Preparing Activity: USACE Superseding
UFGS-35 01 70.13 (May 2014)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
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USACE / NAVFAC / AFCEC / NASA	**UFGS-35 01 70.13 (May 2021)**

Preparing Activity: USACE	**Superseding** **UFGS-35 01 70.13 (May 2014)**

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SECTION 35 01 70.13

WIRE ROPE FOR GATE OPERATING DEVICES

05/21

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NOTE: This guide specification covers the requirements for supplying and installing wire rope (new or replacement) needed by gate operating devices (i.e. spillway gates, Tainter gates, etc.)

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: This guide specification is based on the assumption that a single Contractor will be responsible for supply and installation of the wire rope. Please refer to US Army Corps of Engineers Engineer Manual 1110-2-3200 Wire Rope Selection Criteria for Gate-Operating Devices (
http://www.publications.usace.army.mil/Portals/76/Publications/EngineerManua
)prior to editing this section. It is recommended that the designer talk with wire rope manufacturers to get their consensus that the proposed wire rope type can be manufactured and used successfully.

If a specification is needed only for supply of wire rope, or for installation of wire rope, there are example specifications included in the appendices of US Army Corps of Engineers Engineer Manual 1110-2-3200 Wire Rope Selection Criteria for Gate-Operating Devices (link above). It is also assumed the wire rope is for replacement for a gate operating device. Paragraphs written in regard to removal of existing wire rope, and cleaning drums and sheaves would need to be deleted if the application is for a new installation.

Ensure products used in this section comply with Federal procurement preference under Section 9002 of the Farm Security and Rural Investment Act of 2002. See Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING for requirements associated with EPA designated products.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A148/A148M	(2020; E 2020) Standard Specification for Steel Castings, High Strength, for Structural Purposes
ASTM A351/A351M	(2018) Standard Specification for Castings, Austenitic, for Pressure-Containing Parts
ASTM A1023/A1023M	(2021) Standard Specification for Stranded Carbon Steel Wire Ropes for General

Purposes

ASTM E1571 (2011; R 2016; E 2016) Standard Practice for Electromagnetic Examination of Ferromagnetic Steel Wire Rope

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1 (2014) Safety -- Safety and Health Requirements Manual

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS RR-S-550F (2018) Sockets, Wire Rope

FS RR-W-410 (2022; Rev J) Wire Rope and Strand

WIRE ROPE TECHNICAL BOARD (WRTB)

WRTB (2005) Wire Rope Users Manual

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Wire Rope Work Plan; G[, [_____]]

Wire Rope Safety Plan; G[, [_____]]

Contractor Qualifications; G[, [_____]]

Contractor Installation Qualifications; G[, [_____]]

Wire Rope Tensioning Plan; G[, [_____]]

Wire Rope Flux Leakage Test Plan; G[, [_____]]

SD-02 Shop Drawings

End Terminations; G[, [_____]]

SD-03 Product Data

Lubrication; G[, [_____]]

Pre-Stretching; G[, [_____]]

End Termination Attachment Method; G[, [_____]]

SD-06 Test Reports

Tension Testing; G[, [_____]]

Attaching and Proof Loading Terminations; G[, [_____]]

Wire Strength and Ductility; G[, [_____]]

Pre-Forming; G[, [_____]]

Stress Relief "(Wrapping Test)"; G[, [_____]]

Zinc Coating; G[, [_____]]

End Terminations; G[, [_____]]

Wire Rope Magnetic Flux Leakage Test Results (Pre-Installation); G [, [_____]]

Wire Rope Magnetic Flux Leakage Test Results (Post-Installation); G [, [_____]]

Spelter Socket Ndt Test Results; G[, [_____]]

SD-07 Certificates

Warranty

Type of Wire Rope; G[, [_____]]

Tension Testing Equipment; G[, [_____]]

Wire Rope Tension Equipment Calibration Certifications; G[, [_____]]

Tension Equipment Operator Qualifications; G[, [_____]]

SD-09 Manufacturer's Field Reports

Delivery Report

1.3 CONTRACTOR INSTALLATION QUALIFICATIONS

Submit the contractor installation qualifications for installation of the wire rope. The Contractors' installer must have performed work similar to that required in this contract on at least three separate occasions. The Contractors' installer must be on site at all times when wire rope is being delivered, stored, un-reeled, during testing, installation, and after installation testing.

