DESFA
Hellenic Gas Transmission System Operator

HELLENIC GAS TRANSMISSION SYSTEM OPERATOR

357-359, MESSOGION AVE.,
15231 ATHENS, GREECE
Tel.: 210 6501258
Fax : 210 6501551

TECHNICAL JOB SPECIFICATION

799/5

REVISION 0

DATE 05/04/2011

HIGH PRESSURE (HP) TRANSMISSION SYSTEMS

FIELD INSTALLATION AND TESTING OF ELECTRICAL EQUIPMENT

QUALITY ASSURANCE PAGE

CHANGES LOG

REVISIONS LOG

0	05-04-2011	FIRST ISSUE	PQ DPT.	V.G.
Rev. No	Rev. Date	REASON FOR CHANGE	Made By	Approved By

CONTENTS

REFERENCE DOCUMENTS

Job Spec. No. 181/2
[Pressure Testing]

EU DIRECTIVE 94/9/EC ATEX
[Equipment Explosive Atmospheres Directive]

ELOT HD 384
[Erection of power installations with nominal voltages up to 1000 V]

Standard Specification ΠΤΠ Ο 150, ΦΕΚ 294/66 Β

1.0 GENERAL

This specification has the scope to give a guide of technical requirements to be followed by Contractor at the Field.

The following denomination are used in this Specification:

- Contractor
- Supervisor

2.0 PROJECT BASIS

2.1 SPECIFICATIONS

Installations, assemblies and tests must be carried out very skillfully and according to EU Directives and National legislation in force.

For installation purposes relevant articles of **ELOT HD 384** shall be applied.

In addition to the above the PPC regulations shall be applied where applicable.

The supply of materials by Contractor must be in accordance with the regulations referred as above and with the IEC Recommendations issued by the International Electrotechnical Commission.

Equipment and materials to be installed in hazardous areas (site where there potential hazard of explosion or fire exists) must be certified and approved for their use in classified areas by a Notified Body as required by applicable EU Directives.

Contractor in the terms of Contract shall provide the following:

- carry out the assembly and installation of the plant according to all mentioned EU Directives and European Standards and provide for the plant components a layout such as to prevent any ignition and protect them from deterioration or stresses due to potential ignition in a hazardous explosive atmosphere.
- carry out acceptance tests which consist of ascertaining the compatibility of the installations and assemblies and materials to the above mentioned EU Directives and European Standards.

Contractor takes all the responsibility to comply with the aforesaid legislation as well as of the National one.

2.2 PROJECT DOCUMENTS

Installation and assemblies must be carried out in strict compliance to this Specification and to the Project documents issued by Contractor and listed in the relevant Erection Requisition.

Hereafter these documents are mentioned with the reference number only, without stating the revision; the revision to be considered valid is the one stated in the above mentioned document.

The documents issued by Contractor to be considered integrant part of this Specification are all the documents listed in the Material Requisition No.

Upon completion of the works Contractor must forward to Supervision for approval a copy of all drawings with modifications and variations as carried out marked in red.

3.0 SERVICES TO BE PROVIDED BY CONTRACTOR IN FIELD

3.1 CIVIL WORKS BY CONTRACTOR

Contractor must provide:

Necessary excavation (Contractor's Scope of Works) regarding or related to the electrical installation and foundation of the electrical installation (if required) subject of this Specification.

Execution of civil works related to electrical installations such as drilling for passage of cables and closings, fixing of shelves and supports, execution of bases for H.T. equipment, panels, waterproof or protected batteries, transformers, lighting, installations, etc.

Assure that the civil works provided by Contractor and related to the electrical installation are according to the Scope.

3.2 POSITIONING, ASSEMBLING AND FIXING OF SORT OF THE ELECTRICAL EQUIPMENT AND MACHINES

Placing and fixing of electrical equipment, transformers, switches, circuit breakers, isolators, metering transformers, lightning arresters, medium and low voltage distribution panel, prefabricated substations, switchboards, metering boards, pushbutton columns, push-buttons, signaling and alarm devices, accumulator batteries and of any other element which forms the electrical plants (except the rotary machines in general), lighting equipment, etc.

Assemblage of several elements of the same unit, assembly and fixing of fitting elements, both electrical and mechanical, which have been supplied disassembled for transportation reasons.

The relevant parts in contact and in sliding must be cleaned and greased; bolt, nut and terminals control and tightening that must be controlled and tightened in accordance with Manufacturer's prescriptions.

Assembly of any fitting element both electrical and mechanical, as long as this concerns the electrical installation.

Mounting of telephone and communication equipment in general (microtelephones, loudspeakers, person search, clocks, data transmission and similar etc.).

Mounting of electrical equipment of fire fighting and fire alarm network.

Supply, make mounting of every support and anchorage for above mentioned equipment, included the small pertinent works as clinching, nog, and nail shooting, according to Project documents.

3.3 LAYING OF UNDERGROUND AND ABOVEGROUND ELECTRICAL LINES

Laying of cables, underground and aboveground, inside cable ducts and/or in underground passages, on gangways, seamed to structural works or to walls, inside the buildings.

3.4 CONNECTION OF POWER OR AUXILIARY CABLE

Connection of the cables to panels, machine equipment, and electrical user in general and to any other device subject of this Specification (para. 3.2).

3.5 CONNECTION AND/OR CONSTRUCTION OF BUS-BAR SYSTEMS

Connection and/or construction of bus-bar systems as shown in **para. 4.4.**

3.6 MODIFICATIONS AND/OR ACCOMMODATION OF EXISTING INSTALLATIONS

Modifications and/or accommodation of existing installations as shown in **para. 4.6.**

3.7 ACCEPTANCE, CONSERVATION AND RETURN OF MATERIALS AND EQUIPMENT

When receiving in Field materials and/or of electrical equipment Contractor must take care as follows:

- Periodically to rotate the cable coils with paper insulation and/or with lead mantle, according to the Manufacturer's regulations.

- To seperate all fittings which have not been separately sent, to mark them properly with the label of the equipment which they belong and deliver them to the warehouse where they will be kept.

- To measure with a Megger and to transcribe the values of resistance of insulating of every winding, panel, electrical equipment. What stated above must be carried out as soon as possible after the arrival at the field of each machine or equipment. Any possible defects, must be immediately reported to the Supervisor.

- To clean joints and exposed machined surfaces with solvent and to strew them with protective grease.

- To check the liquid level to electrical equipment immerged in oil or other liquids.
Any possible defects, must be immediately reported to the Supervisor.

