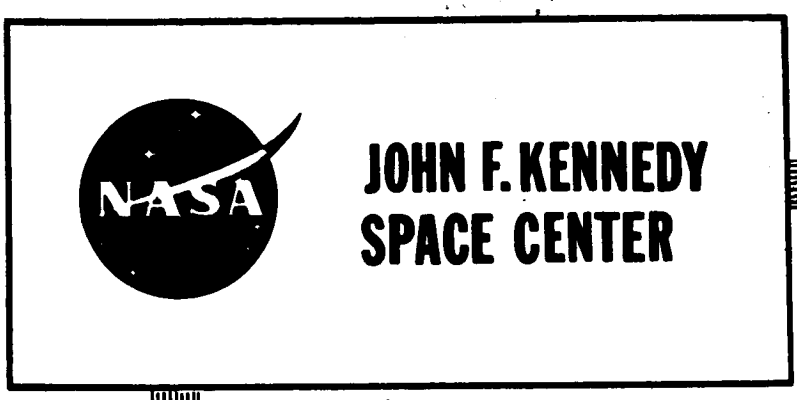

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TECHNICAL MANUAL

BASE SUPPORT SERVICES CONTRACTOR

ROADS AND GROUNDS MAINTENANCE

VOLUME 3 OF 6 VOLUMES

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NOTICE

1. This volume is one of six volumes describing the functional responsibilities of the Base Support Services Contractor.

2. The six volumes comprising this series are as follows:

   Vol. 1 ADMINISTRATION OF THE MAINTENANCE AND OPERATIONS PROGRAM
   Vol. 2 PREVENTIVE MAINTENANCE
   Vol. 3 ROADS AND GROUNDS
   Vol. 4 HEAVY EQUIPMENT
   Vol. 5 BASE UTILITIES
   Vol. 6 SHOPS, FIELD ENGINEERING, AND AREA SERVICES

3. Additional copies of these manuals are available upon written request to the Assistant Manager, Maintenance Engineering, TWA-651.

TM-431-TWA

TECHNICAL MANUAL

BASE SUPPORT SERVICES CONTRACTOR

ROAD AND GROUNDS MAINTENANCE

VOLUME 3 OF 6 VOLUMES

APRIL 1, 1966

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SECTION I
CRAWLER/TRANSPORTER REFUELING

1.1 PURPOSE

To establish responsibilities and procedures for refueling crawler/transporters (CT).

1.2 GENERAL

1.2.1 LOCATION OF FUEL TANKS. There are two 2500-gallon main fuel tanks; they are located between the crawlers at each end of the crawler/transporter (Figure 1-1). Each generator utilizes an independent fuel tank, which is commonly referred to as a day tank.

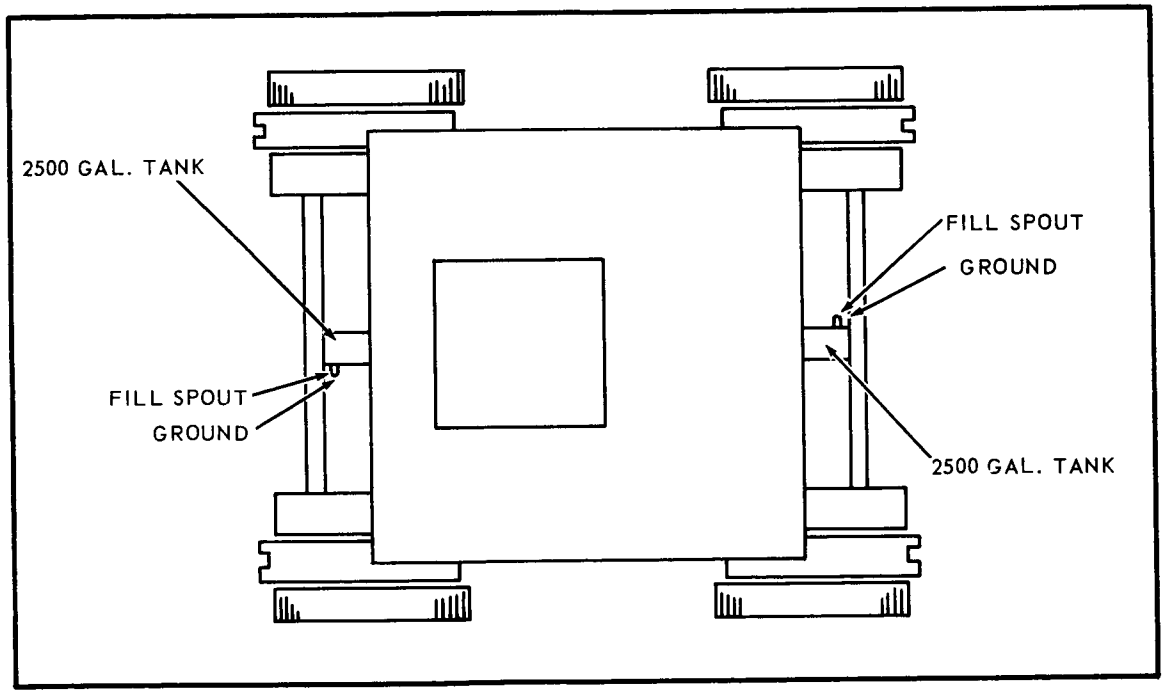


Figure 1-1. Location of Fuel Tanks, Fill Spouts, and Grounds

1.2.2 MAIN TANKS. The main fuel tanks shall contain at least three quarters capacity of fuel at all times. This requirement minimizes condensation accumulating in the tanks.

1.2.3 DAY TANKS. The day tanks are equipped with an automatic feature which continually transfers fuel from the main tanks. This keeps the day tanks full. Provisions are provided to bypass the automatic feature and manually fill the tanks. Day tanks will be checked daily to ensure proper operation of the automatic keep full feature.

1.3 PROCEDURES

1.3.1 LAUNCH SUPPORT OPERATIONS DIVISION (LSOD). The LSOD will obtain periodic status reports to ensure that the fuel tanks are topped off (filled) before sustained crawler/transporter operations or movement of loads. When the status report indicates that refueling is needed, LSOD will notify the Launch Control Center (LCC) at least 4 hours before the refueling is required.(Normally, 24 to 48 hour notification is desired.) The notification will include: estimate of fuel required, location of the crawler/transporter, and the time that refueling must be completed.

1.3.2 LAUNCH CONTROL CENTER (LCC). Upon receipt of a refueling request from the LSOD, the LCC will notify the Base Operations Division (BOD) within one hour.

1.3.3 BASE OPERATIONS DIVISION (BOD). The BOD, upon receipt of the refueling request from LCC, will immediately notify the Base Support Services Contractor (BSSC) superintendent of heavy equipment. This notification will include the estimated quantity of fuel required, location of the crawler/transporter, and the time that the refueling must be completed. Current work control procedure will be used.

1.3.4 BSSC SUPERINTENDENT OF HEAVY EQUIPMENT. Upon receipt of the refueling request, the BSSC superintendent of heavy equipment will immediately take the following action:

a. Dispatch a 5,000-gallon tanker, with sufficient fuel, to arrive at the designated place and time.

b. Notify the KSC Fire Department to dispatch a fire truck to the refueling site. Provide the refueling starting time and an estimated time that fire protection coverage is required.

c. Notify the KSC Security Patrol to dispatch patrolmen to the refueling site. Provide the refueling starting time and an estimated time that coverage is required.

The BSSC Superintendent of Heavy Equipment is responsible for:

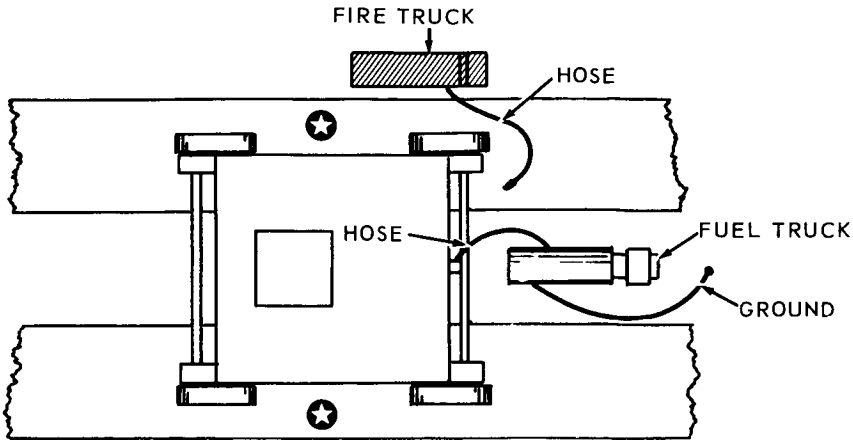
1. Ensuring the readiness of the refueling tankers to provide service. This includes 150 feet of hose on the reel, externally and internally grounded to the fittings and spouts. A pig-tail should be available at the spout to provide grounding to the tank. A reel containing 300 feet of grounding wire, equipped with terminal clips, lugs, or plugs to facilitate making connections to a grounding system, will be mounted on the refueling tanker.

2. The availability of sufficient qualified personnel to perform the refueling operation. Training will include but will not be limited to: proper fuel handling procedures, hose handling methods, location of fill spouts, location of grounding points, and all other safety precautions pertaining to refueling operations. Figures 1-2 and 1-3 show the refueling procedures.

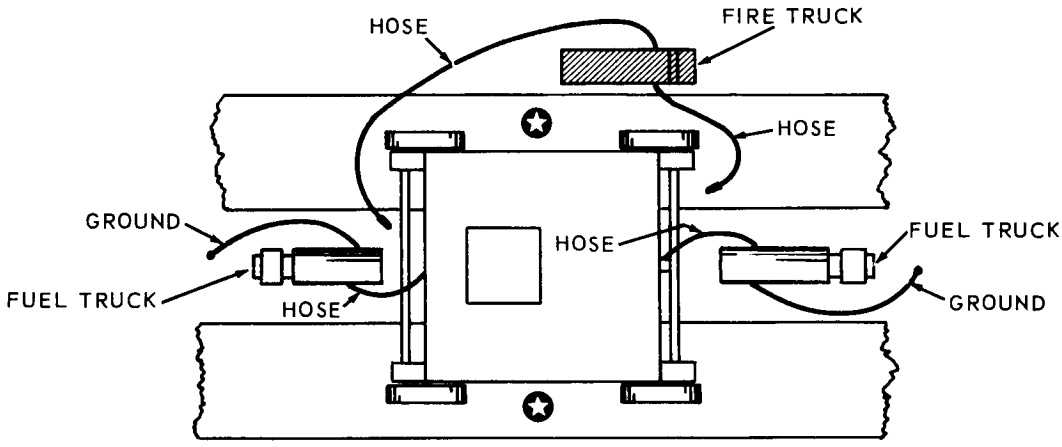
Refueling crews will be thoroughly indoctrinated in the importance of their mission and the value of the equipment being refueled. Stress will be placed on the impact on the space mission that could result from equipment loss due to a fire or an accident.

1.3.5 KSC FIRE DEPARTMENT. Upon receipt of the refueling notification, the KSC Fire Department will dispatch a fire truck equipped to fight a diesel fire to the refueling site. The fire truck must be in position before the refueling operation starts and will remain until refueling is completed.

1.3.6 KSC SECURITY PATROL. Upon receipt of the refueling notification, the KSC Security Patrol will dispatch two patrolmen to arrive at the refueling site before the refueling operation begins. Smoking or open flames are prohibited within 50 feet of the refueling operation.



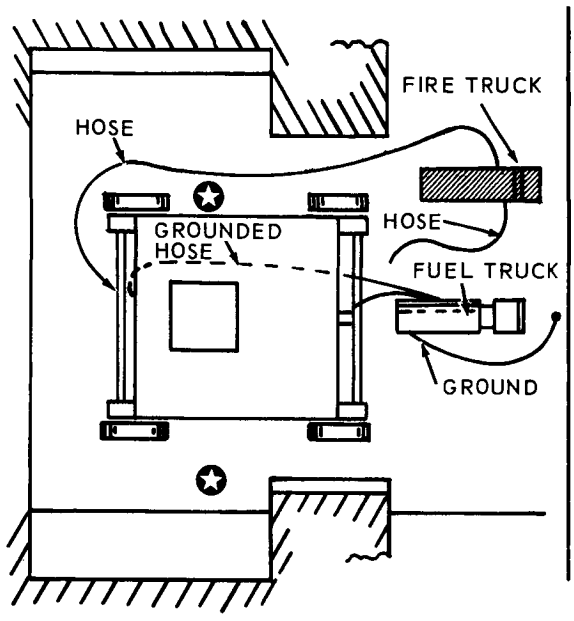
ONE TANKER – ONE TANK AT A TIME



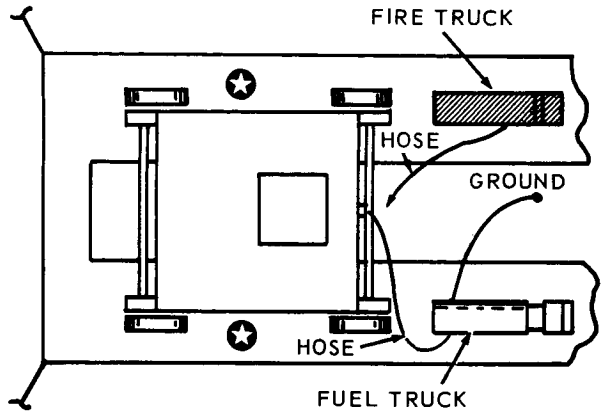
TWO TANKERS – ONE TANK AT A TIME

✪ LOCATION OF SECURITY PATROLMEN

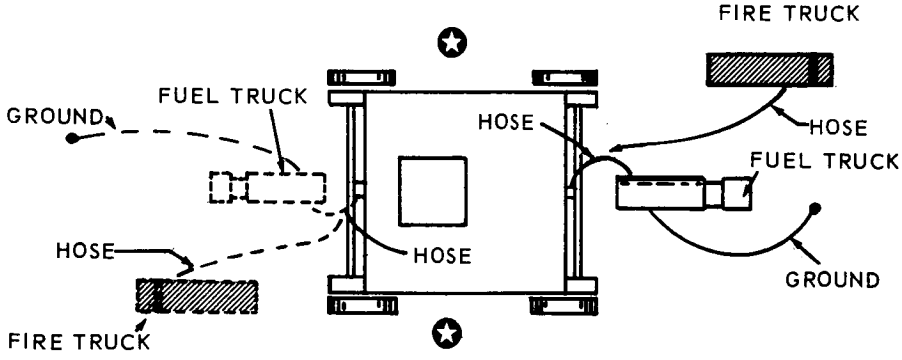
Figure 1-2. Refueling Procedures on Crawlerway.



VAB AREA



LAUNCH PAD AREA



PARKING AREA, ML AREA, AND MOBILE SERVICE STRUCTURE AREA

LOCATION OF SECURITY PATROLMEN

Figure 1-3. Refueling Procedures at VAB, PAD, Parking Area, ML Area, and Mobile Structure Area.

SECTION II
CRAWLERWAY SURFACE MAINTENANCE

2.1 PURPOSE

The purpose of this section is to establish a periodic inspection procedure for the crawlerway base and surface courses to determine the need for and planning of repairs and maintenance.

2.2 SPECIFIC OBJECTIVE

The specific objective of this procedure is to ensure that the surfaces of the crawlerway and the crawler/transporter parking area are maintained in as strong and safe a condition as possible. In addition, all practical means will be taken to prevent or minimize the damaging effects of usage and weather. It has been computed that during the first traverse of the fully loaded crawler/transporter, a deflection (consolidation) of 2.8 inches (.233 ft) will occur, resulting in a possible rutting of the crawlerway surface. Subsequent moves thereafter will result in a .0012-inch deflection (consolidation) which is negligible, but should be verified.

2.3 MAINTENANCE STANDARDS

The crawlerway will be maintained at the highest possible standard to ensure the safe and efficient movement of the loaded crawler/transporter at any time.

2.4 RESPONSIBILITIES

The responsibilities concerning maintenance and repair of the crawlerway are initially borne by the Launch Control Center (LCC), Base Operations Division (BOD), and Base Operations Support Contractor (BSSC).

2.4.1 LAUNCH CONTROL CENTER. The LCC will notify the BOD as early as possible (preferably 10 days in advance) concerning any scheduled crawler/transporter traversing of the crawlerway.

2.4.2 BASE OPERATIONS DIVISION. The BOD will notify without delay the BSSC of the impending move.

2.4.3 BASE OPERATIONS SUPPORT CONTRACTOR. The Base Operations Support Contractor is responsible for maintenance and repair of the crawlerway surface. To ensure no delay in crawler/transporter movement, he will initiate

immediate action to effect maintenance and repair in accordance with the procedure established in this section.

2.5 TRAFFIC PROHIBITION (WHEELED VEHICLES)

Since the crawlerway was designed to be used only by the crawler/transporter, which is a slow-moving tracked vehicle capable of carrying extraordinarily heavy loads, no wearing course or surface has been provided. Therefore, use of the crawlerway by high speed and semi-high speed wheeled vehicles (passenger cars, trucks, forklifts) would result in pockmarking and rutting of the crawlerway surface. Wheeled vehicles are prohibited (except at crossings) from using the crawlerway. Wheeled vehicles normally assigned to service the crawlerway will remain off the traveled portion. Wheeled vehicles assigned to service the crawler/transporter will remain off the crawlerway unless it is manifestly impossible to carry out the service without using the crawlerway.

2.6 QUALITY OF REPAIR

Repairs to the crawlerway and access road will conform to original construction and surfacing requirements in strength, appearance, and surface texture (Figure 2-1).

2.7 APPLICABLE DOCUMENTS

The issues of the following publications in effect on the publication date of this document form a part herein to the extent as indicated:

1. American Society for Testing Materials Standards (ASTM)

   a. C29-60 - Unit Weight of Aggregate

   b. C88-63 - Test for Soundness of Aggregate by use of Sodium Sulfate or Magnesium Sulfate

   c. C117-62T - Materials Finer Than No. 200 Sieve in Mineral Aggregates by Washing (Tentative)

   d. C127-59 - Specific Gravity and Absorption of Coarse Aggregate

e. C131-64T - Test for Resistance to Abrasion of Small-Size Coarse Aggregate by Use of the Los Angeles Machine (Tentative)

f. C136-63 - Sieve or Screen Analysis of Fine and Coarse Aggregates

g. D75-59 - Sampling Stone, Slag, Gravel Sand, and Stone Block for Use as Highway Materials

h. D422-63 - Grain - Size Analysis of Soils

i. E11-61 - Sieves for Testing Purposes (Wire Cloth Sieves, Round Hole, Square Hole Plate Screens, or Sieves)

j. A15 -

k. A16 -

l. A160 -

2. Military Standard

a. MIL-STD-621(CE) - Test Method for Pavement Subgrade, Subbase, and Base Course Material

3. American Association of State Highway Officials Standard

a. T147-54 - Field Determination of Density of Soil In-place

4. Federal Specification

a. MM-L-751 -
b. TT-W-571 -
c. FF-S-606 -
d. WW-P-521 Type II -

2.8 WORK CONTROL PROCEDURE

All work on the crawlerway will be accomplished by utilizing standing work order authorization under the work control procedures now in effect.

2.9 REPAIRS

This procedure covers the repair of damage to the crawlerway caused by the loaded crawler. This includes the preparation of the base course surface, the placing, processing, and finishing of additional graded crushed aggregate base course material, the placing of river-run gravel, and the repairs to curbs.

2.10 INSPECTION

Inspections will initially be performed on receipt of information concerning an impending move of the crawler/transporter and when directed or requested after the loaded crawler/transporter has traversed the crawlerway.

2.10.1 INSPECTION PRIOR TO MOVEMENT OF CRAWLER/TRANSPORTER.

On receipt of information of an impending move of the crawler/transporter, the BSSC will conduct an inspection of the crawlerway to be traversed by the crawler/transporter. This inspection will consist of a visual determination of the condition, smoothness, and depth of the river-run gravel surface course to ensure a safe passage of the crawler/transporter. Special concern will be given to crossovers, wood curbs, and other areas where the river-run gravel could be disturbed or displaced. When inspection reveals the necessity for repairs, replacement, or addition to the river-run gravel or wood curbs, this work will be initiated without delay and be completed prior to scheduled crawler/transporter movement. The standing work order authorization will be the authority for the accomplishment of this work.

2.10.2 INSPECTION AFTER MOVEMENT OF CRAWLER/TRANSPORTER.

After the loaded crawler/transporter has completed a traverse of the crawlerway or when directed or requested by authorized personnel, a visual inspection of the crawlerway will be conducted to determine the amount of gravel compaction, deflection, settlement, water-ponding and/or damage that has occurred. Any discernible evidence of possible or probably impairment of the crawlerway other than normal gravel compaction within the tracked area will immediately be made known to the NASA Roads and Grounds Technical Representative.

2.11 REPAIR PROCEDURE

The BSSC will initiate no repair to, on or adjacent to the crawlerway unless such action is approved and directed by the NASA Roads and Grounds Technical Representive. The blading, mixing, reworking, leveling and/or fine grading of the gravel layer on the crawlerway is not to be construed as falling within the meaning of the word "repair", as used in this paragraph.

2.11.1 BASE COURSE (WEATHER LIMITATIONS). No scarification or processing of the existing base course shall be accomplished when rain is expected to occur before the new surface is placed. Any areas of completed base course that are damaged by rainfall or other weather conditions shall be brought to a satisfactory condition in conformance with the requirements of this specification before river-run gravel is replaced.

2.11.2 EQUIPMENT. All plant equipment, tools, and machines used in the performance of the work covered by this section shall be approved prior to commencement of work and shall be maintained in satisfactory working condition at all times.

a. Power rollers shall be the self-propelled, three-wheel type, weighing not less than 10 tons, and having a minimum weight of 300 pounds per inch width of rear wheel. The wheels shall be equipped with adjustable scrapers. The use of vibratory rollers is optional.

b. Blade graders shall have a wheel base of not less than 15 feet and a blade of not less than 12 feet and shall be self-propelled.

c. Heavy, rubber tired, self-propelled rollers shall be of a type having seven or more tires capable of being loaded to 30,000 pounds and have a maximum tire pressure of 100 psi. The loading shall be equally distributed to all wheels and the tires shall be uniformly inflated.

d. Sprinkling equipment shall consist of tank trucks, pressure distributors, or other equipment designed to apply water uniformly and at controlled quantities to variable widths of surface.

e. Hauling equipment shall consist of pneumatic-tired vehicles having dump bodies suitable for dumping materials in windrows.

f. Scarifiers shall have two rows of teeth, with the teeth in each row not more than 8 inches apart. The rows shall be staggered so that the paths of the teeth will be not more than 4 inches apart.

g. Miscellaneous equipment (tractors and other equipment) shall be of approved types suitable for performing the specified work.

2.11.3 SURFACE PREPARATION. The existing surface shall be leveled by scarifying and blading as shown in Figure 2-1.

a. Before the existing material in any area is scarified, the surface shall be sufficiently wet to minimize segregation. Scarification shall be accomplished with a scarifier - or such other equipment that will ensure the thorough breaking of bond between aggregates. The existing material shall not be scarified more than 2 inches below the surface upon which the additional base course is to be placed.

b. After scarifying, the surface shall be leveled as shown in Figure 2-1 by means of a blade grader. Blading of the aggregate material shall follow as closely behind the scarification as possible while the moisture in the base course material is sufficiently high that segregation will be minimized. Segregated areas shall be corrected by adding moisture, windrowing, and reshaping the base material.

2.11.4 GRADED-CRUSHED-AGGREGATE BASE COURSE. The graded-crushed-aggregate base course shall consist of the blended aggregate, placed and compacted. Aggregates shall consist of clean, sound, durable particles of crushed stone, crushed slag, or crushed gravel. It shall be the responsibility of the Contractor to obtain materials that will meet the requirements specified herein and that can be constructed to meet the grade of smoothness requirements specified herein after all compaction and proof-rolling operations have been completed. Slag shall be an air-cooled, blast-furnace product having a dry weight of not less than 65 pounds per cubic foot as determined by ASTM Standard C29. The aggregates shall be free of silt, clay, vegetable matter, and other objectionable materials or coatings. The portion retained on the No. 4 sieve shall be known as the coarse aggregate; that passing the No. 4 sieve shall be known as fine aggregate.

a. Coarse aggregate shall be angular particles of uniform density. The coarse aggregate shall not have a loss greater than 20 percent weighted average at 5 cycles when tested for soundness in magnesium sulfate in accordance with ASTM Standard C88 (using standard grading and standard examination procedures). The

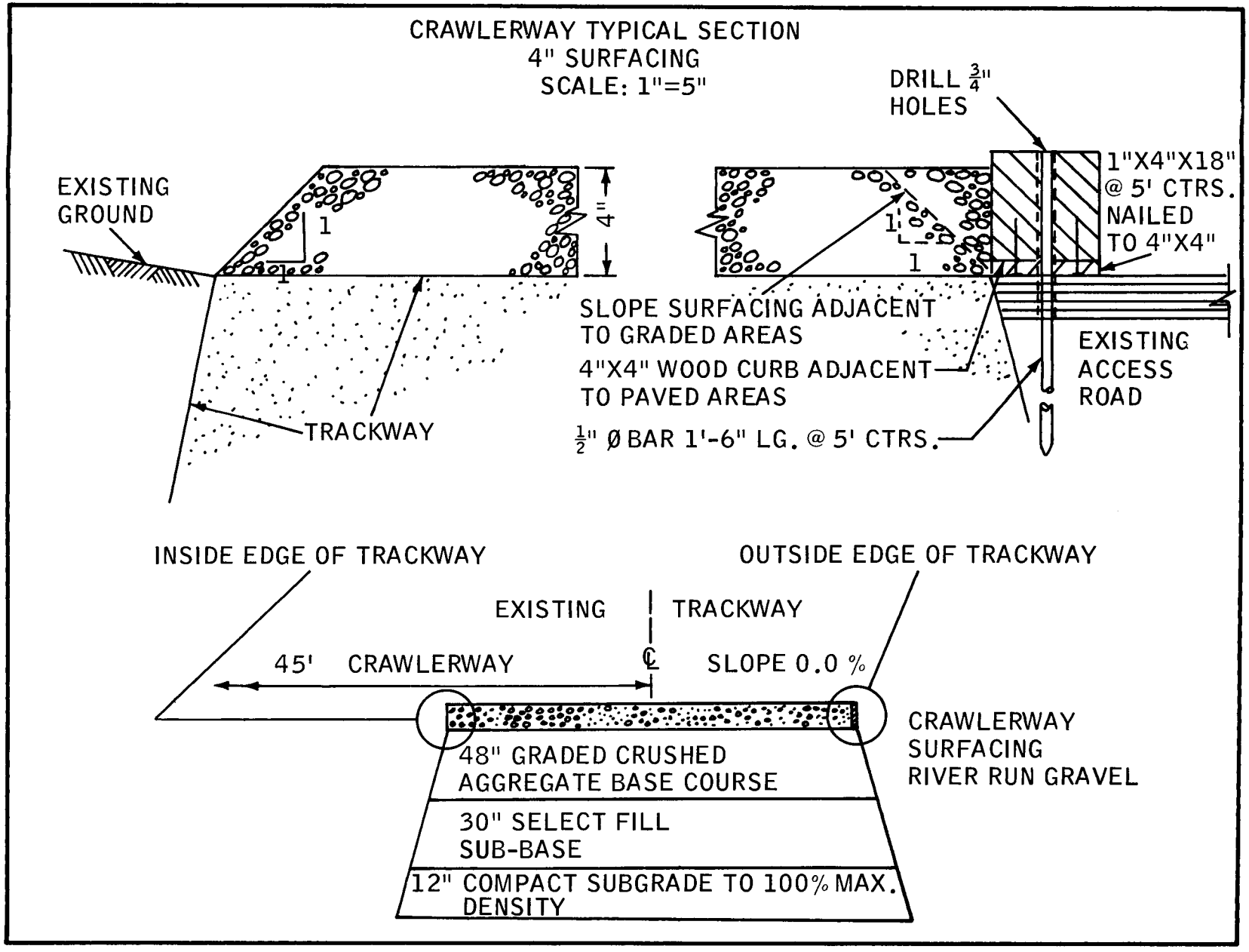


Figure 2-1. Crawlerway Surfacing (Sheet 1 of 2)

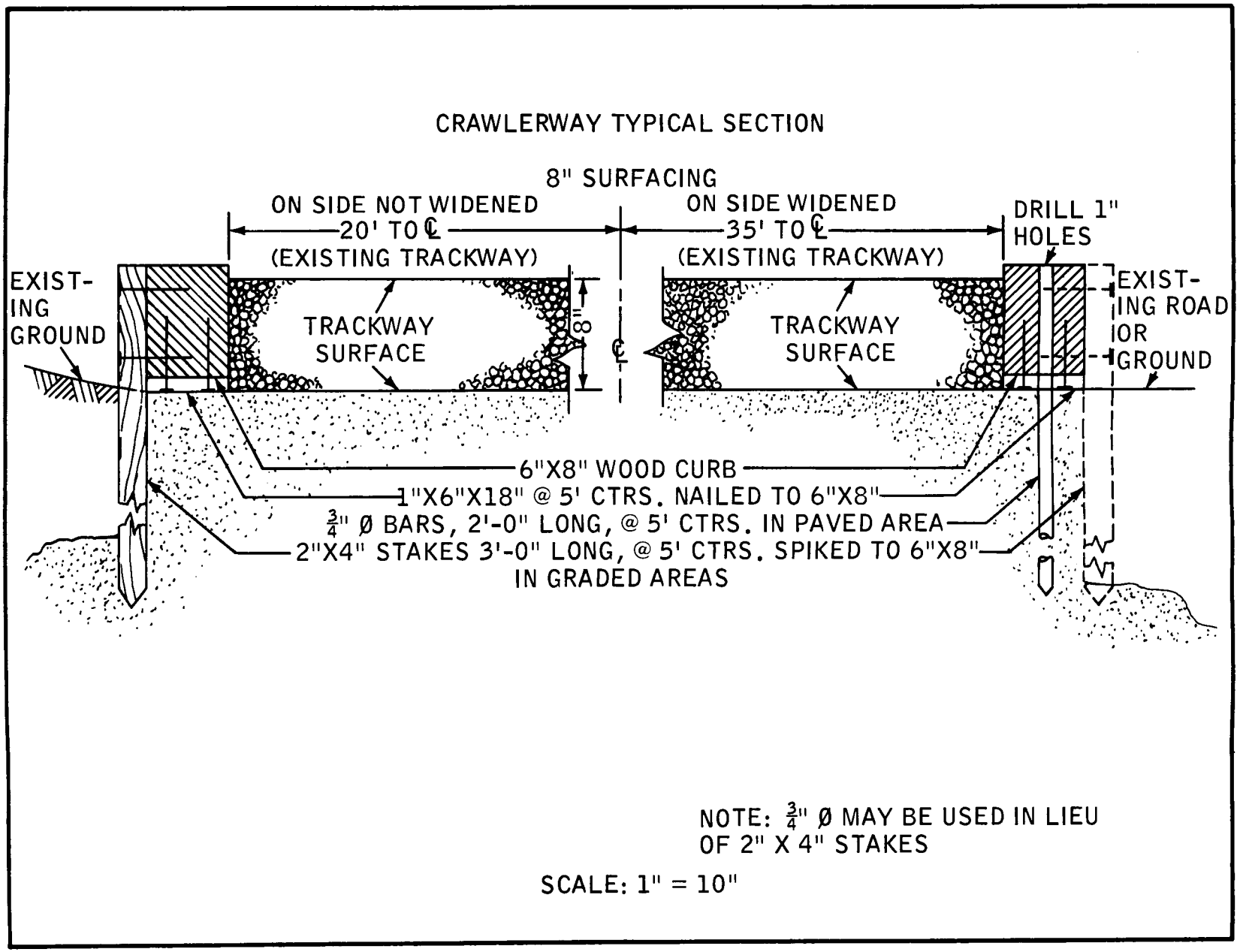


Figure 2-1 Crawlerway Surfacing (Sheet 2 of 2)

coarse aggregate shall have a percentage of wear not to exceed 40 after 500 revolutions as determined by ASTM Standard C131. The percentage of flat and/or elongated particles shall not exceed 20 in the fraction retained on the 1/2-inch sieve and in the fraction passing the 1/2-inch sieve. A flat particle is one having a ratio of width to thickness greater than 3, and an elongated particle is one having a ratio of length to width greater than 3. When the coarse aggregate is supplied from more than one source, aggregates from each source shall meet the requirements set forth herein. In the portion retained on each sieve specified, the crushed gravel shall contain at least 90 percent by weight of crushed pieces having two or more freshly fractured faces with the area of each face being at least equal to 75 percent of the smallest midsectional area of the piece. When two fractures are contiguous, the angle between the planes of the fractures must be at least 30 degrees, in order to count as two fractured faces.

b. Fine aggregate shall consist of manufactured sand or a combination of manufactured sand and natural sand and shall be composed of clean, hard, durable particles. Fine aggregate shall be a byproduct of the manufacture of coarse aggregate and shall be produced from the same pit. Fine aggregate shall meet the requirements for wear and soundness specified for coarse aggregate, except that the soundness loss shall not be greater than 40 percent weighted average.

c. Gradation requirements specified herein shall apply to the completed base course after undergoing the mixing, placing, compacting, and other operations. The aggregates shall have a maximum size of 2 inches. The gradations shown in Table 2-1 represent the extreme limits that will determine suitability of aggregate for use from all sources of supply. The aggregate as finally selected for use in the work shall have a gradation within the limits designated in Table 2-1 and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve, or vice versa, but shall be continuously well graded from coarse to fine. The methods of test used will be ASTM Standards C117, C127, C136, and D422. Sieves shall conform to ASTM Standard E11. Table 2-1 is based on aggregates of uniform specific gravity, and the percentage passing the various sieves may require appropriate correction when aggregates of varying specific gravity are used.

