1.1.2 DESIGN SPECIFICATION

(1) Pressure piping shall be designed with sufficient strength, and shall be based on the design specifications considering the working temperature and pressure.

The power plant piping shall be designed to have reliable strength for impact, vibration, thermal expansion, abnormal weather condition, etc., and to meet all safety requirements.

(2) Piping subject to external pressure shall be designed for the maximum differential pressure anticipated for either the normal operating condition or shutdown condition.

(3) The piping shall be designed for a metal temperature representing the maximum sustained condition expected.

The design temperature shall be assumed to be the same as the fluid working temperature in the piping.

(4) The piping shall be designed with adequate provisions to withstand external forces such as earthquake, wind, abnormal loading or vibration.

(5) It is not necessary to consider that seismic force will occur concurrently with wind force.

(6) Weight effects, such as weight of the piping components, insulation, fluid loads, etc., shall be considered in the design of the piping.

(7) The design of power plant piping shall take into consideration the forces and moments due to thermal expansion, and their reaction and effect on the equipment.

(8) The piping shall be installed on adjustable hangers, properly levelled rigid hangers, supports, spring hanger, constant hanger, sway bracing, vibration dampeners, etc., where considered to be neccessary.

(9) Hangers and supports shall be designed in consideration of weight, vibration, thermal expansion and other external forces.

The Contractor shall be required to submit the technical data of hanger supports to the Owner and the Engineer for approval.

(10) Main steam piping, cold reheat piping, hot reheat piping, turbine bypass piping (if applicable) and feedwater piping shall be designed in accordance with the code of ANSI or JIS, or equivalent.

(11) Extraction steam piping shall be designed in accordance with the following specification.

Design Pressure	: 102% of extraction pressure at Maximum load.
Design Temperature	: Extraction temperature at Maximum load.
Design Flow	: 102% of extraction flow at Maximum load.

(12) Design pressure and temperature of heater drain piping shall be the same as the heater design pressure and temperature.

(13) The piping up to shutoff valves downstream of control valves shall be designed with the same condition as that of the upstream side of the control valves.

(14) The piping at downstream side of check valves shall be designed with the same conditions as that of the upstream side of check valves.

(15) Pressue relief valves shall be furnished on downstream piping of pressure reducing valves or pressure control valves.

(16) The design pressure of piping, having safety or relief valves shall be the same pressure as that of the setting pressure of safety or relief valves. Generally, no valve shall be installed between the pipe and safety or relief valves.

In case that valves are installed between pipes and safety or relief valves, open lock provision for the valve shall be provided.

(17) The design pressure of piping not specified in the Applicable Standards and Codes, but connected to equipment shall be the same as the design pressure of equipment.

(18) The design temperature of piping not specified in the Applicable Standards and Codes, but connected to equipment shall be the same as the design temperature of equipment.

(19) The design pressure and temperature of the drain, vent, blow and instrument piping shall be the same design pressure and temperature as those of the main piping. The drain, vent and blow lines for the piping with pressure of 35 kg/cm^2g or more and the oil piping shall be furnished with two (2) shutoff valves in series.

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(20) The design pressure and temperature of bypass valves and pipings for control valves or equipment shall be the same pressure and temperature as those of the upstream side of the control valve or equipment.

(21) The glands of valves using under vacuum condition and having nominal diameters of 65 mm or larger shall be of the water seal type. The valves less than 65 mm nominal diameters shall be provided with such seal devices as bellows seal or back sheet to prevent atmospheric air leaking into the system. Gland sealing water shall be supplied from the condensate line.

(22) The piping applied to the entire system beyond the blow off valves on the boiler or vessel to the blow off tank or other points where pressure is reduced approximately to the atmospheric pressure and which cannot be increased by closing the valves shall be designed in accordance with ANSI B 31.1.

(23) All piping shall be so designed as to provide a neat and economical layout having the shortest possible run and requiring the minimum number of fittings.
Pipings shall be arranged so that full access is provided for the operation and maintenance of equipment, and that removal or replacement of equipment can be carried out with the minimum dismantling of piping.

(24) The drain and blow off valves shall be furnished on both sides of each control valve.

(25) A safety valve having ample capacity shall be provided on

the N_2 gas injection main pipe line.

(26) Straight pipes of sufficient length to meet the requirements in the applicable standards shall be provided on both sides of nozzles or orifices.

(27) The cooling water pipes for pumps or compressors, etc., shall be connected by flanges to facilitate maintenance.

(28) Recommended velocities in pipe are as follows.

	Fluid	Velocity m/sec
Steam:	Saturated	20 - 30
	Superheated	30 - 45
	" (larger size)	50 - 70
	Exhaust to atmosphere	25 - 50
Water:	Pump suction	0.5 - 2.5
	Pump discharge less than 10 kg/cm^2g	2.5 - 3
	Pump discharge 10 kg/cm^2g or more	3 - 3.5
	Drain	1 - 2
	Water	1 - 3
Air and gas:	Low pressure air (less than 10 kg/cm^2g)	20 - 30
	High pressure air (10 kg/cm^2g or more)	10 - 15
	Compressor suction	10 - 20
Oil:	Fuel oil and lubrication oil	0.5 - 2

Higher values than these listed above may be allowed in special applications (e.g. low pressure heater bled steam

lines) or for system used intermittently.

(29) The piping material shall be selected in accordance with the following requirements.

(a) Classification of piping material and design condition.

Classification	Max. working pressure kg/cm^2g	Max. working temperature ^oC	Used for
SGP (A120)	10	350	Water, steam, oil, air
STPY (A139)	10	350	"
STPG38, 42(A-53)	100	350	Water, steam, oil, air
STPT38, 42, 49 (A-106 Gr.B)	No limitation	450	Water, steam
STPA12 (A-335 Gr.P1)	"	500	High pressure and temperature steam
STPA22 (A-335 Gr.P12)	"	550	"
STPA23 (A-335 Gr.P11)	"	575	"
STPA24 (A-335 Gr.P22)	"	600	"
SUS321 (A-376 321)	"	800	Chemical, high pressure and temperature steam

(b) Circulating water piping shall be of welded steel pipe and painted with tar epoxy resin in thickness of not less than 0.7 mm for inside wall.

The outside surface of the pipe buried in earth shall be covered with a double layer of tar epoxy glass wool cloth, in thickness of 4.5 mm and more.

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(c) Fuel oil piping shall be of STPG38 (A-53) and Schedule 40 in minimum. Pressure piping shall be of seamless pipe.

(d) The water piping for auxiliary cooling water or fire protection water shall be made of carbon steel. The outside surface of pipes buried in earth shall be covered with two (2) layers of asphalt jute cloth or equivalent.

(e) The inside of carbon steel pipe which is used for acids or caustic fluids shall be lined with acid or caustic-proof material. The inside of washing drain piping for boiler, air preheater and stack shall be coated with acid-proof lining.

(f) The drain piping of boiler blow down tank (flush pipe) shall be of STPG38 (A-53) and Schedule 80 in minimum.

(g) The chlorine and chloric solution piping shall be of rubber lining or anti-corrosive material or equivalent.

(h) The sampling piping including root valves for water and steam shall be of stainless steel.

(i) Instrument air piping shall be of galvanized carbon steel or copper. The joints of piping shall be of welded type and, in case of thread type joints, seal weld shall be applied. Soft annealed seamless copper tubing shall be used for the instrument and signal air tubing. Flared brass fitting shall be applied for the joints of tubing. The size of seamless copper tube shall be as follows.

Outside diameter in mm	Wall thickness in mm
6.0	1.0
10.0	1.0
12.0	1.2

(j) The water piping for demineralized water shall be made of stainless steel and that drinking water shall be made of galvanized carbon steel pipe.

(k) The turbine oil piping shall be made of steel pipe of STPG38 (A-53) and Schedule 40.

The connection shall be of the welded type as far as possible.

(l) Piping materials under special conditions shall be as follows.

- o Sodium hydroxide - Stainless steel or semi transparent FRP or equivalent
- o Hydrochloric acid - Polyvinyl chloride pipe or F.R.P. or equivalent
- o Other chemicals - Polyvinyl chloride pipe or F.R.P. or equivalent

(m) For the pipe of drain, vents, instruments, etc., the same material as the main piping shall be used up to the shutoff valve on main piping.

(n) Any plastic piping used in outdoor applications shall be fully suitable to withstand the effects of sunlight over the life of the plant.

(30) The piping of fluid temperature of 50°C or more shall be

insulated.

(31) The piping shall be designed for seismic force and wind velocity in accordance with Clause 9 of "Design Conditions" in Part I, Section I.

(32) Safety valve exhaust piping, starting ejector discharge, H_2 gas vent, turbine lubricating main oil tank exhauster discharge, blow down tank exhaust, boiler drum vent and other required vents, shall be led to outside of the building and brought up to 3 m above the roof surface. Weather hoods and silencers (if required) shall be provided at the open ends of all upward facing atmospheric exhaust or vent pipings.

(33) The minimum drainage slope in steam pipework shall be 1 in 100. The design of steam pipework shall ensure that drainage slopes are maintained with pipe support deflections, pipe expansions and other condition which can arise during transient and steady-state operation. The piping installation shall be designed to prevent the collection of pockets of water during operation and start up periods. For this reason drain outlets shall be installed at the obstructions such as flow orifices, low points of piping, etc.