- To check cable ducts and/or conduit to make sure that the interior surface is free of unevenness and roughness which may damage the cables during their insertion.
Any possible defects, must be immediately reported to Supervisor.

- To carry out, after authorization by Supervisor, small repairs or setting up of materials or equipment which have been damaged during transportation and/or installation.

- Before the tests and verifications and however before the delivery of the installations to the Owner, Contractor must clean all equipment and installation, removing the dirt, the working remainders, foreign materials, etc.

- Check that all oil levels in the tank are correct (transformers, equipment immerged in oil, etc.), check the greasing and lubrication of moving parts and of check the good preservation of the installations in general.

3.8 PRELIMINARY MEASUREMENTS OF GROUND RESISTIVITY

If required in this Specification and/or by the Supervisor, Contractor must carry out the preliminary measurements of ground resistivity (carried out applying the four soil samples method) and provide the necessary equipment.

3.9 EXECUTION OF GROUNDING OF THE INSTALLATIONS

Execution of grounding of the installation as described in **item 4.4.**

3.10 DRAWING AND DETAILED ENGINEERING SERVICES

Before the delivery of the installation, Contractor must submit to Supervision at least one copy of the drawings with all modifications carried out during the laying of the installation marked in red.

Contractor must provide detailed engineering drawings for some assembly parts which are bound in special conditions of laying and shall be submitted to Supervision for approval.

Contractor must submit to Supervision for approval reproducible copies of the drawings of the lighting installation complete with all detailed electrical connections such as: final location of lighting centers and boxes; the course of cables, pipes and ganways, and any other information necessary to fully understand in detail the drawing of the lighting installation.

4.0 EXECUTION MODALITIES

4.1 WORKS OF PREARRANGEMENT AND LAYING OF CABLE DUCTS AND OF CABLES AND WIRES IN UNDERGROUND PASSAGES, PULLED IN CONDUIT, OR DUCT OR DIRECT LAID BURIED UNDERGROUND

Contractor must carry out with the Supervisor a preliminary examination of the underground cables run, of the underground ducts run and of the courses in the underground passages, to check that there are no interferences with other parts of installation and that the laying and/or pulling of the cables and wires is easy.

All underground cable ducts and/or conduit, isolated or in bundle, must be protected by a continuous or discontinuous concrete casting.

The underground cable ducts and conduit must be fixed and anchored so as to prevent displacements and sliding at the time of the concrete casting.

The spacers must not protrude from the casting. The concrete casting must be carried out monolithic, as much as possible. If some construction joints are necessary during concreting then perfect adherence must be achieved between the joining concrete surfaces.

Concrete must be of grade C15/20 as a minimum and must be colored in red, by a permanent additive, intimately mixed with the concrete itself.

In the joints, where ground settlings may occur (for example passage from paved areas to unpaved ones, road crossings) suitable joints, protected with tar and sand casting, must be provided if required by Supervision.

All cable ducts and/or conduit must be carefully cleaned and blown with air before inserting the cable and wires. The unevenness and roughness in the conduit, if any, must be eliminated with a buffer or chain with a diameter of 6 mm smaller than the inside diameter of the tube, this operation must be carried out before installation.

All conduits which are not connected to a user or to a sealing box must be temporarily closed with threaded plugs, supplied by Contractor, until the final connection is provided.

Preparation of trenches or underground passages for the laying of the underground cables with execution of the sand bed (the leveling of the bottom of the excavation is Contractor's Scope of Work). In case of several tiers of cables, the laying of the intermediate sand layers must be provided by Contractor.

Moreover Contractor must carry out the laying of separating bricks and the covering with protection plates or bricks.

Contractor shall carry out the backfilling of trenches after completion of the installation.

In case of laying in underground passages, the latter must usually be filled with sand by Contractor. The supply of sand, protection bricks and plates is Contractor's Scope of Work.

For the sand bed on which cables are directly laid and for the backfilling up to the grade level or up to concrete slab covers, the sand shall be uniformly graded and compacted up to 90% of Proctor modified method as per **Standard Specification ΠΤΠ Ο 150,** to reduce the void ratio and to achieve a better thermal dissipation. The compaction shall be carried out on the sand bed and on each sand layer with thickness not greater than 20 cm up to top ground level.

Laying of the cables directly underground or in underground passage or in underground duct according to what depicted and stated on the approved drawings and with respect of the rules established by the cables Manufacturer for the installation, in particular the allowable bending radius and the maximum allowed pulling tensions must be applied by Contractor.

Particularly for cables with insulation and/or sheath of thermoplastic material, suitable measures must be taken in case of lying with ambient temperature near 0°C or lower. All equipment necessary for the laying of cables is at Contractor charge (coil holders, slip rolls, pull devices, dynamometers, etc.).

A particular care must be taken by Contractor in the laying and pulling of the cables and wires which are not provided with and abrasion resistant sheath.

Affixing at both ends of each cable, in the particular points of deviation and crossover (usually at the sections shown on the drawings) and however at least every 20 m, of the suitable marks of identification of metal type approved by Supervision with wording as indicated in the details.

The through joints for the underground cables shall be positioned evenly on the prepared well compacted base as above, where bases are provided otherwise the through joint shall be solidly, supported by selected packed earth to provide an even bedding, in order to prevent sinking or displacement of the junction boxes. The junction box shall have metallic or resin body.

The cables shall be so positioned that only the absolute minimum strain is placed on the joint or termination. Cut cables shall have sufficient overlap on each end from the centre point in order to prevent tractive efforts inside the junction box, due to settling.

The cable positioned against the unit to be connected allowing sufficient length for final positioning and for splaying of the cable cores up to the separate connections to the terminals of the motors and of the users in general.

4.2 WORKS OF PREPARATION AND LAYING OF CONDUIT, CABLE TRAY, CABLES AND WIRES ABOVEGROUND

Contractor must carry out with the Supervisor a preliminary examination of the condition of the cables and conduit runs, check that there are no interferences with other parts of the plant and that the laying and/or pulling of the cables and wires is easy.

Working and erection of conduit aboveground and/or underground for a short length and/or flexible conduit, where included cut, bending thread, welding, etc., i.e. any work required to achieve a perfect installation.

Supply, prefabrication and erection of every eventual support and anchorage, for conduit and cable tray, included any relevant minor works such as seaming, nog and nail shooting is Contractor's Scope of Work. Construction must be carried out according to the Project documents.