Table 2-1 Aggregate Limits

Designation	Percentage by Weight Passing Square-Mesh Sieve
2-in. Sieve	100
1-1/2-in. Sieve	70-100
1-in. Sieve	45-80
1/2-in. Sieve	30-60

Note: Aggregate gradation may be adjusted within limits of table.

Table 2-1 Aggregate Limits (Cont.)

Sieve Designation	Percentage by Weight Passing Square-Mesh Sieve
No. 4	20-50
No. 10	15-40
No. 40	5-25
No. 200	3-10

Note: Aggregate gradation may be adjusted within limits of table.

d. Job-mix proportioning (8 inches of limerock and 4 inches of sand mixed to depth of 12 inches) is shown in Table 2-2.

Table 2-2 Job-Mix Proportion Tolerances

Aggregate	Tolerance
Aggregate Passing No. 4 Sieve or Larger	Plus or Minus 5 Percent
Aggregate Passing Nos. 10 and 40 Sieves	Plus or Minus 4 Percent
Aggregate Passing No. 200 Sieve	Plus or Minus 2 Percent

Note: Aggregate gradation may be adjusted within the limits of table.

e. Liquid limit and plasticity index requirements stated herein shall apply to any aggregate component that is blended to meet the required gradation and also to the aggregate in the completed base course. The portion of the aggregate passing the No. 40 sieve shall be either nonplastic or shall have a liquid limit not greater than 25 and a plasticity index not greater than 5, when tested in accordance with Method S-4 of MIL-STD-621(CE).

2.11.5 STOCKPILING MATERIAL. In all cases the fine and coarse aggregate shall be piled in separate piles. The coarse aggregate shall be separated into at least two separate sizes. Each component of the various-sized aggregates to be blended shall be placed in separate stockpiles in such a manner that the separate sizes will not be intermixed. The various-sized aggregates shall be stockpiled in uniform layers by use of a clamshell or by other approved methods in such manner as to prevent segregation. The use of bulldozers in stockpiling of aggregate will not be permitted.

2.11.6 PREPARATION OF UNDERLYING LAYER. Prior to constructing additional base courses, the previously constructed layer shall be cleaned of all foreign

substances. The surface of the layer will be inspected for adequate compaction and surface tolerances; ruts or soft-yielding spots, areas having inadequate compaction, and deviations of the surface shall be corrected to line and grade and to all referenced requirements.

2.11.7 GRADE CONTROL. During construction, the line and grade of each layer of base course will be maintained by means of line and grade stakes.

2.11.8 MIXING OF MATERIALS. The coarse and fine aggregates shall be mixed on an approved paved working area.

2.11.9 PLACING. The mixed material shall be placed on the prepared subgrade or subbase in layers of uniform thickness in an approved manner. No layer shall be in excess of 6 inches or less than 3 inches when compacted and shall not vary more than 1 inch in thickness in 100 feet. The layers shall be so placed that when compacted they will be true to the grades or levels required with the least possible surface disturbance. The previously constructed layers shall be cleaned of loose and foreign matter by sweeping with power sweepers, power brooms, or hand brooms as directed. The previously placed layer shall be lightly scarified to a depth not exceeding 2 inches before the placing of the next layer to ensure bond between layers. The water content of the material shall be maintained during the placement and compaction period at optimum moisture content. Such adjustments in placing procedures or equipment shall be made as may be directed, to obtain true grades, to minimize segregation and degradation, to reduce or accelerate loss or gain of water, and to ensure a satisfactory base course. Longitudinal joints in each layer shall be placed so that the joint in the layer will not coincide with the joint in the previously placed layer and will be offset by at least 1/2 foot.

2.11.10 COMPACTION. Final compaction of each layer of base course material as specified herein shall be accomplished within 24 hours after placement.

2.11.10.1 Compaction Requirements. Each layer of base course shall be compacted by initial steel wheel roller sealing and final application of 8 coverages, not counting finish-rolling with a heavy rubber-tired roller (each tire loaded and inflated as directed), followed by any additional coverages necessary to produce a field-measured density of not less than 100 percent of the maximum density obtained in the laboratory. A coverage is defined as the application of one tire print over each point in the surface of the designated area. Water content shall be maintained during the entire compaction procedure at optimum moisture content. The speed of the rubber-tired rollers used for compaction and/or finish-rolling shall not exceed 5 miles per hour. In all places not accessible to the rollers, the base course material shall be compacted with mechanical tampers. Records will be maintained on the compaction rolling, reflecting the number of coverages, moisture of base course material being rolled, and relationship

between the date the material was placed and the date the material was rolled. Maximum density determination of the design blends will be made in the laboratory in accordance with MIL-STD-621 (CE) Method S-1, compaction effort designation CE55. Density shall be measured in the field in accordance with AASHO Standard T147.

2.11.10.2 Finishing Procedure. The surface of the top layer of base course shall be finished after final compaction by cutting any overbuild to grade and rolling with a power roller. In no case will thin layers of material be added to the top layer of base course in order to meet grade. If the elevation of the top layer of base course is 1/2 inch or more below the grade, the top layer of base shall be excavated and replaced with new material to a depth of at least 3 inches in compacted thickness. The new material shall then be compacted as hereinbefore specified. Such adjustments in rolling and finishing procedures shall be made as may be directed to obtain true grades, to minimize segregation and degradation of base course material, to reduce or accelerate the loss or gain of water, and to ensure a satisfactory base course. Material found to be unsatisfactory shall be removed and replaced with satisfactory material as directed and at no additional cost to the government.

2.11.11 FINISH ROLLING. Finish rolling of the surface of the completed crushed aggregate base course shall be in addition to the compaction specified above and shall consist of the application of ten coverages with a heavy rubber-tired roller having four or more tires, each loaded to a minimum of 50,000 pounds and inflated to a minimum pressure of 150 pounds per square inch. A coverage is defined as the application of one tire print over each point in the surface of the base course. The water content of the top lift of the underlying course on which the graded-crushed-aggregate base course is laid shall be maintained at optimum from the start of compaction to the completion of that layer. Materials in the base course or underlying materials indicated to be unsatisfactory by the finish-rolling shall be removed and replaced with satisfactory materials as directed.

2.11.12 EDGES OF BASE COURSE. Approved material shall be placed along the edges of the base course in such quantity as will compact the thickness of the base course being constructed. When the base course is being constructed in two or more layers, the quantity of material shall compact to the thickness being constructed, allowing in each operation at least 1-foot width of the shoulder to be rolled and compacted simultaneously with the rolling and compacting of each layer of the base course, as directed.

2.11.13 SMOOTHNESS TEST. The surface of the top layer of the finished and completed base course shall not show any deviations in excess of 3/8 inch when tested with a 10-foot straightedge applied parallel with and at right angles to the centerline of the paved area. Any deviation in excess of 3/8 inch shall be corrected as directed.

2.11.14 THICKNESS CONTROL. The thickness of the completed base course shall be within 1/2 inch of the thickness as shown in Figure 2-1. The depth measurement shall be made by means of before and after cross sections.

2.12 CRAWLERWAY SURFACING

When crawlerway and pad-top surfacing work tasks are to be initiated, they shall conform to the following standards.

2.12.1 MATERIALS. The aggregate shall consist of gravel free from adherent films of clay, be clean, sound, durable water-warn pieces free from an excess of soft or disintegrated particles, dust, dirt, or other objectionable matter. The aggregate will be tested for gradation at the source. The gradation of the aggregates shall be determined as specified in ASTM Standard C136 and conform to grading as shown in Table 2-3.

Table 2-3 Gravel Grading

Size (U. S. Standard Square Mesh)	Percentage by Weight Passing Individual Screens		
	No. 4 to 1/2 inch (Pad Top)	No. 4 to 3/4 Inch (4-inch thickness and transition areas)	1 to 2 Inches (8-inch thickness)
2-1/2-Inch Sieve			100
2-Inch Sieve			95-100
1-1/2-Inch Sieve			35-70
1-Inch Sieve		100	0-15
3/4-Inch Sieve	100	90-100	- - -
1/2-Inch Sieve	90-100	- - -	0-5
3/8-Inch Sieve	- - -	20-55	
No. 4 Sieve	0-15	0-10	
No. 8 Sieve	0-5	0-5	

2.12.2 EQUIPMENT, TOOLS, AND MACHINES. Equipment, tools, and machines used in the performance of the work covered by this section shall be subject to approval and shall be maintained in satisfactory working condition at all times.

a. Mechanical spreaders shall be adjustable and capable of spreading aggregate at controlled amounts per square yard.

b. Power brooms and power blowers shall be suitable types for the effective cleaning of primed subgrades and bases or pavement surfaces.

2.12.3 PREPARATION OF SURFACE. Immediately before applying the aggregate, the crawlerway surface shall be cleaned of loose material with power sweepers, power blowers, or hand brooms, as directed. Care shall be taken to remove all dirt, clay, and other loose or foreign matter.

2.12.4 SPREADING AGGREGATE. The aggregate shall be spread uniformly over the surface to the thickness shown in Figure 2-1. When hand spreading is employed in inaccessible areas, aggregate shall be dumped in piles adjacent to the area to be treated and spread by means of shovels or, if practicable, spread directly from trucks. Additional aggregate for areas having insufficient thickness shall be spread by hand and shall be continued during the operations whenever necessary.

2.12.5 THICKNESS TOLERANCES. The thickness of the completed surfacing shall be within the following tolerances. The method to be used for determining the thickness shall be as follows: The thickness shall be measured at intervals in such manner that there will be a depth measurement for at least each 1,000 square yards of surfacing. Where the deficiency in thickness is more than 1/4 inch, the area will be corrected by adding additional aggregate. When the measured thickness is more than 1/4-inch thicker than shown on the drawing, it shall be considered as the specified requirement plus 1/4 inch. The average job thickness shall be the average of the depth measurements determined as specified above, and shall not be less than the thickness shown in Figure 2-1.

2.13 WOOD CURBS (MATERIALS)

Timber and construction material for wood curbs shall conform to the following specifications.

2.13.1 MATERIAL. Timber for the wood curbs shall be dense southern pine, or Douglas fir and shall conform to Fed. Spec. MM-L-751. Pine shall be dense Number 2 heavy dimension southern pine graded in accordance with Grading Rules for Southern Pine lumber. Fir shall be Select Structural Grade, graded in accordance with Grading and Dressing Rules for Douglas Fir. All timber shall be rough sawn, full dimension and shall be pressure treated with creosote-coal-tar solution in conformance with Fed. Spec. TT-W-571. Minimum retention for pine shall be 12 pounds per cubic foot and 14 pounds per cubic foot for fir. Cutting and fitting shall be done as far as practicable before treatment. Timber surfaces cut or drilled after treatment shall be brush coated generously or flushed thoroughly with not less than three applications of the same type creosote that was used at the treatment plant. Each application of creosote shall be allowed to penetrate thoroughly before the succeeding application is made. Spikes and nails shall conform to Fed. Spec. FF-S-606. Bar anchors shall be plain steel bars conforming to ASTM Standard

A15, A16, or A160 or wrought-iron pipe conforming to Fed. Spec. WW-P-521, Type II.

2.13.2 CONSTRUCTION. The wood curbs shall be installed on the edge of the crawlerway, as indicated in Figure 2-1. All timber shall be accurately framed, fitted, and securely fastened together as indicated on the drawings. Care shall be taken, in placing the curbs, to work out all permissible defects whenever possible.

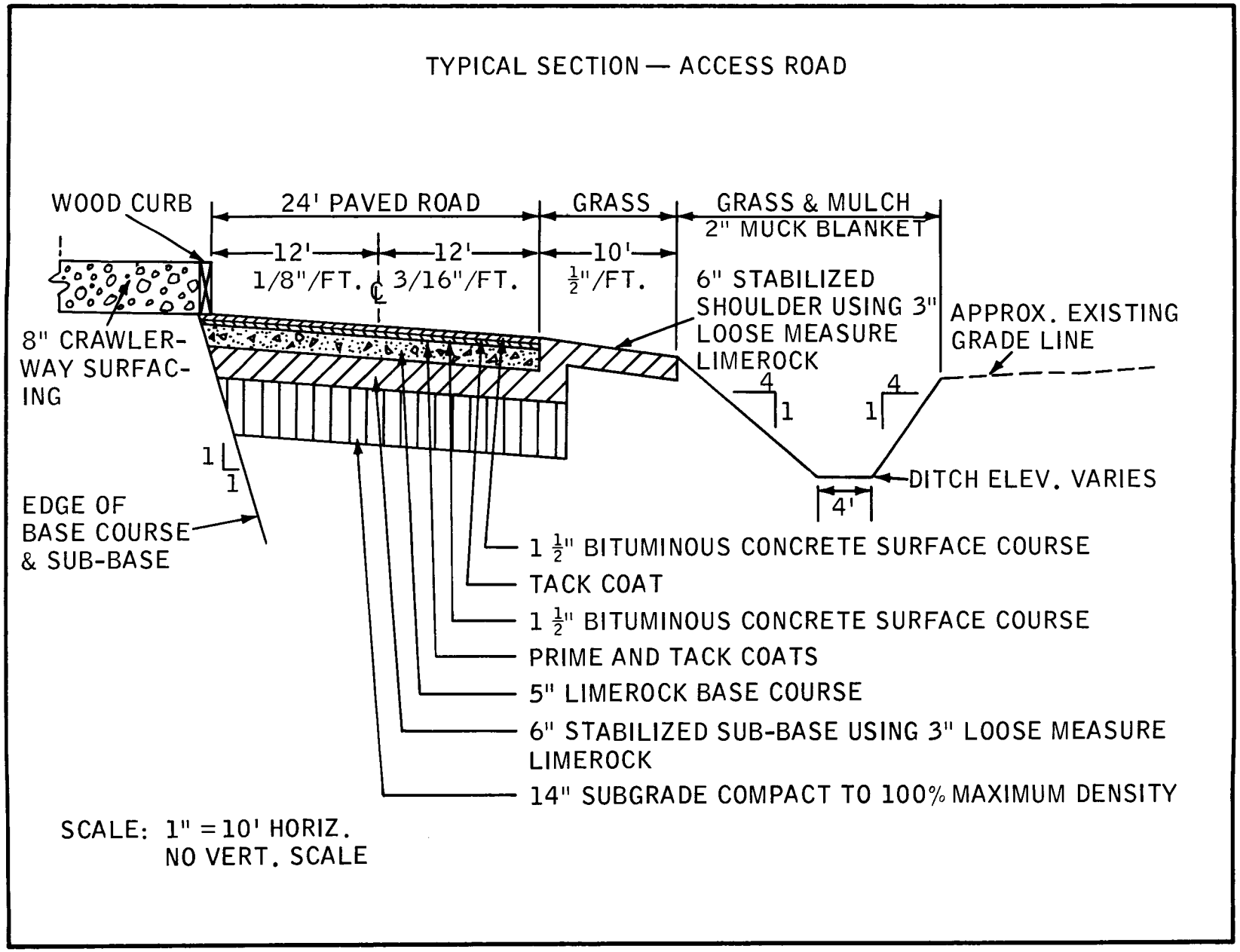


Figure 2-2 Access Road Surfacing

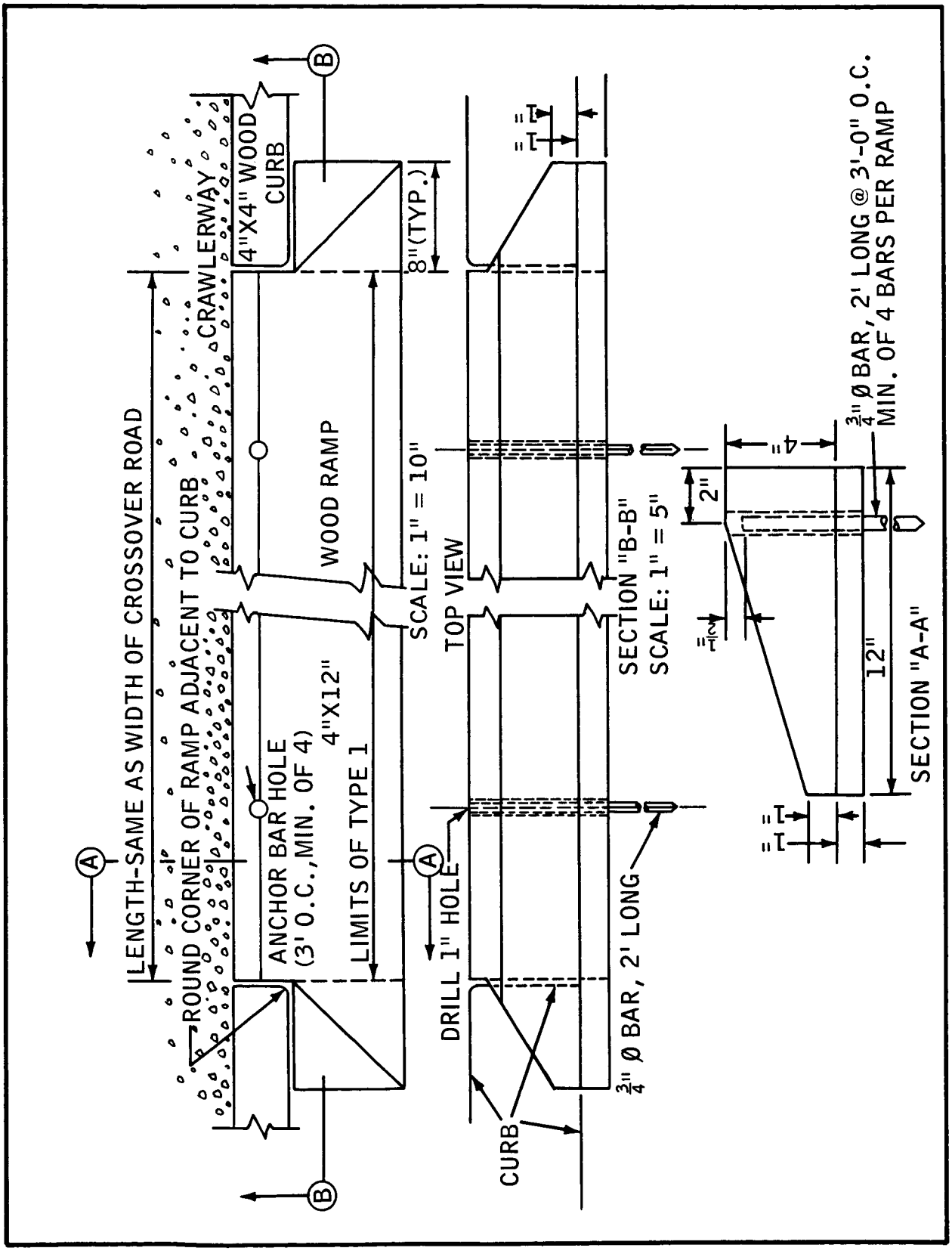


Figure 2-3 Wood Ramp Types I and II

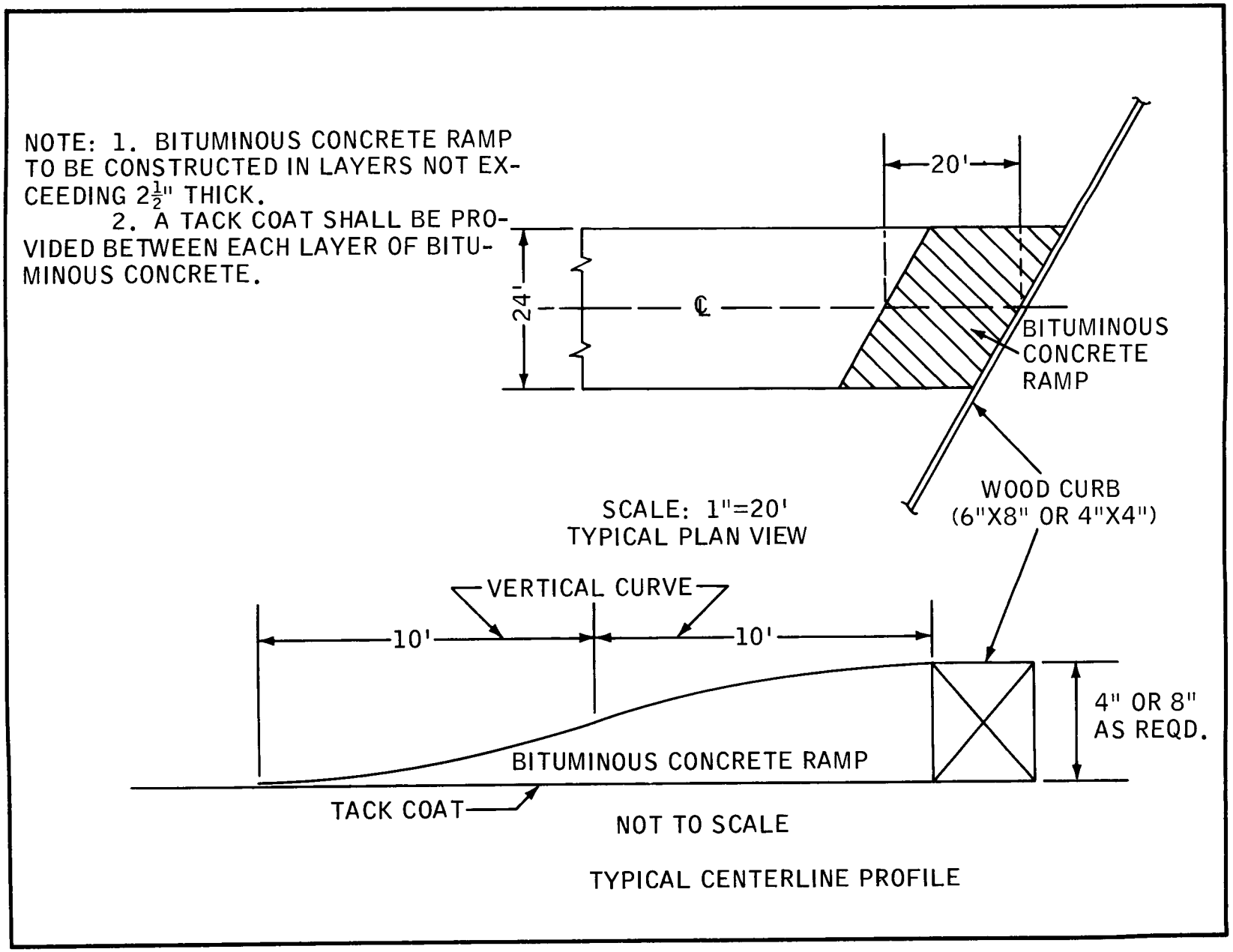


Figure 2-4 Bituminous Concrete Ramps

VOLUME 3

SECTION III

MAINTENANCE, INSPECTION AND REPAIR OF DOCKS, FENDERS AND PILINGS

NOTE

Information for this section was not available for publication at this time. When this section is available, copies will be forwarded to recipients of this manual.

SECTION IV
EMERGENCY PROCEDURES FOR MOVABLE SPAN BRIDGES

4.1 PURPOSE

To establish responsibilities and operating procedures to be followed when malfunction of any movable span bridge occurs.

4.2 GENERAL

4.2.1 STORAGE OF TRAFFIC CONTROL DEVICES. Lockers are provided at each end of the Indian River Bridge for the purpose of storing traffic control signs, cones, warning lights, and temporary barricades. This equipment is available for use by the KSC security patrol personnel. The key to these lockers will be kept in the control house.

4.2.2 ROSTER OF BRIDGE TENDER AND EMERGENCY PERSONNEL. A current roster of bridge tenders and personnel to be notified when a malfunction of a bridge span occurs will be maintained at each bridge. The roster will include name, office telephone, and home telephone. The roster will be posted for ready reference in the control house at each movable span bridge.

4.3 RESPONSIBILITIES

4.3.1 BRIDGE TENDERS. All bridge tenders will be required to read and understand this procedure. A copy of this procedure will be posted in all control houses or bridge tender buildings at each movable span bridge.

4.3.2 RECORDING MALFUNCTIONS. The bridge tenders will maintain a log book for the purpose of entering all malfunctions, dates, phone calls, and corrective action taken to correct the malfunction. Bridge tenders will advise repair crews of the action taken to correct the malfunction and the probable cause of the failure.

4.4 OPERATIONAL PROCEDURES

4.4.1 ACTION BY BRIDGE TENDER - MINOR MALFUNCTIONS. Bridge tenders will take the following action when minor bridge malfunctions occur.

a. Attempt to reverse the cycle.

b. Use the bypass push button (use extreme caution) if equipment is so equipped.

c. Reset all overloads and circuit breakers if necessary.

Tables 4-1 through 4-3 are checklists showing the corrective action for malfunctions at the Indian River, Banana River, and Haulover Canal Bridges.

4.4.2 OPERATIONAL ACTION FOR MAJOR MALFUNCTIONS. Bridge tenders will notify the following personnel of any major malfunctions (report the particular failure, repairs required, and the length of time necessary to restore the bridge):

a. KSC Security Office, Phone 867-2121

b. Trouble Call Desk, Phone 867-3131

c. The Supervisor or Assistant of Roads and Grounds, Phone 867-3380 or at home after normal hours

4.4.3 ACTION BY SUPERINTENDENT - ROADS AND GROUNDS. The superintendent of Roads and Grounds will determine which of the following actions are necessary in order to correct the (bridge span) malfunction.

4.4.3.1 During Normal Working Hours (0730 - 1600, Monday through Friday).

a. Request emergency repair crews from the appropriate maintenance shop or contractor emergency work order desk, Phone 867-3131.

b. Inform the Area Engineer, Phone 867-3380 or 867-6437.

c. Notify the NASA Technical Representative, Phone 867-4321.

d. Request the Contractor Motor Vehicle Pool Operator to furnish two standby vehicles for emergency.

4.4.3.2 During Other than Normal Working Hours (1600 - 0730, Monday through Friday and for 24 hours during Saturday and Sunday and all holidays).

a. Dispatch emergency repair personnel to the bridge requiring repairs.

b. Notify the Area Engineer (R&G) at home.

c. Notify the Bridge Mechanic at home.

d. Notify the NASA Technical Representative at home in case vehicle or marine traffic will be unduly delayed.

e. Notify the Coast Guard, Phone 853-3353 , if marine traffic will be affected.

f. Inform the local radio stations if it appears that vehicle traffic will be unduly delayed.