(34) The pipe joints shall be of the welded type, but flange or union joints shall be used at places requiring dismantling for maintenance.

(35) Steam traps shall be provided at all low points in steam piping. Drain traps shall be provided at all low points in

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compressed air piping. Strainers shall be provided at up stream of each trap. Traps and strainers shall have suitable block valves and bypass valves.

Where steam traps are located outdoors and the drain is discharged on the ground, the drain shall be led into the steel ring which shall be 200A steel pipe and contain gravel.

(36) All piping shall have vent valves and drain valves at appropriate points. The minimum valve size shall be 20 mm diameter.

(37) All pipes shall be of seamless drawn steel unless otherwise specified or approved. Unless otherwise approved, the following pipe size (32 mm-1 1/4", 65 mm-2 1/2", 90 mm-3 1/2", 125 mm-5") shall not be used.

Each pipe shall be of the longest length commercially available. If the pipe schedule specified is not available for any reason, then the next thicker wall standard schedule pipe may be substituted.

(38) Support locations shall be selected dependent on pipe size, piping arrangement, the location of heavy valves and fittings, and the structure that is available for the support of the piping. Pipe spans between hangers or supports shall be based upon by following list and notes.

Nominal Pipe Size (mm)	Spans (mm)
25	2,000
40	2,700
50	3,000
(65	3,300)
80	3,600
100	4,200
150	5,100
200	5,700
250	6,700
300	7,000
350	7,600
400	8,200
450	8,500
500	9,100
600	9,700

Note:

(a) These spans are based on a combined bending and shear stress of 105.4 kg/cm^2 when the pipe is filled with water, and 2.54 mm deflection is allowed between supports without insulation.

(b) The above rules shall not be applied, where weights, such as valves or heavy fittings, are concentrated or where the direction of the piping system is changed between supports.

(c) Where the direction of any piping system is changed

between hangers, it is desirable to keep the total lengths of pipe between the supports less than three fourths (3/4) of the full spans mentioned above.

(d) Supports should be placed as close as possible for concentrated load in order to minimize bending stresses.

(39) Pipe sleeves shall be installed where the piping passes through walls, floors and ceilings.

(40) Additional hanger beams shall be provided by the Contractor when main structual beam is not available for pipe hanging or supporting position.

(41) Where pipe runs under the road, protective sleeves (steel pipe or reinforced concrete pipe) shall be provided by the Contractor.

Standard drawings for the protective sleeves, including civil work, shall be submitted to the Engineer for approval.

(42) The level of top surface of the underground piping shall be deeper than GL-600 mm.

(43) When valves are needed in underground piping, a pit shall be provided for the valves. The pit cover shall be supplied by the Contractor.

(44) If underground piping requires expansion joints, protective sleeves shall be provided.

(45) Butt welding shall be applied for pipes of 65 mm diameter or larger, and socket welding shall be applied for pipes of 50 mm diameter or smaller.

(46) The use of covered trenches below basement floors or ground levels for the accommodation of pipes shall be avoided

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wherever possible.

Wherever practicable all main and auxiliary piping, drains, etc., shall be arranged so that they may be run above basement floor or ground levels with adequate headroom and access.

It is envisaged that it may be necessary to take pipes below ground levels and to pass them under roadways.

In this case, the pipelines shall be installed below the ground level for this purpose. The pipes shall be positioned in concrete-lined culverts of sufficient dimensions to provide crawling access for maintenance staff.

In no case shall pipework be run in trenches carrying electrical cables except for instrument lines.

1.1.3 SHOP AND FIELD TESTS

(1) Hydrostatic tests or air leak tests for piping shall be carried out in accordance with the applicable standards and codes before applying painting or insulation works.

(2) Welding points where the hydrostatic test is not possible shall be examined by non-destructive inspection, such as X-ray or gamma ray.

(3) In principle, welding points, especially field welded ones, shall be examined with non-destructive inspection, such as X-ray or gamma ray in accordance with the applicable standards and codes.

(4) All rigid hangers and spring hangers shall be firmly fixed during the hydrostatic test, and shall be adjusted for service after the test.

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(5) Expansion joints shall be firmly fixed by tie rods during the hydrostatic tests.

(6) During the hydrostatic test, the tightness of all gate, globe, butterfly and check valves shall be ascertained.

(7) Waste water of testing shall be disposed in accordance with the manner approved by the Engineer.

(8) The Contractor shall carry out the following flushing or cleaning in addition to the previously mentioned testing.

(a) Water flushing

(b) Steam flushing

(c) Blowing out of main steam pipe, cold reheat pipe, hot reheat pipe, turbine bypass pipe (if applicable), air ejector steam pipe and gland steam pipe

(d) Chemical cleaning (acid and alkaline)

(e) Oil flushing

(f) Air flushing

(9) The Contractor shall prepare all necessary equipment, spare parts and expendables for testings.

1.1.4 TECHNICAL INFORMATION

(1) The design of piping arrangement shall satisfy the following requirements.

(a) Each valve handle shall be located at the height in the range of 300 to 1,500 mm above floor level, and shall be designed not to obstruct the operation passage.

(b) Valves which require operation at the same time shall be located near each other.

(c) Instruments which need watching shall be grouped

together with valves in one place to facilitate supervision of the piping system.

(d) The vent, sampling, instrument piping, etc., shall be designed to prevent the return of drain into main pipes.

(e) The piping arrangement shall be designed to allow sufficient space for necessary maintenance of machinery or equipment.

(2) Raised face flange shall be used for pressures of 20 kg/cm^2g and over.

For all piping of fuel oil, lubrication oil and vacuum line, raised face flanges shall be used where the flange connections are required.

(3) In case of screw joints, the pipe wall thickness shall be of Schedule 80 or more.

(4) Fabrication details

(a) All straight pipes shall have correct circular sections. All bends shall have correct radius and free from wrinkling.

(b) All pipe bends except bend pieces shall have a radius at least three point five (3.5) times the nominal diameter of the pipe.

(c) The Contractor shall take proper precautions to prevent the occurence of craks and wrinkling in bending of steel pipe.

(d) No water or other cooling agents shall be used during hot bending of pipe.

(e) All pipings shall be fabricated in the shop except small size pipings which can be fabricated at the Site

(f) All free ends of pipe shall be properly provided with welding bevels.

(g) Stress relieving after welding of insulation lugs or supporting lugs on pipes of high tensile or alloy steel and their fittings shall be conducted in accordance with the applicable standards and codes.

(5) Shipping

(a) All piping shall be identified by the abbreviated name, piece number and flow direction marked on the surface before shipping.

The naming method shall be as stated in Item (9).

(b) The joint facing of all flanged joints shall be protected with suitable discs or caps which shall be securely fastened to the pipe for shipping. The free ends of pipe for welded or thread joints shall be protected in the same manner against damage during shipping and field transportation.

(c) All exposed finished surfaces, except weld end surfaces, shall be slushed with protective compound before shipping.

(d) The inside of piping such as turbine lubricating oil pipe, extraction steam pipe and fuel oil pipe shall be protected from rust by means of anti-rust powder or solvent before shipping.

(6) Welding at field

(a) All bevelling (weld end preparation) shall be done by accurate machining or grinding.

(b) Fillet welding for the piping shall be allowed only for attaching small branch piping, socket, thermometer wells and seal welding.

(c) Prior to welding, welding surfaces shall be thoroughly cleaned and free from scale, rust, grease, oil and undesirable matter.

(d) The first layer or beads of every weld shall be thoroughly fused into both members to be joined. Penetration shall be sufficient to completely fill all bead without leaving any gaps or cracks at the bottom of the weld or elsewhere.

(e) If any cracks, blow holes or other unacceptable defects appear on any bead of welding, the defect shall be completely and smoothly removed by grinding, and re-welding shall be done.

(f) All slag or flux remaining on any bead of welding shall be thoroughly removed before laying down the next successive layer.

(g) All prefabricated sections shall be thoroughly cleaned after welding and bending, and the inner and outer surfaces shall be smooth and free from dirt and other injurious matter.

(h) After welding, all spatters on the metal shall be removed from the inside and outside of the pipe.

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(i) All welding points at field shall be marked with white paint.

(j) Preheating and stress relieving for welding part shall be executed according to the applicable standards and codes.

(7) Painting

(a) Outside surface of all pipings (except oil piping of which outside surface will be contact with oil) shall be painted with rustproof paint.

(b) The piping which is not required for insulation shall be painted in accordance with Clause 1.13 of "Painting".

(c) The color code, band, direction of flow and name shall be indicated on all pipings according to the Owner's standard.

(d) Painting is not required for temporary piping.

(e) All hangers, supports, anchors and similar devices shall be painted as specified in Clause 1.13 of "Painting".

(8) Insulation

(a) All piping shall be insulated as specified in Clause 1.12 of "Insulation".

(b) Temporary piping shall be temporarily insulated for human protection.

(9) Naming of piping

The following abbreviated names and kind of materials shall be designated on all pipes and hangers before shipping.