Bending of the conduits must be carried out exclusively cold with suitable bending machines in compliance with the prescribed radius. Hot bending is allowed only for conduit with a diameter larger than DN 100 and for PVC pipes.

The stirrup works must be proceed together with the erection works: they may follow them only in exceptionally rare cases and within a reasonable elapse of time in order to make the final erection of tubes and the equipment.

For the duct and conduit treatment see **para. 4.1.**

The cable carrier pipes must be installed so as to assure draining of the condensate water in the fixed points, where suitable drain seal devices must be installed.

The slope must be at least equal to 1%.This junction of the conduit must be carried out by applying to the threads before placement a suitable lubricant to achieve a good seal on the joint, to prevent rust and a good ground continuity (Lubricant STL type of Grouse Hinds or similar).

Wires and cables must be pulled in the ducts or conduit in one piece between the terminal and junction box points. Grease or other lubricant may be used on the cables to case pulling providing the lubricant used is compatible with the cable outer covering.

For the laying see **para. 4.1.**

4.3 JUNCTION AND TERMINALS OF THE CABLES AND WIRES

In the circuits with rated tension not higher than 500 V junctions and terminals must be carried out with special screw terminals and compression connectors and must be placed in boxes with required protection degree. The terminals must be of the type specified and/or approved by Supervision. The connectors must be of the type specified and/or approved by Supervision; the junctions and terminals with pressure connectors must be wound with tape with a complete remaking of the insulation.

The connectors must be applied with suitable indent tools.

Junctions for wires and cables inside the conduit are not allowed; junctions on wires and cables placed on cable tray must be approved by Supervision.

In the circuits with tension higher than 500 V the junction must be carried out with parallel wires and in any case according to the cable Manufacturer's regulations.

Generally the compression connectors relevant to the regulations given in **4.3.1** must be used.

The assembly of the cable ends of the joints must be carried out very skillfully according to the regulations of the Project drawings and particularly to the regulations of the Manufacturer of the cable and/or of the cable terminal box and junction box; Contractor must verify or identify the phases and/or the wires. The connections relevant to three- phase systems must be carried out keeping into account the phase sequence.

Unless otherwise specified in **chapter 5.0** the assembly of cable terminals and the junction for cables at nominal tension higher than 3 KV must be carried out by skilled personnel of the Manufacturer of the cables and/or the Manufacturer of the terminals, on Contractor's care and cost.

This requirement could be valid only for nominal tension higher than 30 KV provided that Contractor proves to carry out this work with competent skilled personnel (proved the required experience-certified personnel) according to the regulations of the cable Manufacturer.

For the auxiliary cables of power and for communication cables with insulation and protective sheath in rubber or thermoplastic material, Contractor must supply also the materials of minute assembly, such as insulating tapes and pipes of protection and/or of marking, "Modernotecnica" type or similar and however of a type approved by Supervision.

For the power cables with paper insulation, the terminals, boxes and relevant kit for assembly with fluid, semifluid, solid or at injected resin mixture (Scotch type) are supplied by Contractor, if not differently specified.

For the cables with solid insulation, "Pirotenax" type, Contractor must supply the terminals, the junctions and the outfit for their assembly which must be carried out by skilled personnel with proved the required experience (certified personnel). Materials must be approved by Supervision.

Contractor must supply and position the identification marks of the single wires of power control and auxiliary of the multicore cables; adhesive tapes or small rings "Modernotecnica" type or similar, however of type approved by Supervision can be used.

The lead sheath and/or metallic and/or cable shielding must be suitable grounded with the flexible copper wires and adequate section, however not less than 16 mm^2, supplied by Contractor.

The pressure or mechanical tightening cable terminals type, shall be of type previously approved by Supervision, must if not otherwise specified, be supplied by Contractor and must be fitted for all cables.

For the flexible wires only pressure or mechanical tighten terminals type must be used.

4.4 EXECUTION OF THE CONNECTIONS TO THE EQUIPMENT

Before carrying out the connections of the cables to the motors, the electrical users in general or to any other device, the insulation of the cable and of the equipment must be verified.

The cable connections must be carried out with suitable compression cable terminals of a corrosion resistant type, after coverage taping and identification marking.

The cable terminals must be of the compression type complying to the regulations

given in **para. 4.3.**

Construction of copper bus-bars of interconnections, prefabricated or to be built on site. Cut, bending and drilling of bars, the supply of the bolt and nuts, of the insulators and/or insulating supports included, all according to the Project documents; construction and/or accommodation of the cages or protective metal enclosure.

Suitable non-magnetic materials must be used where required.

4.5 FIXING OF CABLES AND WIRES

Contractor must supply and install the clamps of treated wood with relevant bolts and tightening and/or fixing stirrups, the hooks, cable fixing clamps and claws of the type approved by Supervision for the single case. Supervision must decide the position and the quantity of the fixing points according to the Project documents. Suitable nonmagnetic materials must be used in case of fixing of unipolar cables and wires.

4.6 MODIFICATIONS AND/OR ACCOMMODATIONS TO EXISTING CIRCUITS AND PANELS

Modifications of circuits relative to power, auxiliary and control panels, etc., consisting of the disassembly and reassembly of equipment, modifications to structural works and restoration of paintings, modifications and/or remaking of bus-bars and/or wiring harnesses.

Contractor must supply the materials necessary for the wiring harnesses (wires, raceway, clamps, etc.) and use as much as possible the materials deriving from the disassembly, after the Supervision's approval.

4.7 EXECUTION AND CONNECTION OF THE GROUND INSTALLATION

Contractor must carry out with the Supervision a preliminary examination of the run of the ground wires which do not follow the underground runs, and of ground rods location before their laying and must moreover carry out an accurate detailed survey of their position when the installation is completed.

If required by this Specification or by Supervision, Contractor must carry out the check necessary to ascertain the ground resistivity.

The ground installation must be carried out according to the requirements of the Project documents.

Contractor must supply and install the ground bars and relevant interconnections in bar or in cord inside the buildings and in the plant. Connections to the ground rods (underground cord and ground rods) are included.

The metallic conduit with threaded junctions carried out as per para. 4.2.6 are considered to be grounded through the threaded junctions to the terminal boxes; the free end, if any, must be grounded as well.

Contractor must carry out the connection of all the electrical and non- electrical equipment which according to the mentioned codes and to the Project documents must be connected to the main ground rods.