4.4.4 ACTION BY NASA REPRESENTATIVE. If marine traffic will be unduly delayed, the NASA Representative will be responsible for the following:

a. Notify the Corps of Engineers, Jacksonville (District), Florida, Phone 355-6411.

b. Notify the Coast Guard, Port Canaveral, Florida, Phone 853-3353.

c. Notify appropriate NASA (Key) personnel.

4.4.5 KSC SECURITY PATROL VEHICLE TRAFFIC PLAN. The following traffic plan will be implemented by the KSC Security Patrol, when any of the movable span bridges have malfunctions, causing a vehicle traffic problem.

a. Dispatch Security Patrols to any bridge with a nonoperative span, for the purpose of directing vehicle traffic.

b. Establish emergency traffic routes for the purpose of rerouting traffic, when malfunctions of bridge spans require all traffic lanes to be blocked.

c. Dispatch patrols to bridges when one traffic lane is blocked during the time of heavy traffic (0645 and 1545 Monday through Friday) to direct traffic. During normal traffic, provide control for one lane at the bridge with a malfunction span.

Table 4-1. Malfunction and Corrective Action-Indian River Bridge

Malfunction	Operator Function	Effect
Normal or emergency main circuit breakers will not close with power available.	Close manual circuit breaker 5CB in Auxiliary Control Cabinet.	Restore power to control circuits.
Normal power not available.	Start emergency generator set and close emergency power circuit breaker.	Emergency power is made available.
Safety gates will not lower.	Bypass Traffic Light Time Delay Relay with bypass switch B3S (South Road) or B3N (North Road).	Gates lower by operation of control switch C3S (South Road) or C3N (North Road).
Center locks will not draw.	Bypass gate limit switches with bypass switch B4S (South Road) or B4N (North Road).	Locks draw by operation of control switch C5S (South Road) or C5N (North Road).
Leaves will not rise.	Bypass center lock limit switches with bypass switch B6S (South Road) or B6N (North Road).	Leaves rise by operation of raise-lower selector switch S30A (Near - South) S30B (Far - South) N30A (Near - North) N30B (Far - North) and run button S42A (Near - South) S42B (Far - South) N42A (Near - North) N42B (Far - North)
Center locks will not drive.	Bypass fully seated limit switch with bypass switch B5S (South Road) or B6A (North Road).	Locks drive by operation of control switch C5S (South Road) or C5N (North Road).

Table 4-1. Malfunction and Corrective Action-Indian River Bridge (Continued)

Malfunction	Operator Function	Effect
Safety gates will not rise.	Bypass center lock limit switches with bypass switch B2S (South Road) or B2N (North Road).	Gates rise by operation of control switch C4S (South Road) or C4N (North Road).
Traffic lights fail to turn green after raising safety gates.	Bypass gate limit switches with bypass switch B1S (South Road) or B1N (North Road).	
Any motor fails to operate when power is available.	Reset overload elements in Magnetic Motor Contactor. Check related branch Circuit Breaker.	Motor operates by restoration of power supply.

Table 4-2. Malfunction and Corrective Action-Banana River Bridge

Malfunction	Operator Function	Effect
Warning gates will not lower.	Bypass traffic light and safety gate interlocks with bypass switch 42-1.	Gates lower by operation of control switch 41-1 (near side) or 41-2 (far side).
Safety gates will not lower.	Bypass center lock and warning gate interlocks with bypass switch 42-2.	Gates lower by operation of control switch 41-3 (near side) or 41-4 (far side).
Center locks will not draw.	Bypass safety gate and leaf interlocks with bypass switch 42-3.	Center locks draw by operation of control switch 46.
Emergency brakes will not release.	Bypass center locks limit switches with bypass switch 42-4.	Brakes release by operation of control switch 45-3 (near side) or 45-4 (far side).
Near leaf will not rise.	Bypass door interlock with bypass switch 42-5.	Near leaf can be raised by operation of push button near-raise.
Center locks will not drive.	Bypass safety gate and leaf interlocks with by pass switch 42-3.	Center locks drive by operation of control switch 46.
Safety gates will not rise.	Bypass center lock and warning gate interlocks with bypass switch 42-2.	Gates can be raised by operation of control switch 41-3 (near side) or 41-4 (far side).

Table 4-2. Malfunction and Corrective Action - Banana River Bridge (Continued)

Malfunction	Operator Function	Effect
Warning gates will not rise.	Bypass traffic light and safety gate interlocks with bypass switch 42-1.	Gates can be raised by operation of control switch 41-1 (near side) or 41-2 (far side).
Power goes off.	Check and reclose main circuit breaker manually. Avoid simultaneous operation of both span leaves.	Power restored. Voltage drop limited (open-phase-relay may trip main breaker due to low voltage).
Any motor fails to run.	Reset overload elements of magnetic motor contractor. Check that all circuit breakers are closed.	Restore power to motor and related control circuits.

Table 4-3. Malfunction and Corrective Action-Haulover Canal Bridge

Malfunction	Operator Function	Effect
Warning gates will not lower.	Bypass traffic light and safety gate interlocks with bypass switch.	Gates lower by operation of control switch (near side) (far side).
Safety gates will not lower.	Bypass center lock and warning gate interlocks with bypass switch	Gates lower by operation of control switch (near side) or (far side).
Center locks will not draw.	Bypass safety gate and leaf interlocks with bypass switch.	Center locks draw by operation of control switch.
Emergency brakes will not release.	Bypass center locks limit switches with bypass switch.	Brakes release by operation of control switch (near side) or (far side).
Near leaf will not rise.	Bypass door interlock with bypass switch.	Near leaf can be raised by operation of push button near-raise.
Center locks will not drive.	Bypass safety gate and leaf interlocks with bypass switch.	Center locks drive by operation of control switch.
Safety gates will not rise.	Bypass center lock and warning gate interlocks with bypass switch.	Gates can be raised by operation of control switch (near side) or (far side).

SECTION V
BANANA RIVER BRIDGE OPERATION

5.1 PURPOSE

This section outlines the procedures for the operation of the Banana River Bridge on the NASA/KSC Causeway East, which is normally unattended. The section explains the actions required to ensure that the bridge tender is on duty to alleviate a possible 6-hour traffic delay.

5.2 HIGHWAY SIGNAL AIDS

To properly control highway traffic and to comply with required safety regulations, each approach to the bridge is equipped with the following signals:

a. Traffic lights

b. Warning gates

c. Safety gates

5.3 BRIDGE AND VESSEL NAVIGATION AIDS

To ensure safe and expedient navigation, the bridge is equipped with visible and/or audible communications indicators as shown in Table 5-1.

Table 5-1. Bridge Indicator Locations

Indicator or Device	Location
Telephone (867-4300)	Bridge control room
Electric siren	Control house roof
Vessel traffic lights	Low-point span clearance at center of bridge, north and south sides
Navigation lights (6 red)	Bridge channel fender; one at each end (4); one at the center (2)
Clearance indicators and lights	End of starboard (right) fender of each approach
Portable light, battery operated	Bridge control room
Signal flag (white)	Bridge control room

5.4 PREPARATION AND SAFETY PROCEDURES

Prior to operating the bridge, the bridge tender will perform the following checks:

a. Verify that all circuit breakers in the control panel, lower level, are closed (see Figure 5-1).

b. Verify that all control house doors are closed.

c. Check for correct voltage (3 phase, 440-480v); use test switch 2-1; read on voltmeter 3-1.

d. Verify that all bypass switches (42-1, 42-2, 42-3, 42-4, and 42-5) are locked SAFE.

e. Turn control power switch (44) ON.

5.5 BRIDGE OPERATIONS

To ensure the presence of a bridge tender, authorized agencies and/or vessel operators, who require the bridge to be opened for navigation traffic, must notify the KSC Security Patrol, telephone 867-2121. This notification must be given at least 6 hours prior to the expected arrival time of the vessel.

5.5.1 KSC SECURITY PATROL. Upon verifying the validity of the request, the KSC Security Patrol will notify the Base Support Services Contractor (BSSC) call desk, telephone 867-3131. The BSSC call desk will then notify the BSSC Roads and Grounds Section, telephone 867-3380. This section will ensure that the bridge tender will be present to perform the preparatory checks outlined in Section 5.4.

5.5.2 BSSC ROADS AND GROUNDS SECTION. In addition to opening the bridge for navigation traffic, this section will open the bridge for testing purposes and/or preventive maintenance operations. The KSC Security Patrol will be notified as to time and duration of traffic interference prior to the bridge opening. When the bridge has been closed, regardless of the reason for its opening, and normal traffic can be resumed, the KSC Security Patrol will be notified.

5.5.3 BRIDGE LOG BOOK. The bridge tender will maintain a log book with the following entries:

a. Time and date of receipt of instructions to open bridge

b. Results of checks prior to opening bridge

c. Time and date of closing bridge

d. Any unusual happenings

5.5.4 BRIDGE SIGNS. Signs will be displayed on the north and south sides of the Banana River Bridge, at the Indian River entrance to the barge canal, and at the Canaveral Lock. Signs are to read as follows:

"NOTICE---BANANA RIVER BRIDGE, ORSINO CAUSEWAY IS UNATTENDED. TO GIVE 6-HOUR NOTICE REQUIRED FOR OPENING, CALL KSC SECURITY PATROL, TELEPHONE 867-2121."

5.5.5 SIGNAL REQUIREMENTS. Table 5-2 lists the procedures to be used during the daylight hours for signalling operations between an oncoming vessel and the bridge tender.

Table 5-2. Signalling Operations - Day*

Originator	Signal	Meaning of Signal
Oncoming vessel	Three blasts of whistle, horn, siren, or bell; voice signal may be given by "Bull Horn."	Passage desired
Bridge tender	Three blasts of siren WARNING If malfunction occurs while bridge is rising, signal navigation traffic by giving 4 distinct blasts on the siren.	Request heard; bridge operable and will be opened
Bridge tender	Four or more distinct blasts of siren	STOP !! Bridge inoperable; cannot be opened
Bridge tender	Visual signal (flag) moved over a horizontal plane at least 4 times	STOP !! Bridge inoperable; cannot be opened; notify KSC Security Patrol in advance if possible

* Good weather conditions, audible sound signals and wind velocity less than 15 mph.

Table 5-3 lists the procedures to be used for signalling operations during inclement weather (includes hours of darkness).

Table 5-3. Signalling Operations - Night **

Originator	Signal	Meaning of Signal
Oncoming vessel	Lantern or flag moved in a circular motion WARNING If malfunction occurs while bridge is rising, signal navigation traffic by giving 4 distinct blasts on the siren.	Passage desired
Bridge tender	Lantern or flag raised and lowered in a vertical plane 3 times	Request for passage acknowledged; bridge operable and will be opened
Bridge tender	Lantern or flag moved over a horizontal plane 4 or more times	Request for passage acknowledged; bridge inoperable; cannot be opened; notify KSC Security Patrol in advance if possible

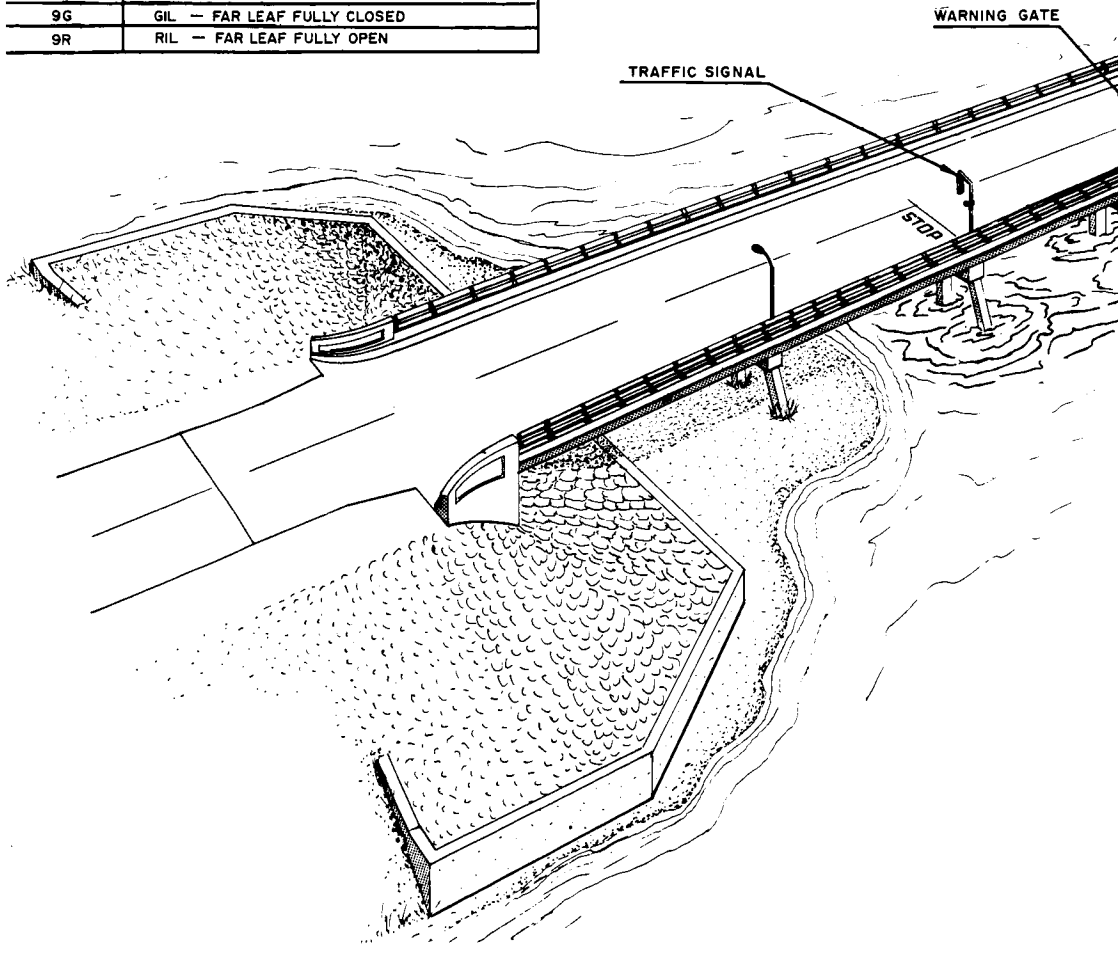
** Poor weather conditions (stormy, foggy, high winds, etc.)

5.5.6 BRIDGE RAISING PROCEDURES. The bridge tender will raise the bridge, following the steps in Table 5-4 (also refer to Figure 5-1).

5.5.7 BRIDGE LOWERING PROCEDURES. The bridge tender will lower the bridge, following the steps in Table 5-5 (also refer to Figure 5-1).

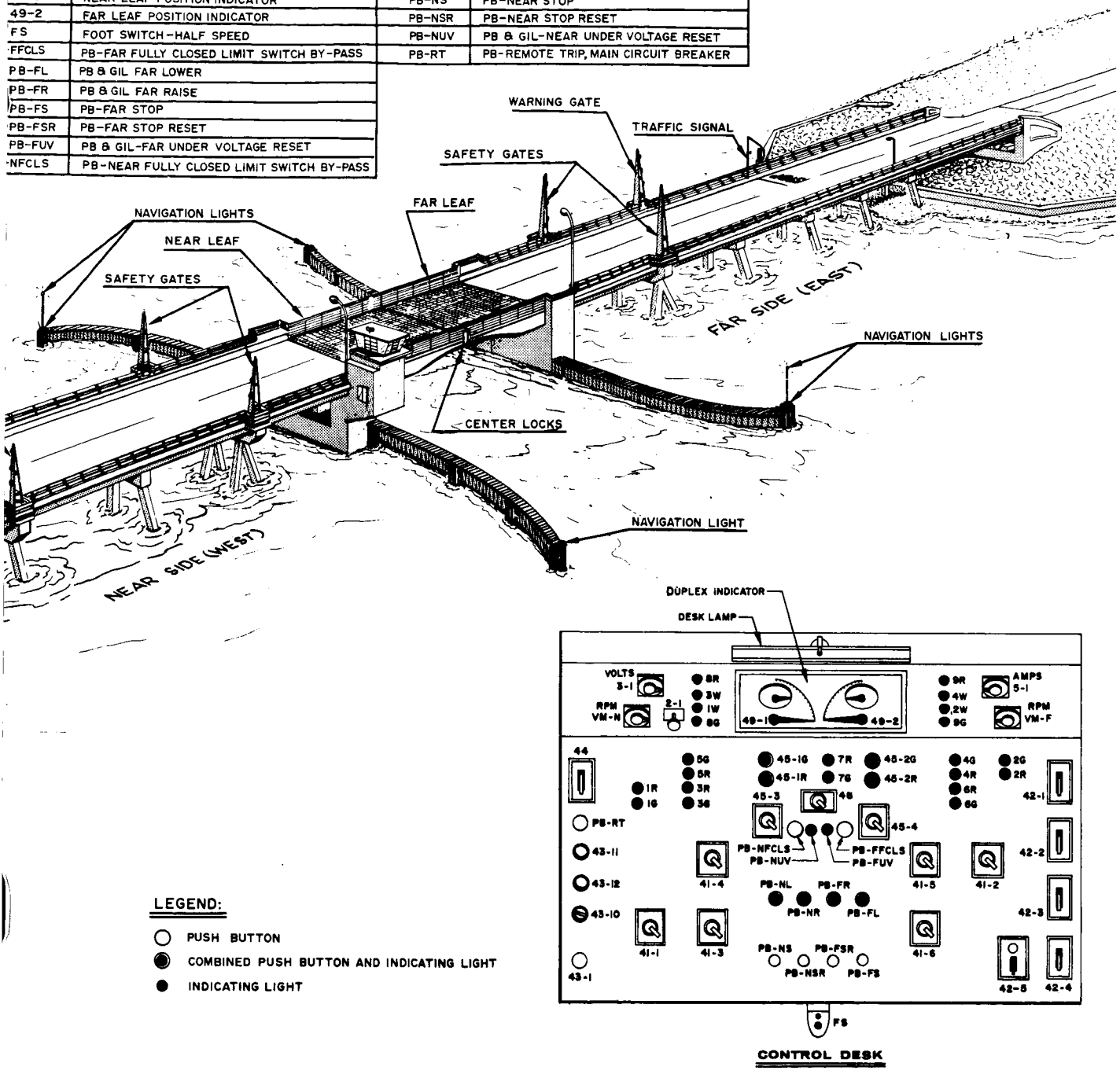
SWITCH NO.	DESCRIPTION
1G	GIL — NEAR WARNING GATE RAISED
1R	RIL — NEAR WARNING GATE LOWERED
1W	WIL — NEAR LEAF NEARLY CLOSED
2-1	VOLTMETER SWITCH
2G	GIL — FAR WARNING GATE RAISED
2R	RIL — FAR WARNING GATE LOWERED
2W	WIL — FAR LEAF NEARLY CLOSED
3-1	VOLTMETER
3G	GIL — NEAR SAFETY GATE-ONCOMING -RAISED
3R	RIL — NEAR SAFETY GATE-ONCOMING -LOWERED
3W	WIL — NEAR LEAF NEARLY OPEN
4G	GIL — NEAR SAFETY GATE-OFFGOING-RAISED
4R	RIL — NEAR SAFETY GATE-OFFGOING-LOWERED
4W	WIL — FAR LEAF NEARLY OPEN
5-1	AMMETER
5G	GIL — FAR SAFETY GATE-ONCOMING-RAISED
5R	RIL — FAR SAFETY GATE-ONCOMING-LOWERED
6G	GIL — FAR SAFETY GATE-OFFGOING-RAISED
6R	RIL — FAR SAFETY GATE-ONCOMING-LOWERED
7G	GIL — CENTERLOCKS DRIVEN
7R	RIL — CENTERLOCKS PULLED
8G	GIL — NEAR LEAF FULLY CLOSED
8R	RIL — NEAR LEAF FULLY OPEN
9G	GIL — FAR LEAF FULLY CLOSED
9R	RIL — FAR LEAF FULLY OPEN

SWITCH NO.	DESCRIPTION
41-1	CONTROL SWITCH, FAR WARNING GATE
41-2	CONTROL SWITCH, NEAR WARNING GATE
41-3	CONTROL SWITCH, NEAR SAFETY GATE-ONCOMING
41-4	CONTROL SWITCH, NEAR SAFETY GATE-OFFGOING
41-5	CONTROL SWITCH, FAR SAFETY GATE-ONCOMING
41-6	CONTROL SWITCH, FAR SAFETY GATE-OFFGOING
42-1	BY-PASS SWITCH, WARNING GATE INTERLOCK
42-2	BY-PASS SWITCH, SAFETY GATE INTERLOCK
42-3	BY-PASS SWITCH, CENTER LOCK INTERLOCK
42-4	BY-PASS SWITCH, LEAF INTERLOCK
42-5	BY-PASS SWITCH, DOOR INTERLOCK
43-1	PB-SIRENS
43-10	SWITCH-DESK LIGHT
43-11	SWITCH-ROADWAY LIGHTS
43-12	SWITCH-NAVIGATION LIGHTS
44	SWITCH-CONTROL POWER
45-1G	PB & GIL NEAR GREEN TRAFFIC LIGHT
45-1R	PB & RIL NEAR RED TRAFFIC LIGHT
45-2G	PB & GIL FAR GREEN TRAFFIC LIGHT
45-2R	PB & RIL FAR RED TRAFFIC LIGHT
45-3	CONTROL SWITCH NEAR EMERGENCY BRAKE



WITCH NO.	DESCRIPTION
45-4	CONTROL SWITCH FAR EMERGENCY
46	CONTROL SWITCH CENTER LOCKS
49-1	NEAR LEAF POSITION INDICATOR
49-2	FAR LEAF POSITION INDICATOR
FS	FOOT SWITCH-HALF SPEED
FFCLS	PB-FAR FULLY CLOSED LIMIT SWITCH BY-PASS
PB-FL	PB & GIL FAR LOWER
PB-FR	PB & GIL FAR RAISE
PB-FS	PB-FAR STOP
PB-FSR	PB-FAR STOP RESET
PB-FUV	PB & GIL-FAR UNDER VOLTAGE RESET
NFCLS	PB-NEAR FULLY CLOSED LIMIT SWITCH BY-PASS

SWITCH NO.	DESCRIPTION
PB-NL	BP & GIL-NEAR LOWER
PB-NR	PB & GIL-NEAR RAISE
PB-NS	PB-NEAR STOP
PB-NSR	PB-NEAR STOP RESET
PB-NUV	PB & GIL-NEAR UNDER VOLTAGE RESET
PB-RT	PB-REMOTE TRIP, MAIN CIRCUIT BREAKER



LEGEND:

- ○ PUSH BUTTON
- ◉ COMBINED PUSH BUTTON AND INDICATING LIGHT
- ● INDICATING LIGHT

Figure 5-1. Bridge Controls and Component Location

Table 5-4. Bridge Raising Operations

Step	Procedure	Switch and/or Indicator	Normal Indication
	WARNING If malfunction occurs while bridge is rising, signal navigation traffic by giving 4 distinct blasts on the siren.		
a.	Sound siren 3 times	43-1	Siren sounds, bridge is operable
b.	Change traffic signals from green to red	45-1R 45-2R	Gongs start to ring when light turns red
c.	Lower near and far warning gates	41-1 41-2	Lights 1R & 2R will illuminate * [If gates do not lower, activate by-pass interlock switch (42-1) and repeat step c.]
d.	Lower near and far safety gates (oncoming)	41-3 41-5	Lights 3R & 5R will illuminate * [If gates do not lower, activate by-pass interlock switch (42-2) and repeat step d.]
e.	Lower near and far safety gates (offgoing)	41-4 41-6	Lights 4R & 6R will illuminate * [If gates do not lower, activate by-pass interlock switch (42-2) and repeat step e.]
f.	Pull center locks	46	Red light (7R) will illuminate * [If center locks do not respond, activate bypass interlock switch (42-3) and repeat step f.]

* In high winds, reduce speed of leaves by operating foot switch located in the center of the control room in front of the control console.

Table 5-4. Bridge Raising Operations (Cont.)

Step	Procedure	Switch and/or Indicator	Normal Indication
g.	Release near and far emergency brakes	45-3 45-4	Light PB-NUV PB-FUV will illuminate * [If brakes do not respond, activate bypass interlock switch (42-4) and repeat step g.]
h.	Reset near and far under-voltage relays	PB-NUV PB-FUV	
i.	Raise near and far leaves (spans)	PB-NR PB-FR	Indicators will show position (49-1 near, 49-2 far). Lights (3 W near, 4 W far) will illuminate when leaves are nearly opened. Lights (8 R near, 9 R far) will illuminate when bridge is fully opened. * [If leaves do not fully open, activate bypass interlock switch (42-5) and repeat step i.]

* In high winds, reduce speed of leaves by operating foot switch located in the center of the control room in front of the control console.

Table 5-5. Bridge Lowering Operations

Step	Procedure	Switch and/or Indicator	Normal Indication
a.	Sound siren 4 times	43-1	Siren sounds, bridge is to be closed
b.	Lower near and far leaves (spans)	PB-NR PB-FR	Leaves begin to lower * [If leaves cease to close, activate bypass interlock switch (42-5) and repeat step b.] White lights (1W, 2W) will illuminate when leaves are in "nearly closed" position. Indicator dials show position of each span during descent.
c.	Close bridge when leaves are in "nearly closed" position	PB-NFCLS PB-FFCLS (Hold down for 5 seconds)	Bridge will slowly descend to "fully closed" position. Lights (8G, 9G) will illuminate.
d.	Drive center locks	46	Wait for green light (7G) to illuminate * [If center locks do not respond, activate bypass switch (42-3) and repeat step d.]
e.	Set near and far emergency brakes	45-3 45-4	Light PB-NUV, PB-FUV will illuminate
f.	Raise near and far safety gates (offgoing)	41-6 41-4	Indicator 4G & 6G will turn green * [If gates do not rise, activate bypass interlock switch (42-4) and repeat step f.]

* During high winds, reduce speed of leaves by operating foot switch located in the center of the control room floor in front of the control console.

Table 5-5. Bridge Lowering Operations (Cont)

Step	Procedure	Switch and/or Indicator	Normal Indication
g.	Raise near and far safety gates (oncoming)	41-5 41-3	Indicators 3G & 5G will turn green * [If gates do not rise, activate bypass interlock switch (42-4) and repeat step g.]
h.	Raise near and far warning gates	41-1 41-2	Indicators 1G & 2G will turn green * [If gates do not rise, activate bypass interlock switch (42-1) and repeat step h.]
i.	Switch traffic lights from red to green	45-1 45-2	Lights will turn green and gong ceases ringing
j.	Enter all information into log book		

* During high winds reduce speed of leaves by operating foot switch located in the center of the control room floor in front of the control console.

SECTION VI
INSPECTION AND TESTING WIRE ROPE, SLINGS, AND HOISTS

6.1 PURPOSE

To establish safety requirements and rules for governing the operation, inspection, and periodic testing of all hoisting and lifting machinery, rigging equipment, and supplies assigned to the Base Operations Division and the Base Support Operations contractor for maintenance. This section also establishes the requirements for a crane and rigging shop to support an operation of this magnitude.

6.2 GENERAL

The procedures in this section are applicable to the types of equipment, rigging supplies, or machinery listed below:

1. Hoisting Equipment
2. Cranes
3. Elevators
4. Draglines
5. Towers
6. Guys
7. Ropes
8. Slings
9. Lifting and Hoisting Machinery

6.3 RESPONSIBILITIES

6.3.1 BASE OPERATIONS DIVISION (BOD). The BOD is responsible for providing the necessary support for inspecting and testing all wire rope, slings, and hoisting machinery in compliance with the procedures and requirements herein. This support will normally be administered by the Base Support Contractor to the following:

1. Launch Support Operations Division (LSOD). The support covers but is not limited to hoisting machinery, cranes, etc. in the Vehicle Assembly Building (VAB), Mobile Launcher (ML), Launch Pads, and Mobile Service Structure (MSS) as requested by LSOD or the LSOD contractor, utilizing work order control procedures now in effect.

2. NASA Base Facilities such as elevators, overhead cranes, hoists, vertical doors, towers, and guys.

3. Base Operations Support equipment such as truck mounted and crawler mounted cranes, dozers, hi-lifts, and hoisting or lifting machines and equipment.

6.3.2 BASE SUPPORT SERVICES CONTRACTOR (BSSC). To provide the support directed by BOD and to implement the procedures and requirements established herein, the BSSC is required to organize, equip, and man the Crane and Rigging Shop. The heavy equipment section is responsible for establishing the Crane and Rigging Shop mentioned above and complying with the procedure herein. This shop will be soley responsible for the inspection, repair, maintenance, serviceability, and testing of all ropes, cables, slings, fittings, and rigging supplies and materials. This shop will also be responsible for the fabrication or procurement of wire rope slings, chain slings, fittings, and other rigging items. A rigging team (or teams) for light, medium, or heavy rigging will be organized to operate under the general supervision of this shop. This shop will provide storage for all material to be used for hoisting or rigging. The storage must provide protection from the elements and from damage from any source. Sufficient space will be provided to store rigging materials, wire rope in various sizes, tool test blocks, testing devices or equipment, etc. The storage space will be located in an area devoid of unrelated items, personnel, etc.

6.3.2.1 Equipment Required. The following equipment is required to establish the Crane and Rigging Shop capability:

1. Hydraulic Sling Press--to fabricate wire rope slings of various types and sizes (from 1/8-inch to 2 inches in diameter and up to 100 feet in length).

2. Hydraulic Press, 800-ton--with alumimum-base alloy clamp or swedge, to accomodate dies from 1/8-inch to 1-$\frac{1}{2}$ inches.

3. Hydraulic Press, 500-ton--to handle wire rope from 1/8-inch to 1-$\frac{1}{2}$ inches in diameter.

4. Horizontal Cable or Chain Tester--to load test all rigging fabricated in the shop, and to perform periodic retesting of rigging in use. The tester shall be capable of testing up to 100 feet of cable to 200,000 pounds (figure 6-1).

5. Crane Scale or Dynamometer--to measure the test load lifted by cranes and slings, and to measure weight traction and tension (figure 6-2). A number of crane scales or dynamometers of different ranges are required to permit measurement of loads within specific ranges (i.e., 0 to 5,000 pounds; 0 to 20,000 pounds--- --; and 0 to 200,000 pounds) Greater accuracy is obtained from the upper 50-percent portion of the scale.

