's plant, must meet the specification requirements for thickness of coating. Bars not so inspected at the applicator's plant will have an unknown number of holidays and possibly uncoated sharp edges plus handling damage when they arrive at the site and, in addition, the coating thickness will not have been checked. Bars that contain rolling defects or have uncoated sharp edges that are found during the inspection shall be rejected.
8. The basis for acceptance will be the total of defects per 1 foot (300 mm) of bar, i.e., holidays plus handling defects as located with the electronic detector.
9. A total of six defects in any 1 foot (300 mm) of the bar will be permitted. As an example, in a bar of given length, if any 1 foot (300 mm) section of that bar has no more than the two allowable holidays and four handling defects, the bar is acceptable, providing none of the four handling defects has an area greater than 0.0025 ft.^2 (225 mm^2). [A square measuring $0.05 \text{ ft} \times 0.05 \text{ ft}$ ($15 \text{ mm} \times 15 \text{ mm}$) has an area of 0.0025 ft.^2 (225 mm^2)]. All handling defects having an area greater than 225 mm^2 must be repaired.
10. The following points may be helpful in the inspection and repair of epoxy coated rebars in the field.
 - a. Inspect bars for coating defects, using the electronic detector, as they come out of the bundle.

- b. It may not be necessary to check all bars in each bundle, but enough bars out of each bundle should be checked in order to determine the quality of coating on all bars in the bundle.
 - c. When the number of defects per 1 foot (300 mm) section exceeds six, only the number of defects necessary to bring the bar into compliance need be repaired. Only exception is that all defects greater than .00005 in² (.035 mm²) must be repaired.
 - d. Repair of defects is accomplished with an approved two component epoxy compound supplied by the coating manufacturer.
 - e. Epoxy compounds used for repair have a minimum temperature at which they may be used and a limited pot life, as recommended by the manufacturer.
 - f. Any rust showing through the defect must be removed before applying the epoxy compound. A file or grinding wheel may be used provided no substantial reduction in the area of the bar occurs.
 - g. Coating thickness of the painted repair area must be as specified for the factory applied coating.
 - h. Coating on bars may be damaged during placement at the site. Such damage to the bars must be repaired when the bars are in place, if the six defects per 1 foot (300 mm) section limitation is exceeded.
 - i. Check coating thickness if bars were not inspected at the coating applicator's plant. This should be done as they come out of the bundle. Coating thickness is checked with a magnetic thickness gage.
 - j. To obtain a holiday detector, contact the nearest branch laboratory or the Construction Division. "Electrometer" magnetic thickness gages may be obtained by requisition from the Engineering Equipment Section, "Inspector" or "Microtest" thickness gages which are used for checking paint film thickness cannot be used for checking epoxy coating thickness on reinforcing steel.
11. For situations where there is no information available as to what type of touch-up material should be used, 3M Corporation has two products available:
- a. SCOTCHKOTE 213 is often used to repair minor nicks and gouges.
 - b. SCOTCHKOTE 312 is a two component epoxy that has been used to repair both small and large areas of damage.

NOTE: Repaired areas do not have as much corrosion or abrasion resistance as factory-applied coatings.

K. Bar Designation System

1. You must be very careful when you review a bar list. Currently, steel bar in the USA is usually measured in English units. Do not assume anything; measure to be sure you are getting the correct size. In general, the mark number for reinforcing bars as shown in the plans generally uses the following designation system. The first letter or letters identify the general location of the bar such as abutment, pier, or slab bar.

<u>Location</u>	<u>Code</u>
Abutment	A
Pier	P
Slab	S

2. The first number or numbers indicate the size of the bar and the last two numbers indicate whether the bar is bent or straight. (Even numbers are straight bars and odd numbers are bent bars.)
3. For example, P1002 would be a straight No. 10 bar located in the pier; A415 would be a bent No. 4 bar located in the abutment. The last two numbers also indicate the approximate length of the bar. The lower the number the longer the bar; for example, a S602 bar would indicate the longest, straight, No. 6 bar used in the slab, whereas a S612 bar would indicate that there are five groups of straight, No. 6 bars that are longer than the S612 in the slab. The reinforcing steel table in *Appendix 4* lists pertinent information concerning the standard bar designation system.

L. Splicing

1. All reinforcement shall be furnished in the full lengths indicated in the plans. Splices, not shown in the plan, shall not be allowed without approval of the Project Manager. Welding shall be allowed only if shown in the plans or authorized by the Construction Engineer in writing.
2. When splices are required, they should be staggered as far as possible in order that a plane of weakness is not caused in the member. The laps should be at least as long as is shown in the plans and if no lap is shown, the bars should be lapped as required in *SSHC Subsection 707.03*. Splices should preferably be made in areas of low stress concentration. The bars in the top of a slab or beam should be spliced in a positive moment section (bottom of slab or beam in tension) and the bars in the bottom of a slab or beam should be spliced in a negative moment section (top of slab or beam in tension). For example, the longitudinal bars in the top of a slab should be spliced near the center of the span rather than over a pier and the longitudinal bars in the bottom of the slab should be spliced near the pier rather than in the middle of a span. Following is a tabulation of 24 and 36 diameter lap requirements for the various sizes of rebars.

ASTM Standard Reinforcing Bars				
		Nominal Dimensions - Round Sections		
Bar Size Designation	Weight Pounds per Foot	Diameter Inches	Cross-Sectional Area - Sq. Inches	Perimeter Inches
#3	.376	.375	.11	1.178
#4	.668	.500	.20	1.571
#5	1.043	.625	.31	1.963
#6	1.502	.750	.44	2.356
#7	2.044	.875	.60	2.749
#8	2.670	1.000	.79	3.142
#9	3.400	1.128	1.00	3.544
#10	4.303	1.270	1.27	3.990
#11	5.313	1.410	1.56	4.430
#14	7.650	1.693	2.25	5.320
#18	13.600	2.257	4.00	7.090

LAP REQUIREMENTS			
Metric Bar Size	English Bar Size	24 Diameter Lap Grade 40 Steel	36 Diameter Lap Grade 60 Steel
10	2	6 in (150 mm)	9 in (225 mm)
10	3	9 in (225 mm)	14 in (350 mm)
10	4	12 in (300 mm)	18 in (450 mm)
15	5	15 in (375 mm)	23 in (575 mm)
15	6	18 in (450 mm)	27 in (675 mm)
25	7	21 in (525 mm)	32 in (800 mm)
25	8	24 in (600 mm)	36 in (900 mm)
30	9	27 in (675 mm)	41 in (1025 mm)
30	10	30 in (750 mm)	44 in (1100 mm)
35	11	33 in (825 mm)	49 in (1225 mm)

3. There are times when splicing of rebar in a manner other than lapping is necessary. Examples include:
 - a. Complicated placement where the cage could be tied off site, in sections, and set in place.
 - b. Reinforcement cages for drilled shafts.
 - c. Situations where an existing rebar is not long enough to develop strengths by lapping.

4. Example: During removal of an existing curb on a bridge deck widening project existing rebar is either cut with the saw or broken during concrete demolition. In this case additional demolition is needed to provide a lap development length.

5. Mechanical splices are only authorized where shown in the plans and materials must be in the NDR Approved Products List. Currently, several couplers are manufactured which can be used to mechanically splice rebar. Mechanical splices, for field approval, shall develop 125% of the rebar's yield strength. Consideration for splice usage must be initiated by the contractor. The Project Manager is to forward that request to the Construction Division for review.

705.04 METHOD OF MEASUREMENT (*SSHC Subsection 707.04*)

- A. Reinforcing steel for concrete structures is measured by the pound. Quantities to be paid for are computed from the theoretical mass of bars and wire mesh. The mass of steel reinforcement required for structures of varying sizes is usually given in tables on standard and special plans. The quantities contained therein may be used for computing final payment for structures except bridges. Plan quantity may be used for final quantity reinforcing steel for bridges.

706.00 CONCRETE CONSTRUCTION (SSHC Section 704)

706.01 DESCRIPTION

- A. This section of the Specifications deals with the construction of structures composed of portland cement concrete. This work includes constructing, setting and supporting the forms, and handling, placing, finishing and curing the concrete for bridges, box culverts, arch culverts, headwalls, retaining walls and steps, and the miscellaneous structures listed in the incidental construction portion of the Specifications.

706.02 MATERIAL REQUIREMENTS

A. Composition of Concrete

1. The class of concrete to be used in the work is specified in the plans or special provisions and shall be one of those described in *SSHC Subsection 1002.02*. In the event that the contractor has a choice of several classes, he/she is required to advise the Project Manager by letter of the one to be used. This information should be obtained prior to any concrete construction to allow engineering personnel to make provisions for necessary inspection and testing. The contractor may not change classes of concrete during construction without the written permission of the Project Manager.
2. *SSHC Subsection 1002.03* prescribes requirements for concrete materials. The Contractor's responsibility for material requirements may be summarized as follows:
 - a. Check with Materials & Research as to the approval of cement, coarse aggregate, fine aggregate, air-entraining agent and curing compound.
 - b. Submit samples of non-approved materials to the Central Testing Laboratory in sufficient time before use to allow time to receive results. The size and frequency of samples are provided in the "*Materials Sampling Guide*".
 - c. Materials for which approval has not been received must not be used in the work.
3. The inspector is concerned not only with the approval of materials but also with the storage of materials. Bag cement shall be stored in a dry location. If stacked more than 8 bags high for a period of time the lower layers take on a "warehouse set" and should not be used. Cement stored over 90 days must be retested before use.

B. Admixtures

1. Admixtures are those ingredients in concrete other than portland cement, water, and aggregates, that are added to the mixture immediately before or during mixing. Admixtures typically encountered on our jobs can be classified by function as follows:
 - a. Air entraining admixtures (optional)
 - b. Water reducing admixtures (optional)

- c. Set retarding admixtures (required)
 - d. Set accelerating admixtures (optional)
 - e. Finely divided and permeability mineral admixtures (Fly Ash & Silica Fume) (optional)
 - f. Coloring agents (normally not used for NDR work) (optional)
2. The amount of any admixture used in a mix should be as recommended by the manufacturer. Effectiveness of an admixture depends upon such factors as type, brand, and amount of cement; water content; aggregate shape; gradation and proportions; mixing time; slump; and temperatures of concrete and air.
 3. Concrete with a low air content shall not be incorporated into work. One addition of air entraining admixture is allowed at the site according to specification.
 4. Concrete with a high air content should not be incorporated into work except under extreme circumstances. If low compressive strengths result, the concrete may be required to be removed and replaced. (*SSHC Subsection 106.05*)

C. Air Entraining Admixtures

1. Air entraining admixtures are used to purposely entrain microscopic air bubbles in concrete. Air entrainment will dramatically improve the durability of concrete exposed to moisture during cycles of freezing and thawing. Entrained air greatly improves concrete's resistance to surface scaling caused by chemical deicers.
2. Rules-of-Thumb
 - a. As cement content increases, air agent must increase to maintain equal entrained air.
 - b. As cement fineness increases, the amount of air agent must increase to maintain equal entrained air.
 - c. As coarse aggregate size decreases, the air content increases for a given amount of air agent.
 - d. As fine aggregate volume increases, the air content increases for a given amount of air agent.
 - e. As mixing water increases, the air content increases for a given amount of air agent.
 - f. Air entraining admixtures should be introduced into mix at the plant, but additional may be added at the site to adjust mix for correct air content.
 - g. Air entraining admixtures should (usually) be added to the front of the truck at the plant. If corrosion inhibiting admixture is used, air entraining agents should be added to the back of the truck.

D. Water Reducing Admixtures (Type A) (optional)

1. Water reducing admixtures are used to reduce the quantity of mixing water required to produce concrete of a certain slump or reduce the water/cement ratio. Regular water reducers reduce water content by about 5% to 10%.
2. Adding a water reducing admixture to a mix without reducing water content can produce a mixture with a much higher slump.
 - a. Rules-of-Thumb
 - (1) Typically, water reducing admixtures do not reduce the rate of slump loss; in most cases, it is increased. Rapid slump loss results in reduced workability and less time to place concrete at the higher slump.
 - (2) Typically, water reducing admixtures decrease on bleed water because less water is available.
 - (3) Certain types of sulfate starved portland cements may cause false set with certain brands of water reducers. Typically, water reducers contain lignosulfonates and these sulfates are easily attracted by sulfate starved cements. This action may cause early false set.
 - (4) Despite reduction in water content, water reducing admixtures can cause a significant increase in drying shrinkage.

E. High Range Water Reducing Admixtures (Type F) (optional)

1. They are added to concrete with low-to-normal slump and water content to make high slump "flowable" concrete. Flowable concrete is a highly fluid, but workable concrete that can be placed with little or no vibration and can still be free of excessive bleeding or segregation. Flowable concrete has applications:
 - a. In areas of closely spaced and congested reinforcing steel.
 - b. In tremied concrete where "self consolidation" is desirable.
 - c. In pumped concrete to reduce pump pressure.
 - d. To produce low water/cement ratio - high strength concrete. High-range "super plasticizers" can reduce water content by about 12% to 30%.
2. Rules-of-Thumb
 - a. The effect of most super plasticizers in increasing workability or flowable concrete is short lived. Typically, maximum is 30 to 60 minutes followed by a very rapid loss in workability.

- b. Typically, super plasticizers are added as split treatments (part at the plant part at the site). Sometimes the addition is totally at the site.
- c. Setting time may be affected depending on the brand used, dosage rate, and interaction with other admixtures.
- d. Excessively high slumps of 10 inches (250 mm) or more may cause segregation.
- e. High-slump, low water/cement super plasticized concrete has less dry-shrinkage than does high-slump high water/cement conventional concrete.
- f. Effectiveness of super plasticizer is increased with an increased amount of cement and/or increased fineness of cement.
- g. Effectiveness of water reducers on concrete is a function of their chemical composition, cement composition and fineness, cement content concrete temperature, and other admixtures being used.
- h. Some water reducing admixtures, such as lignosulfonates, may also entrain some air in the mix.

F. Retarding Admixtures (required)

- 1. Retarding admixtures (retarders) are used to delay the initial set of concrete. High temperatures of fresh concrete 85°F (30°C) and up often cause an increased rate of hardening. Since retarders do not decrease the initial temperature of concrete, other methods of counteracting the effect of temperature must be used.
- 2. Rules-of-Thumb
 - a. Retarders are sometimes used to delay initial set of concrete when difficult, long placement times, or unusual placement conditions exist.
 - b. Retarders offset the set acceleration effect of hot weather.
 - c. Retarders can be added at the site.
 - d. In general, some reduction in strength at early ages (one to two days) accompanies the use of retarders.
 - e. Use of retarders must be closely monitored, because there is probably no single admixture which has caused more field problems.
 - f. If too much retarder has been used in a mix:
 - (1) Time will usually counter the effects.
 - (2) Be sure to maintain the cure during the added time.

G. Accelerating Admixtures (optional)

1. Accelerating admixtures (accelerators) are used to accelerate the setting time and strength development of concrete at an early age. Strength development can also be accelerated by using:
 - a. Type III "high-early" cement
 - b. Lowering water/cement ratio
 - c. Curing at controlled higher temperatures
 2. Calcium Chloride (CaCl_2) is the material most commonly used in accelerating admixtures. Besides accelerating strength gain, calcium chloride also causes an increase in drying shrinkage, potential reinforcement corrosion, discoloration, and potential scaling.
 - a. Rules-of-Thumb
 - (1) Always add calcium chloride in solution form as part of the mixing water.
 - (2) Calcium chloride is not an antifreeze agent. When used in allowable amounts, it will only reduce the freezing point of concrete by a few degrees (may cause deck cracks).
- H. Finely Divided Mineral Admixtures
1. These admixtures are powdered or pulverized materials added to concrete to improve or change the properties (plastic or hardened) of concrete. Based on the mineral's chemical or physical properties, they are classified as: (1) Cementitious, (2) Pozzolans, (3) Pozzolanic and Cementitious, and (4) Nominally inert. Typical PCC mix designs use pozzolanic and cementitious minerals.
 2. Pozzolanic Materials
 - a. A pozzolan is a siliceous or aluminosiliceous material that in itself possesses little or no cementitious value but will, in finely divided form and in the presence of water, chemically react with the calcium hydroxide released by the hydration of portland cement to form compounds possessing cementitious properties. Pozzolans include fly ash and silica fume.
 3. Fly Ash (Class C & F)
 - a. Fly ash is a finely divided residue that results from the combustion of pulverized coal in electric power plants.
 4. Silica Fume
 - a. Silica fume, also referred to as micro-silica or condensed silica fume, is another material that is used as a pozzolanic admixture. This light to dark gray powdery product is a result of the reduction of high-purity quartz with coal in an electric arc furnace.

- b. Fly ash and silica fume have a spherical shape. Silica fume has an extremely small particle size (about 100 times smaller than the average cement particle). Although silica fume is normally in powder form, because of its small size and increased ease of handling the product is commonly available in liquid form.

- c. Rules-of-Thumb
 - (1) Mixes containing fly ash will generally require less water (about 1% to 10%) for a given slump. Silica fume concrete requires more water for a given slump.
 - (2) The amount of air-entraining admixture required to obtain a specified air content is normally greater when fly ash or silica fume is used. The amount of air-entraining admixture for a certain air content is a function of the fineness, carbon content and alkali content.
 - (3) Fly ash will generally improve the workability of concretes of equal slump. However, fly ash in low slump concrete will tend to tear and have reduced workability. Silica fume tends to reduce workability, thus high-range water reducers are usually added to maintain workability.
 - (4) Concrete using fly ash or silica fume generally shows less segregation and bleeding than plain concrete.
 - (5) Use of fly ash will reduce the amount of heat buildup in concrete. Silica fume most likely will not reduce the heat of hydration, because typically high-range water reducers are used and they increase mass temperatures.
 - (6) Use of fly ash will tend to generally retard the setting time of concrete. Silica fume alone will accelerate the setting time, however, high-range water reducers tend to offset this.
 - (7) Use of fly ash generally aids the pumpability of concrete. With adequate and correct curing, fly ash generally reduces the permeability. Silica fume is especially effective in this regard.
 - (8) With adequate and correct curing, fly ash generally reduces for permeability. Silica fume is especially effective in this regard.

I. Concrete Temperatures

1. Recommended Concrete Temperatures

- a. Concrete should be between 45°F and 80°F (7°C and 27°C) when placed. To ensure a concrete temperature of at least 50°F (10°C) for 72 hours after placement the concrete for thin sections such as culvert walls, end posts, piling encasements, etc. should be 65°F (18°C) or higher, since the only additional heat source is the heat of hydration. Concrete for massive sections such as abutments, heavy piers, and footings should be in the 55° to 65°F (13° to 18°C) range.
- b. Since only dry insulation is effective, any insulation that has a propensity to absorb water or become saturated must be protected with a waterproof membrane. The insulation system must provide complete coverage and be secured to provide maximum protection during the full curing period.
- c. For typical protection applications, insulated forms must be left undisturbed for 96 hours before being removed.

2. Checking Temperature of Concrete

- a. For checking compliance with minimum temperature requirements during the 48-hour period after placement thermometer wells should be cast in the concrete during the pour. The following procedure for checking temperature is suggested:
 - (1) Drill a 5/16 inch (8 mm) hole through the form at one or more locations where temperature checks will be made.
 - (2) Grease the thermometer probe and insert it through the hole about 4 inches (100 mm) into the plastic concrete.
 - (3) Remove probe after the concrete is set and cover hole with insulating material.
 - (4) Further checks can be made by inserting the thermometer through the insulation into the well developed in step 2. Leave thermometer in place if desired, but protect from damage or theft.

NOTE: The thermometer stem should be inserted about 3 inches (75 mm) into the concrete because the sensitive portion of the stem is about 1¾ inch (44 mm) below the groove.

- b. Record the temperature daily for 5 days following the pour. Temperature readings below 50°F (10°C) during the first 48 hours should be entered in the Field Book and reported to the District Construction Engineer for evaluation of possible damage or price adjustment.
- c. A thermocouple - - with recorder can also be used to document temperatures during curing.

3. Deck Concrete Temperature and Curing
 - a. Subsection 706.03 identifies requirements for placing and curing concrete bridge floors. Of importance for this section are:
 - (1) Plastic concrete, when placed, shall not exceed 86°F (30°C).
 - (2) The curing method requires "wet" burlap cure for four (4) days.
 - (3) If the forecast high outside air temperature for the day is predicted to be above 80°F (26°C) the contractor should cast the deck starting at 5:00pm.
 - b. The placing of concrete will require close monitoring to comply with the specifications. Obtain a weather report to determine predicted air temperature, wind velocity, and relative humidity for the pour day.
 - c. The above information should be discussed by the inspector, contractor, and ready mix plant operator before a deck pour. The pour should not be attempted if concrete temperature is predicted at 86°F (30°C) or higher and predicted air temperature is above 86°F (30°C).
4. Temperature Field Documentation
 - a. The temperature of concrete should be taken as soon as concrete is placed. It should be taken when the first load is placed. Additional checking is warranted if the temperature is running at or near maximum. Air temperature should also be taken about the same time as the concrete temperature.
5. Maximum Air Temperature--No continuous placement is to be attempted when temperature forecast is above 86°F (30°C).
 - a. Working time of concrete varies with the temperature of concrete, and concrete temperature varies with the temperature of different materials used in the mix. In order to determine the dosage rate of retarder, an estimate of the mix temperature must be made. The following are suggested estimating methods:
 - (1) The temperature of concrete from previous placements could be taken.
 - (2) If a ready mix producer is placing concrete the day before a deck placement, this concrete could be checked for concrete temperature.
 - b. Regardless of the method used, make the best estimate of what the concrete temperature will be during the warmest part of the day. Remember, concrete shall not be placed in new decks if the concrete temperature is above 85°F (30°C).

706.03 CONSTRUCTION METHODS

A. Prepour Meeting

1. It is very important to use the prepour meeting to discuss the specifics of placement, establish communication, and resolve potential "sticky" issues prior to placement. Generally it is recommended to discuss:
 - a. Chain-of-command. Who is in charge for the contractor? Who needs to be notified if material tests do not comply with specifications? Establish prior to placement how test results are reported (i.e., does the Contractor want to be notified verbally, or in writing each time?).
 - b. More cement paste will cause more cracks and less paste means fewer cracks.
 - c. Material requirements and admixtures needed for the placement (Examples: Single cement source, concrete temperature and methods used to cool the mix, source and amount of any admixtures, specific mixes required for bridge decks, etc.)
 - d. Vibration can make a stiff mix workable with better results than adding water.
 - e. Procedures for introducing admixtures during mixing operations need to be discussed and formalized. For example: How and where will the air entraining agent be introduced? There is a growing concern that placement location of admixtures is causing significant variability in mixes. The plant monitor must watch and document how admixtures are introduced during mixing.
 - f. Method and frequency of acceptance testing during any placement. Inform the Contractor what is expected if non-acceptable material is found during placement.
 - g. Scheduling, truck availability, placement method, and required placement rates.
 - h. Establish an acceptable source of preplacement weather forecasting. Agree on weather parameters which will be used for "go" or "no-go" decisions both "prior to" and during the placement activity.
 - i. Larger limestone aggregate will reduce deck cracks. The gradation tables all have tolerances. Make sure we get as large of limestone aggregate as is available.
2. Adequate Labor Force
 - a. At preplacement meetings talk about and, before starting a placement be sure the contractor has:
 - (1) Proper and adequate materials to protect the placement.

- (2) Adequate numbers of sufficiently skilled laborers available.
 - (3) Proper tools on the job.
 - (4) Arranged for the rate of delivery of concrete to make the placement operation efficient.
- b. 25 cy (20 cubic meters) per hour should be a minimum placement rate. Any method of delivery to the deck should be checked to see that rate of placement can be such that finishing operations can proceed at a steady pace, with final finishing completed before the concrete starts its initial set.

B. Concrete Plant Inspector's Checklist

1. Specifications regarding plant inspection, equipment approval, and batching operations should be reviewed for familiarity. **In addition to proper plant calibration, the inspector should verify that each truck mixer used on the job has a current certification as required by SSHC Section 1002.** It is good practice to inspect a random sample of ready mix trucks that will be used on the job, verifying that the certification accurately reflects the truck's condition. Truck certification numbers should be recorded in the inspector's diary and will need to be reverified at least every 30 days.
2. Batching and mixing should be limited to the lead truck until slump and air content have been tested for conformance with specifications. **Contractors may make preliminary tests at the plant but project acceptance is based on job site tests.** It is intended that the ready mix plant supply concrete to the construction site that conforms to all applicable specifications at the point where the acceptance sample is taken.
 - a. *SSHC Table 1002.02, Concrete Proportions*, lists slump and air content requirements.
 - b. If concrete is being delivered which deviates much from these target values, the contractor is responsible for taking corrective action to bring the mix to within target values. Even if the current mix is within specified limits. The intent of the tolerance is to provide latitude during placement for unforeseen changes in materials, mixes, and placement methods. Placing concrete "consistently" near a tolerance limit is not desirable and warrants additional sampling.
 - c. What is important, is the contractor's response to test results approaching tolerance limits. Continually having to add water and/or air agent to each load at the site will not be permitted. If such practice is occurring, the inspector shall notify the contractor (or whomever was designated as "the" responsible individual in charge of the concrete at the site.) Ultimately, it is the contractor's responsibility to initiate immediate corrective action.
3. Non-responsiveness on the contractor's part is reason to initiate sampling and testing of each truck or halt placement. The purpose for additional testing is to ensure that no noncomplying materials are incorporated into the project.

4. In some cases admixtures, such as water reducers, are required to be added in split doses or sometimes totally at the site.
5. All Structural Concrete
 - a. At the start of each day's placement, no concrete is to be placed in the forms or on the deck until the first truck has been sampled, tested, and approved. Incorporation of materials from this truck will not be permitted unless desired slump and air content are within specified limits. Continuous placement shall not begin until after test results indicate the material meets specified requirements.
 - b. If the first load is close to a limit value, it is recommended to sample and test the second load unless site experience indicates it is not necessary.
 - c. Initial start up test results (if taken from the truck chute) must account for method of placement. For example: If placement will be through a pump, air values should be on the high side of target to account for loss during pumping. Again, site/project experience should be factored in this decision.
 - d. Routine acceptance testing will be at a minimum frequency of one sample per 100 yd³ (100 m³). This frequency may be changed for large, continuous placement where placement rates warrant a lesser frequency. Minimum quantity placed between routine acceptance tests is 100 yd³ (100 m³). This rate of testing may be increased (made more frequent) if the inspector has a concern that target values are not being met.

NOTE: Only the Materials and Research Division has authority to approve decreasing (less frequent) testing frequencies from those listed in *Materials Sampling Guide*. PLAN AHEAD and obtain approval for those cases where a variance would be reasonable.

- (1) For routine acceptance testing, obtain a representative sample at the last practical point before incorporation, but prior to consolidation.

NOTE: When concrete is placed by means other than directly from the back of the truck the sample shall be taken after the concrete has passed through the conveyance method being used. (This includes placement by bucket, belt, pumps, power buggies, etc.)

- (2) Routine acceptance sampling and testing does not require holding a truck until results are available. However, if there are obvious deficiencies, the inspector has the authority to hold that truck until test results are available.
- (3) Inspectors should be alert to obvious visual changes in consistency, with routine acceptance air and slump tests being made as noted above. Any load having questionable consistency should be checked for slump, and air content.
- (4) If noncomplying test results are found during routine acceptance sampling, no more material (from that truck or others) shall be incorporated until complying test results are obtained. When test results indicate noncomplying material:

- (a) The rest of that load shall be rejected and not incorporated, unless adjustments can be made to bring it back into compliance.
 - (i) In an attempt to bring noncomplying concrete into compliance, the supplier may make field adjustments (i.e., add air entraining agent, or rotate the drum). Such "field" adjustments shall be an EXCEPTION and not the general rule and the 90 minute time restriction shall not be waived for any situation.
 - (b) For all noncomplying test results the inspector shall immediately notify the contractor or their representative in charge of the concrete. This notification shall also inform the Contractor if noncomplying materials have been incorporated into the structure.
 - (c) If test results indicated noncomplying materials have been incorporated, the inspector shall make a note in the diary indicating the test results, approximate volume incorporated, location the material was placed, and to whom the notification was given. The inspector should also note a noncomplying event on that particular truck's delivery ticket.
 - (d) When noncomplying materials are found, the inspector will:
 - a) hold each truck, and
 - b) initiate sampling and testing of each truck until two consecutive loads meet specifications. At this point sampling and testing may return to normal project acceptance frequency.
6. Specifications spell out requirements that materials must meet to be acceptable. Further, the *Materials Sampling Guide* identifies a frequency for sampling/testing and whether the test is an acceptance or assurance test.
- a. Authority for initially rejecting noncomplying materials and poor quality work performance is given to the inspector in *SSHC Subsection 106.05*. This rejection authority is only superseded by the Project Manager. There is an old saying to the effect "*We shall not knowingly incorporate noncomplying material into a project.*" This means exactly what it says and there is ample support in the specifications for this position.
7. During placements, the inspector should alternate sampling among the various trucks involved in the operation.
8. If there is a specific truck which is identified as causing a problem with consistency, that truck shall be rejected from further use.

9. Transit mixers shall be completely emptied of wash water before reloading. If the truck's top fill hopper is washed after loading, no wash water shall be allowed to enter the mixer.
10. The inspectors will need to satisfy themselves regarding compliance with the specifications for the number of drum revolutions at mixing speed.
11. If water, air entrainment or other admixtures are added at the project site, acceptance testing will not be performed until all additions have been made AND required mixing has been completed following the change.

C. Falsework

1. General: *SSHC Subsection 704.03*, paragraph 7.f. requires the contractor to submit 6 copies of falsework plans when required or when certain conditions apply. These plans shall be prepared by an Engineer registered in the State of Nebraska. The contractor shall prepare falsework plans, as called for in plans or in the special provisions, and for:
 - Support of plastic concrete for concrete slab bridges with spans greater than 50 ft (15.25 m) in length.
 - Cast-in-place concrete girders
 - Slab bridge false work should allow for ? inch (3 mm) of deflection for each 10 feet (3 m) of span. This means that on an 80 foot simple span bridge the falsework should be 1 inch high at midpoint.
2. Falsework Inspection
 - a. Contract requirements governing falsework construction are contained in *SSHC Subsection 704.03, paragraph 7*.
 - b. The Project Manager should observe the falsework as it is erected to ensure that:
 - (1) Only sound materials are used.
 - (2) Quality work is used.
 - (3) During concrete pour, the falsework will carry the load. (More than ½" movement is bad.)

NOTE: Any inspection and/or acceptance by the Project Manager is not intended to relieve a contractor of responsibility under the contract for falsework design and construction.

- c. By specification, a contractor is responsible for proper evaluation of the quality of their falsework materials. However, the Project Manager should not permit use of any material, when there is doubt as to the materials ability to safely

carry the load. If there is any question, the contractor should be required to perform a load test or furnish other evidence of structural adequacy.

- d. Timely inspection is essential. Falsework deficiencies should be brought to the contractor's attention at once. Deficiencies include:

- (1) Poor quality work.
- (2) Use of unsound or poor quality materials.
- (3) Construction which does not conform to the contractor's falsework drawings.

- e. If the contractor fails to take corrective action, a noncompliance letter shall be issued. Corrective action will be required prior to placement of any additional dead or live load to the support structure.

3. Falsework Foundations

- a. Falsework piling should be driven to adequate bearing unless mudsills or spread footings can be founded on rock, shale, compact gravel, coarse sand, firm clays in natural beds, or well compacted fill.

(1) Falsework Piles

- (a) If requested, pile bearing values will be determined by the wave equation. Otherwise, the contractor is responsible for adequate foundation support.
- (b) The pile bearing value required to support the design load must be shown on falsework drawings, and the pile driving operation must be inspected sufficiently to ensure that falsework piles attain required bearing.

b. Mudsills and Spread Footings

- (1) Foundation material should be inspected before the footings are placed.
- (2) To ensure uniform soil bearing, falsework pads must be set on material that provides a firm even surface, free of bumps or depressions within the pad bearing area. If necessary to obtain uniform bearing, a thin layer of sand may be used to fill in surface irregularities.
- (3) Continuous pads must be analyzed differently than individual pads, and the two should not be considered equivalent. A change from one to the other requires resubmittal in the Construction Division for review by the Bridge Division.

- (4) Falsework pads should be level. Benches in fill slopes should be cut into firm material, with the pad set well back from the edge of the bench.
- (5) Many soils lose their supporting capacity when saturated. Adequate falsework construction must provide for drainage and protect pads from being undermined or ponded in water.

c. Soil Load Test

- (1) Project Managers should require the contractor to perform a soil bearing test if there is any doubt as to the ability of foundation material to support the falsework load without appreciable settlement. One method to evaluate in-situ bearing capacity is to perform a plate bearing test as per ASTM D-1 194. (The above referenced method is not the only such test procedure, but is included to provide one method of determining in-situ capacity.)

4. Falsework Materials

- a. One aspect of a falsework design and review is based on the use of undamaged, high-quality materials. Material strength values must be reduced if lower quality materials are to be used. Obviously, evaluation of the quality of materials actually furnished is an important, and essential, part of the falsework inspection procedure.

(1) Timber

- (a) Inspecting falsework materials is necessary to prevent the use of materials which obviously do not meet the "undamaged high-quality" design criteria.
- (b) Falsework materials delivered to the job site, should be equal to or greater than the grade, or type of material, assumed in the design review. Timber having large shakes, checks or knots, or which are warped or split should not be used at critical locations. Abused timber, although stress graded, may no longer be capable of withstanding the original allowable stress.
- (c) Rough sawn timbers should be measured to determine their actual dimensions. Unlike surfaced/finished material, the dimensions of roughcut timber are not uniform from piece to piece. The variation may be appreciable, particularly in the larger sizes commonly used for falsework posts and stringers. If actual dimensions are smaller than the dimension assumed in design, the member may not be capable of carrying the imposed load without overstress. Therefore, undersized material should not be incorporated into the falsework, unless the design is reevaluated using smaller dimensions.

(2) Structural Steel

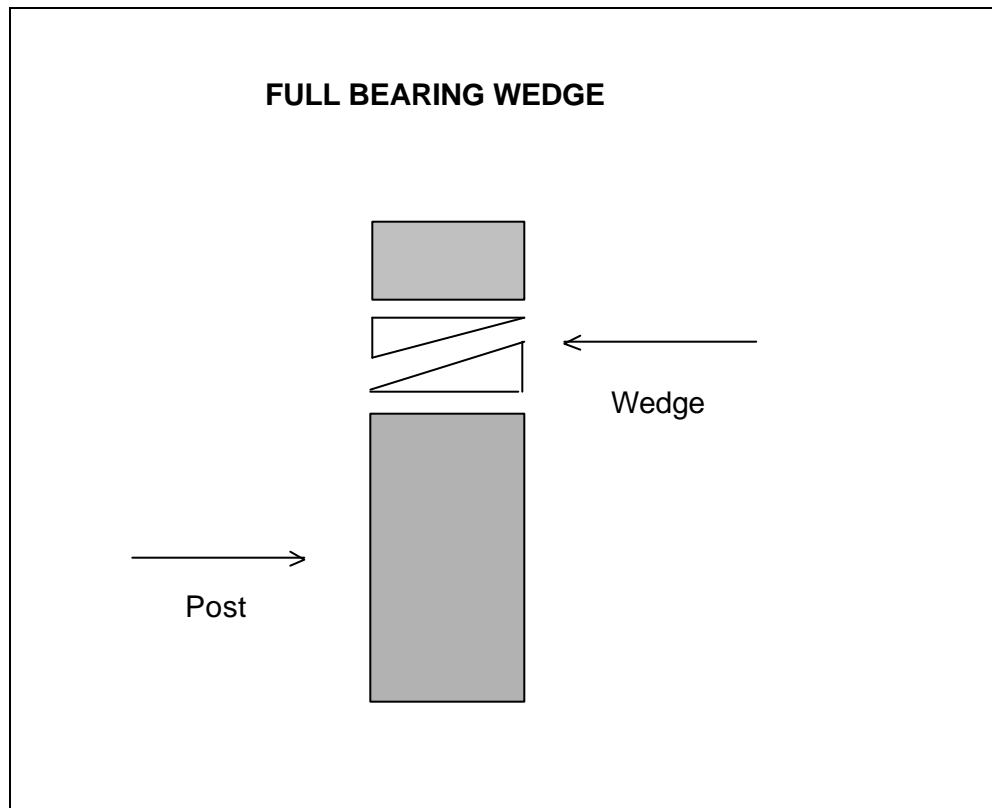
- (a) Used beams, particularly beams salvaged from a previous commercial use, should be examined carefully for loss of section due to welding, rivet or bolt holes, or web openings which may adversely affect the ability of the beam to safely carry the load imposed by the falsework design.
 - (b) Welded splices should be inspected visually for obvious defects. Radiographic inspection or other methods of nondestructive testing will not be required as a means of determining the quality of the splices unless the Project Manager has reason to believe the welds are defective.
 - (3) Manufactured Products
 - (a) Manufacturer's ratings are based on the use of new material or used material in good condition. The determination as to whether a manufactured product is in good condition is highly subjective and requires experience and judgment.
 - (b) When manufactured assemblies are used in falsework, they shall be shown on the falsework plans along with their identification number. The actual assembly shall be clearly and permanently marked with the identification number.
 - b. Identification numbers will allow field inspectors to verify the capacity and proper application of various devices.
 - c. Identification by the contractor applies not only to jacks, beam hangers, overhang brackets, and similar devices, but to all vertical steel shoring systems as well.
 - d. Manufactured products such as tubular steel shoring and steel overhang brackets are particularly vulnerable to damage by continual reuse. Fabricated units in which individual members are bent, twisted, or broken will have a substantial reduction in load carrying capacity. Steel shoring materials should be examined carefully prior to use. Shoring components should not be used if they are heavily rusted, bent, dented, or have broken/damaged welds or other defects. Connections, in particular, should be examined for evidence of cracked or broken welds. Miscellaneous components such as screw jack extensions, clamps, and adjusting pins should be inspected as well.
 - e. Proprietary scaffolding must be used as intended and not subjected to additional stresses or conditions for which it was not originally designed and tested.
- (1) Cable Bracing
 - (a) Cable bracing systems must be carefully inspected to ensure that field installation conforms to details shown on the falsework drawings. This is particularly important with respect to the location and method of cable attachment to any falsework.

- (b) Prior to installation, each cable should be inspected to verify that the type, size, and condition (new or used) are consistent with design assumptions. Used cable should be inspected for strength-reducing flaws. Use of obviously worn, frayed, kinked, or corroded cable should not be permitted.
- (c) Particular attention should be paid to cable clamp fasteners. Improperly installed clamps will reduce the safe working load by as much as 90 percent. Also, the omission of the thimble in a loop connection will reduce the safe working load by approximately 50 percent. After installation, clamps should be inspected periodically and tightened as necessary to ensure their effectiveness.
- (d) A cable clamp has two parts - the "U-Bolt" and the "Saddle." Also a cable has two parts, the wrapped non-continuous end (dead end) and the continuous portion which supports the load (live side). Always put the cable clamp's "saddle" on the live side and the "U-bolt" over the "dead end."

5. Falsework Quality

- a. High quality work, particularly in such details as wedges, fasteners, bracing, friction collars, jack extensions, etc., is critical to the proper performance of falsework. Accordingly, construction details should receive close attention from the project inspector.
 - (1) Timber Construction
 - (a) The following checklist is included as a guide to points which require special consideration:
 - (i) Diagonal bracing, including connections, must conform to details shown on the falsework drawings.
 - (ii) Diagonal bracing should be inspected after any falsework has been adjusted to grade. Connections must be securely fastened to ensure their effectiveness in resisting horizontal forces. Bolted connections may need retightening.
 - (iii) Timber posts may be wedged at either the top or bottom for grade adjustments, but not at both locations. Large posts may require two or more sets of wedges (side by side) to reduce compression stresses perpendicular to the grain.
 - (iv) Blocking and wedging should be kept to a minimum. It is poor workmanship to extend a short post by piling up blocks and wedges. This practice should not be permitted.

- (v) Particular attention should be given to falsework bents where grade adjustment is provided at the bottom of the posts. Differential grade adjustment of posts within a particular bent may induce undesirable stresses in the diagonal bracing.
- (vi) Splicing of wood posts will not be allowed unless shown on approved falsework plans.
- (vii) The ends of spliced posts must be cut square. The need for a post splice should have been anticipated by the contractor and the splice detail shown on falsework drawings. If this is not the case, the contractor must submit a detail for approval.
- (viii) Posts must be plumb and centered over the falsework pad or corbel.
- (ix) Abutting edges of soffit plywood should be set parallel to the joists and continuously supported on a common joist.
- (x) A sufficient number of telltales must be installed to accurately determine the amount of joint take-up and settlement. Telltales should be attached to the joists as close as possible to the supporting post or bent.
- (xi) Full bearing must be obtained between all members in contact. Deficiencies in this respect may be improved by feather wedging. If the joint requires more than a single shim or wedge, extra care should be taken to ensure that full bearing is obtained.



When using wedges, it is a good practice to use wedges inserted from both sides rather than deeply setting a single wedge. Using only one wedge increases the twisting effect on the member.

- When using wedges, it is good practice to install them parallel to and with the flat (nontapered) side against the main member. This improves contact with the main member and decreases the chance of a wedge "backing out" from vibration.
- Nail or clamp the wedge in place after installation.

(2) Steel Shoring (Scaffolding)

- a. This checklist may be used as a guide by inspectors when inspecting falsework constructed of steel shoring.
 - (1) Shoring components should be inspected prior to erection. Any component that is heavily rusted, bent dented or rewelded, or which is otherwise defective, should be rejected. Fabricated units having individual members that are bent twisted, broken, or where welded connections are cracked or show evidence of rewelding should be rejected.
 - (2) A base plate, shore head, or screw jack extension device should be used at the top and bottom of all vertical components.

- (3) All base plates, shore heads, and extension devices must be in firm contact with the footing at the bottom and the cap or stringer at the top.
- (4) Shoring components should fit together evenly, without any gap between the upper end of one unit and the lower end of the other unit. Any component which cannot be brought into proper contact with the component it is intended to fit, should not be used.
- (5) Shore heads, extension devices, and similar components must be axially loaded. Eccentric loads are not permitted on any shoring component.
- (6) All locking devices on frames and braces must be in good working order, coupling pins must align the frame or panel legs, and pivoted cross-braces must have the center pivot in place.
- (7) Shoring should be plumb in both directions. Maximum deviation from true vertical should not exceed 3 inches per 1000 inches (3 mm per meter).

6. Miscellaneous Falsework Items

- a. This checklist covers items that may be used in either type of support system.
 - (1) New high strength bolts shall be used on any item that requires bolts to be torqued.
 - (2) Friction collar bolts and concrete anchors should be torqued initially and checked again just prior to concrete placement.
 - (3) Permanently deflected stringers should be placed with the crown turned upward.
 - (4) Jacks should be plumb and not overextended.

7. Falsework Adjacent to Traffic

- a. This will be an unusual situation in Nebraska. If it occurs, the Construction Division should be notified.

8. Falsework Field Changes

- a. If supplemental calculations are necessary to verify compliance with contract requirements, the change will be considered substantial. In this case, the proposed change must be submitted for review and approval in the same manner as the original drawings.
- b. The following are examples of changes considered substantial and must be shown on revised falsework drawings, regardless of other considerations:
 - (1) A change in size or spacing of any primary load-carrying member.

