

AMENDMENT NO. 4
SPECIFICATION NO. L-500 kV (REVISION 1)
CONSTRUCTION OF 500 KV TRANSMISSION LINE
APRIL 2001

The following amendment shall be made with the entitled specifications.

1. **Section D. Insulator and Hardware, Article D-7. Tests, Item a. Complete Conductor Insulator and Hardware Assemblies**, revise as follows:
- a) On page D7, **revise sub-item (1) Corona and RIV Tests, sub-sub-item (a) Type of Test Assemblies**, revise this sub-sub-item to read as follows:

“(a) Type of Test Assemblies. A complete set of each of the following assemblies or EGAT’s requirement shall be tested to satisfy the requirements specified.

<u>Type of Assembly</u>	<u>Reference Assembly</u>
Conductor suspension assemblies "V-String"	3D, 5D, 8D, 9D 19D and 20D
Conductor deadend assemblies	13D, 14D OR 13AD and 15D
Jumper support assembly - "V-String"	-
Jumper support assembly 17 "I-String"	17D "

(b) Test Station. The test station shall be subject to EGAT's approval. Such test station shall possess an excellent and wide reputation, having at least 10 years of experience in conducting electrical performance tests of insulators, hardware and complete insulator and hardware assemblies including extensive knowledge and experience in conducting tests at the 500 kV voltage level.

(c) Test Arrangement. Before performance of any corona and RIV test the Contractor shall submit detail drawings showing the assemblies to be tested to EGAT for approval. The drawings shall be complete and show the arrangement of all hardware, insulators suspension unit with armor rod installed and any accessories such as weights which will be used in the actual test. The drawings shall show the calculated corona inception voltage, distance from the ground plane, dimensions of the laboratory and location of the test specimen with respect to hereby large pieces of equipment. Test arrangements shall be in accordance with the following requirements:

(1) Corona observation and RIV measurements shall be made in a darkened and quiet laboratory or other suitable location approved by EGAT.

(2) The test shall be performed on a simulation arrangement of the tower that will actually be used. If the test is to be performed in an outdoor laboratory, the assemblies shall be placed on a mock-up of the ground plane that simulates the tower to be actually used. The mock-up configuration shall include complete tower window.

(3) Each conductor suspension and conductor deadend assembly to be tested shall be completely assembled with hardware, insulators and conductors in accordance with the drawings approved by EGAT.

(4) The conductor dead end assembly shall be tested complete with compression dead-ends, jumper terminals and a partial jumper loop.

(5) The test arrangement shall consist of a four conductor bundle configuration of same type in the contract or aluminum tube with same diameter of that conductor. The type and length of conductor or tube to be used shall be approved by EGAT. The conductor or tube to be used for the tests shall be provided by the Contractor at his own expense and shall be in clean and good conditions.

(6) It is intended that the basis for establishing the corona levels of these assemblies in clean and dry condition shall be by comparison with the corona inception level of the conductor when in clean and dry condition. The geometry of the test with single phase voltage shall be such as to reproduce the electrical surface gradients on the conductors which would be obtained when in the geometry of 3-phase voltages of the actual line.

(d) Test Procedure. Test shall be performed in accordance with the following requirements:

(1) Before performing the test, the Contractor shall submit a proposed voltage range to be applied during the test to EGAT for approval.

(2) Install 1 (one) type of hardware assemblies from the list in a(1)(a) with complete dimension as shown in approved drawing by EGAT except that grading ring is not included.

(3) Perform the pretest with the following procedure:

a. Apply a starting voltage above the visual corona level until the visual corona appears.

b. The voltage shall be reduced slowly while visual corona just disappears in turn from each identifiable item of the assembly, and until the assembly as a whole is free from visual corona. These levels shall be photographed with a minimum one minute time exposure, and voltage maintained on each assembly for a minimum of five minutes.

Soravich Hirinman

(4) Perform the test with the following procedure:

- a. Apply a starting voltage above the visual corona level until the visual corona appears.
- b. The voltage shall be reduced slowly while visual corona just disappears in turn from each identifiable item of the assembly, and until the assembly as a whole is free from visual corona. These levels shall be photographed with a minimum one minute time exposure, and voltage maintained on each assembly for a minimum of five minutes.
- c. RIV readings shall be recorded at each voltage level with at least consist of voltage level of 280 kV, 300 kV, 320 kV and 340 kV. A curve of ambient RIV shall be obtained up to the maximum test voltage.

The RIV measurements including definitions, test conditions and test circuit shall be made in accordance with NEMA Standard 107 or an equivalent approved by EGAT.

(5) The first criterion for acceptance of the hardware assemblies, or of any item thereof, shall meet all three of the following conditions.