Contractor must carry out the connection of the ground installation of all metal structures, supports, frames of machines, cable tray, stairs and railings, metal window and door frames, etc., according to the mentioned code and to the Project documents.

All bolts and nuts used for the ground connections must be of iron, with flat washers, brass grower and nuts.

Contractor must install the lightning network according to the requirements of the mentioned code, the Project documents and Manufacturer's regulations.

Moreover Contractor must supply and install all fittings necessary for the installation completion.

Contractor must install the protection installations against the electrostatic discharges, according to the requirements of the mentioned code and the Project documents.

5.0 FIELD TESTS AND INSPECTIONS

5.1 PREPARATION

Contractor must prepare the installations set up, assembled and connected and/or modified for the execution of the tests and inspections scheduled to be carried out both for the part and the whole deliveries.

The operations of inspection will be carried out at Contractor's care and cost by his personnel and with his equipment in the presence of Supervision, in corporation with the supplier of the machinery and/or equipment which are used for the inspection.

Before carrying out the aforesaid tests and inspections Contractor must assure that all the necessary technical documentation is available on site.

Contractor must have available in the field at least the following measurement and control instruments, and always sufficient in quantity for the persons that will work for the assembly and installation:

1 1000V Megger

1 5000V Megger

1 Universal Tester

1 Megger for measure of ground resistance

1 Box of relay test (if specifically required by this Specification and/or by the Supervisor).

1 Equipment for test of medium voltage cables

1 Luxmeter

1 Sequencescope

1 Ammeter pliers with different scales for maximum capacity of at least 600 A

1 Recorder tape oscillograph with at least 3 races, suitable for frequencies up to about 1 kHz (if specifically required by this Specification or by the Supervisor).

5.2 GENERAL CHECKS

Check of the compliance of the electrical plant to the standards and to the Project documents.

Check of the exact location of the lighting fixtures, outlets, switches and of all equipment in general, in comparison to the requirements of the project drawings.

Check of the best orientation of the covers of the junction boxes, taking into consideration that they must be accessed easily for inspection by Owner's Operation and Maintenance personnel.

Check of the good execution of the splices of the electrical wires of the terminal connections to the equipment.

Check of the greasing of all the covers of the explosion-proof boxes, of the breathers and drains fittings.

Check of the appropriate execution of all sealing fittings.

Check of all bolted connections to the earthing rods and to earth bars and check of the bolted connections of earthing conductors to earth plates.

Check of the connections of the protective conductors to the electrical equipment and the connection of the solid earthed transformer star points to the earthing rods and the connection of the normal operating earthing conductors.

Check of the connections to the ground bus of the earthing for the electrostatic charges.

Check of the earthing of the metallic parts which are not components of electric equipment such as cable rack, platforms, stairs, railings, windows and door frames, supports, gas sewage and water drain pipes.

5.3 FIELD TESTING OF MACHINERY, EQUIPMENT AND MATERIAL

Contractor shall carry-out all field tests on machinery, equipment and material following the specific procedures and filling-in all test data in the appropriate forms. Procedures and forms are part of this Specification (see next pages).

5.3.1 POWER TRANSFORMER
See test instructions and forms.

5.3.2 ELECTRIC MOTORS

See test instruction and form.

5.3.3 SWITCHGEARS

See test instructions and forms.

5.3.4 CIRCUIT BREAKERS & CONTACTORS
See test forms.

5.3.5 PROTECTIVE RELAYS
See test forms.

5.3.6 CABLES

See test instructions and forms.

POWER TRANSFORMERS

Item No. : ..... Supplier : .....
Type & Connection : .....
Shelf Cooled / Forced Cooled Rating : .....
Primary / Secondary Voltage : .....

TEST	*VALUES*	*Minimum Acceptable Values*	*DATE*
Winding Insulation Resistance :		1000 MΩ for 150KV	
- Primary - Ground		Megger 2500 Volt	
- C1 - Secondary - Ground		500 MΩ for 6 KV	
- Primary - Secondary		Megger 2500 Volt	
Dielectric Strength of Insulating Oil :		50 KV	
- Test Standard Used CEI 232 Point 3.2.08 Point 5.2			
Thermostat Settings :			
- Alarm			
- Trip			

Tap Changer Setting :	*REMARKS*
- Check Operation of Bucholz.....	
- Check Operation of Tap Changer.....	
- Check Transformer Ground.....	
- Check Neutral Ground.....	
- Check Primary Connection.....	
- Check Secondary Connection.....	
- Oil Level.....	

	Sub-Contractor		*Contractor*				*Owner*	
	Name	*Signature*	*Name*	*Signature*	*Name*	*Signature*	*Name*	*Signature*
Mechanical Completion (PRETURNOVER)								

TEST INSTRUCTIONS OF POWER TRANSFORMERS

A. Test samples of liquid insulating immersed transformer winding rated for 150 KVA service and above must undergo a dielectric strength test.

The test sample must withstand the following minimum voltage stress without an insulation breakdown when tested with a standard testing device.

Oil - 22,000 volts D.C.

If the voltage causing a breakdown is less than the minimum value, the liquid must be (dried) passed through a suitable filter press until the minimum voltage stress can be sustained.

B. Liquid dielectrics shall be tested for dielectric strength with a standard testing device consisting of a test cup, instruments, control and high voltage power supply. The test cup internals shall support two butted electrodes, separated by 2,5 mm gap. Each electrode shall have a polished 25 mm diameter circular disc parallel to the other electrode at the gap interface. 1/2 kg of liquid will be required for the test. After the electrode spacing has been checked with a standard round gage, having a diameter of 2,5 mm, the electrodes will be locked in position. After a suitable rinsing procedure, the test cup will be immediately filled with the liquid sample to be tested. The liquid should be at a temperature of 40°C. During the test the uniform rate of voltage increase should be about 2,000 volts per second. One breakdown should be made on each of 5 fillings, of the test cup. Any individual test which deviates from the average by more than 25% will be test recorded and replaced by an additional test. An average of the first five tests within the allowable deviation will be taken as the dielectric strength of the liquid.

C. Completely assembled, factory-sealed-tank transformers shipped with an insulating liquid successfully passing the preliminary dielectric strength test without filtering, may be put into service after inspection if the cold coil insulation resistance between windings and between windings and ground tests above 6 megohms.

In the event that the insulation resistance value falls below 6 megohms the transformer coils must be dried.