- (2) A change in method of providing lateral or longitudinal stability.
- (3) Any change, however minor, which affects the falsework to be constructed over or adjacent to a traffic opening.
- (4) A revised concrete placing sequence, if it significantly affects the stresses in load-carrying members.
- (5) When revised drawings are required, they must be submitted for review in the same manner as the original falsework drawings. The Department does not approve falsework! Time shall be allowed for review of revised falsework drawings. Typically this is the same as required for the original submittal.
- (6) The PM should be alert to and document any field changes to falsework plans.

9. Falsework Inspection During Concrete Placement

- a. As concrete is being placed, the falsework should be inspected at frequent intervals. In particular, look for the following indications of potential failure:
 - (1) Excessive compression at the tops and bottoms of posts and under the ends of stringers.
 - (2) Pulling of nails in lateral bracing.
 - (3) Movement or deflection of braces.
 - (4) Excessive deflection of stringers.
 - (5) Tilting or rotating of joists or stringers.
 - (6) Excessive settlement of tell-tales.
 - (7) Posts or towers that are moving out of plumb.
 - (8) Sounds of falling concrete or breaking timbers.
 - (9) If any member deflects unduly or shows evidence of distress, such as splintering on the bottom of stringers, crushing of joints or wedges, etc., placement work in the affected area should be stopped immediately and the falsework strengthened by addition of members, installation of supplementary supports, or some other means.

- (10) Settlement of the falsework should be limited to a maximum of ? inch (10 mm) deviation from the anticipated settlement. Should actual settlement exceed the anticipated settlement by more than the ? inch (10 mm) allowable, and if it appears that a serious problem is developing, concrete placing should be temporarily discontinued in affected areas until the contractor provides satisfactory corrective measures. Concrete placing should not be resumed until the Project Manager is satisfied that further settlement will not occur.
- (11) If it is apparent that satisfactory corrective measures cannot be provided prior to initial setting of the concrete, the Project Manager shall stop placing of concrete and contact the Construction Division.
- (12) One important and often overlooked point is the danger of curing water softening the falsework foundation. Some means should be provided to prevent curing water from reaching and soaking the foundation material beneath the falsework bearing pads.
- (13) The contractor should provide the drainage for any water that accumulates in box-girder cells. Such accumulated water could easily overstress the falsework.

b. Falsework and Centering

- (1) It is the contractor's responsibility to provide form work adequate to support the dead load of the fresh concrete. However, the inspector shall consult with the contractor and the Project Manager concerning any form work which he/she has reason to believe is inadequate to support the load capacity. In calculating the strength of centering, a mass of 150 lb/ft³ (2400 kg/m³) shall be assumed for fresh concrete.
- (2) All falsework shall be rigidly braced and cross braced. Timber piling shall be free from defects with at least a 7 inch (175 mm) butt and a 5 inch (125 mm) tip, measured under the bark. The contractor shall provide jacks or suitable wedges to take up any settlement in the form work during the placing of the concrete. When setting grades for falsework or structure forms, allow 1/16 inch (1.5 mm) settlement or "take-up" for each lap in the falsework timbers.
- (3) Build falsework for slab bridges with ? inch camber for each 10' of span. Deflection after forms are removed should bring deck back to the proper elevation.
- (4) Settlement caused by the concrete loads may be checked as placing of the concrete progresses by means of vertical "telltals" fastened to the bottom of the floor form. When this settlement has reached the amount allowed for "take-up" in the falsework timbers, any further settlement should be prevented by means of the wedges or jacks previously noted. Any adjustments that have to be made must be completed before the concrete has taken its initial set. If adjustments are made after the concrete has set, the concrete may be damaged

irreparably. (In general, if falsework settles more than ½ inch, the PM must investigate and determine the damage.)

10. Removal of Falsework (SSHC Table 704.02)
 - a. Specifications and applicable special provisions, contain specific criteria which must be met before falsework may be removed. Project Managers and inspectors should review these sections prior to falsework removal operations.
 - b. The Project Manager should discuss falsework removal methods and procedures at the preconstruction and/or prepour meeting. The need to provide for employee and public safety is of particular concern.
 - c. In general, all elements of the falsework bracing system must remain in place for the specified time period or until concrete attains the specific strength. In the case of cast-in-place, post tensioned construction, falsework elements must not be removed until stressing is completed.

D. Forms

- a. The inspector shall check the lines, grades and dimensions on all structural form work before allowing the contractor to place concrete. On walls and columns this is best done as the form work progresses.
- b. Forms shall be made of wood, metal or other approved materials. The forms shall be substantial, unyielding and mortar tight. All forms for exterior exposed surfaces, except those locations requiring a specific texture finish as listed in *SSHC Subsection 704.03* shall be lined with pressed wood, plywood or other approved materials used in the largest practicable panels. Forms shall be coated with a colorless oil to prevent sticking to the concrete. The forms should be oiled before placing the reinforcing steel to avoid splattering of oil on the steel. Forms for walls and columns, or wherever else required, may be constructed with the bottom board removable for cleaning out wood chips, dirt, etc., before placing the concrete. Metal tie rods or anchors within the forms shall be constructed so as to permit their removal to a depth of one inch below the surface of the finished concrete. All tie rod and tie-wire holes shall be filled with cement mortar as soon as possible to insure proper bond with the structure concrete.
- c. Pier columns may be constructed using a laminated fiber form which is moisture resistant and seamless. These forms must be capable of withstanding the hydraulic pressure of fresh concrete. Any questions concerning the acceptability of a proposed fiber form should be referred to the Construction Engineer through the District Construction Engineer.
- d. Removal of Forms and Falsework
 - (1) Specific requirements concerning the time limitations for form removal are listed in *SSHC Subsection 704.03*. Proper inspection includes both the monitoring of this time and the method of removing forms. Stresses in concrete due to its own weight must be introduced slowly and carefully during form removal operations to prevent concrete failures. For instance, the removing of falsework from under a cantilevered element, must begin at the point furthest from the support and proceed toward the support. In removing the falsework from under a structure that is continuous over its supports, removal should begin near the areas of maximum dead load positive moment and proceed in both directions towards the supports. In general, all

falsework should be removed before placing any surcharge, such as sidewalks and railings, on the superstructures.

- (2) The requirements listed in the Specifications are based on sound engineering principals and the structures inspector should be thoroughly familiar with and rigidly enforce these requirements.

12. Use of Insulated Forms for Protection

- a. Commercial insulation may be used for protecting concrete during cold weather, or when the contract documents require controlling the heat of hydration. This technique is the contractor's option and could be used in lieu of housing and heating. The contractor must furnish housing and heating and/or insulation of sufficient quality and thickness to maintain concrete at a temperature of not less than 50°F (10°C) for the first 72 hours after placing, and above 41°F (5°C) for the next 48 hours.

E. Placing Concrete

1. Concrete shall be proportioned, mixed and handled in accordance with the requirements of *SSHC Section 1002*. The inspector should also refer to the Materials and Research Manual which outlines the method of proportioning, sampling and field testing the materials necessary for the production of concrete. The contractor shall organize his/her work so that the maximum interval between batches shall not exceed 30 minutes.
2. Concrete should not be placed in footings, columns, etc, until all pile driving within a radius of 50 feet has been completed. If concrete pours must be made within this area prior to the completion of pile driving, such concrete shall set at least three days before further driving is permitted within this radius. Concrete shall not be placed without special permission in steel pile shells for cast-in-place concrete piles for each bent, pier, or abutment until all the shells for that bent pier or abutment have been driven (*SSHC Section 703*).
3. When depositing concrete in the forms, segregation must be avoided. The mass of concrete should be generally free of surface cavities resulting from the trapping of air and water along the forms. Careful spading of concrete along vertical forms and tapping of the forms will usually release the air and water bubbles. Forms which are not mortar tight will leak cement paste and result in "sand streaking." Forms should be mortar tight to the maximum extent possible. Chutes shall be of metal or metal lined and of sufficient number to preclude the necessity of shifting the chutes. If necessary, the contractor shall leave holes in the forms for the entry of the chutes or pipes. Concrete must be deposited within 8 ft (2.5 m) horizontally of the place of its final location. Concrete shall not be dropped vertically more than 5 feet (1.5 m). Concrete in walls, footings, columns, etc, shall be placed in continuous horizontal layers not more than 18 inches (450 mm) thick and vibrated to a monolithic mass. Do not allow dried concrete to collect on forms or reinforcing bars where it will fall into the work.
4. See Section 1003.06 Concrete Cylinder Policy for cylinder requirement.

F. Placement Considerations

1. If there is any doubt about the concrete temperature exceeding 86°F (30°C), the contractor needs to identify measures which will be implemented to keep mix temperatures within specifications. If the contractor is not prepared to maintain a mix temperature below specifications, the pour should be postponed.
2. There are several ways concrete temperatures may be kept within specifications. They are:
 - a. Scheduling placements during cooler times of the day.
 - b. Wetting the aggregate stockpiles.
 - c. Covering/shading the aggregate stockpiles.
 - d. Maintaining a supply of portland cement on hand to preclude getting hot material from the supplier.
 - e. Chilling the mixing water is one of the most effective ways to lower mix temperatures.
 - f. Shaved ice can be used, however, the ready mix operator must submit a proposal for this to the Project Manager for review by the Construction Division.

NOTE:

- No payment will be made for methods taken to keep concrete temperatures within specifications.
 - If pour has to be delayed because of temperature, and pouring is the controlling operation, no working days will be charged.
 - Location of permissible headers should be discussed with the contractor during the pour, it appears the temperature may exceed 86°F (30°C).
 - When casting deck on Phased Construction under traffic make sure potholes in the driving lanes are filled.
3. General - The wind velocity temperature relationships stated in the specifications should be enforced to avoid loss of water from the concrete surface faster than it can be replaced by normal bleeding and to avoid the resultant formation of plastic shrinkage cracks. Anemometers and thermometers must be available on site to measure wind velocity and temperature.
 4. Concrete in bridge floors shall be placed uniformly on both sides of the centerline and shall be placed continuously between specified joints. The sequence of placing shall be in accordance with the pouring diagram shown in the plans. If no pouring diagram is shown in the plans, concrete shall be placed as directed by the Project Manager.

5. Wet the deck forms and approach slab grade before placing the concrete. Concrete shall be adequately vibrated to encase the lower bars of the reinforcing mat where these are near the deck form.
6. Special attention shall be given to finishing the riding surface on the bridge floors. *SSHC Subsections 706.03, 710.03, and 711.03* explain concrete bridge floor finish.
7. It has been the policy to permit the contractor to use mechanical finishing machines of an approved type whether or not they are required by the plans or special provisions.
8. Method of Finish - When the hand method is employed, the concrete surface shall be struck off with a strike board which conforms to the cross section shown in the plans. If this is pulled by hand, care shall be taken not to displace the reinforcing steel by the workmen doing the pulling. A small air winch anchored to a girder outside of the day's pour will pull the strike off at a slow, uniform rate, giving a truer surface with no displacement of the reinforcing steel. The strike board shall be operated with a combined longitudinal and transverse motion, always carrying a small roll of concrete in front of the cutting edge. The strike off shall be pulled a sufficient number of times to properly distribute the concrete. A longitudinal float generally is required and is described in *SSHC Section 704*. The longitudinal float shall be lapped 1/2 its length when moved to a new position and shall be operated across the surface a sufficient number of times to produce a uniform, smooth riding surface. Occasionally during the finishing operation, conditions may require the use of the long-handled transverse float, which require extreme care in its use to preserve the desired cross-section and a smooth riding surface.
9. Regardless of whether hand or machine finishing methods are used, the floor surface shall be tested for trueness with a straightedge 10 foot (3 m). The bridge contractor is required to furnish a 3 m master straightedge for use in trueing and checking the working straightedges.
10. A burlap drag is required and this operation should be performed as soon as the surface will support the drag. A tined surface is also required by the specifications.
11. Templates used to support the strike off should be in short sections [(10 to 14 ft) (3 m to 4 m)] so they may be removed as the finishing operation advances, allowing the final floating and surface testing to take place, and the wet burlap to be applied immediately. Decks should be cast after the afternoon high temperature is reached. (In summer, this can be as late as 7:00 p.m.) Protection of the aggregates from the sun is also helpful.
12. When mechanical self-propelled finishing machines are used, they shall be capable of obtaining a finish equal to or better than that obtained by the hand method. The screeds of the finishing machine should be set to the exact cross section shown in the plans. Elevation shots will be required for the setting of the riding rails. The usual procedure is to give a fill to grade at the locations where girder shots were taken. The contractor will then set the rail to the correct height to accommodate the machine. An "eyeball" check of the rail for smoothness should always be made. On girder bridges the rail will follow a line that should be smooth after the girders have deflected from the dead load. Correct elevations of the rail can be checked by measuring the distance from the screed to the formwork which should give the correct thickness of slab.

13. Careful attention should be given to the depth of cover over the top steel. With the extensive use of salt, the service life of the steel is reduced if the concrete cover is less than that shown in the plan. (The finishing machine must be dry run to check the minimum clearance of the reinforcing steel and to check the grade of the expansion devices.)
14. If the finishing machine is used when there is a transition between regular crown and full superelevation, a system should be worked out well in advance of pouring to insure that the screed can be changed rapidly and correctly at intermediate points of the transition. This is important in order that there are no long delays caused by screed adjustments while pouring the transition.
15. Retarders – Retarders shall be used to delay the setting time of the bridge floor concrete. If the temperature is 60°F (15°C) and rising, retarders must be used. A good goal is to be finishing at the next pier before the concrete is setting-up at the previous pier. Acceptable retarders are Pozzoloth 300R and Doratard-17. Water reducing admixtures like WRDA-82, Procrete-N, and Masterpave-N are not acceptable retarders.
16. When a retarder is required the rate of placing concrete for any positive moment section will be within two-thirds of the initial setting up time of the retarded concrete after the previous negative moment section has been poured. For example, if the initial set takes place in 6 hours, the pouring of a positive moment section must be completed within 4 hours after the completion of the previous negative moment section. This same procedure should be required regardless of whether or not retarders are used.
17. Calibration of Concrete Proportioning Equipment - Calibration of this equipment should be as described in the National Ready Mixed Concrete Associations' Quality Control Manual.

G. Placement Methods (Pumping, Belting, And Crane Bucket) (*SSHC Subsection 704.03*)

1. Much concern has been expressed about the method of concrete placement because of lost entrained air. Rough handling of plastic concrete during placement has, at times, reduced entrained air to less than 2% not to mention potential segregation problems. While testing at the point of placement "should" identify such problems, varying placement conditions during the pour can affect concrete conditions significantly.
2. General conditions which must be avoided (Points to watch for), or at least severely minimized, are explained for each delivery system that follows: If one of the following cannot be avoided, at least be aware of the condition, and be sure to conduct additional testing should any of the conditions present themselves.
3. Crane and Bucket
 - a. In the past it was felt the crane and bucket placement method did not adversely affect concrete. This is now in question when viewed from loss of air and potential segregation. Therefore, this method will now also require testing at the placement location, if practical.

b. Points-to-Watch For

- (1) Free fall of unrestrained concrete shall not exceed 5 ft (1.5 m.) Avoid exceeding a 5-ft. free fall by removing a section of form work for intermediate placement or by use of a tremie.
- (2) Discharge from the bucket must be controllable.
- (3) Cross section of the drop chute should allow it to be inserted into the form work without interfering with reinforcing steel.

4. Belt Placement

a. Belt equipment is typically used to convey concrete to a: (1) lower, (2) horizontal, or (3) somewhat higher level.

b. Points-to-Watch For

- (1) Keep the number and distance of drops between belts to an absolute minimum. Drops tend to encourage segregation and reduce entrained air.
- (2) As belt conveyors are removed from the line (i.e., as on deck pours), recheck the "as placed" air content.
- (3) Be sure all mortar is being removed at the discharge. (No mortar should be on the return belt.)
- (4) Check discharge for potential segregation problems.
- (5) In adverse weather (hot and/or windy conditions), long belt runs need to be covered.

H. Pump Placement

1. The modern mobile pump with hydraulic placing boom is economical to use in placing both large and small quantities of concrete. These units are used to convey concrete directly from a truck unloading point to the concrete placement area.

2. Points-to-Watch For

- a. Typically, pumps are initially flushed with a thin water/cement paste mixture to coat the lines. This slurry must be wasted and the lines charged with the project mix before beginning. Observe, and be sure initial pump charge is thoroughly removed from the pipelines.
- b. Always pump at a constant rate and keep pipelines full of concrete. High air loss can occur when concrete is allowed to free-fall inside pump lines.

- c. Avoid, if at all possible, having steep angles in the pump pipelines. Steep angles and slow placement rates are probably the worst conditions for minimizing air loss and segregation. If this condition occurs:
 - (1) Attempt to relocate the pumper, thereby minimizing lift angle.
 - (2) If discharge is not maintaining a constant flow with the partial concrete head in the pipe, request the pump operator to place a reducer and short section of hose at the discharge end. The purpose is to avoid free falling concrete from impacting the deck or forms at high velocity.
 - (3) If the above condition is unavoidable, watch and test the discharge frequently for loss in air and potential segregation.

3. Rule-of-Thumb for Pumping

- a. Pump concrete with pipelines as flat as possible (or at least with minimal down angle).
- b. Minimize (or eliminate) free falling concrete in the pipelines. To do this, maintain some amount of concrete head in the pipelines.
- c. Pump concrete through as few elbows and restrictions as possible.
- d. Pump concrete at "some" constant rate.
- e. Watch and test the air content frequently, when drop may exceed 5 feet.

I. Consolidation of Concrete

- 1. The contractor must establish a pattern for vibrating the concrete and ensure the pattern is followed across the entire deck.
- 2. Consolidation of concrete should be accomplished by the use of a sufficient number of vibrators of a type approved by the Project Manager. The vibrators must be of such an intensity as to visibly affect one-inch slump concrete over a radius of 18 inches (450 mm). The contractor is required to furnish a tachometer for the purpose of checking the speed of the vibrator elements.
- 3. Lateral movement of the concrete by means of a vibrators shall be avoided. Over vibration is harmful and is evidenced by grout appearing in the concrete around the vibrator head. Insert and withdraw the vibrator slowly. It should not come in contact with reinforcing steel which extends into previously placed concrete nor should the vibrator head be placed in concrete which is taking its initial set.

J. Reinforcement Bar Cover

- 1. Reinforcement bar cover has contributed to shadow effect. This occurs when reinforcing cage is not rigid or has only a minimum of cover and too much vibration was used. The remedy:

- a. Increase bar cover to 2 ½ inches (65 mm) from minimum of 2 inches (50 mm).
 - b. Maintain uniformity of bar cover.
 - c. Build in rigidity to the reinforcing bar cage by placing diagonal braces as described above.
 - d. Reduce slump and do not over vibrate the concrete.
 - e. Require a dry run to check alignment and uniform spacing between the edge of the mule and rebar cage.
2. Shadowing occurs when slip forming a radius because of nonuniform form pressures inside the mule. The problem manifests as repetitious surface bumps, not depressions as one might think. This problem is inherent with slipforming a radius and is especially noticeable as the radius becomes smaller. In order to minimize shadowing effects, the contractor needs to have finishers work out the bumps by hand.
- K. Use of Finishing Machine (*SSHC Subsections 710.03 and 711.03*)
1. The finishing machine shall be approved before use. Care must be taken to adjust the screeds to proper crown. Support rails must extend beyond the bridge at both ends at proper grade and sufficient distance to accommodate the machine. This permits finishing to begin promptly at the start of the run and also permits the required straightening to proceed on schedule at the end of the run.
- L. Straightedging
1. Following the finishing machine, straightedging should be completed to check for longitudinal smoothness. Straightedges, 10 ft (3 m) in length, need to be operated parallel to centerline of roadway. Each pass should overlap the previous one by a half length. If bull-floating (mopping) is needed to close up the surface, it should always be followed by straightedging.
- M. Tining (Transverse Grooving)
1. Tine bridge decks with a rake. No longer use a bull-float.
 2. After straightedging, and as soon as practical following finishing, the entire traffic surface, except areas within approximately 2 ft (600 mm) from the curbs, shall be given a suitable tining with corrugated tining rake.
 3. Tine all bridge decks where posted speed limit will be 40 mph or greater, except for county road bridges 100 feet (30 m) or less in length that have gravel approaches and no plans exist for future hard surfacing.
 4. On bridge decks, stop the tining 2 ft (600 mm) from the face of the bridge curb.
 5. **Do not overlap the grooving.**

N. Curing

1. The Bridge Deck Curing Special Provision defines how to cure the deck.
2. The surface must be covered with wet burlap as soon as possible. (Slight surface marring and removal of tining is acceptable.) Burlap must be wet before placing. In hot dry weather, it is better to be a little early than late with burlap cover.
3. Since shrinkage cracks are due to rapid loss of mix water before the concrete has attained adequate strength, it is imperative that curing protection be initiated before much evaporation can occur.

O. Ways to Avoid Deck Cracks

1. Verify falsework is stable.
 - (a) Temporary piles need to have significant bearing – practical refusal is best.
 - (b) Wood crush needs to be minimized. Avoid gaps between layers of timbers – be careful to shim the entire length of support timbers.
2. Avoid unnecessary vibrations.
 - (a) Use shooflys where possible to keep traffic away from the bridge.
 - (b) Do not rest falsework on active bridge during phased construction unless there is no other alternative.
 - (c) However, when it comes to intentional consolidation – the contractor should be very careful to establish a fix pattern for vibration and make sure it is achieved along the entire length of the deck and approaches.
3. Check the temperature of the concrete as it arrives on site. It should not be greater than 86°F.
4. Check the slump and if the slump is less than 3.5 inches, confirm that the mix is not too dry – especially if retarders or water reducers are used. Low slump measurements are a good indicator that mix is too dry especially on hot days. Also, with a low slump, it will be hard to get the mix around and in between rebars and tining with the tining rake is much more difficult.
5. Verify camber on girders is correct.
6. Avoid skewed construction of approach sections. If there must be a skew, limit it to 20 degrees. If skew is above 20 degrees, then reinforce the area near the obtuse angles because the stress is significantly increased in this region.
7. Cover the concrete with saturated wet burlap 1 ½ hours after the concrete leaves the truck or pump chute.

8. If the outside air temperature is predicted to be above 80°F (26°C) then start casting the deck at 5:00 pm and finish before dawn.
9. Check the outside air temperature during casting. It should be less than 86°F.
10. If the evaporation rate during casting exceeds .15 lbs/sf/hr, then fogging as prescribed in the Nebraska Fogging Special Provision will replace the evaporating water, keep the deck cool, and slow the setting time.

P. Seal Bridge Deck Cracks

1. Bridge deck cracks should be sealed before de-icing salt is ever applied on or near the deck.
2. High molecular weight methacrylate is the best sealant and is squeegeed into cracks.

Q. Cold Weather Placement

1. On account of the high incidence of shrinkage cracks due to artificial heat during the protection period, no bridge floors will be constructed during cold weather except with the special written permission of the Construction Division.

R. Floor Drains

1. Check floor drain locations against floor grades to be sure deck surface will drain. Adjustments of drain height may be advantageous on every flat grade surface. Also, at this time, study the discharge area from the floor drain for potential damage to features under the structure such as shoulders, railroads, or berm slopes. Major problems foreseen should be brought to the attention of the Construction Division.

S. Flowable Fill (*SSHC Section 1003*)

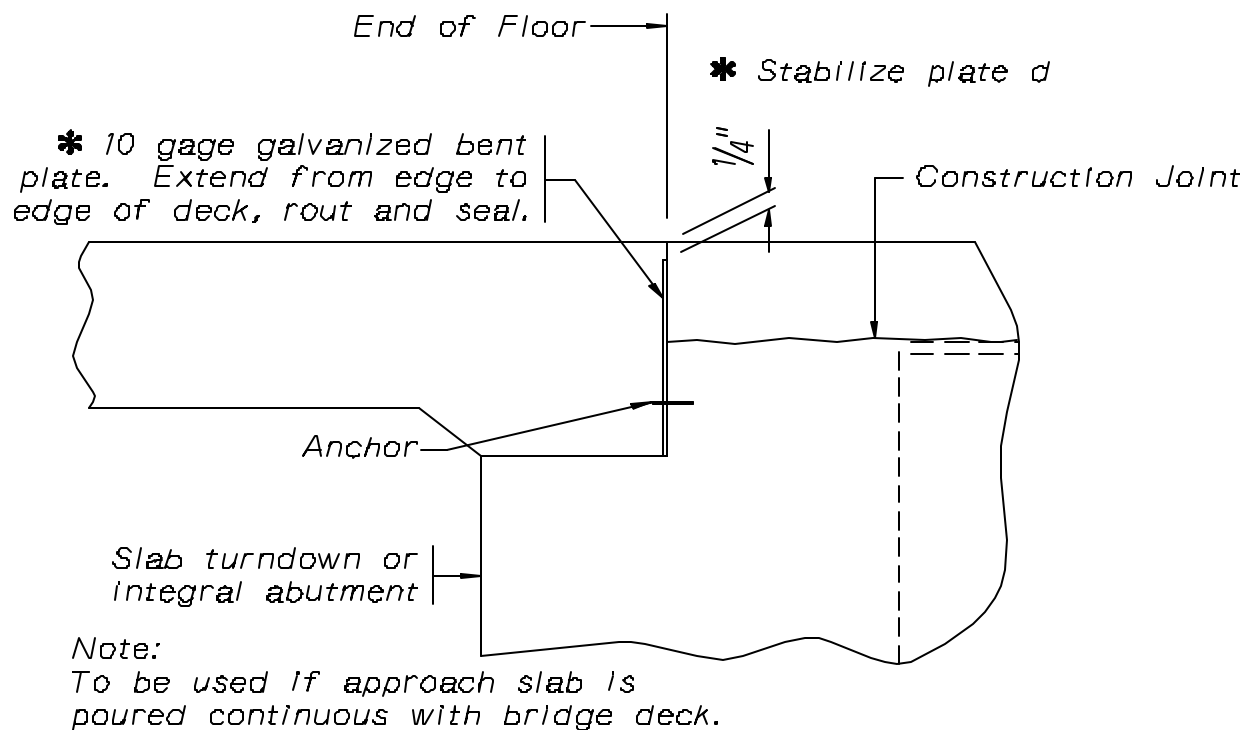
1. The inspector shall make daily entries in the field book on all concrete placed for each project. Record concrete placement location, all results of sieve analysis tests, all data on test beams made and tested and all quantities placed.
2. Flowable fill can be used for the following purposes:
 - a. Backfilling culverts.
 - b. Backfilling culverts constructed under bridges.
 - c. Filling void between culvert and culvert liner.
 - d. Plugging culverts.
 - e. Slope stabilization.
3. Free water in the sand pile must be considered as mix water because a mix design uses oven dried sand.

4. The plans may call for a sewer pipe to receive a gasket, otherwise, see *SSHC Section 722*.
 5. If the contractor uses crushed limestone for granular backfill, it shall meet the requirements for Granular Backfill. (Refer to *SSHC Section 1033*.)
 6. Remember flowable fill is a liquid until the water has dissipated. Bulkheads should be strong enough to withstand the hydraulic pressures.
 7. Under normal conditions, flowable mortar should be set-up sufficiently within 24 to 48 hours for placement of the final lift of either earthfill or special backfill. If "set-up" does not occur or if it seems slow, typically the problem relates directly to drainage of the granular backfill. Often contamination or "dirty" granular backfill is the culprit. Check to be sure it is draining. If not, additional time will help.
 8. Placement of 2 ft (0.6 m) of flowable mortar.
- T. Installation of Joints (*SSHC Subsection 704.03*)
1. Reinforcement
 - a. Reinforcement must be accurately placed and rigidly fastened. If cages are not rigid and braced diagonally in both transverse and longitudinal directions, problems can occur. The remedy:
 - (1) Recommended Procedure:
 - (a) Epoxy coated smooth bar, about ¼ inch (6 mm) in diameter can be placed diagonally from the top of a leading cage to the bottom of the second trailing cage. (Description is referenced to direction of paver's travel.)
 - (2) Alternate Procedure:
 - (a) Welding of diagonal braces to provide longitudinal rigidity is possible, but material would need to be epoxy coated and repair of weld location is necessary.
 2. Preformed Neoprene Joints
 - a. Preformed neoprene expansion joints are used on a large number of bridges.
 - (1) Inspection Checklist

- (a) Neoprene cellular joints, if properly installed, provide a leak-proof joint capable of functioning within expansion limits of the bridge. To insure that a joint will function properly, there are a number of precautions that should be noted regarding the installation of this type of joint. Precautions:
 - (i) A neoprene seal can be placed in two positions, one correct and one incorrect. Make sure that the seal is not installed upside down or sideways.
 - (ii) Position of the $\frac{1}{2} \times \frac{1}{4}$ inch (13 x 6 mm) keeper bars on vertical face of the expansion plate angles has to be consistent with the recommendations of the manufacturer of the neoprene seal. The depth that a seal is set varies greatly with the different manufacturers.
 - (iii) The neoprene seal has to be installed so bottom of the seal touches top of the $\frac{1}{2} \times \frac{1}{4}$ inch (13 x 6 mm) keeper bars, but should not be forced past the keeper bars.
 - (iv) Make sure expansion opening between angles of the expansion device are consistent with the expansion setting shown on design plans and that the same expansion opening is maintained from gutter to gutter.
 - (v) The neoprene seal must project beyond the outside edge of slab as shown on the plans.

b. Summary

- (1) When uncertain as to which side of the seal is top, or when the position of keeper bars is in question, the contractor must be required to submit drawings prepared by the manufacturer which indicate correct position of installation.



OPTIONAL JOINT DETAIL

U. Curing Concrete

1. The structure inspector should give careful attention to the curing, since proper curing is essential to good quality concrete.
2. When the evaporation rate exceeds 0.15 lb/sf/hr, the contractor must either fog the entire deck while placing the concrete; cover the concrete with wet burlap 1 ½ hours after the concrete leaves the truck; or take some action which will lower the evaporation rate on the entire deck below the 0.15 lb/sf/hr limit.
3. Applying wet burlap as soon as possible is essential – limited removal of tining is acceptable. The wet burlap should always be on the deck by 1½ hours after that portion is finished.

V. Concreting in Cold Weather (*SSHC Subsections 704.03 and 1002.02*)

1. As colder weather approaches each fall, the Department experiences a series of problems connected with concrete construction in cold weather. The first indication of the problem usually shows up as a low test result on a 7 day cylinder. At that stage, it is not known if the problem is an improperly fabricated cylinder.

2. A cylinder which has been exposed to colder conditions than the structure, or if the low strength actually represents the concrete in the structure. Sometimes the later cylinder tests show satisfactory results, but in other cases, low strengths are found in these tests also.
3. In some cases, definite information regarding the true condition of the concrete in the structure can only be obtained by coring the material and carrying out a series of special tests.
4. The best fogging system may be the simplest. Hand held fogging nozzles that mix compressed air and water to form a fog are some of the best fogging systems observed. (One nozzle that works very effectively is called a Hydro-Air Washer made by Power Systems Inc. of Lancaster, TX.)

W. Simultaneous Casting of Deck and Approach Slabs

1. Casting the approach slabs and the deck simultaneously creates a smoother transition and ride. However, to avoid maintenance and to preserve the integrity of the deck and the approach slabs, a metal bond breaker should be placed over the abutment across the entire width and depth of the deck. This will ensure that a random crack does not occur before the joint can be cut. At the grade beam, the joint is usually blocked out with styrofoam.
2. The rail that the finishing machine rides on must be uniformly rigid. Unfortunately, where the rail passes over the grade beam and abutment, the rail is frequently more rigid than either side of these substructures. This can cause a dip either side of the abutment and the grade beam, which can result in a "bump" over the abutment, and grade beam.
3. Another problem can result when the deck overhangs the outside girder. Typically, the deck forms are supported by outrigger jacks braced against the outside girder. The weight of the concrete and the finishing machine can momentarily bend the outside girder as the placing operation progresses. Temporary construction braces (usually wood blocks) between all girders can prevent girder movement.

X. Surface Checking (Not in Spec)

1. A 10 ft (3 m) straightedge surface check shall be conducted on all bridges and deck overlays not covered by the Smoothness Specification. Surface areas inaccessible to profilometer shall also be checked.
2. On some projects only one wheel path may be included in the placement width. For price adjustment or incentive pay, only the portion within the traveled lane shall apply. Variable width sections for on and off ramps, which are outside the through traveled lane, will be checked with the surface checker.

Y. Test Procedure for Smoothness

1. A Special Provision entitled "Bridge Deck and Approach Slab Smoothness" will usually be included in the contract proposal. This Provision deals with the method of testing for smoothness and the method for correcting surfaces outside of the smoothness limits. The contractor is responsible for scheduling the testing, which will be performed by Materials and Research Division personnel. The contractor must give the Project Manager seven days notice prior to the date he requests that testing be done. The Project Manager shall contact the Materials and Research Division and arrange for testing on the requested date. Evaluation
2. Materials and Research Division will furnish a profile index to the contractor within 72 hours of the completion of the tests.

Z. Smoothness of Bridge Decks

1. Checklist - The following items should be checked and procedures followed prior to, during, and after the overlay is placed to insure a smooth riding deck surface:
 - a. Guide rails are used to support and guide the finishing machine. Check for rail deflection during passage of finish machine. Any vertical or horizontal movement could compromise smoothness and rideability. Request that the contractor readjust anchor legs and/or tie-downs.
 - b. Check that all propulsion and control equipment are fully operational prior to placing concrete. The contractor shall traverse the finishing machine over the entire length of section to be placed. This not only serves to verify that equipment and control systems are functioning properly, but also provides a check to assure that screeds are adjusted for proper crown and height above existing surface.
 - c. Sufficient materials (water, cement aggregate, and admixtures) are available on site to complete the intended placement in a continuous operation.
 - d. The contractor may have to limit size of placement or provide additional mixers (HD-LS only).
 - (1) If a mobile mixer is not large enough to provide adequate volume for the placement, or
 - (2) If there is no provision for recharging.
 - e. Ensure that adequate number of vehicles are available at the work site to transport mix from mixer to the placement area at a volume necessary to provide a uniform rate of forward progress. Any equipment working on the deck should be checked for oil and hydraulic fluid leaks.
 - f. Contractor must provide sufficient, trained personnel to carry out the various phases of deck placement. Timeliness is of utmost importance during placement operations. Be sure specialized crafts, such as finishers, are

adequately represented and preferably have only one task during the placement.

- g. Check concrete for smoothness with the 10 ft (3 m) straightedge. The straightedge should be placed on the surface from a vertical position, not pushed over the surface. Irregularities can be detected by comparing deck surface with a straightedge. Irregularities noted at this time should be corrected.

2. Surface Correction

- a. Corrective work shall be done in the presence of the Engineer with a diamond bladed grinder at least one meter wide. Grinding residue must be controlled. After the deck is ground, a second test will be made to determine if the deck now meets the smoothness requirements. This second test will also be performed by Materials and Research personnel and it is anticipated they will be on-site at the time of grinding, in order that they may perform the retest while the grinding equipment is on-site.

3. Acceptance

- a. Materials and Research personnel will notify the Project Manager whether or not the corrective work has resulted in an acceptable deck surface. If grinding cannot correct the surface profile, the Specification requires removal and an overlay with high-density low slump concrete.
- b. Troubles and expense of this sort could virtually be eliminated by careful and detailed inspection by project personnel during construction and proper handling of test cylinders.

4. Missed Texturing

- a. There will be times, due to various reasons, when texturing will have to be omitted from a pour. One such event could be when inclement weather catches a pour and covering prevents texturing. Obviously this condition is **NOT** desirable.
- b. After full cure time has expired, grind in the required texture.

AA. Approach Sections--Bridge Approach Tapers

- 1. On deck overlay construction, normally some treatment of the approach is necessary and will be indicated on the plans. Watch the contract documents for bid items for ACC material. For projects where asphalt tapers are proposed and no quantity for ACC is given, an extra work order will be required.
 - a. Shoulder Maintenance - When temporary concrete barrier rails are used on deck repair and overlay jobs, traffic is constricted into a narrower lane. This in turn could cause a rapid deterioration of shoulders at bridge approaches and require the following corrective measures:

- (1) Ruts developing in earth and granular shoulders should be repaired as necessary with a granular surfacing material. This is extra work order and a change order will be issued for this work.
- (2) Ruts and loss of asphaltic cement concrete surfacing on Interstate shoulders should be repaired using an asphalt cement concrete pre-mix, hot mix, or some similar treatment to minimize the development of holes or ruts. A change order may be needed for this work unless there is an ACC contract item for shoulder maintenance and even then it may have to be extended.
- (3) When shoulder strengthening was not included as a bid item, but is needed for the project, the change order must consider:
 - (a) Present shoulder construction and experience with shoulder stability in the immediate area.
 - (b) Traffic volumes, percent of trucks, and duration of potential problem.

BB. Setting Beams

1. The following should be used as a guide in conjunction with *SSHC Section 704*:
 - a. On diaphragm piers, beams may be set as soon as doing so will not mar or chip the concrete. It is recommended that 24 hours be considered a minimum cure time. (In cooler weather, ambient temperatures below 40°F (5°C), the minimum time indicated should be increased to 48 hours.)
 - b. No beams may be set on piers until the cap concrete is at least 7 days old and has its design compressive strength.
 - c. On stub abutments, steel beams and girders may be set as under A above. Concrete beams on stub abutments, same as A above. On full abutments (solid and continuous from spread footing), same as A above.

706.04 METHOD OF MEASUREMENT

- A. The cubic yards of concrete for structures of varying sizes are computed from dimensions shown in the plans and placed in tables in the plans. All structures using the same type of concrete are lumped together.

707.00 BRIDGE DECKS AND OVERLAYS (*SSHC Sections 710 and 711*)

707.01 DESCRIPTION

- A. The concrete bridge floor is the wearing surface of the bridge superstructure and is commonly referred to as the bridge "deck". This work consists of forming, reinforcing, and placing concrete to the lines, grades, and typical cross sections shown in the plans.

707.02 MATERIAL REQUIREMENTS

- A. See Subsection 706.02

B. Density Testing

1. Durable, low maintenance bridge decks require impermeable (very dense) concrete. Therefore, checking density during placement is an essential part of deck surfacing and overlay inspection. Test frequencies for determining the density of bridge deck surfacing and overlays are listed in *SSHC Subsection 711.04*. A test should be taken at 5 ft (1.5 m), 10 ft (3 m), 15 ft (4.5 m), and every 50 ft (15 m) thereafter per placement width per bridge. Density tests will not be required for overlaying approach paving areas.
2. It is always desirable to take more than the minimum nuclear density tests per length of overlay placed. If densities are at or near the lower specification limits, additional testing will need to be performed.
3. Vibrating Mix at Test Well Location
 - a. On some projects, contractors have been vibrating the concrete mix in the test well with a hand-held vibrator prior to passage of the finishing machine. This practice will not be permitted.
 - b. If the oscillating screed vibrators are functioning properly, complying density of the concrete mix in the test well will be obtained without any difficulty. Obtaining required density at test well locations, without supplemental vibration, assures us that the contractors' equipment and placement procedures are capable of producing the desired results throughout the overlay being placed.
4. Density Test Wells on Bridge Deck Repair Projects
 - a. Follow guidelines in *SSHC Subsection 710.04, para. 7.b*.

707.03 CONSTRUCTION METHODS

- A. General – The wind velocity-temperature relationships stated in the specifications should be enforced to avoid loss of water from the concrete surface faster than it can be replaced by normal bleeding and to avoid the resultant formation of plastic shrinkage cracks. Anemometers and thermometers must be available on site to measure wind velocity and temperature.

1. Concrete in bridge floors shall be placed uniformly on both sides of the centerline and shall be placed continuously between specified joints. The sequence of placing shall be in accordance with the pouring diagram shown in the plans. If no pouring diagram is shown in the plans, concrete shall be placed as directed by the Project Manager.
2. The deck forms shall be dry when using HD-LS but must be wet when using silica fume concrete before placing the concrete. Concrete shall be adequately vibrated to encase the lower bars of the reinforcing mat where these are near the deck form.
3. Special attention shall be given to finishing the riding surface on the bridge floors. *SSHC* Subsections 706.03, 710.03, and 711.03 explain concrete bridge floor finish.
4. It has been the policy to permit the contractor to use mechanical finishing machines of an approved type whether or not they are required by the plans or special provisions.
5. Method of Finish - When the hand method described in Section 704 is employed, the concrete surface shall be struck off with a strike board which conforms to the cross section shown in the plans. If this is pulled by hand, care shall be taken not to displace the reinforcing steel by the workmen doing the pulling. A small air winch anchored to a girder outside of the day's pour will pull the strike off at a slow, uniform rate, giving a truer surface with no displacement of the reinforcing steel. The strike board shall be operated with a combined longitudinal and transverse motion, always carrying a small roll of concrete in front of the cutting edge. The strike off shall be pulled a sufficient number of times to properly distribute the concrete. A longitudinal float generally is required and is described in
6. *SSHC Section 704*. The longitudinal float shall be lapped 1/2 its length when moved to a new position and shall be operated across the surface a sufficient number of times to produce a uniform, smooth riding surface. Occasionally during the finishing operation, conditions may require the use of the long-handled transverse float, which require extreme care in its use to preserve the desired cross-section and a smooth riding surface.
7. Regardless of whether hand or machine finishing methods are used, the floor surface shall be tested for trueness with a 10 ft (3 m) straightedge. The bridge contractor is required to furnish a 10 ft (3 m) master straightedge for use in trueing and checking the working straightedges.
8. Phased construction of a bridge deck usually requires a form longitudinally down the bridge deck near the center of the bridge. The location of the form is shown in the plans. Sometimes it is more efficient to move the location of the longitudinal phasing joint. On bridges with concrete girders it is nice if the joint can be lined up to use the notched lip in the girder flange. However, the resulting lane widths must be checked to confirm there is adequate clearance for vehicles.

B. Bridge Deck Curing

1. When the high temperature for the day that the deck will be cast is expected to exceed 80°F the deck should be cast at night. The Contractor should contact the concrete plant and schedule the concrete deliveries to the bridge deck to begin at 5:00 pm. The Contractor must also confirm that the concrete will have a 1-hour set delay when it arrives on the deck.

C. Bridge Deck Joints

1. If a joint compound is not specified the Contractor may use hot tar to seal bridge deck joints.

E. Deck Overlay Preparation

1. Securing an adequate bond at the interface of the existing prepared deck surface and proposed overlay course is essential in obtaining a durable and maintenance free bridge deck system. General surface preparation requires milling, shotblasting, and/or sandblasting depending on the surface condition or amount of existing surface material to be removed. Any reinforcing bar which is exposed must be sandblasted to remove all rust contaminants, and unsound concrete. Also, prior to placing the grout the surface must receive an air blast to remove dust and other foreign particles from the prepared surface.
2. The surface, once cleaned, must remain clean until the grout and concrete is placed. There have been cases where the prepared deck surface has become contaminated during the decking operations by concentrated traffic of vehicles transporting the concrete. This is especially true when the skid-steer type loaders are used to transport mix. The deck surface is contaminated by the abrasive action between the concrete surface and the rubber tires, and also from oil and other foreign material tracked in from off the bridge. Contamination can be recognized by discoloration or oil on the deck surface. Contamination is especially noticeable in the wheel paths used by the vehicles.
3. Core specimens taken and tested for bond strength from areas as mentioned above showed a marked decrease in bond strength between the interfaces.
4. To prevent the cleaned deck surface from being contaminated by traffic, the contractor shall cover any prepared surface with sheets of plywood, multiple layers of plastic, or other suitable material. To ensure a clean surface prior to placement of the overlay system, areas which become contaminated shall be resandblasted followed by an air blast.

F. Class I Floor Repair (*SSHC Sections 710 and 711*)

1. Follow guidance in SSHC Subsections 710.04, para. 1 and 711.04, para. 1.

G. Work on Adjacent Lanes

1. *SSHC Section 423* prescribes traffic provisions when traffic is present.

