

Islamic Republic of Iran
Vice Presidency for Strategic Planning and Supervision

**General Technical Specification and
Execution Procedures for Transmission
and Subtransmission Networks
General Technical Specification at
HV Substations**

NO: 458

**Office of Deputy for Strategic Supervision
Bureau of Technical Execution System
<http://tec.mporg.ir>**

**Energy Ministry - Tavanir Co.
Power Industry Technical Criteria
Project
www.tavanir.ir**

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GENERAL TECHNICAL SPECIFICATION

1- Introduction

This publication presents the general technical specifications of different type of high voltage substations such as transmission and switching. This publication is prepared to prevent from repetition of some common technical specification of equipments or different systems of substation and also to keep cases in touch with general design and operation which is not considered in the sections about equipment.

2- Design

2-1- Reliability

The work shall be designed to facilitate inspection, cleaning, repairs and operation where continuity of supply is the first consideration. All apparatus shall also be designed to ensure satisfactory operation under variety of atmospheric conditions, sudden variation of load and voltage as may be met at power system working conditions including those due to short circuit.

2-2- Safety

The design shall incorporate all reasonable precautions and provision for the safety of those concerned in the operation and maintenance.

2-3- Newness

All used materials shall be new and of the best quality and most suitable for working under the conditions specified conditions and shall withstand the variations of temperature and atmospheric conditions. No repair of defective parts will be permitted.

2-4- Other Considerations

Economic considerations shall be considered.

All outdoor apparatus and fittings shall be designed so that water cannot collect at any point.

All connections and contacts shall be suitable for carrying continuously the specified currents without overheating.

Kiosks, cubicles and any enclosed compartments shall be adequately protected and ventilated to prevent from condensation. All contactors or relay coils and other parts shall be protected over corrosion.

All apparatus in substations shall be designed to obviate the risk of accidental short circuit due to animals, birds, insects, mites, rodents or micro-organisms.

3- Nameplates

Each item of the plant shall be provided with a nameplate in the English language. The nameplate should be suitable for specified service condition and shall be placed in visible location and beveled. The plate shall be in accordance with relevant standard.

The nameplates shall be permanent and shall be of white non-hygroscopic material with appropriate size and engraved black lettering for easy distinction

Each item of plant such as valves, which are subject to handling, shall be provided with an engraved chromium plated nameplate.

Descriptive nameplates shall be provided for all protection relays, switches, fuses, indication lamp and similar items.

4- Labels

4-1- Outdoor Equipment

Labels shall be so designed and placed to facilitate orientation both within the switchyard and when approaching it from outside. Label text shall be in English.

Material for labels shall be either enameled sheet metal or fiberglass reinforced polyester with an embedded color layer.

The label background shall be white, the text shall be red and there shall be a red frame around the label.

The apparatus designation labels shall have the same symbols as used in the layout diagram and the phase markings shall have the symbols A, B and C for the phases. The same size shall be chosen for designation label and phase markings in each case.

Labels shall be placed on the normal operating and/or inspection side of the apparatus, in such a way as to be easily readable.

One designation label, in the middle phase of HV equipment and one designation label on each operating mechanism should be installed.

One busbar designation label and one phase marking label on both sides of the middle phase should be installed. One of foresaid labels on the outer side of the other phases should be installed. This should be repeated at least in 4 locations of each busbar.

A set of phase marking labels should be installed on each phase of HV equipment. One bay number/name label should be installed at least in two location of each bay.

Also dispatching code which is taken by employer shall be attached on different equipment.

Labels of BCR shall be attached to be visible from central control room and shall be easily readable from central control room

Size and location of all the labels should be approved by the engineer.

4-2- LV Equipment

Each switchboard, control and protection board shall have one label stating the insulation voltage class and one label identifying the board in the plant.

Each unit of switchgear or control gear (such as a cell, panel, cubicle or box) shall have an identifying label. The purpose of the unit in the plant shall be written on the label.

Incoming and outgoing circuits shall be identified by labels stating the purpose of the circuit, the size of the connected cable or cables and, when applicable, the size of fuse element to be used.