D. Coils for factory sealed-tank-transformers shipped with an insulating liquid failing the preliminary strength (before filtering) and coils for tank type transformers shipped separately without insulating liquid must undergo an out-of liquid short-time "megger" test for insulation resistance to ground and to other windings at a temperature between 60-70°C.

The out-of-liquid insulation resistance must measure above megohm per thousand volts of rated line voltage. Coils with insulation resistance values failing this requirement must be dried.

E. In the event that drying is necessary the transformer coils will be heated to a temperature of 60-70°C for a period of 24 hours by circulating current through the windings.

This may be accomplished by short circuiting either windings (HV or LV) and impressing one to one-half percent of nameplate voltage. (At normal frequency) across the other. Current should be limited to one-fifth to the rated normal full load current by a rheostat in series with the exciting winding.

As the maximum coil temperature is approached, the circulating current should be gradually reduced until a steady state temperature condition is reached within the 60-70°C range.

F. The transformer tank and all fittings shall be inspected and tested for adequate sealing to prevent leakage of insulating liquid, entrance of moisture and loss of inert gas protection before the transformer is energized. During a leakage test the transformer tank shall not be subjected to a pressure greater than the amount specified on the nameplate. If there is no nameplate pressure specified a test pressure of 0,35 bar (5 psi) will be used. The liquid dielectric will be slowly pumped into the sealed transformer until the pressure reads 0,35 bar (5 psi). Joints, connections and gaskets will be checked with chalk dust to detect leaks. Any appreciable leakage will cause a pressure drop within a few hours.

G. The following precautions should be taken before placing the transformer in service :

1. Check liquid level.
2. Check no-load tap changer to be sure it is in operation condition.
3. If provided, check operation of temperature alarm.
4. If provided, check operation of cooling fan relay and circuit.
5. Check grounding of transformer.

ELECTRIC MOTORS

Item No. : ..... Supplier : .....
Power : .... Voltage :
Rated Current : ..... Starting Current : ..... Speed : .....
Fuse Size : .....

TEST	*VALUES*		*Minimum Acceptable Values*	*DATE*
	Before Cable Connection	*After Cable Connection*		
Motor Winding Inasulation Res. : - (Phase 1 - Phase 2) If 6 ends - (Phase 2 - Phase 3) brought - (Phase 3 - Phase 1) out - Phase 1 - Ground - Phase 2 - Ground - Phase 3 - Ground			4 MΩ for 6 KV Megger 5000 V 1 MΩ for 400 V Megger 500 V	
Fuse Size : Protection Relay Settings : - Overcurrent and Time delay - Inst. Overcurrent - Inst. Ground Fault 60/30 Dielectric Absorption Ratio for Motors above 600V : 4 Light Run Test : - Starting Temperatures - Casing Temperatures - Phase Current - Check Operation of Control CCT ..... - Check Direction of Rotation ..... - Check Ground Connection Secure ... - Check Relay Settings in Compliance with Specification ..... - Vibration				

	Sub-Contractor		*Contractor*				*Owner*	
	Name	*Signature*	*Name*	*Signature*	*Name*	*Signature*	*Name*	*Signature*
Mechanical Completion								

TEST INSTRUCTIONS OF MOTORS

A. Insulation Resistance

1. All alternating current synchronous and inductive type machinery rated 7,000 KW and below shall be subjected to an insulation test prior to connecting the machine terminals to the motor feeder. One minute "megger" reading not less than the following minimum values at a machine temperature of 40°C (*) shall be observed before energizing:

Minimum Megohm Values for Machines

7.000 KW & Below - Class A & B Insulation

110V	440V	550V	2300V	3000V	4000V
1.11 meg.	1.5 meg.	1.6 meg.	3.3 meg.	4.0 meg.	5.0 meg.

For all other voltage ratings, the minimum insulation resistance value shall be determined from the following formula:

$$Rm = Kv + 1$$

Where Rm = recommended minimum insulation resistance in megohms at 40°C (*) of the entire machine winding

KV = rated machine potential in kilovolts

(*) If the winding is not at a temperature of 40°C, the observed one minute resistance must be reduced by multiplying the observed value by the temperature co- efficient of insulation resistance (Kt40c) found in the following table:

Winding Temp. °C	0	5	10	15	20	25	30	35	40
Kt40c	0.065	0.09	0.13	0.19	0.25	0.38	0.5	0.7	1.0

2. Three phase machines with only three loads brought out shall have the insulation resistance measured with all three leads connected together.

Three phase machines with all six leads brought out shall have the insulation resistance of each phase measured separately with the other two phases grounded. The observed resistance of each phase shall be divided by two to obtain a value, which after correction for temperature, can be compared with the recommended minimum value of insulation resistance.

3. If the corrected insulation resistance is below the minimum value, the machine must be dried out, as specified below.

It should be noted that for machines in good condition, insulation resistance readings of 10 to 100 times the recommended minimum values are not uncommon.

B. Drying Out Process

1. Machine windings shall be dried out by supplying heat electric strip heaters, from heat lamps or by passing current through machine windings until a sufficiently high, rising insulation resistance is obtained. When current is applied through the windings, it shall not exceed the nameplate rating.

   The temperature maintained during the drying out process should not exceed the following:

   a. Class A Insulation

      By a thermometer .....80°C
      By resistance bridge or a thermal-consitive resistor.....90°C

   b. Class B Insulation

      By a thermometer .....90°C
      By a resistance bridge or a thermal-consitive resistor circuit (RTD) ..... 110°C

   NOTE : Temperatures shown for class B insulation are applicable to class F insulation.

2. Wound rotor induction machines rated 2300 volts and above will be dried out by mechanically locking the rotor than applying a 440 volt, 3 phase, A.C. supply to the stator.

   Regulation shall be obtained from a resistance inserted in the rotor circuit.

3. The applied voltage to produce drying current for other synchronous and induction machines rated 2300 volt and above should not exceed 10% of the nameplate voltage and should not cause more than 60% of nameplate full load current to pass through the windings. The voltage may be increased to 15% of nameplate, after a low insulation resistance increases to 1/2 of the minimum value.

4. The insulation resistance shall be periodically recorded during the drying out process. In large high voltage machines the unitial cold coil resistance value will be high (20 megohms 20°C). (*) As the drying process continues and water vapor is boiled out from the internals of the machines, the insulation resistance will rapidly full to a minimum (6 megohms 90°C).(*) As the drying process nears completion the insulation resistance will reverse its downward trend and settle at a steady higher value (12 megohms 90°C).(*) As the coils cool, after the drying process has been completed, the insulation resistance will rapidly rise (150 megohms 20°C.(*)

5. A period of 24 hours will usually be found sufficient for drying machines rated 600 to 2000 horse powers. Less time will be required for drying smaller machines. Windings which have been exposed to damp and free moisture will take longer to dry out than machines which have been properly stored.