708.00 Bridge Diaphragms

- A. Steel diaphragms, if allowed, are shown in the plans for prestressed beam structures. Shop drawings are required for steel diaphragms showing details of beam layouts, location of the diaphragms, and location of mounting holes.
1. High strength bolts for steel diaphragms shall be tightened by Turn-of-Nut method. (Refer to *SSHC Subsection 708.03* for information on proper bolt inspection and installation.) Inspection and field installation acceptance will be based on observing proper Turn-of-Nut procedures. (A tensioning device and inspection torque wrench is recommended, but will not be required.)
 2. Concrete diaphragms at piers of prestressed concrete girder bridges should be cast to 2/3 of their intended depth. The final 1/3 and the deck are then placed at the same time. However, there are instances where allowance has been given for specific diaphragms to be placed prior to slab placement. If there is a construction option shown in the plans, the diaphragm can be poured separate from the deck. Note the construction joint detail will show how to strike-off the surface. Consult with the Construction Division in situations where the contractor requests to place concrete diaphragms other than as shown in the plans.
 3. Phased bridge decks which have inverted "T" girders should not have the portion of the diaphragms cast between the two girders on each side of the longitudinal phasing construction joint until the second phase deck is cast. If the girder diaphragms for the gap between the two girders which are on each side of the phasing joint are cast before the second phase deck is cast, the diaphragms will lock the girders under the second phase deck at a position higher than the phase 1 girders. Cast the diaphragms between the two girders that are on each side of the phasing construction joint at the time the second phase deck is cast. The remaining girder diaphragms in the second phase should be cast before the deck is cast.
 - a. Casting the intermediate (midspan) diaphragms before the deck is cast removes some of the girder camber and will make the structure more stable for the deck casting.

709.00 Girder Shims

A. Definition

1. A girder shim is defined as the distance measured from top of girder to top of finished slab. There are three different types of bridges which we build that have girder shims. The first type is a steel girder bridge, either a rolled beam section or a plate girder section. The second type is a prestressed girder (NU Girder Section). The third type is a prestressed twin tee girder. When taking shim shots on a prestressed twin tee girder, they should be taken at the edges of the twin tee. Take shim shot on steel girders or NU girders along the girder centerline.
2. For each type, the definition of the girder shim is the same; girder shim is the distance measured from the top of girder to top of finished slab.
3. Stages of the Girder Shim Process The Bridge Division, upon completion of the design, will prepare the shim input forms. After the project has been let, we send these forms to the Project Manager. After the girders are erected and prior to forming the deck for the slab, shim shots are required to be taken. These shim shots should be taken at the bearings, field splices, and at 3 m intervals along the length of the girder. The shim shots can be recorded on the input forms.
4. The H.I. Elevation needs to be recorded by the inspector at the time the shim shots are taken.
5. The rod readings at each location are recorded on RDP Form 50a. This information is normally sent by computer to the Bridge Division. The Bridge Division will run a computer program which uses the grade of the roadway, crown of roadway, the dead load deflection of the girder, and your rod readings to determine the amount of shim at each location.
6. The Bridge Division will look at the shims to see if they are too large or too small. The final shim information will be sent to the Project Manager along with solutions to any problems which may have occurred.
7. The proper girder shims are critical to ensure that construction of the bridge is in accordance with the intended design.
8. Composite Girders
 - a. There are two methods of designing girders. One method is a non-composite design and the other method is a composite design. The non-composite design is basically the slab sitting on top of the girders. By providing shear connectors on the top of the top flange, we can tie the slab to the girders into what we call a composite section. On prestressed girders, the stirrups extending out of the girder into the slab provide the composite action. The composite section produces a more economical design. The Bridge Division designs the girders as a composite section.
 - b. AASHTO Specifications

- (1) In order for this composite action to actually take place, it is critical that these shear connectors extend into the slab the proper amount. For steel girders, AASHTO specifications require that the shear connectors penetrate at least 2 inches (50 mm) above the bottom of the slab.
- (2) The AASHTO specifications also state that the clear depth of concrete over the tops of the shear connectors for steel girders shall not be less than 2 inches (50 mm). So this gives the Bridge Division a range for the location for the top of the shear connectors.
- (3) Proper vs. Improper Shims
- (4) When you are inspecting a job, a visual inspection of the relationship of the shear connectors to the slab reinforcement will help you determine if something is wrong. Based on the slab thicknesses that we normally use [7.5 inches (190 mm) or 8 inches (205 mm)] thick, the length of stud that we normally use [5 inches (125 mm long)] and if the slab is reinforced, the end of the sheer connector should be located somewhere between the top and bottom transverse slab reinforcing steel.
- (5) We specify 1 inch (25 mm) of clearance between the bottom of the slab and the bottom transverse reinforcing steel. A $\frac{3}{4}$ inch (20 mm) bar is the largest bar specified. Therefore, knowing that we need 2 inches (50 mm) of penetration for the shear connectors, the top of the shear connector should always be above the transverse bar in the bottom of the slab.

3. Problems and Solutions

- a. When we have the problem of too large of a shim, there are a couple of things we can do to solve this problem. One solution is to provide some reinforcing bars at each shear connector location that properly extend into the slab. Another solution is to weld a plate onto the top of the shear connectors to gain the proper penetration length.
- b. Where we have the problem of too small of a shim (top flange extending into the slab) there is only basically one thing you can do. That is to raise the grade of the roadway.

4. Critical Item - Proper Girder Seat Elevations

- a. The most important thing that our inspectors can do to insure proper shims is to make sure that the girder seats are poured to the proper elevations. If the girder seat elevations are wrong, you can almost be sure that you will have problems with your shims. If your girder seats are correct, more than likely your shims will also be correct.

5. Critical Item - To Ensure Proper Shim

- a. Steel girders must be set on substructure by following the blocking diagram shown on the plans.

Example Computer Print

IDENT	PROB. NO.	GIRD. NO.	DIST. CL PROJ. TO CL ROADWAY	E FROM BASELINE	H.I. ELEV.			
7018	1	1	O.C.	10.0000 LT.	1719.24			
Girder No.	Station	Centerline Grade	Crown Correction	Girder Elevation	Dead Load Deflection	Rod Reading	X Distance	Shim
1	22+10.77	1715.662	-0.150	1714.920	0.0	4.32	0.0	0.592
1	22+20.77	1715.753	-0.150	1715.020	0.015	4.22	10.00	0.598
1	22+30.77	1715.840	-0.150	1715.100	0.023	4.14	20.00	0.613
1	22+40.77	1715.925	-0.150	1715.180	0.021	4.06	30.00	0.616
1	22+50.77	1716.006	-0.150	1715.260	0.011	3.98	40.00	0.607
1	22+60.77	1716.084	-0.150	1715.320	0.001	3.92	50.00	0.616
1	22+65.77	1716.122	-0.150	1715.350	0.0	3.89	55.00	0.622
1	22+70.77	1716.189	-0.150	1715.370	0.004	3.87	60.00	0.644
1	22+80.77	1716.281	-0.150	1715.470	0.019	3.77	70.00	0.630
1	22+90.77	1716.300	-0.150	1715.490	0.033	3.75	80.00	0.693
1	23+ 0.77	1716.365	-0.150	1715.550	0.040	8.69	90.00	0.705
1	23+10.77	1716.427	-0.150	1715.610	0.033	3.63	100.00	0.701
1	23+20.77	1716.486	-0.150	1715.700	0.019	3.54	110.00	0.655
1	23+30.77	1716.342	-0.150	1715.730	0.004	3.51	120.00	0.666
1	23+35.77	1716.588	-0.150	1715.770	0.0	3.47	125.00	0.648
1	23+40.77	1716.594	-0.150	1715.810	0.001	3.43	130.00	0.636
1	23+50.77	1716.644	-0.150	1715.860	0.011	3.38	140.00	0.645
1	23+60.77	1716.690	-0.150	1715.900	0.021	3.34	150.00	0.661
1	23+70.77	1716.733	-0.150	1715.950	0.023	3.29	160.00	0.656
1	23+80.77	1716.773	-0.150	1715.980	0.015	3.26	170.00	0.658
1	23+90.77	1716.809	-0.150	1716.010	0.0	3.23	180.00	0.649

710.00 Pot Bearings

- A. The Materials and Research Division inspects pot bearings at the site. In order to facilitate the work, we request that the Materials and Research Division be notified immediately when the pot bearings arrive at the site. This will permit Materials and Research personnel to inspect the bearings in a timely manner.

- B. The person to notify is Mr. Mark Burham at Materials and Research. His phone number is (402) 479-4746.

711.00 Barrier Rails

711.01 Description

A. Fixed Form Jersey & Retrofit Rail

1. Before cast-in-place barrier rail is constructed on the existing bridge curb section, *SSHC Subsection 704.03*. requires that old concrete which is to be in contact with the new concrete be cleaned of all laitance (loose particles of concrete, dirt, or other foreign materials).
2. Structurally, the existing curb surface need not be roughened, but must be clean. To assure a clean surface and to obtain maximum bond at the interface, sandblasting the old curb surface shall be required. Other methods of cleaning may be approved by the Project Manager.
3. Surface preparation, such as sandblasting, should be completed prior to setting the epoxy coated dowels.
4. When retrofit is part of a deck overlay, the contractor may request permission to place the finish machine on the retrofit rail. Construction's policy will be:
 - (a) A minimum cure time of at least 48 hours prior to placing the mass of a finish machine on the rail, AND
 - (b) Finish machine rail support feet must be spaced less than 1'-9" (550 mm) apart.
 - (1) If these conditions are unacceptable to the contractor, a minimum cure time of 72 hours will be required. After 72 hours there are no special conditions for placing a finishing machine on the barrier rail.

B. Cast-In-Place (Retrofit) Barrier Rail

1. This work is routinely combined with a deck repair project and includes an overlay. Often contractors will place the new rail prior to placing overlay. In these situations, the contractor intends to place the finish machine's rail on top of the new barrier rail. Question: How long must the new rail cure before allowing the deck finishing machine to be placed on it?
 - a. 48 hours must expire prior to placing the weight of a finishing machine on the rail.
 - b. Rail supports (legs) must be placed at a spacing of no greater than 18 inches (500 mm).
 - c. Rail supports and rail cannot be placed until the surface has sufficiently cured to prevent scuffing and/or marring.
 - d. Care must be taken to prevent damage to the face or back of the barrier rail.

C. Slip Form Barrier Rail

1. Slip form rails have at times displayed transverse cracks, longitudinal cracks, reinforcing steel shadows, and nonuniformity of top elevations. Consideration of the following construction problems and solutions will help to eliminate problems:
2. Longitudinal Cracks
 - (a) Longitudinal cracks and vertical cracks near posts can be prevented with proper construction techniques. (Consolidate uniformly, obtain proper rebar clearance and wet cure.)

711.02 Material Requirements (See Section 706)

711.03 Construction Methods

A. Concrete Surface Finish (Rail and Beams)

1. Ordinary surface finish is required for rails. Beams need only have "popcorns" filed.

B. Surface Finish

1. The type of surface finish required for concrete structures is governed by the special provisions, the plans and *SSHC Subsection 704.03*. A pre-construction study of these sources will bring to light any possible differences of opinion concerning requirements and allow time for their solution.
2. For either ordinary surface finish, rubbed finish, grout cleaned finish, or floated surface finishes, the contractor should be required to perform the work as promptly as practical after the removal of the forms. If this work is started promptly, and the surface finishing work performed before the concrete becomes excessively hardened, a much better surface finish will be obtained. Also, this better finish will be obtained with less work and consequently at lower cost.
3. If the required finish is a rubbed finish, then *SSHC Subsection 704.03* does not authorize plastering an excess of mortar on the surface of the concrete. The mortar is to be applied, as stated in the Specifications.
4. Note that proper rubbing is a sequence of three steps:
 - a. The surface is thoroughly saturated and then rubbed with the medium coarse stone faced with mortar. The paste (rubbed up from the surface of the concrete, and not applied as a plaster) is left on.
 - b. The surface is wetted and rubbed with a fine carborundum stone. The paste is left to dry on the surface.

- c. The dried paste is rubbed off completely with burlap. Some laborers will not distinguish between coarse and fine stones, or the contractor may originally furnish only one grade. Check with the Project Manager as to the proper degree of fineness of the stones being used, on the basis of the finished results. Request the Project Manager's inspection of the first finishing work done in order that he/she can set standards for methods and results in subsequent work. Ordinary surface finish, rubbed finish, grout cleaned finish, and floated surface finishes include leaving all chamfer lines and all plane surfaces intersection lines cut clean and straight.
- 5. Special provisions currently allow the use of a special surface coating as an alternate to a rubbed surface finish.
- 6. Special attention and inspection should be given to the close tolerance required in finishing of the concrete at the bearing plate areas on abutment and pier caps. Promptly after the concrete has hardened sufficiently, remove the anchor-bolt templates and finish the bearing area to a true surface. A small carpenter's level is very helpful to level the area. Prompt and efficient performance of this work will save much grinding of the hardened concrete at the time the bearing plates are set, and will yield better, more uniform bearing areas.

NOTE: To enhance the ability to hand finish slipped rail, CONFILM is recommended. CONFILM is a Master Builders product and should be used per manufacturer's recommendations.

712.00 HAND RAILS (SSHC Section 716)

712.01 DESCRIPTION

- A. This work shall consist of furnishing and erecting all steel or ornamental handrail and all miscellaneous hardware such as anchor bolts, capacity plates, and splices.

712.02 MATERIAL REQUIREMENTS

- A. Handrails shall conform to the horizontal and vertical curves specified in the plans. Posts shall be set normal to the top of the curb, except when otherwise noted in the plans or special provisions.

712.03 CONSTRUCTION METHODS

A. Ornamental Handrail

1. Care must be taken in storing, handling, and erecting ornamental handrail so as not to permanently mar or injure the finish on the post and rail elements. Aluminum ornamental handrail which is to be stored in the open should be removed from the cardboard cartons since cartons may stain the handrail when they become wet and considerable effort is required to remove these stains.
2. Ornamental handrail inspection is not generally waived at the fabrication plant even if small quantities are involved. If the Project Manager does not have a copy of a shop inspection report on file indicating inspected material, the material should be inspected by Materials and Research Division. If there is a question of whether the material has been inspected or not, the Materials and Research Division should be contacted for clarification.
3. The Project Manager should make a visual check of the handrail before placing it in the structure. In the case of aluminum tubing, "carbon streaks" that develop in the manufacturing process are not cause for rejection. However, the carbon streaks should be limited to one 90-degree segment of the surface of any rail. Particular attention is necessary at the time of erection. Tubing should be placed in the bridge railing in such a manner that the carbon streaks are not visible to traffic.

713.00 PAINTING (SSHC Section 709)

713.01 DESCRIPTION - The painting of metal structures has a dual purpose. The primary function of paint application is to preserve the life of the metal. A second function, especially important in highway grade separations, is to produce and maintain an improved appearance. Painting includes the preparation of the surface and the application of the paint coatings.

A. Painting (SSHC Section 709)

1. New Non-Weathering Structural Steel

- a. Shop applied paint system shall be used for non-weathering steel bridges.
- b. A field applied "top coat" is usually required. A top coat will also be required when it is deemed necessary due to aesthetics.
- c. The contractor will be required to touch-up any damaged areas after erection. Touch-up with top coat paint system shall be the same paint as the shop coat.

2. New Weathering (ASTM A 588) Structural Steel

- a. The plans require shop applied prime paint to selected areas on the structure. They also require:
- b. The approved paint system.
- c. Only paint where shown in the plans with approved paint system.
- d. The contractor to touch-up any damage to primed areas after erection prior to top coating. This includes bolts in those areas. Touch-up paint shall be the same paint as the shop coat.

3. Field Painting

- a. Field painting of structural steel shall be done as shown in the plans and special provisions.

713.02 MATERIAL REQUIREMENTS - Paint sampling should be done according to the "*Materials Sampling Guide*" unless the paint to be used is from tested stock in which case it will be tagged to show acceptance.

A. Mixing Paint

- 1. Follow the manufacturers recommended mixing and thinning procedures.

713.03 CONSTRUCTION METHODS

A. Painting Structural Steel

1. Paint which has been applied on rust, or dirty surfaces will peel and crack. If rust blisters form under the paint film, they can, in time, seriously reduce the effective cross section of structural shapes. The specifications require that all erection work be completed before the cleaning process is started. The cleaning should be done in a systematic manner, with the painters cleaning a given area or member before painting it.
2. Paint shall be applied as prescribed by contract specifications or the manufacturer's recommendations, whichever is most demanding. The Project Manager shall determine the correct procedure if the contract specifications differ from the manufacturer's recommendations.
3. The Project Manager or inspector should insist that the painting be done systematically, with painters working in groups on a given coat. The practice of having cleaners and painters spread out all over a bridge, with the inspector not knowing what men are working on each operation, nor which members have been cleaned and painted, should not be permitted. Painting should, in general, be started with the highest bridge members and progress downward, in order to cover areas where paint has dripped from the work above. Painting operations below deck level, should be permitted only after the deck slab concrete has been placed. Girders painted prior to the concrete placement are likely to be spattered by form leakage and may be badly scarred by form removal, necessitating considerable recleaning and repainting of all coats.
4. The plans and specifications require different paint film thickness depending on the type of paint specified. The Project Manager should check the plans and specifications to determine the types of paint required to verify that the correct system has been certified and should check for the required dry film thickness.
 - a. County bridges usually only get one coat.
 - b. New state structures usually get two coats.
 - c. Repainting an existing structure usually means adding a third coat.
5. The Project Manager or inspector should check the dry film thickness of the shop and field coats of paint applied on structural steel in accordance with the following instructions:
6. Shop Coat - The shop coat of paint may or may not have been checked in the fabricator's shop; nevertheless the shop coat should always be checked in the field, and any deficiency in paint film thickness corrected, before the second coat is started. When the dry film thickness of the shop coat is found to be inadequate, the Materials and Research Engineer should be notified in order that the particular fabricator involved may be made aware of the situation.
7. Second and Third Coats - Checking the thickness of the second and third coat with the magnetic gauge is accomplished by measuring the cumulative thickness of the first (or shop coat) and the additional coats. The dry film thickness of the second coat should always be checked and any deficiency in paint film thickness corrected before the third coat is started. Any deficiency in paint film thickness must be corrected before the work can be considered complete and consideration of acceptance given.

8. The equipment used to check the dry film paint thickness is called a magnetic dry film thickness gauge. One or two of these gauges are being furnished to each District Office for use in the District in checking the painting of steel structures. These gauges are expensive, delicate instruments and must be carefully handled and always kept in the carrying case when not in use. The procedure for using the gauge is as follows:
 - a. Turn dial to maximum reading.
 - b. Place pole on the surface to be measured.
 - c. Be sure the magnetic contact is touching the painted surface.
 - d. Slowly and as continuously as possible, rotate the dial clockwise until magnetic contact breaks. A click will be heard when the pin breaks contact. At this point the coating thickness can be read on the dial indicator. The reading will remain on the dial when the gauge is removed from the surface being checked. The gauge can also be held in any position to take a reading. The magnetic gauge reads directly in mils. A reading of 2 on the dial indicates that the thickness of the paint film is 2 mils or .002 inch.
9. The frequency of testing for paint thickness should be as follows:
 - a. Girders - Each line of girders should be checked at a maximum interval of 50 ft (15 m) and at each check point, 3 or 4 tests should be made. For example, on a 200 ft (60 m) bridge each line of girders should be checked at the abutments and at 3 intermediate points. At each one of these points three or four places should be checked such as a point on the web, a point on each flange, and a point on a stiffener.
 - b. Separators, Cross-frames and Floor Beams - Alternate lines of separators, cross-frames and floor beams should be checked two times at one location. For example, the top and bottom angle should both be checked for every other line of cross-frames.
 - c. Lateral Bracing - Lateral bracing should be checked at about 50 foot intervals.
 - d. Miscellaneous Material - Material such as expansion devices, tie rods, bearing plates and drainage systems should be spot checked for required paint film thickness.
10. Additional tests should be made, as required, to determine the extent and location of any areas deficient in paint film thickness.
11. The bridge notebook or diary should verify that the paint film thickness on each structure meets the thickness requirement specified, and the entry should include the signature of the inspector and date of inspection.

714.00 **CULVERTS** (*SSHC Sections 717 to 726*)

714.01 **GENERAL**

- A. The backfill near a pipe or box culvert is more expensive than excavation in the surrounding area. Therefore, in the *SSHC Subsection 702.03*, limits are placed on the quantities “Excavation for Box Culvert” and “Excavation for Pipe, Pipe-Arch Culverts, and Headwalls.”

715.00 CONCRETE BOX CULVERTS (SSHC Section 717)

715.01 DESCRIPTION

- A. A culvert may be defined as a structure to convey water under a roadway. Concrete box or arch culverts are used when drainage areas are too large for the conventional culvert pipe or when cattle passes under the roadway are desired. These structures are cast-in-place according to standard or special plans under *SSHC Sections 702, 704, 705 and 717*.
- B. The contractor may request that culverts be built to the nearest whole English units. Any material savings will be deducted from the payments due the contractor.

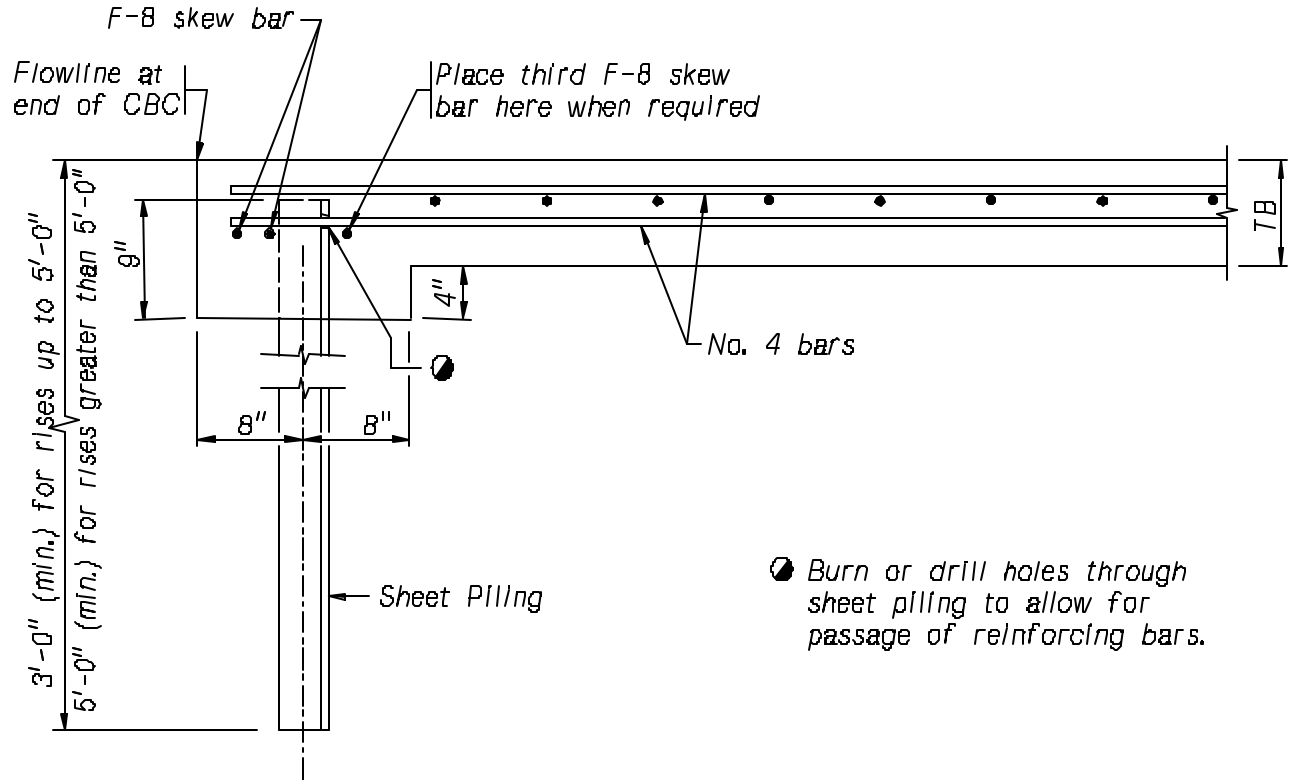
715.02 MATERIAL REQUIREMENTS

- A. See Section 706.02. Note in SiteManager the date the reinforcing steel is verified on-site.

715.03 CONSTRUCTION METHODS

- A. General - The concrete placement for box and arch culverts is discussed in Section 706 of this manual. *SSHC Subsection 717.04* further provides that foundation excavations shall be "as dry as practicable before concrete is poured". This requirement recognizes the necessity of an adequate foundation for roadway structures. When the excavation for a footing is completed, the project manager or his/her representative should be contacted for his/her approval of the footing subgrade before any concrete is placed. In the event that unsuitable foundation subgrades are encountered, suitable ones composed of sand, gravel, concrete aggregates or a concrete seal course must be constructed (see *SSHC Subsections 702* of this manual).
 - 1. Construction of curtain walls on culvert footings usually is quite a problem because of the difficulty in maintaining the excavation in proper condition while placing concrete.
 - 2. If material to be excavated is of such nature that neat lines for the curtain wall cannot be maintained, the Project Manager may allow forming and placing the curtain wall to the bottom of the footing. Mud must be prevented from working up into the concrete.
 - 3. Currently, the plans for box culverts show the backside of the wing battered 3/8" in 12", which results in a varying wall thickness. Contractors may be permitted to construct walls using the wall's base thickness, thus eliminating the batter. A plan revision or change order will not be required to effect this change.
- B. Placing Concrete and Form Removal
- C. Placing Concrete
 - 1. Placing Concrete in Walls and Top Slab. *SSHC Subsection 704.03* states that culvert, sidewalls, and top of slab may be constructed as:
 - a. A monolith unit or,
 - b. Concrete in sidewalls may be placed and allowed to harden before the top slab is placed.

2. If the contractor chooses to use the hardened concrete method, keyways will have to be installed to anchor the cover slab.
- D. Sheet Pile Turndown. Option to Use Steel Sheet Piling in Lieu of the Planned Turndowns at Box Culvert Ends.

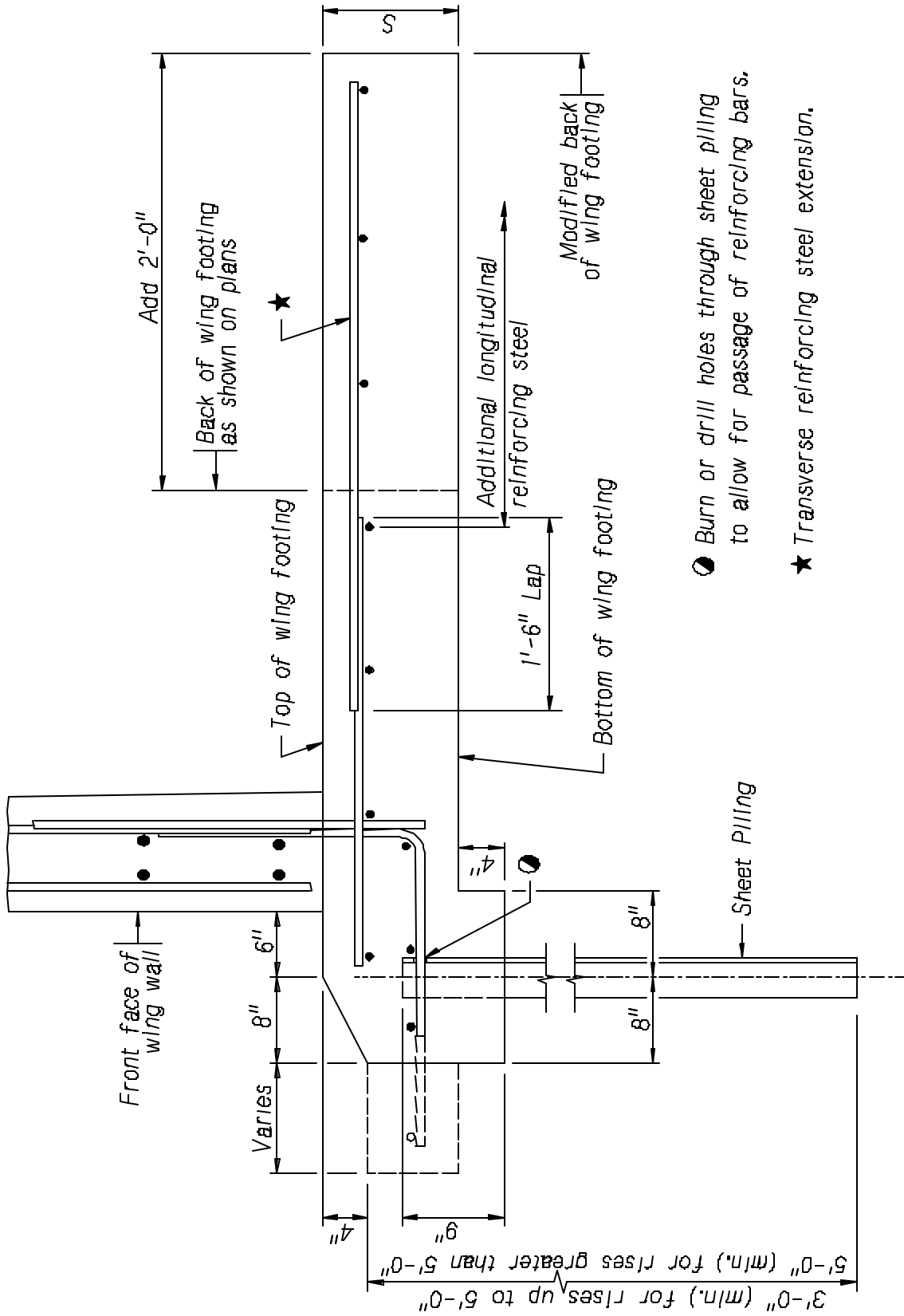


OPTIONAL SHEET PILING TURNDOWN AT END OF BARREL FLOOR
(Longitudinal section taken at midspan)

NOTES

The wing footing width, including the horizontal taper (dimension P to dimension Q), must be increased at the same footing thickness by an additional 2'-0". Additionally, the distance from the top of the wingwall footing to the bottom of the sheet piling turndown shall be 3'-0" for rises up to 5'-0", and, 5'-0" for rises greater than 5'-0". This option shall include the extension of the transverse reinforcing steel, placement of additional longitudinal reinforcing (same spacing as the No. 4 bars in the top of the footing), and the placement of additional concrete. The wing footing extension shall be poured monolithically with the rest of the wing footing. All sheet piling, additional concrete, reinforcing steel, preparation, equipment, tools, labor and incidentals necessary to complete the work shall be supplied at no additional cost to the Department.

All sheet piling shall be interlocking. Steel sheet piling shall have a 7 gage thickness (minimum). Plastic sheet piling may be used with permission from the Bridge Division.



- Burn or drill holes through sheet piling to allow for passage of reinforcing bars.
- ★ Transverse reinforcing steel extension.

OPTIONAL SHEET PILING TURNDOWN AT WING FOOTING
(For concrete box culvert wings)

E. Removal of Wall Forms

1. On large culvert jobs, it is a distinct advantage for the contractor to remove wall forms before the top slab has attained sufficient age to remove supporting forms. This will be permitted under the following conditions:
 - a. Vertical forms may be removed as provided in *SSHC Subsection 704.03*.
 - b. Slab forms must be supported independently of the wall forms.
 - c. Vertical supports for the slab forms must be capped with timbers. Longitudinal spacing of supports with 4x6 inch (100 x 150 mm) caps on edge should not exceed 4.5 ft (1.4 m). With 4x8 inch (100 x 200 mm) caps, spacing should not exceed 6 ft (1.8 m). Rows of supports must not be over 4 ft (1.2 m) apart. There must be at least two rows of support, with the outside rows not more than 2 ft (0.6 m) from walls. Variance from the above suggested spacing should be reviewed by the Project Manager.
 - d. Vertical posts shall not be smaller than 4x4 inches (100 x 100 mm), but may be built up of two 2x4 inches (50 x 100 mm) pieces of lumber. Lateral bracing will be required. A vertical clearance of ¼ inch (6 mm) must be provided between the wall form studs and the slab form joists.

NOTE: Lumber may be sized in metrics using actual, not the conventional nominal sizes.

- e. The slab form must remain in place as provided in *SSHC Subsection 704.03*.
- f. The interior walls of the culvert must be coated with white pigmented curing compound as provided in *SSHC Subsection 704.03*.

F. Flume Reinforcement

1. Regarding Type I, II, IV, and V Flumes, welded wire fabric reinforcing is now required on the Special Plan C (4341, 4342, 4344, 4345 – both E & M) for the flume and spillway areas. This wire can be awkward to place and keep in position. Contractors may place **intersecting No. 3 rebar at 12” centers** as an alternative to the welded wire fabric.

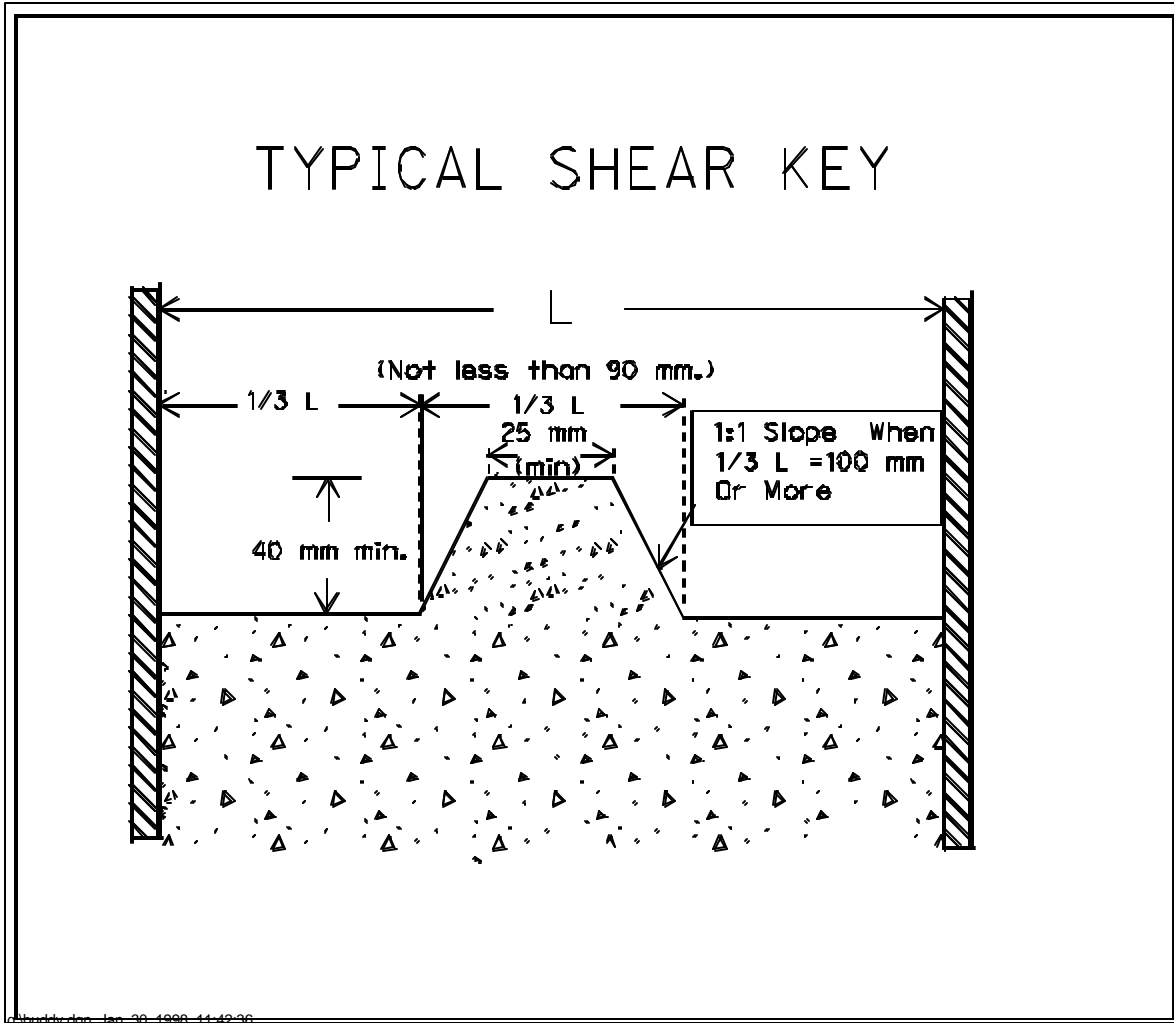
G. Backfilling Culverts – Typical Grading

1. The plans define the area used to calculate plan quantities for flowable mortar and granular backfill. (Flowable mortar plan quantities should include 30% additional for anticipated consolidation of the granular backfill and shrink due to loss of water.) If the Contractor opts to excavate a larger area than assumed for plan quantity, additional excavation, backfill, and flowable mortar will not be considered for pay. We will however, require additional excavation to be backfilled in a manner as identified by the plans or typicals.
2. Placement of flowable mortar shall always be computed from "top down." This means allow for:

- a. Pavement thickness.
- b. 1 foot (0.3 m) of special backfill, if required.
- c. Variable thickness of earth fill where cover heights are over 8 ft (2.5 m).

H. Joints (*SSHC Subsection 704.03*)

1. The location and dimensions for construction joints will generally be shown on the plans.
2. In cases where the pour is larger than can be accomplished at one time, or for some other reason it is necessary to make a construction joint not shown on the plans, approval should come from the Construction Engineer.
3. When an emergency arises, construction joints shall be placed as directed by the Project Manager. If there is some doubt as to the proper location of the joint, the District Construction Engineer should be contacted.
4. Construction joints shall be paid for as outlined in SSHC 704.04.
5. Where it is necessary to transfer shear, shear keys or inclined reinforcement shall be used. It should be pointed out that in practically all cases, shear transfer is essential and therefore shear keys or inclined reinforcement will usually be required. When inclined reinforcement is used as a means of shear transfer No. 5 bars at 1 foot (300 mm) centers should be considered a minimum. The angle of inclination should be approximately 15 degrees from the direction of shear and the length of bar should be at least 2'-3" (685 mm) in order that 20 bar diameters can be placed in both sections of the pour.
6. Shear keys should be formed with beveled strips or boards at right angles to the direction of shear. Typical dimensions for a shear key are shown in the following sketch.
7. If the volume of concrete culvert pour is greater than can be placed in a normal day's operation, or in case of emergency, construction joints located in accordance with the details shown in the drawing "Construction Joints for Box Culverts" may be constructed. Construction joints between roadway shoulder lines are not shown in this drawing since they are not to be so constructed unless authorized by the Construction Engineer.
8. Construction joints in box culverts should be located as follows: Vertical floor joints, wall joints and top slab joints should be constructed in accordance with the sketches in this article and should be staggered by approximately 3 ft (1.0 m). When the walls and top slab are placed simultaneously, the top slab should be stopped and jointed approximately 3 ft (1.0 m) before ending the wall. (Refer to sketch "Construction Joint for Box Culverts".)



[The side slopes of the key will be less than one to one until the widest dimension of the key reaches 4 inches (100 mm).]

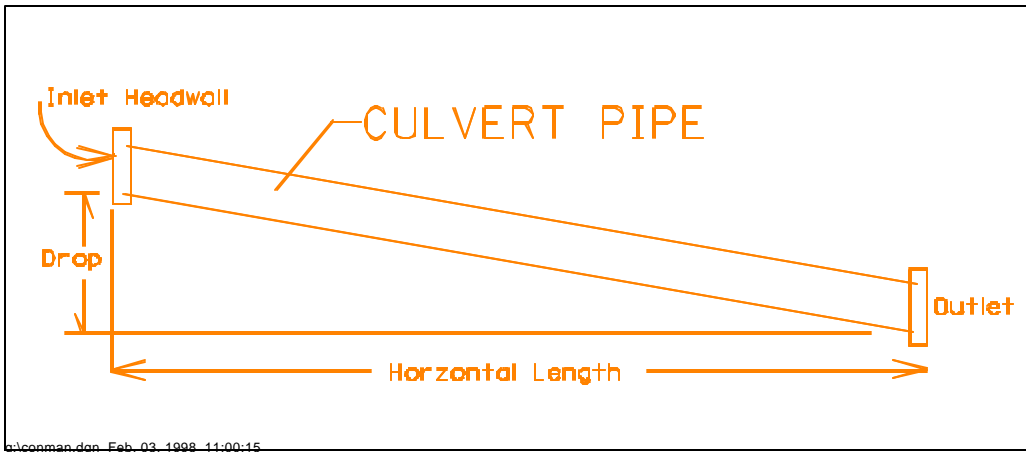
716.00 CULVERT PIPE (SSHC Section 718)

716.01 DESCRIPTION

- A. This work shall consist of furnishing and installing culvert pipe. The contractor has the option to furnish any of the types of culvert pipe listed in the specifications.

716.02 CONSTRUCTION METHODS

- A. Culvert List. The contractor is not permitted to order or deliver culvert pipe until a "culvert list" listing the correct sizes and lengths of pipe is furnished to him/her by the Project Manager.



B. Pipe Bedding

1. Pipe bedding is explained in the special plan for "Pipe Policy".
2. The following soil classifications are necessary to use the pipe special plans to determine correct bedding materials.

