INDEPENDENT POWER TRANSMISSION OPERATOR S.A.

TRANSMISSION NEW PROJECTS DEPARTMENT

TRANSMISSION LINES EQUIPMENT ELECTRICAL DESIGN AND CABLES ENGINEERING SECTION

SPECIFICATION TR - 4

FITTINGS FOR 150 kV TRANSMISSION LINES

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ATHENS - GREECE

INDEPENDENT POWER TRANSMISSION OPERATOR S.A.
TRANSMISSION NEW PROJECTS DEPARTMENT
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Specification TR - 4

1. SCOPE

This specification covers the design, manufacturing and testing of the fittings for 150 kV Transmission Lines. The assemblies of the fittings in strings are shown in drawings TR-4/00-1, TR-4/00-2 and TR-4/00-3.

2. GENERAL REQUIREMENTS

2.1 General

The fittings shall be in accordance with the basic requirements of the drawings TR-4/01 up to TR-4/33B and present specification. The fittings shall also be in accordance with the requirements of paragraph 4.1 of IEC Standard 61284 when applied and don't conflict with the requirements of this specification. The quality of the fittings during the manufacturing process will be verified by standard EN ISO 9001. Also the fittings must be designed so as to:

- be free from appearance defects such as cracks, burrs, notches, and distortions, defective machining of the surfaces, bubbles and castings defects in general.
- be inherently resistant to atmospheric corrosion or be suitably protected against corrosion, such as can occur in transport, storage and in service.
- have breaking load not smaller than those referred to in the corresponding drawings.

2.2 Materials

2.2.1 Fittings shall be made of material suitable for the purpose that they are intended for and must meet the requirements of the corresponding drawings. Also materials' quality shall meet the requirements of International Standards ISO and DIN, such DIN 17100, DIN 17200, ISO 630, ISO 683, in order to achieve the required mechanical properties. Welded fittings are not acceptable if the welding is stressed during the operation of the fitting.

2.2.2 The material of cotter-pins, washers and spring-washers shall not cause galvanic corrosion with the adjacent parts. Especially the cotter-pins shall be made of brass or bronze except for cases of contact with aluminium where the cotter-pins shall be made of stainless steel.
The stainless steel shall have great resistance to corrosion and its quality shall be 18Cr-8Ni or equivalent.

2.2.3 Iron and steel parts of the fittings shall be hot dip galvanized in accordance with the EN ISO 1461/99 and ASTM A 143/A 143M – 03 Standards.

2.3 Dimensions

Dimensions of the fittings shall conform to the requirements of the basic dimensions and tolerances indicated in the corresponding drawings. These dimensions are final (after galvanization). Tolerances applied to the dimensions shall ensure that the fittings meet their specified mechanical and electrical requirements of the present specification. When tolerances are not specified in the drawings, they shall meet the following requirements:

	Dimension	**Tolerance**
-	Up to and 35 mm	±0,7mm
-	Over 35 mm	±2%

Basic dimensions indicated in the drawings are indispensable for the assembling of the fittings in strings as indicated in drawings TR-4/00-1, TR-4/00-2 and TR-4/00-3.
These dimensions are not connected with the dimensions which are required to secure the

specified strength of the fittings. These last dimensions shall be determined by the manufacturer.
The bolts that referred to the fittings and corresponding drawings shall be of the metric system.

2.4 Marking

2.4.1 Each fitting shall be marked in relief with the identification number of the fitting shown in the IPTO's corresponding drawing, the characteristic mark of the manufacturer and specified minimum failing load.

2.4.2 Compression fittings must be also marked with the conductor size or the code name for which they are intended, compression die sizes and the length to be compressed. Parallel groove clamps must be also marked with the conductor diameter for which they are intended and the specified installation torque of their bolts and nuts.

2.4.3 Each of the performed armor rods shall be clearly and indelibly marked with a tab where the specified data will be marked according to paragraph 2.4.1 of present specification. Also at each rod, it shall be marked the characteristic mark of the manufacturer, the conductor diameter or code name of conductor for which the set is intended and also the mark AR. Armor rods shall be centre marked in an approved manner.

2.5 Packing and Handling

2.5.1 Packing and handling of the fittings must be in such a manner that protects them from damage in transit (by sea, plane, rail way, on road), handling and outdoor storage.

2.5.2 Fittings must be packed in strong wooden cases with suitable dimensions that can be packed in pallets (Europallet is preferable with dimensions 0.8x1.2m), or wooden pallet cases with proper modulation for easy longshoring with suitable forklifts. In case of cases that are packed in pallets the maximum gross weight shall be 50kg and shall also be fitted with two handle ropes.