- a. In the test mention in (4)b: all visual corona just disappears at a voltage not less than the apparent corona level shown in hardware assemblies proposal data of the conductors, both hardware and conductors being observed simultaneously.
- b. In the test mention in (4)c: RIV reading at 320 kV is not more than the RIV state in the hardware assemblies proposal data.
- c. In the test mention in (4)c: when a graph of RIV reading against the voltage level of 280 kV, 300 kV, 320 kV and 340 kV is plotted, slope of the line pass through the 280 kV, 300 kV, 320 kV is the same to slope of the line pass through the 300 kV, 320 kV, 340 kV

(6) At the same type of hardware assemblies, install the grading ring and then perform the procedure in (3), (4) and (5) respectively with additions.

- a. Visual corona just disappears at a voltage not less than the voltage in (5a)
- b. RIV reading at 320 kV is not more than the RIV in (5b)

(7) The hardware assemblies satisfied by the first criterion for acceptance (5) and the second criterion for acceptance (6) pass the corona RIV test. Otherwise, the hardware assemblies fail the corona RIV test.

Soravich Hirroman

(e) Modification of Hardware Components. Any component of hardware or portion thereof failed to meet the requirements specified above shall be modified or replaced to the satisfaction of EGAT at the Contractor's expense. The entire group of assemblies shall then be retested at the Contractor's expense.

Modification of Hardware Components can only made at once for each hardware assemblies type. If a modification are made but failure to meet the requirements is still occurred, The hardware assemblies shall be rejected.

- b) On page D9, **sub-item (2) Lightning Impulse, Switching Surge and Power Frequency Flashover Tests, sub-sub-item (a) Type of Test Assemblies**, revise this sub-sub-item to read as follows:

“(a) Type of Test Assemblies. Each of the following insulator assemblies shall be subject to test.

<u>Type of Assembly</u>	<u>Reference Assembly</u>
	<u>4x1272 MCM</u>
Conductor suspension assemblies “45°/45° V-String”	3D
Conductor deadend assemblies	14D
Jumper support assembly “I-String”	17D ”

- c) On page D10, **sub-item (2) Lightning Impulse, Switching Surge and Power Frequency Flashover Tests, sub-sub-item (c) Test Arrangement**, revise this sub-sub-item to read as follows:

“(c) Test Arrangement. Simulation arrangement for these tests shall be as follows:

- (1) Assembly 3D shall be tested on a full-scale mock-up of a DL(3°) or DQV3 tower. This assembly shall be fixed at a swing angle which results in a conductor to tower clearance of 4 meters for these tests.
- (2) Assemblies 14D and 17D shall be tested on a full-scale mock-up of the DT40 or DQT40 tower. ”

2. **Section HH. Air Navigation Obstruction Marking and Lighting**, pages HH2 through HH5, **Article HH-3. Marking of Overhead Shield wire and HH-4. Lighting of Steel Towers**, delete this article in its entirety and replace with the following:

“HH-3. Marking of Overhead Shield wire

Where required, the overhead shield wires shall be marked with orange and white colored fiber glass spheres. The spheres shall be 60 to 80 cm in diameter. Any metal parts, if used, for holding the spheres in position shall not cause corrosion or harmful effects to the overhead shield wire.

Soravich Hiraman

The position of the spheres shall meet the following requirements:

- a. The spheres on the two overhead shield wires of any span shall be so staggered that the maximum distance between any two spheres is not greater than 40 m.
- b. The first and the last spheres in any span shall be approximately 10 m from the towers defining the span.

HH-4. Lighting of Steel Towers

The Contractor shall furnish lighting system for installation on towers in accordance with the following detailed requirements:

1. Lighting of Obstacles. Where Obstacle Lights are required, they will be installed on steel towers as shown in drawings attached in the Contract Documents, equipped with solar energy generator. For completeness of the lighting system installation, the Contractor shall furnish and install all conduits, conduit fittings, outlets, wiring, lighting fixtures, lamps, control and protection devices, including any other materials as necessary for Obstacle Lights. Nominal voltage of the lighting system shall be appropriate for the direct current source. All equipment shall be products of recognized manufacturers who regularly supply lighting equipment and solar energy generator. All work shall be performed in accordance with the standard practice for weather proof installation. All metal parts shall be rust-resistance or hot-dipped zinc galvanized materials.
 - a. Obstacle Lights. The characteristics of obstacle lights shall meet requirements indicated in this specification of Lighting of Obstacles and International Civil Aviation Organization (ICAO) International Standards and Recommended Practices for Aerodromes (Annex 14, Volume I). The obstacle light shall show a succession of red flashes and be equipped with one bulb for operation and spare bulb enclosed in aviation red color lens globe. The spare bulb shall replace the out bulb by means of an automatic control rotating bulb changer. The efficient LED or other lighting technology shall be allowed to be used when their characteristics of light meet requirements including the long life time, resistance to weather corrosion conforming to the related international standard and ability to operate continuously under environmental conditions of application on high voltage transmission line. Detailed specifications shall be as follows:
 - (1) Obstacle light on Top of tower for transmission tower higher than 45 meters above ground level and Crossing tower.