1.4 SYSTEM DESCRIPTION

****

NOTE: The wire rope work plan submittal is only applicable if the contract work involves field installation. This is not needed for a supply contract.

If the wire rope work plan is needed, the designer should carefully consider all steps which are likely to accomplish the wire rope replacement. Add items below the wire rope work plan paragraph as needed.

****

1.4.1 Wire Rope Work Plan

Submit a work plan for Government approval indicating how the existing wire rope will be removed and how the new wire rope will be installed prior to field work proceeding. Describe specific details and practices considering the current condition of existing equipment. At a minimum include the following topics in the plan:

a. Schedule for delivery.
b. Removal plan for old wire rope.
c. Un-reeling and installation plans for new wire rope.
d. Plan for tensioning wire ropes.
e. Schedule for delivery.
f. Schedule for installation.
g. Lubrication method.
h. Field tensioning method.

1.4.2 Wire Rope Safety Plan

Submit a safety plan for approval indicating how work will conform to

EM 385-1-1. Include details of how the wire rope will be handled and installed to minimize the risk to personnel. [Include the safety provisions of this section in the safety plan required by [Section [_____] SPECIAL CONTRACT REQUIREMENTS] [Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS].]

1.4.3 Tools, Equipment and Expertise

****
NOTE: The last sentence may or may not be needed, or consider propane powered equipment.
****

The work may take place [over water] in areas with limited ventilation. [Only electric or air powered tools and equipment will be allowed within those areas (no internal combustion engines will be allowed inside of machinery spaces or indoors).]

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 General

[The work and storage areas are as indicated on the plans] [or as directed by the Contracting Officer]. Wind the wire ropes on spools in the same direction as they were bent during manufacturing. Cover the [coils] [spools] for protection from rain, snow, and/or road debris during shipping.

1.5.2 Inspection on Delivery

****
NOTE: Consider altering or deleting this paragraph to reduce cost if the wire rope can be inspected completely, while being installed.
****

Upon delivery to the work or storage area, inspect the wire [ropes] [ropes and sockets] in the presence of the Contracting Officer. Inspect the wire rope for dings, kinks or other damage.[Unreel the wire ropes from spool to spool to allow complete inspection of the wire ropes over their entire length. Perform the unreeling/reeling operation, and furnish extra spools or any other equipment required.] Upon completion of the inspection, furnish the Contracting Officer with a written delivery report of the results.

1.5.3 Storage

Store wire rope on site in a [covered] location stated on the plans. [After delivery, store spooled wire rope in well ventilated enclosures in the storage area and protect from the elements.]

1.6 ENVIRONMENT PRECAUTIONS

Submit lubricant catalog data for environmental applicability review.

1.7 WARRANTY

****
NOTE: Designer should contact wire rope

manufacturers to determine the extent of manufacturer's warranties available. Warranties may vary with type of rope and application.
****

Submit signed copies of a [1][_____] year[s] warranty for all materials and services provided under this section.

PART 2 PRODUCTS

2.1 WIRE ROPE[AND SOCKETS]

Provide wire rope [and sockets] which are the standard product of a Contractor regularly engaged in the manufacture of wire rope, and that essentially duplicate products having been in satisfactory use for at least 5 years prior to [bid opening] [proposal evaluation]. Submit Contractor qualifications statement.

2.1.1 Quantity

Furnish [_____] wire ropes [with end terminations (sockets) [at both ends]]. Each wire rope must be [of the length indicated on Drawing No. [_____], and within the tolerance also indicated on that drawing.] [[_____] meters feet in length.] Wind the wire rope on reels in lengths such that [_____] sections, each with a length of [_____] meters feet available for use, as splicing will not be allowed.