ASTM D 2487 Description and Identification of Soils			
		SIEVE RANGE	
GRAVEL	COURSE	Passes 3-inch	Retained on ¾-inch
	FINE	passes ¾-inch	Retained on No. 4
SAND	COURSE	Passes No. 4	Retained on No. 10
	MEDIUM	Passes No. 10	Retained on No. 40
	FINE	Passes No. 40	Retained on No. 200

C. Temporary Culvert Pipe

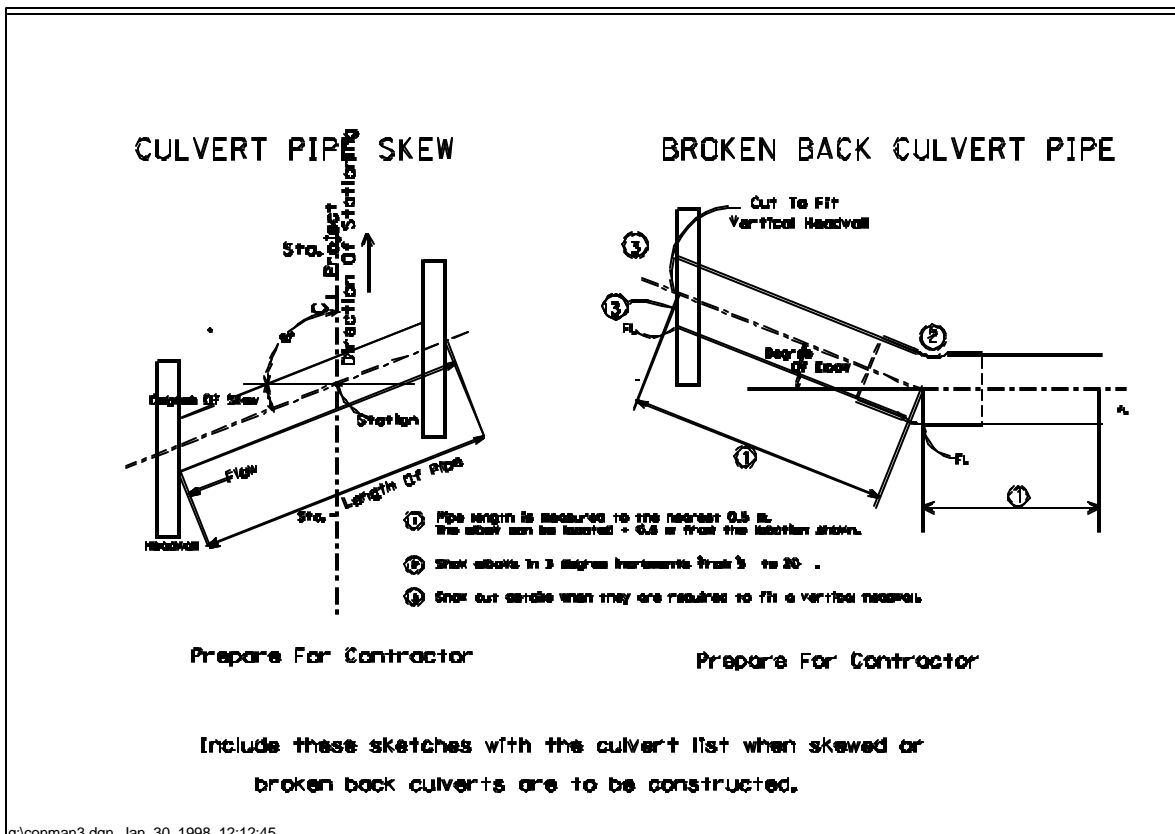
1. The Districts will be responsible for making a determination (presumably during the plan-in-hand inspection) regarding whether or not to ask for new pipe.
 2. Logistics Division maintains a list of pipe values which can be used to determine damages to the Department when pipe is not returned to us in usable condition.
- D. Salvaged Culvert Pipe. The following listed examples and rules are given to help clarify removal and salvage of culvert pipe.
1. Rules
 - a. The decision to salvage or not to salvage the culvert pipe at each location must be made by the Inspector or Project Manager prior to beginning removal work on the culvert pipe, and the contractor must be advised of your decision prior to his/her commencing work on the removal.
 - b. Culvert pipe ordered salvaged and carefully removed by the contractor will be paid for as per the specifications even though after removal it is apparent that the removed pipe has no salvage value.
 - c. The contractor must carefully remove the culvert pipe to prevent damage to the culvert pipe.
 2. Examples
 - a. The contractor is ordered to salvage the culvert pipe. The contractor carefully removes the culvert pipe. The culvert pipe has almost rusted through from the outside and really has no salvage value. The length of pipe removed will be included for payment.
 - b. The contractor is ordered to salvage the culvert pipe. After the pipe has been uncovered, it is apparent that it has very little salvage value. If the contractor is agreeable, the Inspector or Project Manager can rescind their salvage order and the contractor can complete the removal any way possible. The length of pipe removed under these conditions will not be included for payment.
 - c. The contractor is ordered to salvage the culvert pipe. The contractor is careless in removing the culvert pipe and damages it. The length of pipe removed less the damage length may be included for payment, or the Inspector or Project Manager may determine that there is no salvage value left in the culvert pipe and no payment will be made for salvaging the culvert pipe at this location.
 - d. The contractor is ordered to not salvage the culvert pipe. The contractor removes the culvert pipe and disposes of part of it. The contractor advises that the remaining removed pipe may be picked up by the Department. The Department may refuse to pick it up, inasmuch as all such material is the property of the contractor and it is his/her responsibility to properly dispose of such material. If the Department picks it up the lengths may be included for payment as salvaging culvert pipe or they may be picked up without payment

being made. The Inspector or Project Manager shall determine what is fair and just.

3. Decisions and Documentation

a. There will undoubtedly be conditions arising which are not entirely covered by these rules or examples but the Inspector or Project Manager should be able to make the proper decision within the spirit of these guidelines.

4. The project records must include pertinent notes explaining and detailing decisions made on salvaging culvert pipe.



**ADDITIONAL EXCAVATION FOR EMBANKMENT OR BACKFILL
(Left in English Units for Your Convenience)**

The following charts may be used for computing Additional Excavation for Embankment or Backfill for circular culvert pipe, arch culvert pipe or elliptical culvert pipe (pages 450C, D, E, F). “Y” is the distance from natural ground to the center of the pipe or in the case of arch pipe to the widest part of the pipe. The numbers in the columns under the different size pipe diameters are the end area in square feet of the backfill required by the specification.

Example: A 24" circular culvert pipe is laid at Station 17+30 with Flowline Lt. 2416.60 at 47' and Flowline Rt. 2415.00 at 51': The field design cross-section is 16.6 at 50' Lt., 16.3 at 35' Lt., 16.2 at

Culvert Pipe

18' Lt., 16.2 at CL, 16.0 at 5' Rt., 16.0 at 10' Rt., 15.3 at 15' Rt., 15.0 at 27' Rt., 15.7 at 42' Rt. and 15.5 at 55' Rt.

16.6 at 50'		
16.5 at 47'	FL = 16.6 at 47'	Y = 1.1
16.3 at 35'	FL = 16.4 at 35'	Y = 1.1
16.2 at 18'	FL = 16.1 at 18'	Y = 0.9
16.2 at CL	FL = 15.8 at CL	Y = 0.6
16.0 at 5'	FL = 15.8 at 5'	Y = 0.8
16.0 at 10'	FL = 15.7 at 10'	Y = 0.7
15.3 at 15'	FL = 15.6 at 15'	Y = 1.3
15.0 at 27'	FL = 15.4 at 27'	Y = 1.4
15.7 at 42'	FL = 15.1 at 42'	Y = 0.4
15.6 at 51'		
15.5 at 55'	FL = 15.0 at 51'	Y = 0.4

24"x98' Culvert Pipe

Circular Culvert Pipe Embankment Areas
 (Y=Height, TC = Center of Pipe)
 Pipe Diagram

Y	12"	15"	18"	24"	30"	36"	42"	48"	54"	60"	72"
0.1	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
0.2	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
0.3	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
0.4	2.0	2.0	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
0.5	2.6	2.6	2.6	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
0.6	3.3	3.3	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.1	3.1
0.7	4.1	4.0	4.0	3.9	3.9	3.9	3.8	3.8	3.8	3.8	3.8
0.8	4.9	4.9	4.8	4.7	4.6	4.6	4.6	4.6	4.6	4.5	4.5
0.9	5.7	5.7	5.7	5.5	5.4	5.4	5.4	5.3	5.3	5.3	5.3
1.0	6.6	6.6	6.6	6.4	6.3	6.2	6.2	6.2	6.2	6.1	6.1
1.1	7.5	7.6	7.6	7.4	7.2	7.1	7.1	7.1	7.0	7.0	7.0
1.2	8.5	8.6	8.6	8.5	8.2	8.1	8.0	8.0	7.9	7.9	7.9
1.3	9.5	9.6	9.6	9.4	9.4	9.1	9.0	9.0	8.9	8.9	8.8
1.4	10.5	10.7	10.7	10.7	10.6	10.3	10.1	10.0	10.0	9.9	9.8
1.5	11.6	11.8	11.9	11.9	11.8	11.5	11.2	11.1	11.0	11.0	10.9
1.6	12.7	12.9	13.0	13.1	13.1	12.8	12.5	12.3	12.2	12.1	12.0
1.7	13.9	14.1	14.2	14.4	14.4	14.1	13.7	13.5	13.4	13.3	13.2
1.8	15.1	15.3	15.5	15.7	15.7	15.5	15.2	14.8	14.7	14.5	14.4
1.9	16.3	16.6	16.8	17.0	17.1	17.0	16.7	16.2	16.0	15.8	15.6
2.0	17.6	17.9	18.1	18.4	18.5	18.5	18.2	17.7	17.4	17.2	17.0
2.1	18.9	19.2	19.5	19.8	20.0	20.0	19.8	19.3	18.9	18.6	18.3
2.2	20.3	20.6	20.9	21.3	21.5	21.5	21.4	21.0	20.5	20.1	19.8
2.3	21.7	22.0	22.3	22.8	23.1	23.1	23.0	22.7	22.2	21.7	21.3
2.4	23.1	23.5	23.8	24.3	24.7	24.8	24.7	24.4	24.0	23.4	22.9
2.5	24.6	25.0	25.4	25.9	26.3	26.5	26.4	26.2	25.8	25.2	24.5
2.6	26.1	26.6	26.9	27.5	28.0	28.2	28.2	28.0	27.7	27.1	26.2
2.7	27.7	28.1	28.5	29.2	29.7	29.9	30.0	29.9	29.6	29.1	28.0
2.8	29.3	29.8	30.2	30.9	31.4	31.7	31.9	31.8	31.5	31.1	29.8
2.9	30.9	31.4	31.9	32.6	33.2	33.6	33.8	33.7	33.5	33.1	31.8
3.0	32.6	33.1	33.6	34.4	35.0	35.5	35.7	35.7	35.5	35.2	33.9
3.1	34.3	34.9	35.4	36.2	36.9	37.4	37.7	37.7	37.6	37.3	36.1
3.2	36.1	36.7	37.2	38.1	38.8	39.3	39.7	39.8	39.7	39.5	38.3
3.3	37.9	38.5	39.0	40.0	40.8	41.3	41.7	41.9	41.9	41.7	40.6
3.4	39.7	40.4	40.9	41.9	42.8	43.4	43.8	44.0	44.1	43.9	43.0
3.5	41.6	42.3	42.9	43.9	44.8	45.5	45.9	46.2	46.3	46.2	45.4
3.6	43.5	44.2	44.8	45.9	46.9	47.6	48.1	48.4	48.6	48.5	47.8
3.7	45.5	46.2	46.8	48.0	49.0	49.7	50.3	50.7	50.9	50.9	50.2
3.8	47.5	48.2	48.9	50.1	51.1	51.9	52.6	53.0	53.2	53.3	52.7
3.9	49.5	50.3	51.0	52.2	53.3	54.2	54.9	55.3	55.6	55.7	55.3
4.0	51.6	52.4	53.1	54.4	55.5	56.5	57.2	57.7	58.0	58.2	57.9
4.1	53.7	54.5	55.3	56.6	57.8	58.8	59.6	60.1	60.5	60.7	60.5
4.2	55.9	56.7	57.5	58.9	60.1	61.1	62.0	62.6	63.0	63.3	63.1
4.3	58.1	58.9	59.7	61.2	62.5	63.5	64.4	65.1	65.6	65.9	65.8
4.4	60.3	61.2	62.0	63.5	64.9	66.0	66.9	67.6	68.2	68.5	68.6
4.5	62.6	63.5	64.4	65.9	67.3	68.5	69.4	70.2	70.8	71.2	71.4
4.6	64.9	65.9	66.7	68.3	69.8	71.0	72.0	72.8	73.	73.9	74.2
4.7	67.3	68.2	69.1	70.8	72.3	73.5	74.6	75.5	76.2	76.7	77.0
4.8	69.7	70.7	71.6	73.3	74.8	76.1	77.3	78.2	78.9	79.5	79.9
4.9	72.1	73.1	74.1	75.8	77.4	78.8	80.0	80.9	81.7	82.3	82.9
5.0	74.6	75.6	76.6	78.4	80.0	81.5	82.7	83.7	84.5	85.2	85.9

Culvert Pipe-Arch Embankment Areas
(Y=Height to Widest Section of Pipe)
Equivalent Round Size

Y	12"	30"	36"	42"	48"	54"	60"	66"	72"
0.1	0.6	0.6	0.7	0.7	0.8	0.9	1.0	1.2	1.3
0.2	1.1	1.1	1.1	1.2	1.3	1.4	1.5	1.7	1.8
0.3	1.6	1.6	1.6	1.7	1.8	1.9	2.1	2.2	2.4
0.4	2.0	2.2	2.2	2.2	2.24	2.5	2.6	2.8	2.9
0.5	2.8	2.7	2.7	2.7	2.9	3.1	3.2	3.4	3.5
0.6	3.7	3.6	3.5	3.4	3.4	3.7	3.8	4.0	4.2
0.7	4.6	4.6	4.5	4.4	4.2	4.1	4.5	4.7	4.9
0.8	5.5	5.6	5.6	5.5	5.3	5.0	4.9	5.4	5.6
0.9	6.5	6.6	6.7	6.7	6.5	6.2	5.9	5.8	5.7
1.0	7.5	7.7	7.8	7.9	7.8	7.5	7.1	6.8	6.7
1.1	8.6	8.8	9.0	9.1	9.1	8.9	8.6	8.1	7.8
1.2	9.7	10.0	10.2	10.4	10.4	10.3	10.0	9.6	9.2
1.3	10.8	11.2	11.5	11.7	11.8	11.7	11.5	11.2	10.8
1.4	12.0	12.4	12.8	13.1	13.2	13.2	13.1	12.8	12.4
1.5	13.2	13.7	14.1	14.5	14.7	14.7	14.6	14.4	14.1
1.6	14.5	15.0	15.5	15.9	16.2	16.3	16.3	16.1	15.8
1.7	15.8	16.4	16.9	17.4	17.7	17.9	17.9	17.8	17.6
1.8	17.1	17.8	18.4	18.9	19.3	19.5	19.6	19.6	19.4
1.9	18.5	19.2	19.9	20.4	20.9	21.2	21.4	21.4	21.3
2.0	19.9	20.7	21.4	22.0	22.6	22.9	23.1	23.2	23.2
2.1	21.4	22.2	23.0	23.7	24.3	24.7	25.0	25.1	25.1
2.2	22.9	23.8	24.6	25.4	26.0	26.5	26.8	27.0	27.0
2.3	24.4	25.4	26.3	27.1	27.8	28.3	28.7	29.0	29.1
2.4	26.0	27.0	28.0	28.8	29.6	30.2	30.7	31.0	31.1
2.5	27.6	28.7	29.7	30.6	31.5	32.1	32.6	33.0	33.2
2.6	29.3	30.4	31.5	32.5	33.4	34.1	34.7	35.1	35.3
2.7	31.0	32.2	33.3	34.3	35.3	36.1	36.7	37.2	37.5
2.8	32.7	34.0	35.2	36.3	37.3	38.1	38.8	39.3	39.7
2.9	34.5	35.8	37.1	38.2	39.4	40.2	41.0	41.5	41.9
3.0	36.3	37.7	39.0	40.2	41.4	42.3	43.1	43.8	44.2
3.1	38.2	39.6	41.0	42.2	43.5	44.5	45.4	46.1	46.6
3.2	40.1	41.6	43.0	44.3	45.7	46.7	47.6	48.4	48.9

Culvert Pipe-Arch Embankment Areas
(Y=Height to Widest Section of Pipe)
Equivalent Round Size

Y	24"	30"	36"	42"	48"	54"	60"	66"	72"
3.3	42.0	43.6	45.1	46.4	47.8	48.9	49.9	50.7	51.3
3.4	44.0	45.6	47.2	48.6	50.1	51.2	52.3	53.1	53.8
3.5	46.0	47.7	49.3	50.8	52.3	53.5	54.6	55.6	56.3
3.6	48.1	49.8	51.5	53.0	54.6	55.9	57.1	58.1	58.8
3.7	50.2	52.0	53.7	55.3	57.0	58.3	59.5	60.6	61.4
3.8	52.3	54.2	56.0	57.6	59.4	60.7	62.0	63.1	64.0
3.9	54.5	56.4	58.3	60.0	61.8	63.2	64.6	65.7	66.6
4.0	56.8	58.7	60.6	62.4	64.3	65.7	67.1	68.4	69.3
4.1	59.0	61.0	63.0	64.8	66.8	68.3	69.8	71.0	72.0
4.2	61.3	63.4	65.4	67.3	69.3	70.9	72.4	73.8	74.8
4.3	63.7	65.8	67.8	69.8	71.9	73.6	75.1	76.5	77.6
4.4	66.0	68.2	70.3	72.4	74.5	76.2	77.9	79.3	80.5
4.5	68.5	70.7	72.9	75.0	77.2	79.0	80.6	82.2	83.4
4.6	70.9	73.2	75.5	77.6	79.9	81.7	83.5	85.0	86.3
4.7	73.4	75.8	78.1	80.3	82.6	84.5	86.3	88.0	89.3
4.8	76.0	78.4	80.7	83.0	85.4	87.4	89.2	90.9	92.3
4.9	78.5	81.0	83.4	85.1	88.2	90.2	92.2	93.9	95.3
5.0	81.2	83.7	86.2	88.5	91.1	93.2	95.1	97.0	98.4

Elliptical Culvert Pipe Embankment Areas
(Y = Height to Center of Pipe)
Equivalent Round Size

0.1	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
0.2	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.0	0.9
0.3	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
0.4	2.0	2.0	1.9	1.9	1.9	1.9	1.9	1.9	1.9
0.5	2.6	2.6	2.6	2.5	2.5	2.5	2.5	2.5	2.5
0.6	3.3	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2
0.7	4.0	4.0	3.9	3.9	3.9	3.9	3.9	3.9	3.9
0.8	4.9	4.8	4.7	4.7	4.7	4.6	4.6	4.6	4.6
0.9	5.9	5.7	5.6	5.5	5.5	5.4	5.4	5.4	5.4
1.0	6.9	8.7	6.5	6.4	6.4	6.3	6.3	6.2	6.2
1.1	8.0	7.8	7.5	7.4	7.3	7.2	7.2	7.1	7.1
1.2	9.1	9.0	8.6	8.4	8.3	8.2	8.2	8.1	8.1
1.3	10.3	10.2	5.9	9.5	9.4	9.3	9.2	9.1	9.1
1.4	11.5	11.5	11.2	10.8	10.6	10.4	10.3	10.2	10.1
1.5	12.7	12.8	12.6	12.2	11.9	11.6	11.5	11.4	11.3
1.6	14.0	14.1	14.0	13.7	13.3	12.9	12.7	12.6	12.5
1.7	15.3	15.5	15.4	15.2	14.9	14.3	14.1	13.9	13.7
1.8	16.6	16.9	16.9	16.7	16.3	15.9	15.5	15.2	15.1
1.9	18.0	18.3	18.4	18.3	18.1	17.6	17.0	18.7	16.5
2.0	19.4	19.8	19.9	19.9	19.8	19.4	18.7	18.2	18.0
2.1	20.9	21.4	21.5	21.6	21.5	21.1	20.6	19.9	19.6
2.2	22.4	23.0	23.2	23.3	23.3	23.0	22.5	21.7	21.2
2.3	24.0	24.6	24.8	25.0	25.1	24.8	24.4	23.7	23.0
2.4	25.6	26.2	26.0	26.8	26.9	26.7	26.4	25.7	24.9
2.5	27.2	27.9	28.3	28.6	28.8	28.7	28.4	27.9	27.1
2.6	28.9	29.7	30.1	30.5	30.7	30.7	30.4	29.9	29.2
2.7	30.6	31.4	31.9	32.4	32.7	32.7	32.5	32.1	31.5
2.8	32.3	33.3	33.8	34.3	34.7	34.8	34.7	34.3	33.7
2.9	34.1	35.1	35.7	36.3	36.7	36.9	36.8	36.5	36.0
3.0	35.9	37.0	37.7	38.3	38.8	39.0	39.1	38.8	38.4
3.1	37.8	38.9	39.7	40.4	40.9	41.2	41.3	41.1	40.7
3.2	39.7	40.9	41.7	42.5	43.1	43.6	43.6	43.4	43.2
3.3	41.7	42.9	43.8	44.6	45.3	45.7	45.9	45.8	45.6
3.4	43.7	45.0	45.9	46.8	47.5	38.0	48.3	48.2	48.1
3.5	45.7	47.1	48.1	49.0	49.8	50.4	50.7	50.7	50.6
3.6	47.8	49.2	50.3	51.3	52.1	52.7	53.2	53.2	53.2
3.7	49.9	51.4	52.5	53.6	54.5	55.2	55.7	55.8	55.8
3.8	52.0	53.6	54.8	55.9	56.9	57.6	58.2	58.4	58.5
3.9	54.2	55.9	57.1	58.3	59.3	60.1	60.8	61.0	61.2
4.0	56.4	58.2	59.4	60.8	61.8	62.7	63.4	63.7	63.9
4.1	58.7	60.5	61.8	63.2	64.3	65.3	66.0	66.4	66.7
4.2	61.0	62.9	64.3	65.7	66.9	67.9	68.7	69.1	69.5
4.3	63.4	65.3	66.7	68.3	69.5	70.6	71.8	71.9	72.4
4.4	65.8	67.8	69.3	70.8	72.1	73.3	74.2	74.8	75.3
4.5	68.2	70.3	71.8	73.5	74.8	76.0	77.1	77.6	76.2
4.6	70.7	72.8	74.4	76.1	77.5	78.8	79.9	80.5	81.2
4.7	73.2	75.4	77.0	78.8	80.3	81.6	82.8	83.5	84.2
4.8	75.7	78.0	79.7	81.6	83.1	84.5	85.7	86.5	87.3
4.9	78.3	80.6	82.4	86.3	85.9	87.4	89.7	89.5	90.4
5.0	80.9	83.3	85.2	87.2	88.8	90.4	91.7	92.6	93.5

Cu. Yds. of Concrete to be deducted from one Headwall because of skew.

Corrugated Pipe 8" Headwalls

Size/Skew	5"	10"	15"	20"	25"	30"	35"	40"	45"	50"	55"	60"
18" Pipe	.000	.001	.002	.003	.005	.007	.010	.013	.018	.024	.032	.044
24" Pipe	.000	.001	.003	.005	.008	.012	.017	.024	.032	.043	.058	.078
30" Pipe	.000	.002	.004	.008	.013	.019	.027	.037	.050	.067	.090	.121
30" Pipe	.001	.003	.006	.011	.018	.027	.039	.053	.072	.097	.130	.174
42" Pipe	.001	.004	.008	.015	.025	.037	.052	.073	.098	.132	.177	.238
48" Pipe	.001	.005	.011	.020	.032	.048	.068	.095	.128	.172	.231	.310
54" Pipe	.001	.006	.014	.025	.041	.061	.087	.120	.163	.218	.292	.393
60" Pipe	.002	.007	.017	.031	.050	.075	.107	.148	.201	.269	.360	.485
72" Pipe	.003	.011	.025	.045	.072	.108	.154	.213	.289	.388	.519	.698
84" Pipe	.004	.015	.034	.061	.098	.147	.210	.290	.394	.528	.706	.950

Corrugated Pipe 6" Headwalls

Size/Skew	5"	10"	15"	20"	25"	30"	35"	40"	45"	50"	55"	60"
18" Pipe	.000	.001	.001	.002	.003	.005	.007	.010	.014	.018	.024	.033
24" Pipe	.000	.001	.002	.004	.006	.009	.013	.018	.024	.052	.043	.058
30" Pipe	.000	.001	.003	.006	.009	.014	.020	.028	.038	.051	.068	.091
36" Pipe	.001	.002	.005	.008	.014	.020	.029	.040	.054	.073	.097	.131
42" Pipe	.001	.003	.006	.011	.018	.028	.039	.054	.074	.099	.132	.178
48" Pipe	.001	.004	.008	.015	.024	.036	.051	.071	.096	.129	.173	.233
54" Pipe	.001	.005	.010	.019	.030	.046	.065	.090	.122	.164	.219	.294
60" Pipe	.001	.006	.013	.023	.038	.056	.080	.111	.151	.202	.270	.364
72" Pipe	.002	.008	.018	.034	.054	.081	.116	.160	.217	.291	.389	.523
84" Pipe	.003	.011	.025	.046	.074	.110	.157	.218	.295	.398	.530	.713

Concrete Pipe 8" Headwalls

Size	T	5"	10"	15"	20"	25"	30"	35"	40"	45"	50"	55"	60"
18" Pipe	2½	.000	.001	.003	.005	.007	.011	.016	.022	.030	.040	.053	.071
24" Pipe	2¾	.000	.002	.004	.008	.012	.018	.026	.036	.049	.065	.087	.117
30" Pipe	3	.001	.003	.006	.011	.018	.027	.039	.053	.072	.097	.130	.174
36" Pipe	3½	.001	.004	.009	.016	.026	.039	.055	.076	.103	.138	.185	.249
42" Pipe	4¼	.001	.005	.012	.022	.035	.053	.076	.105	.142	.191	.255	.343
48" Pipe	5	.002	.007	.016	.029	.047	.070	.100	.138	.188	.252	.337	.453
54" Pipe	5"	.002	.009	.019	.035	.057	.085	.122	.168	.228	.306	.410	.551
54" Pipe	5½	.002	.009	.020	.037	.059	.088	.126	.14	.236	.316	.423	.569
60" Pipe	5½	.003	.010	.024	.044	.070	.105	.150	.207	.281	.377	.505	.579
60" Pipe	6"	.003	.011	.025	.045	.072	.108	.154	.213	.289	.388	.519	.698
72" Pipe	7"	.004	.015	.035	.064	.130	.154	.220	.304	.412	.553	.740	.996
84" Pipe	8"	.005	.021	.048	.086	.139	.208	.297	.411	.558	.748	1001	1346

Concrete Pipe 6" Headwalls

Size	T	5"	10"	15"	20"	25"	30"	35"	40"	45"	50"	55"	60"
18" Pipe	2½	.000	.001	.002	.003	.005	.008	.012	.016	.022	.030	.040	.053
24" Pipe	2¼	.000	.001	.003	.006	.009	.014	.019	.027	.036	.049	.065	.088
30" Pipe	3"	.001	.002	.005	.008	.014	.020	.029	.040	.054	.073	.097	.131
36" Pipe	3½	.001	.003	.007	.012	.019	.029	.041	.057	.077	.104	.139	.187
42" Pipe	4¼	.001	.004	.009	.017	.027	.040	.057	.079	.107	.143	.191	.258
48" Pipe	5"	.001	.005	.012	.022	.035	.053	.075	.104	.141	.189	.253	.340
54" Pipe	5"	.002	.006	.015	.027	.043	.064	.091	.126	.171	.230	.307	.414
54" Pipe	5½	.002	.007	.015	.027	.044	.055	.094	.130	.177	.237	.317	.427
60" Pipe	5½	.002	.008	.018	.033	.053	.079	.112	.155	.211	.283	.378	.509
60" Pipe	6"	.002	.008	.018	.034	.054	.081	.116	.160	.217	.291	.389	.523
72" Pipe	7"	.003	.012	.026	.048	.077	.116	.165	.228	.309	.415	.555	.747
84" Pipe	8"	.004	.016	.036	.065	.104	.156	.223	.308	.418	.561	.751	1.010

717.00 CONCRETE PIPE CULVERTS (SSHC Section 720)

717.01 DESCRIPTION

- A. This work shall consist of furnishing and installing new reinforced concrete culvert pipe (round, pipe-arch and elliptical), reinforced concrete slotted pipe and the relaying of existing reinforced concrete pipe.

717.02 MATERIAL REQUIREMENTS

- A. Pipe Marking. Each section of pipe used should be marked with the fabrication inspector's initial and the class of pipe, when it arrives at the site. The culvert inspector should not permit the laying of any section that does not have these markings. The project manager will receive a copy of the "Report of Shipment of Reinforced Concrete Pipe" (Form DR-420), listing the size, class, length, number of sections of pipe, the inspector's identification mark and stock report number. The inspector will use the information contained in this report to verify approval of reinforced concrete pipe received on the project. The diameter, class, length, number of sections and the pipe identification number shall be recorded in the culvert notebook. Each section of pipe should be examined for damaged ends, cracks and evidence of poor manufacture. All irregularities should be referred to the Project Manager before using of the pipe.
- B. Ordering Material
1. The contractor is **not permitted to order or deliver** culvert pipe until a "culvert list" listing the correct sizes and lengths of pipe is furnished by the Project Manager.
 2. The Project Manager shall furnish a pipe list for driveway and sewer requirements.
 3. The District Construction Engineer, and the Project Manager should go over the drainage situation and features in the field to confirm that the structures shown in the plans are adequate to handle the drainage. The cross sections taken at each culvert site should be plotted, the roadway cross section template and the structure plotted thereon at the proper flow line elevations, and the length of the structure thus determined. If the Project Manager includes either a larger drainage structure, or an additional drainage structure in the culvert list, he/she should, if possible, specify the same type of structure, or the same kind of pipe (culvert pipe, concrete pipe or corrugated metal pipe) as is shown in the approved plans for the project for the other structures.
 4. In detailing and ordering the pipe culverts, the following rules should be followed for all kinds of culvert pipe (concrete pipe, corrugated metal pipe or culvert pipe):
 - a. The overall length of culvert pipe should be given to the closest 2 ft (600 mm).
 - b. The minimum distance from either end of the pipe to the break point of a broken back pipe culvert shall be 10 ft (3 m).

- c. The dimensions from ends of the pipe to break points, or between break points of a broken-back pipe culvert should be given to the closest 2 ft (600 mm) along the centerline of the pipe. The fabricator will be permitted to locate the elbows 1 foot (300 mm) in either direction from the locations shown in the culvert sketch.
- d. Generally, pipe culverts should not be designed or constructed with elbows of less than 5 degrees.
- e. Prepare a sketch for each broken-back pipe culvert, designing and detailing the structure using the chart "Slope Data for Pipe Culvert" as a guide, and including dimensions, details and elevations as shown in the sample culvert sketch shown in this Subsection.
- f. Pipe arch culverts are to be detailed and dimensioned the same as round pipe culverts. Broken-back pipe arch culverts should be avoided.
- g. If flared end sections are to be installed, the pay length shall be the order length shown in the culvert list and sketch. A note should be made as part of the list indicating that order lengths do not indicate the "Y" distances shown in the applicable Standard Plan in the case of metal pipe.
- h. The condition, kind of pipe, diameter and lengths right and left of centerline should be carefully checked before ordering extensions for an existing pipe culvert. Careful checking will eliminate ordering extensions which are improper as to length, diameter, kind of pipe, etc.
- i. The maximum discharge of the average pipe culvert without head on the inlet will be provided when such pipe are given a slope of between one percent and two percent. Slopes steeper than this will not increase the water carrying capacity of the culvert. The Project Manager should make every effort to use such slopes when they are compatible with other drainage requirements at the individual culvert site. In choosing between a straight and a broken-back culvert pipe, the Project Manager should realize that little, if any, value is gained by installing elbows of less than 5 degrees.
- j. If settlement or subsidence is anticipated under higher fills, pipe culverts and box culverts should be cambered. The plans will usually include a "Camber Note" which will state that the pipe culverts should be laid and box culverts constructed on parabolic camber grade as shown in the applicable standard plan, and will state the proportion of fill height which the foundation soil is expected to settle. Settlement or subsidence is generally zero at the toe of the slope, and at a maximum at the shoulder line.

717.03 CONSTRUCTION METHODS

- A. Excavation and Backfilling
 - 1. See Section 702 of this manual.

B. Installation

1. Begin laying concrete pipe at the downstream end of the culvert with the groove or bell portion of each section upstream.
2. Irrigation culverts shall be constructed of concrete pipe and must have approved gaskets at the joints. These gaskets shall be installed as per the manufacturer's recommendations and standards. Here is example of how to calculate payment for excavation.

EXAMPLE CALCULATION

Area for 1.25 m depth:

1a

Area for 2.75 m depth:

1b + 2b + 3b

Area for 4.25 m depth:

1c + 2c + 3c

Area for 5.75 m depth:

1d + 2d + 3d

Area for greater than 5.75 m depth:

1e + 2e + 3e

718.00 CORRUGATED METAL PIPE CULVERTS (SSHC Section 719)

718.01 DESCRIPTION

- A. This work shall consist of furnishing and installing new corrugated galvanized metal pipes and pipe arches and the relaying of existing corrugated metal pipe and pipe arches.

718.02 MATERIAL REQUIREMENTS

- A. Pipe Marking. SSHC Tables 1035.01 & 1036.01 contain the required minimum gage or sheet thickness for the various pipe diameters. The "Materials and Sampling Guide" provides that the necessary tests for acceptance will be handled by the Materials and Research Division. Material samples need not be taken by project personnel unless a special request is made for samples. The diameter of the pipe and number of sections of pipe covered by each heat number and delivered to each culvert location should be recorded in the culvert notebook. The pipe shipment should be checked against the shipment report and any discrepancy should be reported to the Project Manager. The pipe shipment should also be checked for shipping damage and any damage noted should also be reported to the Project Manager.
- B. Ordering Material
1. **The contractor is not permitted to order or deliver corrugated metal pipe or pipe arches until a "culvert list" listing the correct sizes and lengths of pipe is furnished to him/her by the Project Manager.**

718.03 CONSTRUCTION METHODS

- A. Excavating and Backfilling
1. Refer to Section 702 of this manual.
- B. Installation
1. The culvert inspector should insist on careful handling of the corrugated metal pipes or pipe arches. Corrugated metal pipes or pipe arches should be lifted and moved with a rope sling or similar device which will not damage the galvanized surfaces of the pipes or pipe arches. The contractor should not be allowed to drag the pipes or pipe arches over abrasive surfaces as this will also damage the galvanized surfaces.
 2. Corrugated metal pipes and pipe arches shall be laid with the inside circumferential laps lapped downstream so that the water will flow over the lap. The pipe shall be rotated so that the longitudinal laps are horizontal. When joining sections of pipe, the connecting bands should be pulled up as tight as possible. The band should be tapped with a wooden mallet as the bolts are tightened. Excessive pressure on the bolts should be avoided to keep from pulling the steel angle loose from the band. A gap of about 1 inch (25mm) should be allowed between the pipe ends being joined,

CHAPTER NOTES:

807.00 EROSION CONTROL

807.01 EROSION CONTROL CHECKLIST

SSHC Reference: Section 807 -- Erosion Control & Special Provisions

Other References: Approved Products List

Inspection Crew: Construction Technician

Inspection Equipment: NA

- General Comments:*
1. Has the finish grade been accepted for this area? (*SSHC Subsection 807.03, Para. 1*)
 2. Is the material on the approved products list? (*SSHC Subsection 807.02, Para. 1*)
 3. Does the contractor have the right pins? (*SSHC Subsection 807.02, Para. 2*)
 4. Does the contractor have the right fertilizer? (*Special Provisions*)
 5. Is the seed bed properly prepared? (*SSHC Subsection 807.03, Para. 4*)
 6. Does the seed have the department tags for this project? (*SSHC Subsection 803.02, Paragraphs 3 & 4*)
 7. Usual work sequence:
 - a. Soil preparation including the slots for the erosion checks
 - b. Fertilize
 - c. Install filter fabric for check slots and soil fill
 - d. Seed and rake the seed into the soil
 - e. Install erosion control material
 - f. Some erosion control materials come with the filter fabric attached. When this material is used, direct seed into the erosion control material and then soil is spread over the seed
 8. Questions -- call 402-479-4537, Roadside Development.

807.02 FILTER FABRIC

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Cut the fabric so that the excess material lies under the outlet so that the water falls on a double layer. This is shown on the plans.

The filter fabric detail should show the fabric covering the area above a box culvert opening and the boxes wings.

The bale check includes the necessary filter fabric so do not include this quantity when calculating the pay quantity for filter fabric. Pay limits will be added to the plan detail.

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808.00 EROSION CHECKS

808.01 EROSION CHECKS CHECKLIST

SSHC Reference: *Section 808 -- Erosion Checks & Special Provisions*

Other References: Approved Products List

Inspection Crew: Construction Technician

Inspection Equipment: NA

- General Comments:
1. Work generally performed in conjunction with erosion control after an area is final graded.
 2. Make sure that the center bale is lower than the outside bales
 3. The erosion control material for the erosion checks must match the erosion control material used in the ditch. Is the material on the approved products list?
 4. Work performed similar to erosion control
 5. Seed is never to be placed under the filter fabric - only on top of the filter fabric
 6. Some erosion control materials have the filter fabric attached. When this occurs, the seed is directly seeded onto the erosion control material and then soil is spread over the seed
 7.
 - a. "Temporary Silt Checks" (TSC) are to be installed as soon as rough grading begins. TSC should be placed as shown in the plans or as directed by the engineer.
 - b. Temporary Silt Checks (TSC) have to be removed in order for final grading to be completed. However, once final grading is complete, the TSC's need to be reinstalled.
 - c. The contractor does not have to reinstall TSC if instead the permanent erosion checks are available and will be installed immediately after finish grading.
 8. Roadside Development (402) 479-4537 Questions -- call 402-479-4537, Roadside Development

808.02 PLACEMENT

The suggested sequence of work for special ditch control is as follows:

Shape

@ Shape the ditch and prepare the seed bed approximately **3/4 inch (20 mm)** deep. If ditches are unstable and equipment leaves them in a rough condition, the seed bed must be prepared by hand. The ditches should be shaped so that the ditch drains without water ponding and has a minimum depth of **6 inches (150 mm)**. Minor irregularities in ditch alignment must be corrected so the completed ditch will follow the ditch line constructed during the grading operation. This may not be possible in cases of severe washing of the ditch bottom. All rocks and clods more than **1½ inch (40 mm)** in diameter, and all sticks and other materials, which prevent contact of the special ditch control materials with the seed bed, shall be removed.

@ The vegetation on new slopes may take more than one construction season to be effectively established and bale checks and silt fence should not be removed until they are no longer needed. It would be unacceptable to hold the contract open until the vegetation was established.

The only time that steel rebar should be used is when the stake must penetrate shale – then the PM needs to let Maintenance know this was allowed.

@

10. Q. - We did everything like we should and we still had some silt get away.

A. - Hari-kari is not required. The erosion process is a natural one. We are just trying to slow it down and keep our "dirt" at home. Take photographs of what did and did not work and send them in. We will pass on the good and redesign the bad.

809.01 SILT FENCING CHECKLIST

SSHC Reference: *Section 809 -- Silt Fencing & Special Provisions*

Other References: Silt Fence Guideline & Approved Products List

Inspection Crew: Construction Technician

Inspection Equipment: None

Silt Fencing Procedures:

- General Comments:
1. Silt fencing is a first item of business -- before any soil is disturbed.
 2. Does the contractor have the right material? (SSHC Subsection 809.02, Para. 1.)
 3. Is the material on the approved products list?
 4. Does the silt fence location need to be adjusted to function better?
 5. Silt fences only work when they are:
 - a. installed correctly
 - b. kept clean
 - c. kept repaired
 6. Questions -- call 402-479-4537, Roadside Development
- Roadside Development (402) 479-4537:

809.02 SILT FENCE

@

At bridge approaches and on other steep slopes, the contractor should place extra rows of silt fence if necessary. The Plan requirements are only a guide and should be adjusted by the project manager to fit the actual field circumstances.

The bay portion of the silt fence is shown partially buried on some details is not correct. The silt fence should be shown on top of the slope.

@ The objective is to place the silt fence so that silt will not leave our ROW. Design depends on site visits and preliminary survey data. However, erosion control has not been the focus in past surveys. Therefore placement of silt fence and other erosion control items may have not been optimal. If there is a better place – site the fence there; if more is needed, get it placed; the bottom line is do whatever is necessary to provide erosion control – in the long run it is really cheaper.

The District should remove silt fences and bail checks when the ground cover is established.

If the silt fence is properly installed and some subsequent construction activity damages the silt fence, is additional payment authorized?

It will depend on the circumstances. If the fence had to be installed at a location where subsequent activity was necessary and caused the fence to be removed and replaced, then additional payment is justified. However, if the contractor was negligent and did not use reasonable caution and his neglect resulted in damage to the silt fence, then no additional payment is authorized to replace the fence.

@

810.00 SLOPE PROTECTION

810.01 SLOPE PROTECTION CHECKLIST

SSHC Reference: *Section 810 -- Slope Protection & the Special Provision*

Other References: None

Inspection Crew: Construction Technician

Inspection Equipment: Yard stick, meter stick and small balance scale

Procedures and General Comments:

1. The mulch must be prairie hay and certified as noxious weed free (*SSHC Subsection 810.02*)
2. The seed will be mixed at the seed company and tagged with department supplied tags
3. All areas possible are to have the seed drilled. The drilled seed will establish much faster than broadcast seed. The percentage of the area to be drilled is given in the Special Provisions.
4. Hay buster machines have proven to be satisfactory for the mechanical application of the mulch
- @ 5. Sampling for the proper weight of mulch per **yd² or m²**. Use the meter stick or yard stick -- which ever applies -- and gather all the hay in a square before crimping -- and weigh this on the scale -- the results are approximate. Use them as a guide and not as an absolute
6. Best hay information -- Establish a test plot with the exact amount of hay per yd² or m² -- crimp -- and use this plot for a visual comparison
7. Questions -- call 402-479-4537, Roadside Development

Roadside Development
(402) 479-4537

DIVISION 900 INCIDENTAL CONSTRUCTION

901.00 FIELD LABORATORIES AND SCALE HOUSES

901.01 GENERAL REQUIREMENTS

The Project Manager shall determine if the field laboratories or scale houses furnished by the contractor conform to the requirements of the specifications, supplemental specifications and/or the special provisions. Inspection report forms for the laboratories are available at the district offices.

The Project Manager shall require the contractor to furnish, relocate when necessary and maintain the field laboratory or scale house as specified.

The personnel using the contractor furnished facility shall use due care in performing their required duties to prevent unnecessary wear and tear on the facility.

901.02 METHOD OF MEASUREMENT

Appendix 3 of this manual has an example of the field book records required for a field laboratory.

901.03 BASIS OF PAYMENT

Payment of 100 percent will be made for the field laboratory after it is inspected and approved by the Project Manager. When two or more projects are included in the same contract the cost for the field laboratories may be prorated to the projects on the contractor's estimate forms furnished the Project Manager. When preparing the form for submittal, the Project Manager will use the same decimal quantities, shown under contract quantities on the form, for each project on the first estimate that payment is made for this item even though work has started on only one of the projects involved. Payment for the field laboratory will not be related to the percent of work performed by the contractor.

902.00 GUARDRAIL CHECKLIST

		YES	NO
@	1. Before construction of the guardrail, is the slope from the shoulder line 2 ft. (600 mm) past the guardrail post 10:1 or flatter?	_____	_____
	2. Are offsets correct? [± 1 " (25mm)].	_____	_____
	3. Is rail height above ground, 27 to 27.5 inches (686 to 702 mm) is OK, but 27 $\frac{3}{4}$ " to 30" (702 to 762 mm) preferred for W-beam; 32? inches (810 mm) for thrie-beam including the bull-nose; cable is at 30 inches.	_____	_____
	4. Is rail alignment good?	_____	_____
	5. Are laps to specified case in direction of traffic?	_____	_____
@	6. Is post spacing correct?	_____	_____
	7. Are plate washers on post bolts according to plans?	_____	_____
	8. Is 8x8 inches (200 mm x 200 mm) plate washer installed correctly (nails)?	_____	_____
	9. Are washers in correct location on all connections?	_____	_____
	10. Is surfacing/pavement around timber guardrail posts removed and backfilled properly [7" (180 mm) behind post.]?	_____	_____
@	11. Are high strength bolts used in bridge end connection? (See 903.03)	_____	_____
	12. Are object markers and new hardware in correct location?	_____	_____
	13. Are delineators in correct locations?	_____	_____
	14. If 6x8 inch (150 mm x 200 mm) posts are used, are they installed properly?	_____	_____
	15. Is end anchorage cable tightened? (Remove all slack)	_____	_____
	16. Are the vertical steel tubes at the correct elevation [less than 4" (100 mm) above soil]?	_____	_____
	17. Are the horizontal steel struts between the end post and the 2 nd posts resting on the ground?	_____	_____
	18. Is the horizontal steel strut below the hole in the wood post?	_____	_____

@ 903.00 W-BEAM/THRIE-BEAM GUARDRAIL

903.01 DESCRIPTION

The construction inspection for this work includes:

1. Checking the plan information with actual field conditions to assure plan information is correct or to modify it as necessary to more closely fit field conditions.
2. Preparing a field checked order list for the contractor's use in ordering the necessary materials. This order list should be prepared in letter form to the contractor and include the following listed items.
 - a. List stations of guardrail.
 - b. Side of project.
 - c. Build, remove, reset, etc.
 - d. Lineal feet (meters) of rail.
 - e. Type of rail.
 - f. Type of end treatment.
 - g. Number, type and dimensions for special posts.
 - h. Special and/or standard plan numbers.