All apparatus or units of apparatus in the panels, cells etc. shall have labels or marking identifying the apparatus or units thereof. Reference in the technical documents for the switchgear or control gear shall be made to these markings. On several occasions this marking ought to be completed with function marking in plain text. Apparatus label shall be applied in such a manner that it does not follow the apparatus when it is dismantled or changed, for instance under the apparatus.

All labels shall be of plastic and shall have the text or symbol engraved.

All labels shall be in English.

Warning notices shall be in Persian and English.

5– Fire Precautions

All apparatus, connections and cabling shall be designed and arranged to minimize the risk of fire and any damage which might be caused in the event of fire. Operation and malfunction finding facility shall be considered. The contractor shall be responsible for dealing in an approved manner against damage or fire on cabling. All apparatus, connections and cabling shall be in accordance with IEEE 979.

6– Bolts, Nuts, Eye Bolts and Lifting Tackle

In control and measuring circuit brass terminal bolts or studs of less than 6 mm diameter shall not be used for electrical connections. Where a lower size is necessary, stainless steel phosphor bronze or high tensile brass may be used (at least 4 mm diameter) provided that the current capacity is adequate.

All bolts, nuts and washers placed in outdoor positions shall be treated to prevent corrosion of the threads and electrolytic action between dissimilar metals.

Where bolts are used on external horizontal surfaces where water can collect, approved methods of preventing the ingress of moisture on the threads shall be provided. In metal structure case, which is base of equipment, nuts which fasten to anchor bolt shall be fixed in a proper manner (such as ramming) specially breaker which produce severe vibration.

Each bolt shall project at least one thread but not more than three threads through its nut. If bolts and nuts are placed so that they are inaccessible by means of ordinary spanners, special spanners shall be provided. The length of the screwed portion of the bolts shall be such that no screw thread may form part of a shear between members. Taper washers shall be provided where necessary.

All slings, eye bolts and other lifting tackle provided shall be proof tested to twice the safe working load and suitably marked with embossed labels to show clearly the safe working loads. Also recommendation of ACI, ASCE and ASTM standards shall be considered.

7- Galvanizing

All surfaces which may corrode shall be galvanized in accordance with the specified specification.

All galvanizing shall be applied by the hot dip process and shall comply with the Iranian standard No. 2478 and ASTM standards. Zinc coating shall be smooth, clean of uniform thickness and free from defects.

All welds shall be de-scaled, all machining carried out and all parts shall be adequately cleaned prior to galvanizing.

The preparation for galvanizing and the galvanizing itself shall not adversely affect the mechanical properties of the coated material.

The threads of all galvanized bolts and screwed rods shall be cleaned by brushing. All nuts shall be galvanized with the exception of the threads which shall be oiled. Surfaces which are in contact with oil shall not be galvanized or cadmium plated.

8– Equipment Earthing

All metal parts other than those forming part of any electrical circuit, shall be connected to the main earth system in an approved manner by means of a high conductivity copper conductor with appropriate cross section area.

All cubicles and connection boxes shall be provided with an earth bolt for connection to the earthing system of the station. All cubicles shall be provided with earth busbar and its doors and movable parts shall be connected to it.

Smaller components e.g. limit switches, which are mounted directly on larger earthed objects should be earthed via the fixing bolts. Such earthing methods shall be checked.

9– Earthquake Considerations

The contractor shall show that the equipment is capable to withstand the earthquake forces as specified and shall include full evidence with the tender to substantiate this claim. Also recommendation of IEEE 693 shall be considered.

All outdoor equipment shall be capable of repeatedly withstanding accelerations due to seismic disturbances as specified in table (I) without damage to or impairment of the operation ability of the equipment or components thereof.

All equipment mounted in cubicles, panels or other enclosures shall be mounted in such a manner so as to be protected from repeated accelerations due to seismic disturbances of 0.5g.

10- Lubrication

Bearings which required lubrication either with oil or grease shall be fitted with approved nipples complying with BS 1486. Where necessary the accessibility adapters or bushings shall be provided. If different oils/greases are required they should be readily obtainable. The number of required greases/ oils must be kept in minimum.

11– Cubicle Locks

Locks shall preferably be of the barrel type.

Three keys shall be supplied for each lock and all locks and keys shall be non interchangeable.

Where a set of locks is provided under any particular section of plant or apparatus, a master key is to be supplied in addition.