2.1.2 Type of Wire Rope

****
NOTE: Base selections on EM 1110-2-3200, Fed Spec RR-W-410, and the Wire Rope Users Manual. Consider flattened strand in applications where wire rope wraps on a disk-layered drum.
****

Provide wire ropes as follows:

2.1.2.1 Strand Configuration

[6x19 Seale] [7x19 Seale] [6x26 Warrington Seale] [6X37 Warrington Seale] [_____]; [Flattened strand]

2.1.2.2 Lay

****
NOTE: The advantages of Lang lay wire rope are discussed in more detail in EM 1110-2-3200. In many Army Corp of Engineers applications existing regular lay wire rope would best be replaced by Lang lay wire rope.
****

[Right, Lang] [Left, Lang] [Right, regular] [Left, regular]

2.1.2.3 Diameter

[_____] mm inch, with a tolerance of minus and plus 5 percent

2.1.2.4 Finish

[Galvanized] [Plain]

[2.1.2.5 Minimum Breaking Strength

[_____] kN [pounds] [tons]

]2.1.2.6 Material

****
NOTE: Stainless steel wire rope tends to abrade on itself when wrapped on disk-layered drums. Some manufacturers are questioning the wisdom of making regular lay stainless steel wire rope with flattened strands, as the cold-working tends to be excessive and weaken the rope. Stress relieving to alleviate the cold working can be difficult and inconsistent with the stainless steels. Do not use stainless steel wire rope in saltwater applications because of susceptibility to crevice corrosion. If they are used, they must be inspected regularly and add O&M manual requirement for required duration of wire rope inspection.

Kevlar wire rope has specific needs which must be included if it's desired to be used. Kevlar rope is very susceptible to abrasion damage and must be protected with a jacket. See EM-1110-2-3200.
****

[Extra improved plow steel] [AISI 302 stainless] [AISI 304 stainless][Kevlar] [_____]

2.1.2.7 Core Type

****
NOTE: It is not recommended that fiber core be used for a gate lifting device.
****

Independent wire rope core.

2.1.2.8 Pre-Formed

****
NOTE: There is no reason not to preform.
****

[Yes] [No]

2.1.3 Pre-Stretching

****
NOTE: In the following paragraphs the manufacturer is tasked with some testing. This is intentional, as personnel who are familiar with the required procedures should perform these tasks.

Pre-stretching is highly recommended for installations with multi-rope drums, because initial stretch in the wire ropes tends to be uneven. Pre-stretching will likely result a more equal tension between the ropes. It is also recommended for other wire rope so that final length after use will be closer to length at the time of installation.

****

Submit Pre-Stretching procedure. Pre-stretch the [wire rope] [wire ropes before attaching their end terminations] in accordance with ASTM A1023/A1023M. This is done by subjecting them to three cycles at 40 percent of its nominal strength. Hold the 40 percent loads for 5 minutes with 5 percent loads for 5 minutes between cycles. A method of dynamic pre-stretching may be proposed.

2.1.4 Wire Strength and Ductility

Perform testing in accordance with FS RR-W-410 to verify wire strength and ductility. Submit test results.

2.1.5 Pre-forming

Provide pre-formed wire rope, and perform testing in accordance with FS RR-W-410 to verify pre-forming. Submit test results.

2.1.6 Magnetic Flux Leakage Testing

****

NOTE: Magnetic flux leakage testing is an NDT method to examine wire rope for internal defects. It provides a baseline condition for new wire rope. If a District does not require the baseline condition for future wire rope inspection/maintenance, the NDT testing may be removed from the spec.

Contractors may prefer to perform this inspection during installation of the wire rope, as this is the easiest method to complete 100 percent testing. After the rope is installed, the full length of wire rope cannot be inspected without several setups.

Excerpt from EM 1110-2-3200 (2016) paragraph 8-3.m states: " NDT can be used to determine the internal condition of wire rope. However, there are conditions that cannot or may not be detected, such as breaks in small wires, closely-spaced broken wires, broken wire versus pit corrosion, and possibly other defects. The percentage of outer wires compared to the total cross sectional area of wire rope is 36 percent to 44 percent. Thus, NDT can provide valuable information on the condition of over 50 percent of the wire rope area. The end user should recognize that NDT is a valuable tool that nevertheless does have some limitations. It also does not require opening up the rope and damaging it in the process. The loss of metallic cross-sectional area and local faults, such as broken individual

wires and strands can usually, but not always be detected."