(*) values for comparative purposes only.

C. Inspection

1. Prior to energizing the machine, all foreign objects between the rotor and the stator field coils should be removed.

   Brushes must move freely in their holders making a firm and even contact with collector rings. Voltage and frequency on the nameplate of the machine must correspond with the terminal line voltage and frequency. Belts for directly connected excilers (auxiliaries) shall be in proper running condition.

   All bearings must be properly filled with oil or grease.

   Machine shafts (rotors) shall be cheeked for alignment and rotation before being coupled to other machinery.

2. During the machine test-run, inspect for smoke, unusual noises, vibration and over-heating. Operating conditions must be investigated and corrective action taken when the total temperature (ambient plus rise) exceeds the following values:

3. a. For Class A Insulation 90°C
   b. For Class B Insulation -110°C
   c. For Class H Insulation - 150°C

MEDIUM VOLTAGE MOTOR CONTROL CENTERS

Item No. : ..... Supplier : .....
System Voltage : KV Substation : .....
Type : Indoor / Outdoor Serial No. : .....

TEST	*VALUES*		*Minimum Acceptable Values*	*DATE*
	Disconnect Device Open	*Disconnect Device Closed*		
Bus-bar Insulation Resistance : - Phase 1 - Phase 2 - Phase 2 - Phase 3 - Phase 3 - Phase 1 - Phase 1 - Ground - Phase 2 - Ground - Phase 3 - Ground			50 MΩ Megger 2500V	
	REMARKS			
- Check Floor/Wall Fastening ..... - Check Grounding Connection .... - Check Bus-bar Security ..... - Check Alignment of Withdrawable Elements ..... Note : Protection Device Settings Covered in Motor Record Sheet				

	Sub-Contractor		*Contractor*				*Owner*	
	Name	*Signature*	*Name*	*Signature*	*Name*	*Signature*	*Name*	*Signature*
Mechanical Completion (PRETURNOVER)								

LOW VOLTAGE MOTOR CONTROL CENTERS
TURNAROUND POWER CENTERS & SWITRACTS

Item No. : ..... Supplier : .....
System Voltage : 400 Volt Substation : .....
Type : Indoor / Outdoor Serial No. : .....

TEST	*VALUES*		*Minimum Acceptable Values*	*DATE*
	Disconnect Device Open	*Disconnect Device Closed*		
Bus-bar Insulation Resistance : - Phase 1 - Phase 2 - Phase 2 - Phase 3 - Phase 3 - Phase 1 - Phase 1 - Ground - Phase 2 - Ground - Phase 3 - Ground			3 MΩ Megger 500 V	
	REMARKS			
- Check Floor/Wall Fastening ..... - Check Grounding Connection .... - Check Bus-bar Security ..... - Check Alignment of Withdrawable Elements ..... Note : Protection Device Settings Covered in Motor Record Sheet				

	Sub-Contractor		*Contractor*				*Owner*	
	Name	*Signature*	*Name*	*Signature*	*Name*	*Signature*	*Name*	*Signature*
Mechanical Completion (PRETURNOVER)								

SWITCHGEAR

Item No. : ..... Supplier : .....
System Voltage : KV Substation : .....
Type : Indoor / Outdoor Serial No. : .....

TEST	*VALUES*		*Minimum Acceptable Values*	*DATE*
	C / B's Out	*C / B's in position*		
Bus-bar Insulation Resistance : - Phase 1 - Phase 2 - Phase 2 - Phase 3 - Phase 3 - Phase 1 - Phase 1 - Ground - Phase 2 - Ground - Phase 3 - Ground			50 MΩ Megger 5000V	
Circuit-breaker Insulation Resistance : (Breaker withdrawn from cubicle and manually closed) - Phase 1 - Phase 2 - Phase 2 - Phase 3 - Phase 3 - Phase 1 - Phase 1 - Ground - Phase 2 - Ground - Phase 3 - Ground			50 MΩ Megger 5000V	
D.C. Control Circuit Insulation Resis. Line 1 - Ground Line 2 - Ground			0.5 MΩ Megger 500V	
- Check Protection Settings in accordance with Specs..... - Check Operation of Local / Remote Trip / Close Circuit..... - Check Alignment of withdrawable elements..... - Check Bus-bar Security..... - Check Operation of Automatic Transfer Circuit, ...	*REMARKS*			

	Sub-Contractor		*Contractor*				*Owner*	
	Name	*Signature*	*Name*	*Signature*	*Name*	*Signature*	*Name*	*Signature*
Mechanical Completion (PRETURNOVER)								

TEST INSTRUCTIONS OF SWITCHGEAR

A. Before connecting cable leads to switchgear terminals, internal bus bars and connections shall undergo a short- time "megger" test.

Megger tests should be made preferably during dry, temperate weather.

The switchgear must be dried before going into service if the insulation resistance to ground falls below the following minimum values:

600 volts and below	601 volts to 15,000 volts	Above 15,000 volts
3 meg. (breakers in)	50 meg. (breakers out)	200 meg. (breakers out)

B. Oil, insulating immersed contractors or circuit breakers, must undergo the dielectric strength test.

C. Prior to energizing the switchgear bus, the following items shall be inspected and tested for proper operation.

1. Control, protective and metering circuits.
2. Contact alignment on all contactors and circuit breakers.
3. Setting and calibrating all over current relays as herein after described where this is a part of contractor responsibility.
4. Tanks for oil circuit breakers must be filled before tests begin.

Place the circuit breaker in its "Test Position", (use a plug jumper where necessary) and make the following tests:

a. Close and trip the breaker with its control switch.

b. Manually trip the breaker.

c. Close and trip the breaker from any remote control position.

5. Where the switchgear is arranged for a secondary selective system with automatic transfer schema, the transfer circuits shall be tested by simulated fault and under voltage condition.

6. Operate other auxiliary devices.

CONTRACTOR ..... REPORT No. .....

LOW/VOLTAGE CIRCUIT BREAKERS AND CONTACTORS TEST REPORT

ITEM .....SUPPLIER ..... TYPE : INDOOR/OUTDOOR

VOLTAGE .....KV SUBSTATION..... SERIAL No. .....