Where a group of locks is supplied for any section of the substation, a rack shall be supplied for the accommodation of keys while they are not in use. The keys shall be engraved with a suitable identifying code or inscription and this shall be repeated on the racks on engraved labels attached thereto.

12- Electrical Insulation, Voltage Withstand Capability and Disturbing Voltage Resistance

Electrical circuits and components in secondary circuits shall fulfill the voltage withstand demands for testing with alternating voltage for 1 minute as specified in IEC 60255-5.

The insulation resistance between circuits which are separate electrically and between circuits and earth shall be at least 1 M ohm unless a higher value is required with regard to a particular environment. The steady state resistance shall be measured using 500V direct voltage megger for 60 seconds.

The measurement of the insulation resistance of LV equipment shall be in accordance with IEC 60255-5.

The LV equipment shall withstand the disturbing voltages according to IEC 60255-3 without affecting the function of equipment.

13- Sulfur- Hexa Fluoride (SF₆)

The SF₆ shall conform to IEC 60376 and shall be suitable in all respects for use in the equipment when operated at site under the conditions expressed in this specification.

14- Control Equipment

The control equipment shall be subdivided electrically and mechanically, so that isolated faults in the equipment can not have an affect on more than one of the items of equipment which have redundant functions. In addition to this dominant requirement, the following shall be observed when making the different divisions of the control equipment:

Elimination of electrical disturbances from the switchyard and disturbances generated in the control equipment.

The various parts of the control equipment shall be accessible during testing and maintenance work, without unnecessarily blocking of functions. It shall be possible to perform future modifications and extensions to the control equipment with the minimum interference to the operation of other parts of the installation.

The structure division shall be consistent and cover even the documentation and symbol designation of the component parts in the control equipment.

The control installation shall be systematically divided up according to the function of the equipment in the system, and shall not unnecessarily be integrated with each other.

Regarding to the type of the substations, the arrangement of the control equipment is changed.

14-1- Conventional Substation

In conventional substation control equipment for lines, transformer feeders, busbars, and etc. shall be placed in a common control building. Control equipment placed outside the building are connection boxes and operating mechanisms of equipment.

14-2- DCS Substation

In DSC substation, control equipment for lines, transformer feeders, busbars, and etc. shall be placed in bay control room (BCR). Communication and data transfer of the BCR's to each other and central control room (CCR) shall perform through fiber optic. HMI, server, engineering computers, printers, LAN network equipment, gateway, modem and GPS shall be placed in CCR.

15- Cables

All power and control cables shall be of a single length with no splicing joint. Conductors belonging to different feeders or group wires shall not be located in the same cable.

All cables for CT and PT circuits, control circuit and medium voltage power cables shall be copper shielded with their shield grounded at both ends.

Data and networking cables shall be protected against external electrical effects by metal shields and plastic cover. External shield shall be connected to ground at one end of the cable.

16- LVAC

The low voltage ac (LVAC) system shall comprise of indoor main and distribution boards, outdoor distribution boards, lighting board and auxiliary transformers boards. All identical equipment and corresponding parts shall be fully interchangeable, without having to carry out modifications.

All boards shall be of metal clad design and protected as specified.

Each board shall be fabricated using suitable mild steel structural sections or pressed and shaped cold rolled sheet.

Temperature inside the LVAC board should be kept under a specified value.

17- LVDC

The contractor shall guarantee the capacity of the battery for the specified duty with regard to load requirements and minimum ambient temperature condition.

Internal resistance of battery shall be low enough to permit correct operation of battery.

The battery type shall be lead acid cells and cells shall be suitable for indoor installation. Cells shall be delivered dry.

The ventilation and cooling requirement of batteries under site conditions and all layout and floor loading data requirements shall be forwarded to the purchaser for his building design coordination.

18- Protection

Protection system shall be immune to electromagnetic disturbances.

All numerical protection units must be able for connecting to the numerical substation control system and support the standard communication protocols such as RS 485, MOD BUS, IEEE 802, IEC 61850-105-3, etc.

Only the minimum possible part of the substation shall be tripped to isolate the fault or clear abnormal conditions.

The design of numerical relay protection shall be such that high tripping reliability will be achieved.

The tripping circuits of the main and backup protection relays shall be entirely separated electrically and mechanically.