2.5.3 In both alternative ways of packing, each case or pallet case shall contain only one type of fitting and shall have total quantity of 100 items, maximum. The use of lag, from metal or synthetic material is also required in order to secure each case between them and on pallets.

2.5.4 Especially compression fittings shall be packed properly, with film or individual sealed plastic case, in order to protect electrical contact surfaces of each sleeve and terminal.

2.5.5 Especially for the preformed armor rods, each set of rods shall be taped together as a unit. It is not acceptable the tying/tightening with rope or wire.

2.5.6 Each case or pallet case shall be plainly and indelibly marked with distinctive markings of the following data:
- Manufacturer's name or trademark,
- Order/Contract number,
- Fitting code name or corresponding IPTO's drawing,
- Gross weight,
- Quantity.

3. TECHNICAL DATA

All the requirements shall be in accordance with paragraph 4.2 of IEC Standard 61284, when applied and don't conflict with the requirements of this specification.
Every fitting at 104 kV (20% higher than the nominal phase voltage) shall have a radio noise level not higher than 50 db above 1 microvolt across 300 Ohms at 1 MHz.
Manufacturer/suppliers shall provide IPTO with the assembly or installation instructions of T.L. fittings, as long as necessary. Also for specific types of fittings the followings are valid:

3.1 Compression fittings for phase conductor and shield wire

3.1.1 General: The compression fittings shall be of the hexagonal type and shall bear, without damage or slipping of strands of the conductor, the loads defined in the drawings which correspond to the 95% of the ultimate breaking strength of the corresponding conductor or shield wire. Values of the ultimate breaking strength of each type of the conductor or shield wire are referred to in paragraph 7 of the present specification.
All compression fittings shall be designed to minimize internal voids and to prevent the ingress or entrapment of moisture during service.
All the aluminium parts of compression dead-end clamps, joints and repair sleeves shall be of at least 99.5% pure aluminium.
The materials of compression fittings shall be capable of withstanding the cold working due to compression. Furthermore, the steel compression components shall have sufficient impact strength after the compression.
The manufacturer shall use for the tests suitable compression dies of hexagonal type so that the dimensions after compression shall be those shown in the corresponding drawings.

3.1.2 Compression fittings for phase conductor: The compression fittings of phase conductor shall meet the requirements shown in the drawings TR-4/20 up to TR-4/21A-2 and TR-4/23 up to TR-4/24A and TR-4/26, TR-4/27. Each joint and dead-end clamp or any part thereof shall have an electrical resistance not exceeding 75% of an equivalent length of the conductor.
Aluminium repair sleeves shall be used for the repair of damaged aluminium strands of conductor. These sleeves shall be of the compression type and shall be designed to make good a conductor of which less than one-third of the strands in the outer most layer have been severed. Fittings and connectors intended for the restoration of electrical and mechanical properties of a conductor shall have clearly defined the manufacturer's instructions as to the extent of damage which is intended to be repaired.

3.1.3 Compression fittings for shield wire: The compression joints and the compression dead-end clamps of the shield wire shall meet the requirements shown in the drawings TR-4/22, TR-4/22A, TR-4/25 and TR-4/25A.

3.2 Insulator set fittings and earth wire fittings

Insulator set fittings and earth wire fittings shall meet the requirements shown in the drawings TR-4/01 up to TR-4/15. In cases of the fittings shown in drawings TR-4/02, TR-4/02L, TR-4/03, TR-4/03L, TR-4/13 and TR-4/13L the cotter-pins shall be made of phosphor-bronze or of stainless steel. Dimensions of balls and sockets of the fittings shown in the drawings TR-4/01, TR-4/02, TR-4/02L, TR-4/03, TR-4/03L, TR-4/12, TR-4/13 and TR-4/13L shall be designed and checked in accordance with IEC Standard 60120/84, for 16 mm pin diameter (standard size 16A).
Manufacturer shall submit with the offer the Specified Minimum Damage Load (SMDL), Specified Minimum Failing Load (SMFL) and the permanent deformation at SMDL for the above fittings.