6. Metal Stamping typewriter--to record values obtained during load tests and measurements. Metal tags are required.

7. Lift-Truck Weight Indicator--to indicate the weight of the load being carried by the lift truck (figure 6-3).

6.3.2.2 Stock Inventory Required. A stock inventory of the following items is required to support the Crane and Rigging Shop:

1. Wire Rope
2. Eye Hooks
3. Safety Latches
4. Swivel Hooks
5. Choker Hooks and Eyes
6. Slip-Through Thimbles
7. Standard Thimbles
8. Crescent Thimbles
9. Pear-Shaped Links
10. Shackles
11. Turnbuckles
12. Swedges (Swages)
13. Ferrules
14. Test Blocks

6.3.3 USING AGENCY. To comply with the requirements specified herein, or when the condition is doubtful, the using agency is responsible for inspecting or requesting inspection and test of any sling, wire rope, or hoisting device. The support request or work control procedures now in effect will be utilized to obtain such inspection and test.

6.4 REQUIREMENTS

6.4.1 GENERAL. The installation, maintenance, inspection, and testing of wire rope, slings, chains, and other rigging materials will be done only by qualified personnel, and as specified herein. Any new, altered, or repaired hoisting machinery, crane elevator sling, etc. shall be inspected, tested, and certified safe for rated loads by qualified personnel. When the item is in a safe

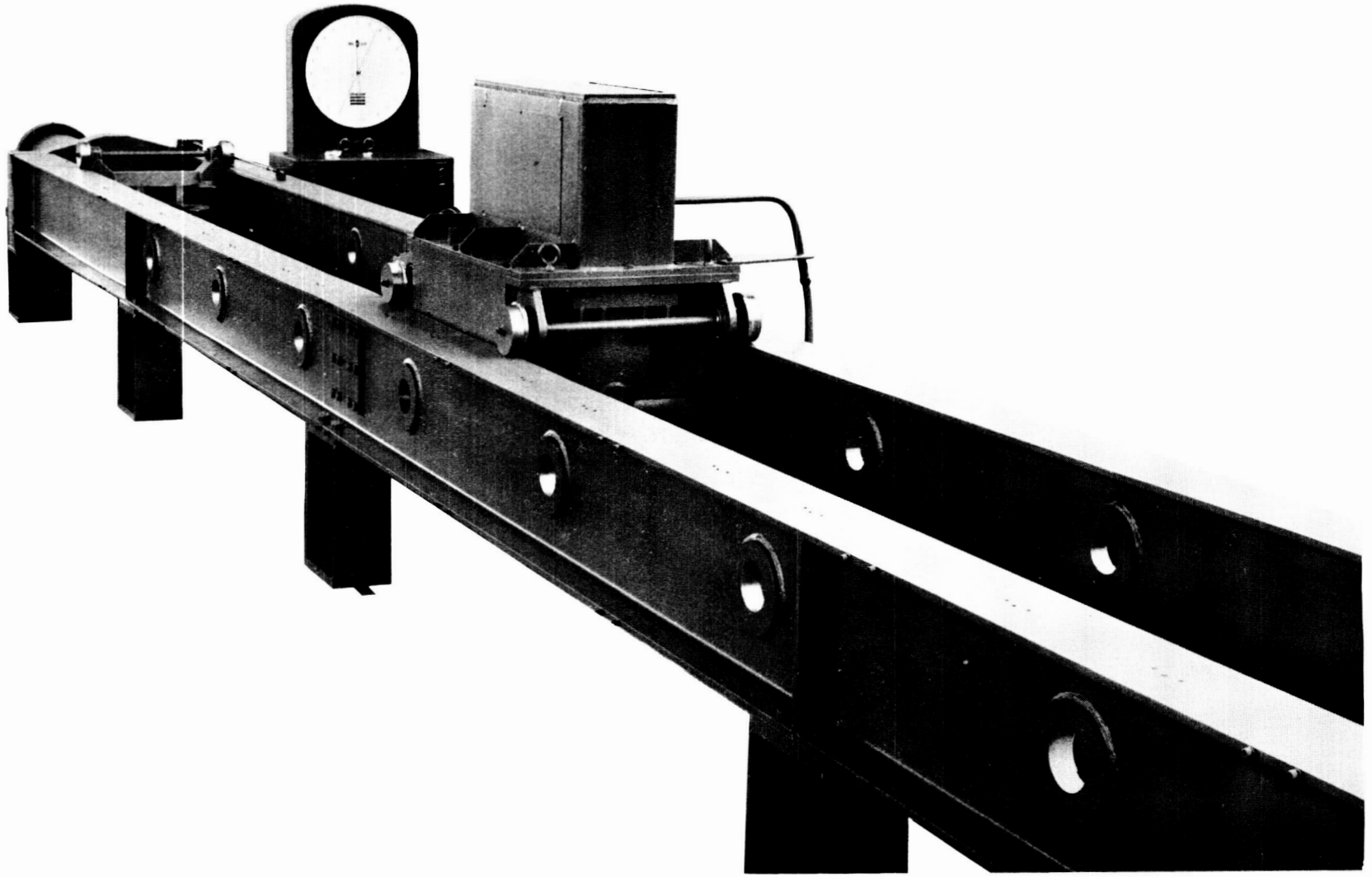


Figure 6-1. Chain and Cable Tester

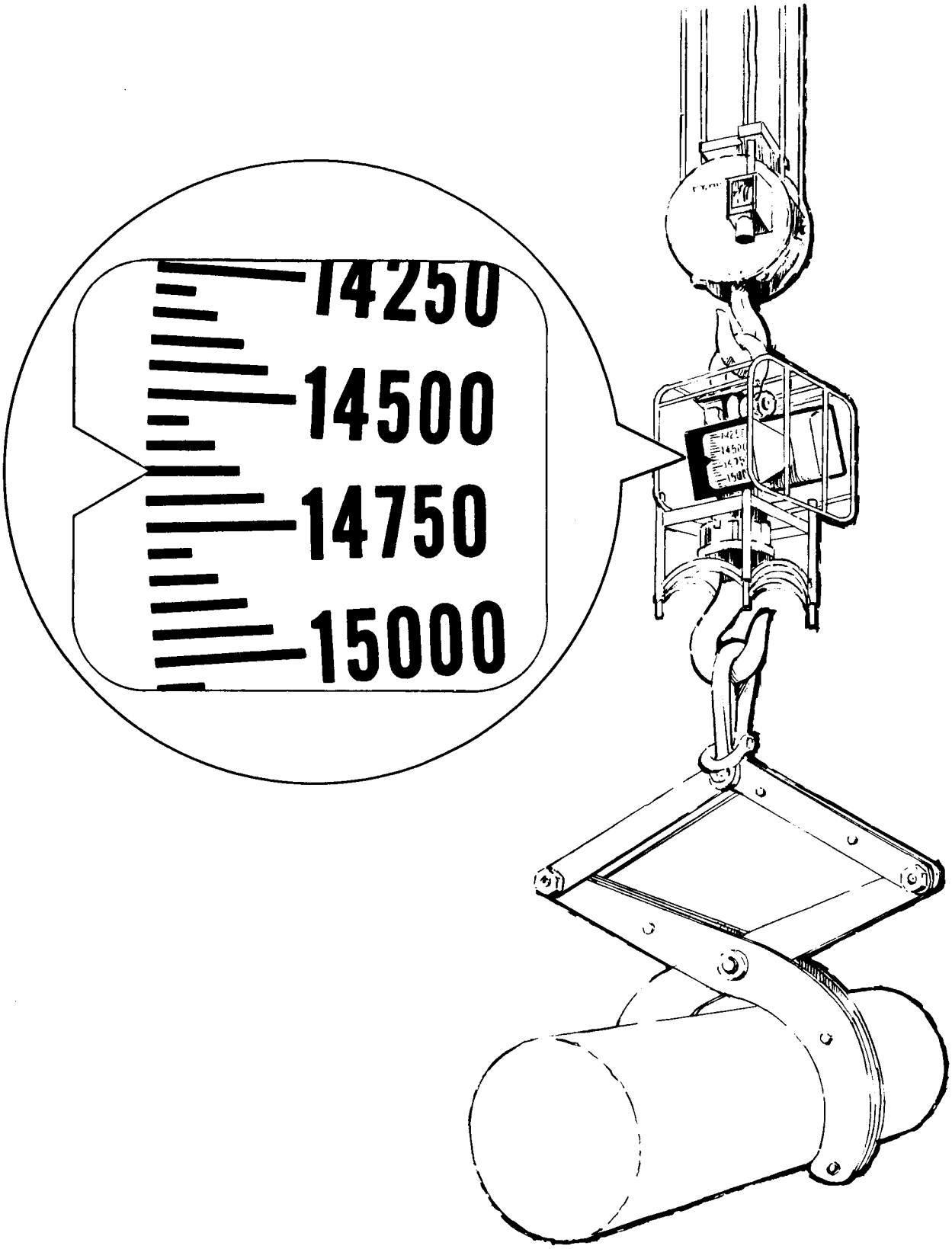


Figure 6-2. Crane Scale.

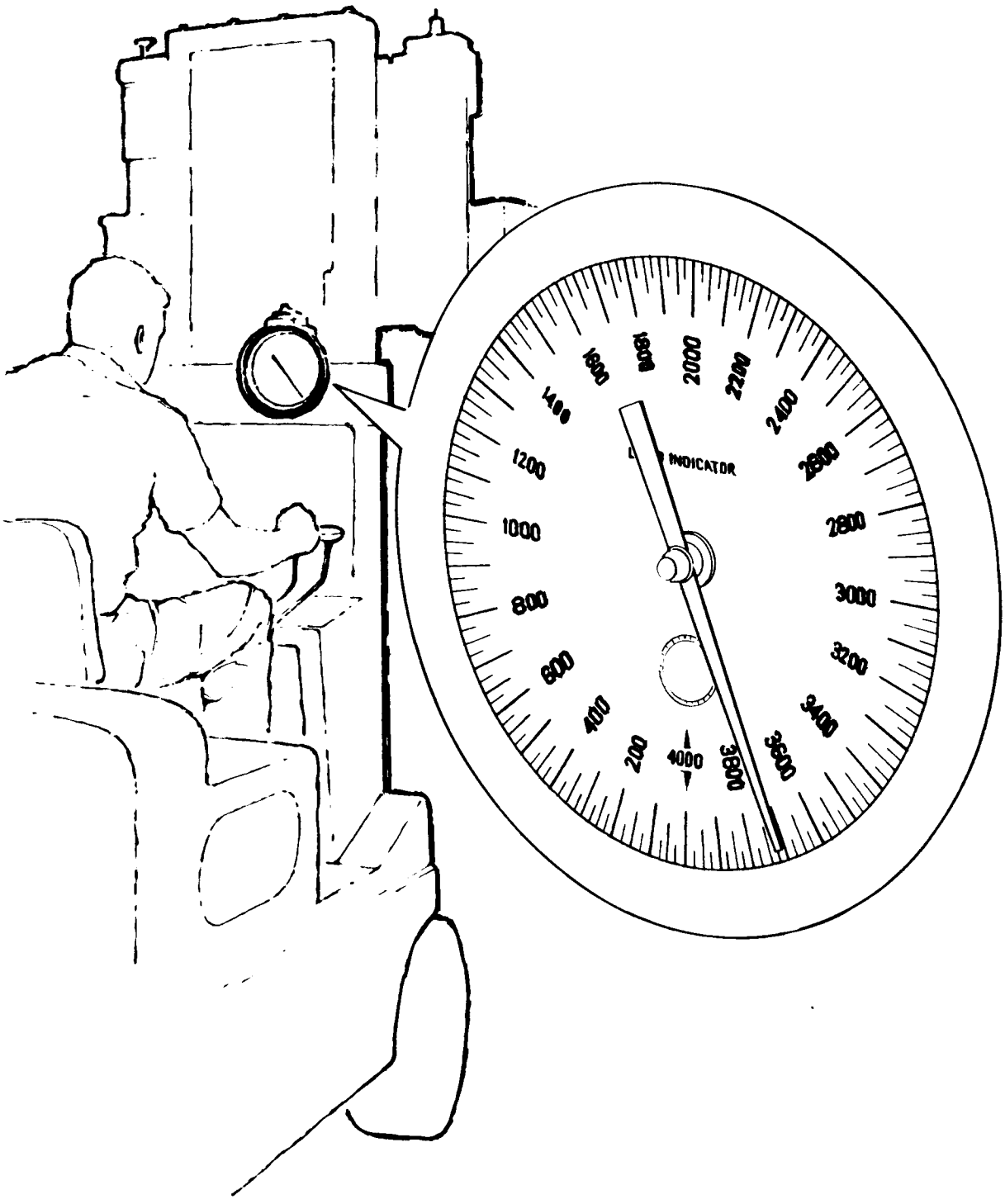


Figure 6-3. Lift - Truck Weight Indicator

operating condition, it may be released for service and so tagged.

6.4.2 WIRE ROPE AND CHAINS. The use of wire rope and chains shall comply with the safe working loads recommended by the manufacturer or modified herein, whichever is lower. Refer to Tables 6-1 and 6-2 for breaking strength and safety factor values. Wire rope or chains shall be used within the safe limits recommended by the manufacturer of the equipment with which they are used.

Table 6-1. Breaking Strength of 6 x 19 Wire Rope

Diameter In.	Mild Plow Steel Tons*	Plow Steel Tons*	Improved Plow Steel Tons*	Extra Improved Plow Steel Tons*	Weight Per Foot Pound
1/4	2.07	2.39	2.74	3.40	.11
5/16	3.22	3.71	4.26	5.27	.18
3/8	4.62	5.31	6.10	7.55	.26
7/16	6.25	7.19	8.27	10.2	.35
1/2	8.13	9.35	10.7	13.3	.46
9/16	10.2	11.8	13.5	16.8	.59
5/8	12.6	14.5	16.7	20.6	.72
3/4	18.0	20.7	23.8	29.4	1.04
7/8	24.3	28.0	32.2	39.8	1.42
1	31.6	36.4	41.8	51.7	1.85
1 1/8	39.8	45.7	52.6	65.0	2.34
1 1/4	48.8	56.2	64.6	79.9	2.89
1 3/8	58.8	67.5	77.7	96.0	3.50
1 1/2	69.6	80.0	92.0	114.0	4.16
1 5/8	81.2	93.4	107.0	132.0	4.88
1 3/4	93.6	108.0	124.0	153.0	5.67
1 7/8	107.0	123.0	141.0	174.0	6.50
2	121.0	139.0	160.0	198.0	7.39
2 1/8		156.0	179.0	221.0	8.35
2 1/4		174.0	200.0	247.0	9.36
2 3/8			222.0		
2 1/2		212.0	244.0	302.0	11.6
2 3/4		254.0	292.0	361.0	14.0

* Divide by Factor of Safety in Table 6-2 to Obtain Safe Load.

Table 6-2. Minimum Factor of Safety

Use	F.S.
Slings	8
Overhead Electric Hoist (Small)	7
Overhead Traveling Cranes (Small)	$6\frac{1}{2}$
Truck Cranes	6
Derricks	6
Crawler Cranes	6
Overheading Traveling Cranes (Large)	$5\frac{1}{2}$
Shovels	5
Derrick Guys	5
Tower Guys	4
Elevators (Passenger 50 ft/min.)	7.60
(Passenger 1500 ft/min)	11.90
(Freight 50 ft/min)	6.65
(Freight 1500 ft/min.)	10.55

6.4.3 LIFTING HOOKS. All hooks used in lifting workmen or loads that pass over workmen will be closed or "moused." Open hooks will not be used to lift any load when there is danger of the load or hook fouling.

6.4.4 SLINGS. The loads placed on slings will not exceed the values listed in Table 6-3.

Table 6-3. Safe Working Loads on Various Types of Slings

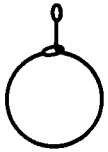
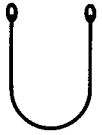
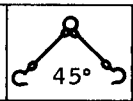
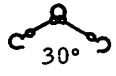
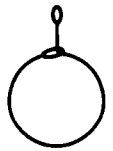
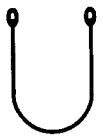
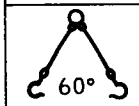
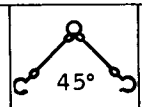
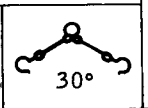
Type of Sling	Nominal Size Inch	 Single	 Choker		 Basket	Total load on two-leg slings (For three-leg slings, multiply by 1½. For four-leg slings multiply by 2.)  60°	 45°	 30°	Weight per ft. (exclusive of hook, ring, thimble, or splice) in lbs
		Sling, ton	Sling, ton	U Sling, ton	Sling, ton	Bridle, tons	Bridle, tons	Bridle, tons	
6 x 19 improved plow steel rope	3/8	0.675	0.505	1.350	1.180	1.165	0.955	0.675	0.23
(Federal Spec. RR-R-571	7/16	0.920	0.690	1.840	1.610	1.590	1.300	0.920	0.31
Factor of safety = 8	1/2	1.210	0.907	2.420	2.120	2.090	1.710	1.210	0.40
	9/16	1.450	1.087	2.900	2.540	2.500	2.055	1.450	0.51
Splice efficiency=80%	5/8	1.900	1.425	3.800	3.325	3.285	2.700	1.900	0.63
	3/4	2.630	1.970	5.260	4.600	4.550	3.725	2.630	0.90
	7/8	3.500	2.625	7.000	6.125	6.050	4.950	3.500	1.23
Rope diameter	1	4.500	3.375	9.000	7.875	7.775	6.375	4.500	1.60
	1-1/8	5.600	4.200	11.200	9.800	9.700	7.950	5.600	2.03
	1-1/4	6.900	5.175	13.800	12.100	11.950	9.775	6.900	2.50
8-part braided wire strand sling	1/8	0.770	0.575	1.540	1.350	1.335	0.815	0.770	0.18
	3/16	1.710	1.280	3.420	2.995	2.960	2.425	1.710	0.42
Factor of safety = 5	1/4	3.250	2.435	6.500	5.690	5.650	4.610	3.250	0.80
	5/16	5.400	4.050	10.800	9.425	9.350	7.650	5.400	1.28
Splice efficiency=100%	3/8	7.060	5.300	14.120	12.325	12.200	10.000	7.060	1.84
Rope Diameter	7/16	9.410	7.075	18.820	16.500	16.300	13.300	9.410	2.48
	1/2	12.100	9.075	24.200	21.150	20.950	17.150	12.100	3.20
	9/16	15.120	11.350	30.240	26.500	26.150	21.450	15.120	4.08

Table 6-3. Safe Working Loads on Various Types of Slings (cont)

Type of Sling	Nominal Size Inch	 Single Sling, ton	 Choker Sling, ton	 U Sling, ton	 Basket Sling, ton	Total load on two-leg slings (For three-leg slings, multiply by 1½. For four-leg slings multiply by 2.)  60° Bridle, tons	 45° Bridle, tons	 30° Bridle, tons	Weight per ft. (exclusive of hook, ring, thimble, or splice) in lbs.
3-strand manila rope (Federal Spec. T-R-601) Factor of safety = 10 Splice efficiency = 80%	1/2	0.105	0.080	0.210	0.185	0.182	0.150	0.105	0.075
	3/4	0.217	0.162	0.435	0.380	0.370	0.307	0.217	0.167
	1	0.360	0.270	0.720	0.630	0.625	0.510	0.360	0.270
	1-1/4	0.540	0.405	1.080	0.950	0.940	0.765	0.540	0.418
	1-1/2	0.740	0.555	1.480	1.300	1.285	1.050	0.740	0.600
Rope Diameter									
Iron Crane Chain ASTM Spec. A-56-39 Factor of safety = 5	3/8	0.855	0.640	1.710	1.500	1.485	1.210	0.855	1.66
	1/2	1.422	1.065	2.845	2.490	2.470	2.015	1.422	2.75
	5/8	2.190	1.640	4.380	3.840	3.800	3.100	3.190	4.30
	3/4	3.207	2.410	6.415	6.100	5.575	4.550	3.207	6.15
	7/8	4.425	3.315	8.850	7.750	7.675	6.340	4.425	8.20
Stock Diameter	1	5.875	4.400	11.775	10.300	10.200	8.325	5.887	10.45
	1-1/8	7.675	5.750	15.350	13.450	13.325	10.850	7.675	13.10
	1-1/4	9.625	7.200	19.250	16.850	16.750	13.625	9.625	16.00
Alloy-steel chain Factor of safety = 5 Stock Diameter	1/4	1.625	1.218	3.250	2.843	2.814	2.297	1.625	
	3/8	3.300	2.475	6.600	5.775	5.715	4.666	3.300	
	1/2	5.625	4.218	11.250	9.843	9.742	7.953	5.625	
	5/8	8.250	6.187	16.500	14.437	14.289	11.665	8.250	
	3/4	11.500	8.625	23.000	20.125	19.918	16.261	11.500	
	7/8	14.375	10.781	28.750	25.156	24.897	20.326	14.375	
	1	19.375	14.531	38.750	33.906	33.557	27.396	19.375	
	1-1/8	22.250	16.687	44.500	38.937	38.537	31.461	22.250	
	1-1/4	28.750	21.562	57.500	50.312	49.795	40.652	28.750	

6.5 INSPECTIONS

6.5.1 GENERAL. The Crane and Rigging Shop will provide qualified inspectors to inspect all hoisting and lifting equipment and rigging gear on a scheduled basis. The inspections shall disclose any condition that could contribute to equipment malfunction or hazardous conditions.

6.5.2 WIRE ROPE. Wire rope or cable shall be inspected at the time of installation; then once a week thereafter, while it is in use. Wire rope shall be removed and tagged "Unsafe", if any of the following are found:

1. Broken wires: when the number of broken wires exceeds the number listed in Table 6-4.

2. Wear on outside wires: when worn areas exceed 33 percent of the outside area.

3. Kinks

4. Evidence of overloading

Table 6-4. Allowable Wire Breaks and Wear on Hoisting Ropes

Use	Wire Breaks Conditions	6x19 Warrington	6x37	8x19 Warrington	6x19 Seale	Conditions
Cranes	Total	18	30	24	___	
	Adjacent	4	6	4	___	
Hoists	Total	24	___	32	___	Wear on
	Adjacent	5	___	5	___	outside
Passenger	Total	12	___	16	8	wires in
Elevators	Adjacent	4	___	4	3	excess
Freight	Total	13	___	18	9	of 33%.
Elevators	Adjacent	4	___	4	3	
Total = Number of wire breaks in all strands in one rope lay.						
Adjacent = Number of adjacent wires broken.						

To determine wear on outside wires, proceed as follows:
Measure the length of the shiny, worn spots on the outside wires with a steel scale graduated in one-hundredths of an inch. These shiny, worn spots are an index of reduction in area and strength of the wires and of the rope due to wear.

5. Safe condition in doubt, for any cause

6. Evidence of excessive corrosion

6.5.3 SLINGS. All slings and their fittings, splices, and fastenings will be inspected daily while in use. Slings found to be stretched, kinked, or otherwise defective will be removed and tagged as unsafe. Chains shall be normalized or annealed periodically, as recommended by the manufacturer.

6.5.4 SHEAVES, PULLEYS, AND DRUMS. Sheaves, pulleys, and drums shall be smooth and free from surface defects injurious to wire rope. Particular care will be taken to detect corrugated sheaves and pinching sheave grooves. Drums, sheaves, or pulleys that are out of round or that have cracked hubs or flanges will be removed from service. The ratio between wire rope diameters and the diameter of pulleys, sheaves, or drum treads shall be as given in Table 6-5. Allowable tolerances for drum and sheave grooves are given in Table 6-6. In no event will the safe values of replacement drums, pulleys, or sheaves be less than those of the replaced items, unless the safe loads of wire rope to be used therewith are reduced accordingly.

Table 6-5. Sheave and Drum Tread Diameters

Type	Recommended Tread Diameter	Minimum Tread Diameter
6 x 7 rope	72 times rope diameter	42 times rope diameter
18 x 7 nonrotating rope	51 times rope diameter	34 times rope diameter
6 x 19 rope	45 times rope diameter	
6 x 19 G rope		34 times rope diameter
6 x 19 E rope		30 times rope diameter
6 x 25 F rope		26 times rope diameter
8 x 19 rope	31 times rope diameter	21 times rope diameter
6 x 37 rope	27 times rope diameter	18 times rope diameter

Table 6-6. Sheave and Drum Groove Tolerances

Nominal Diameter of Rope (Inch)	Min. Clearance Before Sheave Replacement or Remachining Grooves	Min. Clearance for New or Remachined Grooves
5/15 and smaller	1/128	1/64
Over 5/16 to 3/4 incl.	1/64	1/32
Over 3/4 to 1-1/8 incl.	3/128	3/64

Table 6-6. Sheave and Drum Groove Tolerances (Cont)

Nominal Diameter of Rope (Inch)	Min. Clearance Before Sheave Replacement or Remachining of Grooves	Min. Clearance For New or Remachined Grooves
Over 1-1/8 to 1-1/2 incl.	1/32	1/16
Over 1-1/2 to 2-1/4 incl.	3/64	3/32
Over 2-1/4 to 2-1/4 incl.	1/16	1/8
Over 3	5/64	5/32

6.5.5 CONNECTIONS, FITTINGS, AND FASTENERS. The clips, thimbles, clamps, shackles, hooks, etc. that are used in conjunction with wire rope and chains shall be of the highest quality and of the proper size and strength to allow the rated capacity of the wire rope and chains to be developed. Socketing, splicing, and sizing of wire rope will be accomplished only by qualified personnel. All eye splices shall be made as required by the Handbook of Rigging, Prentiss - Hall Publishers, or other approved specifications. Eyes should be equipped with thimbles, except in the case of slings, where they are optional. Wire-rope clips shall be attached with U-bolts bearing upon the dead or short end of the rope. The U-bolt nuts shall be tightened after the initial loading, and then be checked weekly thereafter. The number of clips and the spacing required is given in Table 6-7. (Do not use malleable-iron clips.) Wedge sockets will be installed so that the pulling portion of a wire rope is directly in line with the clevis pin; otherwise, a sharp bend will be made in the rope as it enters the socket. The short or dead end of the rope will be clipped with a U-bolt or otherwise secured against loosening. Hooks, shackles, rings, thimbles, and other fittings that show excessive wear or have been bent, twisted, or otherwise damaged shall be replaced.

6.5.6 RECORDS AND REPORTS. The Crane and Rigging Shop inspector will make out the appropriate form. (Refer to figures 6-4 through 6-7.) A file, which will be reviewed by the superintendent of the Heavy Equipment Section, will be maintained in the Crane and Rigging Shop. This file will be reviewed periodically by the Safety Department.

Table 6-7. Number and Spacing of Clips Required on Wire Rope

Diameter of Rope	Min. No. of Clips*	Space Between Clips (Inch)	Length of Wrench (Inch)	Diameter of Rope (Inch	Min. No. of Clips	Space Between Clips* (Inch)	Length of Wrench (Inch)
7/16 and smaller	2	3-3/4	8	1-3/8	6	9	16
1/2	3	3-3/4	12	1-1/2	6	10	16
9/16	3	3-3/4	12	1-5/8	6	10	16
5/8	3	3-3/4	12	1-3/4	6	11	20
3/4	4	4-1/2	12	2	7	12	20
7/8	4	5-1/4	16	2-1/4	7	12	20
1	4	6	16	2-1/2	8	12	24
1-1/8	5	7	16	2-3/4	9	12	24
1-1/4	5	8	16	3	9	12	24

*For heavy duty ropes or where there is a possibility of property damage or personal injury, the number of clips should be increased by one or preferably two.

Wire Rope Service Record

Location _____ Job No. _____

Machine Data

Make _____ Number _____

Shovel Drag Line ( ) Crane ( )

Truck Hoe ( ) Other ( ) _____ (specify)

Shovel Hoist	Shovel Crowd	Drag	Drag Hoist	Boom Hoist	Clam Holding	Clam Closing

Wire Rope Data

Rope Users Order No. _____ Date _____

Make _____ Reel No. _____

Length	Construction		
Diameter	Long Lay ( )	Regular Lay ( )	
Grade	Fiber Core ( )	Independent wire Rope Core ( )	Wire Strand Core ( )

Wire Rope Service

Date		
Installed		
Cut or turned	Cut or turned	Cut or turned
Cut or turned	Cut or turned	Cut or turned
Removed		

REMARKS:

Figure 6-4. Service Record

Daily Record of
Hoisting Equipment Use

For Month of _____ Year _____

Days	Number of Hours				Days	Number of Hours			
	Shift					Shift			
	1st	2nd	3rd	Total Hours		1st	2nd	3rd	Total Hours

Total Hours: _____

Figure 6-5. Daily Record

Report of Hoist Chain, Running Rope, and Accessories on Cranes and Hoists

Week _____
Location _____

Crane No. or Hoist Type	Condition of Sheaves Drums Pulleys	Main Hoist				Auxiliary Hoist				Remarks on Condition of Wire Rope or Chain & Hooks, and Fittings	Date of Inspection	Name of Inspector
		Diameter of Rope or Chain		Reach or Length		Diameter of Rope or Chain		Reach or Length				
		New	Now	New	Now	New	Now	New	Now			

Figure 6-6. Crane and Hoist Equipment Report

Sling Inspection Report

week _____
location _____

Sling Serial No.	Wire Rope Or Chain	Type	Diameter Of Rope Or Chain		Reach Or Length	Remarks On Condition Of Wire Rope Or Chain, Hooks, Rings, Sleeves, Fittings	Date Of Inspection	Name of Inspector
			New	Now				

Figure 6-7. Inspection Report

6.6 TESTING

6.6.1 GENERAL. Upon approval of this document, tests of all present lifting and hoisting equipment and all present rigging gear will be instituted. Any new equipment or gear obtained or any that has been repaired or modified after this document is in effect must pass the prescribed tests before being released for use All equipment and gear will be tested periodically while in use.