19- SCADA Interface

Supervision and control of the substation is to be effected from Regional Dispatching Center (RDC) and System Control Center (SCC). Supervisory Control and Data Acquisition (SCADA) equipment is to be installed in substation.

All necessary connections, cables, test switches, auxiliary relays, transducers, panels, etc. shall be provided to meet the supervisory controls, indications and metering.

The SCADA interface also includes the supply of all necessary interface marshalling racks for SCADA and the contractor shall be responsible for the connections to these marshalling racks from the equipment.

The SCADA interface shall consist of the followings:

- Control of circuit breakers, earthing & disconnecting switches and tap changers
- Reset of lock - out relays and alarms
- Telemetry of current, voltage, watt, var, watt-hour and var-hour of lines, transformers and busbars.

- Indication of circuit breakers, earthing & disconnecting switches, tap changers and alarms.

The substation equipment shall be properly designed and equipped with all auxiliaries and ancillaries to be suitable for local, remote and control via national electric power dispatch system for control.

SCADA interface requirements and list of required control points and signals will be handed over to contractor during the project progress. Also SCADA interface shall be in accordance with the standards of ministry of energy such as: interface of 230 & 400 kV substation with dispatching systems, interface of 132/20 kV substation with dispatching systems and interface of 63/20 kV substation with dispatching systems.

20- Painting

All painting shall be carried out on dry and clean surfaces and under suitable atmospheric in accordance with the paint manufacturers recommendations.

All surfaces shall be cleaned in accordance with the steel structure painting council specification SSPCSP3-63. All grease and oil deposits shall be removed by wiping with a clean cloth dipped in universal solvent.

Paint coating shall be uniform and free from any defects. Primers and pretreatment shall be applied as soon as practicable after surface has been cleaned.

Damage to primer coat shall be repaired before succeeding coats are applied and the succeeding coats shall be applied as soon as practicable in accordance with manufacturer's written recommendations.

Painting equipment shall be kept clean using paint manufacturer recommended thinner or other compatible thinner.

For multicast application, the individual coats shall be tinted such as to give distinct and easily visible color difference between coats to facilitate inspection

All bright surfaces shall be thoroughly cleaned, coated with a suitable easily removable corrosion resisting compound.

The paint used for the finish coats shall have special heat, oil and weather resistant properties, and shall be light gray color. The method of applying the outside coats of paint shall be in accordance with the manufacturer's established practice.

21- Delivery Schedule

The delivery of equipment and material to the sites shall be completed within the time period stipulated in tender documents.

The contractor shall prepare and submit a comprehensive schedule for completion of the work which shall be approved by the Engineer and shall perform the works in accordance with the time schedule.

22- Accessibility

Apparatuses and components shall be designed and fitted with considering the relevant operating conditions, possibilities for comfortable reading, inspection, cleaning and maintenance. Especially such equipment having a limited life time shall be easily accessible for replacement and service.

23- Drawings and Technical Document

During the course of the contract the contractor shall submit all calculations and drawings for acceptance before commencing manufacture and works. The schedule time should be sufficient for modifications resubmitting for acceptance by the Engineer without any delay to completion of the contract works.

If, at any time before the completion of work, the necessary changes are made of at the approved drawings and documents, the contractor shall make such revisions and proceed in the same routine as for the original approval.

Any document prepared by the contractor and approved by the Engineer shall be considered as a part of the specification. However, examination and approval of documents by the Engineer shall not relieve the contractor of his responsibility for engineering, design, workmanship and materials under the contract. The contractor shall be responsible for any discrepancies or errors in or omissions from documents whether such documents have been approved or not by the Engineer. Approval given by the Engineer to any documents shall not relieve the contractor from his liability to complete the contract works in accordance with this specification and the conditions of contract or exonerate him from any of his guarantees.

All drawing, documents and calculations shall be prepared in 4 copies. Technical documents and calculations shall be in A4 size and the size of drawings shall be so easily visible.

All drawing and documents shall be delivered in CAD and/or PDF version.

24- Spare Parts

The tenderer shall state the spare equipment, parts and renewal items which he deems necessary for the first five years normal service operation of the substation.

All spares supplied under this contract shall be strictly interchangeable with the parts for which they are intended to be replaced.