3.3 Suspension clamps

Suspension clamps shall meet the requirements shown in the drawings TR-4/04, TR-4/05, TR-4/06 and TR-4/07. The suspension clamps shall be free to pivot in the vertical plane containing the conductor and shall permit the conductor to slip (25% of U.T.S. of conductor) before the failure of the aluminium strands occurs. The suspension clamps must be designed to avoid the localized pressure or damage to the conductor or the earth wire in service and shall have sufficient contact surface to avoid damage by fault currents. Also clamps shall be designed so that the effects of vibration, both on conductor or on the shield wire and on the clamps themselves, are minimized.
The phase conductor installed in the suspension clamps can be used bare or equipped with a set of aluminum preformed armor rods.
Manufacturer shall submit to the offer of the Specified Minimum Damage Load (SMDL), Specified Minimum Failing Load (SMFL), the permanent deformation at SMDL and also the values of Specified Minimum Slip Load and the specified installation bolts tightening torque.

3.4 Protective fittings

Protective fittings are distinguished in preformed armor rods which shall meet the requirements shown in drawings TR-4/28A, TR-4/29A and arcing horns which shall meet the requirements shown in the drawings TR-4/16, TR-4/17, TR-4/18 and TR-4/19.

3.4.1 Preformed armor rods: Armor rods are required to reinforce the conductor at the suspension point and to protect it against bending, compression, abrasion and arcover damage. Also it's required to restore full conductivity and mechanical strength to conductor where damage does not exceed 50% of the outer strand layer or 25% of outer and inner strand layers and is located at suspension point or within mid span area. Performed rods shall have right-hand lay direction, identical to lay-direction of the outer layer of the phase conductors LINNET and GROSBEAK.
Beside the data written on the drawings, the length of armor rods shall be as follows, in order to install the Stockbridge vibration dampers in their specified placement:

- for conductor *LINNET* : ≤ 1830 mm,
- for conductor *GROSBEAK* : ≤ 2490 mm.

The design of the performed fittings shall consider the optimum combination of the conductor diameter, inside diameter of helical rods, diameter of individual rods, and number of rods, pitch length, number of pitch lengths, lay direction, rated breaking strength and material. The helical rod fitting shall have the inner diameter smaller than the outer diameter of the conductor, to which it is applied and will distribute the gripping pressure on the conductor over a large area, thus avoiding stresses and potential damage that exist when the pressure is applied at one point on the conductor. The maximum efficiency is maintained by each rod exerting a uniform low radial pressure inherent with spring tempered material.
The performed rods to be applied on conductors LINNET and GROSBEAK shall be BALL-ENDED to provide a smooth and round finish.
Material quality and manufacture methods shall be in such a way that there will be no relaxation and subsequent looseness after application.

3.4.2 Arcing horns: Arcing horns shall be designed so as to provide sufficient protection to insulator sets against damage caused by 30kA power arcs of 0.5 sec duration. Also they shall be designed in such a way so as not to be subjected to breakage through fatigue due to vibrations caused by wind.
In case that steel tubes are used as arcing horns, both the internal and external surfaces of the tubes shall be hot dip galvanized according to International Standards EN ISO 1461/99 and ASTM A 143/A 143M – 03.

3.5 Parallel groove clamps and counterpoise connector

Parallel groove clamps and counterpoise connectors shall be in accordance with the requirements of drawings TR-4/33A, TR-4/33B and TR-4/32. Also parallel groove clamps shall be snuffbox-type for two (2) conductors, cast from aluminum alloy, with proper bolts and nuts made from stainless steel which cannot be separated from each other when the clamp is disassembled. Manufacturer must submit the specified installation tightening torque of the bolts and nuts. Parallel groove clamps with different dimensions of body and keeper are also accepted after tests or proper test reports which verify that they shall withstand the specified 30kA/0.5s power arc.

4. TESTS

All required tests should be preformed in proper laboratories, accredited according to International Standard ISO/IEC 17025. Sample and routine tests could be also performed to manufacturer's laboratory, if it is certified by ISO 9001. Test reports shall be written in Greek or English language and shall be certified by laboratory where the tests have taken place. All tests shall be in accordance with the requirements of International Standards IEC 61284, EN ISO 1461/99, ISO 2859, ASTM A 143/A 143M – 03 and DIN VDE 0212 Part 51, where applicable and according to following paragraphs.
All tests for fittings shall meet general requirements of paragraph 6 of IEC 61284 and shall take place, depending on the type of fitting, in accordance with Table 1 of the same

specification, where it's applicable and don't conflict with the requirements of this specification. Especially mechanical type tests shall be performed on 3 (three) fittings and electrical type tests shall be performed on 4 (four). All fittings shall pass the type tests.
Sample tests will take place in delivery of fittings and the samples to be tested shall come up from sampling plan procedure according to International Standard ISO 2859. There will be inspection by attributes, with Acceptable Quality Level AQL = 0.65, Inspection Level S–4, Normal Inspection and Single Sampling Plan.