****

Perform magnetic flux leakage testing for [25][50][100] percent of the wire rope to identify defects that are pre-existing in the ropes. Perform the testing prior to the rope being installed. Repeat the testing after the rope has been installed. Perform the testing in accordance with ASTM E1571. Personnel performing the testing must be qualified in accordance with the requirements of ASTM E1571.

Prepare and submit a Wire Rope Flux Leakage Test Plan that details the step-by-step procedure to inspect the ropes. Detail any differences in the testing procedure between the pre-installation testing and post-installed testing. Include in the plan the qualifications of the personnel who will be performing the testing, and the up-to-date calibration certificates of the test instruments.

Prepare and submit Wire Rope Magnetic Flux Leakage Test Results (Pre-Installation) and Wire Rope Magnetic Flux Leakage Test Results (Post-Installation) reports. Reports must contain the results from the Magnetic Flux Leakage Testing. Include the following in each report:

a. Identify which wire rope(s) the report covers. Reports must identify which end of the wire rope that the testing started from and all data must be identified by the corresponding rope.

b. Identify all local flaw (LF) and loss of metallic cross-sectional area (LMA) indications that are detected during testing. Document where the indications are located along the rope. For post-installation reports only; identify which LF and LMA indications are new from the pre-installation testing.

c. Verification from the Contractor that all LF or LMA indications are within acceptable values for that kind of defect.

2.1.7 Stress Relief "(Wrapping Test)"

Stress relieve the wire rope, and perform testing in accordance with FS RR-W-410 to verify stress relief. Submit test results.

2.1.8 Weld Distribution

Wire joints in any strand must not be closer than 450 mm 18 inches in any strand.

2.1.9 Galvanizing

****

NOTE: Wire rope woven from galvanized wires will have much better resistance to corrosion than un-galvanized wire rope woven from bare carbon steel. It will also have better resistance to corrosion than wire rope woven from drawn galvanized wire. However, it will also have a significantly lower strength. If full strength is required, then use wire rope woven from plain carbon steel or from drawn galvanized wire depending on how important corrosion resistance is. If full strength is not required, but high corrosion resistance is required,

use wire ropes woven from galvanized wire and perform the zinc coat test to verify the zinc thickness. See FS RR-W-410 for information on the rate of zinc coating. Stainless steel or Kevlar wire rope would not be galvanized, and this entire paragraph would be deleted.

****

[Weave the wire rope from drawn galvanized wire. That is, the wires galvanized prior to their last drawing operation. The wire rope must have the same accepted industry standards for nominal strength as it would, had it not been galvanized.] [Weave the wire ropes from galvanized wire. Apply zinc at a rate of [_____] grams per square meter ounces per square foot of wire surface. The Contractor must perform testing in accordance with FS RR-W-410 to verify the zinc coating has been applied at the required rate. Submit test report.] [Apply zinc coating by either the electrolytic plating process or by hot dipping in molten zinc. The weight of the zinc coating on each wire must be as specified in ASTM A1023/A1023M.]

2.1.10 Strand Pitch Length

Must not be less than 4-1/2 times the nominal rope diameter.

2.1.11 Core Strand Wires

The number of wires in the core strand must be equal to or greater than the number of wires in the other strands. Use the same material as the wires in the other strands, or use a material with a lower tensile strength.

2.1.12 End Terminations

****

NOTE: EM 1110-2-3200 discusses materials and coatings, and attachment methods for sockets. Note that the wire rope industry usually recommends replacing sockets when replacing wire rope. Sockets are usually selected from a catalog, however they can be custom fabricated. Spelter sockets are the Army Corp of Engineers standard for end terminations. Swaged sockets can be specified but are not suitable for Lang lay rope. Both types should develop 100 percent of the wire rope strength. Do not use molten zinc with stainless steel spelter sockets. Do not use molten zinc or epoxy resin spelter sockets with stainless steel wire rope in saltwater applications due to susceptibility to crevice corrosion. Swaged sockets can be used in saltwater applications.

****

Submit shop [fabrication] drawings, as specified. [The wire rope end terminations must be [an open] [a closed] spelter socket type with poured zinc or epoxy resin. Spelter sockets must be [forged] [cast alloy] [galvanized steel] [stainless steel] [swaged type of carbon steel suitable for cold forming] conforming to FS RR-S-550F.][Submit spelter socket NDT test results.] [Provide fabricated wire rope end terminations as indicated [on Drawing No. [_____]], and cast from [steel conforming to ASTM A148/A148M, Grade 105-85] [stainless steel conforming to

ASTM A351/A351M CF8M] [_____]. Secure the wire rope in fabricated sockets with poured zinc or epoxy resin.]