Abbreviated Name	Name
MS	Main Steam
CR	Cold Reheat
HR	Hot Reheat
TB	Turbine Bypass
AS	Auxiliary Steam
ES	Extraction Steam
CD	Condensate
BD	Boiler Drain
FS	BFP Suction
FD	BFP Discharge
BF	Boiler Feedwater (After final feedwater heater)
HD	Heater Drain
MD	Miscellaneous Drain
GS	Gland Steam
SS	Steam Seal and Leak-off
CF	Chemical Feed
WT	Water Treatment
CW	Circulating Water
RO	Residual Oil
HO	High Speed Diesel Oil
LO	Lubrication Oil
IA	Instrument Air
SA	Service Air
CWB	Cooling Water (Bearing)
FP	Fire Protection Water
AE	Air Extraction

Abbreviated Name	Name
H_2	Hydrogen
CO_2	Carbon Dioxide
CL	Chlorination
BV	Boiler Vent
SE	Safety Valve Exhaust
RE	Relief Valve Exhaust
ME	Miscellaneous Exhaust
APS	Air Preheater Supply
APR	Air Preheater Return
SB	Soot Blowing Steam
IW	Intake Water
DW	Demineralized Water
N_2	Nitrogen
AF	Air Foam
DRW	Drinking Water
RW	Raw Water

1.2 HANGERS, ANCHORS AND SUPPORTS

In general, pipe supports and anchors shall be situated at those points in the building where provision has been made for the loads imposed. The cutting of floor or roof beams or the reinforcement in slabs would not be permitted. The supporting arrangements shall be capable of supporting the piping system when full of water during chemical cleaning or hydraulic testing.

Pipework shall be supported and anchored in an appropriate manner, in accordance with the provisions of approved relevant codes and standards to which the pipework is designed.

No point of passage of pipes through floors or walls shall be used as a point of support.

(1) All hangers shall be given the tag number indicated in the shop drawings. A metal tag, having this number, shall be securely attached to each hanger before shipment.

(2) The Contractor shall decide the type of hangers, anchors and supports based upon the results of stress analysis of pipings. The arrangement of hangers shall be approved by the Owner and the Engineer.

(3) Appropriate alloy steel for rods, clamp rings, etc., for hangers shall be used for pipings where temperatures exceed 400^{o}C.

(4) All high temperature pipe lines shall be supported with flexible hangers, such as constant and variable spring hangers, to permit axial and lateral movements without restraint of any movement of piping.

(5) The method of pipe suspension shall be such as to prevent

excessive stress and vibration of supporting devices as well as possible resonance imposed from vibration while the system is in operation.

(6) All hangers and supports shall be capable of withstanding the entire piping load imposed by expansion or contraction.

(7) Accurate weight balance calculations shall be made to determine the required supporting force for each hanger.

(8) If vibration of piping is encountered, the vibration shall be absorbed by additional spring cushions or energy absorbing devices.

(9) Hangers and supports shall be installed at proper locations, and shall be of sufficient type and size to limit weight and reaction on equipment to an acceptable value.

(10) Any over or under support shall not be permitted whenever the pipe is in cold or hot condition.

(11) All hangers shall be furnished with beam clamps, rods, pipe clips and all other material required for the attachment of the hangers to the building structure, or supplementary hanger supporting steel, if required.

(12) For purposes of hydrostatic test and chemical cleaning, all constant and variable spring hangers shall be equipped with preset pins or pieces to prevent travel.

(13) The variation range of supporting load of variable spring hangers shall be within 25% of maximum supporting load.

(14) Constant spring hangers shall be used where piping is subjected to large amount of vertical movement. The hangers shall be sufficient to permit pipe movement caused by thermal

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expansion and contraction in the piping system.

(15) The variation range of the supporting load of constant spring hangers shall be within 5% of the maximum supporting load.

(16) For constant spring hangers, the maximum travel shall be the design travel plus 20% or more.

(17) All constant and variable spring hangers shall be of the precompressed enclosed type with design cold and hot loads indicated on the enclosure. Open or partially enclosed types shall not be acceptable.

(18) Sway braces shall be used to prevent undesirable movement or vibration in all flexibly supported pipe lines.

(19) The random supply of spring hangers for field fabricated piping shall not be acceptable.

(20) Piping systems, where flexibility is not required, shall be supported by rigid hangers.

(21) Rigid hangers shall be designed and fabricated so that they will not receive excessive force by pipe movement.

(22) Turnbuckles and lock nuts shall be provided for constant and variable spring hangers with bolts having sufficient length of thread, and the amount of adjustment shall be visible at all times.

(23) Hanger rods shall be provided with suitable sockets or eyes to permit lateral piping movement without imposing bending movement on the hanger rods. Safe loads for hanger rods shall be calculated on the root area of the threads.

(24) Beam clamps shall be made of steel.

(25) Bolted plate pipe clamps used in connection with rod hangers

shall have a minimum thickness of 6 mm for weather protected locations, and 9 mm for places exposed to weather.

(26) All hangers, anchors, supports and similar devices shall be given one (1) coat of shop paint. Parts that come in contact with or in the immediate vicinity of high temperature piping shall be given a coat of shop paint resistant to high temperature.

(27) No hangers shall be directly attached to splice plates of beams.

(28) The numbering of hangers on each piping shall be in continuous orders, starting from the upstream end. The abbreviated name of each hanger shall be, in principle, the same as that of the piping.

(29) Outdoor pipe sleeper foundations, pipe rack foundations and pipe trenches shall be carefully designed by the Contractor. The Contractor shall supply all foundation bolts and shall set them in the intended locations before concrete filling, except where other methods for foundation bolt settings are required. The Contractor shall provide all materials for foundations of additional pipe sleepers, pipe racks and pipe trenches, as follows.

- o Where the above items are required as a result of detail piping design by the Contractor in addition to pipe sleepers and pipe rack foundations and pipe trenches to be constructed by another contractor.

(30) In case where underground piping is required, all civil works necessary for the pipe installation including material

preparation shall be carried out by the Contractor.

The Contractor shall submit the standard civil work drawings for the underground pipe installation to the Owner and the Engineer for approval.

(31) The Contractor shall arrange sliding shoes for pipe where axial movement is required.

1.3 VALVES AND SPECIALITIES

1.3.1 GENERAL

(1) Valves covered in this Clause shall include all gate, globe, needle, angle, check, non-return, plug, cock, butterfly, regulating and control valves including the valves of motor/solenoid/air operated valves and safety/relief valves.

(2) Specialities covered in this Clause shall include all strainers, flow glasses, drain traps, steam traps, filters, expansion joints, flexible hoses and others.

(3) All valves and specialities which are included in this specification shall be supplied by the Contractor. Although major valves are indicated in the Owner's Drawings, the Contractor shall be required to provide all necessary valves and specialities for the pipings in the detailed drawings.

1.3.2 DESIGN SPECIFICATION

(1) Gate valves which are of the pressure - sealed bonnet type shall be used for high pressure and high temperature pipings such as main steam, feedwater, high pressure extraction and other necessary piping.

(2) Gate valves shall not be used for flow control purposes. The bypass valves of the control valves shall be of globe, angle or plug type.

(3) Diaphragm valve is preferable in corrosive applications or in case where contamination of fluid is not permissible, such as in the water treatment equipment, waste water treatment equipment, and chlorination equipment, etc.

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Under corrosive applications, diaphragm valves shall be made of stainless steel or they shall be lined with glass, rubber, plastics, titanium or other anti-corrosive materials.

(4) Butterfly valves shall not be used for pressure-tight service.

(5) Control valves shall be installed with gate stop valves on both upstream and downstream sides. Bypass valves shall be installed for control valves as a rule. However, if backup control line is provided for the main control valve, bypass valve may be omitted for each control valve. A relief valve shall be installed on the low pressure side of the pressure control valve.

A pressure gauge shall be installed on the low pressure side of the pressure control valve.

(6) Relief valves or safety valves shall be used in all cases where excessive pressure in the system may cause damage or malfunction.

(7) Cocks shall not, in principle, be used for high temperature services, such as steam and high temperature water.

(8) Valves of 65 mm or larger in diameter shall be joined by butt welding. Valves of 50 mm or smaller shall be joined by socket welding. Where disconnection is required for maintenance, valves shall in principle be of the flanged type.

(9) It is desirable to apply hammer blow wheels to large manual operating valves for easier operation.

(10) The valves and specialities, except for steam trap, shall be

insulated where the related pipings are insulated. The insulation of the above valves shall be in accordance with Clause 1.12 of "Insulation".

(11) Valves which are installed in pits or underground shall be provided with extension rods for easier operation. The Contractor shall provide a proper cover for the pit.

(12) Back seats shall be provided for gate or globe valves, as a rule.

(13) Stems of gate valves which are installed outdoors shall be covered to prevent rust and dirt.

(14) Valves of 65 mm or larger in diameter which are used for the vacuum line shall be of the water gland seal type.

(15) Valve handles shall be of wheel type and the material shall be malleable cast iron for minimum grade, except in cases of cast or bronze valve.

(16) Opening scale indicators shall be provided for manual valves which are used for bypass or flow control.