This field checked order list should be prepared and submitted to the district office for their review. The district office will distribute the original and copies of the order list after they have reviewed it.

3. This field checked order list should be prepared and submitted as soon as possible to allow the contractor ample time to obtain the necessary materials prior to the date established for beginning the work.
4. All build items will be staked by the field personnel. Stakes will be set at the ends of guard rail locations. Nails (red heads with wire flags as guards) should be set at each post location. The location of end treatments, bridge approach sections, etc. should be marked with stakes.
5. The field book record for this work should include:
 - a. Plan data.
 - b. Construction data.
 - c. Staking information.
 - d. Inspection information.

- e. Quantities and summary of quantities.
- @ f. **End treatment.**
- 6. Usually guardrail contract work cannot be started until other contract work on the project is completed. Therefore, the Project Manager must keep the district office, the contractor and the construction office informed as to the date the work site will become available.
- @ 7. **The Contractor must submit to the Construction Division shop plans on the type of “end treatment” that will be installed. Approved shop plans will be distributed to Maintenance so that future repair work has good reference documents. The PM must indicate on the “As-Built” Plans the types of “end treatments” that were installed.**

GENERAL INSTRUCTIONS

@ Safety implications make it very important that the Project Manager, inspector, and contractor know the plans **and** specifications that apply to this work.

A guardrail inspection checklist is provided at the beginning of this Division. This checklist may be helpful in preparation and inspection for guardrail work. Inspection and material acceptance requirements are identified in the Plans and Specifications.

Guardrail installations are dependent on correct location of shoulder or bridge approach paving and 10:1 (or flatter) approach slope to guardrail. Prior to the start of guardrail installations, these need to be reviewed and verified.

@ Slope on finished surface between shoulder and a point at least **2 feet (600 mm)** behind back of posts should be 10:1 or flatter. This provides a slope which will keep vehicle wheels in contact with the ground and adequate soil support for the posts.

If the inspector or the Project Manager observe a variance from plans or specifications, then the contractor should be advised immediately. When situations arise that are not covered by specifications, plans, standard plans, or this instruction, contact the Construction Division.

903.02 MATERIAL REQUIREMENTS

The plans, special provisions and specifications will include the material requirements. The Materials and Research Manual includes the inspection and test requirements for the materials. The field personnel must insure that all materials used in the work conform to these requirements.

903.03 CONSTRUCTION METHODS

@ Standard plan **for** Traffic Control Devices for Construction and Maintenance, is a part of all guardrail project plans. Field personnel shall insure that project traffic (whether local only or traffic maintained condition are in effect) is controlled and workmen protected so this work is performed under safe conditions for all involved. Generally, guardrail work would be considered to require traffic control procedures similar to the situation sketches for minor maintenance of short duration or road repair.

- @ The specifications are very detailed on construction methods and the field personnel must insure that these methods are used. All connections must be tightened, etc. Cables that are anchored in concrete cannot be tightened until the concrete has attained **2000 psi (14 Mpa)**. The work is not complete until the contractor has tightened all turnbuckles, **cables, nuts**, etc.

W-BEAM AND THRIE-BEAM GUARDRAIL INSTALLATION

Rail Alignment

Rail shall be installed with reasonably smooth vertical and horizontal lines. Kinks in both straight and shop curved sections shall be avoided. Face of rail shall have no protrusions that could catch a vehicle sliding along the rail. The project plans will show how to install the guardrail. Minor adjustments may be made to meet plan requirements.

Guardrail Posts

- @ Posts shall be installed at prepunched holes and at intervals shown on the correct plan. Post details on the plans show required backfill materials and correct hole sizes.

Where longitudinal obstructions (electric cables, curbs, etc.) are encountered, 2 or 3 posts may have a maximum of 2 blockouts to provide an offset. If this cannot be done, obstruction shall be removed or relocated. We could also use a 25 ft (7.62 m) section of **nested guardrail** over one or two posts and avoid using post in obstructed locations. Plans will show **these** details.

- @

Rail Section Location

All prepunched rail sections should be in proper location within each guardrail assembly.

- @ This involves sections with **3 feet-1½ inch** post spacing, sections with **6 feet- 3 inch (1.905 m)** post spacing, and appropriate **end treatments** section as shown in the plans.

Rail Height

Guardrail installations are constructed with W beam and thrie-beam rail. The Standard

- @ Plans indicate the mounting height is measured from surface of ground at the face of rail to the top of rail. Target height is **27¾ (705 mm)** for W-beam and **32 ? inch (829 mm)** for thrie-beam.

On a project where all new guardrail is installed or existing guardrail is being removed and reinstalled, tolerance will be.

Lapping of Guardrail

Lapping of rail must be accomplished in a uniform manner. Details shown in the plans will achieve uniformity statewide. However, clarification may be helpful in obtaining this uniformity in specific instances.

- @ Plans indicate guardrail shall normally be lapped in direction of traffic flow. Following this general rule, most installations will be lapped correctly. Plans provide a lapping procedure detail for each type of guardrail installation except:
 - Where guardrail alignment is curved away from centerline (bridge ends or end sections), lap should protect approach vehicles.

Keep in mind that the basic principle of lapping has to do with favoring the traffic for which the guardrail is being installed.

- @ All laps of rail shall take place at a post. The 5/8 inch (16 mm) x 1 ¼ inch (32 mm) splice bolts at these laps should not have washers.

BRIDGE CONNECTIONS

- @ All end treatments including bridge approach sections shall be installed so that the end post sleeve is not more than 4 inches above ground level so that the undercarriage of a vehicle cannot be snagged. Exception to this is on trailing end of a one-way bridge where Type "J" terminal section shall be installed on outside of rail.

On guardrail attachments to concrete which require a bolt longer than 2 ft (600 mm), 7/8 inch (22 mm) bolt anchors may be grouted into concrete using threaded insert anchors with epoxy.

All bolts on bridge end connections shall be high strength, galvanized hex bolts. Surface of bolt head should be marked A-325, A449 or have three radial marks at 120° intervals.

GUARDRAIL POST

- @ W-beam and thrie beam guardrail posts – wood and steel – must be able to rotate if the beam rail is to work properly. Care must be taken to insure compliance with the details shown on the plans regarding “space” and density of material behind the posts.

END TREATMENTS

- @ There are two general types of end treatments (Type I & II). Future plans will no longer provide “end treatment” details. Contractors will be required to submit shop plans for the “end treatment” they want to use. The plans will indicate where the end treatment is to be installed and whether Type I or Type II end treatment is required and also the acceptable styles for each “Type” (such as Best, ET-2000, etc).

End treatment Type I is dimensioned as 50 feet (15.2 m) so that ET-2000, Best and SKT-350 can be bid competitively. The ET-2000 is only 37 feet- 6 inches (11.4 m) and the extra

12 feet-6 inches (3.8 m) split will be standard W-beam, either placed parallel or 25:1 as shown on the guardrail layout special plan.

End treatment Type I is generally used on expressways and interstates where the speed limit will be at or above 65 mph. "Type I" will be on a guardrail which is set on a 25:1 taper.

End treatment and Type II is used at locations where the posted speed is under 65 mph. Type II will be on guardrail which is on a 15:1 taper.

The PM must indicate the type of end treatment that was installed in the "As-Builts".

END ANCHORAGE

@ To insure that concrete does not become attached to bottom and sides of breakaway end anchorage post a small amount [1 or 2 inch (25 or 50 mm)] of soil may be tamped around post bottom or bottom 6 inches (150 mm) of post may be wrapped with expanded polystyrene foam sheets in place as shown on the plans. If steel tubes are used, grease the bottom 12 inches (300 mm) of the wood post and the inside of the sleeve generously. This is done so that it would be easy to remove the damaged ones.

Soil removed from all end anchorage holes should be disposed of away from the hole to insure proper installation height.

To remove post a small quantity of diesel fuel can be poured on expanded polystyrene foam. This will dissolve foam for easy removal.

903.04 METHOD OF MEASUREMENT

Final field measurement will not be required when the guardrail is constructed as ordered.

904.00 SUBDRAIN EARTHWORK

904.01 SUBDRAINS

Subdrains are constructed on grading, paving, and structures contracts. Refer to *SSHC Sections 914 and 915*.

Subdrains are used for tile relocations, backslope drains, longitudinal and cross drains under the roadway area.

Subdrains are also used with granular blankets to develop a drainage layer in areas where the soil has a high moisture content and poor stability.

904.02 BACKSLOPE DRAINS

Backslope drains are used in areas where seepage and/or a slide is possible. Where a water table is perched on a very dense layer, a subdrain is installed at or below the surface of the very dense layer. The flow line is very important in this case. A backslope drain may also be used to drain a sand pocket, again plan flow line is important.

904.03 LONGITUDINAL DRAINS

Longitudinal drains are usually installed at the pavement edge to remove any water that accumulates under the pavement.

Inspection considerations must include:

- **Trench Excavation**

The trenching equipment must be adjusted and maintained so the trench is excavated to the specified depth. It is important that all of the loose excavated material is removed from the bottom of the trench to minimize settlement of the trench backfill. Trenchers have a metal device on the end of the trencher's boom called a "cumber." The "cumber" is to be adjusted so the loose material is scraped off of the bottom and removed.

- **Outlets**

All outlets should be inspected prior to backfilling. The pipe coupling should be inspected to assure proper installation. The flow line of the outlet should be checked for uniform downward grade toward the ditch. All outlets are to be marked with an orange fence post.

Some projects require that existing subdrain outlets be extended, for example, on a shoulder widening project. On these projects, the contractor must remove the existing rodent guard before extending the pipe.

DIVISION 1000

MATERIAL DETAILS

1001.00 GENERAL

Specification Division 1000 provides detailed descriptions of the materials specified for highway construction. (Refer to the *Standard Specification for Highway Construction Manual Division 100* for further material information.)

1001.01 MATERIAL CERTIFICATIONS

Construction materials may required certificates of compliance, certified tests, or reports of inspection from an outside agency for their use and acceptance. These materials will not be incorporated into the work until such information has been received by State Personnel.

After the material information has been received, the following course of action will be taken:

- A. The information will be reviewed by State Personnel to insure that it conforms with the material requirements.
- B. The information will be dated when it is received from the contractor. This can either be initialed and dated or date stamped.
- C. The original copy of the information will be forwarded to the Materials & Research Division immediately. A copy will be kept in the Project Manager's project file.

Material inadvertently incorporated in the work without the required material documentation should not be included for payment on the progress estimate. If an item is on the estimate, it should be removed until proper documentation is received.

1001.02 MATERIAL CERTIFICATION RECEIPT & INTEREST DATE DETERMINATION

The interest beginning date is normally the sixty first day following tentative acceptance.

If the certifications are not received in a timely manner, then the interest date will be adjusted to the date that the documentation is in NDR possession. This is why it is extremely important to date the information when it is received from the contractor.

1002.00 APPROVED PRODUCTS LIST

1002.01 DESCRIPTION

Many material items are not described in detail in the plans and specifications but are authorized for use as shown on the NDR Approved Products List. The NDR Approved Products List is on file on the NDOR web page and is updated when a new product is added to the list or when a product is dropped from the list.

@

1002.02 ACCESS COMMANDS

Moved following paragraph from page 479 and deleted text.

Contact Terry Masters in the NDR Materials and Research Division at (402) 479-4754 if there are any questions concerning the viewing or printing of the Approved Products List.

1002.03 ADDITIONS/DELETIONS TO THE APPROVED PRODUCTS LIST

The Approved Products List is normally updated on Friday. Materials that meet NDR's *Standard Specifications for Highway Construction* may be added to the list at any time. Materials may also be deleted from the list at any time.

Contact the Physical Testing Section in the NDR Materials and Research Division at (402) 479-4746 to obtain information on required certification and documentation that is necessary for a specific product.

SSHC Subsection 1001.03 identifies details relating to the use of the Approved Products List and the procedure for using a material that is not included on the Approved Products List.

1003.00 WHITE PIGMENTED CURING COMPOUND AND HOT-POUR JOINT SEALER

@

1003.01 DESCRIPTION

White pigmented curing compound and hot-pour joint sealer are sampled at the manufacturer's plant and tested in the Lincoln laboratory before being shipped to Nebraska. Test results for curing compound and joint sealer are on file on the computer. When either of these materials arrive at the construction site, it is necessary to identify the manufacturer and lot number of the material, then check the [Approved Products List on the Department's web-site](#) to verify that the material has been tested and approved for use on the project. The possibility always exists that untested material may be shipped to the construction site.

@

1003.02 REPORTING MATERIAL USAGE

If you use white pigmented curing compound and/or hot-pour joint sealer, Materials and Research needs to know. Send Terry Masters an e-mail note with product name, manufacturer, lot number, approval date and the quantity used.

@

@

@ **1004.00 PCC REQUIREMENTS**

1004.01 CEMENT CERTIFICATIONS

Note 7 in the Materials Sampling Guide, Volume II, requires that the pink copy of the cement certificate of compliance, DR Form 228 or a copy of the mill's own certification form be mailed to the Materials & Research Division. However, Materials & Research does not need the pink copy of the certification mailed to them anymore. The copy at the concrete production facility is enough for Materials & Research records.

The certificate of compliance is needed both for mills that require sampling and those that do not. When a sample is required, normal procedure has been to submit the pink copy with the sample. This is acceptable. For those mills which do not require sampling, please collect and submit the certifications on a routine basis but at a minimum of once each week.

1004.02 CONCRETE STRENGTH

The following English and Metric unit “Concrete Strength Variation” table is provided to define the different strengths that may be specified. The specified strength has varied as the Department has converted from English to Metric units and then back to English units. In the following table, the standard strengths are given in pounds per square inch (psi) and the various equivalent units that have been used in the past 5 years to specify this strength are shown. **However, the strength that a contractor is held-to can only be what is contained in the contract. So if the contract calls for 2900-psi, we cannot reject or deduct if he does not provide 3000-psi.**

Concrete Strength Variation

Current Standard Strength (psi)	Actual Specified Strength (psi)	Actual Specified Strength (Mpa)
3000	3000, 2900	20, 20.7, 21
3500	3500, 3625	25, 24.3, 24
4000	4000, 4350	30, 27.6, 27

1004.03 CONCRETE CYLINDER POLICY

@

Cylinders

All concrete cylinders applicable to this policy will be 6 inches by 12 inches. All cylinders shall be cast by currently certified technicians, or by new or temporary employees trained and approved by qualified Materials and Research personnel in accordance with the NDR technician training program.

Structures

A set of three cylinders will be made for the first 100 cubic yards placed and an additional set of three cylinders will be made for the remainder of the concrete placed for each day provided at least 50 cubic yards more is placed. A minimum of three cylinders will be made for each day's placement. One cylinder from each set will be tested at 28 days. The other two cores from each set will be tested at the intervals designated by the engineer. If no intervals are designated, the cylinders will be tested at 7 days and 14 days respectively.

Pavements

A set of four cylinders will be made for each day's placement. These cylinders will be tested at the intervals designated by the engineer unless the pavement does not need to be cored. If the pavement will not be cored, at least one cylinder must be tested at 28 days. The other cylinders will be tested at the intervals designated by the engineer.

If the pavement must be cored and no intervals are designated, the cylinders will be tested at 7, 10, and 14 days or until the specified strength is attained. If needed, the fourth cylinder will also be tested at 14 days and the average strength of the two cylinders reported. If the pavement will not be cored and no intervals are designated, the cylinders will be tested at 7, 10, 14, and 28 days or until the specified strength is attained.

Miscellaneous Concrete

Concrete placements requiring five cubic yards or less and which are noncritical, may be accepted by the engineer without testing. Noncritical refers to placements that will not sustain traffic loading and for which failure is not likely to disrupt traffic or pose a threat of harm to the traveling public.

CONCRETE CYLINDER REQUIREMENTS SUMMARY						
CONCRETE PRODUCT	REQUIRED NUMBER OF CYLINDERS	REQUIRED BREAK DATE				
		7-DAYS	10-DAYS	14-DAYS	28-DAYS	OTHER
STRUCTURES*	3				2	2
PAVEMENTS**	4	1	1	1	1	
MISCELLANEOUS CONCRETE	Concrete placements requiring 5-cubic yards or less which are noncritical, may be accepted without testing.					
*3-cylinders are required for the first 100-yd ³ each day and another set of 3-cylinders is required if a total of at least 150-yd ³ is required in one day. The Engineer may set the date of the third cylinder break as necessary.						
**Four cylinders are required for each day's placement. The Engineer may designate the date the cylinders are to be broken; if the pavement will not be cored at least one cylinder will be broke at 28-days; if the pavement will be cored then cylinders are broke at dates designated by the Engineer or as shown above.						

@

1005.00 MATERIALS & RESEARCH DIVISION'S FINAL REVIEW PROCEDURES

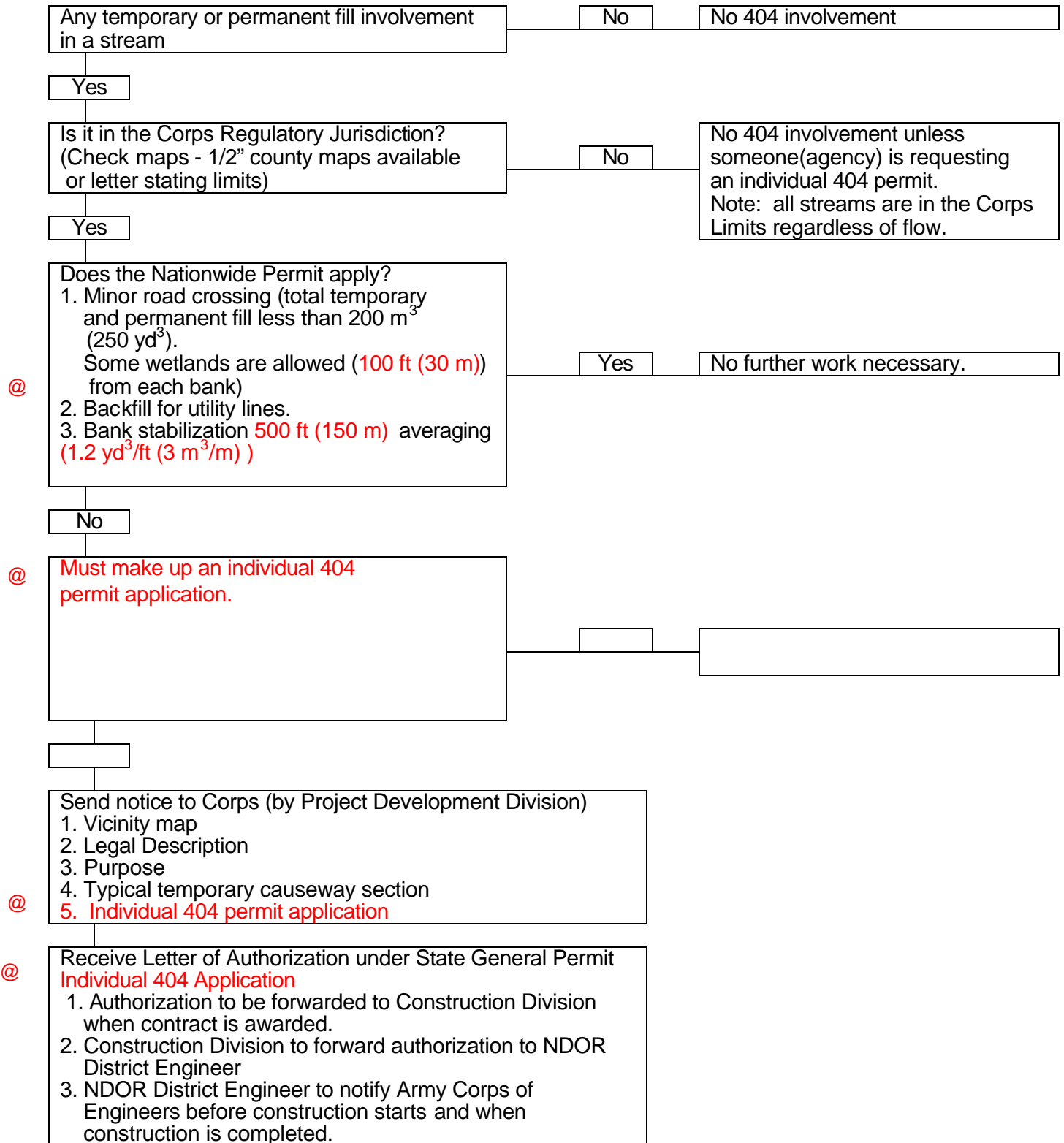
The Materials and Research Division's Final Review Section will perform the following steps:

- The Materials and Research Division will receive notification from the Project Manager that the project is complete and ready for the material review.
- The Materials and Research Division's Final Review Section will make a listing of all materials that need to be reviewed.
- This listing will be routed through the various laboratories in the Materials and Research Division. The individual laboratories will review their areas and note if the material is satisfactory or a deficiency exists (i.e.: required samples or certifications not received, materials not meeting specification requirements, deductions in compensation for failing materials).
- When complete this listing will be returned to the Materials and Research Division's Final Review Section.
- The Materials and Research Division will determine which materials are deemed critical and non-critical.
- Non-Critical Materials will be accepted by a blanket letter of acceptance. This letter will be generated by the Materials and Research Division's Final Review Section and sent to the Project Manager by e-mail or fax. By signing this letter the Project Manager is stating that all of the materials met specification requirements and that the necessary documentation is in their files. The Project Manager can fax or mail the signed letter to the Materials and Research Division (fax number 402-479-3975).
- Critical Materials will require that the necessary certifications and samples are on file in the Materials and Research Division. The Materials and Research Division's Final Review Section will send an e-mail to the Project Manager listing these materials and requesting that the required documentation be submitted.
- Once all of the necessary information is received in the Materials and Research Division a letter will be sent to the Project Manager stating that the material review is complete. (There is the possibility that another material shortage could occur if a subsequent estimate adds an item or increases a quantity. If this happens the Project Manager will be notified).

- The Construction Division will contact the Materials and Research Division when a final estimate is ready for our approval. When all necessary documentation has been received we will release this estimate for final payment. A letter will be sent to the Project Manager stating that the Materials and Research Division has released the final estimate.
- @ ➤ If you have any questions regarding this procedure please contact Rhonda DeButts @ 402-479-4760 or Dave Hall @ 402-479-4837.

CHAPTER NOTES:

404 Determination Checklist



- I. Corps of Engineers (C.O.E.) Wetland Regulatory Authority
 - A. Rivers and Harbors Act - 1890 - Navigable Waters
 - B. Federal Water Pollution Control Act - 1972
 1. Section 404 Permits - Regulate discharge of dredged or fill material from or into waters of the United States.
 2. Act amended in 1977 and given common name "Clean Water Act" (C.W.A.).
 3. Wetlands are under the jurisdiction of Clean Water Act through 1985 court case. Those wetlands covered by the Clean Water Act are called jurisdictional wetlands.
- II. C.O.E. Changes Jurisdictional Wetland Policy
 - A. Regulatory Guidance Letter - November, 1995 - in some cases, wetlands are no longer under the jurisdiction of the C.W.A. - no Corps regulation.
 1. Former Policy - Wetlands in roadside ditches were under the jurisdiction of the Clean Water Act, thus regulated by C.O.E. - possible mitigation.
 2. Current Policy
 - (a) Wetlands occurring in typical ditches, in upland areas are nonjurisdictional. Therefore, not under the jurisdiction of C.W.A. No Corps authority. No mitigation for impacts.
 - (b) If ditch was constructed in a wetland, then the ditch would be under the jurisdiction of C.W.A. Corps has regulatory authority. Possible mitigation for impacts.
 - (c) Borrow pits which exhibit wetland characteristics are under the jurisdiction of the C.W.A. Corps has regulatory authority. Possible mitigation for impacts.
 - B. Overall mitigation requirements will lessen which will result in lower costs.
- III. C.O.E. Concerns
 - A. C.O.E. perceives there to be a problem with:
 1. Disposal of road materials in waterways and wetlands.
 - (a) Section 404 of the Clean Water Act
 - (1) Dredge and fill activities require permit from C.O.E.

- (b) Violation of Section 404 - Work done without a permit. Up to \$25,000 fine per day that the violation is in place. Examples - filling wetland or dumping old bridge in waterway.
 - (c) Noncompliance with Section 404 - Not following permit conditions. Up to \$10,000 per violation plus remedial costs. Examples - using asphalt or allowing concrete with exposed rebar for bank stabilization.
- 2. Impacting wetlands not cross hatched on plans. Examples - storing equipment in wetland areas or rock in ditched jurisdictional wetland to prevent the accumulation of mud on the road.
 - 3. Failure to utilize silt fences.

The wetlands point of contact is:

Wetlands Program Manager
Project Development Division
(402) 479-4418

1100.15 WASTE GENERATED

"Solid Waste" means garbage, refuse, rubbish, and other similar discarded solid or semisolid materials, including but not limited to such materials resulting from industrial, commercial, agricultural, and domestic activities. This shall not prohibit the use of dirt, stone, brick, or similar inorganic material for fill, landscaping, excavation, or grading at places other than a sanitary disposal site. It shall be unlawful for any private or public agency to dump or dispose or permit the dumping or depositing of any solid waste at any place other than an approved sanitary landfill.

"Open Dumping" means the depositing of solid wastes on the surface of the ground or into a stream or body of water.

"Toxic and Hazardous Wastes" means waste materials including, but not limited to poisons, pesticides, herbicides, acids, caustics, pathological wastes, flammable or explosive materials, and similar harmful wastes which require special handling. These items must be disposed of in such a manner as to conserve the environment and be protective of public health and safety.

"Free Liquids" or wastes containing free liquids shall not be disposed of in a sanitary landfill. This includes industrial sludge and toxic or hazardous wastes.

1100.16 WATER WELLS

Occasionally contractors request permission to drill water wells on state property in order to secure water to use in the construction of a project. A written agreement should be executed between the state (DEQ) and any contractor who wants to develop a well on state property in order to assure that the contractor assumes responsibility and liability for use of the well.

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1100.17 ARCHEOLOGICAL AND PALEONTOLOGICAL DISCOVERIES

If Indian relics, fossils, meteorites or other articles of historical or geological interest are encountered in highway excavation operations, such operations shall be suspended in the area involved "until such times as arrangements are made for their removal and preservation".

Under present procedures, the department is cooperating with the Nebraska State Historical Society and the University of Nebraska State Museum. Preliminary plans for highway improvements are made available to these agencies as far in advance of construction as practical. Their archeologists examine the plan locations and correlate any findings with their records and information. If any known historical relics or Indian habitations or relics are involved with the construction, arrangements are then made cooperatively with the department to remove and preserve such items in advance of the construction of the project.

It is expected that only rarely will such items be encountered during construction. However, if such articles are encountered, the Project Manager will have work suspended in the area involved, and immediately notify the Construction Division. Arrangements will then be made from that office for the removal and preservation of the articles.

Project Managers or their representatives should make a periodic inspection of the work site or sites on all archeological or paleontological work. This inspection is to determine that the work called for in the agreement is being performed. This periodic inspection should be made at least once a week. The Project Manager should keep himself advised of the progress so that no unnecessary delays to the contractor will occur. Confirmation that the contractor can resume work at the site will come from the Construction Division.

1100.20 UNDERGROUND TANKS

@ NDEQ has a website (www.deq.state.ne.us) which is an excellent environmental and underground storage tank reference.

Underground Storage Tanks (USTs) represent one of the more common environmental problems encountered. USTs may have been (or may currently be) used to store almost any kind of viscous material including petroleum products, chemicals, and discarded wastes (some of which could be classified as hazardous). Leaks from these tanks or their auxiliary components (i.e., piping, couplings, pumps, and valves) are not uncommon.

An Underground Storage Tank (UST) is defined as a tank and associated piping with 10% or more of its volume below the ground which has stored or is storing a regulated substance. Regulated substances include petroleum based substances (motor fuels, motor oil, home heating fuels, solvents, etc.) and any other substance which, if released into the environment may present substantial danger to public health, welfare, or the environment.

1100.21 REGISTRATION

EPA established a program for regulating Leaking Underground Storage Tanks (LUSTs). Under this program the design, installation, maintenance, monitoring, and failures of LUSTs are regulated. In Nebraska, this federal program is administrated by DEQ. All underground storage tanks are required to be registered with the State Fire Marshal Office. Tanks that have been registered should have a metal tag affixed to the fill pipe. Owners (including NDR) of underground storage tanks must:

- A. Register existing tanks, previously removed tanks, and abandoned tanks. (The "registration" of a tank includes "any" tank from a tank at a gas station to one located in the middle of Timbuktu.)

In Nebraska, the registration includes attaching a numbered metal tag to the fill pipe of any underground tank. The lack of a tag does not necessarily mean the tank is not registered, but obviously the presence of a tag indicates it is registered. If there is a question about registration, contact the Construction Division. This office has access to the registration file at State Fire Marshal Office via computer, and can look up any registered tank with minimal basic information.

NOTE: Currently in Nebraska, there is a registration exclusion for tanks:

- @ • Farm tanks holding 835 gal (3164 L) or less.
 - Tanks on or above the floor of underground areas such as basements.
 - Tanks storing home heating oils used on the premises where it is stored.
 - @ • Tanks holding 110 gal (416 L) or less.
- B. Meet tank performance standards for new installations.
- C. Make tanks leak proof for their entire life.
- D. Install leak detection systems.

- E. Keep operational records.

1100.22 REMOVAL OF USTs

@ The following procedure for removing underground tanks is based on **State Fire Marshall (SFM)** regulations. For clarity, the following has been divided into known tank locations and unknown tank locations. (The law considers both the same. But because of bid items, contract administration requires them to be treated differently.) For all removals of underground tanks, follow appropriate Supplemental Specification.

Removal of Known Tanks

These tanks are the ones identified on the project plans and will be noted for removal.

A. Removal Process

IMMEDIATELY upon starting any project requiring UST removal, check the tankfill pipes for a metal Registration Tag.

- If tank has a registration tag, note its number in the inspectors daily diary.
- If the tank does not have a registration tag, the Project Manager must notify the Construction Division immediately. This notification will allow the Construction Division to check Fire Marshal records for a valid registration. Also, it will allow time for registration should the tank not be listed with the Fire Marshal.

@ Note: Nonregistered tanks cannot be removed until after they have been registered, and that process can take a couple of weeks to complete. In addition, the Construction Division must submit a closure notification to **SFM and Closure Assessment Report (CAR)** as specified on the permit to close.

B. Closure Notification

- The Project Manager must initiate and submit a "Notification of Tank Closure or Change-in-Service" to the Construction Division 35 days prior to removal.
- @ • After the form has been submitted and processed, **SFM** will send removal information and instructions directly to the Project Manager.

C. Tank Removal

@ Contractor's consultant is required to **have certified Closure Individual** with the **SFM on site during the entire removal process. The contractor shall provide the NDOR Project Manager a photocopy of the individual's card and also Contractor's license to close tanks.**

- Tanks must have ALL liquids **and** any explosive vapors REMOVED prior to extracting the tank.
 1. All removed liquids must be disposed in accordance with DEQ regulations.

@ 2. Vapors are typically evacuated by placing dry ice into the tank. As the ice evaporates, carbon dioxide is released and the fuel vapors are displaced.

- State Fire Marshal may be on site to inspect the removal.
- Removed tank must be stenciled according to SFM requirements.
- Any registration tags must be removed and retained by the project inspector. These tags are to be submitted to (SFM) when the closure report is filed.
- Any extracted tanks should be removed from the site on the day of removal.
- A "Certificate of Destruction" must be completed for each tank at the time the tank is disposed.

D. Sampling

- @
- All removals require soil and/or water samples to be taken by the contractor's consultant and analyzed for potential contamination.
 - DEQ requires samples collected from tank sites to be analyzed using specific laboratory methods.
 - Soil sampling locations are identified in the removal information and instructions furnished by DEQ. **Soil samples may be required below the Static groundwater table. The water shall be sampled if water is encountered during excavation.**
- @

E. Contamination

- If contamination is found or suspected during the tank extraction, contact the Construction Division immediately. If appropriate Construction Division personnel are not available, the Project Manager shall notify DEQ directly. The telephone number for DEQ's tank section is (402) 471-4230. (The contractor's consultant will provide site information based on air monitoring if there are any questions.)
 - The NDR has 24 hours to report this contamination unless an immediate threat exists. In that case, reporting times are reduced to 6 hours.
 - Immediate threat means a potential exists for explosive conditions, immediate danger to life or health, or an immediate threat to water supplies.
- @

- F. Site Safety

1. If, based on site conditions and situations, the inspector or contractor feels there is an immediate threat for **explosion**, the contractor shall:

- Immediately shut-off all operating equipment, extinguish all sources of ignition (i.e., cigarettes etc.), and evacuate the area. This includes all personnel.
- After the site is evacuated, establish controls to prevent site access and contact local **and state** authorities.

@

- **No smoking signs must be in place. (No smoking within 50 feet).**

The inspector shall contact the Construction Division.

2. If, based on site conditions and situations, the inspector or contractor feels there is an **immediate** danger to life or health **other than** by explosion, the contractor shall:

- Immediately evacuate the area. This includes all personnel and could include equipment.
- After the site is evacuated, establish controls to prevent site access.

The inspector shall contact the Construction Division.

3. If, based on site conditions and situations, the inspector or contractor feels there is an immediate danger to a water supply, the contractor shall:

- Using whatever means are available, immediately establish positive restrictions to limit or prevent migration of contamination to a water supply. **(If threats to life or health from explosion are not present).**
- Watch for changing conditions which could present threats due to explosion and/or danger to life or health. If site conditions change, implement the appropriate response as noted above.

@

The inspector shall contact the Construction Division.

G. Removal of Contaminated Soil

If the site is determined to be contaminated, one method of remediation is to overexcavate. Contaminated soil which has been over-excavated must be "properly" disposed. **(DEQ may provide approval to over-excavation--see pages 3-5 of the DEQ "Petroleum Contaminated Soils Guidance for Leaking USTs".)**

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H. Disposal Options

There are several approved methods for disposal, however, DEQ must preapprove any disposal option. Some options which have been successfully used include:

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1. Removal of soil and disposing in a **licensed** landfill. This not only requires prior approval by DEQ, but also approval from the local receiving landfill.

@ Typical costs for this option range from \$15 to \$40/yd³ (\$15 to \$40/m³) plus trucking.

2. Another option which is limited by physical location is that of "soil burning." The process involves treating petroleum contaminated soil by passing it through a rotating drum where there is high heat and flame. (It is a converted asphalt drum dryer.) During "treatment," soil moisture is driven off, combustible products in the soil are first volatilized and then flashed off. The result is dry "petroleum" free soil.

@ While the remedial concept is reasonably sound, the cost for this remediation is very expensive (costs range from \$30 to \$70 per Ton (Megagram)) not to mention trucking costs to the plant. However, if a project is in that area, "soil burning" is one option available for remediation.

For completeness, a word of caution must be included about this process. The process, if properly operated, removes petroleum contamination, however, it does not remove other potential contaminants (i.e., heavy metals, pesticides/herbicides, etc.) Often the plant requests anyone bringing soil to the plant to back haul "processed" soil. Obviously, clean/remediated soil is a by-product of this operation. **DO NOT AGREE TO BACK HAUL ANY "REMEDiated" SOIL FROM THIS OPERATION WITHOUT FIRST CONTACTING THE CONSTRUCTION DIVISION.** This does not mean the facility should not be used, or that the remediated soil is not clean. DEQ needs to be sure there are adequate and quantifiable analytical results to assure back-hauled soils are not contaminated with other substances.

3. Another option is to remove the soil (over-excavate) and spread it out on the surface. This method is called Land Application and also requires preapproved permit from DEQ. The land application of petroleum contaminated soil provides an effective means of treatment through volatilization and biodegradation. Land application has been used successfully in situations where NDR owns (not by temporary easement) a parcel of excess right-of-way.

In situations where contaminated soil must be remediated, the Project Manager should look for and identify suitable locations to the Construction Division. Criteria for land application are:

- @ • Maximum application rate is 4 inches (100 mm) thick **OR** 500 tons/acre(1.12 Gg/hectare). Based on an estimated excavation volume, the inspector can calculate approximate remediation area.
- Petroleum saturated soil cannot be land applied. (The KEY is "petroleum saturated" not "moisture saturated." Soil excavated below the water table may be land applied, as long as it does contain free (decantable) petroleum products.
- Petroleum contaminated soil cannot be applied any closer than:
 - @ a. 525 ft (160 m) from a well.

- b. 200 ft (61 m) from an occupied residence.
 - c. 200 ft (61 m) from a stream, river, lake, pond, sinkhole, or down gradient intake for a tile line or culvert.
- Slopes must be less than 5%.
- Potential land farming areas with sandy, sandy loamy, and high silty soils are not acceptable. There also must be at least 6 ft (2 m) of existing topsoil over bedrock.
 - Obviously the site must be accessible to trucks or hauling equipment and have no other planned traffic or activity during the remediation time.
 - Soil for remediation will have to be leveled and disced at least two times during the course of remediation. One discing needs to be soon after placement and leveling, the other about 2 months later. Once the soil has been tested and analytical results indicate it is clean, the area should be fertilized and seeded with a suitable stabilization crop.

I. Closure Report

- Contractor and/or the contractor's environmental consultant are responsible to complete the closure report.
- The report shall locate all removed tank locations by station and offset.
- Closure reports are to be submitted to the Project Manager within 20 days of completion of sample analysis. The Project Manager shall keep a copy of all reports in the project files and forward original to the Construction Division within 5 days of receipt. The State Fire Marshall's Office must receive a copy of the closure report before the deadline listed in the permit to close, usually 45 days from date of tank removal.

Closure reports are to contain:

1. Completed preprinted SFM closure forms. Check to be sure the following information is included:
 - a. All lab reports.
 - b. Construction details.
 - c. Scale dimensional site drawing showing location and depth, location and depth of all piping, location and depth of all sampling and monitoring well locations. NOTE: All locations are to be referenced by station and offset from mainline or side road survey.
2. Tank registration tags.

Removal/Discovery of Unknown Tanks ("Orphan" Tanks)

For the purposes of this chapter, "unknown" tanks should be considered those tanks not identified on the plans but encountered during a project. Most likely the discovery of an unknown tank will come at the worst time. For example, machinery running, work time in a crunch, and "any" appreciable delay will work a severe hardship on the contractor. Therefore, timeliness and notification become critical in dealing with the issues.

Upon finding a previously unknown tank, follow these guidelines:

FIRST: Immediately stop all work in and around the tank.

SECOND: Determine the site conditions. For example:

A. Note tank condition and damage. Is liquid leaking from the tank? If so:

1. If fuel is released, call:

- NDEQ at (402) 471-4230 during office hours or (402) 471-4545 NSP (State Patrol) afterhours. **Leaking Underground Storage Tank/Release Assessment Section (LUST/RA).**
- State Fire Marshal's Office (**SFM**)
Flammable Liquid Storage Tank Division
(402) 471-9465 Clark Conklin
- Construction Division (402) 479-4532

@

2. If, based on site conditions and situations, the inspector or contractor feels there is an immediate threat for **explosion**, the contractor shall:

- Immediately shut-off all operating equipment extinguish all sources of ignition (i.e., cigarettes etc.) and evacuate the area. This includes all personnel.
- After the site is evacuated, establish controls to prevent site access and contact local authorities.

The inspector shall contact the Construction Division.

3. If, based on site conditions and situations, the inspector or contractor feels there is an immediate danger to life or health other than by explosion, the Contractor shall:

- Immediately evacuate the area. This includes all personnel and could include equipment.
- After the site is evacuated, establish controls to prevent site access.

The inspector shall contact the Construction Division.

4. If, based on site conditions and situations, the inspector feels there is an immediate danger to a water supply, the contractor shall: **(Threats to life or health and explosion are not present.)**

- Using whatever means are available, immediately establish positive restrictions to limit or prevent migration of contamination to a water supply.
- Watch for changing conditions which could present threats due to explosion and/or danger to life or health. If site conditions change, implement the appropriate response as noted above.

The inspector shall contact the Construction Division.

B. If leakage is not apparent determine if any liquid is in the tank.

C. Attempt to determine the size of the tank (volumetric and/or dimensional size estimation).

@ D. Is there any indication of past leakage? (Stained (discolored) soil or smell of fuel are indicators.)

E. Establish tank location by station, offset and approximate depth. Also indicate approximate street address if available.

THIRD: Begin to establish some positive control to eliminate access to the immediate area. (Silt fence, snow fence, or orange safety fencing set on fence posts are examples of temporary restraints.)

FOURTH: Notify the Project Manager or supervisor of the discovery and provide site conditions to them. If the Project Manager will not be available for some time (3 to 5 hours), the inspector shall contact the Construction Division directly.

FIFTH: The Project Manager shall notify the Construction Division. (NDOR has a legal responsibility, and time limit, to report finding previously unknown USTs.)

1. For Reference: Time expired since first discovering the tank shall not be more than 5 hours before contacting the Construction Division.

2. Leave tank in place.

@ 3. Post "No Smoking Within 50 ft (15m)" signs near tank and secure from general public. Use snow fence.

4. The Logistics Division will apply for a permit to remove tanks as soon as possible. Permit required from Fire Marshal's Office.

5. Removal by licensed contractor (State or private company) will be scheduled as soon as possible.

@ 6. The firm or person in charge of tank removal must notify the Fire Marshal's Office 72 hours before taking out the tank and give the DEQ a minimum of 24 hours advance notice. If NDOR completes a Closure Assessment Report, DEQ advance notice is not needed.

7. Tanks removed from the ground shall be stored in a secure location inaccessible to the general public.
8. A licensed certified closure individual must be present during excavation and tank removal.
9. If contamination is present in the excavation, the State Fire Marshal and the Department of Environmental **Quality** must be notified within 24 hours if they are not present during the scheduled time of tank removal.
- @ 10. Soils will be disposed of as directed by the **NDEQ**. Land farming may be required. Contact **Waste Management Section of NDEQ** (402) 471-4210.
11. The excavated area should be backfilled with clean soil and compacted as required by the Project Manager.
12. For more information, refer to Title 159, Rules and Regulations for Underground Storage Tanks. A copy is available in the Lincoln **Logistics Division** Office.
13. If fuel contaminated soils are encountered during normal construction activities, notify the Lincoln **Construction** Office even if no tank is found. The Lincoln Office will notify the **NDEQ LUST/RA Section and Waste Management Section**.

Recap:

- All construction activity around the area of the tank shall be halted, and remain that way, pending further investigation.
- Preliminary site assessment shall be completed. Included in this assessment shall be an evaluation for imminent dangers.
- Site "SPILL CONTROL" measures should be implemented if needed.
- Positive constraints shall be in place to prevent free public access of the site.
- The Construction Division shall be notified of the discovery.

What Happens Next?

- Construction Division notifies **NDEQ and SFM** about finding an unknown UST.
 - **DEQ does not need to be notified about an unknown UST unless there has been a release or unless DOR will not be completing a Closure Assessment Report.**
- Construction Division will determine if the UST is registered. If not, a registration process will be initiated. (An unregistered UST cannot be removed until after it is registered.)
- The Construction Division will request **SFM's** approval to remove the tank, once registration status is resolved.

- The Project Manager needs to use this time to negotiate an Change Order for tank removals.

@ Once SFM authorizes removal, a notice will be provided to the Project Manager. Removal from this point forward is outlined in SFM approval documents.

1100.30 STORM WATER DISCHARGE (NOT YET FULLY IMPLEMENTED)

All NDR construction projects which disturb 2 ha (5 acres) or more are required to have a STORM WATER PERMIT. (The rules also apply to cities and counties with populations of 100,000 or more.)