Light Type	Medium-intensity, Type B
Operating voltage	48.0 / 24.0 volt D.C. or equivalent
Effective intensity of red light	Not less than 2000 CD
Flashing frequency, approx.	Between 20 and 60 flashes per minute

Sorajich Hirroman

Lens	300 mm red tempered glass, single piece Fresnel vertical divergence at least 5° at 1/10 peak intensity
Mounting base	Corrosion – resistance cast alloy

- (2) Obstacle light on Top of tower for transmission tower having a height not exceeding 45 meters above ground level and other position of installation being specified in drawings for Crossing tower.

Light Type	Low-intensity, Type B
Operating voltage	48.0 / 24.0 volt D.C. or equivalent
Effective intensity of red light	Not less than 32 CD
Lens	155 mm red arorylic, single piece Fresnel vertical divergence at least 4° at 50% intensity
Mounting base	Corrosion – resistance cast alloy

- (3) Obstacle light for other transmission tower being specified in drawings attached to the Contract Documents.

Light Type	Low-intensity, Type A
Operating voltage	24.0 volt D.C. or equivalent
Effective intensity of red light	Not less than 10 CD
Lens	155 mm red arorylic, single piece Fresnel vertical divergence at least 4° at 50% intensity
Mounting base	Corrosion – resistance cast alloy

b. Control. The Obstacle lights shall be switched by a photoelectric control and load contactor. The photoelectric control shall provide automatic switching of contactor so that the lights will be turned on and off at a sky intensity level approximately 35 foot-candles and 60 foot-candles, respectively.

The Obstacle lights shall be installed in the manner to ensure vision from aircraft at any normal angle of approach. The equipment with solid state devices shall be designed to withstand transient voltage by including or separating surge protection devices.

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2. Power Supply Circuit Breaker. Circuit breaker for termination of the tower lighting circuits shall be automatic, fuse less, thermally operated, 2-pole, 125 volt D.C., interrupting power rating not less than 1.0 kA and thermal overload current as shown in the drawings attached in the Contract Documents. The deviation of lighting circuits shall be considered with the appropriation of the installed equipment and shall be approved by EGAT.
3. Power Supply Source. The units of power supply for lighting system shall be in accordance with those specified in the drawings.
 - a. Battery. Battery shall be of sealed lead acid battery, and capable to stand in service without need of water addition throughout battery life period. The batteries in association with the solar panel shall be sized for the nominal load under normal condition and additionally shall be sized for at least 120 hours stand by operation (one day operation and four days stand-by) under condition of no sun days. Each battery shall have capacity of containing not less than 100 ampere hours at 100 hours and self-discharging not less than 5 ampere hours per month. The battery container shall be made of high quality polypropylene.
 - b. Battery Charge and Discharge Control. Battery charge and discharge controller shall be matched with D.C. supply voltage of the system. Charge controller cut-off voltage shall be adjustable between 115 – 120% of rated voltage. Discharge controller cut-off voltage shall be 87.5% of rated voltage and initial discharge shall not be less than 104% of rated voltage.
 - c. Solar Energy Generator. Solar energy generator for generating D.C. power to charge battery shall consist of one or more than one set of a unit of one solar cell contained in one panel. Each solar cell shall not be less than 36 silicon photovoltaic cells. Silicon wafers shall be positioned in two closely fitted plates molded of borosilicate crown glass or high transmittivity of unused infrared. A blocking diode shall be provided to prevent power feedback from the battery bank at night. Solar module frame shall be made of highly corrosion-resistant aluminium alloy. The front and back glass surfaces shall be able to withstand damage from humidity, salt water and abrasion. Detailed specifications shall be as follows:

Power	Not less than 50 watts at 25°C
Open circuit voltage	Not less than 21 volts
Terminals/output connection	Naval brass coated with tin or equivalent, enclosed in water proof box
Fixing solar cell in panel	Solar cell shall be fixed in panel by suitable mounting with bolts in array frames and the position of solar cell shall be able to provide terminals connected in series/parallel.
Solar generator panel	15 degrees angle from the horizontal plane and facing south

Computer simulated sizing of batteries and solar panel shall be provided by supplier for EGAT's approval, where sizing is performed based on meteorological data of the applicable location during, at least, the last one year.

4. Solar Regulator. Solar regulator shall be provided with overcharge, deep discharge and reverse current protection, reverse polarity connection of solar panels and reverse polarity connection batteries. The solar regulator housing shall also be provided with termination facilities for batteries, short circuit protection of batteries and isolation of system for maintenance purpose.
5. Lighting Cable and Conduit. The lighting cable shall be insulated by single conductor. Sizes of lighting cable and conduit are as shown in the drawings. Positive and negative polarity shall be red and black respectively. The Connection wiring lead shall be standard joint wiring with protected insulation suitable to use in conduit. The conduit shall be of galvanized corrugated steel, covered with polyvinyl chloride (PVC).
6. Battery and Necessary Equipment Cabinet. The battery and necessary equipment cabinet shall be made of hot-dip galvanized steel, weather proof and well ventilation designed, with opened and locked door. "

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