(17) The material of valves used for lubricating oil, residual oil and HSD oil pipings shall be of cast steel or forged steel.

(18) The protection cover for valve spindles projected to the operation passage or access area shall be provided by the Contractor.

(19) To ensure safe operation and easy maintenance, ladders or steps, grating, handrails, etc., shall be provided for access to all valves which are located in inconvenient places.

(20) Standard for valve selection

The following tables shall be used as a guide in selecting the type, materials, rating, etc., for valves. The Contractor shall select valves in accordance with this standard.

LINE NAME			MAIN STEAM		
			PRESS. kg/cm^2g	TEMP. °C	RATING
			127 ∿ 169	539	2000-II ∿ 2500-II
VALVE SPECIFICATION	NOMINAL SIZE		65 mm and larger		50 mm and smaller
	MATERIAL	BODY	CAST ALLOY STEEL		FORGED ALLOY STEEL
		DISK	FORGED ALLOY OR CAST ALLOY STEEL + STELLITED		FORGED ALLOY OR CAST ALLOY STEEL + STELLITED
		SEAT	"		"
	BONNET		PRESSURE SEAL		WELDED SEAL
	END TYPE OF VALVE		BUTT WELD		SOCKET WELD
	YOKE		OS & Y		OS & Y
	BACK SEAT		YES		YES
REMARKS	OS & Y - Outside screw and yoke construction				

LINE NAME	HOT REHEAT		
	PRESS. kg/cm^2g	TEMP. °C	RATING
	-	-	600 PSI

VALVE SPECIFICATION				
	NOMINAL SIZE		65 mm and larger	50 mm and smaller
	MATERIAL	BODY	CAST ALLOY STEEL	FORGED ALLOY STEEL
		DISK	FORGED ALLOY OR CAST ALLOY + STELLITED	FORGED ALLOY OR CAST ALLOY + STELLITED
		SEAT	"	"
	BONNET		PRESSURE SEAL OR BOLTED	WELD SEAL OR BOLTED
	END TYPE OF VALVE		BUTT WELD	SOCKET WELD
	YOKE		OS & Y	OS & Y
	BACK SEAT		YES	YES

REMARKS	

LINE NAME	HIGH PRESSURE FEEDWATER AND SPRAY WATER		
	PRESS. kg/cm^2g	TEMP. °C	RATING
	-	-	1500 PSI ∿ 2500 PSI

VALVE SPECIFICATION				
NOMINAL SIZE			65 mm and larger	50 mm and smaller
MATERIAL	BODY		CAST CARBON STEEL	FORGED CARBON STEEL
	DISK		CAST CARBON STEEL + STELLITED	FORGED CARBON STEEL + STELLITED
	SEAT		"	"
BONNET			PRESSURE SEAL	WELDED SEAL
END TYPE OF VALVE			BUTT WELD	SOCKET WELD
YOKE			OS & Y	OS & Y
BACK SEAT			YES	YES

REMARKS

Note: Large valves for high pressure use, as stated below, shall be provided with small bypass valves, if required.

Valve diameter ..... 250 mm or larger

Working pressure ..... 100 kg/cm^2g or higher

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LINE NAME	EXTRACTION STEAM		
	PRESS. kg/cm^2g	TEMP. °C	RATING
	-	-	-

VALVE SPECIFICATION				
	NOMINAL SIZE		65 mm and larger	50 mm and smaller
	MATERIAL	BODY	CAST CARBON STEEL	FORGED CARBON STEEL
		DISK	CAST CARBON STEEL + STELLITED	FORGED CARBON STEEL + STELLITED
		SEAT	"	"
	BONNET		PRESSURE SEAL OR BOLTED	WELD SEAL OR BOLTED
	END TYPE OF VALVE		BUTT WELD	SOCKET WELD
	YOKE		OS & Y	OS & Y
	BACK SEAT		YES	YES

REMARKS	

LINE NAME	CONDENSATE		
	PRESS. kg/cm^{2}g -	TEMP. °C -	RATING 20 kg/cm^{2}g (300 psig)

VALVE SPECIFICATION				
NOMINAL SIZE			65 mm and larger	50 mm and smaller
MATERIAL	BODY		CAST CARBON STEEL	FORGED CARBON STEEL
	DISK		CAST CARBON STEEL + STELLITED	FORGED CARBON STEEL + STELLITED
	SEAT		"	"
BONNET			BOLTED	BOLTED OR WELD SEAL
END TYPE OF VALVE			BUTT WELD	SOCKET WELD
YOKE			OS & Y	OS & Y
BACK SEAT			YES	YES

REMARKS

CONDENSATE PUMP SUCTION LINE RATING 10 kg/cm^{2}g (150 psig)

BOILER FEED PUMP SUCTION RATING 10 kg/cm^{2}g (150 psig)

3-157

LINE NAME	FEEDWATER HEATER DRAIN		
	PRESS. kg/cm^2g	TEMP. °C	RATING
	-	-	-

VALVE SPECIFICATION				
NOMINAL SIZE			65 mm and larger	50 mm and smaller
MATERIAL	BODY		CAST CARBON STEEL	FORGED CARBON STEEL
	DISK		CAST CARBON STEEL + STELLITED	FORGED CARBON STEEL + STELLITED
	SEAT		"	"
BONNET			BOLTED OR PRESS SEAL	BOLTED OR WELD SEAL
END TYPE OF VALVE			BUTT WELD	SOCKET WELD
YOKE			OS & Y	OS & Y
BACK SEAT			YES	YES

REMARKS

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LINE NAME	HIGH PRESSURE AUXILIARY STEAM		
	PRESS. kg/cm^2g	TEMP. °C	RATING
	17	350	20 kg/cm^2g (300 psig)

VALVE SPECIFICATION				
NOMINAL SIZE			65 mm and larger	50 mm and smaller
MATERIAL	BODY		CAST CARBON STEEL	FORGED CARBON STEEL
	DISK		CAST CARBON STEEL + STELLITED	FORGED CARBON STEEL + STELLITED
	SEAT		"	"
BONNET			BOLTED	BOLTED OR WELD SEAL
END TYPE OF VALVE			BUTT WELD	SOCKET WELD
YOKE			OS & Y	OS & Y
BACK SEAT			YES	YES

REMARKS

3-159

LINE NAME	LOW PRESSURE AUXILIARY STEAM		
	PRESS. kg/cm^2g 7, 4	TEMP. °C 300 or SATU.	RATING 10 kg/cm^2g (150 psig)

VALVE SPECIFICATION	NOMINAL SIZE		65 mm and larger	50 mm and smaller
	MATERIAL	BODY	CAST CARBON STEEL	FORGED CARBON STEEL
		DISK	CAST CARBON STEEL + STELLITED	FORGED CARBON STEEL + STELLITED
		SEAT	"	"
	BONNET		BOLTED	BOLTED OR WELD SEAL
	END TYPE OF VALVE		BUTT WELD	SOCKET WELD
	YOKE		OS & Y	OS & Y
	BACK SEAT		YES	YES
REMARKS				

3-1/60

LINE NAME	COOLING WATER		
	PRESS. kg/cm^2g	TEMP. °C	RATING
	7	50	10 kg/cm^2g (150 psig)

VALVE SPECIFICATION				
NOMINAL SIZE			65 mm and larger	50 mm and smaller
MATERIAL	BODY		CAST CARBON STEEL	FORGED CARBON STEEL
	DISK		CAST CARBON STEEL + STELLITED	FORGED CARBON STEEL + STELLITED
	SEAT		"	"
BONNET			BOLTED	BOLTED OR WELD SEAL
END TYPE OF VALVE			BUTT WELD	SOCKET WELD
YOKE			OS & Y	OS & Y
BACK SEAT			YES	YES

REMARKS

LINE NAME	CIRCULATING WATER (CONDENSER COOLING WATER)		
	PRESS. kg/cm^2g	TEMP. °C	RATING
	-	45	5 kg/cm^2g

VALVE SPECIFICATION				
NOMINAL SIZE			Over 100 mm	100 mm and smaller
MATERIAL	BODY		CAST IRON + RUBBER LINING	CAST IRON OR BRONZE
	DISK		CAST IRON + RUBBER LINING	CAST IRON OR BRONZE
	SEAT		"	"
BONNET			BOLTED	BOLTED OR SCREW
END TYPE OF VALVE			FLANGE	FLANGE OR SCREW
YOKE			BUTTERFLY	OS & Y
BACK SEAT			NO	NO

REMARKS

3-1/2

LINE NAME	COMPRESSED AIR (SERVICE AIR / INSTRUMENT AIR)		
	PRESS. kg/cm^2g	TEMP. °C	RATING
	10	40	10 kg/cm^2g (150 psig)

VALVE SPECIFICATION				
NOMINAL SIZE			65 mm and larger	50 mm and smaller
MATERIAL	BODY		CAST CARBON STEEL	FORGED CARBON STEEL OR BRONZE
	DISK		CAST CARBON STEEL + STELLITED	"
	SEAT		"	"
BONNET			BOLTED	BOLTED OR SCREW
END TYPE OF VALVE			BUTT WELD	SOCKET WELD
YOKE			OS & Y	OS & Y
BACK SEAT			YES	YES

REMARKS

1. The valves for hose connections shall be of bronze valves.

3-163

LINE NAME	DRAINAGE AND WASTE WATER		
	PRESS. kg/cm^2g	TEMP. °C	RATING
	-	-	-

VALVE SPECIFICATION				
NOMINAL SIZE			65 mm and larger	50 mm and smaller
MATERIAL	BODY		CAST IRON OR CAST CARBON STEEL	CAST IRON OR BRONZE
	DISK		"	"
	SEAT		"	"
BONNET			BOLTED	BOLTED OR SCREWED
END TYPE OF VALVE			FLANGE	SCREW OR FLANGE
YOKE			OS & Y	OS & Y
BACK SEAT			NO	NO

REMARKS

The valves shall be designed and selected by taking into account acid and alkali water use.