A Storm Water Permit requires specific actions intended to reduce and/or eliminate the problems associated with runoff, soil erosion, and siltation. To comply with this environmental regulation, the NDR has developed the following procedure:

- Projects which disturb 2 ha (5 acres) or more are identified by Project Development.
- When projects are turned in, Project Development tabulates projects with PPPs and sends NOIs and newspaper notices to the Construction Division.
- The Construction Division forwards required notices to appropriate newspapers for publication. Once publication verification is returned, the Construction Division assembles all parts for NOIs and forwards copies to DEQ and the Project Manager.
- At this point, the Project Manager administering a particular project is notified that a Storm Water Permit is in place. (The contractor may begin work any time after that notification.)

Project Manager shall check to assure that projects requiring a Storm Water Permit have a Pollution Prevention Plan (PPP). Along with a PPP there should be bid items for pollution control items such as silt fence, stabilizing crops, ditch checks, etc. As always, it is important to check preliminary plans whenever possible to be sure all needed contract items have been included. Obviously, if a contract is let without erosion control items, the Project Manager will have to change order those items.

1100.31 NOTICE OF INTENT (NOI)

NOIs are NDR's official notification to DEQ that there is a project located at "xxxxxxxxxxxxxxx," and the project will be disturbing at least 2 ha (5 acres) or more are required to have a STORM WATER PERMIT. (The rules also apply to cities and counties with populations of 100,000 or more.)

1100.32 CONSTRUCTION DIVISION POLICIES

- Project Managers shall have a copy of all contractor NOIs (noncommercial sources) on file in the project documents before allowing a contractor to produce or provide material for the project.
- *SSHC Subsection 204.02* restricts exposing erodible soil to less than $75000 \pm \text{m}^2$ (90,000 sy) without prior approval of the Project Manager. Criteria for approving a variance to the maximum exposure limit will be based on:
 - A. Having current exposed area protected with erosion control measures. Minimum measures would include silt fence around the perimeter of the area, ditch checks, and additional silt fence where sediments may leave the project.

This includes all disturbed areas (i.e., borrows, areas within temporary and permanent easements.)

- B. The contractor has demonstrated ability and willingness to keep erosion control measures current and maintained within existing work areas.
- C. Consideration must be given for the time of year before exposing additional areas. For example: It would not be unreasonable to deny a request for additional working area in a situation where it is late in the grading season and the contractor is falling behind in finishing, applying mulch, or temporary seeding.

Also, it would not be unreasonable to place a condition on approving an additional spread. For example: "Contractor, you may open area "X" as soon as you have finished and stabilized up to Station "Y.""

- D. The contractor has successfully followed their erosion control work plan. The Project Manager has not noted storm water violations, and has every reason to believe additional open areas will **not** over-extend the contractor's ability to comply with our Storm Water Pollution Permit.

It is strongly recommended that the Project Manager approve additional area on a case-by-case basis and consider approval on the contractor's previous work experience as well as site conditions.

- Contractors have been told it is their responsibility to maintain the project within storm water compliance. They have also been told about the need to be prepared to complete requirements of **their** Pollution Prevention Plan should a subcontractor not be able to perform.

Pollution prevention is necessary even through most of the erosion control work is subcontracted to DBEs. However, compliance is a must and project administrators **MUST** be sure the project is maintained within storm water requirements and that the Pollution Prevention Plan is followed.

1100.33 QUESTIONS OFTEN ASKED

The weather is not favorable to establish temporary seeding or silt fences. What do we do?

- A. Stabilization

Regulations say if an area will not have any activity for 21 days; by the 14th day, some form of stabilization will be required. There is very little latitude in that statement even if it is wet or freezing.

To be in compliance with storm water regulations, something needs to be done. For example, incorporating mulch, using HydroMulch or Soil Binders which are comprised of wood fiber and paper mulch. Both work, but tend to be expensive knowing it is less than temporary and we will have to ultimately seed.

Best solution is to conduct temporary seeding in a timely manner and not let the contractor get so much open that it cannot be stabilized by seeding. At the least keep it to a minimum so if one of the other alternates is necessary, costs can be kept to a minimum.

B. Localized Soil Erosion (Ditch Check and Slit Fences)

Bale checks used as ditch checks are most likely not as effective as "properly" installed silt fence. However, in situations where you are unable to properly install silt fence, bale checks are far superior to nothing at all. For example:

- It is wet and muddy, a trencher cannot get in to place silt fence. Interim ditch check should be bale checks.
- The ground is frozen to a point where a trencher will not work. Winter is coming. Rather than do nothing, bale checks should be installed. At least there is protection in place during the spring thaw. If an "Indian Summer" comes along and silt fence can be installed, by all means replace the bale check.

Bottom Line: Bale checks are very good interim erosion control measures when used in emergency situations. (Check the Road Standards as Roadside Development is resurrecting a standard for bale checks.)

How are borrows evaluated for Storm Water compliance?

All project specified borrows are included in the calculation for a Pollution Prevention Plan (PPP).

A. Pond Borrows

- All pond borrows (wet or dry) during construction must have at least the perimeter protected by erosion control measures. Plus, site specific considerations must be included if there is any dredging involved during construction.
- Temporary stabilization and mulching will not be required on concave slopes within the borrow. However, channels (in-flow and/or out-flow) will require stabilization or erosion control measures.
- Seeding for pond borrows will be required on any disturbed area above normal design pool or ground water elevation.

B. Wetland Mitigation Areas

- Seeding for wet land areas typically does not require special attention. Usually these areas are seeded with the same vegetation crop as any other disturbed segment on a project. Check the contract documents for non-standard situations where special aquatic plants such as cattails, wild rice, etc. may be required.
- Refer to Pond Borrows (Section A, above) for guidance in areas of standing water and selected sections in Normal Borrows (Section C, below) for those areas which are dry during seeding. In either case, all "normal" erosion control practices are required for wet land areas.

C. Normal (Dry) Borrowes

- All normal borrowes must be protected by perimeter erosion control measures, and are included for temporary erosion control measures if work is halted at that site for more than 21 days.
- All normal borrowes, purchased by fee title, shall be included in the area which is permanently seeded.
- Normal borrowes obtained by temporary easement:
 1. That require replacement of topsoil **AND** are used for agricultural row crops. The Project Manager needs to ask the property owner if they want the area permanently seeded.
 - a. If the property owner requests permanent seeding, provide that seeding.
 - b. If the property owner does not want permanent seeding, shape and place temporary seeding on the area. In this case, because the property will be returned to agricultural row crop use, consider temporary seeding as complying with storm water requirements. Note: Other temporary erosion control measures in that area will have to be maintained until the project is accepted.
 2. For temporary easements NOT used for agricultural row crops, permanent seeding will be required. (Examples of this situation would be permanent pastures, timber land, non-farmed land, etc.)

Is snow considered temporary cover in the Storm Water regulations? YES.

Storm water regulations are written recognizing that snow is a "**temporary**" preventive measure. However, just because it snows may or may not fulfill a winter long stabilization and definitely will not comply as spring thaws begin. As soon as the snow is gone, some other means of stabilization is required. ("Gone" could be by melting, wind, or snow plow.) Best advice is to keep working on some form of soil stabilization until it absolutely freezes so hard that work from then on will not be practical.

EXAMPLE: If snow comes in late October and is blown off the site by mid December, then some other form of temporary stabilization is required from that point forward.

Plan notes have designated a plant site within NDR right-of-way. Further, the contractor is told it is their responsibility to provide a permit for this activity. Who is ultimately responsible?

@ The contractor is responsible for that portion of area designated as the "plant site." When this situation occurs, **the contractor should** modify the project PPP by note to exclude the plant site when the contractor's NOI becomes effective.

Often "negative air" is a term used to describe air exhausting systems. For our purposes, this term will be used to signify that the exhaust system is withdrawing at least as much air as:

- Is being supplied by the blasting nozzle(s) and
- The combined effects of all leakage in the containment.

Obviously in situations described above, "**NO NOTICEABLE DUST**" can escape the containment.

While the exhaust system capacity is important it is only as effective as the system's filtering ability. All exhausted air must be filtered to remove suspended dust and particulate. Typically, a dust collection system (i.e., bag house) is attached to the discharge or exhaust equipment.

Rules-of-Thumb:

Good field checks on the effectiveness of any containment are to:

- Watch for signs of dust escaping the containment and/or dust being discharged from exhaust system.
- Containments with proper air handling systems should appear concave along the walls during blast operations. They should **NEVER** appear to bulge during blasting.
- Containments with proper air handling systems should not be so dusty inside that visibility is severely limited.

1100.43 PAINT WASTE DISPOSAL

Toxic Characteristic Leaching Procedure Testing

All waste generated during removal operations SHALL BE sampled and analyzed by the contractor. The waste sample shall be submitted to a laboratory for a TCLP heavy metals analysis. This analysis is for eight environmentally regulated metals typically found in paint and abrasive wastes.

Hazardous Waste Designation

Paint debris is classified as hazardous due to the characteristic of toxicity, if after testing by TCLP, the leachate contains any of the elements in the concentrations equal to or greater than those listed below.

REGULATED LEVELS *	
METAL	mg/L
Arsenic	5.0
Barium	100.0
Cadmium	1.0
Chromium	5.0
Lead	5.0
Mercury	0.2
Selenium	1.0
Silver	5.0
* All regulated levels are "AS OF" spring 1994.	

The Construction Division will attempt to issue a timely memo to all field Construction Divisions when changes occur.

NOTE: Other elements, chemicals, and characteristics can cause a material to be hazardous as defined in *40 CFR 261*. It is for this reason the *Supplemental Specifications* require that no other waste be mixed with paint waste generated during the cleaning process.

If any analysis indicates the presence of metals in levels close to (or above) those listed, contact the Construction Division **BEFORE** issuing a notice for transporting the waste.

Notice for Transfer of Nonhazardous Paint Waste

For all projects involving the removal of paint wastes, some form of manifesting is required. For "nonhazardous" paint wastes (waste with leachable levels below those listed above), *Supplemental Specifications* states:

@ "Accumulated wastes shall not be removed from the temporary storage area without **proper documentation**."

This **notice of disposition** has been standardized and is used as NDR's internal manifest of material being shipped.

The contract documents will identify an NDR facility which has been designated as the "RECEIVING FACILITY." Currently, for construction projects only (not maintenance projects) this is the central complex at Lincoln, Nebraska. There has been a fenced facility designated for storage of nonhazardous paint, which is located at the NDR Maintenance Facility in Lincoln.

Prior to shipping any waste:

1. Waste analysis results shall have been reviewed and determined that the waste is **NOT** hazardous.
- @ 2. A "Notice for Transfer of Nonhazardous Paint Waste" form shall be completed by the **contractor**. (Instructions for completing the form are printed on the form.)
3. The completed form, with required copies, is given to the contractor as their **"notice of disposition."** At this time, the contractor and Project Manager will sign the form "and,"

@

1100.50 DISPOSAL OF CONSTRUCTION WASTES

1100.51 ASBESTOS

@ Asbestos is the name for a group of natural minerals that separate into strong, fine fibers. The fibers are heat-resistant and extremely durable. There are a number of different types of asbestos including Chrysotile, Amosite, Crocidolite, Anthophyllite, Actinolite, and Tremolite. The typical size of asbestos fibers is from 0.1 to 10 micrometers. This makes them usually invisible to the human eye. Because of their fine size, they can remain suspended in air for hours when disturbed. This increases the possibility of human exposure via inhalation.

Health Concerns

Medical studies have shown that the primary exposure route for asbestos is through inhalation. The following diseases can result from inhalation of asbestos fibers:

- Asbestosis - A noncancerous respiratory disease that consists of scarring of lung tissue
- Lung Cancer
- Mesothelioma - A rare cancer of the thin membrane lining of the chest and abdomen
- Other Cancers - Some studies have suggested that exposure to asbestos is responsible for some cancers of internal organs such as esophagus, larynx, stomach, colon, and kidney.

Asbestos Removal

U.S. EPA regulates the removal of asbestos containing material from facilities which are being demolished or renovated. EPA regulations for removal, and subsequent disposal, are set forth in 40 CFR 61. Generally speaking, the following procedures must be followed:

- For all facilities, U.S. EPA must be notified prior to renovation or demolition. This notification must include an estimate of the approximate amount of regulated asbestos containing material to be handled. For the NDR, this notification is handled through the Project Development Office.
- Regulated Asbestos-Containing Material (RACM) must be removed prior to any activities that would disturb the materials or prevent future access to them for removal.
- When RACM has been removed, it must be contained in a leak-proof wrapping or bag and properly labeled for disposal.
- All asbestos removal and handling operations must be performed under the supervision of an individual trained and certified in asbestos handling.
- U.S. DOT regulates the transportation of asbestos and identifies it as a hazardous material. Before accepting RACM for transportation, a transporter must ensure that

DIVISION 1200 -- SITEMANAGER

1200.01 INTRODUCTION

@ SiteManager™ is one of the most powerful software support systems available to transportation agencies. It seamlessly integrates field-based data collection, administration of contract records, contractor payments, project-oriented civil rights monitoring, and materials management. All this is combined with a state-of-the-art, client/server environment and is available to field, project, district, laboratory and central office personnel.

1200.02 INFORMATIONAL GUIDANCE

Each lap top that is used for Construction Inspection and management has the SiteManager documentation installed on the hard drive. This is the official source for guidance and use of SiteManager. In addition, supplemental help files are available on DORSRV81/runtime/how_to.chm.

1200.03 SITEMANAGER SUPPORT LIST**System Administration**

	Lee Burbach	Information Systems	(402) 479-3982
	Shirley Daugherty	Construction Division	(402) 479-4559
	Jim Ferguson	Construction Division	(402) 479-4454
	Mitch Hendricks	Information Systems	(402) 479-3616
	Bill Hitzeman	Construction Division	(402) 479-4456
@	Jill Danburg	Construction Division	(402) 479-4453

District Trainers

	Jeff Kisicki	District 1	(402) 471-0850, Ext. 1910
	Jodie Domenge	District 2	(402) 595-2534, Ext. 223
	Bill Mainquist	District 3	(402) 370-3470
	Terry O'Neel	District 4	(308) 385-6265
@	Scott Clinger	District 5	(308) 262-1920
	Russ Frickey	District 5	(308) 262-1929, Ext. 201
	Ronda Lewis	District 6	(308) 535-8031
	Kelly Doyle	District 7	(308) 345-8490
	Linda Jackson	District 8	(402) 376-1126
	Rhonda DeButts	Materials & Research	(402) 479-4760

Resident Trainers

	Craig Washburn	District 1	(402) 471-0850, Ext. 1138
	Jeff Kisicki	District 1	(402) 471-0850, Ext. 1910
	Bill Jasa	District 1	(402) 335-4131
	Russ Eltiste	District 1	(402) 335-4131
	Mel Kuper	District 1	(402) 729-3489
	Bob McClure	District 1	(402) 729-3489
	Karl Burns	District 2	(402) 595-2534, Ext. 269
	Micky Jacobs	District 2	(402) 727-3292
	Gary Mangen	District 2	(402) 595-2534, Ext. 268
@	Darin Brown	District 2	(402) 727-3292
	Lynette Norman	District 3	(402) 370-3474
	Lisa Sudbeck	District 3	(402) 254-6552
	Gary Schmid	District 3	(402) 564-5751
	Lyle Kohmetscher	District 4	(402) 462-4996
	W. T. Farber	District 4	(308) 462-1996
	Richard Kwiatkowski	District 4	(308) 754-5411
	Tom Anderson	District 4	(402) 362-5934
	Arlen Zaruba	District 4	(308) 728-5655
	Scott Griepenstroh	District 4	(308) 385-6265
	Calvin Splattstoesser	District 4	(308) 385-6265

Resident Trainers		
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Duane Katen	District 5	(308) 432-6144
Sylvia Hilderbrand	District 5	(308) 262-1920
Darryl Steinwart	District 5	(308) 632-1429
Kerri Lewandowski	District 6	(308) 535-8031
Bill Teahon	District 6	(308) 872-6733
Duane Collins	District 7	(308) 345-8490
Gene Colfack	District 8	(402) 336-2051
Mike Freeman	District 8	(402) 387-2471
Dean DeButts	Materials & Research	(402) 479-4809
Chris Dowding	Materials & Research	(402) 479-4753

@

DIVISION 1300

PROJECT SURVEYS

@

DIVISION 1300 -- PROJECT SURVEYS

1300.01 GENERAL REQUIREMENTS

- A. General. Horizontal and Vertical Control. *SSHC Section 114*, Construction Surveying, requires that certain vertical and horizontal control stakes be set for the various items of work to be constructed. This is interpreted to mean the Department will provide the contractor with sufficient intermediate grade and alignment points or stakes, so the contractor can construct the work according to contract documents. Remember the contract plans were created from the preliminary survey which may be several years old by the time construction starts.
- B. Grade And Alignment Stakes. When grade and alignment stakes, including intermediate points, are set by an NDR survey crew, the Department will be responsible for correctness of staking. The contractor shall be responsible for the correct transposing of data from the construction stakes to the work.
- C. Staking. Refer to NDR training book "Introductory Surveying" for instructions on construction staking for the various types of work (Use the stock control number "70-79600" to obtain the manual from Logistics.). District 4 has a written a "Preliminary Survey Manual" that is available on the "Network Neighborhood". There is also a GeoPak Course Guide "NDOR Survey with GeoPak Survey 98" available from Roadway Design.
- D. The Department's ROW Line. The Department's ROW line is not usually placed by registered land surveyors. Therefore it is not usually a legal description of our boundary. Use of rebar to mark the Department's ROW can be misleading. Our NDOR caps should be treated as "temporary" monuments.
- E. Consultant Survey Data. Consultant survey data must be electronically compatible with GeoPak.
- F. Consultant Surveyors. Consultant Surveyors must provide reports of all on site survey activity either in advance of the activity or immediately following the activity so the Department can readily check all stake locations and other survey information provided.
- G. Survey Accuracy
 - 1. The required accuracy for construction survey staking are as shown in Table 1300.1a.
 - 2. The required accuracy for construction survey closures are as shown in Table 1300.1b
 - 3. Bench levels, control points, and any significant location should be checked against two known locations.
 - 4. All computations should be checked by someone on the survey crew, other than the person who did the initial computation. The check should be done in the field while still on site.

Table 1300.1A Survey Staking Accuracy Requirements*		
Description	Metric (m)	English (ft.)
Alignment (Project) PI's, PT's, etc. and CP's/BM's	0.003	0.01
Farmstead Drives	0.3	1
Field Entrances	0.3	1
County Roads	0.03	0.1
Intersecting Highways	0.003	0.01
Telephone Poles/Power Poles (offset)	0.3	1
Drainage Pipes (Stationing)	0.3	1
Length of Pipe	0.3	1
Box Culverts (Stationing)	0.3	1
Length of Pipe	0.03	0.1
Bridges (Stationing)	0.003	0.01
Wells (Stationing/offset)	0.3	1
Cross-Section Slope Stakes; Rough Grading Stakes; Hub Line	.03	.1
Final Grading (Blue Tops)	.015	.05
Paving Hubs	.0063	.01
POT, PI, PC, PT, ETC	0.003	0.01

***All locations are to be based on a known location and checked against another known location.**

Table 1300.1B		
Maximum Closure Allowance For Survey Tasks And Activities*.		
(Checking In At A Known Bench Or Other Control Point)		
Activity	Conventional Survey Methods. (Differential Leveling)	Modern Survey Methods (Total Station Type, Trigonometric Level, Survey)
Paving Hubs	< or = 0.05' vertically. (Always adjust out any error encountered on paving grades) Horizontally hubs should always be set sighting thru to the next point, eliminating any error.	It's not recommended that you set paving hubs using this method. As vertical control is not as accurate using trigonometric methods.
Blue Tops	< or = .07' vertically. (Always adjust out any error encountered on blue top grades) Horizontally hubs should always be set sighting thru to the next point eliminating any error in the alignment. Outside hubs should be set pulling a tape perpendicular to centerline.	< or = .07' for vertical closure. < or = to .15' for horizontal closure
Slope Staking	< or = 0.10' vertically. Horizontal alignment is established pulling a tape perpendicular to centerline.	< or = 0.10' vertically. < or = .50' horizontally
Bridges:	< or = .01' horizontally and vertically	It's not recommended that you stake bridges using this method. . As vertical control is not as accurate using trigonometric methods.
Culverts	< or = 0.10' vertically. < Or = to 0.5' horizontally	< or = .10' vertically. < or = 0.5' horizontally
Cross-Sections & Borrow Pits	< or = .15' vertically. < or = 1.0' horizontally	< or = .15 vertically. < or = 1.0' horizontally
Bench Levels	Use formula- .05' multiplied by square root of miles. Any error should be adjusted out thru the entire level run. Use .035' for preliminary bench levels.	It's not recommended that you established benches using this method. . As vertical control is not as accurate using trigonometric methods.
Alignment	< or = .05' horizontally	< or = .05' horizontally
Storm Sewer Systems	< or = 0.05' vertically. < or = to 0.1' horizontally. NOTE: Inlets need to be accurate within a couple of hundreds from centerline to insure proper placement of wall, back of curb and inlet throat.	< or = 0.05' vertically. < or = to 0.1' horizontally.

*All units are represented in feet.

*Note: Under no circumstance should accuracy be compromised. This chart is only to be used as a guide to help you understand the closure tolerance that may be allowed before you need to take the time reviewing your work. These numbers may not fit all situations. If you have any questions it's best to consult with your project manager.

1300.02 CONSTRUCTION STAKES

A. General - Construction Staking

1. Construction surveying represents a large proportion of the construction engineering cost and, therefore, requires study to eliminate all needless refinements. The goal to be reached is a satisfactory project constructed according to the approved plans with a minimum of cost. Centerlines, right-of-way monuments and benchmarks should be established within recognized limits. Other stakes should be established to standards commensurate with their use.
 - Rt or Lt is relative to stationing – align yourself looking up to next higher station number to determine left or right.
 - The Department usually stakes the ROW as needed for the relocation and location of utilities before the contract is awarded. Utility companies need references to determine how to move their property before the project begins.
 - Utilities may damage stakes—communicate the Departments desire to maintain stakes and require utilities to relocate damaged stakes where possible.
 - The project manager needs to communicate with the contractor to determine where the contractor plans to start work. With good communication, the Project Manager should be able to accommodate the contractor's need for stakes within time requirements specified in the contract.
 - Today the centerline is generally defined by coordinates however, it is still significant in the majority of the construction staking.
 - The survey crew should set the construction stakes as far ahead of the contractor as practicable. The Project Manager must have the area staked sufficiently in advance to avoid construction delays.
 - The stakes provide the contractor the construction lines and grades and also serve as an inspection guide.
 - Stakes must be accurate.
 - Keep communication with the contractor open so if a change is necessary, staking will not delay the project.
 - The contractor shall be responsible for the protection and integrity of the stakes after placement. The contractor shall take the necessary measures to achieve this.

- All preliminary survey results go to Ken Hartwig, Geodetic Survey Section. Ken checks the data then passes the data onto both Kurt Svoboda, Right-of-Way, and to the Roadway designer responsible for the project.
 - ROW surveys are generally done as part of the Preliminary survey. However, Gene Thomsen does many of the ROW surveys.
 - Hydraulic surveys are also part of the Preliminary survey and the data is provided to Don Jisa,
- The Geodetic Survey Section does Photogrammetric surveys. The Photogrammetry Section plots/maps the survey data.
- GPS Pairs are permanent monuments.
 - On each project the Geodetic Survey Section will provide a GPS pair at the beginning, end and every 2-3 miles along the project.
 - Usually the monuments are offset 500-1,000' left and right of the centerline.
- The GPS establishes the state coordinate system.
 - HARN was created in 1995 with the help of a National Geodetic Survey, which established a grid of accurate points across Nebraska based on GPS sightings.
 - Contact the Bridge or Roadway Design Division if you need the coordinates of any point.
- Geodetic surveys are expensive.
 - Preliminary surveys are estimated at 200 hours per mile in rural areas \pm correction factors.
 - Preliminary surveys are estimated at 800 hours per mile in urban areas \pm correction factors.
 - If a contract survey is estimated above in-house time allocations, try to find a way to do the work in-house.

B. Minimum Survey Requirements

Each project is unique and has different survey requirements. Table 1300.2 describes the common stakes. Table 1300.3 explains the minimum stakes necessary and their appropriate location in normal conditions for the item listed. Table 1300.4 shows the minimum placement intervals for stakes. Finally Table 1300.5 shows how to stake structures (Bridges & culverts).

Table 1300.2 STAKE DESCRIPTION*	
STAKE	DESCRIPTION
Hub (Right of Way)	1" x 2" x 18" (oak)
Hub (Blue Tops)	2" x 2" x 9" (oak) or 1" x 2" x 18"
Hub (Paving Hubs)	2" x 2" x 9" (oak)
Guard Stakes for Marking/Describing Hubs	1/2 " x 2" X18"
Information Stakes For Use in Right of Way, Structures	1" x 2" x 18" (pine)
Slope Stakes	1/2" x 2" x 18" (pine)
Lath (marks hub/guard sites)	1/2" x 2" x 48"
Pink Ribbon	Delineates lath or other objects for visual locating.
Wire Flags – Pink	Marks Bluetops, Paving Hubs, ROW, Structure Stakes, etc.
Rebar	5/8" x 36" Used in establishing control points, ROW breaks.
Aluminum Caps	Placed on rebar to accurately establish a given survey point and stamp point information.

*Ground conditions may require other sizes and or types of stakes, than those indicated.

STAKE DEFINITIONS		
Table 1300.3		
	DESCRIPTION	PURPOSE
HUB LINE	1" x 2" x 18" oak/pine hub stake set usually at 100' intervals or at plan cross section locations between ROW breaks on the ROW boundary. The hub is protected with a 1" x 2" x 18" guard stake with station/offset information, and a ½" x 2" x 48" pine lath.	Establishes the boundary of the Department property, shows the offset location of the centerline and shows stationing. Also may be used to define rough grading. May also be used to mark temporary and permanent easements.
ROW	½" x 2" x 18" hub or 5/8" or ¾" x 36" rebar rods set at points in the Hub Line where the ROW changes directions (Deflections). Set on PC's, PT's of curves, in Hub Line where tangent sections are over 1,000 feet in length and on hills so ROW may be viewed.	Establishes the boundary breaks of the Department property. Right of Way markers are normally installed on these points by the contractor. (Confirm control points before staking ROW.) Or at ROW hub (See example at Subsection 1300.02 C.)
SLOPE STAKES	½" x 2" x 18" pine stake with lath (optional) and guard stake (optional) with information describing the limits of rough grading. Set on the extreme outside points of the designed cross section where the grading work and natural ground intersect. Usually set at 100-foot intervals and where changes in slopes, roadway width, sharp curves or ditch dimension change. Slope stakes are protected by a wire flag or lath for visibility.	Defines rough grading requirements – cut/fill, slope, offset from centerline, toe of backslope distance, hinge point/shoulder distance and ditch dimensions. A cut or fill to centerline may be written on the back of the stake.
BLUE TOPS (A Subgrade Lath is sometimes used instead of a Blue Top in cases of extreme subgrade overfill or deficiency with the PM's approval)	2" x 2" x 9" or 1" x 2" x 18" oak/pine Hub stake depending on soil conditions with plain, blue or white colored top. Set the stake at finished subgrade elevation and place another stake (short lath) or wire flag near it for protection. Sometimes colored fiber tail ("chaser") is placed atop the stake to aid grader. Generally the Department will not color the top of the hub or place a fiber tail chaser – that is the responsibility of the contractor.	Used to establish the final subgrade elevations and final grading slopes. These stakes are set centerline; edge of mainline roadway (¼ points), & edge of shoulder transversely across the roadway. (Additional stakes are needed on multilane highways.) Bluetops are usually set at 100' intervals longitudinally. Additional blue tops may be set at 50' intervals in cases such as vertical curves, sharp horizontal curves, or slope transition areas. Set Blue tops at the exact finish grade elevation—the contractor must make any adjustment.
PAVING HUBS	2" x 2" x 9" oak/pine hub with a tack set at a contractor specified offset distance from the pavement centerline/edge of pavement. A ½" x 2" x 18" pine stake is driven beside the paving hub which explains offset, grade (cut/fill) and station of the paving hub. Usually set at 50' intervals on both sides of the mainline. In cases of sharp vertical curves, horizontal curves over 1 degree, or transition areas, hubs are set at 25-foot longitudinal increments.	Used to set the string line to guide the trimming and pavement-finishing machines. Grade (cut/fill) is indicated on the stake. Need to determine with the contractor whether the offset is level from the edge of pavement or is the projected slope.
DRAINAGE, PIPE, CULVERT, BRIDGE, WALL, DRIVEWAY, CURB, SIDEWALK AND OTHER STRUCTURE STAKES.	1" x 2" x 18" oak/pine Hub set at a specified offset from the structure being staked. A (1" x 2" x 18") pine guard stake which explains offset, grade (cut/fill) and station of the paving hub and a ½" x 2" x 48" lath stake is driven beside the hub for visibility and protection. On long pipe runs usually for storm sewers, offset stakes are set at 50' intervals.	Shows the location of structures in terms of project stationing and offset distances.
SHIM SHOTS	Points on a girder. At locations directed by the Bridge Division. Use a paint mark to mark location.)	Used to determine the final grade of the bridge deck. (Make sure all the Bridge Division knows where on the girder the points were taken.) The actual shim amount is shown with a black marker on steel girders and with paint on concrete girders.
STATIONING LATHS	½" x 2" x 48" pine stake (lath). Usually only needed on asphalt overlay projects.	Defines the project stationing. Usually placed before the subgrade is set to help define/establish pavement quantities. Offset near edge of shoulder.
PAVEMENT STAMP	Imprinted station number on pavement. (3" brass number stamps imprints in plastic concrete). Place stamp every 100-feet or 20-meters. Normally place on the right side, progressing up stationing so the stamp can be read from the shoulder. Avoid rumble strip location.	Defines the project stationing.
ALIGNMENT POINTS OR CONTROL POINTS	May be ¾" or ½" x 36" rebar for permanent points; a 60d spike for a less permanent point; or frequently a 1" x 2" x 18" oak/pine hub with a tack. ½" x 2" x 48" pine stake (lath) is used to protect the hub.	Defines the centerline alignment. Such as the beginning or ending of a curve, or the point of deflection of two tangent segments. Control points may also be offset from the centerline at various locations and are tied to the highway with coordinates.

MINIMUM SURVEY REQUIREMENTS

Table 1300.4

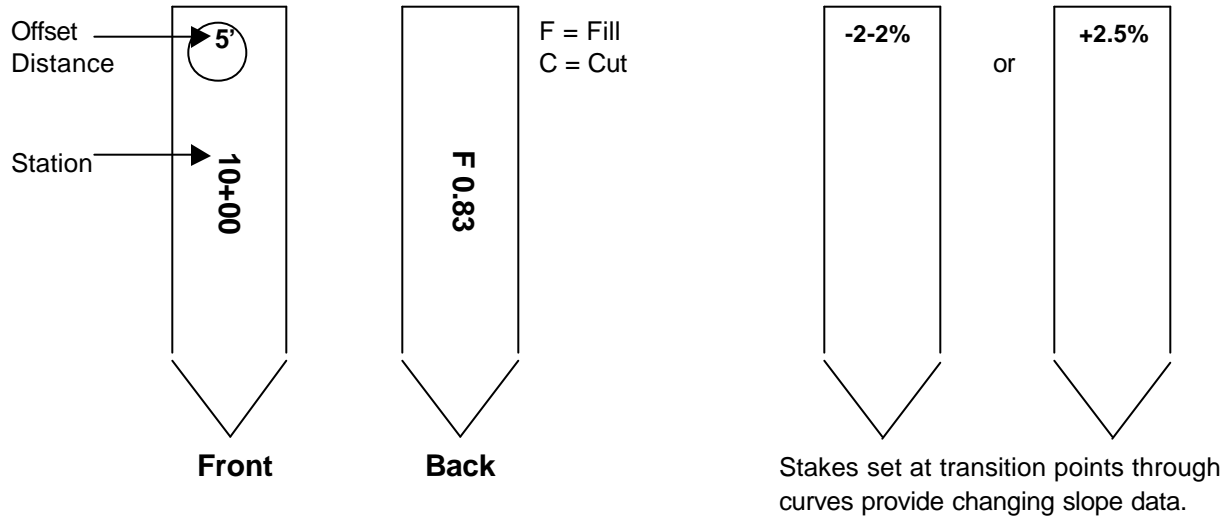
MAJOR CONSTRUCTION						
TYPE OF STAKE	LOCATIONS	LEVEL GRADE (feet)	HORIZ. CURVES >2 degree (r≤2865') (feet)	HOR. CURVES <2 degree (r≥2865') (feet)	SHARP VERT. CURVES (feet)	OTHER REQUIREMENTS
Hub Line	Hub, guard and Lath set between ROW Breaks on the ROW boundary	HL(100')	HL(100')	HL(100')	HL(100')	Hubs may be "graded" to centerline for use by the grading contractor.
ROW	Hubs or Rebar rods, guard and lath set at points in the hub line where the ROW changes direction (deflects).					Set a stake at each break point; on level ground every 1000-feet; at Control points; and at the top of hills to provide Line of Sight and at other locations described in Subsection 1300.02. .
Slope Stakes	Slope stake and wire flag or lath to be set at the extreme outside points of the designed cross section where the grading work and the natural ground intersect.	SS(100')	SS(100')	SS(100')	SS(100')	Changes in roadway width, slopes, ditch dimensions or sharp curves may require additional slope stakes.
Blue Tops	White or blue topped hubs with wire flag or colored fiber tail (chaser) set to final grade elevations across subgrade template. Bluetops may be replaced by subgrade lath if approved by the Project Manager. Only a short lath with cut/fill marked on them is placed on subgrade template.	BT(100')	BT(50')	BT(100')	BT(50')	Blue Tops establish the final grading limits. These stakes are set at centerline; ¼ points; & subgrade/foreslope intersection (edge of shoulder). (Additional stakes may be necessary on multilane roads.)
Paving Hubs	Hubs with guard stakes are set at specified offset distance from edge of pavement.	PH(50')	PH(25')	PH(50')	PH(25')	Offset needed for their equipment. Graded to top of proposed pavement surface. (Level or projected grades as required by the contractor.)
Radius Points and Other Control Points	Locate and verify control points and benchmarks from preliminary survey.	As necessary	As necessary	As necessary	As necessary	Add construction benchmarks and roadway alignment as necessary.

PH=Paving Hubs
HL=Hub Line
BT=Blue Tops-Final Grading
SS=Slope Stakes

SURVEY REQUIREMENTS		
Table 1300.5		
STRUCTURES (BRIDGES AND CULVERTS)		
	STAKES LOCATION	
ABUTMENT CENTERLINE	BS (8 each)	Normally two stakes are placed on each side of the bridge at specified distances from centerline of the bridge at each abutment.
WING ENDS	BS (8 each)	Two stakes are placed at specified distances from the end of the wing. These stakes are on the same azimuth as the wing.
PILE LOCATIONS AND ELEVATIONS		Contractor measures from existing stakes to pile locations. Elevations should be verified by the inspector.
PIER CENTERLINE	BS (4 each/pier)	Two stakes are placed on each side of the pier at specified distances from the center of the bridge pier.
GRADE BEAM CENTERLINE	BS (8 each)	Two stakes are placed on each side of the grade beam at specified distances from the center of the bridge.
SHIM SHOTS ON EACH GIRDER	SSR – As Directed By The Bridge Division.	Used to determine the final grade of the bridge deck. (Make sure all the Bridge Division knows where on the girder the points were taken.) The actual shim amount is shown with a black marker on steel girders and with paint on concrete girders.
PIPE CULVERTS	CS (2 each) @ each end of pipe offset as required.	Hub, guard and lath should be placed at a specified offset from the end of the floor on centerline of the pipe, at each end. Any broken back or horizontal break should also be referenced on the end stakes or staked separately.
BOX CULVERTS	CS (2 each) @ each end of pipe offset as required	Hub, guard and lath should be placed at a specified offset from the end of the floor on centerline of the box, at each end. Some contractors may require parapet stakes and wing stakes (mostly on skewed boxes). These should be set at a specified distance to the centerline of the box or end of wing, on the parapet line or wing line. Any broken back or horizontal break should also be referenced on the end stakes or staked separately.
CS=culvert stakes require a hub, guard and lath. BS=bridge stakes may require a hub with nail, information guard and lathe. SSR=shim shot reading		

C. Survey Stake Minimum Requirement Examples—Suggested Format

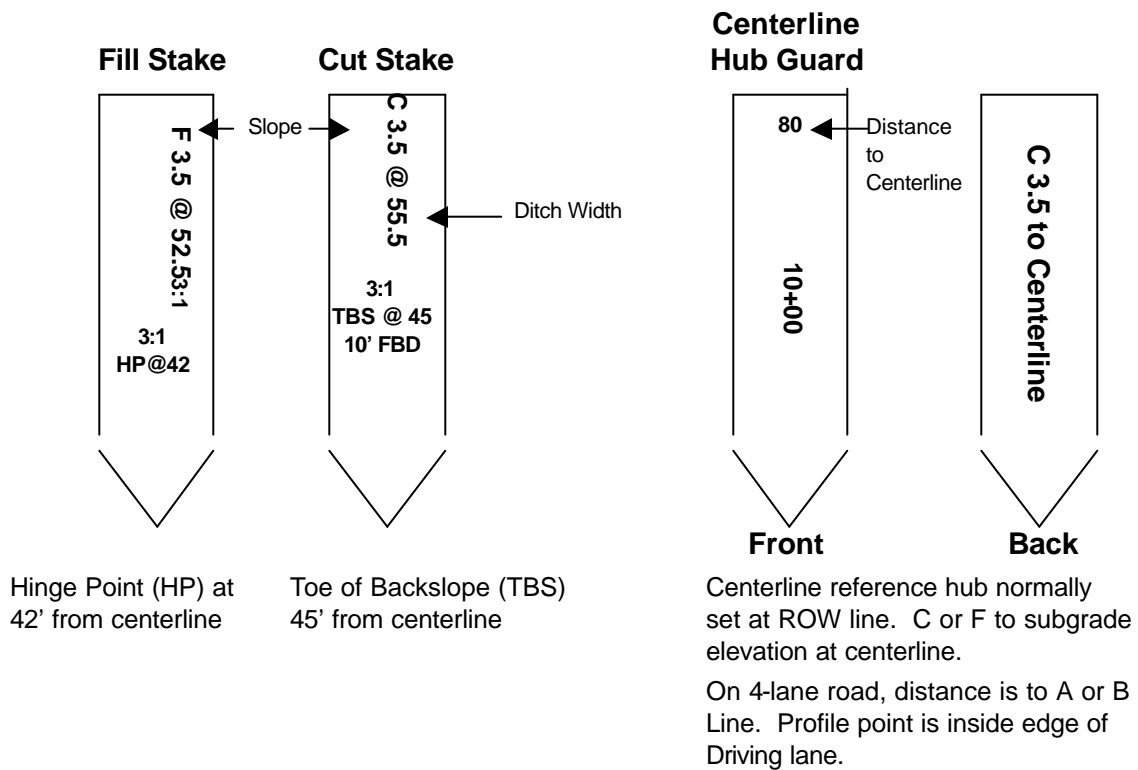
PAVING STAKES



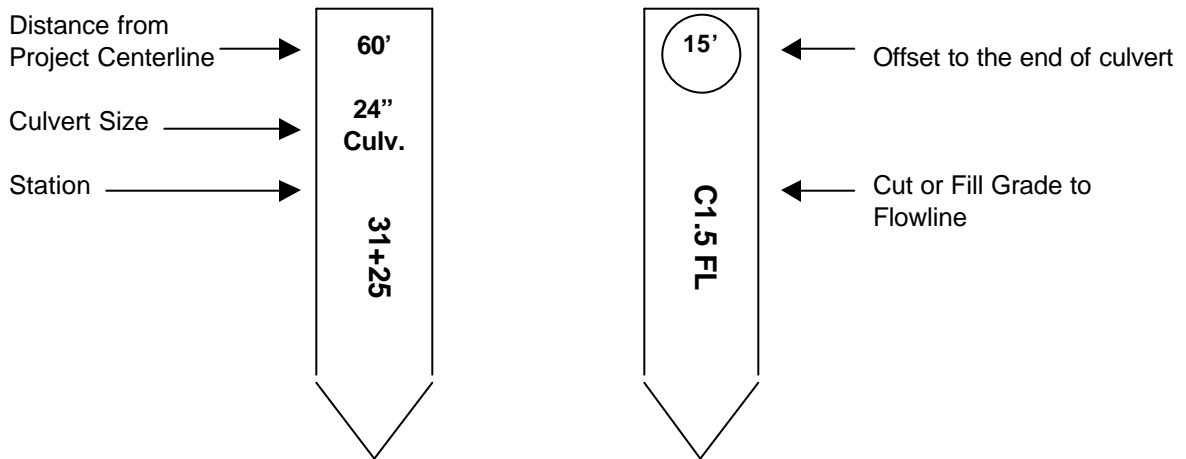
Fill (cut) is to the top of the pavement at outside edge.

Pavement grades may be computed flat from edge of pavement to paving hub, or on projected slope of pavement out to paving hub. Coordinate with contractor for method preferred.

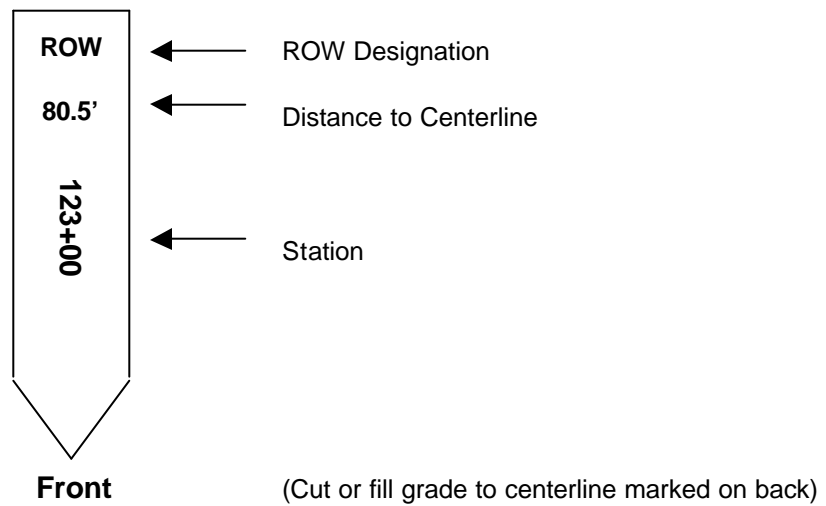
SLOPE STAKES



CULVERT STAKES



ROW STAKES



Hub Flags: Green-Yellow flag for easements.
Orange flag for ROW.