The spares shall be treated and packed for long storage under the climatic conditions prevailing at the site e.g. small items shall be packed in sealed transparent plastic bags with desiccators packs as necessary. Storage conditions of spares shall be specified by contractor.

Each spare shall be clearly marked or labeled on the outside of its packing with its description and purpose. When more than one spare part is packed in a single case, a general description of the contents shall be shown on the outside of the case and a detailed list should be enclosed. All cases containers and other packages must be suitably marked and numbered for the purposes of identification.

Any spare apparatus, parts and tools shall be subject to the same specification, tests and conditions as similar material supplied under definite work of the contract.

All spare apparatus or materials containing aging sensitive apparatus or electrical insulation or electronic components, shall be packed in an approved manner and delivered in approved cases suitable for storing such parts or materials over period of years without deterioration. Such cases shall have affixed to both the underside and topside of the lid a list detailing its contents.

The case & packing material shall remain the property of purchaser.

25– Maintenance & Operation Tools and Tackle

Each tool or appliance and other devices shall be clearly marked with its size and/or purpose.

Each set of tools and appliances shall be suitably arranged in fitted boxes of mild steel construction, the number of boxes being determined in relation to the layout of the plant in question. The taps, stocks and dies shall be kept in approved mild steel boxes with compartments for individual items. If the weight of any box and its contents is such that it cannot be conveniently carried, it shall be supplied on suitable rubber tired wheels.

Each tool box shall be fitted with a lock and two keys and clearly marked with the name of the plant for which the tools and appliances are used there.

The required tools and appliances, with the appropriate boxes, for operating are to be handed over to the purchaser at the time of temporary delivery.

Contractor shall provide at least three years warranty form the date of delivery of good to the operator. Manufacturer shall furnish sufficient documentary evidence in the tender to prove availability of after sales services for at least 20 years.

Training shall include familiarization for the owner's staff, who will operate the system.

26- Packaging

Only packages constructed out of sound material shall be used. The dimensions of the package shall be proportional to the size and weight of contents. Bundled materials shall be strapped rigidly with steel band over the protective covering.

Fragile materials shall be securely braced within the containers or otherwise amply fastened and packed to prevent shifting or rattling. Soft non-hygroscopic packing materials shall be placed between the hard packing materials and the fragile equipment.

Articles which do not completely fill the selected container must be cushioned, braced, fastened or blocked to prevent damage to the article itself or destruction of the container. Inner bracing or blocking must be such that the contents weight is distributed over interior surfaces rather than concentrate on one or two critical points.

Loose materials, e.g. bolts, nuts and etc. shall be packed in gunny bags and sealed in polythene bags with proper tags.

Components containing glass shall be carefully covered with shock absorbing protective material such as expanded polystyrene.

All openings in the equipment shall be tightly covered, plugged or capped to prevent foreign material from entering.

In the case of large and bulky equipment, the contractor shall consider transport limitations in Iran and supply the equipment in the minimum number of components or sub assemblies, within the framework of transport limitations.

Wherever necessary, proper arrangements for attaching slings lifting shall be provided.

The contents of the packages shall be sealed in thick polythene sheets and all the inside walls of the packages shall be lined with waterproof paper to protect the equipment from damage due to dust and moisture.

All equipment shall be protected for the entire period of dispatch, storage and erection, against corrosion, incidental damage due to vermin, rain, high temperature, humid atmosphere, rough handling in transit and storage in the open including possible delays in transit. Material and equipment shipped across the sea shall be packed to withstand damage and the effects of salt spray. All machined and plated parts shall be protected with anti rust grease.

Silica gel or approved equipment moisture absorbing material in small cotton bags or papers that can absorb moisture shall be placed and tied at various points on the equipment, wherever necessary. The amount of that shall be proportion to package volume.

Switchgears cubicles and other electrical equipment shall be packed in separate and convenient sections. Adequate provision of skids or pallets shall be made to keep the packages above the collecting drainage. Crates and other large containers should have drain holes in the bottom to prevent collection of water within the packing.

All cases shall be provided with suitable cut-outs, closed by bolted wooden planks to facilitate inspection. Waterproof transparent papers shall be provided at the cut-out locations to prevent water ingress into the casing through the cut-out.