4.1 Tests of compression fittings for phase conductor and shield wire

Fittings shown in drawings TR-4/20 up to TR-4/27 shall be subjected to following tests with corresponding acceptance criteria. In case of repair sleeves, shown in drawings TR-4/26 and TR-4/27, they shall be assembled for the test in samples of conductor, where the number of severed strands shall be the nearest whole number to one third of the total number of strands in the outermost layer.

4.1.1 Mechanical tests: Mechanical tests shall be carried out by using the conductor for which compression fittings are intended.

4.1.1.1 Tensile test

Procedure: Compression fittings, shown in drawings TR-4/20 up to TR-4/25A, shall be subjected to type and sample test and repair sleeves, shown in drawings TR-4/26 and TR-4/27, shall be subjected only to sample test according to paragraph 11.5.1 and paragraph 11.7 of IEC 61284, respectively.
Value M of load P which is required for the tensile test must be equal to M = 0.2×RTS (Rated Tensile Strength) of the conductor for which fittings are intended and the SMFL must be equal to SMFL = 0.95×RTS. Time T, for which the load will be maintained to a value equal to 60% of SMFL, must be equal to T = 30min. Test shall be completed according to alternative (a) and the load shall be steadily increased until it reaches the value of SMFL in 1min.
When the test is completed the load shall be steadily increased until failure of fittings occurs. Values of failure load shall be recorded.
Value of load RTS is the nominal tensile strength of the conductor and its values for each type of conductor are referred to paragraph 7 of the present specification.

Acceptance criteria

a) Type tests: Acceptance criteria shall comply with the requirements specified in paragraph 11.5.1, for type tests with alternative (a) method.
b) Sample tests: Acceptance criteria shall comply with the requirements reported in the acceptance criteria for type tests.

4.1.2 Electrical tests: Compression fittings of phase conductor shall be subjected to type and sample test according to paragraph 13 of IEC 61284. These types of fittings belong to class A of joints (class A: tension joints) and shall be subjected to Heat Cycle test.

4.1.2.1 Heat cycle test

Procedure: Heat cycle test is carried out with the typical test circuit that is described in Annex B of IEC 61284. The procedure shall meet the requirements of paragraph 13.5.2 with the following data of Table 3 of paragraph 13.5:
N = 1000 cycles
T_f = 70°C (temperature rise of the reference conductor above the ambient)

Acceptance criteria

a) Type tests: Acceptance criteria shall comply with the requirements specified in paragraph 13.5.2.2.
b) Sample tests: Acceptance tests shall comply with the requirements reported in the acceptance criteria for type tests.

4.1.3 Visual examination: Compression fittings shall be subjected to type and sample test.

The procedure of the test shall meet the requirements of paragraph 7 of IEC 61284.

4.1.4 Dimensional and material verification: Compression fittings shall be subjected to type and sample test. The procedure of the test shall meet the requirements of paragraph 8 of IEC 61284.

4.1.5 Hot dip galvanizing: Compression fittings made of iron or steel parts shall be subjected to type and sample tests. Procedure and acceptance criteria of the test shall comply with the requirements of EN ISO 1461/99 and ASTM A 143/A 143M – 03, when don't conflict with the requirements of this specification.

4.2 Tests of insulator set fittings and earth wire fittings

Insulator set fittings and earth wire fittings shall be subjected to the following tests with relevant acceptance criteria.

4.2.1 Mechanical tests: Insulator set fittings and earth wire fittings shall be loaded in a direction which is as close as possible to the direction of load in service.

4.2.1.1 Mechanical damage and failure load test

Procedure: Insulator set fittings and earth wire fittings, except suspension clamps shown in drawings TR-4/04 up to TR-4/07, shall be subjected to type and sample test according to paragraph 11.3.1 of IEC 61284. The Values of SMDL, SMFL and permanent deformation of the fitting at SMDL, which are required for the tests, shall be given by the manufacturer, because these values depend on the quality of material and the treatment of each fitting, during fabrication.

Acceptance criteria

a) Type tests: Acceptance criteria shall comply with the requirements specified in paragraph 11.3.1 of IEC 61284.
b) Sample tests: Acceptance criteria shall comply with the requirements reported in the acceptance criteria for type tests.

4.2.2 Visual examination: Insulator set fittings and earth wire fittings shall be subjected to type and sample test. The procedure of the test shall meet the requirements of paragraph 7 of IEC 61284.

4.2.3 Dimensional and material verification: Insulator set fittings and earth wire fittings shall be subjected to type and sample test. The procedure of the test shall meet the requirements of paragraph 8 of IEC 61284.