TEST	*VALUES*		*NOTE*
		MINIMUM ACCEPTABLE	
INSULATION RESISTANCE OF CLOSE TRIP CIRCUITS	/KΩ		1000 V MEGGER
MINIMUM TRIP VOLTAGE	V		
MINIMUM CLOSE VOLTAGE.....	V		
TIME FROM TRIP APPLIED AT RATED VOLTAGE TO CONTACTS PART	msec		
TIME FROM CLOSE SIGNAL AT RATED VOLTAGE TO CONTACTS TOUCH	msec		
MAIN AND ARCING CONTACT WIRE	mm		WHERE APPLICABLE

REMARKS

1. PROTECTIVE DEVICE SETTING COVERED IN RELAY TEST REPORT
2. SWITCHGEAR, CONTROLGEAR AND M.C.C. TESTS IN RELEVANT TEST REPORT

CONTRACTOR SIGNATURE	*SIGNATURE*	*OWNER SIGNATURE*
DATE	*DATE*	*DATE*

	NEGATIVE SEQUENCE CURRENT RELAY No.....MFG.....LEAFLET.....		TEST REPORT No. .....

PLANT.....
SWITCHGEAR..... CUBICLE..... IDENTIFICATION.....

COMPLETE NAMEPLATE DATA :
In.....A .....Hz Uaux=.....V STYLE.....
SETTING RANGES current unit..... Indicator.....

C.T. RATIO : .....
RELAY SETTINGS : current unit ..... Indicator.....

VISUAL INSPECTION :

FUNCTIONAL TEST :

- INSULATION : 2KV x 1 minute
- MINIMUM PIC-UP CURRENT : range .... measured .....A
- AUXILIARY SWITCH CHECK : ....
- INDICATOR :

TEST DEVICE :

REMARKS :

.... DATE .... TESTED BY ....

	DEFINITE TIME ..... VOLTAGE RELAY ..... No.....MFG.....LEAFLET.....		TEST REPORT No. .....

PLANT.....
SWITCHGEAR..... CUBICLE..... IDENTIFICATION.....

COMPLETE NAMEPLATE DATA :

Vn=.....V .....Hz Uaux=.....V STYLE.....

Setting Ranges..... low voltage .....-.....time delay ..... - .....s.....
..... high voltage .....-.....time delay ..... - .....s.....

V.T. RATIO : .....

RELAY SETTINGS :

SETTING	VOLTAGE UNIT (V)	TIME UNIT (s)
Low voltage		
High voltage		

VISUAL INSPECTION :

FUNCTIONAL TEST :

- INSULATION . 2KV x 1 minute

- MINIMUM PICK-UP VOLTAGE :

TERMINALS	Low Voltage (V)		High Voltage (V)	
	Range	Measured	Range	Measured

- TIME DELAY :

TIME DELAY UNIT	TIME DELAY (s)	
	Range	Measured
Low Voltage		
High Voltage		

- INDICATOR :

TEST DEVICE :

REMARKS :

....DATE.. . ... TESTED BY..... ... .

	INVERSE TIME OVERCURRENT RELAY ..... No.....MFG.....LEAFLET.....		TEST REPORT No. .....

PLANT.....

SWITCHGEAR..... CUBICLE..... IDENTIFICATION.....

COMPLETE NAMEPLATE DATA :

In=.....A Ino=.....A .....Hz Uaux=.....V STYLE.....

Setting ranges inverse unit current .....-.....time .....-.....

definite time unit current.....-.....time.....-.....

instantaneous unit current.....-.....indicator.....

C.T. RATIO : PHASE..... GROUND.....

RELAY SETTINGS :

UNIT	PHASE		GROUND	
	Current (A)	Time	Current (A)	Time
Inverse				
Definite time				
Instantaneous				
Indicator				

VISUAL INSPECTION :

FUNCTIONAL TEST :

- INSULATION : 2KV x 1 minute
- MINIMUM PICK-UP VOLTAGE :

TERMINALS	INVERSE UNIT (A)		DEFINITE TIME UNIT (A)		INSTANTANEOUS UNIT (A)	
	Range	Measured	Range	Measured	Range	Measured

- TIME CURRENT CHARACTERISTIC :

TERMINALS	INVERSE TIME UNIT				DEFINITE TIME UNIT (A)	
	(s) at CURRENT.....xIset		(s) at CURRENT.....xIset			
	Range	Measured	Range	Measured	Range	Measured

- INDICATOR :

TEST DEVICE :

REMARKS :

.....DATE..... .....TESTED BY.....

DEFINITE TIME OVERCURRENT RELAY .....
No.....MFG.....LEAFLET.....

TEST REPORT
No. .....

PLANT.....
SWITCHGEAR..... CUBICLE..... IDENTIFICATION.....

COMPLETE NAMEPLATE DATA :

In=.....A Ino=.....A .....Hz Uaux=.....V STYLE.....

Setting ranges over load current .....-.....time delay .....-.....
short circ. current.....-.....time delay.....-.....
ground current.....-.....time delay.....-.....

C.T. RATIO : PHASE..... GROUND.....

RELAY SETTINGS :

SETTING	CURRENT UNTI (A)		TIME UNIT (s)	
Overload				
Short circuit				
Ground				

VISUAL INSPECTION .

FUNCTIONAL TEST .

- INSULATION : 2KV x 1 minute
- MINIMUM PICK-UP VOLTAGE :

TERMINALS	Overload (A)		Short circuit (A))		Ground (A)	
	Range	Measured	Range	Measured	Range	Measured

- TIME DELAY :

TIME DELAY UNIT	TIME DELAY (s)	
	Range	Measured
Overload		
Short circuit		
Ground		

- INDICATOR .

TEST DEVICE :

REMARKS :

....DATE. ....TESTED BY .....

TRANSFORMER DIFFERENTIAL RELAY .....
No.....MFG.....LEAFLET.....

TEST REPORT
No. .....

PLANT.....
SWITCHGEAR..... CUBICLE..... IDENTIFICATION.....

COMPLETE NAMEPLATE DATA :
In=.....A .....Hz Uaux=.....V STYLE.....
Setting ranges parcentage.....% sensitivity.....%
matching range .....-.....
instantaneous .....-.....A indicator .....

C.T. RATION : HV side..... MV side..... LV side.....
Relay settings : percentage .....% sensitivity .....%
matching set : HV side ..... MV side.....
LV side ..... LV side.....
instantaneous .....A indicator .....