Each crate or package shall contain a packing list in a waterproof envelope. Copies of the packing list, in triplicate, shall be forwarded to the Engineer prior to dispatch. All items of material shall be clearly marked for easy identification against the packing list.

All spare parts shall be packed and treated for long storage conditions at site.

27- Marking

All packages shall be clearly, legibly and durably marked with uniform block letters (preferably with waterproof paint) on a least three sides with:

- Destination address
- Contract No.
- Dimensions
- Net and gross weights
- Sign showing, side up
- Sign showing slinging and sling position.
- Any handling and unpacking instructions
- Identification mark relating them to the appropriate shipping.
- Sign showing indoor or outdoor storage.

In case of spare parts, each spare part shall be clearly marked and labeled on the outside of its packing with its description and catalogue/part number.

Two packing lists, suitable for climatic condition, one for inside and other for outside of each case should be considered.

28- Handling and Transport

The contractor is solely responsible for proper design and safe transport of the equipment. He should carefully check the selected routes, clearances and bearing capacities of tunnels and bridges at the design stage and at the time the shipment planned. Transport of materials and equipment from port(s) to the site shall be under the contractor responsibility.

The contractor shall ensure that all materials and items included in the works are adequately packed and protected for transport by sea, rail and roads against corrosion, physical damages, contamination, water damage and damages due to climatic conditions or any other source that may be encountered during handling, transport and storage.

The contractor shall make all necessary arrangements for custom clearance in Iran, in country of origin and in any country through which the transport may be routed. The Engineer shall be immediately informed if any item has not arrived when expected.

The contractor shall obtain all the necessary import and export permits as well as any other documents required for transportation.

Copies of all forms and documents relating to customs, permits, packing lists, bills of lading, insurance, etc. shall be forwarded to the Engineer.

Shipping reports shall be submitted to the Engineer for all shipments. The reports shall include weights, shipping dimensions and parcel numbers. Parcel numbers shall be unique and sequentially assigned for all parcels of the entire contract. In the shipping report the contents of each parcel shall show full details of inscriptions outside of all packages or containers.

Custom offices at points of entry in Iran shall be informed in advance of the size and quantity of packages, origin and destination, the name of the owner and carrier and expected date of arrival.

29- Tests

29-1- Factory Tests

All plants and equipment covered by this contract shall be subjected to inspection and testing by the contractor/Engineer or his appointed representative. The contractor shall provide all services to establish and maintain quality of workmanship in his works and that of his sub-suppliers to ensure the accuracy of components, compliance with standards, specifications, drawings, identification and acceptability of all materials, parts and equipment.

The minimum inspection requirements for all components/equipment shall conform to the design and fabrication requirements as defined in the reference codes and standards.

Approval or passing of any such inspection by the purchaser and/or Engineer shall not however, prejudice the right of the purchaser to reject the plant if it does not comply with the specification when erected or give complete satisfaction in service.

Before any series of equipment or plant is packed or dispatched from the contractor's or his sub-supplier's works, all tests shall successfully carried out in the presence of the Engineer. Five copies of the contractor's record of tests shall be supplied to the Engineer for approval.

The contractor shall be responsible for the proper testing of the work completed or plant or materials supplied by a sub-contractor the same as if the work plant or materials were completed or supplied by the contractor himself.

The costs for factory routine and sample tests shall be included in the price for the substation equipment. No additional charge shall be paid for the aforementioned tests. The contractor shall quote separate prices for carrying out each of the type and special tests for any equipment are indicated in the related sections of specification.

The contractor must submit acceptable type test certificates and documents for tests is already carried out on the same equipment as specified for this project. The type test documents shall include full technical details and in general shall not be older than 5 years.

The type tests should have been performed/to be performed at an internationally known and independent laboratory that is confirmed by employer.

Any additional information asked for by the Engineer as related to the type tests shall be furnished by the contractor. The Engineer shall review the type test documents submitted by the contractor and decides on the type test requirements.

For all parts of the equipment for which factory testing is required, a comprehensive test program and time schedule shall be made by the contractor and submitted to the Engineer for approval. The test program shall include such details as the sequence of the tests, blank test record sheets, the number of any equipment to be tested, test procedures, test circuits, details of the testing equipment to be used and calibration related information. No equipment shall be dispatched to the site without inspection or approval by the Engineer, and/or without his written consent.