Internal lining or special material for valve bodies shall be adopted for waste water containing high concentrations of acid or caustic solution.

LINE NAME	FUEL OIL (RESIDUAL, HSD OIL)		
	PRESS. kg/cm^2g 10, 30	TEMP. °C 40, 105	RATING 10 kg/cm^2g (150 psig) 40 kg/cm^2g (600 psig)

VALVE SPECIFICATION				
NOMINAL SIZE			65 mm and larger	50 mm and smaller
MATERIAL	BODY		CAST CARBON STEEL	FORGED CARBON STEEL
	DISK		CAST CARBON STEEL + STELLITED	FORGED CARBON STEEL + STELLITED
	SEAT		"	"
BONNET			BOLTED	BOLTED
END TYPE OF VALVE			BUTT WELD	SOCKET WELD
YOKE			OS & Y	OS & Y
BACK SEAT			YES	YES

REMARKS

Note: Welded joints shall be applied. However, the joints between equipment and piping shall be of the flanged joint type. Valve joints for future extension shall be of the flanged joint type.

3-164

LINE NAME	MAKE UP WATER		
	PRESS. kg/cm^2g	TEMP. °C	RATING
	-	40	10 kg/cm^2g (150 psig)

VALVE SPECIFICATION				
NOMINAL SIZE			65 mm and larger	50 mm and smaller
MATERIAL	BODY		CAST CARBON STEEL	FORGED CARBON STEEL
	DISK		CAST CARBON STEEL + STELLITED	FORGED CARBON STEEL + STELLITED
	SEAT		"	"
BONNET			BOLTED	BOLTED OR UNION
END TYPE OF VALVE			BUTT WELD	SOCKET WELD
YOKE			OS & Y	OS & Y
BACK SEAT			YES	YES
REMARKS				

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LINE NAME	RAW WATER, DEMINERALIZED WATER AND FIRE WATER (FRESH WATER)		
	PRESS. kg/cm^2g	TEMP. °C	RATING
	10 and below	30	10 kg/cm^2g (150 psig)

VALVE SPECIFICATION				
NOMINAL SIZE			65 mm and larger	50 mm and smaller
MATERIAL	BODY		CAST CARBON STEEL	FORGED CARBON STEEL
	DISK		CAST CARBON STEEL + STELLITED	FORGED CARBON STEEL + STELLITED
	SEAT		"	"
BONNET			BOLTED	BOLTED OR UNION
END TYPE OF VALVE			BUTT WELD	SOCKET WELD
YOKE			OS & Y	OS & Y
BACK SEAT			YES	YES

REMARKS

LINE NAME	LUBRICATING OIL		
	PRESS. kg/cm^2g	TEMP. °C	RATING
	–	–	20 kg/cm^2g (300 psig) 10 kg/cm^2g (150 psig)

VALVE SPECIFICATION				
NOMINAL SIZE			65 mm and larger	50 mm and smaller
MATERIAL	BODY		CAST CARBON STEEL	FORGED CARBON STEEL
	DISK		CAST CARBON STEEL + STELLITED	FORGED CARBON STEEL + STELLITED
	SEAT		"	"
BONNET			BOLTED	BOLTED
END TYPE OF VALVE			BUTT WELD	SOCKET WELD
YOKE			OS & Y	OS & Y
BACK SEAT			YES	YES

REMARKS

Note: Each drain valve of the tank shall be provided with a lock.

LINE NAME	INTAKE WATER		
	PRESS. kg/cm^{2}g	TEMP. °C	RATING
	-	-	10 kg/cm^{2}g

VALVE SPECIFICATION				
NOMINAL SIZE			Over 100 mm	100 mm and smaller
MATERIAL	BODY		CAST IRON + RUBBER LINING	CAST IRON OR BRONZE
	DISK		"	"
	SEAT		"	"
BONNET			BOLTED	BOLTED OR SCREW
END TYPE OF VALVE			FLANGE	FLANGED OR SCREW
YOKE			BUTTERFLY	OS & Y
BACK SEAT			NO	NO

REMARKS

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Note (a) The bolted bonnet in which the internal pressure tends to open the joint shall not be acceptable for valves having the pressure rating 1,500 psig or more.

A screwed bonnet shall be provided with the means to prevent loosening.

Note (b) Valve seats, disks or plugs and back seating shall be hardened with stellite facing or other appropriate means.

Note (c) Steam and water sampling valves shall be of the stainless steel, union bonnet and socket weld type. The tap valves (root valves), including the second valves, shall be of stainless steel. The rating shall be the same as main piping.

(21) Motor operated valve

Manual operating hand wheels shall be provided to all motor operating valves.

Provisions to minimize the turn of manual hand wheels shall be provided.

Protection against overload shall be equipped on the motor gear set.

(22) Control valve

(a) All control valves shall be of the pneumatic or hydraulic type.

(b) All control valves shall have bolted seal bonnets, unless otherwise specified. For valves operating at a temperature of 230°C or more, the bonnet shall be

provided with cooling fins.

(c) Control valves shall be furnished with a bolted packing gland and teflon impregnated asbestos packing or equivalent.

(d) Double seated valves shall be of the top and bottom guided type.

(e) Valves having a maximum pressure differential in excess of 35 kg/cm^2g shall have welded seat rings.

(f) For flushing liquids, and used with pressure drops over 10 kg/cm^2 stellite faced stainless steel seat rings and plugs or approved equal material, shall be furnished. Guide bushing shall be of hardened stainless steel or equivalent.

(g) Full bored stellited seat, full-faced stellited plug and guides, or equivalent, shall be applied for reducing steam pressure, feedwater and condensate control valves.

(h) The minimum acceptable trim material shall be of stainless steel.

(i) All control valves shall be sized for a flow, which includes an allowance of at least 10% excess over the expected maximum required capacity.

(j) A stem travel indicator shall be furnished for each control valve.

(23) Expansion joint and flexible hose

(a) Expansion joints and flexible hoses shall be used to absorb expansion and contraction caused by temperature

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difference, and to adjust the displacement of connection pipes with related machines.

(b) Suitable anchors shall be provided to sustain the direct pressure thrust, as well as all other mechanical loading which may be imposed upon joints and hoses.

(c) Appropriate guides shall be provided to assure that the joints are protected from all loads. The material of expansion joint shall highly reliable, and shall receive approval by the Owner and the Engineer.

(d) Spacer bars and similar devices shall be used to protect joints and hoses during shipment and installation, and to assure that the desired preset conditions are maintained until installation is completed.

(24) Sight flow (flow glass)

(a) The sight flow body shall be of bronze or steel. Sight flow glass shall be made removable for maintenance.

(b) If the sight flow is filled with flowing liquid, an adequate baffle plate or equivalent shall be installed to indicate the state of flow.

(25) Strainer and filter

(a) Strainers and filters with reliable filtering material such as stainless steel shall be provided for pumps, flow meters, steam and drain traps and other fixtures.

(b) If considerable clogging of strainers is anticipated

due to scale or similar conditions, strainers shall be of the type which permit continual flow of clean liquid.

(c) The free area of strainers and filters shall not be less than four (4) times the cross section area of the pipe.

(26) Steam trap and drain trap

(a) The size of traps shall be chosen on the basis of design discharge capacity, not be based only on the size of the inlet and outlet connection.

(b) Body material of steam traps shall be equivalent to those which are specified in "Valve".

(c) Steam traps shall be of the inverted bucket type, float type, thermostatic type or thermodynamic type.

(d) Drain traps for air or gas lines shall be of the bucket or float type.

(e) All trim parts shall be of stainless steel, and bronze trim shall not be acceptable.

(27) Valve tag number

A valve tag number shall be selected for each piping system, and the tag numbers shall be continuous, starting from the upstream end.

The valve tag numbering system shall be prepared by the Contractor in accordance with the Owner's standard which will be indicated to the Contractor from the Owner/Engineer soon after the Contract of this project becomes effective.

(28) Valve list

The Contractor shall prepare the valve list in accordance with the Owner/Engineer's form, which will be prepared soon after the contract becomes effective.

(29) Valve name plate

All valves shall be attached with valve name plates, which are specified as follows, before the trial operation.