VISUAL INSPECTION :

FUNCTIONAL TEST :

- INSULATION : 2 KV x 1 minute
- MINIMUM PICK-UP CURRENT :

Terminals		Current (A)	
		Range	Measured

- DIFFERENTIAL CHARACTERISTIC :

Restraint current	Operating current (A)	
	Range	Measured

- HARMONIC RESTRAINT : TYPICAL OPERATING CURRENT RANGE.. .. ..- ..... MEASURED
- INDICATOR :

TEST DEVICE

REMARKS

....DATE..... ....TESTED BY..... ..... .

D.C. HIGH VOLTAGE TESTS ON MEDIUM VOLTAGE CABLE CIRCUITS

D.C. High Voltage Test (See **note 1**)

Weather :
Dry.....
Wet.....

- Check terminations not connected to quipment.
- Check ground connection of sheath and armouring

Cable Mark No				
Phase No. (See **note 2**) Test KV (See **note 3**) Start hour and data Test end hour and data Ambient Temperature		....KVx15 (1)	.....KVx15 (1)	.....KVx15 (3)
Current Leakage MA.	0 sec 15 30 45 1 min 2 3 4 5 7 9 12 15			
Voltage Decay KV	0 sec 15 30 45 1 min 2 3 4 5			

NOTES :
1. Tests to be made after installation on metallic shielded or metallic sheathed.
2. Unless in conflict with manufacturers recommendations, the three phase will be tested simultaneously.
3. The test voltage, duration of test and test procedure will be in accordance with the cable manufacturer's specification.

	Sub-Contractor		Contractor				OWNER	
	Name	Signature	Name	Signature	Name	Signature	Name	Signature
MECHANICAL COMPLETION (PRETURNOVER)								

MEDIUM VOLTAGE CABLE CIRCUITS
(Excluding Motor Feeder Cables Operating Below 6,600 Volts)

Weather : Dry..... Wet.....

Cable Mark No.										
Voltage Size & No. Cores Type From Unit No. To Unit No.		KV			KV			KV		
T E S T S		M Ohms			M Ohms			M Ohms		
Insulation Resistance : - Before Backfill :	Phase Phase									
	Phase Ground									
- After Backfill :	Phase Phase									
	Phase Ground									
- Before Energize :	Phase Phase									
	Phase Ground									
Min. acceptable Type of Megger used or test		3 MΩ 5000 Volts			3 MΩ 5000 Volts			3 MΩ 5000 Volts		

	Sub-Contractor		Contractor				OWNER	
	Name	Signature	Name	Signature	Name	Signature	Name	Signature
MECHANICAL COMPLETION								

LOW VOLTAGE CABLE CIRCUITS
(and Motor Feeder Cables Operating Below 6.600 Volts)

Item No.: See Attached Sheet Voltage : .....
Size : ..... Type : ..... Feeder for : .....
Ambient Temp. : .....Weather : Dry ..... Wet .....

TESTS	VALUES			Minimum Acceptable Values	DATE
	Before backfill	After Backfill	Before Energise (1)		
Insulation Resistance : - Phase 1 – Phase 2 - Phase 2 – Phase 3 - Phase 3 – Phase 1 - Phase 1 – Ground - Phase 2– Ground - Phase 3– Ground				3 MΩ for 3KV 1 MΩ FOR 400V Megger 500 V. for 400V. & 2500 Volts for 3 KV	
- Check Ground Connection of Sheath/Armouring..	REMARKS				

	Sub-Contractor		Contractor				OWNER	
	Name	Signature	Name	Signature	Name	Signature	Name	Signature
MECHANICAL COMPLETION								

TEST INSTRUCTIONS OF CABLE

A. Cable considered as part of a primary system installation, with insulation rated for service above 5000 volts, shall be tested for current leakage using a suitable D.C. testing device. The following procedures apply for this testing :

1. Leakage currents should be observed during voltage build-up.

   Faulty installations will cause leakage values to steadily rise after thirty seconds.

2. Final test voltage shall be substained for the required time. A steady leakage current indicates a satisfactory installation. Potheads and terminators isolated by switches, etc. from other equipment may be stresses at the test voltage along with the cable.

3. Cables (or terminators) falling the leakage current test shall be considered as inadequate and must be corrected or replaced :

NOTES:

- Test from each conductor to ground, with other conductors (and shielding, if any) grounded.

- The initial voltage applied to the cable must not exceed the value given for Maximum Initial Voltage, and should preferably be lower. Voltage should be raised from the initial voltage to Test Voltage at a uniform rate such that it takes at least fifteen seconds for each increment equal to the Maximum Initial Voltage.

Test Voltage should be maintained for five minutes and then voltage should be reduced smoothly to the lowest values obtainable before deenergizing the cable. Finally, ground the conductor to drain off any residual charge.

B. Cable considered

Short runs of cable (60m.) rated for service above 5000 volts will be considered as satisfactory installed if the meggered insulation resistance reads above the following minimum values:

Cable Size	Grounded Neutral	Ungrounded Neutral
Up to 25mm^2	5 meg.	6 meg.
35 to 50mm^2	4 meg.	5 meg.
70 to 120mm^2	3 meg.	3 meg.
240 to 400mm^2	2 meg.	3 meg.
500 mm^2	1.5 meg	2 meg

C. Cable for Service, 5000 volts and below, shall be tested with a 500 volt, megohm instrument. Insulation resistance for satisfactory power installation shall not be lower than the following minimum values:

MINIMUM PERMISSIBLE INSULATION RESISTANCE in megohm for 300m. Runs and Below			
CABLE		VOLTAGE	RATING
SIZE	600 V max (*)	3 KV max.	5 KV max.
4 mm^2	1.5	5.0	
6 mm^2	1.5	4.0	
10 mm^2	1.5	4.0	5.0
16 mm^2	1 0	3.0	4.0
25 mm^2	0.4	3.0	3.0
35 mm^2	0 4	2.0	3.0
50 mm^2	0.4	2.0	2.0
70 mm^2	0.3	1.5	2.0
120 mm^2	0.3	1 5	2.0
240 mm^2	0.2	1.0	1.5
500 mm^2	0.2	1.0	1.0

Example: 600 Volt max. 185 mm^2, length below 300 m. -0.3 megohm min. insulation resistance.

(*) Minimum permissible values of insulation resistance for lighting branch circuits (600 V) shall be one-half of the indicated values when fixtures (before lamping) and receptacles are included in the test.