4.2.4 Hot dip galvanizing: Insulator set fittings and earth wire fittings, made of iron or steel parts, shall be subjected to type and sample tests. Procedure and acceptance criteria of the test shall comply with the requirements of EN ISO 1461/99 and ASTM A 143/A 143M – 03, when don't conflict with the requirements of this specification.

4.3 Tests of suspension clamps

4.3.1 Mechanical tests

4.3.1.1 Vertical damage load and failure load test

Procedure: Suspension clamps shall be subjected to type and sample test according to paragraph 11.4.1 of IEC 61284. Test will be carried out according to Method A of the same paragraph. The values of loads, permanent deformation and angle (α) shall be given by the manufacturer.

Acceptance criteria

a) Type tests: Acceptance criteria shall comply with the requirements specified in paragraph 4.2.1.1 of present specification.
b) Sample tests: Acceptance criteria shall comply with the requirements reported in the acceptance criteria for type tests.

4.3.1.2 Slip test

The conductor used in the slip test shall be the one for which the clamp is intended.

Procedure: Suspension clamps shall be subjected to type and sample test, according to paragraph 11.4.3 of IEC 61284. The suspension clamp shall be placed according to figure 5(a) of IEC 61284 and the specified minimum slip load is equal to 25% of minimum failing load of the conductor, for which the clamp is intended.
Slip test shall be carried out according to step «f» and then step «h», of the same paragraph.
Values of minimum failing load for each type of conductor are referred to paragraph 7 of present specification.

Acceptance criteria

a) Type tests: Acceptance criteria shall comply with the requirements specified in paragraph 11.4.3.
b) Sample tests: Acceptance criteria shall comply with the requirements reported in the acceptance criteria for type tests.

4.3.1.3 Clamp bolt tightening test

Suspension clamps shall be subjected to type and sample test according to paragraph 11.4.5 of IEC 61284.

4.3.2 Visual examination: Suspension clamps shall be subjected to type and sample test. The procedure of the test shall meet the requirements of paragraph 7 of IEC 61284.

4.3.3 Dimensional and material verification: Suspension clamps shall be subjected to type and sample test. The procedure of the test shall meet the requirements of paragraph 8 of IEC 61284.

4.3.4 Hot dip galvanizing: Suspension clamps, made of iron or steel parts, shall be subjected to type and sample tests. Procedure and acceptance criteria of the test shall comply with the requirements of EN ISO 1461/99 and ASTM A 143/A 143M – 03, when don't conflict with the requirements of this specification.

4.4 Tests of protective fittings

Protective fittings shall be subjected to the following tests with the relevant acceptance criteria:

4.4.1 Mechanical tests: Preformed armor rods shall be subjected to type tests and arcing horns shall be subjected only to sample test.

4.4.1.1 Static test

Preformed armor rods shall be subjected to type test according to paragraph 3.1.2 of DIN VDE 0212 Part 51. Test shall be performed on 3 (three) sets and all tested sets shall pass successfully the test.

4.4.1.2 Dynamic test

Preformed armor rods shall be subjected to type test according to paragraph 3.1.3 of DIN VDE 0212 Part 51. Test shall be performed on 3 (three) sets and all tested sets shall pass

successfully the test.

4.4.1.3 Endurance test

Preformed armor rods shall be subjected to type test according to paragraph 3.1.4 of DIN VDE 0212 Part 51. Test shall be performed on 3 (three) sets and all tested sets shall pass successfully the test.

4.4.1.4 Tensile test

Arcing horns shall be subjected to tensile test, as sample test. Arcing horns shall be placed properly and a load equal to 1 kN shall be applied in a direction which is as close as possible to the direction shown in relevant drawings. This load shall be kept constant for T = 60s. The test is passed if no failure of the fitting occurs, but permanent deformation of the fitting after the removal of the load is permitted. All fittings shall pass successfully the test.

4.4.2 Visual examination: Protective fittings shall be subjected to type and sample test. The procedure of the test shall meet the requirements of paragraph 7 of IEC 61284.

4.4.3 Dimensional and material verification: Protective fittings shall be subjected to type and sample test. The procedure of the test shall meet the requirements of paragraph 8 of IEC 61284.

4.4.4 Hot dip galvanizing: Arcing horns, made of iron or steel parts, shall be subjected to type and sample tests. Procedure and acceptance criteria of the test shall comply with the requirements of EN ISO 1461/99 and ASTM A 143/A 143M – 03, when don't conflict with the requirements of this specification.