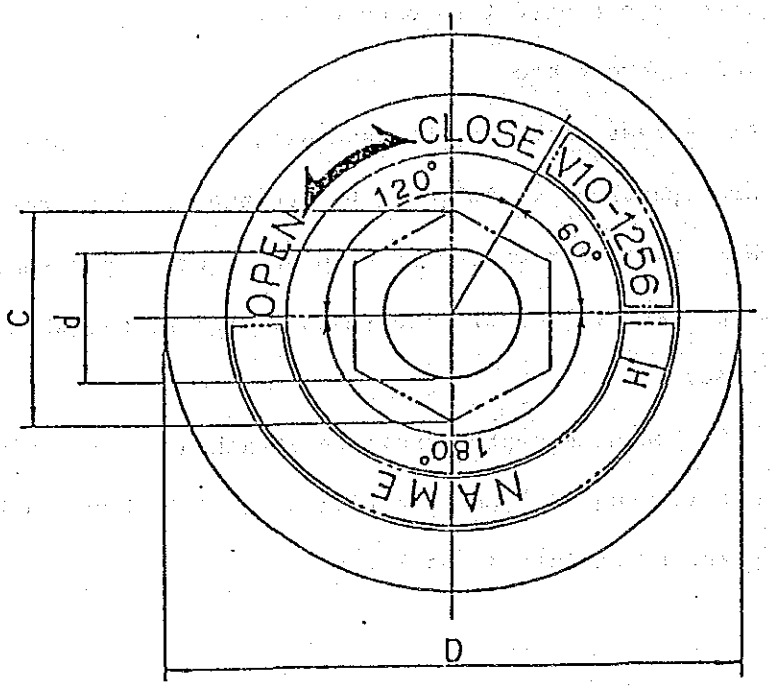
Name plate for valves of size 50 mm or larger shall be "A" type, and valves of size smaller than 40 mm, shall be "B" type.

"A" type name plates shall be attached to the valve hand wheel, and "B" type name plates shall be hung on bonnets or yokes by stainless steel wire.

(A) "A" type name plate

The valve name plate size shall be as follows.

Thickness of plate: 1 mm



(a) Material : Stainless steel 304P or chrome plated steel plate

(b) Indication:

- Valve tag No. and name shall be the same as valve list.
- Lettering shall be made by etching on black background.
- Size of lettering shall be as in the following table.

(c) Abbreviation may be used for long valve names.

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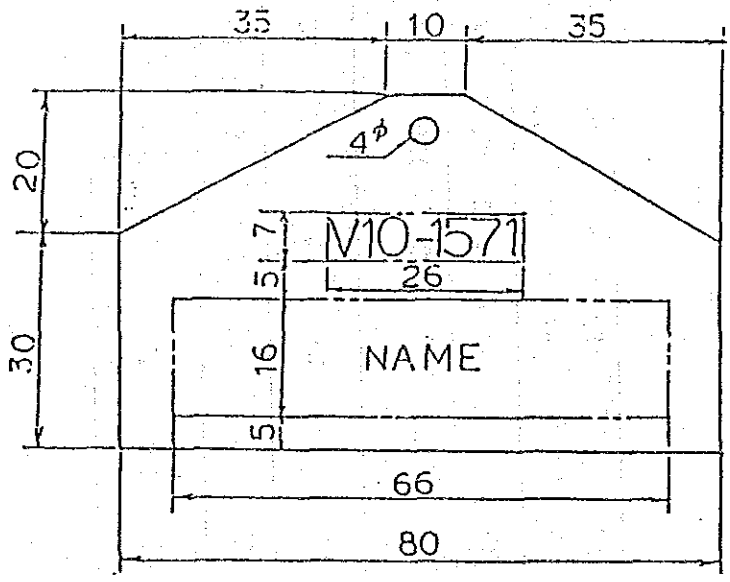
(d) Size of "A" type name plate

Name plate	NP -1	NP -2	NP -3	NP -4	NP -5	NP -6	NP -7	NP -8	NP -9	NP -10	NP -11	NP -12	NP -13
Nut Size C	19.6	19.6	24.2	24.2	30	30	37	40.4	47.3	53.1	57.7	62.4	67
Outside diameter of name plate D	40	50	50	75	75	100	100	100	125	125	150	150	175
Inside diameter of name plate d	10	10	13.5	13.5	17	17	20	23	27	30	33	36	40
Height of letter H	5	8	8	10	10	12	12	12	15	15	18	18	20
Hand wheel diameter (only for reference)	125	125	170	200	260	300	360	410	460 ∿ 560	610 ∿ 650	700 ∿	700 ∿	700 ∿

(B) "B" type name plate

The valve name plate size shall be as follows.

Thickness of plate: 1 mm



(a) Material: Stainless steel SUS 304P or chrome plated steel plate

(b) Indication:

. Valve tag No. and name shall be the same as valve list.

. Lettering shall be made by etching on black background.

. Size of letter, 7 mm maximum.

(c) Abbreviation may be used for long valve names.

(d) Indication of instrument valve may use the instrument tag number.

1.3.3 TESTING

The Contractor shall, before shipment, execute the following shop tests on 20 to 30% of each rating and size of all manufactured valves and specialities. However, the Contractor shall make sure that the tests for all valves have been carried out in accordance with ANSI or JIS requirement or applicable standards and codes by the valve manufacturer.

(1) Material test

(2) Non destructive inspection

(3) Hydrostatic test, leak test

(4) Dimension check, visual inspection

(5) Operation test

(6) Overhaul inspection

1.4 WELDING

1.4.1 GENERAL

(1) All welding shall conform to the approved codes and standards. Before commencing manufacture, welding procedure documents, including Welder Qualification Records, for all piping works, structural steel, pressure vessels, etc., subject to welding shall be submitted to the Owner and the Engineer for the approval.

(2) The welding procedures shall be in accordance with requirements of the standard and relevant code to which the particular piping work, steelwork or pressure vessel shall be designed and fabricated.

(3) In all cases where welds are subject to high stresses or reversal of stress in operations, as may be the case in pressure parts or roating parts, the Contractor shall submit detailed drawings of all proposed weld preparations and general fabrication arrangement drawings before manufacture commences.

All welding shall be carried out under the supervison of competent welding supervisors.

The welding supervisor appointed to the site shall be well experienced in the supervision of welding on construction sites and shall have had prior experience of work to the standard indicated in this Specification.

(4) The Owner and the Engineer reserves the right to visit the Contractor's works at any reasonable time during fabrication of the various equipment and facilities.

(5) Should the Contractor wish to alter any part of the weld preparations, the Contractor shall submit the revised drawing specifying the amended preparation to the Owner and the Engineer for approval.

(6) All expenses incurred by welders and materials and the provision of all equipment necessary to execute the inspection tests, pre-heating and post-weld heating, including thermal insulation for retaining heat and for protection of the welders, shall be borne by the Contractor.

(7) The Contractor shall submit to the Owner and the Engineer the details of the testing of welders, operators, materials and welds.

Copies of all records of all welding procedures, including preheating, post-heating and stress relieving, plus alloy steel chemical analysis and physical properties, shall be made available upon request by the Owner or Engineer.

(8) When weld repairs becomes necessary, the Inspector shall be informed and given the option of making an examination after the defect has been removed and before welding commences. Repairs shall be carried out in accordance with the relevant codes.

(9) In no case shall the cleaning of welds be made by the use of acidic applications. No weld shall be painted until 72 hours has elapsed after completion of welding.

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1.4.2 PIPE WORK

(1) Welding procedure

All welding of piping joints shall be fusion welding using manual, automatic or semi-automatic welding processes for ferritic and low-alloy steel pipework. The arc and the deposited welded metal shall be protected from atmospheric conditions at all times during welding. The procedures, tests and inspections shall be in conformity with the approved codes and standards.

Weld preparations shall be in accordance with the approved codes and standards. The joint end preparation shall be made by machining or grinding. Backing rings shall not be used, unless otherwise approved by the Owner or the Engineer. Full information regarding weld sizes, joint preparation, assembly and the setting up of welding procedures and sequences shall be made available to the Owner or the Engineer and approval shall be obtained before manufacture commences.

Welded-on attachments, such as lugs, supports, etc., shall not invade or overlap any pressure weld. Attachment welds shall have a contour free from notch effects at the weld junction. Such welds may be made only by welders qualified for butt welding under the requirements of the approved codes and standards.

(2) Welder testing

All welders shall be tested in accordance with the requirements of the approved codes and standards. The Owner

and the Engineer shall have the right to have any welder retested at any time, if required.

Each welder engaged shall have his distinctive number or mark stamped on each testpiece. The Contractor shall maintain careful records of the positions of the actual welds made by each welder, and these records shall be submitted to the Owner and the Engineer.

(3) Butt welds

Single side butt weld joints in low alloy steel, high yield steels and other class 1 systems shall be designed to have the root run made by the tangsten inert gas (TIG) process. Backing rings shall not be acceptable for main pipelines of the power plant and shall only be used in other systems based on prior approval from the Engineer.

(4) Branch welds

Branch welds shall be according to the following metal arc welding.

(i) Metal arc welding throughout

(ii) Metal arc welding with argon arc root run

(iii) Metal arc welding with consumable insert in the root fused by argon arc

All welds shall be subjected for stress relief according to the relevant Codes and Regulations.