6.6.2 STATIC TESTS.

6.6.2.1 Cranes, Hoisting Equipment, and Machinery. Tests at not less than 150 percent of rated capacity shall be conducted every 6 months (at the maximum boom radius to be used for a specific operation). The test shall consist of lifting the test load carefully and in all positions to demonstrate the total stability and capacity of the entire gear or equipment under test (equipment having outriggers will be so tested).

6.6.2.2 Elevator Cables. Elevator cables should be resocketed before each test. The test parameters vary with the speed and usage of the elevator system served. The tests will be made in accordance with the American Safety Code for Elevators A 17.1 and A 17.2 - 1960.

6.6.2.3 Rigging Gear. All slings, hooks, eye bolts, wire ropes, and other rigging gear shall be statically tested at 200 percent of their rated lifting capacity. Each item must pass the test before being released for service; then it must be tested annually thereafter.

6.6.3 OPERATING TESTS. Equipment or gear having successfully passed the static test shall be given an operating test before being placed in service, then shall be given an operating test every 6 months thereafter. The tests shall be conducted at 125 percent of the rated load capacity of the equipment (at the maximum boom radius to be used for a specific operation or rated load). The tests shall consist of lifting, lowering, swinging (moving), and braking the test load at operational speeds, plus all other positions and operations normally performed. If all these operations are conducted without strain or damage, the cranes, hoisting equipment, or machinery may be released for use.

6.6.4 TEST REPORTS. Pertinent data and records of all tests mentioned above shall be made a part of the official file of the equipment. Records of tests shall be entered on a Test Report . (Refer to figure 6-8.)

6.6.5 TEST LOADS. For conducted tests to be valid, the weight of the test loads must be known to within 2 percent. Known weights will be

Test Report
of
Equipment, Wire Rope, or Slings

Using Agency_____ Date_____

Name of Equipment, Rated Capacity, and Any Other Pertinent Information.

_____

_____

_____

Test Procedure

_____

_____

_____

Tested (pounds) (tons)_____

_____

Foreman Rigger Operator

_____

_____

Reason for Test:
( ) Routine W.M.Q.SA.A.

( ) On Request ( ) After repairs or maintenance

( ) New ( ) After alterations or modifications

_____

Remarks:

Figure 6-8. Test Report

recorded or stencilled on each test load. Test loads may consist of concrete blocks, masses of concrete, old machinery, etc.

6.6.6 TEST INSTRUMENTS. The weight of the test load shall be verified by using a crane scale or dynamometer of such capacity that the weight is indicated in the upper half of the measuring scale or range (figure 6-2).

6.6.7 TAGGING EQUIPMENT. When a test or inspection has shown that a piece of equipment or rigging gear is damaged or unsafe, the Crane and Rigging Shop inspector in charge of the inspection or test shall attach a "Danger, Do Not Use" tag to the item. The tag will be removed by the inspector only when the item has been made serviceable or has been scrapped. No other person may remove the safety tag or operate such equipment or gear.

SECTION VII
WATERWAYS SOUNDING AND DREDGING

7.1 PURPOSE

To establish the responsibility for conducting periodic surveys of the Saturn V channel (from the barge canal to area 41 and the dock at the VAB) and the procedure for determining the depth of the water and the condition of the channel.

7.2 GENERAL

7.2.1 RESPONSIBILITIES.

7.2.1.1 Base Operations Division. The Base Operations Division is responsible for requesting a survey of the Saturn channel and turning basin at least 2 weeks prior to the movement of the Saturn barge, when deemed necessary to ensure adequate depth of the water.

7.2.1.2 Base Support Services Contractor. The Base Support Services Contractor is responsible for conducting a reconnaissance survey at least every 6 months or when requested by the Base Operations Division. The contractor is responsible for determining the need for detailed surveys based on data collected during reconnaissance surveys.

7.2.1.3 District Engineer. The District Engineer will perform detailed surveys of the Saturn channel, when requested by the NASA Facilities Division in accordance with TM5-235, Special Surveys.

7.2.2 PROJECT DEPTH AND WIDTH. The project depth for the Saturn channel and turning basin has been established at 10 feet, the width at 125 feet at the bottom, and the side slope at 1 foot vertical to 3 feet horizontal.

7.2.3 CHANNEL MARKERS. The channel has been marked with beacons (BN) at each directional change of the range line. Intermediate markers known as daymarkers (DM) have been installed alternately on the 0+00 range and the 1+25 range (i.e., at the edge of the cut) at approximately 5,000-foot intervals.

7.2.4 SILTATION RATE. The siltation rate is that rate at which the project depth is reduced by shoaling or movement of the bottom. This rate varies, depending on currents, wave action, etc. The siltation rate must be closely observed in order to program detailed surveys and maintenance dredging.

7.3 PROCEDURES

7.3.1 RECONNAISSANCE SURVEYS. Reconnaissance surveys of the condition of the Saturn channel and turning basin are made hastily. The purpose of the

survey is to detect shoaling areas, bar formation, and the siltation rate. These surveys are conducted to ensure that no navigational delay will occur.

7.3.1.1 Method of Conducting Survey. The preferable method of conducting survey (using the center of the channel) is to utilize a small boat with a recording depth finder installed. The location of beacons and daymarkers will be indicated on the tape. Shoal areas (if any) detected will be plotted on a map or chart indicating the location in reference to beacons or daymarkers. The accuracy of the depth finder should be checked periodically; it should be checked prior to starting and during and after survey. The accuracy of the recorder is accomplished by sounding the bottom of the channel and checking the recorded depth against the sounded depth at any location. A record of the survey will be made to include the date and time the survey started and ended.

7.3.1.2 Recording Data. Completed tapes will be made a part of the permanent records of each survey. The data collected during each survey will be plotted on the Saturn channel charts maintained by Roads and Grounds. Information obtained will be used when recommending detailed surveys or programming maintenance dredging.

7.3.2 DETAILED SURVEYS

7.3.2.1 Action Required. The Base Support Services Contractor will advise NASA Roads and Grounds section, Base Operations Division when the shoaling or siltation rate has indicated the need for detailed survey of the Saturn channel. When the project depth has been reduced to less than 9 feet in 50 percent of any range (cut section), a detailed survey will be recommended. If the reconnaissance survey detects a bar formation reducing the depth of the water to less than 8 feet, a detailed survey of the bar will be made.

7.3.2.2 Gathering Information. Information is obtained in a systematic and regular manner on definite ranges. The range will be established at the edge of the cut at 20- to 25-foot intervals. Soundings will be taken on these range lines at approximately 10-foot intervals to provide elevation points from which contour maps may be made. Soundings will be taken with a recording depth finder, supplemented from time to time with a graduated sounding rod. The recording depth finder will be checked periodically as required in paragraph 7.3.1.1. Detailed surveys of this type will normally be accomplished by the District Engineer, Corps of Engineers, when requested by the NASA Facilities Division.

7.3.2.3 Compiling Detailed Survey Data. The information obtained by the detailed survey will be plotted on the Saturn channel charts by the District Engineer. Sufficient copies of the charts with bottom elevations, ranges, beacons, daymarkers, etc. shown will be furnished the NASA Facilities Division, without delay. The information obtained will be utilized to determine the need for and programming of maintenance dredging or spot bar or shoal removal, whichever is indicated.

7.3.3 DREDGING

7.3.3.1 Preparation of Recommendation. The Base Support Services Contractor will prepare a recommendation for dredging the Saturn channel and turn basin after considering all data available. The recommendation, containing a brief description of the condition of the channel, approximate reduction in depth, location and extent of shoaling, an estimate of the quantity of material to be removed, and an estimate of the cost to accomplish the work, will be forwarded to the Roads and Grounds section, Base Operations Division, NASA. The recommendation will contain a suggested date the work should start.

7.3.3.2 Contract Document. The District Engineer, Corps of Engineers will prepare the contract document, including estimates of the quantity of material and type of material to be removed. Estimates will allow for 1-foot overdepth in dredging (dredging cannot be accomplished to the nearest foot).

7.3.3.3 Survey After Dredging. The District Engineer will conduct a survey after the dredging has been completed, for the purpose of determining the amount of money to be paid the contractor for the work accomplished, and to ensure that shoal areas and bars have been removed in compliance with the contract.

VOLUME 3

SECTION VIII

DRAINAGE AND EROSION CONTROL

NOTE

Information for this section was not available for publication at this time. When this section is available, copies will be forwarded to recipients of this manual.

SECTION IX
LANDSCAPE MAINTENANCE AND HORTICULTURAL PLAN

9.1 PURPOSE

This section delineates the responsibilities of the Horticulturist in preparing and implementing an overall plan for land maintenance, landscaping, and grounds keeping at the KSC.

9.2 GENERAL

The responsibilities of the Horticulturist at the KSC include the planning and execution of an approved program for the development and management of soil, water, and vegetation. This program ensures the best use of vegetation to control dust and erosion, to promote safe and efficient land maintenance, and to produce a neat and pleasing landscape appearance along roadways and areas adjacent to buildings and other facilities. This program is accomplished by the Base Support Services Contractor, Roads and Grounds Section.

9.3 RESPONSIBILITIES

The Horticulturist provides the planning and direction necessary to successfully carry out the Horticultural Program. The Horticulturist has the following responsibilities:

1. Planning and Programming
2. Maintenance of Records and Charts
3. Training and Safety
4. Land Clearing
5. Landscaping
6. Landscape Maintenance
7. Indoor Planting Program
8. Inspection

9.4 PLANNING AND PROGRAMMING

The Horticulturist formulates plans for implementing the overall program in coordination with other units of the Roads and Grounds Section. The program includes the following functions:

1. Planning - The Horticulturist draws plans for developing and landscaping new areas and facilities accepted for maintenance.

2. Scheduling - The Horticulturist schedules manpower and equipment for even distribution to meet seasonal and operational demands.

3. Provisioning - The Horticulturist prepares an advanced plan for requisitioning supplies and equipment to make it possible to carry out the program according to the approved schedule.

4. Coordination - The Horticulturist coordinates with other units of the Roads and Grounds Section for the cross-utilization of men and equipment to ensure efficient execution of the program.

9.5 MAINTAINING RECORDS

The Horticulturist keeps written records that indicate work progress, work efficiency, and work costs. Evaluation of these written records facilitates provisioning, equipping, and budgeting.

9.5.1 RECORDS. The records maintained by the Horticulturist include the following:

1. Inventories of tools, plants, supplies, and equipment.

2. Maps of soil sampling and grass types, road systems, canals, land clearing, and mowing.

3. Records of liming, fertilizing, seeding, pruning, spraying, temperature, and rainfall.

4. Reports on meetings, inspections, tests, demonstrations, samplings, and work status.

9.5.2 SUPPLEMENTAL DOCUMENTS. The Horticulturist prepares the following:

1. Supplies-Used Report
2. Inventory Recap
3. Soil-Sampling Map
4. Record of Seeding and Fertilizing

9.6 TRAINING AND SAFETY

The Horticulturist supplies written procedures and instructions to crew foremen for personnel training. Frequent instructions to personnel on the approved job procedures and safety methods will increase work efficiency and reduce lost man hours. The following

subjects are to be discussed regularly at crew meetings:

1. Safety in Use of Tools and Equipment
2. Safe Handling, Storage, Mixing, and Use of Chemicals
3. Basic Principles of First Aid and Antidotes
4. Reporting Accidents, Injuries, and Fire
5. How to Prune, Shear, and Root-Prune Plants
6. How to Dig, Burlap, Lift,and Move Plants
7. How to Plant, Water, and Mulch Plants

Other general considerations to be discussed include:

1. Lessening the threat of property damage by pruning or removal of potentially dangerous trees in advance of high winds.

2. Reducing the chance of fire damage to KSC property and facilities by establishing a ground cover of grass in lieu of weeds in fire lanes.

3. Removing of undergrowth and flammable trees or shrubs in areas adjacent to burning pits.

9.7 LAND CLEARING

The Horticulturist cooperates with the Land Maintenance Section in the clearing and improvement of land areas.

9.7.1 RESPONSIBILITIES. The horticultural responsibilities in land clearing include:

1. Tagging native trees and shrubs which have landscape value.

2. Relocation of those plants selected for planting elsewhere, either on the site for landscaping or to the storage-and-care area for future use in landscaping or planting maintenance.

9.8 LANDSCAPE PLANTING

The Horticulturist will program the functional use of vegetation on KSC to stabilize soil, control dust, and conserve water resources and to add to a neat and pleasing landscape. Hedges and trees serve as screens or baffles to shut out views, noise, wind, sun, and headlight glare and to indicate direction of traffic flow.

9.8.1 PREPARATION OF THE AREA FOR PLANTING. The Roads and Grounds Section will prepare areas for planting. This involves the following:

1. Locating existing and proposed overhead and underground utilities.

2. Making soil analysis studies.

3. Analyzing samples of water to be used for plant watering.

4. Applying lime or other soil amendments needed to balance the soil to meet the needs of the vegetation.

9.8.2 PLANT SELECTION. The Roads and Grounds Section will use plants procured from native vegetation, abandoned homesites, and propagation to meet the objectives of the landscaping plans and practical maintenance.

9.8.3 PREPARATION FOR TRANSPORTING. The Horticulturist oversees the advanced preparation required to successfully transport the plants selected from native areas. This includes root-pruning, tying, fertilizing and burlapping. The Horticulturist also coordinates equipment requirements with the Heavy Equipment Division.

9.9 LANDSCAPE MAINTENANCE

The Horticulturist initiates sound maintenance procedures to guarantee the maximum benefit from turfgrass and plantings. Operations important to the landscape effort are discussed in the following paragraphs.

9.9.1 SEEDING. The Roads and Grounds Section will use seeding for soil stabilization along roads, facilities, buildings, and certain open areas. Seeding will be used to get a grass cover over most of the KSC turf area except for limited areas presenting serious erosion problems. The Horticulturist will recommend the proper seed mixture for a given area.

9.9.2 SODDING. The Roads and Grounds Section will use sodding on steep slopes and water courses to quickly provide erosion control. The methods of sodding (strip, block, or solid) will vary according to the grade and extent of the area involved. Greatest need will arise for Bahia grass and Bermuda grass sod in turf maintenance. Accordingly, a limited amount of this sod will be grown for safeguarding steep slopes and for repairing washouts.

9.9.3 MULCHING. Mulching is the covering of the soil with a layer of material that will aid in the establishment of grass and in the maintenance of plants.

Two major objectives in the maintenance operation can be accomplished through the use of mulch:

1. A straw mulch cut into the road, shoulder, and ditch embankments will provide moisture conditions favorable for seed development.

2. A layer of mulch material left undisturbed under landscape plantings will conserve moisture, prevent erosion, restrict weed development, and eliminate mowing.

9.9.4 WATERING. Watering of turfgrass and plantings in the high level maintenance locations will be accomplished by underground sprinkler systems, above ground hoses and sprinklers, and by tanker trucks. The Horticulturist will schedule watering to supplement naturally available water.

9.9.5 FERTILIZING. The Horticulturist will establish a program for fertilizing the vegetation at the KSC. Fertilizing is vital to the care of most vegetation, particularly on sandy soil such as that at the KSC. Fertilizer is rapidly leached from this type of soil by rain and high temperatures. The Horticulturist selects the analysis and the rate of application to fit the plant or grass requirements, soil deficiencies, and desired level of maintenance. The type of fertilizer and timing of application depend upon the desired level of maintenance and seasonal considerations (see attachment A).

9.9.6 WEED CONTROL. Weed control is a major concern in the maintenance program. The reduction of weeds at the KSC will:

1. Reduce the harborage of rats and other vermin.
2. Lessen hazards from brush fires around facilities and buildings.
3. Improve the flow of water in ditches and canals.
4. Contribute to the elimination of mosquito breeding areas.
5. Permit the omission of the first annual mowing in some areas.
6. Improve the appearance of the landscape.

Weed control activities will be scheduled by the Horticulturist. Two basic methods are used for weed control -- mechanical and chemical. Mechanical control includes hand-pulling and mowing. Hand-pulling is limited largely to flower beds, shrubbery borders, foundation plantings, and areas under trees. Mowing is used to curb weed growth in turf areas and to prevent reseeding of the weeds.

Chemical control is used on a selective or nonselective basis to reduce or eliminate weeds from a turf area. Selective chemical control is used to eliminate weeds from a turf area without harming the grass. Preemergence weed killers are used to prevent weed seeds from germinating and postemergence weed killers are used to kill weed seedlings before maturity.

Nonselective chemical control is used to eliminate all vegetation in an area such as a strip around a building, along a fence, around utilities, and in ditches. Nonselective chemical controls are also used in areas where mowing is impractical.

9.9.7 ORNAMENTAL SPRAYING. The Roads and Grounds Section will carry out a program of spraying on shrubs, trees, and grass to control the ravages of insects, diseases,and minor element deficiencies.

Spraying is a very important operation in the horticultural program, since most landscape plants and grasses are subject to several of the previously-mentioned maladies. Without effective and well timed control spraying, these plants may deteriorate or die. Frequent inspections are needed to detect the early symptoms of trouble from these plant pests. Preventive maintenance spraying will be employed where feasible.

9.9.8 PRUNING. The Roads and Grounds Section will prune trees and shrubs to remove the excess or the undesirable plant parts and to control the extent and direction of growth. Trees and shrubs require pruning or shearing to keep them in bounds along walks, buildings, parking lots, and roadways. Plants are pruned to form screens, noise and wind barriers, light shields, and traffic separators. Advance pruning of the root system and the top will be necessary when transplanting trees and large shrubs from native areas.

9.9.9 PLANT STORAGE AND CARE. During the clearing of natural growth land and the clean up of abandoned homesites, usable vegetation and commercial plants are salvaged for use in the grounds improvement program. Vegetative materials are transferred directly to sites for landscaping or to the plant storage area. This area will also serve as a place to propagate, grow, and care for potted plants for indoor decorations. Annual and perennial flowers can also be grown there until ready to put out in the landscape or in the buildings.

9.10 INDOOR PLANTING PROGRAM

The Horticulturist supplies and maintains plants and cut flowers for indoor use. Plants grown in tubs, pots, and planters are used to decorate the lobbies of KSC buildings and offices as designated by NASA. Cut flowers, in season, are provided for decorative purposes. The Horticulturist supplies container-grown plants and cut flowers and prepares floral displays for special events at KSC facilities.

9.10.1 RESPONSIBILITIES. The Horticulturist performs the following functions in the Indoor Planting Program:

1. Visits new locations to determine planting requirements.

2. Selects plants and planters from stock on hand or arranges procurement of appropriate material.

3. Supervises the placement and regular care of indoor plants and materials.

4. Maintains a list of locations in which decorations are in use.

5. Keeps a record of plant care and man hours expended in servicing plantings.

6. Maintains an inventory of plants and containers.

The Horticulturist maintains a nursery in the storage and care area to supply annual flowers for cutting and plants for indoor planting. Cut flowers are also obtained from the foundation plantings around KSC buildings.

9.10.2 RECORDS. The following records are maintained for the Indoor Planting Program:

1. Location of indoor plantings.
2. Seasonal flower schedule.
3. Record of special events
4. Indoor plant inventory
5. Inventory of materials for Indoor Planting Program
6. Indoor plant care log

9.11 INSPECTION

The Horticulturist periodically inspects the grounds, vegetation, and indoor plantings. He will prepare a Road and Grounds Landscape P.M. Inspection Report (KSC Form 26-168NS) for each area inspected. This form indicates the condition of the area or vegetation and the required action. The Horticulturist may initiate the corrective action with a Short Form Work Order (KSC Form 26-94A).

ATTACHMENT A

RECOMMENDED KSC FERTILIZER PROGRAM FOR FISCAL YEAR 1967

I. GENERAL

A program for the fertilization of the road shoulders and landscaping of the KSC is indispensable to the best use of manpower, equipment, and materials available.

II. POLICY

Horticultural policy requires that a practical fertilizer program be carried out as efficiently as possible to provide the desired levels of maintenance of different areas according to the demands for soil stabilization and landscape appearance.

III. CONSIDERATIONS

To determine the best formulations, rates, and scheduling of fertilizer applications, the following factors have been considered:

A. Soil Characteristics - Tests indicate that the following conditions exist over most of the areas under landscape maintenance.

1. Soil Acidity. The results of soil sampling show that the areas concerned are not acid. They are 1 to 2 points higher than is favorable for quickest establishment of the end product - Bahia grass.

Use of acid forming fertilizer wherever possible is recommended.

2. Nitrogen. This most critical plant food is almost totally lacking, especially on the road shoulders.

Application of approximately 170 pounds of nitrogen per acre per year is recommended for the landscape planting and existing grass mixture, predominantly Bermuda grass.

Extra nitrogen is to be added in late fall or early winter in the form of ammonium sulfate on high level maintenance areas as needed.

3. Phosphorus. This primary plant food is in adequate supply. Application of 170 pounds per acre per year will be sufficient.

4. Potassium. This element is present in barely adequate amounts. At least 170 pounds per acre per year will be required. Best results will be obtained if the amount of potassium supplied is kept equal to nitrogen supplied.

5. Magnesium. This element is present in more than adequate amounts. The addition of magnesium is not recommended.

6. Calcium. Calcium is excessive in most areas sampled (road shoulders and ditch front slopes). Liming is not recommended except in isolated areas of low soil pH.

7. Iron. Scarcely a trace of iron is available as it is insoluble due to excessively high soil pH (alkalinity).

While iron may be present but unavailable or may be lacking, it is not practical to supply this element through the fertilizer program.

Spot treatment in the form of spray will be applied to shrubs or areas of grass in serious need of iron.

8. Organic matter. There is scarely a trace of organic matter. It is insufficient to support any appreciable amount of nitrifying bacteria.

This deficiency can be partially remedied in a practical way by supplying 25 percent of the nitrogen from natural and synthetic organic sources.

B. Slope - Much of the turf area is graded to a 4′ to 1′ slope requiring special care to curb erosion and establish a cover in the shortest time possible. Increased frequency of fertilization will accelerate turf coverage. Extra care is thereby justified.

C. Weather Factors - The time and extent of response to applications of fertilizer will be affected by the time, rates, and amounts of rainfall over the area. Applications will be scheduled to coincide with rainy periods whenever and wherever possible.

Temperatures and wind also exert influences that have been taken into consideration in scheduling applications and in selecting formulations.

1. Moist-to-wet season - May through October. Fertilizer applied during this period is more fully utilized while the soil is moist and bacterial action highest.

2. Dry, cold, and windy periods. Dry, cold, and windy periods, while not best suited to applying dry fertilizers, must be utilized to some extent in order to fit in the fertilizing program with other work, so that available manpower and equipment can be utilized.

3. Hurricane preparations. Applications are not scheduled during the period of high winds, heavy rains, or hurricane preparations and watch.

D. Manpower - Present plans for manpower provide sufficient labor to handle the spreading of all the fertilizer during the three peak periods - February, June, and October.

E. Equipment - The fertilizer spreading equipment on hand is adequate to discharge the volume of fertilizer anticipated during the peak periods.

The rotary truck-mounted equipment, the rotary tractor-mounted equipment, and the gravity flow tractor-drawn equipment are capable of spreading the peak load of 171 tons per month (43 tons per week or 8 tons per day).

F. Turf and Landscape Requirements - To achieve maximum efficiency from fertilizing, the following formulations are selected to most nearly meet the plant demands.

1. The landscape plants and trees require only limited amounts of special fertilizer. Landscape plants and trees respond adequately to a standard formula, such as 8-8-8-25 percent organic nitrogen.

2. The turf is intended to be largely Bahia grass. Bahia grass, while not the heaviest nitrogen feeder, does require a balanced mix affording a steady, prolonged feeding during early development. For establishing recently-seeded areas, this mix should be acid-forming. For prolonged feeding, the nitrogen should be derived from both natural and synthetic organic sources and should contain as much available iron, if practical.

Once established, Bahia grass will thrive sufficiently well on a fertilizer containing less organic nitrogen and a higher soil pH (alkalinity) than during the first year after seeding.

3. Certain plants and trees (azalea, hibiscus, ardisia, citrus, dogwood, holly, and others) will require a specialized formulation such as 4-6-8, 0-10-10 or 0-14-14, due to special demands on nitrogen and soil pH.

IV. RECOMMENDED FORMULA

The following mixtures are recommended for the foregoing reasons and at the suggested rates according to the levels of maintenance desired.

A. Third Level of Maintenance - 50 tons 8-8-8-25-percent organic nitrogen 500 pounds per acre twice yearly over 100 acres, including Roberts Road, Swartz Road, Static Test Road, Tel 4 Road, C.I.F. Road, 200-foot tower Road, etc.

B. Second Level of Maintenance - 513 tons 8-8-8-25-percent organic nitrogen 500 pounds per acre three times yearly, over 700 acres, including NASA Parkway, Kennedy Parkway, VAB Area, LC-39, Crawlerway, etc.

C. First Level of Maintenance

1. 107 tons 8-8-8-25-percent organic nitrogen 600 pounds per acre three times yearly over 100 acres, including KSC Headquarters lawn, other industrial area lawns, industrail area road shoulders, landscaping, nursery and sod farm, Boresite and NASA Interchange.

2. 1 ton camellia-azalea (4-9-7), 800 pounds per acre three times yearly for those plants and trees in the landscape planting requiring a more acid fertilizer.

3. 1/2 ton 0-14-14 or other special mix for those landscape plants requiring extra feeding and hardening in the fall without growth stimulation from nitrogen.

V. RECOMMENDED FERTILIZER COMPOSITION

Natural organic source of nitrogen (sewage sludge) is preferred, since it provides much needed iron and trace elements, while providing approximately four times the acidifying action of synthetic organics. Bahia grass needs iron and acid soil conditions for healthy and vigorous growth.

Natural organic nitrogen sources improve the soil structure and increase nitrifying bacterial activity, which converts organic nitrogen to available forms for use by plants.

Natural organics in the mix reduce the hygroscopic reaction during storage that causes all-chemical fertilizer in bags to become moist and difficult to handle. The extended feeding period of the drier, better flowing mixture containing natural organics offsets the advantage of quick feeding and adaptability to rotary application (even during windy weather) of the pelletized mixture available with all chemical and synthetic organics.

Natural organic content provides better chances of getting longer-lasting, even feeding.

1. Most of the fertilizer for Fiscal Year 67 (624 tons of 8-8-8-25-percent organic nitrogen) should be derived from the following:

Sulfate of ammonia
Ammoniated superphosphate
Activated sewage sludge
Urea (minimal amount)
Muriate of Potash

2. The camellia-azalea formula 4-9-7-2 MgO should be derived from all of the following:

Sulfate of ammonia
Ammoniated superphosphate
Cottonseed meal
Tankage
Muriate of Potash
Sulfate of Potash-Magnesia

3. Ammonium sulfate (15 tons) is to be used separately on choice turf grass as early winter supplement if needed.

VOLUME 3

SECTION X

PEST CONTROL

SECTION X
PEST CONTROL

10.1 PURPOSE

This section sets forth procedures and establishes responsibilities for the effective control of insects, rodents, snakes, and other pests detrimental to man and property at KSC.

10.2 GENERAL

Pest control includes the control of mosquitoes, termites, wood borers, roaches, flies, pests detrimental to lawns and ornamentals (including pests such as weeds and undesirable plants) rodents, snakes, and undesirable animals. Pest control is essential in combating disease, preventing property loss, maintaining efficiency, and keeping morale high. The control of insects, rodents, etc is now more effective than ever, due to improved techniques, chemicals, and knowledge of the life history and habits of pests. Pest control is accomplished in two ways, by preventive measures and by corrective measures. Preventive measures eliminate the conditions necessary for pest infestations; corrective measures cope with existing infestations.

10.3 RESPONSIBILITIES

10.3.1 GENERAL. The Roads and Grounds Division of the Base Support Services Contractor (BSSC) is responsible for the control of all pests (insects, plants, and animals) detrimental to man and property. This Division will provide the manpower and materials to operate a successful pest control program. An entomologist will be assigned the responsibility of administering this program.

10.3.2 ENTOMOLOGIST RESPONSIBILITIES. The Entomologist will be responsible for all phases of the pest control program. Specific duties include the following:

1. Establishing and directing the operation of an overall pest control program. Planning and programming the operation to effect the most economical utilization of personnel, equipment, and materials.

2. Prescribing and adapting appropriate formulations of insecticides or rodenticides, types of treatment, and methods of application.

3. Determining supply requirements for insecticides and other pest control materials and procuring adequate quantities of these materials for the operational program.

4. Instructing personnel in the safe and proper handling and application of insecticides, rodenticides, and other chemicals; also instructing them in the proper procedures in cleaning and maintaining the equipment used.

5. Maintaining all maps and records necessary to ensure an effective program.

6. Supervising hourly employees in the application of the program.

7. Coordinating pest control activities in the KSC area with other civilian and governmental agencies.

10.4 EQUIPMENT

Because it is desirable and necessary to utilize insecticides in a variety of ways, various types of dispensing equipment must be used. The Entomologist shall determine the specific equipment required for each operation; he shall also utilize the services of the Heavy Equipment Section where applicable. Equipment used for insect and rodent control includes the following:

1. Gas-operated thermal foggers
2. Power sprayers
3. Power dusters
4. Power misters
5. Compressed-air sprayers
6. Hand-operated dusters

10.5 TRAINING

10.5.1 GENERAL. So that insect and rodent control measures may be effectively applied, personnel engaged in the work must be competent and thoroughly trained. The necessary changes in techniques and the development of new insecticides, rodenticides, and equipment necessitates adequate and continued training of personnel. To assist in maximum efficiency of all operations, records of the employees so trained will be kept in the personnel files.

10.5.2 ON-THE-JOB TRAINING. On-the-job training of personnel will include the following:

1. Equipment operation
2. Insect identification and habits
3. Characteristics of insecticides
4. Insecticide application
5. Safety precautions in mixing, handling, and applying insecticides.

10.6 PROCEDURES

10.6.1 MOSQUITO CONTROL.

10.6.1.1 General. Due to the location of KSC and the type of terrain, the control of mosquitoes will encompass both preventive and control measures. Preventive measures will continue on a regular basis in the form of improvements to drainage facilities and construction of additional drainage ditches, dikes, planned ponding areas, and other associated work. Corrective measures will be employed on areas affected by infestations (due to periods of heavy rain) on both a scheduled and an emergency basis. Complete daily records of inspections and operations will be kept to serve as a guide for future planning.