4.4.5 Installation test: Preformed armor rods shall be subjected to type and sample test as follows:

- Fittings will be installed on samples of the conductors of suitable length under tension, in accordance with the application instructions submitted with the offer.
- Conductors shall not be greased.
- It shall be checked that rods are uniformly applied on the conductor, without distortions and the ends are aligned within the limits specified in the offer.
- The positive grip of the rods shall be checked, e.g. either by sliding individual rods along conductor axis, by hand pressure over the applied length and at the ends of rods, or by hitting over the applied length.
- No looseness of the rods applied on conductor shall be accepted.

4.5 Tests of parallel groove clamps and counterpoise connector

4.5.1 Mechanical tests: The conductor used in the mechanical tests shall be the one for which the fittings are intended. If one size of fitting is offered for more than one size of conductor, the test shall be carried out on both the largest and smallest size of conductors.

4.5.1.1 Tensile test

Parallel groove clamps and counterpoise connector shown in corresponding drawings TR-4/33A, TR-4/33B and TR-4/32, shall be subjected to type and sample test in accordance with the following procedure and acceptance criteria.

Procedure: The test shall be performed by using proper tensile testing machine and the fitting anchored in such a way that the test load is applied in the direction of the conductor, which has the same size and type with that it is to be used. All bolts and nuts shall be tightened with the installation torque specified by the manufacturer.
A tensile load of 0.6 kN shall be applied and the conductor shall be marked in such a way that movement relative to the fitting can easily be detected. Any relative movement less than 2mm is accepted. Without any subsequent adjustment of the fitting, the load shall be steadily

increased up to 1.2 kN. This load shall be maintained for 1 min.

Acceptance criteria

a) Type test: Acceptance criteria for type tests are the following:
- There shall be no movement of the conductor relative to the fitting due to slip during the period of 60s.
- No failure of the fitting (sample) shall occur during test.

b) Sample test: Acceptance criteria shall comply with the requirements reported in the acceptance criteria for type tests.

4.5.1.2 Clamp bolt tightening test

Parallel groove clamps and counterpoise connector shall be subjected to type and sample test according to paragraph 11.4.5 of IEC 61284.

4.5.2 Electrical tests

Parallel groove clamps and counterpoise connector, shown in corresponding drawings TR-4/33A, TR-4/33B and TR-4/32, shall be subjected to type and sample tests. The conductor used in electrical tests shall be the one for which fittings are intended. If one size of fitting is offered for more than one (1) size of conductor, the test shall be carried out on both the largest and smallest size of conductors.
These types of fittings belong to class B of joints (class B: non - tension joints) and shall be subjected to Heat Cycle test and Short - time Overcurrent Pulse test according to paragraph 13 of IEC 61284.

4.5.2.1 Heat cycle test

Procedure: Heat cycle test is carried out with the typical test circuit that is described in Annex C of IEC 61284. The procedure shall meet the requirements of par.13.5.3 with the following data of Table 3 of paragraph 13.5:
N = 1000 cycles
Tf = 70°C (temperature rise of the reference conductor above the ambient)

Acceptance criteria

a) Type tests: Acceptance criteria shall comply with the requirements specified in paragraph 13.5.3.2.
b) Sample tests: Acceptance criteria shall comply with the requirements reported in the acceptance criteria for type tests.

4.5.2.2 Short - time Overcurrent Pulse test

Procedure: Test procedure shall comply with the requirements of paragraph 13.5.3 with similar data to the above test. Also it is required that the number for short-circuit pulses from table 3 of paragraph 13.5 to be as the following:
N_{sc} = 3 pulses.

Acceptance criteria

a) Type tests: Acceptance criteria shall comply with the requirements specified in paragraph 13.5.3.2 for relevant test.
b) Sample tests: Acceptance criteria shall comply with the requirements reported in the acceptance criteria for type tests.

4.5.3 Visual examination: Fittings shown in drawings TR-4/33A, TR-4/33B and TR-4/32 shall be subjected to type and sample test. The procedure of the test shall meet the requirements of paragraph 7 of IEC 61284.

4.5.4 Dimensional and material verification: Fittings shown in drawings TR-4/33A, TR-4/33B and TR-4/32 shall be subjected to type and sample test. The procedure of the test shall meet the requirements of paragraph 8 of IEC 61284.

4.5.5 Hot dip galvanizing: Fittings shown in drawings TR-4/33A, TR-4/33B and TR-4/32, made of iron or steel parts, shall be subjected to type and sample tests. Procedure and acceptance criteria of the test shall comply with the requirements of EN ISO 1461/99 and ASTM A 143/A 143M – 03, when don't conflict with the requirements of this specification.