Routine, acceptance, sample and type tests shall generally be carried out according to relevant standards referred to in related chapter. The general testing program shall be submitted to the Engineer within 3 months after the signature of the contract for all substation equipment.

Unless otherwise stated, type tests when called for shall be made on equipment which has previously passed its routine tests. The arrangement of all tests and the method of computing the results shall be approved by the Engineer.

The Engineer shall be notified 60 days in advance of when a type or routine test shall begin, so that the test may be witnessed if required.

Upon completion of each test phase, a test report stating the obtained results, including any faulty test and describing test procedure and circuit diagrams, calculations, standards followed and particulars of the calibration shall be submitted to the Engineer. The test reports must be signed by the contractor and the Engineer's witness.

The IEC standards shall be regarded as the source of reference for definitions, methods of measurements, etc. Testing shall conform to IEC standards, except where otherwise specified or approved by the Engineer.

29-2- Site Tests

The contractor shall provide the necessary special testing tools required for site testing and commissioning of all equipment. The instruments and tools shall be in good working conditions and properly suited for the type of equipment specified in the project.

The contractor shall give details of all the testing instruments and tools required for site testing and commissioning works along with their prices with his tender proposal. The prices for the above instruments and tools shall not include in the total price for the substation.

Following completion of the substation site testing and commissioning works, the owner may decide to pay for and keep all or part of the testing instruments and tools. The contractor shall furnish full details, catalogs, instruction manuals for operation and maintenance of each instrument and other information as may be need for proper use of the testing instruments and tools.

The contractor shall submit the list of site tests for any equipment and a complete site testing and commissioning procedure and program to be approved by the Engineer along with the test sheets for each equipment/systems.

Testing shall be carried out during normal working hours as far as is practicable.

The contractor shall provide the experienced test personnel.

The contractor shall record the results of the tests clearly, in an approved form and with clear references to the equipment and items to which they refer, so that the record can be used as the basis for maintenance tests during the working life of the equipment. The required number of site test result records shall be provided by the contractor to the purchaser as soon as possible after completion of the tests.

No tests as agreed under the program of tests shall be waived except upon the instruction or agreement of the purchaser in writing.

SCHEDULE GS (I)
RATING AND CHARACTERISTICS GENERAL

ITEM	DESCRIPTION	TECHNICAL PARTICULARS
1	Name of substation	*
2	Site of substation	*
3	Service condition:	
3-1	Max. ambient temperature	°C 40/45/50/55
3-2	Min. ambient temperature	°C -40/-35/-30/-25
3-3	Max. daily temperature	°C *
3-4	Solar radiation	W/m ² *
3-5	Altitude from sea level	m 1000/1500/2000/2500
3-6	Pollution level	Low/medium/high/ very high/special
3-7	Max. wind velocity	m/s 30/40/45
3-8	Wind velocity in ice condition	m/s 20
3-9	Ice coating thickness	mm 5/10/20/25
3-10	Seismic acceleration	m/s ² 0.2g/0.25g/0.3g/0.35g
3-11	Relative humidity	% 90/95/more than 95
3-12	Isokeraunic level	*
4	Type of substation	*
5	Nominal system voltage	kV 63(66)/132/230/400
6	Max. system voltage	kV 72.5/145/245/420
7	Current rating of busbars under IEC standard condition	A *
8	Current rating of switchgear equipment under IEC standard condition	
8-1	Lines bay	A *
8-2	Transformers bay	A *
8-3	Buscoupler or bussction bay	A *
9	Type of system grounding	Effectively grounded/ non effectively grounded
10	Rated frequency	Hz 50
11	Three phase short circuit:	
11-1	Rated value (Isc)	kA *
11-2	Dynamic value	kA _{peak} 2.5 Isc
11-3	Duration	sec 1 or 3
12	Number and rating of transformers	No×MVA *
13	Transformer ratio	kV
14	Number and rating of aux- earthing transformers	No×kVA *
15	Bus bar arrangement	*
16	Number of bays:	
16-1	Existing bays	*