10.6.1.2 Permanent Control. Careful planning will be required by entomology and heavy equipment personnel to provide adequate preventive mosquito control. The preventive control program will require basic surveys and inspections to determine the advantages and disadvantages of any proposed construction of various drainage facilities. In addition to deciding the feasibility of various forms of construction, priorities should be established to relieve critical situations. Measures taken to eliminate breeding areas include the construction of ditches and dikes to facilitate improved drainage, and the use of ponds, incorporating the desirable effects of minnows on mosquito larvae. A periodic inspection of all buildings and installations by the Base Operations Division (BOD) Entomologist is a requirement that must be included in the preventive control program. This periodic inspection will be performed to spot local conditions conducive to infestation by mosquitoes and mosquito larvae, and to familiarize building and ground maintenance personnel with these conditions. When such conditions are discovered, the building and ground maintenance personnel will remove the conditions as directed by the Entomologist. Corrective and preventive measures to be performed include, but are not limited to, the following:

a. Eliminating all unnecessary open vessels positioned where they can trap and hold water.

b. Repairing plumbing or similar associated items necessary to prevent dampness or standing water.

c. Keeping roof gutters clean.

d. Filling any voids in trees with sand, mortar, or other similar material.

e. Keeping all grounds neat and sanitary.

f. Preventing unnecessary stock piling of tires, cans, etc in open areas.

10.6.1.3 Temporary Control. Prior to use, all chemicals used for temporary control of mosquito infestations shall be approved by the Department of Agriculture, State Board of Health, and State Board of Conservation, where applicable. Chemicals used shall be applied by means of dusters, power sprayers, misters, foggers, or other approved methods, as appropriate. Application methods, type chemicals used, and time and location of various treatments shall be coordinated with similar programs initiated by the local (Brevard County) Mosquito Control District, and the Fish and Wildlife Service of the Department of the Interior. Temporary control of mosquito breeding is accomplished by treating water surfaces with larvicides. Breeding areas include not only most types of surface water accumulations, but also water-holding containers such as tin cans, reservoirs, roof gutters, catch basins, and ornamental pools. Materials and chemicals used for larvae control include oils, emulsions, dusts, and granules. Adult mosquitoes are controlled by chemical mists, dusts, and fogs. These chemicals kill mosquitoes on contact but are noninjurious to man and animals when proper precautions are exercised. Space sprays used for indoor control are propelled either mechanically by hand-operated equipment or automatically by self-propellant aerosols. Most sprays have little or no residual effect, and must usually be reapplied when new mosquitoes enter the area.

10.6.1.4 Summary. Mosquito control is necessary for the prevention of disease and the reduction of a substantial nuisance. The urgency for specific mosquito control operations may be determined by study of trap records, larvae counts, and landing orbiting counts. Permanent control is effected by an adequate drainage program. Temporary control is accomplished by the application of insecticides to standing water, plants, and other surfaces. Insecticides may be formulated as solutions, emulsions, dusts, or suspensions. Complete daily records of inspections and operations will be kept to serve as a guide for future planning.

10.6.2 FLY CONTROL. To efficiently control flies, preventive and corrective procedures must be applied indoors and out-of-doors.

10.6.2.1 Indoors. Indoor control of flies consists primarily of adequate methods of sanitation: protection of foodstuffs, disposal of all wastes, use of bait and traps, and use of other approved methods of fly elimination. Foods should be kept properly covered at all times. Food wastes should not be kept in the same area as food storage. All food wastes should be kept outdoors in properly closed containers which are not placed directly on the ground. Periodic spraying, the use of baits, etc will be required. Wastes deposited in outdoor containers shall have disposal priority over all other forms of refuse. Containers used for waste storage shall have tight-fitting lids and shall be periodically inspected and cleaned. Waste storage areas shall be inspected when the containers are being inspected. Any discrepancies noted shall be immediately corrected by the personnel responsible for this function. Baits used indoors for fly control shall be applied daily, using the methods prescribed by the Entomologist.

Any new waste disposal areas or additions to present facilities shall first be approved by the Entomologist and the Refuse-Collection Sections in respect to sanitary requirements and the scheduling of refuse pickups.

10.6.2.2 Out-of-Doors. All outdoor control of flies shall be coordinated with methods used for mosquito control. When possible, chemicals used shall be of a type approved for efficient outdoor control of all flying insects. The equipment and materials used shall be approved and specified for the job, and the materials shall be applied, where applicable, in accordance with procedures outlined for mosquito control. Specific differences in operations shall be determined by the Entomologist, and shall be performed in the manner prescribed by him.

10.6.3 ROACH AND ANT CONTROL. The first consideration in the control of roaches and ants is the elimination of their source of food. This can best be accomplished by instructing personnel in correct methods of food storage and waste disposal. It is recommended that correct food storage and disposal instructions be made a part of an inspection and treatment program. Inspection should include notification to Maintenance of any condition(s) that should be repaired or remedied to prevent infestations. Conditions which would need attention include (but are not limited to) cracks in floors or pavement, crevices, stationary objects improperly mounted, loose boards or siding, holes, and doors improperly fitted (particularly doors to the outside). Chemicals used for roach and ant control are supplied in various forms. These include, but are not limited to, baits, dusts, space and residual sprays, etc. The chemicals are applied in accordance with directions of the Entomologist. The application must be thorough; therefore, special care must be exercised to prevent contamination of foods and eating untensils. Special emphasis is to be placed on spraying all corners, undersides, drains, and all other areas of limited access. Upon completion of the inspection and treatment of each facility, a Work Accomplishment Record (Figure 10-1) will be filled out and signed by the inspector. This form must also be signed by the customer, acknowledging completion of the work and the acceptance of any recommendations made. The form is then returned to the Roads and Grounds scheduler for filing. The scheduler will reschedule the operation in accordance with the frequency determined by survey and inspection. The frequency of the operation must not exceed 1 month.

10.6.4 TERMITE CONTROL. Termites, wood borers, and fungi are responsible for vast annual losses in Florida of lumber, wooden structures, and wood products. The subterranean termite nests in the soil, building earthen tunnels over concrete surfaces and other objects to reach its food source and create destruction. Termite swarms in early spring and fall are often first indications of termite infestation in structures. Included among the destructive wood borers are such insects as carpenter ants and various types of beetles (powder post, long-horned, and metallic). The material attacked varies from structures to implement handles and furniture. Control of these insects can best be effected through the combined efforts of all functions of the Roads and Grounds Division.

WORK ACCOMPLISHMENT RECORD	
DATE	W/O NO.
BUILDING NO.	
FACILITY	
INSECT OR PEST CONTROLLED	
CHEMICAL USED	
QUANTITY	
SANITARY CONDITION	
RECOMMENDATIONS:	
MANHOURS USED	
WORK ACCOMPLISHED BY	
CUSTOMER'S ACKNOWLEDGMENT	

Figure 10-1. Work Accomplishment Record

The Entomologist will perform an inspection of all buildings, storage areas, and other pertinent locations semiannually. This inspection is reported on the Termite and Wood Decay Inspection Report (Figure 10-2). Any recommendations for repair and improvements will be noted on the form. The various agencies, such as Engineering, Refuse Collection, Land and Building Maintenance, etc, can aid in the prevention of termite infestations by following the procedures recommended by the Entomologist. These procedures incorporate instructions for such items as proper disposal of wastes, storage of wooden items, and correct design of improved or added wooden structures. These agencies can aid the Entomologist by promptly notifying him of any conditions favorable to termite infestation that they have noticed during the course of their normal duties and inspections. The Entomologist shall be responsible for prescribing various chemical treatments, preventive and corrective, and shall notify the concerned section of any conditions found conducive to infestation by termites. He shall reinspect to determine if his recommendations have been complied with. If necessary, the inspection period shall be reduced to accommodate the requirements of any particular structure or location.

10.6.5 CONTROL OF INSECTS DETRIMENTAL TO LAWNS AND ORNAMENTS. The control of insects in outdoor areas can best be effected by the combined efforts of the Entomology and Horticulture Sections. Each of these Sections, after their individual inspections, shall furnish the other Section a report, noting the presence of any undesirable insects in areas they have inspected. After a careful study of the reports, methods of treatment shall be determined which will effectively control the insects but not damage the plants, shrubs, or other similar growths that may or may not have been subjected to previous treatment. The Entomologist shall inspect all areas of KSC at a frequency not to exceed 1 month. The inspection shall include all lawns, trees, shrubs, flowers, and other plant life. The Entomologist, in cooperation with the Horticulturist, shall prescribe the methods and types of applications. These applications must be effective against unwanted insects, but caution must be exercised to provide sufficient protection for plants in the area.

10.6.6 RODENT AND OTHER PEST ANIMAL CONTROL. The control of such pest animals as rats, moles, ground squirrels, and mice requires periodic inspections and various treatments. The importance of adequate methods to eliminate these pests can not be overemphasized; they are harmful to man as disease carriers and destructive to equipment and stored items. The first requirement for effective control is a thorough inspection. This inspection shall be conducted once a month, or more often if requested by the BOD Entomologist. The inspection shall include all storage areas, buildings, and all other locations susceptible to infestations and shall consist of determining if rodents, etc are present, identifying them, and prescribing measures to be taken. Visible signs of pests include: droppings, runways, tracks, burrows, nests, and gnawings. The methods of treatment will be determined by the Entomologist. Methods must be based on the degree of infestation, the location, type of pest, etc. Effective control of rats, the predominant pests, may be accomplished through application of the information presented in the following paragraphs.

TERMITE AND WOOD DECAY INSPECTION REPORT

1. DATE		
2. INSPECTOR	3. BLDG. NO.	4. FACILITY

5. CONDITIONS NOTED INVITING TERMITE INFESTATION:

- ☐ A. WOOD IN CONTACT WITH SOIL
- ☐ B. FORM BOARDS LEFT IN CONCRETE
- ☐ C. VINES AND SHRUBS AGAINST BUILDING
- ☐ D. WOOD SCRAP
- ☐ E. OTHER CONDITIONS NOTED

SPECIFY:

6. LOCATION OF INFESTATIONS:

- ☐ A. FOUNDATION TIMBERS
- ☐ B. SILLS
- ☐ C. DOOR FRAMES
- ☐ D. FLOOR

OTHER:

7. DETAILS OF DAMAGE: *(Superficial, Structural Weakening)*

8. RECOMMENDED REPAIRS AND TREATMENT:

- ☐ A. REMOVAL OF WOOD FROM SOIL CONTACT
- ☐ B. REMOVAL OF CONCRETE FORM BOARDS
- ☐ C. OTHER:

9. CHEMICAL CONTROL:

10. CONTROL COST:

LABOR:

MATERIAL:

11. RE-INSPECTION:

A. DATE	B. INSPECTOR	☐ EFFECTIVE ☐ NON-EFFECTIVE

RESULTS:

KSC FORM 36-170NS (6/69) AFSC - Patrick AFB, Fla.

Figure 10-2. Termite and Wood Decay Inspection Report

10.6.6.1 Elimination of Food and Shelter. It is extremely important that food be made unavailable to rats. This can be accomplished through the proper handling of food and prompt and proper disposal of garbage. Storage areas, both inside and outside, should be designed to permit adequate inspection and provide adequate protection. Only approved storage techniques should be used. Whenever practical, storage facilities should be rat-proofed, especially those used for storage of subsistence or medical items. Open refuse dumps should not be utilized. The best method of waste disposal is through the use of easily constructed sanitary fills.

10.6.6.2 Rat Poisoning. If a program is properly planned and supervised, poison baits are effective in the control of rats. Since rat poisons are poisonous to humans, all recommended safeguards must be observed. The baiting process includes test baiting, prebaiting, and poisoning.

10.6.6.2.1 Test Baiting. Before beginning a baiting program, all regular foodstuffs should be made inaccessible to rats; then, for one or two nights, samples of food should be placed in locations frequented by rats to determine which ones are most readily accepted. Test samples should be of three classes: cereals, protein and fat, and fruit and vegetables.

10.6.6.2.2 Prebaiting. After determining the baits most likely to be taken, prebaits are prepared. They should be of the same size and be placed in the same locations as the poisoned baits. Many small baits are better than a few large ones, and the total number should be adjusted so that a few remain uneaten to ensure that every rat is supplied. To protect baits from weather, bait boxes may be required.

10.6.6.2.3 Poisoned Baits. When rats are feeding to the maximum extent on the unpoisoned baits, poison should be introduced. The poison should be thoroughly mixed and placed in the identical amounts and locations as the unpoisoned baits. This procedure should be followed until all rats have been destroyed or the baits have become ineffective. If additional poisoning is required, it should be done in a similar manner. When additional or followup poisoning is to be employed, best results are usually obtained by using a different type bait.

10.6.6.3 Trapping. Pest elimination by trapping can be adapted to rats, moles, ground squirrels, and mice. The type of trap varies according to the pest encountered, but is usually handled in the same manner. Traps are usually placed in runs, burrows, holes, or other locations as necessary. Baits may or may not be used with the traps. The types, number, and placement of traps shall be as directed by the Entomologist.

10.6.6.4 Fumigation. Treatment by gases should be attempted only in open, outdoor areas or after the use of poisons and traps have proven unsuccessful. The methods employed vary, and shall be of the type prescribed by the Entomologist. Careful planning must be exercised to ensure compliance with all safety regulations.

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VOLUME 3

SECTION XI

REFUSE COLLECTION AND DISPOSAL

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VOLUME 3

SECTION XII

ROADS AND GROUNDS MAINTENANCE

SECTION XII
ROADS AND GROUNDS MAINTENANCE

12.1 PURPOSE

The procedures in this section provide the Base Support Services Contractor (BSSC) with a complete, accurate, and comprehensive system for maintaining approximately 112 miles of paved roads and 300,000 square yards of paved parking lots. This section covers all aspects of pavement maintenance and erosion control of shoulders and medians.

12.2 GENERAL

Most maintenance problems on paved roads are the result of inferior design, unsuitable construction materials, and moisture. Each of these in turn produces other maintenance problems.

Inferior road design features such as insufficient elevation of the road above the normal water table, substandard turnouts and aprons, inadequeate road width, and insufficient right-of-way contribute to the maintenance task.

Unsuitable construction materials, such as those in embankment fill and stabilizing materials, add to the maintenance problem

Moisture is the most severe element affecting road maintenance requirements. Rain is the most commonly encountered form of moisture. Rain causes washouts and softening of the roadway shoulders, penetrates into the base courses through minute (often ignored) cracks, undermines pavement edges and drainage facilities, and even prevents normal maintenance operations. An abundance of rain also raises the normal water table, which lead to additional maintenance problems.

Pavement failures most often are not noticed until the roadway has settled, or fracture of the wearing course is revealed by a crack in the surface of the road. These failures are usually caused by moisture which has penetrated into the area of the road bed which actively supports the traffic load. This moisture penetration can be caused by seepage through cracks, through expansion and construction joints on the roadway surface, or by capillary action under the surface and base courses. A plus value change in the water table can also cause moisture penetration of roadways.

When excessive moisture penetrates the base, subgrade, or immediate underlying strata of the road bed, such terms as liquid limit (LL) and Plastic Index (PI) used in the classification of soils become significant. While it is impractical to conduct these tests on soils already in place, major maintenance of particular sections of roadways should consider these aspects as a means of preventing repetitious maintenance problems.

Proper maintenance of roadways requires proper engineering, testing, and road building skills as well as suitable equipment, materials, and responsible personnel.

12.3 RESPONSIBILITIES

The Roads and Grounds Section of the BSSC for KSC is responsible for the efficient and effective maintenance of all roadways and parking lots. This responsibility includes the use of proper road maintenance techniques by all individuals assigned to this section.

12.4 STANDARDS OF MAINTENANCE

The standard for road maintenance is to maintain pavement in a strong and safe condition. In addition, all practical means of prevention are taken to forestall the damaging effects from constant use and weather. The following general maintenance principles apply to all types of pavement:

a. Repairs and extensions to existing pavements must conform closely to the original construction in strength, appearance, texture, and reaction to load. Uniformity of construction and materials simplifies maintenance.

b. Spot strengthening of pavements,when not matched to the strength of surrounding paved areas, is ineffective and uneconomical; such spot strengthening often creates differences in wear and impact which are harmful to the adjoining pavement.

c. Pavements subjected to continual overloads eventually require resurfacing or reconstruction. If possible, precautions should be taken to limit extremely heavy loads to less intensively used routes.

d. The source of trouble must first be determined before any necessary repairs are made. Caution should be taken to prevent the waste of any surface repairs on any defective base or subgrade.

12.5 CRITERIA OF EXISTING ROADWAY

The specification provided in this paragraph ensures efficient and correct methods of repair as prescribed by the American Association of State Highway Officials (AASHO) standards. Materials used for maintenance should be of the same types and gradations as the original construction materials and should conform to the standards set by the American Society for Testing Materials (ASTM).

Two lane paved roadways at KSC generally consist of the following characteristics:

1. Pavement width - 24 feet
2. Base thickness - 6 inches
3. Surface thickness - 2 inches
4. Stabilized subgrade (subbase) depth - 6 inches
5. Stabilized shoulder depth - 6 inches
6. Shoulder width - 10 feet
7. Front slope ratio - 4:1
8. Roadway ditch width - 10 feet, flat bottom
9. Back slope ratio - 4:1

A sketch depicting these characteristics is shown in Figure 12-1.

Existing 4 lane roads at KSC are similar in design. Their basic difference is found in the direction of pavement drainage and median strip requirements. Four lane roads presently constructed at KSC consist generally of the following characteristics:

1. Pavement width - 24 feet
2. Base thickness - 6 inches
3. Surface thickness - 3" total (1-1/2 each binder and surface course)
4. Stabilized subgrade (subbase) depth - 6 inches
5. Stabilized shoulder depth - 6 inches
6. Shoulder width

   low (outside) lane - 10 feet

   high (inside) lane - 8 feet

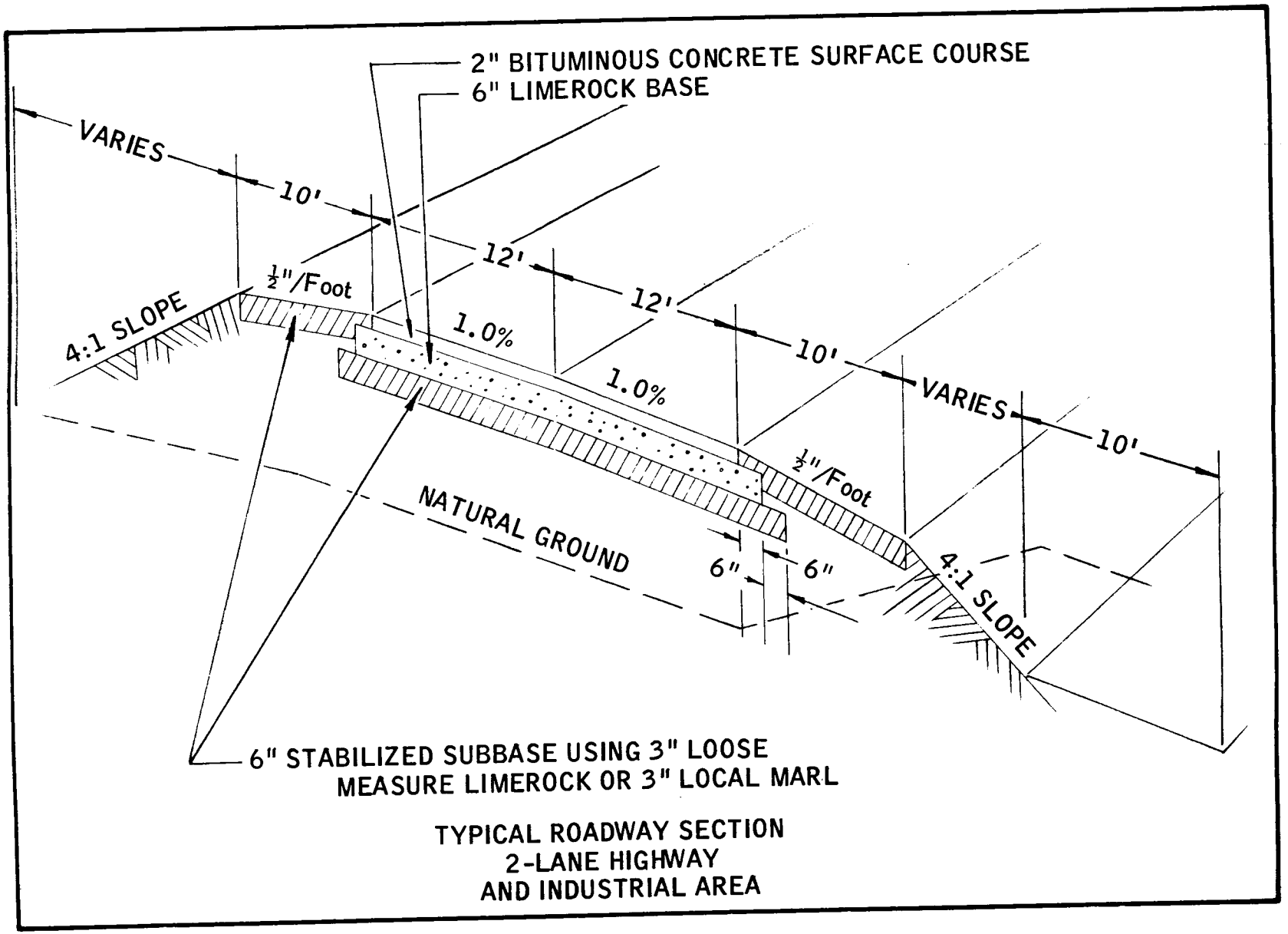


Figure 12-1. Section of Typical 2-Lane Highway

7. Front slope ratios

low (outside) lane - 4:1

high (inside) lane - max. 4:1

8. Roadway ditch width - low (outside) lane only - 10 feet

9. Median ditch width high (inside) lane only - 4 feet

10. Backslope ratios 4:1

A sketch depicting these characteristics is shown in Figure 12-2.

12.6 RELATED PUBLICATIONS

In addition to the information in this section, individuals concerned with roadway maintenance will find valuable assistance in the following publications:

1. TM5-624, Roads, Runways, and Miscellaneous Pavements (Repair and Utilities)

2. Bituminous Construction Handbook, Barber Green Company, Aurora, Illinois

3. Standard Specification for Road and Bridge Construction (1959 or 1965 edition), Florida State Road Department

12.7 PAVEMENT MAINTENANCE

12.7.1 PRINCIPLES OF PAVEMENT MAINTENANCE. The mainteance of all paved areas, whether roads or parking lots, shall generally be in accordance with the following outline:

12.7.1.1 Inspection. Periodic visual inspections of all roadways and other paved areas shall be carried out as set forth in the Preventive Maintenance Instruction Document. This document specifies the items to be checked and the required maximum intervals of inspection.

Inspection reports which will list any discrepencies from the desired standards are distributed to supervisory personnel for analysis, recommendation, and scheduling.

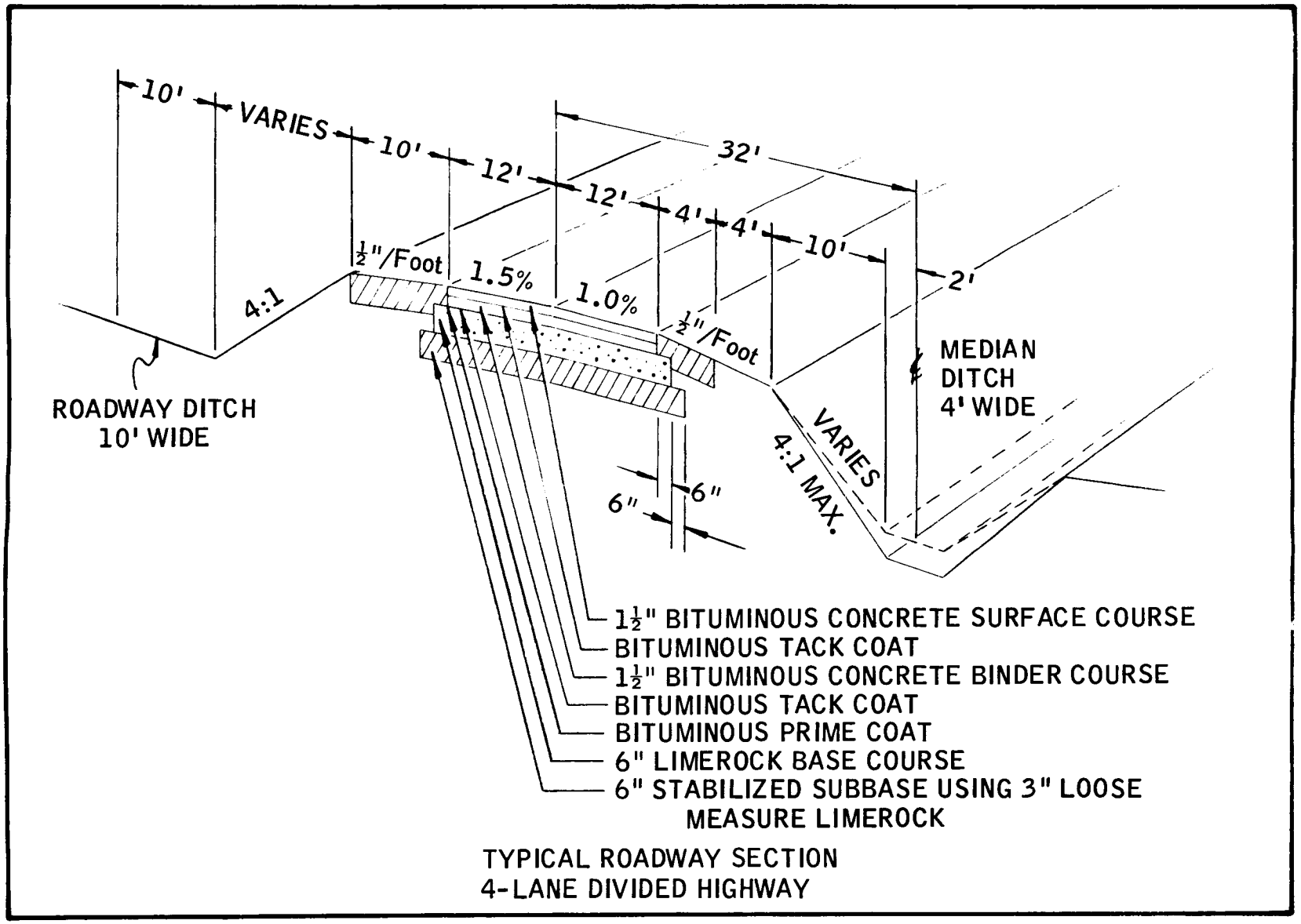


Figure 12-2. Section of Typical 4-Lane Highway

Foremen and/or other personnel assigned to the maintenance of these items and/or areas shall then proceed as outlined in the following paragraph.

12.7.1.2 Examination. After all phases of the inspection have been completed, the assigned personnel shall make a thorough examination of any deficiencies previously noted in order to determine the following:

1. The source of the problem

2. The most efficient means of correction

3. The material and equipment requirements

4. The number and type of personnel required to properly complete the work

5. The estimated time required

12.7.2 TYPES OF PAVEMENTS. There are two types of pavements at KSC, flexible and rigid.

12.7.2.1 Flexible Pavements. Flexible pavements are stabilized mixtures of soil and aggregates, or aggregates and mineral or bituminous binders. Flexible pavements are adaptable to stage construction, i.e., additional pavement courses can be added as required to accommodate heavier loads and more intensive traffic.

12.7.2.2 Rigid Pavements. Rigid pavements consist of Portland-cement concrete slabs with or without steel reinforcement. This type pavement can be resurfaced with bituminous courses when required, but the use of such courses does not materially increase the loading ability. The preferred method of resurfacing rigid pavements requires that the slab characteristics must first be destroyed through the use of crane-operated wrecking balls or air-operated pavement breakers. This method requires that the slabs be cracked on a maximum of 3-foot centers, which effectively destroys the slab characteristics and prevents the expansion and contraction process from affecting the new wearing course. The resurfacing courses usually consist of a leveling course equal to 200 pounds per square yard. Followed by a surface course equal to 100 pounds per square yard.

12.7.3 PRIORITY IN MAKING REPAIRS. If maintenance requirements necessitate the assignment of job priorities, it shall be the responsibility of the Chief of the Roads and Grounds Section or his appointed representative to perform his function.

Methods of determining priority shall include, but not be limited to the following:

1. Emergency - required for preservation of life and property

2. Urgent - required for particular operations involving anticipated launches or associated tests

3. Urgent - required to eliminate dangerous or hazardous conditions existing on heavily-traveled routes

4. Expedite - required to eliminate dangerous or hazardous conditions existing on lightly-traveled routes or in parking lots

5. Expedite - required to meet work order due dates

6. Routine - normal daily (recurring) tasks and scheduled assignments

7. Deferred - normal requests requiring additional engineering or information

12.8 REPAIR PROCEDURES

The following paragraphs provide recommended procedures for various phases of the repair process. Repairs may or may not incorporate the use of all the various phases covered. It shall be the responsibility of the foreman in charge to determine which phases, as provided herein, are applicable to each individual repair. The use of this repair information and the applicable publications listed herein form a package which, if properly utilized and executed, will enable the individuals concerned with the maintenance of roads to perform their tasks efficiently.

12.8.1 CLEANING OF AREAS. Before any repairs can be effectively performed, the area which is to be repaired, as well as the immediate surrounding area, must be thoroughly cleaned and dried. This is required to determine the extent of the affected area and to ensure proper adhesion of the materials used in making the repair.

Items incorporated in this phase include,but are not limited to,the use of hand tools, power brooms, blowers (including air compressors),various heaters, and detergents. Special care must be exercised in cleaning pavement edges when they are included in the affected area. Using both hand brooms and high pressure air offers very satisfactory results.

Sweeping of areas with hand brooms only must be done a minimum of two times. Additional sweeping may be required, especially if the area is damp.

Before patching materials are applied to the area, a thorough visual inspection shall be made to ensure that all cleaning procedures have been performed.