(5) Pre-heating

Pre-heating prior to and during welding shall be in accordance with the requirements of the relevant codes and standards.

Where preheating is required it shall whenever practical be carried out by electric resistance or induction equipment. The heating shall be uniformly done around the section to minimize thermal stresses, and records of the preheat temperatures shall be kept by means of approved methods, such as thermocouples, recording potentionmeter, etc.

(6) Stress relieving

In case of code requirements all welds shall be locally stress-relieved by an approved method and during this period the outside of the pipe shall be insulated for a distance of 4 pipe diameters on each side of the heated zone.

Post-weld heat treatment for stress relieving shall be in accordance with the relevant codes and standards. Stress relieving and/or post-weld heat treatment shall be carried out using equipment specifically designed for the process. Gas burners or hand-held torches will not be permitted. The Contractor shall supply copies of the heat treatment charts. Works which is subjected to heat treatment by means of electrically heated elements shall be monitored by suitable thermocouples connected to a chart recorder. A minimum of two thermocouples shall be used and copies of heat treatment charts shall be made available to the Engineer.

Weld dressings before heat treatment shall be as follows,

(i) Circumferential butt welds shall be dressed to a smooth contour by blending weld and parent metal. This requirement need not apply to semi or fully

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automatically made welds, and the finish shall be of superior quality.

(ii) Branch and fillet welds shall be finished to a smooth contour and in particular the toes of the welds shall be dressed to the satisfaction of the Owner and the Engineer.

1.4.3 PRESSURE VESSELS

(1) Welding procedure

All welding of pressure vessels shall be by fusion welding using an electric arc process whereby the arc and the deposited weld metal shall be protected from atmospheric conditions. The procedures, tests and inspections shall conform to the approved codes and standards.

(2) Welder testing

All welders and welding machine operators shall be tested in accordance with the requirements of the approved codes and standards.

A complete set of tests shall be required for each of the four fundamental welding positions (flat, horizontal, vertical and overhead) for which the weld is intended. Records of welder qualification tests shall be retained by the Contractor, and these shall be submited to the Owner or the Engineer as evidence of the competence of any welder or welding machine operator engaged in the fabrication of a vessel. The Owner and the Engineer shall have the right to retest any welder at any time during the fabrication of the vessels.

(3) Weld design

For pressure vessels having 50 mm thickness or more, all necessary design considerations in respect to pressure vessels shall be applied in addition to the following requirements. At the detailed design stage, full consideration shall be given to the complex residual stress

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which will be expected to occur around discontinuities, such as nozzle openings, etc. The toes of all fillet welds, securing attachments and any other internal fittings shall not be allowed to approach nearer than 40 mm to the toes of large fillet welds of nozzles or undressed main seam welds.

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1.5 FORGINGS AND CASTINGS

1.5.1 FORGINGS

The Contractor shall provide material purchase specifications for all important forgings, and submit copies of these specifications to the Engineer for their use. Specifications shall be prepared for, but not limited to, turbine shafts, diaphram discs, generator rotors, rotor end covers or end bells, exciter shafts, large motor shafts and precision forged turbine blades, feedwater heater water channel, etc. In each case the quality and inspection requirements shall be clearly stated.

Wherever possible steel forgings material and associated requirement shall be selected from approved International Standards.

All forgings shall be manufactured from basic furnace steel or fully killed acid open hearth steel. Consideration shall be given to the use of vacuum degassed steels in appropriate cases.

Forgings shall be free from cracks, externally and internally, extensive non-metallic inclusions and surface defects which cannot be removed by subsequent machining.

Each forging shall be suitably branded with an identification number which shall be transferred throughout all final machining stages. The identification number shall be marked on all documents and test certificates relative to the forging.

1.5.2 CASTINGS

Wherever possible castings shall be selected from the range of materials covered in relevant codes and standards and the inspection and quality requirements together with the other provisions of this Specification shall be regarded as the minimum acceptable standard.

Special attention shall be paid to the design of castings to ensure ample and generous fillets at the point of attachment of flanges, branches or fittings.

Test bars shall be provided from medium and large castings for all necessary material and chemical tests, and these tests shall be witnessed by the Owner or the Engineer. Any castings for rotating or highly stressed parts shall be subjected to non-destructive testing by an approved methods, including radiographic and ultrasonic means.

All castings shall be homogeneous, free of shrinkage, under-sizing, porosity and voids. "Burn-in" repairs shall not be acceptable and no welding, filling, interlocking or plugging of defective parts shall be done without written approval from the Owner or the Engineer. All repairs shall be subjected to non-destructive examination (ultrasonics, X-rays, gamma-rays) after heat treatment.

Welding repairs to castings that may contact corrosive liquids, such as sea-water or brine, shall only be permitted upon approval by the Owner or Engineer.

1.6 PUMPS

Particular attention shall be paid to the materials and construction of pumps, wherever possible all pumps shall preferably be horizontal-spindle split casing to ensure ease of maintenance, and shall be designed so that replacement of rotating part is capable of being withdrawn from the casing without dismantling of any piping.

All pumps shall be capable of continuous operation under required duty, without overheating, cavitation, excessive noise or instability when working singly or in parallel with other pumps.

Pumps shall be installed in positions convenient for operation and service.

Where multiple pump installation are required, each pump shall be arranged so as to permit easy access for operation, maintenance and pump removal without interrupting plant operation.

Care shall be taken that pumps extracting fluid from vacuum spaces having controlled liquid levels shall have an adequate margin of head to ensure operation over the range of flows without cavitation.

Gland or mechanical sealings shall be arranged so that repacking or fitting of replacement seals can be carried out with the minimums of disruption to plant operation.

Horizontal pumps shall be mounted with their drives on a common base plate of rigid construction. Vertical pumps shall be provided with foundation frames.

Pump rotating parts shall be static and wherever applicable, dynamic balance tested after assembly at the rated speed. The first critical speed shall be 20% higher than the rated speed.

All pumps shall be provided with temporary strainers at the suction piping at the stage of initial running and commissioning test period.

All gland sealing water supplies for condensate pumps shall be taken from either the appropriate condensate piping or the demineralised water service. Wherever practicable, all materials in contact with the fluid being pumped shall be compatible and selected to minimize galvanic corrosion.

Pumps shall be designed to have reasonable margins available in head and capacity to compensate for any normal deterioration rate from wear anticipated. Care must be taken to ensure that such excess capacity does not increase velocities inside the associated system up to erosion levels.

Unless otherwise specified in the relevant clause of respective pump, pumps shall have a minimum margin of 10% and 10% in capacity and head, respectively.

1.7 HEAT EXCHANGERS

Heat exchangers shall be designed, manufactured and fabricated in accordance with the approved codes and standards.

Only heat exchangers of proven design shall be accepted. No cast iron components shall be allowed except prior approval by the Engineer.

Heat exchangers shall be installed in positions convinient for operation and services, and shall be fitted with lifting lugs, eyes and special tackles so as to permit easy handling.

Tublar type heat exchangers shall be used whenever practicable, and the tubes shall be protected with impingement protection shield at areas corresponding to inlet nozzles, etc. An adequate number of inspection ports shall be provided in critical areas to facilitate condition monitoring.

Unless otherwise specified, heat exchanger tubes shall be seamless with a circular cross-section and all heat exchanger shells and tubes shall be designed with the design conditions of associated pipings. The minimum design pressure for general use heat exchangers shall be considered as 10 kg/cm^2g for both tube side and shell side unless otherwise specified. Test pressure shall be 1.5 times the design pressure.

Heat exchangers shall be capable of continuous operation with rated duty up to 10% of plugged tubes.

All necessary appurtenances shall be attached to facilitate cleaning of heat exchangers. For cleaning purposes, connection having 50 mm nominal bore shall be provided.

Heat exchangers shall have the required number of vents, drains and

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safety releaf valves.

Pipes from drains, vents and safety valves shall be grouped together and routed to easily observable points. Covered funnels shall be provided as required.

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1.8 VESSELS AND TANKS

All vessels and tanks shall be designed, constructed and be in accordance with the approved codes and standards. The contractor shall submit his design calculations to the Engineer for approval. Connections shall be provided for all pipings, together with connections and nozzles for instrument and control. Manholes of proper size, as well as vents, drains, safety devices and all platforms necessary for safer operation and easy maintenance shall be supplied.

The connections to vessels and tanks shall be made flanged or welded and shall be in accordance with a pressure class of either 10 kg/cm^2g or 150 lbs minimum.

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1.9 BOLTS, NUTS, STUDS AND WASHERS

All bolts, nuts, studs and washers shall conform to the approved codes and standards. Bolts and nuts which are subjected to high temperature and pressure shall be of the best quality, bright steel, machined on the shank and under the head and nut. Where design temperature exceeds 260°C, nuts and bolts shall be made of high creep resistance steel and shall be of the waisted type.

All washers, including locking devices and anti-vibration arrangements, shall be subject to the approval of the Owner or the Engineer. Where stainless steel or non-ferrous bolts and nuts are required, the washers shall be in similar materials. The bolts and nuts threads shall project beyond the outside face of nuts by not less than the equivalent of one thread pitch and not more than approx. 5 mm.