5. TECHNICAL DATA OF THE OFFER

The manufacturer must submit to the Company the following data with his offer:

5.1 Detailed drawing in full scale with all dimensions and tolerances, for every fitting. On the drawing, it shall be also mentioned the method of manufacture, the material and the quality for every part of the fitting and the weight of the fitting. On the drawings, it shall be also mentioned the values of SMDL, SMFL, minimum slip load, permanent deformation of the fitting at SMDL and the specified tightening torque of the bolts, when it is necessary, for the performance of all the specified type and sample tests.

5.2 A reference list of at least three (3) Electrical Companies, who have buy enough quantities of the same or similar type of material with these that are offered which have been used with excellent operation on overhead Transmission Lines, for a period of at least five (5) years followed by the corresponding certificates.
Reference list and corresponding certificate shall include the exact type of material, operation voltage, exact quantity and the date of selling or installation.
Certificates shall be original or validated copies and distinct regarding the Electrical Company that edit and guarantee the excellent operation of corresponding material.
Bidders that have supplied in the last decade, IPTO or PPC with the requested material, have no obligation of submitting the above prerequisites, provided that it does not change the factory of manufacture.

5.3 Description of the manufacturing process shall be given. A quality assurance program (EN ISO 9001) for the factory, to verify the quality of the fittings during the manufacturing process shall also be given. Also manufacturer/supplier must submit the place that each fitting will be manufactured.

5.4 Test reports concerning the type tests specified in paragraph 4, of present specification, with full data in order to enable the Company to evaluate their offers in accordance with the requirements of present specification. All the specified tests must be referred to each type of fitting. The Company has the right to accept or to reject any fitting after checking its suitability.

5.5 Description (drawing) of the package which manufacturer/supplier select for each of two (2) alternative ways specified in paragraph 2.5 of present specification.

5.6 Technical brochures for offered items.

6. INSPECTION

6.1 The fittings shall be subjected to inspection and shall not be released for shipping without the approval of the Company's representative. The approval for shipping shall neither relieve the Manufacturer from responsibility of furnishing material conforming to all requirements of the Company nor invalidate any claim which the Company may make because of defective or unsatisfactory material.

6.2 For type test reports that haven't been submitted or that aren't adequate according to the requirements of paragraph 4 of present specification, IPTO reserves the right to request the performance of any or all type tests specified in corresponding paragraphs of present

specification on samples which shall be taken from the production of the offered items. The Company reserves the right to select test laboratory and witness any or all tests.

6.3 Manufacturer shall submit to the Company copies of the control and test reports of the material. The Company reserves the right to demand all the routine test reports from the manufacturer.

6.4 In each delivery quantity, sample tests shall be performed in accordance with the requirements of corresponding paragraphs of present specification.

6.5 All Bidders shall have to state the manufacturers of the material, as well as all related sub-contractors, if any.
They shall also have to submit along with their offer a Quality Assurance Plan (Q.A.P), for the manufacturing procedure of the stated manufacturer and all potential sub-contractors, by which it shall be evident in a detailed way the entire manufacturing procedure, the quality control equipment as well as all quality control stages, including all of the related printed material and referring to the specific international standards and regulations applied.
During the Technical Evaluation procedure, IPTO shall reserve itself the right to monitor the production procedure so as to ascertain the application of the Q.A.P. and, in general, to conclude on the production procedure, in a way that shall deem the offer technically acceptable or not.

7. INFORMATION DATA

Information data concerning insulators and conductors which are assembled with the fittings of this specification are given below:

Insulators: Insulators from toughened glass with ball and socket type couplings in accordance with IEC 60120/84 for 16 mm diameter (size 16A).

Light conductor: ACSR 336400 CM (code name LINNET). Conductor overall diameter 18.31mm, Al wires 26x2.9mm, St wires 7x2.26mm, steel core diameter 6.75mm, minimum breaking strength 60kN.

Heavy conductor: ACSR 636400 CM (code name GROSBEAK). Conductor overall diameter 25.15mm, Al wires 26x3.95mm, St wires 7x3.08mm, steel core diameter 9.27mm, minimum breaking strength 102kN.

Light reinforced conductor: AACSR type. Conductor overall diameter 18.31mm, ALMELEC wires 26x2.9mm (Al alloy with 0.6% Si, 0.7% Mg and tensile strength 33kg/mm²), St wires 7x2.26mm (R type, tensile strength 160kg/mm²), steel core diameter 6.75mm, minimum breaking strength 91kN.