2.1.13 Tension Testing

Submit rope tension test report. Perform a tension test to verify the wire rope meets the accepted industry standards for nominal strength. Test two rope samples to failure to be sure the expected performance level has been met. Perform the test using suitable tension testing equipment and by qualified personnel. Submit certification of rope tension testing device. Cut the rope samples to no less than 1 meter 3 feet of length. The test will not be considered valid if the failure occurs less than 50 mm 2 inches from either socket or holding mechanism and the test must be repeated. Relative speed between the machine heads must not exceed 25 mm 1 inch per minute.

[2.1.14 Attaching and Proof Loading Terminations

****

NOTE: EM1110-2-3200 suggests that pre-stretching the wire rope and proof loading the terminations might be accomplished simultaneously. However, for multi-rope drums the wire rope would need to be pre-stretched first to be sure they are closer to their final correct length before attaching the terminations. If the sockets must be attached in the field delete this paragraph.

****

The Contractor must attach the end terminations after pre-stretching the wire rope. [The end termination attachment method is indicated on the plans.] After their attachment, proof load the wire ropes at 40 percent of nominal strength of the rope. Measure the length of the wire ropes to the nearest 0.25 mm 0.01 inch at a load of [_____]. Submit proof load of terminations test report and measured rope lengths.

]2.2 LUBRICATION

****

NOTE: All frequently used wire rope should be lubricated, however, if operation is infrequent, it may be best to specify that it not be lubricated. Explained in EM 1110-2-3200, some cases where the wire rope is rarely operated, the presence of a heavy lubricant may increase corrosion on wire ropes. Carbon steel wire ropes in saltwater applications should have a durable protective lubricant coating.

If the end user has their own lubrication product, they may provide the lubricant.

****

Submit literature for proposed factory and field lubricant. The field and factory lubricants must be compatible. [Lubricate the wire ropes at the time of manufacture. Apply the lubricant with equipment capable of forcing the lubricant between the rope wires, including the center strand.] [Do not lubricate the wire rope.] [Lubricant will be supplied by the Government.]

PART 3 EXECUTION

3.1 REMOVAL OF EXISTING WIRE ROPE

Existing removed wire rope becomes the Contractors' property after removal. Remove from the site following all federal, state, and local laws and regulations.

3.2 EXAMINATION

****

NOTE: Insert dates in this paragraph for supply contracts that primarily involve wire rope and do not have full front end sections.

For multi-section design bid build contracts site visit dates are typically included in the Contracting front end documents. Delete this paragraph and include the dates in the front end.

****

[It is recommended that bidders visit the site before submitting bids. A pre-bid site visit, between the dates of [_____] and [_____] can be arranged by contacting [_____] at telephone number [_____]. [See Section [_____] for site visit arrangements.]

]3.2.1 QA Inspections

Provide means for Government witness inspections at the Contractors' manufacturing facility. Up to two representatives of the Contracting Officer will be present to witness the various manufacturing processes for the wire rope. At a minimum, a site visit will be made by the Government to witness the tension test, and the wire rope will be inspected upon delivery. Inspection during removal of the existing wire rope and installation of the new wire rope will be ongoing. Provide means for remote or teleconference inspection upon request.

3.2.2 Verify Dimensions

After becoming familiar with the details of the work, verify dimensions in the field, and immediately advise the Contracting Officer of any discrepancies before performing any work.

3.3 ATTACHING SOCKETS

****

NOTE: Delete this paragraph if the sockets are to be attached at the wire rope factory.

****

Attach the end terminations to the wire rope [as indicated] [in accordance with Drawing No. [_____]] and the recommendations of WRTB.

3.4 CLEAN DRUMS AND SHEAVES

Clean all drum and sheave grooves with a power wire brush, and inspect them for wear, abrasion, corrosion or other roughness and verify their dimensions are suitable for the new wire rope. Immediately advise the

Contracting Officer of any problems.