SCHEDULE GS (I)
RATING AND CHARACTERISTICS GENERAL

ITEM	DESCRIPTION	TECHNICAL PARTICULARS
16-2	Future expansion	*
17	Number of line feeders	*
18	Number of trans. feeders	*
19	Numbers of bus couplers bays	*
20	Number of bus sections bays	*
21	Equipment arrangement in bays	See general single line diagram
22	Protection and measuring system	See protection single line diagram
23	Rated LIWL under IEC standard condition	kV _{peak} *
24	rated SIWL under IEC standard condition	kV _{peak} *
25	Rated one min PFW voltage under IEC conditions	kV *
26	Type and material of insulators	*
27	Min external insulation creepage distance	mm *
28	Color of insulator porcelain	*
29	Max. radio, interference level measured at 1.1 rated system voltage	μV *
30	Min clearance from ground level to the base of insulation	mm *
31	Min. clearance between live metal and earth	mm *
32	Min. clearance between live metal of different phases in bays	mm *
33	Min. clearance between live metal of different phases in busbars	mm *
34	Min. horizontal working clearance	mm *
35	Min. vertical working clearance	mm *
36	Height of live equipment form the main road surface	mm *
37	Distance of guard wire from busbar conductors	mm *
38	Station service auxiliary AC supply:	
38-1	Rated voltage	V 400/230
38-2	Voltage variation	% ±10
38-3	Number of phases and wire	3 ph, 4 wires
38-4	Frequency	Hz 50
38-5	Neutral earthing	Solidly

SCHEDULE GS (I)
RATING AND CHARACTERISTICS GENERAL

ITEM	DESCRIPTION	TECHNICAL PARTICULARS
39	Station service auxiliary DC supply:	
39-1	Rated voltage	V
39-2	Voltage variation	%
39-3	Number of wires	+10,-15
39-4	Earthing	2
40	Cubicle IP	High impedance
40-1	Outdoor	*
40-2	Indoor	*
41	Soil special resistivity	Ω.m

*These will be specified by designer engineer.

SCHEDULE GS (II)
RATING AND CHARACTERISTICS GENERAL

ITEM	DESCRIPTION	TECHNICAL PARTICULARS
1	Service condition:	
1-1	Max. design ambient temperature	°C
1-2	Min. design ambient temperature	°C
1-3	Max. design value of daily temperature	°C
1-4	Design solar radiation	W/m ²
1-5	Design altitude from sea level	m
1-6	Pollution level	
1-7	Design Max. wind velocity	m/s
1-8	Design wind velocity in ice condition	m/s
1-9	Design ice coating thickness	mm
1-10	Design seismic acceleration	m/s ²
1-11	Design relative humidity	%
1-12	Design soil special resistivity	Ω.m
1-13	Isokeraunic level	
2	Nominal system voltage	kV
3	Max. system voltage	kV
4	Current rating of busbars under IEC standard	A
5	Current rating of switchgear under IEC standard	A
6	Type of system grounding	
7	Rated frequency	Hz
8	Three phase short circuit:	
8-1	Rated value	kA
8-2	Dynamic value	kA _{peak}
8-3	Rated duration	sec
9	Busbar arrangement	
10	Number of line feeders:	
10-1	With shunt reactor	
10-2	Without shunt reactor	
11	Number of trans. Feeders	
12	Rated LIWL	kV _{peak}
13	Rated one min PFWL	kV
14	Rated SIWL	kV _{peak}
15	Min external insulation creepage distance	mm
16	Type and material of insulators	
17	Max. radio interference level measured at $\frac{1.1U_m}{\sqrt{3}}$	
	rated system voltage	μV

SCHEDULE GS (II)
RATING AND CHARACTERISTICS GENERAL

ITEM	DESCRIPTION	TECHNICAL PARTICULARS
18	Min. corona inception voltage	kV
19	Min. clearance from ground level to the base of insulation	mm
20	Min. safety clearance between live metal and positions to which access is permissible with other equipment alive	mm
21	Min. clearance between live metal and earth	mm
22	Min. clearance between live metal of different phases	mm
23	Type of substation control system	
24	Station service auxiliary AC supply:	
24-1	Rated voltage	V
24-2	Voltage variation	%
24-3	Number of phases and wire	
24-4	Frequency	Hz
24-5	Neutral earthing	
25	Station service auxiliary DC supply:	
25-1	Rated voltage	V
25-2	Voltage variation	%
25-3	Number of wires	
25-4	Earthing	