1300.03 CONSTRUCTION SURVEY BASIC REQUIREMENTS

A. GeoPak Guidance (Not All Projects Are Available In This Format)

1. GeoPak New Project Instructions:

- a. Create a new folder on your C: drive under C:\geoprjs\11111; Name this folder with the 5-digit control number for this project. In this example the control number is 11111.
- b. Open microstation. The microstation manager window will be on the screen.
 - Set the path on the right to C:\geoprjs\11111.
 - Then click file – new. At the bottom of the window select a seed file. Example – C:\users\data\seed3.dgn. Use seed3.dgn for an English survey or mseed3.dgn for a metric survey.
 - Then type the control number in the window on the left side and click ok. The control number 11111.dgn will appear on the top left side of the microstation manager window. Click ok.
- c. The microstation design screen is now on your screen. The top bar on the screen should read 11111.dgn (3D) – MICROSTATION/J. Click on Applications – GeoPak survey – GeoPak survey tools. The toolbox has four icons.
- d. Click on the Project Manager icon. The Project Manager window opens.
 - Set the path on the right side to C:\geoprjs\11111. The path appears towards the top of the window.
 - Then click project – new. The create new project window opens. Project name: 11111, Working directory: leave blank, Job number: 111, for the job number use the last 3-digits of the control number. Project description: Skyline Dr.- 204th and Dodge.
 - Now click on preferences. GeoPak user preferences window opens. Direction: Azimuth, Coordinate: XY, Unit: English or Metric. Working directory: leave blank.
 - Then click on feature preferences. Select .smd file, Example- C:\GeoPak_Projects\Standards\prelim.smd or mprelim.smd for a metric prelim.
 - Also toggle on the best match feature. Click ok.
 - Then click ok in the GeoPak user preferences window, and click ok in the Create new project window. An alert window appears asking Create Job 111 in directory C:\geoprjs\11111\? Click Yes.
- e. In the Project manager window 11111.prj should appear highlighted on the left side of the window. Click ok. The Project users window opens. Click users – new. Name: your initials, Full name: your full name, Op code: your initials, Description: your title or your titles initials, Click ok. Do you wish to define a password for this user? Click No. Highlite (aa) Click ok.

- f. Click Survey, The Select Run window opens. Click run – new. The run name should correspond with the letter you used for your Sdms project segment. In this example the run is named tra for the traverse segment. The description can be left blank. Highlight tra. Click ok.
- g. The Survey project window opens. The title bar should read, Survey....Project (11111) .. User (aa)..Run (tra).
- h. Highlight Data Source, click Single file. The Select sdms window opens.
 - Set the path on the right side of the window to C:\sdms\prj\11111. On the left side of the window the sdms project segments should appear.
 - Select 1111tra.prj and click ok. Toggle on Remove Sdms tag names from point descriptions.
 - Now click sdms to obs. Click on mapping option.
 - Toggle on draw mapping. The Dgn file should read C:\geoprjs\11111\11111.dgn. The seed file is grayed out.
 - Now click control code. Click open. Click 11111tra.ctl. Click ok. The control file should read C:\geoprjs\11111\11111tra.ctl. Coord fields should now have coordinates.
- i. Now click process survey. The standard unit weight should be 3 or less. A larger number indicates a problem with the process of the observations in the obs file and the control file. The Least squares adjustment takes place when processing the survey and creates the reports for review. These are very useful for checking errors and adjustments. Now press any key to continue. Then click import to gpk. This imports the points and chains to a GeoPak database.
- j. Clicking on the Bentley B and selecting sink can hide the survey project window. You can restore the window by clicking on window – survey project.
- k. To view the project on your screen click fit view. In this example you would see the CP's for this projects traverse.
- l. Continue by opening the survey project window. Click copy run. Select tra. Click ok. Type in the next segment letter and click ok. Proceed with data source as previously explained.
- m. Roadway Design is developing a program to make setup easier and when this is available it will be easier to use GeoPak.

2. Computer Listings Available – For projects developed on the computer, listings will be sent to the Project Manager with the plans or as soon thereafter as they can be printed. If, due to loss or damage, additional listings are needed by the field personnel, they will be supplied upon request. The listings available are discussed under the subsequent paragraphs. GeoPak can reproduce or reformat any of the previous listings/books.
3. **Preliminary Cross Section Listings** – This is a tabulation of the preliminary survey elevations and distance. GeoPak has the capability of projecting cross sections at any location.
4. **Plotted Cross Sections** – Plotted cross sections are available to the Project Manager for all computer designed projects.
 - GeoPak plots both the preliminary and design cross sections. The scale used for both may be modified to any desirable scale. The scale used is printed in the upper left hand corner of each sheet.
5. **Earthwork Computation Listing** – This is a tabulation by stations of areas and volumes.
6. The RDS form is titled “**Earthwork Quantities List for Roadways.**”
7. **Grades and Surfacing Elevations Listing** – This is a tabulation of the finish grades at centerline and at the edge of the surfacing. On horizontal curves all grades have been corrected for transitions and superelevations. GeoPak can furnish grades for any point between the two shoulders.
8. **R.O.W. Limit Listings** – This machine listing is discussed later in this subsection.
9. **Blue Top Book** – This listing is discussed later in this subsection.
10. **Slope Stake Book** – This listing is discussed later in this subsection.
11. **Alignment Book** – This listing gives alignment information and is for use when referencing and relocating centerline.
 - Preliminary alignments are available through Ken Hartwig In Roadway Design [(402)-479-4682].
 - Construction Alignments are available through the Roadway Design, Project Designer [(402)-479-4601].

12. **Locations of “No Passing Zones”** – Vertical curve no passing zones can be obtained from Roadway Design. However, the District can run the two vehicle test method to determine the zones. (Two vehicles follow 1200’ apart and when sight is obstructed that starts the no passing zone one direction and ends the no passing zone the other direction. When sight distance is returned that ends the zone the first direction and begins the zone the other direction. Logistics Division has the equipment for this operation.

B. Checking Bench Levels

1. Good bench levels are one of the important reference features of any construction project.
2. All benchmarks should be thoroughly checked before any other level work is started. If the preliminary survey party has not established benchmarks at proper intervals, intermediate ones should be set. Permanent benchmarks should be established approximately 1000 ft (300 m) apart and also near all major structure locations.
3. In choosing objects for benchmarks, the Project Manager must keep in mind that such objects must be permanent and easily accessible. Nails in fence posts and pole lines should be avoided. A 3 foot “T” post is normally required for a benchmark however, the PM may authorize the use of steel reinforcing rod, at least ½ inch (12.7 mm) round and 3 ft (1.0 m) long driven 2 inches (50 mm) below ground level in a location that will not be disturbed. The location should be marked with a guide stake or lath and red cloth, and the “plus” and “distance right or left of centerline” recorded in the levels book.
4. In running levels, the following rules should be followed:
 - a. Equalize sights. In order to eliminate instrumental errors as much as possible, backsight and foresight distances should be of equal length at all turning points.
 - b. Reading the rod. Rod readings at turning points shall be taken to the nearest .005 foot (.00152 meter). The rodperson shall use a rod plumb or if plumb is not available may wave the rod away from and toward the instrument parallel to the plane of collimation.
 - c. Never take down the instrument without checking on a benchmark other than the one used on the setup or turn.
 - d. In establishing benchmarks, it is important to turn on each benchmark.

5. Benchmarks notes may be kept in the alignment notebook. Recorded rod readings shall never be erased. If an error is made, a line should be drawn through the erroneous figure and the correct figure written above. In checking elevations, the plan elevations shall be used unless an error in elevation of **0.05 ft (15 mm)** or more is found. If errors are found they should be corrected and documented—some errors will have to be prorated over the intermediate points by the data collector. The final cross section levels may then be corrected to the preliminary datum at preliminary benchmarks or at established benchmarks.
6. If difficulty is encountered in checking preliminary bench levels or the Project Manager has reason to believe that an error was made in transferring preliminary elevations onto the plans, he/she may obtain the original preliminary notes by writing the Roadway Design Division at Lincoln.

C. Reproducing And Referencing Centerline

1. The construction centerline shall be reestablished using the plan information. It is a good policy to establish the centerline and set the reference stakes for the entire project as early as possible, so that property owners may have ample time to lower pipe lines, remove fences, power and telephone poles, buildings, etc., before the construction crew arrives.
2. In reestablishing the centerline, the work should proceed as follows:
 - a. Locate and “tie out” all plan transit points.
 - b. Establish and “tie out” any additional required control points.
 - c. Reestablish the centerline.
 - d. Set the centerline reference stakes.
3. Transit points that should be located or established and “tied out” are:
 - a. P.O.T. (Point on tangent)
 - b. P.I. (Point of intersection)
 - c. P.C. (Point of curvature)
 - d. P.T. (Point of tangency)
 - e. T.S. (Tangent to spiral)
 - f. S.C. (Spiral to curve)
 - g. C.S. (Curve to spiral)
 - h. S.T. (Spiral to tangent)

i. P.O.C. (Point on curve)

(Reference these points to at least four permanent objects which will not be disturbed during construction or shall have coordinates accurate to ± 0.01 feet. However, in the absence of available "permanent objects", tacked stakes set at right angles to and at known distances from the project centerline will be satisfactory. Reference ties should be measured horizontally to the nearest ? " (3.0 mm) with a steel tape.)

4. After the transit points have been established, proceed to reestablish the centerline markers. The Project Manager should set the centerline markers with an instrument at 100 ft (25 m) intervals, measured horizontally on tangents and horizontal curves up to 9400 ft (2864.789 m) radius. Curves that are less than radius of 9400 ft (2864.789 m) should use 50 ft (15 m) chords. The distance "plumbed up" by the chaining crew should be checked occasionally with a hand level or from the difference in old ground elevations shown on the plans. Intermediate centerline markers on tangents may be set later with a chain stretched between the station markers. Intermediate centerline markers on curves should always be set with the instrument.
5. When obstructions such as fences, etc. are present on the right-of-way and when the removal of such items are not included in the contract items, the appropriate adjacent property owners shall be notified that they must remove such obstructions. Such notification shall be made well in advance of construction operations so that the owners will have sufficient time to make arrangements for performing the work. They should also be advised of the date on which stakes will be set for their information in removing or relocating their property.
6. Provision for the removal of advertisement signs is handled independently by our Right of Way Division. Should any problems arise relative to the removal of advertisement signs, the Construction Division should be contacted.

D. Checking Plan Grade And Calculating Grade Revisions

1. As soon as possible after assignment to the project, all grade elevations shown on the plan-profile sheets of the plans should be thoroughly checked. This includes percent of grade and vertical curve corrections. On structures, it is recommended that all grades be recomputed including pile cutoff, footing, pier cap, abutment seat, and top of girder elevations.
2. It is particularly important to check the profile of the roadway surfacing which connects with the project being constructed. If this elevation is found to differ from that shown on the plans, it is evident that the project grade line will need to be adjusted. This adjustment will cause changes in grade stake elevations and may even affect lengths of proposed culverts in the area.

3. If any appreciable error is found between the preliminary and preconstruction chaining or bench levels, and an equation is introduced, it will be necessary to recalculate the centerline grade from the equation point to the next point of intersection of tangent grades, or if too distant, to some nearer convenient point of the next grade break. This is particularly important on concrete pavement as any equation or correction in levels or distance will be reflected in the pavement form elevation.

E. Staking Right-Of-Way Fence and Right-Of-Way Limit Listing

1. ROW stakes are needed usually before the contract is awarded to provide references for utility relocations.
2. On some projects, right-of-way fence is a contract item and staked and constructed in accordance with the plans or the right-of-way listing. On other projects, fence stakes must be set on the right-of-way line for the guidance of adjacent property owners. The Project Manager should also check the fence setting as it progresses to see that it is set in correct relation to the fence stakes.
3. Right-of-way fence stakes should not be set in borrow pits or channel changes until the contractor has these finished to the landowner's and the District Engineer's satisfaction.
4. Right-of-way limit listings are available for most projects except interstate. Separate listings will be furnished for the left and right sides of centerline of the project. They will give the right-of-way distances at all breaks in the line and at all intermediate full stations. All distances given on the listings are from centerline of the project to the right-of-way line.
5. Right-of-way limit information will not be given for segregated parcels near section corners. The listing will give the station and distance to the point where the normal right-of-way enters the segregated parcel and also at the exit, with a break in the stationing between the two. The section corner will not be given. If right-of-way markers are to be set for segregated parcels, consult the plans or the right-of-way contract for the necessary information.

F. Setting Slope Stakes

1. The "Slope Stake Book" provides the data for locating the slope stakes and this "book"/file is available from the Roadway Design Division, CADD Applications Section, (402) 479-3986.
2. Construction stakes are placed on the project before work begins to outline for the contractor the location and extent of the work. Slope stakes may be set with an instrument on projects having the excavation quantity computed from plotted cross sections. The notes shall be kept in a separate book.

3. For fill sections, slope stakes are set at the toe of the slope and marked to show the vertical distance and slope from the ground at the stake location to the grade elevation at the hinge point and the subgrade shoulder of the fill.
4. For cut sections, slope stakes are set at the top of the backslope and marked to show the vertical distance and slope from the point on the ground where the stake is set to the grade elevation for the bottom of the ditch.
5. Slope stakes are normally set on both sides of the road at every station (100-feet); and every 50 ft (15 m) on horizontal curves having a radius of 2865 feet (873.25 m) or less. Use Type "D" ½" x 2" x 18" (12.5 x 50 x 458 mm) pine stakes.
6. Some intermediate points at which slope stakes should also be set are:
 - a. P.C. and P.T. of horizontal curves.
 - b. Beginning and ending of superelevation.
 - c. Points where shoulder and backslope change.
 - d. Change in width of roadbed.
 - e. Change in width of side ditch or borrow.
 - f. Any other points helpful to the contractor.
7. Balance points shall be well marked on the ground with a lath and red flag. Call the contractor's attention to these points and see that he/she works to them.
8. The plan data pertinent to each station shall be placed in the slope stake notebook. This data gives the trial distance for the first rod reading and also a check between the plan and the stake as actually set in the field. The information from the plans and the staking data should be similar to the example shown in Appendix 3-12. This example also shows the method for setting stakes for high fills when the instrument height (H.I.) is below the new plan grade.
9. The staking party should watch drainage along the toe of fill slopes, intercepting ditches, dikes, etc., as the machine does not now provide for drainage in all cases. Where necessary, special ditch grades must be computed in the field. They should also watch for vertical banks just beyond the limits of construction and correct slope stake locations accordingly.

G. Setting Finishing Stakes

1. The use of a separate notebook is suggested for the finishing stake (blue top) notes. Several satisfactory methods of keeping notes are presently in use. Following is a description of one acceptable method. The left-hand page of the notebook may be used for the plan data; that is, the station number, the centerline grade elevation, the drop to intermediate points and shoulders, the amount of superelevation on curves, etc. The right-hand page of the book can then be used for recording the staking data. The grade rod, for each point on the grading roadway template to be staked, is computed and placed on this page. The actual level rod reading (Read Rod) can be recorded below the corresponding grade rod and the cut or fill from the existing ground to the grade rod computed. Finishing stakes are then driven at these points and "blue-topped". Only in extreme cases should a cut or fill be marked on the finishing stake. If the grade has been built too high, a hole should be dug deep enough to drive the blue top to grade. The contractor can be expected to protect these stakes so that they will not have to be reset at some future date. If many stake holes are necessary or many stakes are appreciably high [0.3 ft (90 mm) and over], additional work should be done by the contractor before stakes are set.
2. Blue top books are available on all projects designed with the computer. The design information is given for each preliminary cross section on one page with a blank page following for construction information. The elevations included in this information may include an allowance for "trimming". The Project Manager or party chief must determine exactly what elevations are given. When a trimming allowance is not included, up to 0.1 ft (30 mm) may be added to the elevation of the finished grade stakes.

H. Setting Trimming Or Paving Form Stakes

1. When the roadway is in condition for the surface structure, trimming or paving stakes may be set. They should be aligned and graded by instrument.
2. The riding quality of the surface structure depends to a large extent on the vertical accuracy of the stakes and the accuracy with which the trimming is performed or the forms are set. The approved method is to set accurate grades to millimeters for each side of the surfacing at a uniform offset (consult the contractor). Grades may be indicated by stakes either driven to grade or driven flush with the ground and marked with a cut or fill. Stakes driven flush are least likely to be disturbed. The alignment shall be given on one side only and indicated by tacks in the top of the stakes. The appearance of the grade may be checked visually from both directions by sighting along the contractor's string line before the trimming or form setting operation begins.
3. On curves, the tack line may be run on the offset line after computing a chord length for the offset radius, or the centerline of the curve may be run and the tack line set by double chaining the offset line, again using the proper chord length for the offset radius.

4. Stakes are normally set at 50 ft (15 m) intervals on tangent alignments and on horizontal curves up to 2° radius which have straight or long vertical curve grades. On horizontal curves over 2° radius and vertical curves having a grade algebraic difference that is more than 1.75 ft (0.532 m) from the tangent grade in 50 ft (15 m), a 25 ft (7.5 m) interval should be used. The ST, CS, SC and TS or PC and PT of all horizontal and the PVC and PVT of all vertical curves should be clearly marked for the contractor. Stake the transitions in and out through the super's of the curves as per the Standard Plan.

I. Contractor's Forms on Large Structures

1. On viaducts and bridges, the staking crew shall give the contractor line and grade on all bents, piers, abutments, walls, etc. This duty will be continuous throughout the duration of the construction. Using the stakes previously set, the Project Manager shall stake or check all pile layouts, centerline, and grade on all footings, columns, caps and anchor bolts before and after the pouring of concrete. Columns, pier caps and anchor bolts should be checked while the concrete is still fresh enough to allow for adjusting the forms or anchor bolts to line and grade. In addition to checking the line from the survey stakes, anchor bolts may also be checked by steel taping form pier to pier. Temperature, force on the tape, and plumbing for elevation must all be considered when this method is used. On steel girder bridges, a final check shall be made on span lengths, pier and abutment angles, and bearing plate seat elevations before attempting to set the girders in place. This should be done as soon as possible to allow time for minor adjustments in the girders should they be necessary. The following steps are used in making this check:
 - a. From a transit setup, mark the centerline of the structure on the pier caps.
 - b. From a setup, turn the pier angles and mark the centerline of the pier at the center of each set of anchor bolts.
 - c. Check the anchor bolts for proper relation to the pier centerlines you have marked.
 - d. Steel tape the distance along each line of girders between the abutments and piers as a check on the span lengths. Temperature, pull force, and plumbing for elevation must be accurately used in the measurement. (See the "Introduction to Surveying" page 51 & 52 for the chaining requirements and temperature corrections.)
 - e. Take elevations on all bearing plate seats. Across any one pier cap the variation from plan elevation between any two bearing seats should not be more than $\frac{1}{4}$ inch (6 mm). For example, if all bearing seats across the pier are $\frac{1}{4}$ inch (6 mm) too high (or low), the floor grade can be adjusted to compensate. However, if one bearing seat is $\frac{1}{4}$ inch (6 mm) high and the adjacent seat is $\frac{1}{4}$ inch (3 mm) low, the variation is more than $\frac{1}{4}$ inch (6 mm) and the bearing seat elevations should be adjusted by grinding. This will assure the proper fit of the separator angle against the girder web.

- J. Checking Culvert Lengths, Culvert Lists, Slope Stakes, Blue Top Stakes, Paving Hubs, etc.
1. General – Another duty of the survey crew is to take cross sections along the centerline of all culvert sites. This includes existing structures which are to be extended as well as proposed structures. The cross section should follow the centerline of the new structure and be taken along the skew line if the structure is not at right angles to centerline. If the inlet or outlet of the proposed structure does not coincide with the flow line of the existing channel or ditch, sufficient rod readings should be taken off-angle [usually extending [200 to 300 ft (60 to 90 m)] in the existing channel to establish the proper flow line design for the new structure. (The pipes off-line distance, change of skew, and length changes should be noted on the cross section sheets.) The elevation of the intersection of the right-of-way line and existing channel should also be determined.
 2. The specifications provide that “the contractor shall not order and deliver the (culvert) pipe until a correct list of sizes and lengths is furnished by the Project Manager.” Also, the contractor should not order and deliver material for box culverts, inlets, junction boxes, manholes and similar appurtenances, until a correct list of sizes and lengths of such structures is furnished by the Project Manager.
 3. The Project Manager should promptly field-check the culvert and drainage structure locations, and prepare the field-checked culvert list. The instructions included herein provide for designing and detailing culvert pipe, reinforced concrete pipe, or corrugated metal pipe in exactly the same manner. This procedure will enable the Project Manager to field check and prepare the “field checked order list” without delaying to determine identity of the contractor and the kind (concrete or metal) of culvert pipe to be furnished. Accordingly, the Project Manager will be able to and should expedite the preparation of the field-checked culvert list to facilitate and provide time for fabrication and delivery of the culvert materials.
 4. Culvert List – Pipe Culverts – The “field-checked list” of pipe culverts and appurtenances should include the following information for each pipe culvert:
 - a. Station locations.
 - b. Diameter and length.
 - c. Kind of pipe culvert (concrete pipe, corrugated metal pipe or culvert pipe).
 - d. Type of headwalls, inlet, manhole, junction box, or other appurtenance, and applicable standard plan number or numbers, if such items are to be constructed.
 - e. Degree of skew if culvert is to be skewed, if skewed on one end only, show direction of flow by sketch.

- f. Sketch for each broken back pipe culvert.
 - g. Direction of flow for all pipe extensions.
5. Do not make any field changes to pipe culverts without approval from the designer.

K. Culvert List – Box Culverts

1. The “field-checked list” of culverts should include all of the following information for each box culvert:
 - a. Station location.
 - b. Span, rise and barrel length.
 - c. Plan number or numbers.
 - d. Height of fill over the box culvert.
 - e. The “field-checked list” should include additional information for each box culvert which is to be constructed on skew, as a broken-back structure, with control joints, or an extension of an existing box culvert, as follows:
 - (1) Skew angle if the box culvert is to be constructed on skew, include a sketch if the ends or parapet walls are not to be constructed as shown in the standard plans.
 - (2) A sketch for each broken-back culvert, showing dimensions between the ends of barrel and break points and between break points measured on the axis of the culvert, and showing flow line elevations at ends and at break points.
 - (3) A sketch for each box culvert which is to be constructed with control joints. The sketch should show the dimensions from the ends of the barrel to the first control joint and the spacing between control joints.
 - (4) When the plans provide for the extension of an existing box culvert, the removal of the endwalls and/or the preparation of the existing structure will usually be performed in accordance with details shown in a standard plan.
 - (5) Special plans may be provided for large or complicated structure remodeling. The standard plan includes details for connecting to old structures having angle or straight wings, structures with or without floors between wings, etc. The standard plans also give the contractor the option of doweling into the wings of the existing structure, or breaking back and exposing 2 feet (600 mm) of reinforcing steel to connect the extended structure, when the individual structure plan note does not specify the method of extension.

- (6) In detailing the extensions or remodeling of existing box culvert structures, the Project Manager must include with the field-checked culvert list (1) an adequate description of the existing structure, and (2) an adequate description of the preparation work and extension. This information is essential to the contractor and the fabricator of the necessary reinforcing steel.
- f. The description of the existing structure should include:
 - (1) Station location, dimensions (span, rise, barrel length) and type of structure.
 - (2) Plan number if known or available.
 - (3) Type of wing, angle or straight; for straight wings include wing dimensions "L", "C" and "H".
 - (4) Whether or not concrete floors are between the wings.
 - (5) Whether the existing box is suitable for doweling.
 - g. The description of the new work should clearly describe the preparation work and the extension, and should include:
 - (1) Span, rise and extension length, right and left.
 - (2) The standard plan numbers both for the removal and preparation and for the extension.
 - (3) An adequate description of the removal of endwalls and/or preparation work on the existing structure. Typical examples of the preparation work:
 - (a) "Remove end walls and prepare structure as shown on the Special Plans (in case of special plans for preparation of old structure)."
 - (b) It will be seen that, depending on the type, suitability for doweling and condition of the old structure, the description of the preparation work may include one or more of the typical examples listed. Include a good sketch, with dimensions, for the contractor's (and fabricator's) use when the plan and condition of the existing structure and the new work are difficult to describe in words.
2. Do not make any field changes to box culverts without approval from the designer.

L. Staking Culverts And Structures

1. The centerline of culverts shall be indicated by hubs driven on the centerline and offset at such distance from the end of the structure as to protect them from disturbance. The elevation of tops of the hubs above or below the flow line grade at the ends of the culvert should be given, as well as the offset distance [usually 5 to 10 ft (1.5 or 3 m)] from the hub to the end of the new culvert. Guide stakes shall be set in all cases, giving the necessary information relative to the hubs.
2. Hubs for the alignment of headwalls may be placed on each side of the culvert on the line of the headwall face with the guide stakes clearly indicating the face staked. If the culvert has angling wingwalls, it is suggested that stakes be set marking such angle.
3. The centerline of bridges and viaducts may be indicated by hubs driven on the centerline at pier or bent locations and also on centerline of the structure, offset each way from the pier or bent locations. Pier angles shall be turned with a transit and hubs driven on their centerline at such distances as to protect them from disturbance. If possible, three hubs shall be driven on each side of each pier line. Type "E" or specially prepared 2 to 4 inch (50 to 100 mm) stakes, depending on the soil conditions, should be used as hubs to provide stable reference points. All hubs shall be tacked for line and at least two hubs on each side for distance. Since the centerline hubs will usually be destroyed during construction, a based line should be staked both right and left of centerline.
4. Permanent benchmarks should be established at each end of the structure and intermediate points as required. All elevations and chaining should be checked and rechecked.
5. The purpose of this letter is to provide the District Construction Engineer and the Construction Division with information with which to cross check culvert lists. It is felt that the letter may also be of value to the Project Manager for future reference.

M. Land Survey Monuments

The Department is required by law to notify the county board before undertaking any work that may disturb or destroy any corners of land surveys. It is essential that notification be given the county surveyor so that he/she will have sufficient time to properly witness all corners before work is begun. In the event that there is no county surveyor, or the county surveyor is not willing to perform the work, the Project Manager is responsible to schedule a registered land surveyor to perpetuate a monument.

N. U.S. Survey Monuments

1. Occasionally, benchmarks, triangulation stations, or other monuments of the U.S. Geological Survey or the National Geodetic Survey are located within the limits of construction and must be relocated. Such monuments must not be disturbed until specific permission is received from the director of the survey involved.
2. As soon as it becomes apparent that a monument of this type must be relocated, a letter shall be sent to the director of the appropriate survey, stating the necessity for moving the monument giving its designation and requesting instructions regarding the procedure to be followed in moving it. The condition of the monument and its location with respect to section, range, township, county and nearest town should also be included in the letter. The designation consists of letters and numbers stamped with dies on the disk. It is desirable that a rubbing of the disk be submitted also. The address to use for benches and landmarks is:
Director, National Geodetic Survey
601 East 12th Street, Room 1436
Kansas City, Missouri 64106

or

Central Region Engineer
U.S. Geological Survey
Rolla, Missouri 65401
3. A rubbing may be made by placing a piece of light or medium weight paper over the disk and then rubbing over the paper with a pencil, preferably a hard one, to bring out the legend case in the disk and any letters or numbers stamped on the disk with dies.
4. Upon receipt of this information, the director will provide for relocation by their forces or will authorize you to move the monument and furnish a new disk to be used in the relocated monument and instruction to be followed in its relocation.
5. The new monument shall be established strictly in accordance with the director's instructions. The old disk and all notes and information requested shall be transmitted to the director immediately after the monument has been relocated. Extreme care and accuracy shall be exercised in all measurements and work performed and reported so that the accuracy of the original monument may be preserved.
6. It is important that the necessity for moving such monuments be reported promptly when it becomes apparent that they must be disturbed so that delays in construction work due to waiting for permission and instructions from the directory may be avoided. The work of relocating such monuments should be performed promptly upon receipt of the necessary authorization so that the survey office may have definite information regarding the status of the monument at the earliest possible date.

O. Preserving, Perpetuating And Witnessing Land Survey Monuments

1. Preserving Land Survey Monuments – In the course of construction operations, it frequently becomes necessary to remove, or cover with embankments or surfacing, section corners or other land subdivision corners. Due to the fact that so few counties maintain county surveyors, considerable expense is incurred by the department each year in locating corners necessary in acquiring right-of-way. In order to preserve all corners and avoid additional expense in relocating the corners when additional improvements are contemplated, Project Managers are requested to take precautionary steps to preserve all existing corners during construction and to establish permanent markers and witnesses after the work is completed.
2. The county board is required by law to “cause to be perpetuated the existing corners of land surveys along the public roads and highways where such corners are liable to destruction, either by public travel or construction or maintenance.”
3. In order to comply with the law and cooperate with the county surveyor or Project Manager, the District Engineer will notify the county board in writing at least 120 days prior to construction, listing locations of land survey monuments which are within the construction limits. This notification shall be given on all construction projects including pavement resurfacing (except gravel). Copies of the notification shall be sent to the Deputy State Surveyor in the Roadway Design Division and the Construction Division.
4. Where corners have been located by the county surveyor or deputy state surveyor and properly witnessed, it shall be the responsibility of the Project Manager to protect the witnesses during the construction of the project. The Project Manager shall cooperate with the county surveyor by furnishing information regarding the proposed limits of construction so that witnesses may be placed in locations that will not be disturbed. The county surveyor should be notified promptly if it becomes necessary to disturb any witnesses or if witnesses are discovered during construction. Prompt notification in such instances may avoid inconvenience to the county surveyor. The land surveyor who witnessed the land corners prior to construction should be notified. Do not notify deputy state surveyors since they will be unable to return to the project.
5. The contractor is required by *SSHC Subsection 107.09* in the specifications to “protect carefully from disturbance or damage all land monuments and property markers until the Project Manager has witnessed or otherwise referenced their location and shall not remove them until directed.” The Project Manager shall cooperate with the contractor and advise of the location of all monuments which have been located and properly witnessed, marking the location of all witnesses by lath or in some other satisfactory manner and advise regarding any other location where monuments have not been located and where particular care should be exercised in excavating to avoid disturbing the monument if it is uncovered.

6. On resurfacing projects, the written notification directed to the county board shall be considered to have fulfilled the Department's obligation unless the county is not willing or cannot perform necessary work and time and personnel are available to perpetuate known monuments.
7. In the event that the county does not have a county surveyor or the county surveyor is not willing to perform the work, the Project Manager is responsible to get a registered surveyor from the Deputy State Surveyor's Office to set a temporary witness to preserve the location of all existing land monuments during construction and record such temporary witnesses in the project records.
8. After construction, permanent corner markers and witnesses can be established to preserve the location of such monuments. Only existing monuments need to be witnessed since lost or obliterated corners have no status unless their location is established by a registered land surveyor. It is anticipated, however, that when right-of-way is acquired, monuments will be found at all land corners since the Right of Way Division is attempting to have the location of all lost or obliterated corners established by the county surveyor or a deputy state surveyor before construction is begun. In order to avoid confusion in the records, it is important that the following instructions be carefully observed.
9. At some time before construction begins, the county surveyor, if available, should be contacted to determine whether all land corners on the project have been located and witnessed by permanent objects which are on record in his/her office. If witnesses are shown in the plans, they should be compared with those on record and any errors in the plans corrected. Information omitted from the plans should be entered thereon. The witnesses can then be inspected in the field. If it is found that any of the witnesses have been disturbed, or are within the limits of construction, or are in locations where they cannot be protected during construction operations, the county surveyor shall be requested to establish additional witnesses in protected locations.
10. If the county surveyor neglects to set adequate witnesses or if a county surveyor is not available and the witnesses shown in the plans have been disturbed or are inadequate, the Project Manager will be responsible to get a registered land surveyor to establish temporary witnesses to preserve the location of all existing corner monuments. These witnesses shall be set in the same manner as that later prescribed for establishing permanent witnesses, except that they may be set in any protected location without specific relation to right-of-way lines.
11. During construction operations, existing stones or monuments shall not be disturbed unless absolutely necessary. Should construction require disturbing a stone or other government survey monument, the deputy state surveyor in the Roadway Design Division should immediately be contacted before the stone is disturbed. The procedure to be followed in this situation will vary with the situation and the circumstances, however, the deputy state surveyor should be consulted before a government land corner is destroyed. Original monuments which will be under proposed embankments shall not be disturbed and every effort shall be made to protect them during construction operations.

12. If more than one monument is discovered for a land survey corner, the county surveyor and the deputy state surveyor should be contacted so that he/she may determine which marks the legal corner. In the event a county surveyor is not available, both monuments should be witnessed and a detailed description of each monument submitted to the Right of Way Division. In such instances, a very careful examination should be made of the surrounding soil for evidence of any deposit originally placed with the monument and charred stakes or pits and mounds which may have existed when the corner was originally established. These descriptions will be submitted to the state surveyor for a ruling as to which monument marks the legal corner.

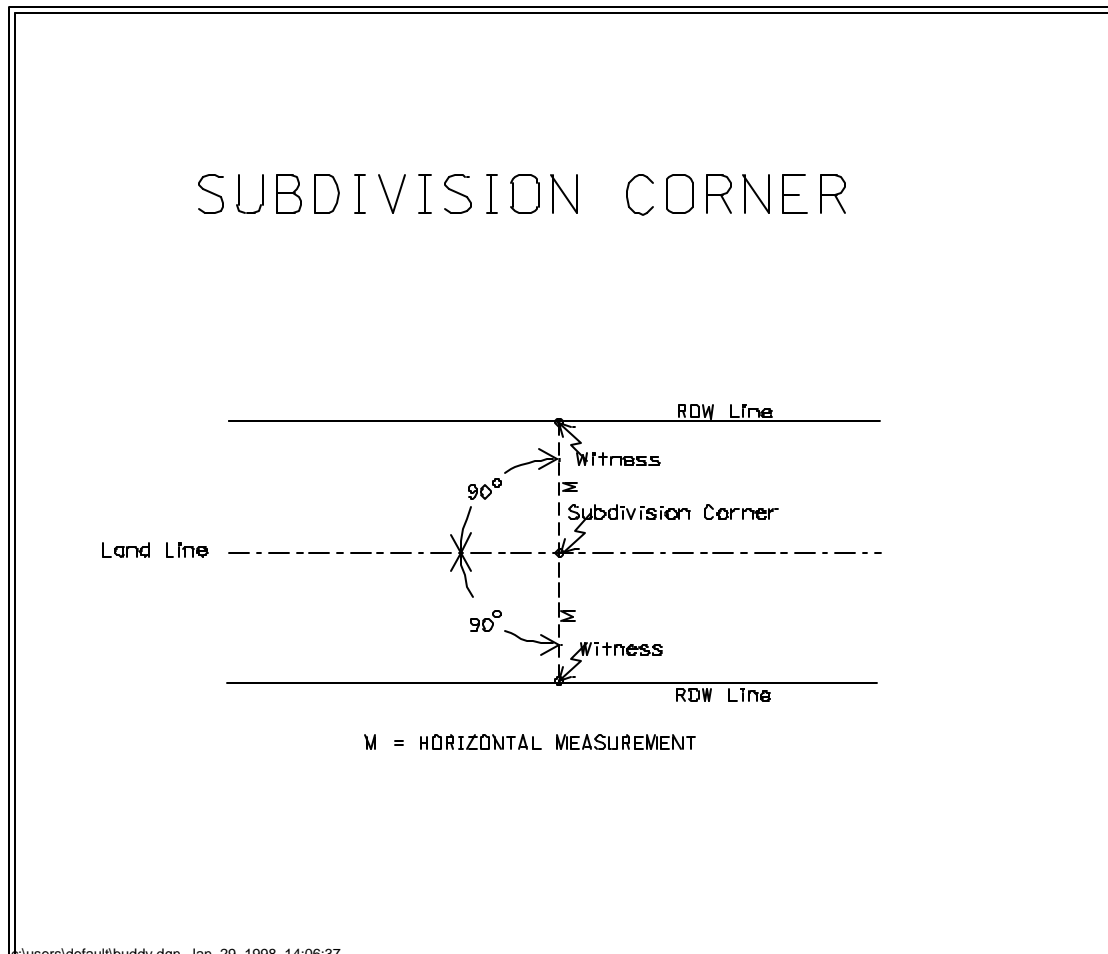
P. Perpetuation Of Section Corner Markers

1. After the work on the project is completed, permanent corner markers shall be established. If a county surveyor has not been handling the work, the Project Manager is responsible to schedule the deputy state surveyor to perpetuate section corners using measurements from the temporary witness corners previously set.
2. Permanent corner markers set by a registered land surveyor shall be $\frac{1}{2}$ inch (12.5 mm) or $\frac{3}{4}$ inch (19 mm) round steel bars at least 2 ft (600 mm) in length. If monuments are set below paved surface, a hole will be dug each time a corner is needed. Angle irons are also suitable. They shall be driven plumb to an elevation 6 inches (150 mm) below the road or ground surface. Corner markers in bituminous pavement shall be driven to an elevation approximately 2 inches (50 mm) below the surface and any depression filled with bituminous material.
3. Corner locations covered by concrete pavement shall be preserved by taking a core and setting the marker in the core hole flush with the surface of the pavement. The hole in the pavement shall be filled with concrete in the same manner as other cores.

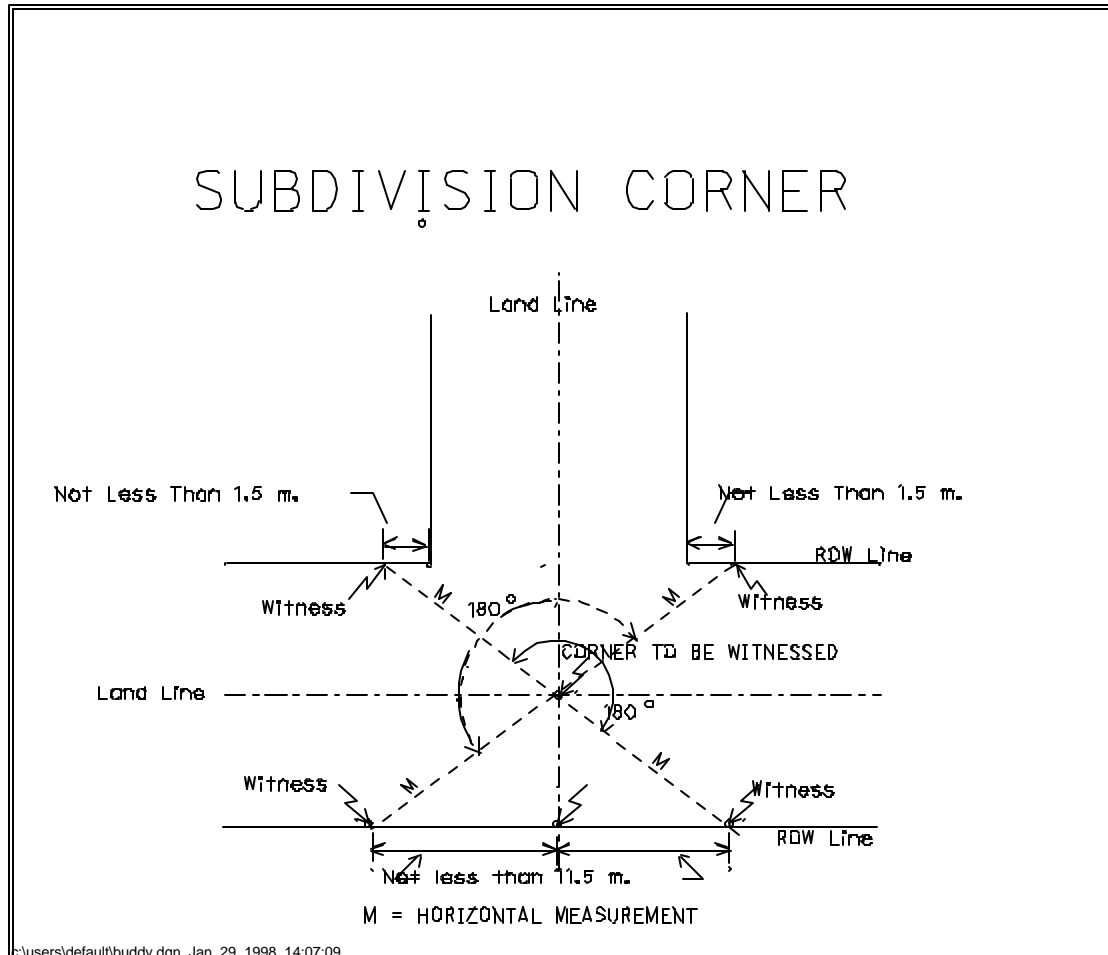
Q. Setting Witness Corners

1. Permanent witness corners to be set by the Project Manager shall be steel bars, angle irons or old grader blades. Steel bars and angle irons shall be driven flush with the ground surface and marked with an oak guide stake. Grader blades shall be approximately 4 ft (1.2 m) in length and set with 2 ft (0.6 m) of the blade below the ground surface. Witness points shall be set with a transit over the corner to be witnessed. The horizontal distance between the corner marker and the witness shall be measured and recorded. If right-of-way markers are in place, they may be used as witness corners and the section corner tied to the near corner of the right-of-way marker.

- Four witnesses shall be set for each section corner and for each subdivision corner located at an intersection of the project and other roads or streets. They shall be set on the Department right-of-way line not less than 5 ft (1.5 m), back of the right-of-way lines of the intersecting roads or streets. Witnesses for section corners not located at an intersection of the project with another road or street shall be set on the Department right-of-way lines not less than 38 ft (11.6 m) (if possible) from the intersecting landline.



- Two witnesses shall be set for each subdivision corner, except those located at an intersection with another road or street. They shall be set on the Department right-of-way lines at right angles to the land.



4. A "Section Corner Tie Sheet" DR-70 shall be prepared for each corner perpetuated by the Project Manager. Three copies shall be submitted to the Deputy State Surveyor by the Deputy State Surveyor employed by this Department. The Deputy State Surveyor shall forward one of these copies to the State Surveyor, and forward one to the county for their records. Signatures and addresses of two local residents observing the perpetuation of the corner markers and establishment of witnesses should be secured as witnesses. In the event local residents are not present, signatures and permanent addresses of other members of the party shall be secured as witnesses.

R. Installation Of Right-Of-Way Markers

The Department's right-of-way marker is international orange reinforced concrete block. See *SSHC Section 913*.

S. Location Of Markers

1. Right-of-way markers shall be set accurately on the following points:
 - At each break in the right-of-way line.
 - At apparent intersections of railroad or county right-of-way line.
 - At beginning and end of each curve plus intermediate points on long curves where necessary
 - At apparent intersection of government land lines.
 - At apparent intersection of street right-of-way lines.
 - At lot line intersections if lot corner was in place prior to construction.
 - Refer to Table 1300.4 for stake placement intervals.
2. Block corners at city street intersections must be referenced out if available. This will simplify setting a pin on the apparent intersecting street right-of-way line and projecting the new right-of-way line from street to street for proper location of sidewalks or retaining walls.

T. Benchmarks

1. During construction of a highway project, many benchmarks may be destroyed and alternate ones must be selected for future use. A permanent benchmark should be established at approximately ½ mile (0.8 km) intervals along the highway route in rural areas. Bridge abutments are good locations for permanent benchmarks. Headwalls of culverts have also been a favorite place for benchmark locations, but a certain amount of settlement may take place during the first year in a new culvert and may result in erroneous benchmark elevations. Best results can usually be obtained by establishing a benchmark circuit after initial settlement has been completed, normally one year after construction. After elevations are established on the new benchmarks, a DR Form 70 should be completed and filed with the survey coordinator or the District office.
2. Utility poles, fence posts, ends of drainage pipes, and railroad rails should all be avoided since these objects tend to be disturbed by frost, wind, and farming operations. Casting of a permanent concrete monument within the right-of-way appears to be the best solution in the absence of some other stable, permanent object.

3. Establishment of permanent benchmarks should be considered near the end of every major grading and paving project. Monument location should be at the direction of the Project Manager. Occasionally, the Project Manager will have cast-in-place concrete monuments placed by contractor and paid by extra work order. Standard brass shall be provided by the Project Manager to be set in plastic concrete.
4. Locations for permanent benchmarks in urban areas include fire hydrants, concrete sign bases, and other permanent objects. Interval of benchmarks should be established at about one per city block.