12.8.2 TACK COATS. Tack coats consist of an application of bituminous material on a previously-prepared base or existing pavement. This application binds together two or more courses of pavement materials.

12.8.2.1 Recommended Materials. The material recommended for the tack coat is Emulsified Asphalt, Grade RS-2.

12.8.2.2 Rate and Temperature of Application. Materials used for tack shall be applied at a rate of between 0.04 and 0.10 gallons per square yard. The temperature of the material shall be between 120^{0} and 140^{0} F.

12.8.2.3 Methods of Application. Tack material may be applied by means of drip buckets, mops, squeegees, or pressure distributors. The specific means of application depends upon the type and size of the area being tacked.

12.8.2.4 Protection. After completion of the tacking operations, the area must be protected from traffic, dust, or other damaging effects.

12.8.2.5 Limitations. Tack material shall not be applied when the air temperature is below 40^{0} F, except in small isolated instances. Tack material shall not be applied on any surface until dirt, dust, moisture, or other affecting elements have been eliminated.

12.8.2.6 General Instructions. Care must be exercised to ensure a satifactory job. Joints and pavement edges require exceptional treatment. The use of a squeegee is recommended for applying a coat of tack material at joints which feather out; it is also recommended for use on small patches. Pools or puddles of tack material must be removed to prevent bleeding.

12.8.3 POTHOLES AND SIMILAR PAVEMENT FRACTURES. The most permanent type of repair is shown in Figure 12-3 and outlined in the procedures that follow:

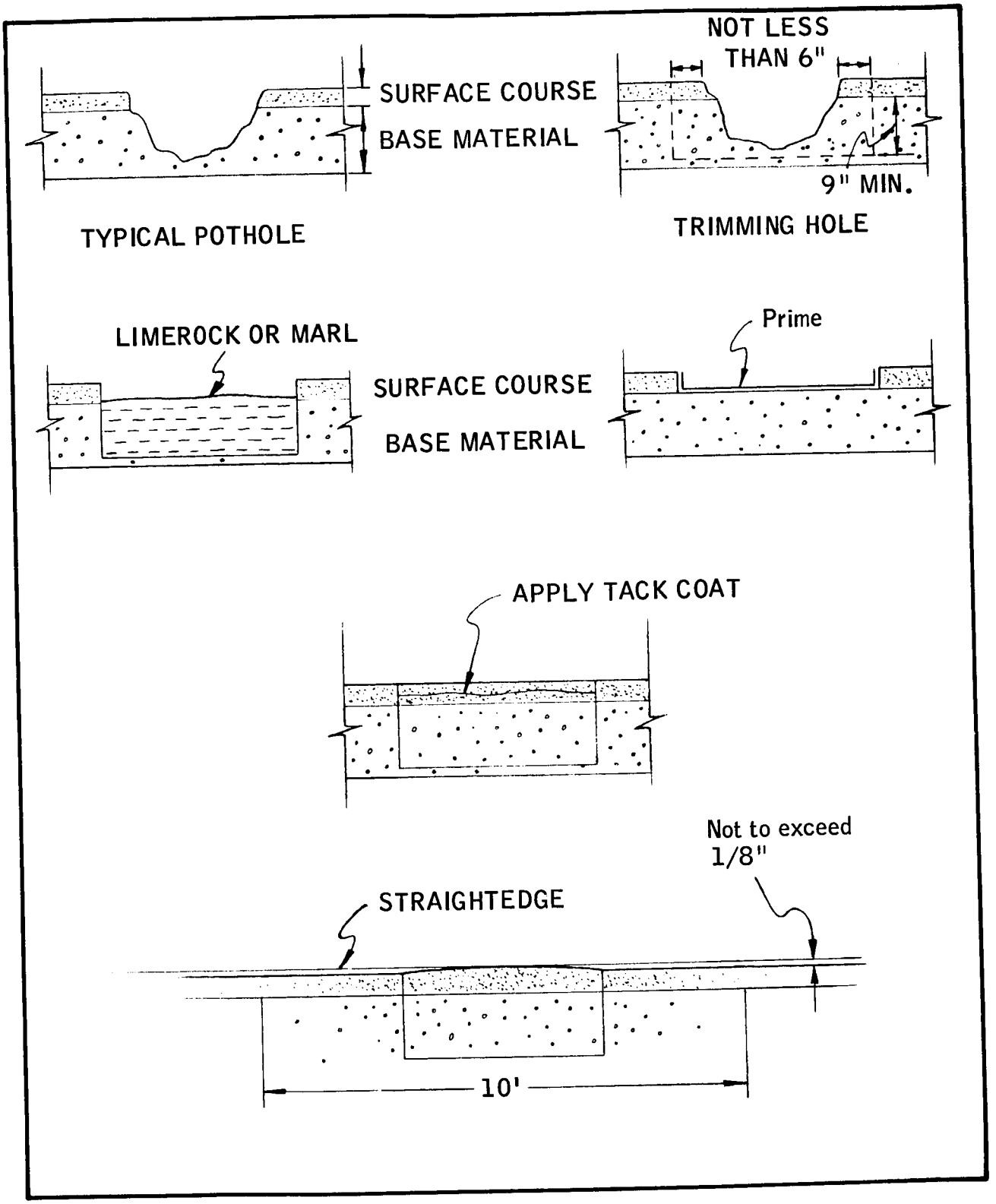


Figure 12-3. Pothole Repair Sequence

NOTE

Too much emphasis cannot be placed on the correct use of the straightedge. The proper use of the straightedge will not only result in a patch of good appearance but will ensure that the patch is of optimum height, which will prevent damage to the patch or the surrounding area from rolling loads.

A typical pothole in a roadway is shown in the upper left-hand corner of Figure 12-3.

a. Trim and clean in accordance with the TRIMMING HOLE drawing shown in Figure 12-3.

b. Replace base material with limerock or marl (Figure 12-3) of optimum moisture content. The thickness of this new base material must be at least 9 inches, placed in 2-inch thick layers compacted thoroughly by means of a mechanical or hand tamp. Very wet material should not be used.

c. Prime sides and bottom of surface course area (Figure 12-3) with a light grade of bituminous material. Rate of application shall be 0.05 to 0.15 gallons per square yard.

d. Replace surface material with TACK COAT (Bituminous Hot Plant Mix), Figure 12-3, in layers not to exceed a thickness of 1-1/2 inches, tamping well between each layer and allowing sufficient time for each layer to cool before further applications. Loose material should be shaped with rakes or lutes to approximately 3/8 inch above the roadway grade. Begin rolling with a steel wheel roller, starting at the edges and progressing to the center of the patch. Do not straddle patch on first pass.

e. Check patch for proper grade, using a straightedge (Figure 12-3) 10 feet long to ensure good riding qualities. Any deficiency exceeding 1/8 inch in grade should be raked loose and the material removed or replaced until the desired grade is obtained.

12.8.4 TRENCHES AND TRENCH BACKFILL. The sides of trenches should be cut as nearly perpendicular as soil and circumstances permit. The various excavated materials should be stockpiled separately, if possible, for use in the backfill operation. Trench widths will vary; but, whenever possible, a ration of 2

pipe diameters width for each 5-foot depth (Figure 12-4) should be followed. The following procedures, which are coordinated with Figure 12-5, are recommended for backfilling ditches and trenches. Adherence to the procedures will result in a backfill that will not settle and cause subsequent failure of the base and surface.

a. For backfill (1) of Figure 12-5, compact in 6-inch lifts, using caution to ensure compaction under the lower half of the pipe. Remove standing water, if possible; if not possible, use a coarse, sandy material for backfill. Materials having a high clay content should not be used.

b. For backfill (1-A), compact as in A above, but disregard pipe overhang if the outside diameter (O.D.) of the pipe is 8 inches or less.

c. For backfill (2), compact in 4-inch lifts to attain a thickness of at least 12 inches, using material similar to the existing subgrade. If the subgrade profile cannot be determined from the trench sides, use a mixture of sand and clay, or similar high-bearing material.

d. Complete the (3) and (4) backfill portions of the ditch or trench in accordance with the procedures outlined in paragraph 12.8.3.

12.8.5 STABILIZATION. Stabilization consists of blending various materials in such a manner as to increase the load-bearing characteristics of local soils. Materials used as stabilizing agents include, but are not limited to, limerock, clay, marl, lime, and cement. Of these, the most commonly used are limerock, marl, and clay.

The load-bearing qualities of a soil are generally increased by adding to its unit weight. This is accomplished by mixing a suitable fine-grained material into the soil which will fill the voids present in the original material.

In effect, stabilizing enables sandy soils to withstand added pressure and adds to the overall capacity of the base and pavements.

Stabilizing is most often accomplished by applying a layer of clay, marl, or limerock the entire width and length of the area and then mixing to the desired depth. Three or four passes of the mixer (rolling between each pass) is usually required to attain the proper mix. Rolling between each pass of the mixer is a definite aid in cutting lumps or balls of material unaffected by repeated mixing. Depth of mixing should be approximately three times the thickness of the layer of the stabilizing materials. Care should be taken to avoid mixing to a greater depth than required, since this will usually result in weak spots that will eventually fail. After completion of all mixing and rolling operations, any material found to be in excess of that required for the

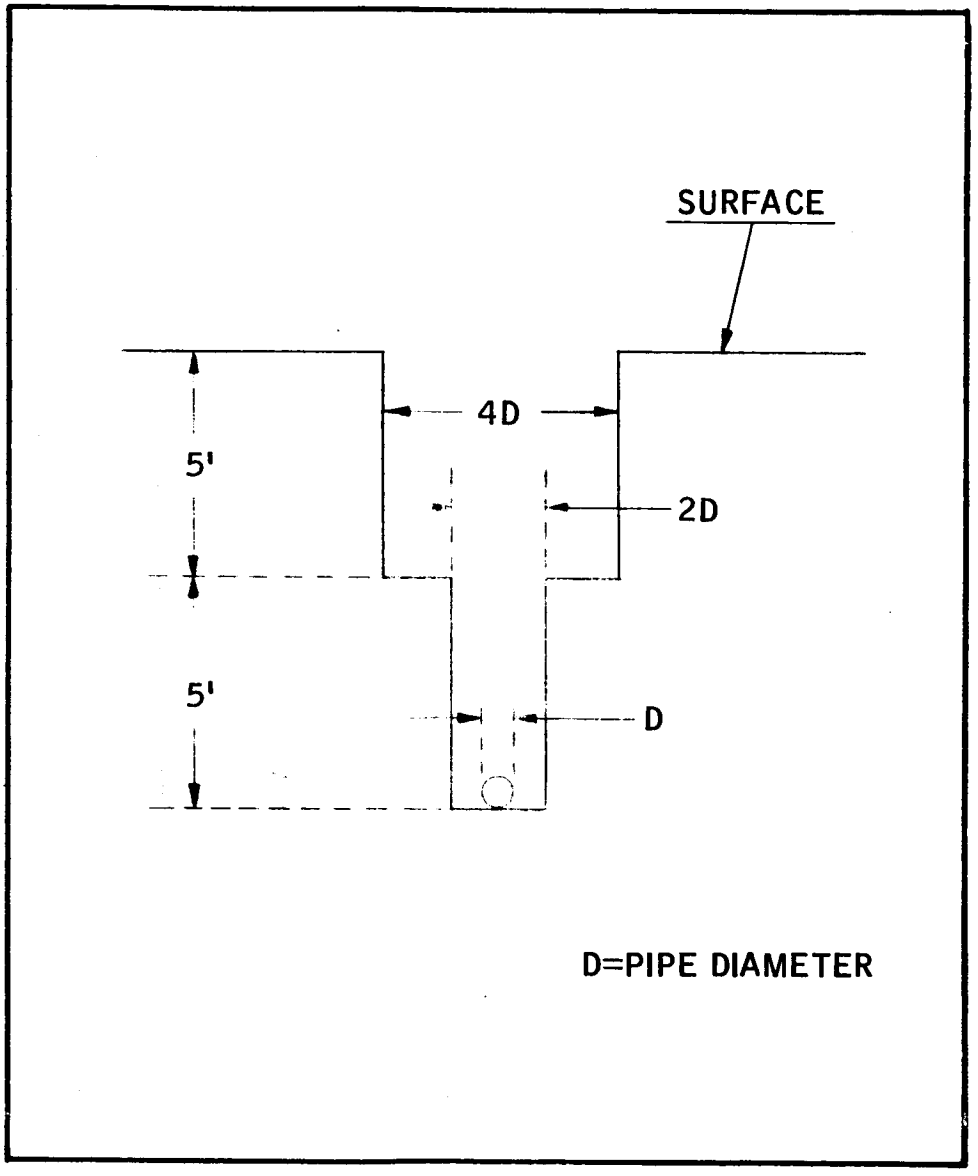


Figure 12-4. Dimensions for Pipe Trench 10 Feet Deep

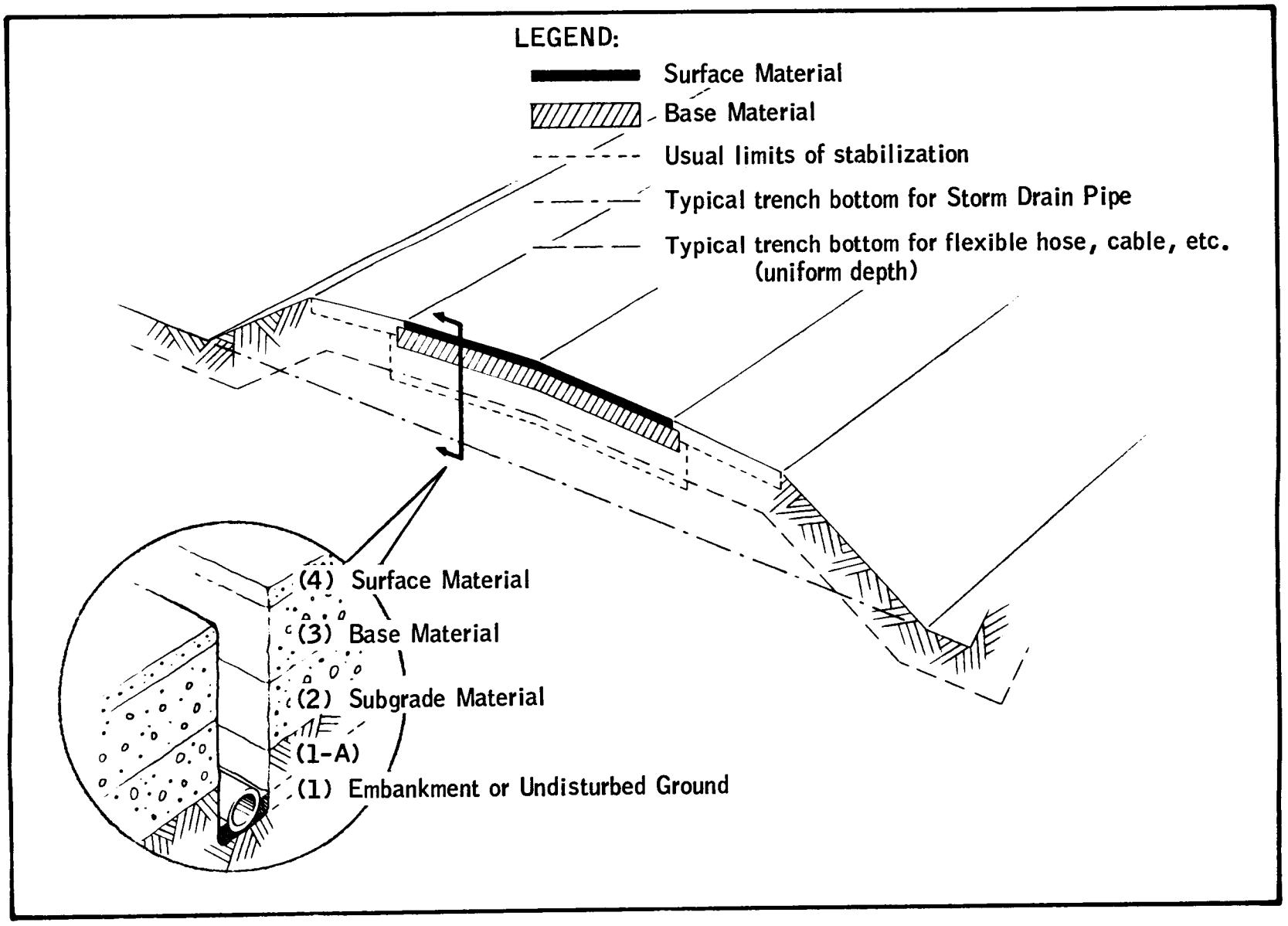


Figure 12-5. Section of Roadway Showing Segments of Backfill

proposed grade should be removed and stockpiled for use on shoulder washouts or other similar areas.

It is recommended that, in the event that a stockpile of limerock, marl, or clay is depleted and further stockpiling of such materials is not anticipated, the area soil should be mixed to a depth proportionate to the amount of the residual stockpile material; the resulting stabilized material should then be salvaged and stockpiled for use in future job requirements.

12.8.6 LIMEROCK AND MARL BASES. The following information applies to construction of limerock or marl bases on previously-prepared subgrades.

Before dumping operations begin, the area should be checked to ensure proper width and grade. Any wet spots found in the subgrade should be removed or aerated and recompacted to the same degree as the surrounding area. Unless form boards are used, the width of the base material should be 6 inches greater on each side than the width of the proposed surface. Any erosion or other form of damage to the subgrade encountered during the dumping operation should be repaired. If the desired compacted thickness is in excess of 6 inches, the base material should be placed in two or more lifts and rolled between applications until the desired compaction is obtained. All base material dumped during the course of a day's work should be sealed the same day by rolling; rain on open bases will require much additional work before satisfactory finishing can be accomplished.

Periodic checking with a template cut to the desired section should be incorporated into the finishing operation. Care must be taken to prevent the introduction of any sand or other materials which might impair the quality of the finished base.

Rolling with a rubber-tired roller should follow the completion of the finishing operation.

12.8.7 PRIME COATS. The following information applies to the application of a bituminous material, followed by an application of local sand or sand-asphalt to a previously prepared base.

Prime coats are desired on limerock, marl, limerock-stabilized, and sand-clay bases. The rate of application is generally 0.1 to 0.3 gallons per square yard but varies with the particular material being primed. Limerock, when properly finished and compacted, should not require more than 0.15 gallons per square yard. Marl, sand-clay, and limerock-stabilized bases usually require between 0.15 and 0.3 gallons per square yard.

Before the asphalt distributor is used, the temperature of the material, condition of the spray bars, and the amount of the material on hand should be checked. Best results are usually obtained when the material is heated to a point near the top of the recommended range.

Bituminous materials recommended for priming are RC-1S,RS-1, RS-2. The use of RC-1S is usually limited to limerock or limerock stabilized bases. RS-1 and RS-2 emulsions are suitable for use on marl or sand-clay bases.

Upon completion of the bituminous material application, the area should be covered with a layer of clean, preferably dry, sand. Rolling with a rubber-tired roller should commence immediately upon application of the cover material and should be continued until the prime is considered cured. The use of a drag broom or an approved substitute should be incorporated into the rolling operation. When the prime is considered cured, the excess cover material should be removed immediately by means of a power broom and blower or other approved methods. Excess cover material left in place after curing will damage the completed prime coat. Until the surface course is placed, primed areas should be periodically checked; all cracks, scrapes, or other damage to the seal should be repaired in a manner similar to the original work.

12.8.8 ASPHALTIC CONCRETE PLANT MIX . The following information applies to the application of hot asphaltic concrete to a previously prepared base or surface course.

12.8.8.1 Rate, Temperature of Application. The recommended air temperature for areas of significant size is a minimum of 40° F. The following rates of application apply to all uses of this material on roadways and other pavements for each application or course.

Item	lbs/sq yd
Leveling courses	50
Patches (hand tamped)	150
Surface Courses	100

12.8.8.2 Methods of Application. Asphaltic concrete plant mix material may be spread by means of (but not limited to the use of) paving machines, spreader boxes, patrol graders, or hand methods. The specific means of application depends upon the size and type job and the desired results.

12.8.8.3 General Instructions. The foreman in charge of the work must exercise careful planning and coordination if a satisfactory job is to be realized. Care must be taken to ensure conformity to the desired lines and grades and to prevent contamination of the material.

Areas must be cleaned, dried, and tacked as specified in preceding paragraphs. The use of a string line for determining the limits of low areas is beneficial, if only patching is to be done. Any areas being patched which have varying depths should be worked in layers, starting with the lowest sections first. These should be tamped; then,additional tack should be added if necessary. As the low sections are built up, the size of the patches will increase. The last application should cover the entire area. A typical sketch depicting this method is shown in Figure 12-6. Care should be taken to prevent the roller wheels from contacting the tack material. If a roller is incorporated into the compacting of small sections within the limits of a tacked area, the tack material must be sanded prior to roller use with a light application of the patching material. Any tack material picked up by the roller must be removed immediately before rolling operations can commence.

12.8.8.4 Straightedging. The surface of the new material and all joints (where the old and new material meet) shall be checked by means of a straightedge at least 10 feet long. Straightedging should begin at the joint and proceed parallel to the center line of the pavement over the new surface on 5-foot centers (if the area is larger than 5 feet). Any discrepancies (high or low spots) in excess of 1/8 inch within the length of the straightedge shall be loosened by means of rakes or other tools; material shall be removed or added as required to meet this desired limitation.

12.8.8.5 Compacting Material. Compaction of the mixture shall begin as soon as an area of sufficient size, in relation to the compacting equipment, has been prepared.

On areas of sufficient size, a steel wheel roller of 5 - to 12-ton size shall be incorporated in the work. Rolling shall begin at the center and progress toward the outside, paralleling the center line of the roadway and uniformly lapping at least one half the width of the roller.

The motion of the roller shall at all times be slow enough to avoid displacement of the mixture, and any displacement shall be corrected at once by the use of rakes and fresh mixture where required. Seal rolling shall be done with a steel wheel roller, followed by rolling with a self-propelled, rubber-tired roller. Air pressure shall be 50 to 55 psi.

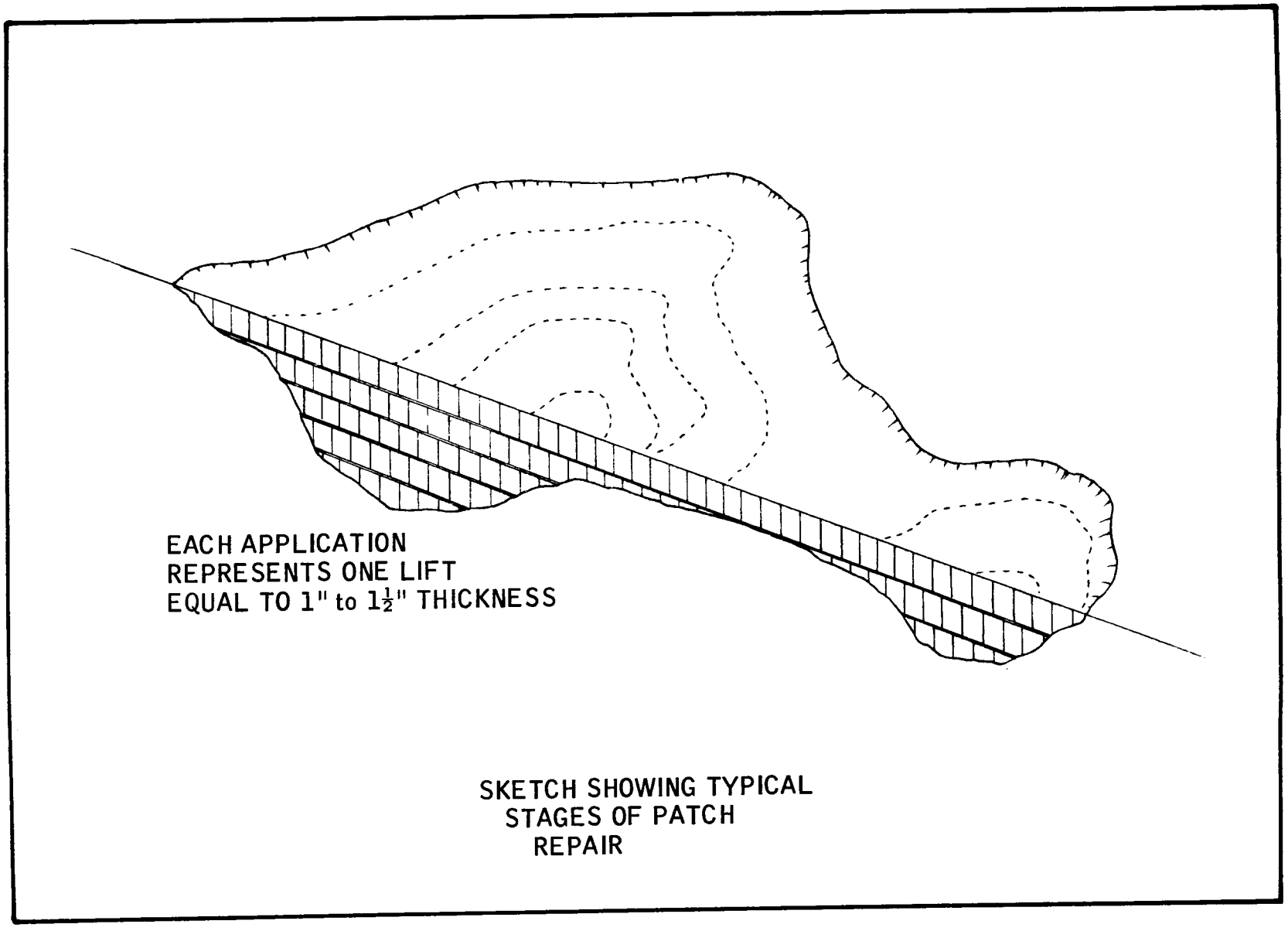


Figure 12-6. Sketch Showing Typical Stages of Patch Repair

Final rolling shall be done with a steel wheel roller in accordance with the procedures outlined above. Rolling shall continue until maximum density has been attained.

12.8.9 BITUMINOUS SURFACE TREATMENT. This treatment consists of alternate applications of bituminous material and cover material applied on a previously-prepared base or surface. Surface treatment is recommended for use on new construction or on existing surfaces where the wearing surface is badly deteriorated due to wear or weathering.

Application of surface treatments shall be performed, upon approval, in accordance with the specifications set forth in the Florida State Road Department "Standard Specifications for Road and Bridge Construction" manual, 1959 edition, section 210.

12.8.10 MINERAL SEAL COAT. The mineral seal coat consists of a wearing surface composed of a single application of cutback asphalt and covered by a single application of mineral aggregate.

This type of repair is especially effective on existing pavements which require sealing and/or are beginning to show excessive wear or raveling. Advantages of this type of repair include the small amount of equipment required and the speed with wich a large area can be treated.

Application of mineral seal coats shall be performed, upon approval, in accordance with the specifications set forth in the Florida State Road Department "Standard Specifications for Road and Bridge Construction" manual, 1959 edition, section 215.

12.8.11 SLURRY SEAL COAT. The slurry seal coat consists of an emulsified asphalt combined with a mixture of fine aggregates to form a thick sealing material, usually applied by means of a mechanical squeegee. The use of a slow-setting asphalt emulsion eliminates the necessity for heating the material prior to the application; it also provides a workability period preventing premature breaking of the emulsion and a consequent balling of the mixture which would prevent adequate squeegee application. The mixture should be relatively free-flowing and of a creamy consistency to allow it to be squeegeed into all cracks, promoting a smooth surface. Such a treatment will contribute little or no structural strength, but it is designed to reduce maintenance and patching work and retard further deterioration of the material. Slurry treatment work often precedes a complete coverage by regular seal coating methods. The slurry seal method can be used for special deslicking coatings designed for nonskid performance. In such cases, special types of fine aggregates providing hard, sharp edges are employed.

12.8.12 PAVEMENT EXTENSIONS. This work consists of extending existing pavements in areas including, but not limited to, parking lots, roadways intersections, or driveways.

The primary principles to be observed in extending any existing pavement is to effect, as nearly as possible, the same texture, appearance, riding qualities, and behavior under loading as the existing pavement. This is most generally accomplished through the use of materials identical with those used in the original construction and the correct matching of existing lines and grades. Care should be taken to ensure proper thickness of the subgrade, base, and surface material.

All materials shall be placed in recommended lifts and thoroughly tamped by the use of hand tools and power equipment until maximum density is realized. Failure to limit the various lifts to recommended amounts will result in bridging of the material when initial compaction is obtained and will result in failure of the area under usage.

Another consideration in obtaining desired compaction is the percentage of moisture available in the material. The desired percentage of moisture for different materials varies considerably. In most cases, desired results can be obtained by a very simple method. First, take a handful of the material in question and attempt to make it into a ball by squeezing and rolling it in the hand. The material contains the desired amount of moisture, for compaction purposes, if a ball which is not crumbly nor clay-like can be formed. If the material is crumbly, moisture is needed. If the material is clay-like, it contains too much moisture. The use of clay material or fine sand containing a large portion of clay for embankment fill or backfill purposes should be avoided.

Table 12-1 shows the general relationship of various materials, their ideal moisture content, their methods of compaction, and their maximum lift thicknesses.