Heavy reinforced conductor: AACSR type. Conductor overall diameter 25.15mm, ALMELEC wires 26x3.95mm (Al alloy with 0.6% Si, 0.7% Mg and tensile strength 33kg/mm²), St wires 7x3.08mm (R type, tensile strength 160kg/mm²), steel core diameter 9.27mm, minimum breaking strength 168kN.

Shield wire: galvanized steel, 7x3.17mm, overall diameter 9.53mm, minimum breaking strength 64kN.

Reinforced shield wire: galvanized steel wires (R type, tensile strength 160kg/mm²), 7x3.17mm, overall diameter 9.53mm, minimum breaking strength 85kN.

Counterpoise: galvanized steel, solid-core, overall diameter 10mm, minimum breaking strength 27kN.

SPECIFICATION TR – 4 DRAWINGS

No.	Description	Drawing No.
1.	Phase conductor and Shield wire suspension assemblies for 150kV T.L.	TR-4/00-1
2.	Phase conductor and Shield wire tension assemblies for 150kV T.L.	TR-4/00-2
3.	Phase conductor double suspension assembly for 150kV T.L.	TR-4/00-3
4.	Self Locking Hook	TR-4/01
5.	Socket Eye for Light conductor	TR-4/02
6.	Long Socket Eye for Light conductor	TR-4/02L
7.	Socket eye for Heavy conductor	TR-4/03
8.	Long Socket Eye for Heavy conductor	TR-4/03L
9.	Suspension clamp for Light conductor	TR-4/04
10.	Suspension clamp for Heavy conductor	TR-4/05
11.	Suspension clamp for Jumper	TR-4/06
12.	Suspension clamp for Shield wire	TR-4/07
13.	Chain link 70kN	TR-4/08
14.	Chain link 160kN	TR-4/09
15.	Shackle 100kN	TR-4/10
16.	Shackle 160kN	TR-4/11
17.	Shackle 90°	TR-4/11A
18.	Ball - clevis	TR-4/12
19.	Socket - clevis	TR-4/13
20.	Long socket - clevis	TR-4/13L
21.	Double tension string yoke	TR-4/14
22.	Double suspension string yoke	TR-4/14A
23.	Extension link for single tension string	TR-4/15
24.	Arcing horn for double tension string	TR-4/16
25.	Twin arcing horn for double tension string	TR-4/17
26.	Arcing horn for single tension string	TR-4/18
27.	Adjustable arcing horn for single tension string	TR-4/19
28.	Compression dead end clamp for Light conductor	TR-4/20
29.	Compression dead end clamp for Light conductor without jumper terminal	TR-4/20-1
30.	Jumper terminal for Light conductor	TR-4/20-2
31.	Compression dead end clamp for Reinforced Light conductor	TR-4/20A
32.	Compression dead end clamp for Reinforced Light conductor without jumper terminal	TR-4/20A-1
33.	Jumper terminal for Reinforced Light conductor	TR-4/20A-2
34.	Compression dead end clamp for Heavy conductor	TR-4/21
35.	Compression dead end clamp for Heavy conductor without jumper terminal	TR-4/21-1
36.	Jumper terminal for Heavy conductor	TR-4/21-2
37.	Compression dead end clamp for Reinforced Heavy conductor	TR-4/21A
38.	Compression dead end clamp for Reinforced Heavy conductor without jumper terminal	TR-4/21A-1
39.	Jumper terminal for Reinforced Heavy conductor	TR-4/21A-2
40.	Shield wire compression dead end clamp	TR-4/22
41.	Compression dead end clamp for Reinforced Shield wire	TR-4/22A
42.	Compression joint for Light conductor	TR-4/23
43.	Compression joint for Reinforced Light conductor	TR-4/23A
44.	Compression joint for Heavy conductor	TR-4/24
45.	Compression joint for Reinforced Heavy conductor	TR-4/24A
46.	Compression joint for Shield wire	TR-4/25
47.	Compression joint for Reinforced Shield wire	TR-4/25A
48.	Repair sleeve for Light conductor	TR-4/26
49.	Repair sleeve for Heavy conductor	TR-4/27
50.	Preformed armor rods for Light conductor	TR-4/28A
51.	Preformed armor rods for Heavy conductor	TR-4/29A
52.	Counterpoise connector	TR-4/32
53.	Parallel groove clamp for conductors ACSR Linnet - Grosbeak	TR-4/33A
54.	Parallel groove clamp for conductors ACSR Linnet - Grosbeak	TR-4/33B