3.5 LUBRICATION

Lubricate the wire ropes after they are installed, but before break-in/testing. Submit the proposed method in the work plan.

3.6 UN-REELING AND INSTALLING WIRE ROPE

****

NOTE: EM 1110-2-3200 suggests at least two and preferably three dead wraps on the rope on the drum.

****

Attach the wire rope(s) to spools or pulleys as shown on the plans. Wind the wire rope under adequate tension and guide the each end of the rope(s) to its proper location. Wind the wire rope in the same direction it was bent during its manufacture. Ensure that no twists or loops occur. Do not install wire rope damaged during installation by kinking, and remove from the site. Submit the proposed method of un-reeling and installing in the work plan.

3.7 FIELD TENSIONING [SINGLE LINE] [MULTI-LINE] HOISTS

3.7.1 Field Tensioning Plan

Submit a wire rope tensioning plan that includes:

1. Pre-Opening Tension Measurements and Adjustments
2. Initial Tension Measurements and Adjustments
3. Final Tension Measurements and Adjustments.

Adjust the wire rope tension of [single line][multi-line] hoists to ensure that they share load equally. Submit the proposed field tensioning method in the work plan. [For each multi-line hoist rope drum, final tension values for each rope must be no more than plus or minus 5 percent from the average of the individual rope tension values. For two multi-line hoists on a gate, the total wire rope load on each hoist is computed by summing the measured tension values for all wire ropes on a hoist.] The total wire rope load on each hoist must be within a range less than or equal to 0.5 percent of the average of the two total wire rope loads. Measure and adjust wire rope tensions while keeping the gate properly positioned and aligned[in the slot]. After "break-in/testing" test the ropes to determine if they share load equally, and if not, re-tension.

[3.7.2 Tensioning Instrumentation and Certificates

At every phase of the tensioning process, take tension measurements of the hoist wire rope using a tension meter. Submit Wire Rope Tension Equipment Calibration Certifications, which includes certifications for current calibration and tension measurement accuracy. Operators of the tension measuring equipment must be trained by the Contractor to use the equipment and have experience performing tension measurements using the equipment. Submit tension equipment operator qualifications detailing the training and experience of the operator of the tension equipment.

][3.7.3 Pre-Opening Tensioning Measurements

Pre-opening tensioning must achieve a tension value for each rope within a range that is equal to ten (10) percent of the average of the wire ropes initial tension values. For the [two (2)][_____] [hoists on a gate][_____], the total wire rope load on each [hoist][_____] must be computed by summing the measured tension values for all wire ropes on a [hoist][_____]. The total wire rope load on each [hoist][_____] must be within a range equal to five (5) percent of the average of the [two (2)][_____] total wire rope loads.

][3.7.4 Tensioning Procedure

Observe the [gate][_____] stopped [two (2)][_____] times prior to operating the equipment to check rope tension. Adjust rope tension during the pre-opening stops until all hoist ropes for the equipment have approximately equal tensions. The first pre-opening stop must occur when the wire ropes are supporting approximately 10 percent load. The second pre-opening stop must occur when the wire ropes are supporting approximately 75 percent equipment load.

][3.7.5 Initial Tensioning Measurements

For each [hoist][_____] rope drum, initial tensioning of the wire ropes must achieve a tension value for each rope within a range that is equal to five (5) percent of the average of the wire ropes initial tension values. For the [two (2)][_____] [hoists][_____], the total wire rope load on each [hoist][_____] must be computed by summing the measured tension values for all wire ropes on a [hoist][_____]. The total wire rope load on each [hoist][_____] must be within a range equal to 0.5 percent of the average of the two (2)[_____] total wire rope loads. Wire rope tensions must be measured and adjusted while keeping the [gate][_____] properly positioned and aligned in the [slot][_____].

]3.8 BREAK-IN/TESTING

After installation is complete, run the gate-operating device through [one] [two] [three] [four] [_____] complete cycles, fully open to fully closed.

3.9 ORDERLY WORK AREA/SITE CLEANUP

Maintain neat and orderly storage and work areas. The Contract will not be considered complete until all the tools, equipment and property have been removed from the site, and the storage and work areas have been restored. Remove all dirt, debris, litter etc. from project and dispose of in a proper manner.

-- End of Section --