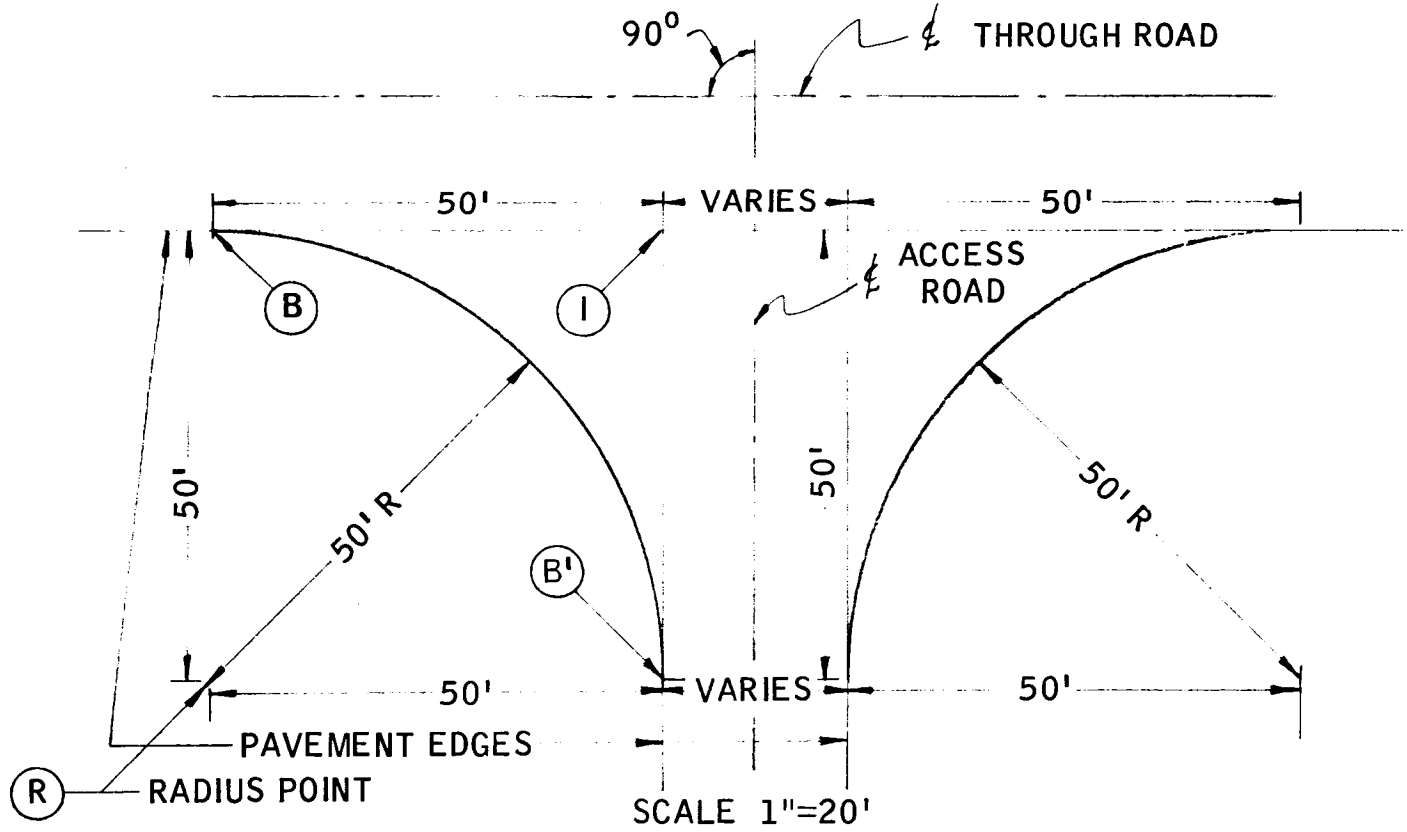
Figures 12-7 and 12-8 show methods of layout for establishing the pivot point for a recommended radius of 50 feet for right angle and other than 90-degree intersections.

It is recommended that intersections be adjusted to meet this minimum standard when major maintenance of the pavement edges and shoulders at any location within the limits of an existing radius is required.

12.8.13 SHOULDERS AND SLOPES. When an unsuitable condition becomes apparent in roadway shoulders and slopes, they must be repaired. The work consists of grading, sloping, compacting, and draining shoulders and slopes

Table 12-1. Embankment Fill and Backfill Materials Data

MATERIAL	Normal Graduation Limits (Sieves)	Particle Sizes mm, inches	Optimum Moisture Range	Lift Thickness (Maximum) Hand Tamps	Lift Thickness (Maximum) Rolling Equipment	REMARKS
Clays	100%-#200	.001-.005	18 - 30	3"	8"	Most suitable as a stabilizing agent. Avoid use in low or saturated fills.
Silts	100%-#200	.005 - .08	16 - 28	---	---	For use on slopes in excess of 2:1 ratio only.
Fine Sands	#40 -#200	.08 - .4	12 - 17	4"	8"	Avoid use in low or saturated portions of fills. Requires small amount of clay for stabilizing.
Medium Sands	#20 - #60	.2 - .8	14 - 18	4"	8"	Usually suitable for all areas.
Crushed Limestone	3" - #200	3" - .08	12 - 15	3"	6"	Base material and excellent stabilizing agent.



METHOD OF LAYOUT FOR ONE QUADRANT

1) Locate point I by visually sighting down both pavement edges.
2) Locate points B & B' by measuring 50' from Point I down both pavement edges.
3) Locate point R by swinging an arc of 50' from both points B & B'. Point R is where these two arcs intersect.
4) Edge of pavement, line B - B' is located by swinging an arc of 50' from point R.

Figure 12-7. Intersection Layout When Roads are at Right Angles

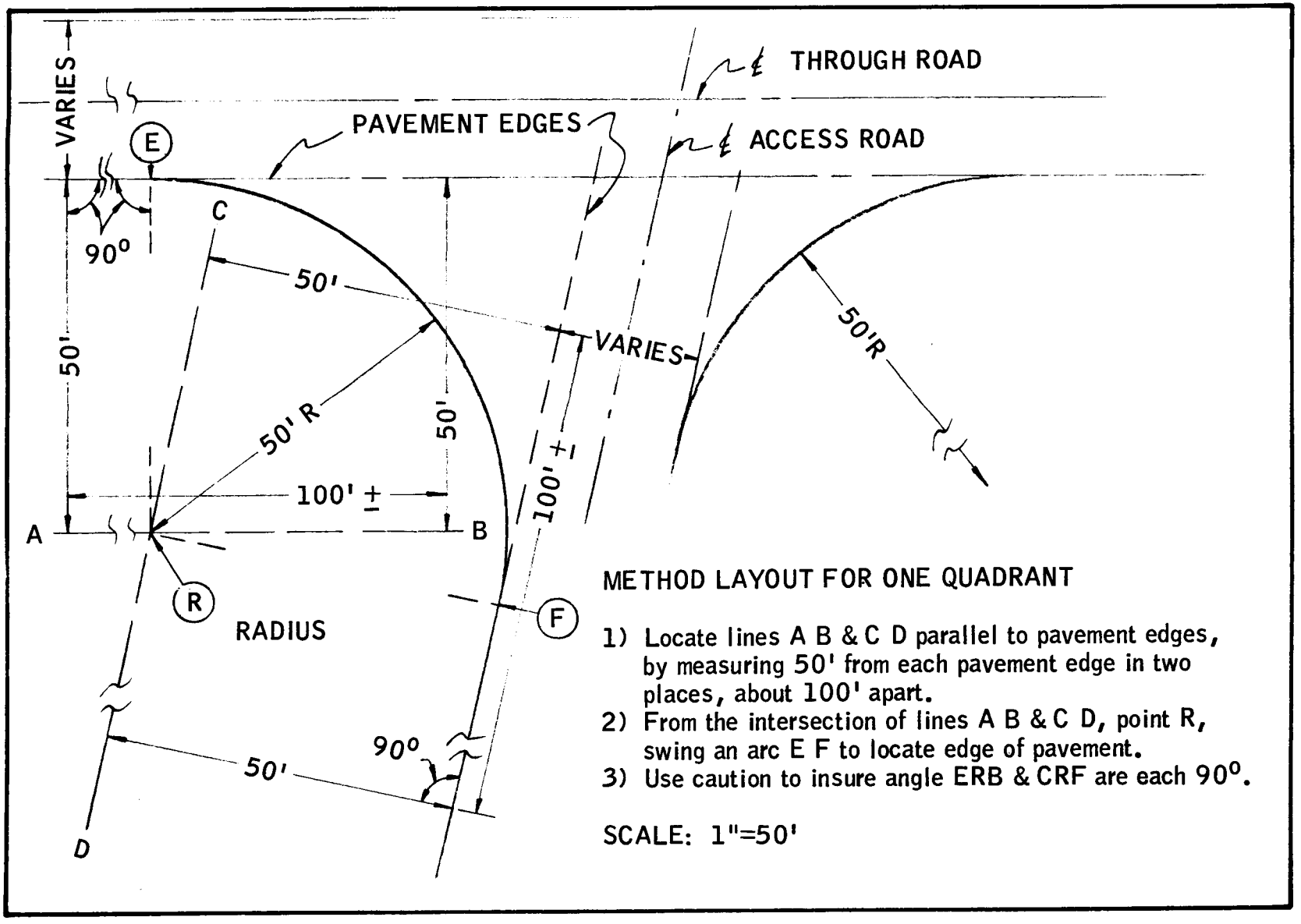


Figure 12-8. Intersection Layout When Roads are not at Right Angles

in a manner that will protect both traffic and pavement, retain an attractive appearance, and permit occasional storage of vehicles for emergency or other approved reasons. When such work has been deemed necessary, certain procedures should be followed to ensure uniformity, efficiency, and accuracy.

The foreman in charge of the work should make an inspection to determine the factors which have caused the unsuitable condition and then determine the required materials and equipment for completing the work. This would normally include the following:

1. The type of material involved (low or high bearing)
2. Location and extensiveness of washouts
3. Presence of wind erosion
4. Condition of the soil in relation to growing grass
5. Extreme dryness or wetness
6. Any other outstanding features

From this initial inspection, the foreman must decide what type of material is best suited for the existing conditions, how much will be required, and what equipment will be needed.

Whenever portions of shoulders of sufficient size are to be reworked, they should be rough graded and then mixed by means of a pulvi-mixer before final dressing begins.

Shoulder widths and slope ratios should be determined from construction blueprints, if available, or graded in accordance with the grades, lines, and dimensions shown in Figures 12-1 and 12-2. Line and grade control of the shoulder point is essential for correct construction. The shoulder line should be established by measuring the appropriate distance from the edge of the pavement. Measurements should be made at sufficient intervals to permit the grader operator to maintain the desired line. Plan shoulder point elevation should be determined and checked by means of lock levels or straightedges and spirit levels. The grader operator can sometimes control the shoulder line elevation by placing a 24-inch or 36-inch spirit level on the cab frame directly in front of the blade controls. A small block, having a ratio equal to the required amount of fall per foot and the length (in feet) of the level used, is then placed under the outside edge of the level. By maintaining a centered bubble, the operator can cut the desired grade. Shoulders within the limits of circular curves are generally graded flat or slightly crowned on the high side of the roadway and graded either to match the slope of the pavement or the normal percent of grade (on the low side), whichever is greater. Shoulder transition lengths are generally equal to those of the pavement.

Compaction efforts should be simultaneous with grading operations. The use of rubber-tired rollers, both self-propelled and pull, are satisfactory for this purpose. Rolling should not stop until 85 to 95 percent maximum density is achieved.

If the area involves a large amount of work at washouts, or if washouts present are limited to particular small sections, improved or additional drainage facilities may be required. The use of asphalt material for construction of irregular flumes often results in a satisfactory method of erosion control. This asphalt material can also be used at the ends of culvert headwalls and around side-drain pipe.

Other methods of erosion control incorporate the use of such items as concrete flumes, grassing and mulching, matting, sodding, and construction of additional parallel ditching at the top of back slopes in areas which are downhill from natural drainage.

12.8.14 ROADWAY DRAINAGE. The work involved in roadway drainage consists of planning, constructing, and maintaining roadway ditches in a manner that will afford maximum drainage and minimum repair.

The construction of new ditches requires an extreme amount of study before work can be undertaken. The use of drainage maps should always be incorporated into the plan, and any work accomplished which would alter or otherwise affect the original condition, plans, or methods must be entered. This is the only way to maintain positive control of the overall drainage plan. Without proper study conclusions, the relief gained in one area may only be offset by the introduction of bad conditions in another.

After a comprehensive study has determined that the effect of the new construction will be beneficial, the proposed route should be staked for alignment and elevation. Location stakes of proposed side-drain pipes, slope and/or ditch paving, and other items should be set and construction work undertaken immediately. The various types of pipe incorporated into the job must be of sufficient size and number to satisfy the design criteria. The flow line of pipes installed should be countersunk 1 to 2 inches below the grade of the ditch. The use of arch-pipe may be required when maximum effective area is desired or when the cut is insufficient to maintain suitable cover material. If salt or brackish water is to be encountered, bituminous-coated or concrete pipe should be utilized. Any and all joints must be properly sealed by means of strap overlays on corrugated metal pipe and grout diapers or gaskets on concrete pipe. Concrete pipe of sufficient size should also be sealed on the inside by the use of sand-cement grout.

If there is less than 1 foot of cover material over pipe placed under unpaved roads, a cover of stabilized material should be used for the entire depth to aid in the prevention of damage from trucks or like vehicles.

12.8.15 GRASSING AND MULCHING. The work involved in grassing and mulching consists of applying and mixing sprigs, hay, fertilizer, and grass seed into shoulders, slopes, or other designated areas.

The purpose of this operation is to provide immediate protection to exposed areas from the effects of wind and rain and to establish a more permanent means of erosion control through the resulting stand of grass.

This work should be planned in conjunction with various grading operations as deemed necessary.

The fertilizer used should be of the grade and quantity recommended by the Horticulturist and should be applied by his methods at a time designated by him.

If grass sprigs are used, they should be applied prior to the mulch material. The spacing of the sprigs, though variable, should not exceed 6 inches, center-to-center. Caution should be used in handling sprigs to maintain maximum freshness to induce growth.

Mulch material should be uniformly distributed in a continous mat 2 inches deep (loose measurement). Care in cutting in the mulch material is required to maintain a 2-inch depth. A visual inspection should be performed to ensure that the completed item results in 40 to 50 percent of the mulch visible on the surface.

The mixing operation should be followed by the combination of seeding and rolling.

All accessible areas should be rolled by means of a culti-packer pulled by a small tractor. All rolling shall be done parallel to the pavement edges. The use of hand implements is required in areas inaccessible to rolling equipment. On most mulched soils, the use of rubber-tired (compaction type) rollers will cause harmful effects to the quality of the overall operation and is not recommended.

If the prevailing weather conditions are such that the anticipated showers during the following 2 weeks will be insignificant, provisions should be made to water the grassed and mulched area until conditions prove favorable to induce growth.

On steep slopes where mechanical methods of mixing cannot be performed, the mulch material can be held in place through the use of matting material staked over the mulch or through the use of strings held tightly in place by small stakes driven no more than 10 feet apart, center-to-center.

12.8.16 ROADWAY SIGNING. Detailed instructions for recommended placement of roadway signs are shown in Figures 12-9 through 12-12. These instructions show the height requirements above the roadway centerline and also the dimensions from the pavement edges. Also shown are the desired distances between various signs,recommended distances from intersections for typical placements, and a template guide for use in painting standard 8-foot roadway lettering.

Compliance with these instructions is required for all sign maintenance and future sign installations.

12.8.17 ROADWAY SANITATION. The Sanitation Division of Roads and Grounds shall be responsible for this function and shall follow the procedures outlined in the Refuse Collection manual. It shall also be their responsibility to report to the Roads and Grounds Division any roadway conditions noted which may require maintenance or further inspection.

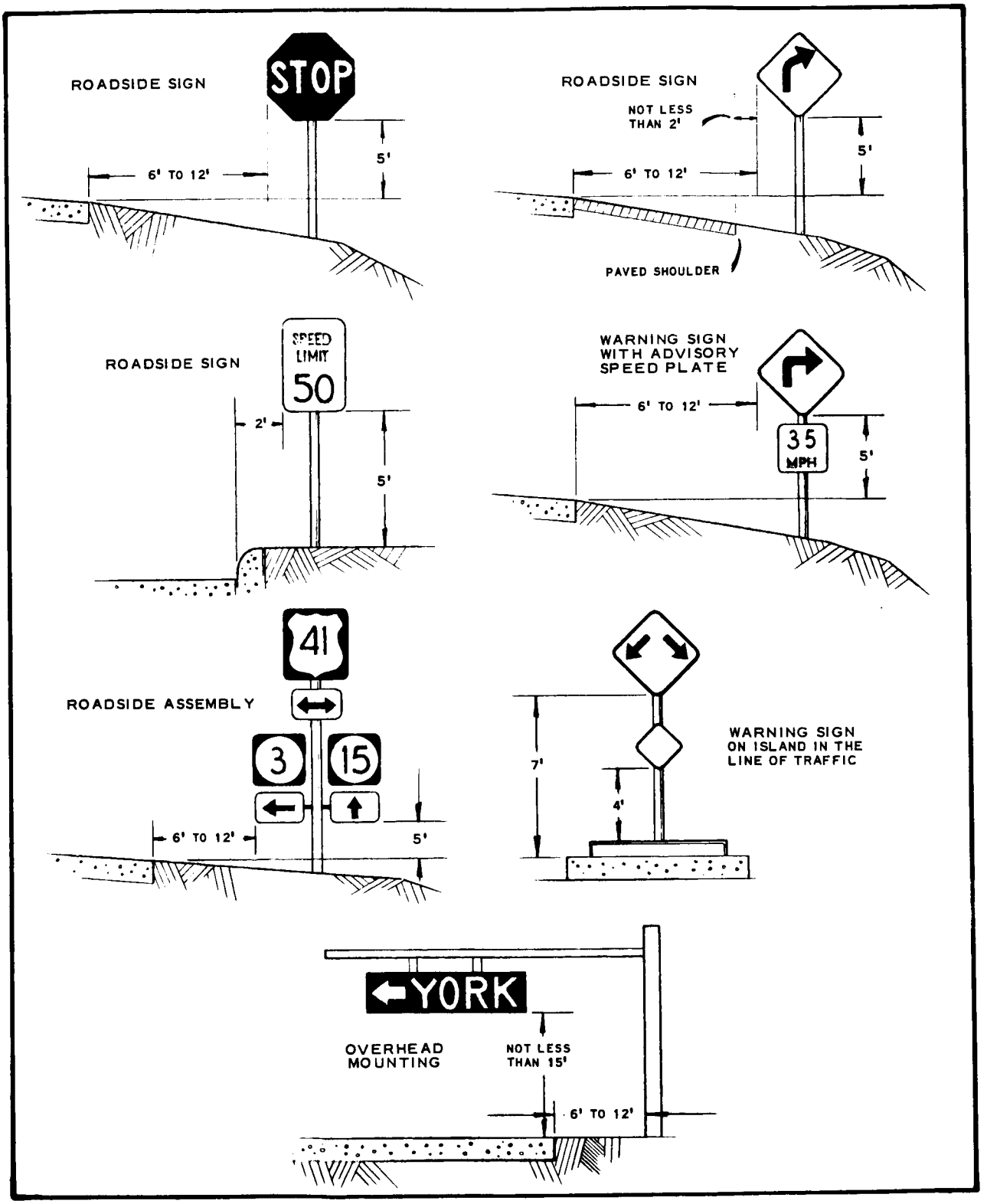


Figure 12-9. Placement of Signs Along a Road

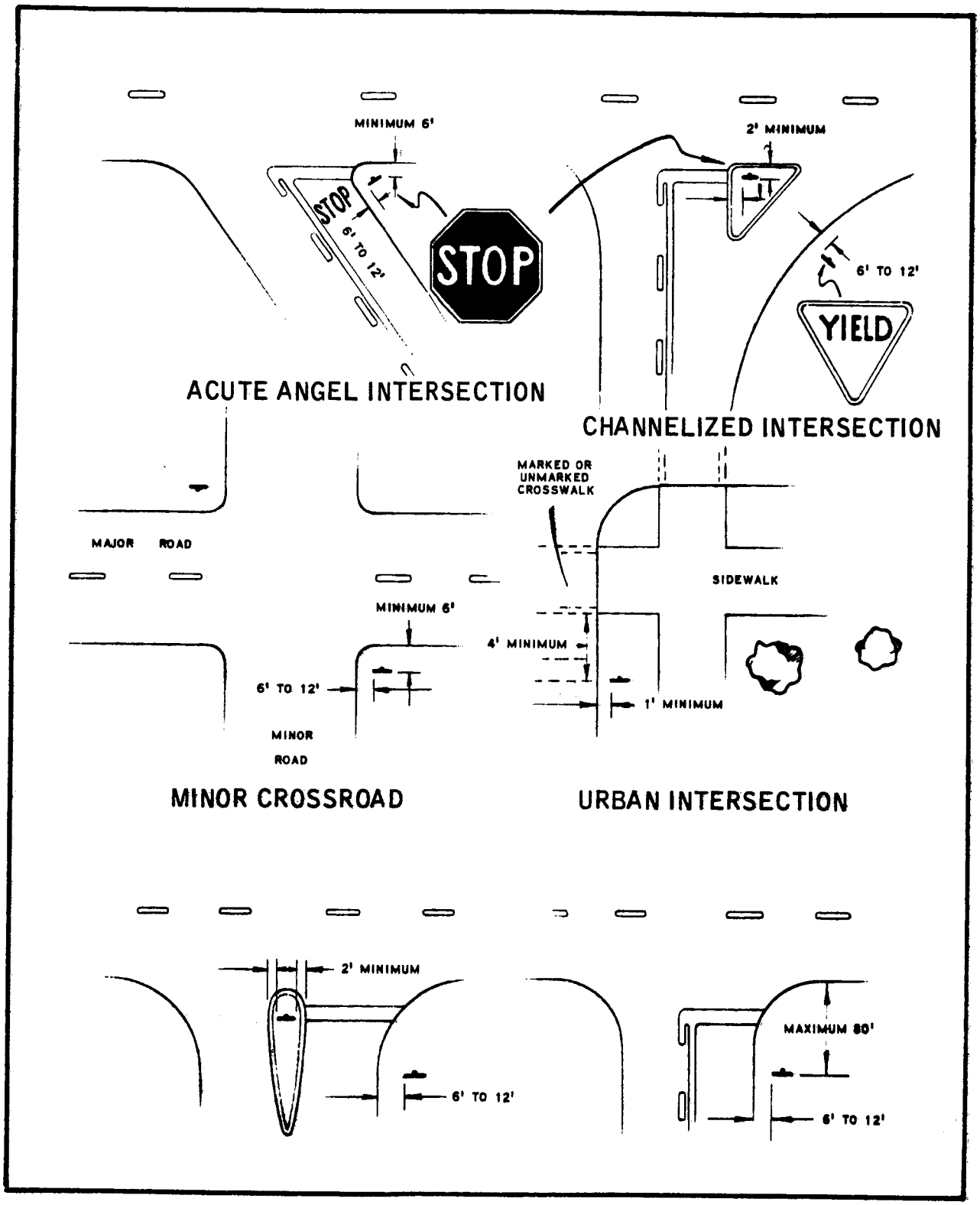


Figure 12-10. Placement of Stop and Yield Signs at Intersections

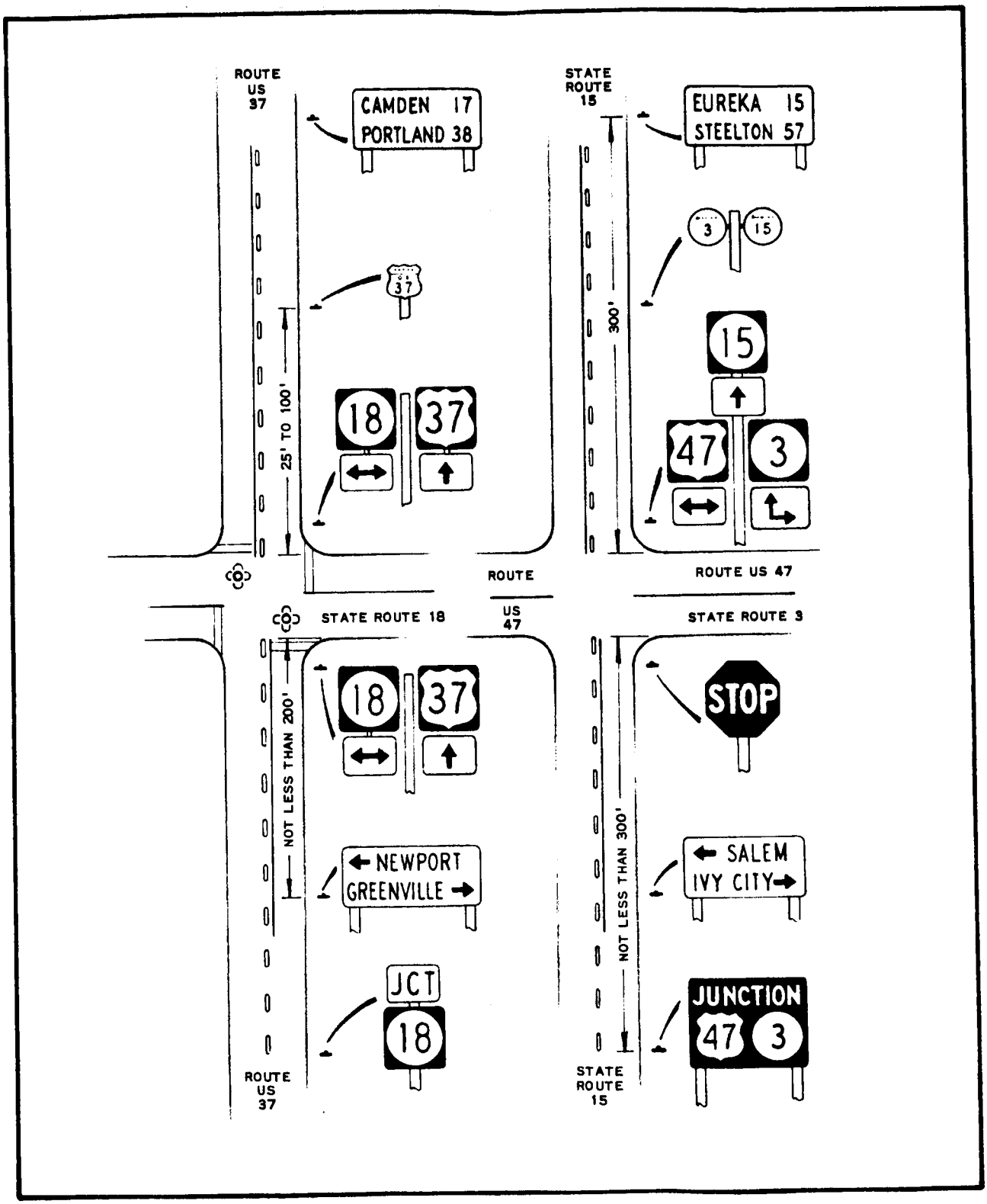


Figure 12-11. Placement of Route and Other Signs at and Near Intersections

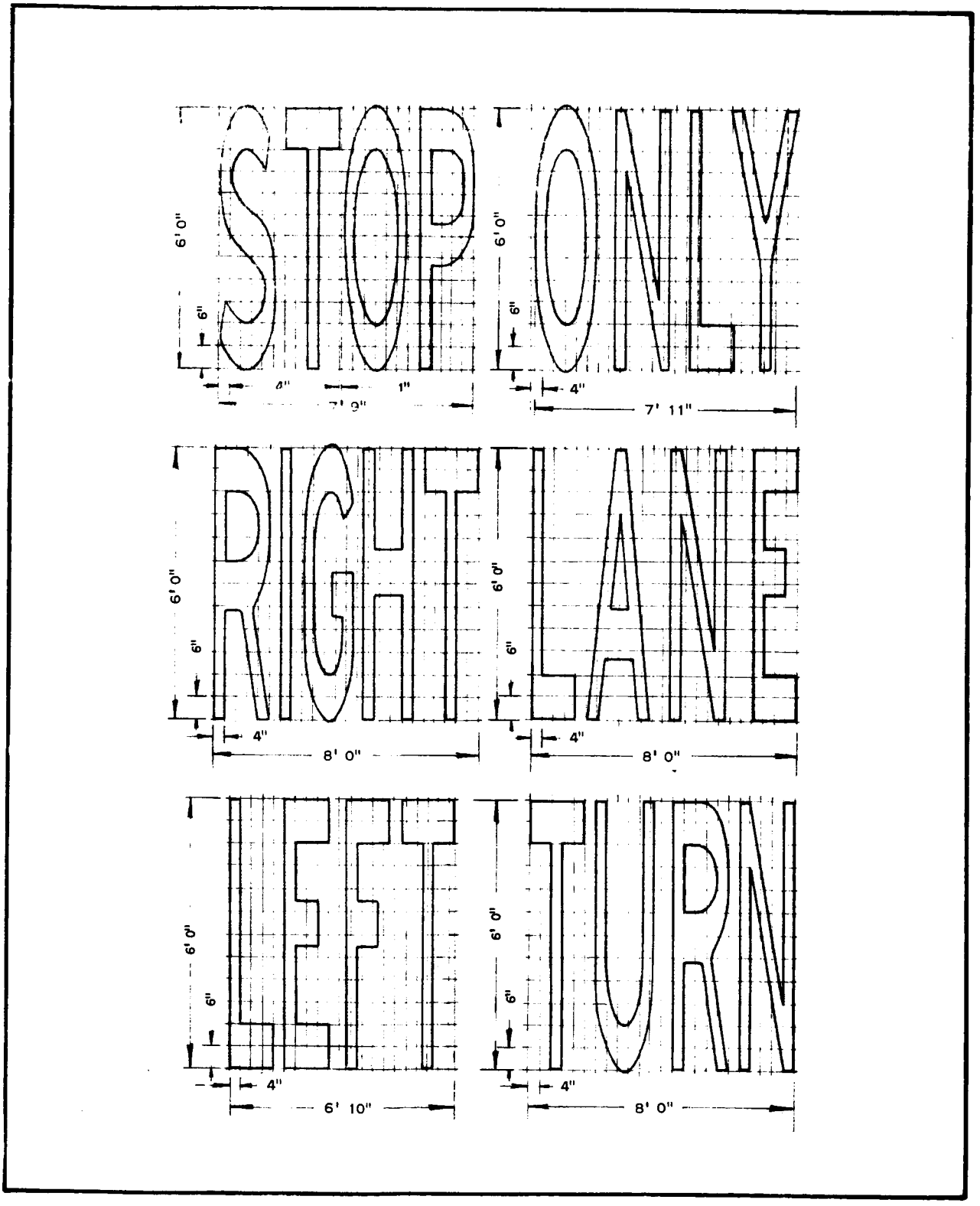


Figure 12-12. Guide for Making Roadway Lettering Templates