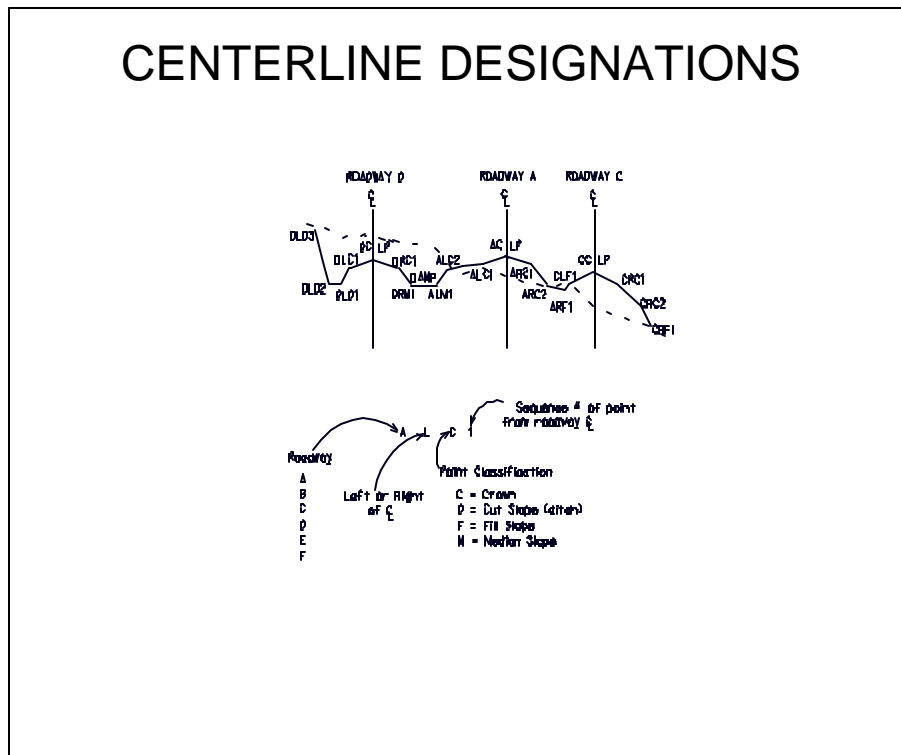
U. Permanent Benchmarks Along Rural Highways

1. Permanent cast-in-place concrete benchmarks should be constructed using the following guidelines. These should be considered minimum dimensions:
 - Excavate a 1 ft (300 mm) diameter hole 5 ft (1.5 m) deep.
 - Insert a #6 English (#20 metric) size diameter reinforcing bar in the center of the excavation.
 - Place concrete around reinforcing bar to a depth of approximately 2 inches (50 mm) below ground elevation.
 - Finish concrete so surface is slightly rounded.
 - Insert a brass cap in center of plastic concrete.
2. Monument shall be tied to construction centerline by station and distance and recorded on "as built" plans.
3. The DR Form 70 is required to report and describe all permanent benchmarks on any construction project. "Bridge Plans" include details for placing benchmarks, (brass caps), at bridge ends. (A district file with copies of these forms is recommended.)
4. All permanent benchmarks must be tied into the highway reference system and this information included on DR Form 70.
5. The benchmark's DR Form 70 shall be sent to:

Nebraska Department of Roads
Roadway Design Division
Mr. Ken Hartwig, Preliminary Surveys
P.O. Box 94759
Lincoln, Nebraska 68509-4759
6. A district file of copies of these forms is also recommended.
7. A computer file of these permanent benchmarks will be maintained and the highway reference post system will be used to identify the benchmarks.

1300.04 TAKING PRECONSTRUCTION CROSS SECTIONS

- A. Preliminary Survey Requirements: The designer and the District will work together to determine the “Preliminary Survey Requirements”. The requirements can vary for each project.
- B. Preliminary Survey with Data Collector/GeoPak – When the preliminary survey is put in a “Husky” or some other Data Collector and loaded in **GeoPak**, then preconstruction cross sections can be taken mathematically at any plane.
- C. Preconstruction Cross Sections. The preconstruction cross sections will, in most cases, consist of additional and extended sections omitted from the preliminary survey. Cross sections must be taken wherever necessary to show the true excavation quality. Some of these points will include:
 - 1. Zero sections between cut and fill.
 - 2. P.C. and P.T. (T.S. and S.T.) of horizontal curves.
 - 3. Points where width of side ditch and borrow changes.
 - 4. Points where backslope changes.
 - 5. Points where width of roadway changes in cut section.
 - 6. Beginning and end of side borrow pits.
 - 7. Extending preliminary cross sections where necessary.
- D. Cross Section Accuracy. Cross sections shall be taken accurately, at right angles to the centerline, at known locations so that final cross sections may be taken at the same stations. Each section shall be an accurate profile of the ground at that location. The rod shall be held vertically and the tape shall be read to the nearest 1 ft (300 mm) from the centerline of the project. The rod shall be read to the nearest 1/10 foot (30 mm). All sections shall be taken both left and right of centerline and shall extend at least 10 ft (3 m) beyond the construction limits.



- E. Preliminary Cross Sections Used to Compute Final Quantities. When final quantities are to be computed in the field office and the preliminary cross sections are to be used as the preconstruction sections, the Project Manager should request the plotted cross sections by letter to the Construction Division. These cross sections should then be carefully checked to determine that they are of sufficient width to cover the construction limits. Preliminary cross sections are sometimes extended arbitrarily beyond the actual cross section limits when the project is designed in the Lincoln Office.
- F. Intersections. The Project Manager should take preconstruction cross sections on intersections occurring in excavation sections. These cross sections shall be taken at right angles to the intersecting road and may begin at the centerline of the project or at the right-way-way line. In either case, they should “close” on a cross section taken at right angles to the centerline of the project on each side of the intersecting road. The notes should include a complete sketch showing the following:
1. The station of the intersecting road or approach road.
 2. The location of the cross sections.
 3. Ties to the project centerline and to the approach road line extended.
 4. Angle of intersection.
 5. North point.

- 6. Station or plus of project cross sections on which intersecting road cross sections are to “close”.

- G. Other Excavation Areas – Channel changes and borrow pits that are not parallel to the centerline of the project shall be cross sectioned separately and tied to the project centerline in a manner similar to that described for intersections. Waste banks shall be cross sectioned if overhaul is involved. They shall be tied to the project centerline and haul routes shown.

- H. Cross Section Notes. Notes on intersections, channels, approaches, etc., are usually kept in a separate notebook. Cross section notes should be kept in a manner similar to the example in Division III. Do not crowd the notes.

1300.05 FINAL CROSS SECTIONS AND FINAL QUANTITIES

A. General

As a general rule, final cross sections are not required as long as the contractor has not disputed the plan quantities and any correction made during construction and agreed to accept the plan quantity as the final pay quantity.

B. Final Cross Section Guidance

When final cross sections must be taken, the following is provided as guidance:

1. Final cross sections may be taken on each 1 mile (1.7 km) as soon as the grading work on that 1 mile (1.7 km) section has been completed and accepted. Final cross sections may be taken while awaiting acceptance if the Project Manager is sure there will be no further work which might change the elevation of any excavation cross section.
2. Final cross sections must be taken at all points where a preconstruction or preliminary cross section was taken, if excavation was made at that point. If it develops that a final cross section must be taken at some plus station which has no preconstruction cross section, a preconstruction section must be interpolated at that point. The final cross section should extend well beyond the construction limits [5 to 10 ft (1.5 to 3 m)]. A rod reading should always be taken on the first definite "natural ground" and this information recorded in the notebook. In addition the surveyor must locate all breaks in each cross section and the maximum distance between shots in each cross section is 20-feet.
3. The excavation involved in undercutting slopes, ditches, borrow pits and shoulders in preparing such areas for the placement of topsoil is not measured for payment and final cross sections shall be taken after the topsoil has been placed.
4. The Project Manager must clearly separate each borrow pit quantity from one another. If the borrow pit is adjacent to the roadway excavation, the final cross section notes must include a rod reading at the R.O.W. line (shear section) and cross sections for the adjacent borrow pit must be separate from the roadway cross sections and computed separately.
5. The option pit block on the plans should be stamped participating and at the end of the detailed estimate breakdown of costs for each such borrow pit will appear. The borrow material costs will be computed in the Lincoln Office. These instructions are in addition to those required in Subsection 109.11, Paragraph V. of this manual.

6. On normal grading contracts, in which no changes in plans are made which would involve overhaul, final cross sections will not be taken for sections which include embankment only. However, when taking the final cross sections for excavation, centerline and shoulder shots should be taken on the embankment at each full station. At locations involving excavation only, or excavation and embankment in the same location, final cross sections shall be taken as necessary to include the excavation.
7. On linear grading contracts where the plans show a grade line elevation (not county agreement projects), the Project Manager shall take a final cross section at each station consisting of shots on centerline and each shoulder of the finished roadway. This may be done at the time the final check is made on the roadway surface to see that it meets the tolerance set forth in the specifications and/or special provisions, and should be submitted as part of the final records. On projects constructed under agreement by county forces, sufficient checks should be made of the finished grade to substantiate conformance with plans, specifications and special provisions.
8. Preconstruction surveys for rebalancing, or additional preconstruction cross sections might be necessary to determine pay quantities. Changes in plan or grade line which might involve overhaul cannot be anticipated during design or at the start of work. It is essential that preconstruction information be complete, so that if necessary, the final cross sections may be adjusted to reflect the existing ground elevations at the start of the project if different from the original preliminary cross sections.
9. When changes in plans involve overhaul, the final cross sections must include all embankment as well as excavation for the balance that the overhaul has occurred in. See Subsection 105.07 of this manual for additional instructions.

C. Earthwork Calculations

1. The final earthwork quantities on all in-house projects can be computed/verified via Microsoft/GeoPak. The Finals Section of the Construction Division can assist with or perform these calculations. However, the specific quantities and their location are necessary to verify or calculate quantities. There are two basic ways that projects are surveyed currently:
 - Total Stationing
 - Conventional Surveying

The Construction Division will convert conventional data to a Microsoft/GeoPak file to accomplish any quantity calculations. The following are required when requesting convention survey verification of quantities:

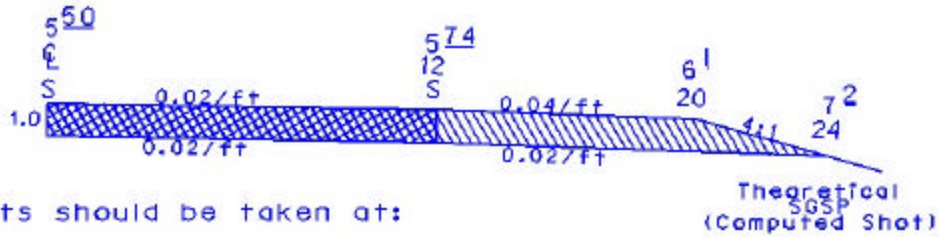
- a. Final cross section notes
- b. H.I. data

- c. Curve data
 - d. Surfacing data
 - e. Preconstruction cross section notes
 - f. Zero-zero sections
 - g. Interpolated cross sections
 - h. Width of preconstruction (preliminary) cross sections
 - i. Preparation and submittal of records
2. Field Notebooks
- a. Final Cross Section Notes – A special effort should be made to keep the notes clear and legible. Do not crowd the notes. Not more than four single line cross sections should be recorded on each page of a 4½ x 7½ inch (115 x 190 mm) field book. It is suggested that a 3H pencil be used in taking notes.
 - b. Notes should be recorded with the stationing reading from the bottom of the page to the top. If there is insufficient room for all readings on one line, the readings should be completed on the next line. The station of each line shall be shown. All shots must be recorded on the proper side of the centerline. See Division III of this manual for example.
 - c. Rod readings shall be expressed in ± 1/10 foot (30 mm) on dirt. Surfacing shots will be expressed in 1/100 foot (3 mm). Use a slightly elevated decimal figure in lieu of a decimal point. All plus rod readings shall be indicated by a plus symbol (+) preceding the reading. Horizontal distances shall be recorded to the nearest 1 ft (300 mm).
 - d. A cross section shall be taken at all equations.
 - e. Final roadway cross sections may originate on either the right or left side of centerline of the project. The cross section must have a centerline (zero distance) rod reading. This also applies to borrow pits or channels cross sectioned from a base (zero distance) line.
 - f. When it becomes necessary to take the final cross sections after completion of the surfacing work, sufficient room shall be left by the note recorder for inserting calculated rod readings. These rod readings will reflect the elevation of the typical grading section shoulder-subgrade point.

D. Surfacing Data

1. Portland Cement Concrete Pavement – The Project Manager should take complete final cross sections after grading is complete prior to performing any surfacing structure work. If cross sections are taken after the surfacing is complete, the following three examples show where rod readings must be taken to reflect the excavation due the contractor in each instance. The letter “S” which indicates surfacing shall be placed under rod readings as shown in the examples. If pavement thickness, foundation course and surfaced shoulders are constructed other than as shown on the typical cross section of improvement sheet of the plans or the station limits are changed from those shown on this plan sheet, this information shall be shown in the notebook and also in the letter of transmittal.

Sufacing w/ Earth Shoulder English Concrete Pavement



Shots should be taken at:

- Centerline
- Edge of driving surfaces or at lane breaks for multiple lane roadways
- Edge of surfaced shoulders
- Hinge points
- All ground breaks - not to exceed 20' between shots

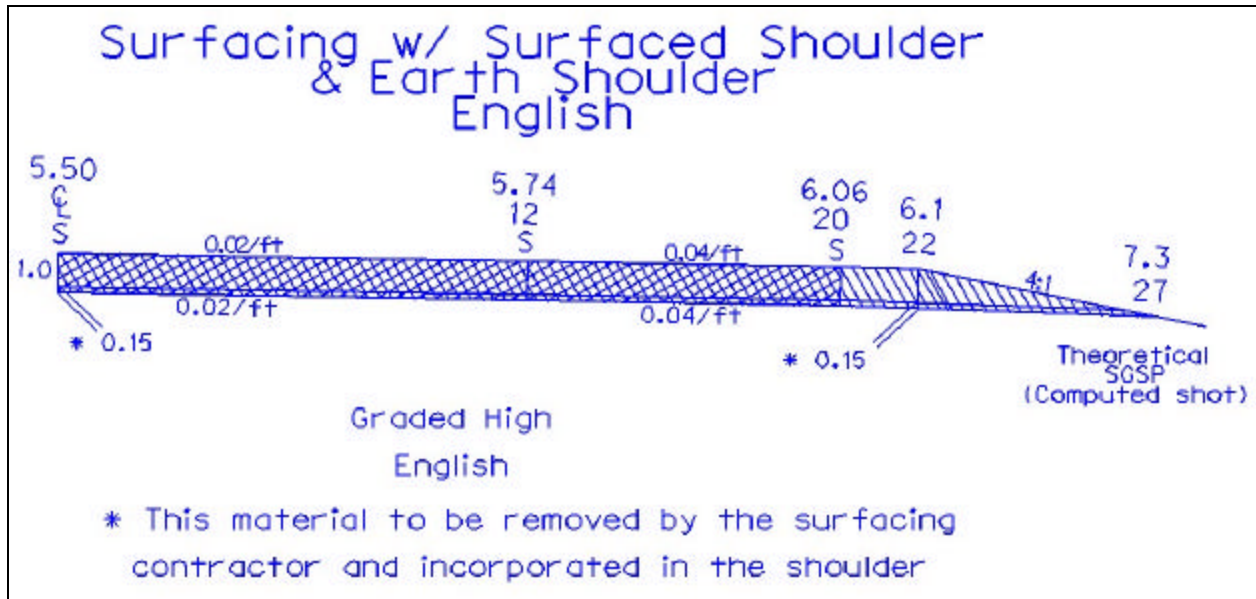
Theoretical Subgrade Shoulder Point (SGSP) should be computed and inserted into the x-section.

English

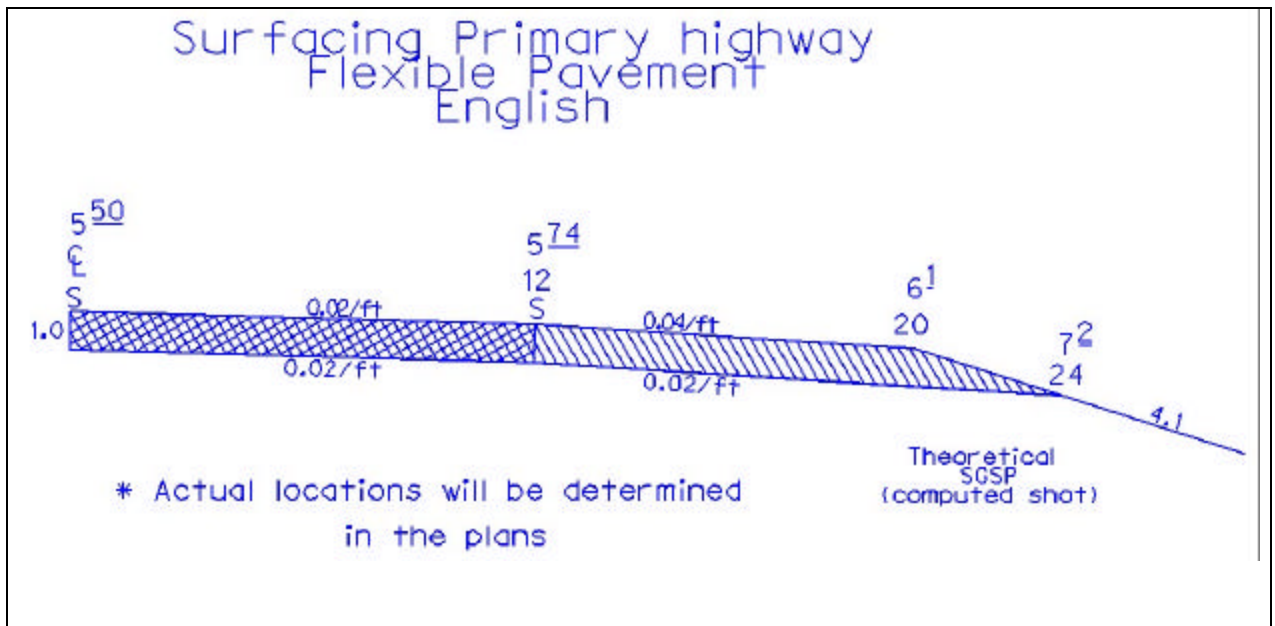
- Surfacing shots read to the nearest hundredth of a foot.
- Ground shots read to the nearest tenth of a foot.

Metric

- Surfacing shots read to the nearest thousandth of a meter.
- Ground shots read to the nearest hundredth of a meter.



2. Flexible Pavements (Asphaltic Concrete, Bituminous, and Base and Armour Coat Surface Courses) – The Project Manager should take complete final cross sections after grading is complete prior to surfacing and shoulder construction. When cross sections are taken after the surfacing is complete, all rod readings taken on the surfacing shall be identified with the letter “S” (indicating surfacing) under the distance. If the surface structure is constructed other than as shown on the typical cross section of the improvement sheet of the plans or the station limits are changed from those shown on this plan sheet, this information shall be shown in the notebook and also in the letter of transmittal. The following sketch shows the rod readings and distances required on the roadway for a 7.3 m (24 ft) asphaltic surface course constructed directly on the subgrade.



3. Any rod readings, other than those shown in the above sketch, necessary to show additional excavation required to be made in constructing variable width surfacing shall be taken, recorded and identified by the letter "s" under the rod reading. One such case would be at channelized intersections.
4. Rod readings beyond the shoulder will not be necessary in embankment sections unless the elevation of the subgrade is below the grade line of the existing embankment prior to grading (locations where the old embankment is lowered or cored out to place a subbase or base course) or it is necessary to accurately determine the quantity of embankment in order to compute overhaul.
5. The Project Manager will be responsible for inserting the shoulder rod readings into the final cross sections.
6. Two (2) methods will be used to determine the shoulder point:
 - a. Slope Stake Data (preferred)
 - b. Theoretical Shoulder Point

(The Project Manager will state, in the transmittal letter, what method(s) was used and where.)

E. Shoulder Construction

1. On both rigid and flexible pavements, the quantity of material required for the earth portion of the shoulder construction will usually be either subsidiary to the subgrade preparation work or measured for payment as "Shoulder Construction". Accordingly, the excavation for the shouldering material is not a pay item. The Project Manager should take complete final cross sections after grading is complete and prior to surfacing and shoulder construction. If final cross sections cannot be taken until shouldering is complete, the quantity of excavation for shoulders should be deducted from the excavation pay quantity. If possible, this deduction should be computed by cross section method of material at the source. When it is not possible to cross section the material at the source, the volume may be computed by using the typical section for shouldering and multiplying by a balance factor of 1.35. If the typical cross section provided for the subgrade to be graded "high" and the material trimmed is to provide the shoulder material, no deduction is required.
2. Topsoil Placement – When the plans provide for topsoil placement as a part of the grading construction, final cross sections should be taken after the topsoil has been placed. This is in accordance with Subsection 929.04 of the specifications which provides no payment for undercutting the topsoil placement.

F. Preconstruction Cross Section Notes

Where preconstruction cross section notes are taken to supplement or replace preliminary cross sections, this fact shall be noted in the letter of transmittal. Give the book and page number location of such notes. The letter of transmittal shall also contain the book and page number location of all extensions to preconstruction and preliminary cross sections.

G. Zero-Zero Sections

The location of zero areas for cut may be shown in the notes without taking a final cross section when there is no cut whatever at the location. Examples: (1) Cut on Lt., C=00 Rt. take final cross section of Lt. (2) Cut on Rt., C=00 Lt. take final cross section on Rt. (3) No Cut Rt. or Lt., C=00 Rt. or Lt., no final cross section is necessary.

H. Interpolated Cross Sections

Final cross sections for which a preliminary or preconstruction cross section is not included in the original notes shall be identified by a note in the final cross section book giving the location in the records where the interpolated cross section may be found. The necessary interpolation shall be made by the Project Manager before submitting the note to the Lincoln Office and shall consist of elevations and distances.

I. Width Of Preliminary And Preconstruction Cross Sections

The Project Manager shall check the preliminary cross section notes, the "Slope Stake Book" and his/her own preconstruction cross section notes to determine whether in all instances these cross sections extend at least as far from centerline as the final cross sections he/she has taken at the same locations. In instances where the preliminary or preconstruction cross sections are not as wide as the final cross section, it will be necessary to extend the preliminary cross section using other available information. This will usually consist of reference hub elevations, slope stake elevations, or as a last resort, the final cross section elevation. The data on which the closure is based shall be entered in the final notes on the left-hand page opposite the inadequate cross section.

J. Example Of Note. The note should show the elevation and the distance from centerline of the point to be used to extend the preliminary (preconstruction) cross section and the manner in which it was established as shown in the following example.

17 Extd. Prelim. to El. 55.6 @ 90 m Lt. S.S. Bk. No. 4
+50 Extd. Prelim. to El. 55.0 @ 90 m Lt. Final Elev.
16 Extd. Prelim. to El. 54.4 @ 100 m Lt. S.S. Bk. No. 4

K. Extension Made Without Note. When no preliminary cross section extension note is given by the Project Manager, the extension will be made by using the last final shot as the last preliminary elevation and distance.

L. Preparation And Submittal of Records

The elevations of all H.I.'s should be reduced and carefully checked to insure their accuracy.

1. The notes should not be reduced to show the elevations of the individual shots on the cross sections except where necessary to check closing shots.
2. The closing shots of all final cross sections in excavated areas shall be checked in the field office to verify closure with the preliminary survey. Cross sections normally will be closed on undisturbed ground. However, this ground often is a plowed field where 6-inch elevation differences are to be expected. Therefore the Department's tolerance on all cross section closures at or near the limits of construction shall be ± 6 inch (150 mm). Cross sections which do not close within these limits shall be field checked or explained by an entry in the final notes. If an error in the preliminary can be substantiated, for example, with slope stake elevations, then an entry correcting the preliminary cross section elevations should be placed in the final notes.
3. Notebooks shall be given a permanent number and completely indexed in the front to show the location of all data included therein. The project number and the name and address of the Project Manager shall be entered on the inside of the front cover.

4. Final cross section notebooks shall be prepared in accordance with these instructions and submitted to the Construction Division. Projects up to approximately 10 km long shall be submitted in their entirety. Projects over 10 km may be submitted in two sections if this will speed up the processing of the final records. If the preliminary notes are at the field office, those stations covered by the final cross sections being submitted shall also be sent to the Construction Division. Final notebooks will not be returned to the field unless specifically requested by the Project Manager. The data submitted to the Construction Division shall be addressed as follows:

Department of Roads
Construction Division – Finals Section
1500 Hwy 2
P.O. Box 94759
Lincoln, Nebraska 68509-4759

M. Plotting Cross Sections

1. Microstation/GeoPak may be used in lieu of hand calculations.
2. Final cross sections need to be plotted only on those projects not designed under the computer program or those portions of projects (channels, borrow pits, intersections, etc.) which are being computed in the field office.
3. For those projects computed in the field office, after checking all H.I.'s, the preconstruction and final cross section notes are reduced and checked. The points are then accurately plotted on cross section paper using a scale of 1 inch=5 ft (25 mm equals 1.5 m) vertically and 5 ft (1.5 m) horizontally, or 5 ft (1.5 m) vertically and 10 ft (3.0 m) horizontally. All plotting should be checked by reading the elevations and distances back from the cross section sheets. Preconstruction cross sections shall not be inked.
4. The final cross sections for excavation only are plotted over the preliminary or the preconstruction cross sections using the same coordinates and drawing in the final with a dashed line.

1300.06 CONTRACTOR FURNISHED CONSTRUCTION SURVEY

- A. Construction Staking And Surveying As Contract Item. On projects with “Construction Staking and Surveying” included as a contract item, the contractor is responsible for construction staking. The prime contractor may subcontract this item.
- B. Additional Survey Work Payment. Additional survey work required because of plan revisions or changes directed by Project Manager shall be paid for as extra work according to *SSHC Subsection 109.05* or be done by the Department.
- C. Contractor’s Responsibilities Include:
- The Contractor’s Surveyor must comply with the minimum requirements in Tables 1300.1 through 1300.5 and all other surveying requirements in this manual.
 - Provide survey data in a format that is compatible with GeoPak.
 - Stake right-of-way, temporary easements, and right-of-entry reference.
 - Preserve and reestablish all centerline control points-point of curve (PC), point of tangent (PT), point of intersection (PI), and point on tangent (POT); and all spirial points (TS, SC, CS, and ST).
 - Establish relocation centerline and related points, including extensions of cross sections, if not established in field by time of advertising for bids.
 - Staking culverts, bridges, sewers and all other structures and pavement requirements.
 - Perform a level circuit to check benchmarks prior to start of construction. Report the results of this survey to the PM immediately upon completion.
 - Stake right-of-way break points.
 - Establish permanent benchmarks and permanent ties to all required points. A copy of all ties must be provided to the Project Manager.
 - Reestablish land corners and section corners. If this is pay item in the contract then this is a contractor requirement.
 - Section corners are usually reestablished by the county.
 - In rural areas the property corners are usually not reestablished by a registered land surveyor.
 - In urban areas property corners are reestablished by a registered land surveyor and this is a separate pay item.

D. Department Responsibilities:

- Take elevation reading of settlement plates.
- Perform work identified in the special provisions of the contract.

E. Special Attention Items

1. The Project Manager should be notified and/or consulted for guidance if the following conditions occur:
 - Proposed culvert is staked and its location does not fit existing ground elevations.
 - Conflicting conditions occur such as existing water line located at same location as the proposed sewer line.
 - Farm subdrains are present. Contractor will determine their location, size, and elevation. The Project Manager will establish final size, location, and elevation for construction of tile line to be staked by the contractor.
 - Slope stakes do not match design cross section.

F. Documentation

1. Field notes are to be kept in the bound field books. After project completion, field books become the property of the Department.

G. Contract Administration

1. By Specification, "construction survey" is identified as a "specialty item."
2. "Construction survey" is considered a professional service, therefore Davis-Bacon requirements do not apply.
3. If survey work is performed by someone other than the contractor, a "Subcontract Request and Approval" form shall be submitted. All requirements of subcontractors are to be fulfilled with the exception of Davis-Bacon requirements.

1300.07 ENGINEERING EQUIPMENT, SUPPLIES AND SERVICES

A. General

Engineering equipment and supplies are a significant annual expenditure of the Department of Roads. It is Department policy to maintain equipment in reliable condition, supplies in adequate amounts, and that expenditures be controlled. All employees are expected to support this policy.

B. Responsibility

1. The employee is charged with full responsibility for the care of all equipment issued to him/her. The employee should instruct assistants in the proper care and handling of all equipment, particularly the more delicate equipment such as transits, levels, balances, etc. When accepting responsibility for an instrument, whether new or old, the person should inspect it carefully and make sure that it is in good conditions and complete when received. When returning an instrument, all missing or damaged parts should be reported.
2. The employee is held directly responsible for the loss or damage of equipment in his/her charge caused by negligence or carelessness and may be required to pay for repair or replacement of this equipment. Equipment when not in use should be stored in a place where it is secure from damage or loss. When equipment is left in an unattended automobile, the vehicle should be locked to prevent theft or damage.

C. Engineering, Surveying And Testing Equipment

A supply of this equipment is maintained at Logistics. Equipment will be issued directly to the employee as ordered and approved by the District Engineer or Division Head. Equipment which is no longer needed should be returned to Logistics.

D. Requisition And Transfer

1. The following example cases are given to explain the procedures to be followed. If your question is not answered, contact the Logistics Division.

Case I - Requests for Engineering, Surveying and Testing Equipment listed in the Department's Statewide Inventory System (SWIS) and included in the Supply Catalog in Class 59, are non-stocked items and must be budgeted by districts and purchased by the Logistics Division, Engineering Equipment Section.

Case II - Requests for Engineering, Surveying and Testing Equipment not listed on the Department's SWIS and included in the Supply Catalog in classes other than Class 59 will be ordered on a DR Form 146, Stock Requisition. Equipment not included in the Supply Catalog will be purchased on a DR Form 151, Purchase Order. It will be coded in the District/Division ONE and Activity 5099.

Case III – Material Sampling and Other Miscellaneous Supplies, sacks, cans, molds, lath, stakes, nails, field books, cloth, etc. included in the Supply Catalog will require a DR Form 146, Stock Requisition. Items not included in the Supply Catalog will require a DR Form 151, Purchase Order. These are “direct purchase” items and are to be charged to specific projects. “O” for participating, “I” for nonparticipating, the OE code for your District/Division and the appropriate activity (Constructing, Design, etc.).

Case IV – Office Supplies, Safety Gear and Medical Supplies included in the Supply Catalog will require a DR Form 146, Stock Requisition. Items not included in the Supply Catalog will require a DR Form 151, Purchase Order. These items are not “direct purchase” items and are to be charged to OE code for your District/Division and Activity 5099. Safety equipment is coded to AFE Y500.

Case V- Transfers of Engineering, Surveying and Testing Equipment listed on the Department’s SWIS between Divisions, Districts or returned to Logistics will be documented on DR Form 332, Furniture and Equipment Issue/Transfer. A DR Form 332 must accompany the equipment transferred. Logistics Division will always receive the original. The transferee, transferor and the Districts or Divisions will all receive copies. The transferee is responsible for submitting this form.

Case VI – Transfer of Engineering, Surveying and Testing Equipment not listed on the Department’s SWIS and in classes other than 59 to Logistics will require a DR Form 147 for cataloged equipment and a DR Form 147a for non-cataloged equipment. A copy of the form will accompany the equipment. OE code for your District/Division and Activity 5099 will be used.

2. All forms except the copies required to accompany the equipment will be routed through the District/Division Office and then to the Logistics Division.

E. Precautions And Maintenance Of Survey Equipment

1. Total Stations (Precautions)
 - a. Never place the Total Stations directly on the ground. Avoid damaging the tripod head and centering screw with sand or dust.
 - b. Do not aim the telescope at the sun. Avoid damaging the LED of the EDM.
 - c. Protect the Total Stations with an umbrella against direct sunlight, precipitation, and humidity.
 - d. Never carry the Total Station on the tripod to another site.
 - e. Handle the Total Stations with care. Avoid heavy shocks or vibration.
 - f. Always switch the power off before removing the standard battery.

- g. Remove the standard battery from the Total Station before putting it in the case.
- h. When the Total Station is placed in the carrying case, follow the layout plan.
- i. Make sure that the Total Stations and the protective lining of the carrying case are dry before closing the case. The case is hermetically sealed and if moisture is trapped inside, damage to the instrument could occur.
- j. Someone should always be near the instruments when it is set up in the roadway or in any other location where it may be disturbed.

F. Total Stations (Maintenance)

- 1. Wipe off moisture completely if the instrument gets wet during survey work.
- 2. Always clean the instrument before returning it to the case. The lens requires special care. Dust it off with the lens brush first, to remove minute particles. Then after providing a little condensation by breathing on this, wipe it with a soft clean cloth or lens tissue.
- 3. Do not wipe the displays and keyboard or carrying case with an organic solvent.
- 4. Store Total Stations in a dry room where the temperature remains fairly constant.
- 5. If the battery is discharged excessively, its life may be shortened. If it is stored, it should have somewhat of a charge in it.
- 6. Check the tripod for loose fit and loose screws.
- 7. When removing the Total Stations from the carrying case, never pull it out by force. The empty carrying case should be closed to protect it from moisture.
- 8. Check the Total Stations for proper adjustment periodically to maintain the instrument accuracy.

G. Electronic Digital Theodolite/Transit (Precautions)

- 1. When the theodolite/transit is not used for a long time, check it at least once every three months.
- 2. Handle the theodolite/transit with care. Avoid heavy shocks or vibration.
- 3. If any problems are found with the rotatable portion, screws or optical parts (e.g., lens) send it in to the Engineering Equipment Shop.

4. After removing the theodolite/transit from the carrying case, close the case to exclude dust and moisture. Never place the theodolite/transit directly on the ground. (Attached dirt may damage the base plate and centering screw.)
5. Never carry the theodolite/transit on the tripod to another site.
6. Protect the theodolite/transit with an umbrella against strong sunlight and precipitation of any kind.
7. When the operator leaves the theodolite/transit, the vinyl cover should be placed over the instrument.
8. Always switch the power off before removing the internal battery on the theodolite.
9. Make sure the theodolite/transit and the protective lining of the carrying case are dry before closing the case. (The case is hermetically sealed; if moisture is trapped inside, damage to the instrument could occur.)
10. Someone should always be near the instrument when it is set up in the roadway or in any other location where it may be disturbed.

H. Electronic Digital Theodolite/Transit (Maintenance)

1. Wipe off any moisture if the instrument gets wet during operation.
2. Always clean the instrument before returning it to its case. The lens requires special care. Dust it off with the lens brush first, to remove minute particles. Then, after providing a little condensation by breathing on the lens, wipe it with a soft, clean cloth or lens tissue. (Theodolite only) when cleaning the display, keyboard and carrying case, never use any organic solvent (e.g., thinners).
3. Store the instrument in a dry room where the temperature remains fairly constant.
4. Check the tripod for loose fitting and loose screws.

I. Survey Levels (General Precautions)

1. Be sure to carry the instrument to the job site in the plastic case.
2. Handle with care.
3. Do not place the instrument directly on the ground.
4. After taking the instrument and accessories out of the plastic case, be sure to close the case cover to keep out dust and dirt.

5. Use both hands to hold the instrument when carrying it at the job site. Remember that when moving the instrument from one job site to another, it must be removed from the tripod for transporting.
6. If the instrument is left mounted on the tripod for any length of time, cap the objective lens and cover the entire instrument with the vinyl cover.
7. Be careful not to expose the instrument to direct sunlight and precipitation. If it gets wet, wipe it with a dry cloth before putting it back in the plastic case.
8. Store the accessories in the specified places in the case.
9. Use neutral cleanser or water to clean up the plastic case.
10. Someone should always be near the instrument when it is set up in the roadway or in any other location where it may be disturbed.

J. Survey Levels (Maintenance)

1. Moisture affects the surveying instrument. Completely wipe off any moisture if the instrument gets wet during surveying work.
2. After use, clean every part of the instrument before putting it back in the case. Breathe on the lens to moisten them and gently clean them with a lens cloth, a clean cloth (preferable, worn out cotton), or soft tissue paper.
3. The tripod shoes may become loose or the legs may become shaky due to faulty wing nuts when used for a long period. Check them periodically.
4. If foreign matter appears to have entered any movable parts or screws or when condensation or fungi appears on the lens, prisms, etc., in the telescope, put on work order and send in to Engineering Equipment Shop.
5. It is recommended to subject the instrument to annual or semi-annual checking and inspection to maintain the high quality necessary for your surveying work.

K. Adjustment Of Instruments

1. All instruments issued to Project Managers should be in proper adjustment when received from the Lincoln Office. They should, however, be checked for accuracy and necessary adjustments made at regular intervals. Adjustments should be made only by the Project Manager or a qualified member of the party who had been authorized by the Project Manager to perform such work. All adjustments should be carefully made strictly in accordance with methods prescribed in surveying handbooks. Any adjustment which requires dismantling must be made in the Lincoln repair shop.
2. All Total Station adjustments should be made in the Lincoln repair shop.

L. Transporting Equipment

1. Surveying equipment should be loaded into cars or trucks in such a manner as to minimize the possibility of damage. Leveling rods, range poles, etc., are easily damaged by rubbing or scratching against other objects. It is suggested that a holder be installed on the car for each of these articles. Level rods should be kept in a canvas case which may be ordered from Logistics.
2. Transits and levels should be carried in their cases when being transported by car or truck over any appreciable distance. It is good practice to provide a special protected holder within the vehicle for these cases. Instruments may be carried out of case over short distances if carefully held in someone's lap.
3. Equipment shall be placed in or on vehicles in the most "safe" position both for the equipment and for the operator and passengers of the vehicle. Employees are encouraged to conceive safe methods of transporting equipment. Any alterations, etc., to the vehicle must be made only with the approval of the District Mechanic.

M. Damaged Equipment

1. All damaged equipment listed in the Department's Statewide Inventory System missing (lost or stolen) is to be reported on DR Form 159.
2. Damaged equipment, especially surveying instruments, should not be used or motions tested to determine the extent of damage until it has been inspected in the Lincoln repair shop. This precaution is necessary for the reason that all damage to the instrument may not be visible. For example, after an instrument has had a fall, the delicate graduated edges of the plates may be seriously damaged by the slightest movement of the plates.
3. All damaged equipment, together with all worn or broken parts, should be promptly shipped to the Logistics Division for repair. Equipment returned to the Logistics Division for repair, adjustment or exchange must be accompanied by DR Form 124, Shop Work Orders. The action desired must be described on this form. The appropriate OE and Activity Coding shall be shown.

N. Shipping

1. If at any time it becomes necessary to ship an instrument, it should be packed securely in its case and arrangements shall be made through the District Construction Engineer for the transfer of the instrument to Lincoln. Total stations and electronic theodolites should be by truck or car and not be shipped.
2. Other equipment shall be carefully packed in the cases provided for that purpose. If cases are not provided, the equipment should be packed in a box or carton of ample strength for protection during shipment. All equipment should be sent to Lincoln in the same manner as transits and levels.

O. Care of Equipment

1. Cloth tapes, pie-tins and other items of similar nature are considered to be expendable equipment for the reason that they depreciate rather rapidly with normal use. The fact that these items are expendable does not relieve the employees of the responsibility for their proper care and conservation.
2. Rods and range poles shall be carried in protective coverings or in holders which prevent marring and scratching. To avoid breakage, they should never be used for any purpose except that for which they are designed.
3. Chains are easily damaged by kinking and by the action of traffic. When practical, a cloth tape should be used instead of a chain, especially if measurements are being made across the line of traffic. When wet or muddy, chains should be cleaned and dried before rolling. They should be cleaned, oiled and inspected occasionally and all kinks removed by hammering on a flat wood surface. Splices are available for use in repairing broken chains.

P. Salvage Of Equipment

1. Marred, broken or worn rods and range poles, badly kinked or broken chains, cut or torn cloth tapes, etc., shall be returned to the Engineering Equipment Repair Section for painting, repair or salvage. Many other items of equipment, usually considered expendable, may often be reconditioned for further use. District Construction Engineers should make periodic checks with Project Managers having such equipment. All broken or salvage equipment should be assembled at the District Headquarters Office and sent to the Engineering Equipment Repair Section using state transportation. The following items of equipment are considered to have salvage value:

Cylinder molds	Paving station numbers
Level rods	Stoves (gasoline and electric)
Range poles	Tapes, 100 ft, 200 ft, 300 ft [30 m, 60m, 90 m] steel
Sieves	Tapes, 50 ft (15 m) filler
	Tapes, 50 ft (15 m) steel, case

2. Also, any other broken or damaged equipment which the Project Manager believes has salvage value.

Q. Supplies

1. The Department policy is to have central procurement of supplies. The Supply Catalog lists the items usually stocked. The Supply Catalog can be accessed via computer terminal. Items not listed in the Supply Catalog may be ordered on DR Form 151, "Purchase Order". Be sure and list adequate description of the item desired.

2. The Project Manager shall prepare a stock requisition DR Form 146 for such office and field supplies as may be required for a reasonable length of time. Additional stock requisitions may be submitted as field supplies are depleted. The carrying of large quantities of supplies in the field office should be avoided.

R. Stakes

Construction stakes are stored at the Department's supply base in Lincoln. The following types of stakes are available and are listed in the Supply Catalog.

Class	Stock No.	Type	Dimensions	Package d	General Use
58	85700	"A" Oak	1" x 2" x 18"	50	Reference Stake; Blue Top
58	85705	"A" Oak	1" x 2" x 12"	50	Reference Stake; Blue Top
58	85712	"B" Oak	2" x 2" x 9"	50	Pavement Hub; Location Hub
58	85740	"C" Pine	1" x 2" x 16"	50	Reference Stake; Blue Top
58	85730	"D" Pine	½" x 2" x 16"	100	Lath; reference, guard and ROW stakes
58	85720	"E" Oak	2" x 2" x 20"	25	Reference Hub
58	09700	Lath	½" x 2" x 36"	50	Reference Stake; Lath

S. Local Purchase Of Services

Local services shall be processed for payment by the Project Manager by coding attachments and by indicating his/her approval signing and dating the bill. Coding attachments are DR Form 160 for all services except telephone bills and DR Form 57 for telephone bills. Chapter 4 of the accounting and DOR-1 80-9 should be reviewed.

T. Equipment Inventory

Equipment listed in the Department's Statewide Inventory System will be inventoried when requested by Logistics. The internal control and inventory of equipment not listed will be established by the District/Division.

U. Non-NDOR Equipment Calibration Policy

1. Highway Construction Work

This policy is applicable to all non-NDOR equipment used for the inspection of highway construction work under the jurisdiction of the Nebraska Department of Roads.

- a. NDOR will not provide calibration services for consultants, contractors, or other testing firms performing inspection work; however, the calibration must be performed by a commercial laboratory or business.

- b. All equipment shall be calibrated at least annually and at any other time when the results of tests are questionable or unreliable. (With the development of Nebraska's Quality Assurance Program for Construction, a set calibration schedule will be implemented for the various types of inspection equipment. This calibration schedule may be other than annual.)
- c. A "Certificate of Calibration" shall be available for inspection by NDOR personnel at any time. The "Certificate of Calibration" shall provide, at a minimum, the following information:
 - Serial number or identification number of the equipment.
 - Date of calibration.
 - Results of the calibration.
 - Name of the laboratory or company performing the calibration.
- d. NDOR inspection personnel have the right to verify the calibration of any inspection equipment owned by a consultant, contractor, or other testing firm by performing an independent calibration check. The decision to perform an independent calibration check rests solely with NDOR personnel and will not be performed on a request basis.

CHAPTER NOTES:

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