1.10 PLATFORMS AND STAIRWAYS

(1) All platforms, galleries, access stairways, ladders, handrails and supports shall be provided to afford ready means of access for operation, inspection, cleaning and overhaul, and shall be of sufficient strength to support all loads which may be placed on them during the overhaul and inspection periods.

(2) All galleries, platforms, stairways, ladders and hand railing shall be of properly painted, unless otherwise specified.

(3) Galleries, platforms and stairways shall be designed generally for a load of 300 kg/m^2. However, where loads in excess of this figure are likely to be imposed during operation or maintenance, due allowance for the increased load shall be taken in the design.

(4) Should it be necessary to support platforms, galleries or stairways from the reinforced concrete of the building, appropriate building design shall be made.

(5) The requirements for the detailed civil engineering design of platforms and stairways shall be specified in the relevant section.

(6) Galleries and platforms around plant, such as those for the main boilers, shall be made with due allowance in the design to allow the thermal movement.

(7) Platforms, galleries and stair treads shall be constructed of an approved type of open mesh steel flooring of substantial design.

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(8) Platforms and galleries shall have a minimum width of 500 mm clear passageway and not less than 1,300 mm clear space which used for tube cleaning and in the way of burners, and shall be enclosed by a hand railing on both sides. The minimum headroom on platforms and galleries shall be 2,100 mm. Access shall not be obstructed at any point by pipes, valves or other plant equipment.

(9) Principal stairways shall have a minimum width of 800 mm, while other stairways shall have a minimum width of 600 mm. Stairways shall, in principle, have a inclination of 40^{o}, but in no case shall be steeper than 60^{o}. Ladders shall be permissible, only where stairways are impracticable and access is required only for inspection purposes.

(10) Double handrails of mild steel pipe of 32 mm (1-1/4") or 40 mm (1-1/2") diameter shall be provided.
The top rail shall be not less than 1,100 mm above the platfrom or gallery level.
Stanchions shall be of mild steel pipe spaced 1.5 meters between center lines, to which the handrails shall be firmly attached.

1.11 INSULATION

1.11.1 SCOPE OF SUPPLY

(1) All piping and equipment of which the inner fluid temperature is over 50°C shall be insulated by insulation, brickworks, refractories, lagging and jacketing.

(2) The insulation for piping and equipment shall include the following.

(a) Insulation, jacketing and lagging

(b) Refractory

(c) Brickwork

(d) Personnel safety insulation

(e) Anti-sweat insulation

(3) The Contractor shall furnish the tools, scaffolding, cleaning materials and all other pertinents required to satisfactorily complete the work.

(4) All piping of which the outer temperature becomes sometimes higher than 50°C shall be provided with personnel safety insulation.

(5) The following piping and those portions located within the following specific areas shall be insulated for personal safety unless otherwise specified.

(a) Exhaust and drain piping of safety and relief valve

(b) Exhaust and drain piping of blowdown tank

(c) Sampling piping

(d) Air compressor outlet air piping up to after cooler

(e) Vent and drain piping for auxiliaries

(f) Air preheater washing water piping

(g) Horizontal piping of the above, where the underside of the pipe is lower than two (2) meters above floors and platforms.

(h) Those portions of vertical piping of the above, which is lower than two (2) meters above floors and platforms

(i) Horizontal piping of the above whose centerline is within one (1) meter of any normal walkway of platforms and floors.

(6) As the dryer is a freezing type, anti-sweat insulation shall be provided for control air outlet piping by applying felt and aspahlt paper or other suitable material and shall be provided with jacketing or lagging.

(7) The Contractor shall supply an additional quantity of insulation material in consideration of shipping damages or other damage during construction.

(8) The Contractor shall protect insulation materials at the site to ensure safe storage and water proofness.

(9) The Contractor shall, before material preparation and execution of fitting, submit the information of insulation materials and their fitting procedures to the Owner and the Engineer for approval.

(10) The Contractor shall repair or add all inadequate portions of insulation at his own responsiblity and expense in case the Engineer so requires.

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1.11.2 DESIGN SPECIFICATION

(1) Ambient condition shall be referred to in Clause 9 of "Design Conditions" in Section I of Part I.

(2) Design specification for insulation of pipings and equipment.

(a) Indoor use insulation materials and material thickness shall be designed to keep the surface temperature of lagging and/or jacket at 50°C or less for 0.5 m/s wind velocity.

(b) Wind velocity for outdoor design shall be 2.2 m/s.

(3) Design specification of personnel safety insulation

The insulation materials and thickness shall be designed to keep the surface temperature of lagging and/or jacketing for personnel safety insulation at 50°C or less.

(4) Design specification of anti-sweat insulation

The anti-sweat insulation materials and thickness shall be designed to avoid sweating on the surface of insulation.

(5) The maximum working fluid temperature of each piping and equipment shall be applied in the design of thickness for insulation materials.

(6) In any case, the Contractor shall select insulation materials free from asbestos.

(7) Recommended insulation thickness

Insulation thickness may be adopted as shown in the table below.

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RECOMMENDED INSULATION THICKNESS (MM)

TEMPERATURE INSIDE PIPE °C

NOMINAL PIPE SIZE	50-100	101-150	151-200	201-250	251-300	301-350	351-400	401-450	451-500	501-550	551-600	601-650
15	25	40	40	40	40	50	50	65	65	65	65	65
20	25	40	40	40	50	50	50	65	65	65	65	75
25	25	40	40	40	50	50	50	65	65	65	75	75
32	25	40	40	50	50	50	65	65	65	75	75	75
40	25	40	50	50	50	65	65	65	75	75	75	75
50	25	40	50	50	65	65	65	75	75	75	75	75
65	40	40	50	50	65	65	75	75	75	75	75	100
80	40	40	50	50	65	65	75	75	75	75	100	100
90	40	50	50	65	65	75	75	75	100	100	100	100
100	40	50	50	65	65	75	75	75	100	100	100	100
125	40	50	65	65	75	75	75	100	100	100	100	100
150	40	50	65	65	75	75	75	100	100	100	100	100
200	40	50	65	75	75	100	100	100	100	100	125	125
250	40	50	65	75	75	100	100	100	100	125	125	125
300	40	65	65	75	75	100	100	100	125	125	125	140
FLAT FACE	60	75	100	100	125	125	150	150	175	175	200	200

NOTES:

(a) Double or multi layer construction shall be used for insulation with thickness of 75 mm or more.

(b) When tube and pipe are insulated in a bundle, the maximum dimension of the bundle to determine the required insulation thickness shall be used. For example if the bundle cross section dimension is 50 mm x 300 mm, the insulation thickness specified for 300 mm pipe shall be used.

(8) Insulation materials for parts of fittings shall be designed to be able to keep the specified thickness and heat conductivity.

(9) The refractory and brick material shall maintain sufficient strength and characteristics so as to be adequate for the actual working conditions.

The maximum allowable temperature of refractory and brick materials shall be in accordance with specified standards and codes.

(10) The following considerations shall be taken into account when selecting refractory and brick materials.

(a) Insulation materials shall be of excellent quality so as to sufficiently resist the working temperature. Deformation or deterioration of refractory and brick materials shall not occur even after long time use.

(b) Heat conductivity shall be held to a minimum.

(c) The insulation materials shall be superior in fireproof qualities, repairable, nice looking, water-proof and

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able to resist seismic disturbance.

1.11.3 TECHNICAL INFORMATION

(1) The insulation materials shall be of best quality available and shall be of the manufacturer's standard. They shall be of uniform composition and shall be capable of withstanding the temperatures and environmental conditions without deterioration, shrinkage, calcination, change of form, setting or pulverization. Only non-combustible insulation materials shall be used.

(2) The insulation covering all piping shall be of the cylindrically moldes sectional type, unless otherwise specified. The molded sectional insulation shall be furnished in standard lengths of not less than 610 mm.

(3) The bolted fittings, flanges, valves and specialities shall be insulated with either molded pipe insulation and mitered to fit, or rock wool blanket insulation of the thickness specified for the piping.

The welded fitting valves and specialities shall be insulated with reinforced rockwool insulation, and the outer layer shall be coated with asphalt.

(4) Aluminum metal jacketing for piping shall be corrosion resistant aluminum alloy sheet of 0.5 mm thickness or more, and shall be fastened with bend over or stainless steel bands.

(5) Aluminum metal lagging for the flat face shall be corrosion resistant aluminum alloy sheet or galvanized steel not less than 1 mm thick, and shall be fastened with tapping, screws,

bolts or bend over.

(6) At least 25 mm over lapping shall be required for joints of jacketing and lagging in consideration of thermal expansion of pipings.

(7) When double or multi-layer insulation is applied, both circumferential and longitudinal joints of two (2) layers shall be staggered not less than 25 mm with relation to each other.

(8) The insulation materials shall be fixed to the pipings by galvanized steel wire so as not to slip. Adequate fixtures shall be attached to the vertical piping to support the insulation materials, and shall be tightened with galvanized steel wire.

(9) Block insulation shall be applied for bolted fittings flanges, valves and specialities, so as to be overhauled without removing the body insulation.

(10) For anti-sweat insulation, the pipe shall be covered with tarpaper, rock-wool or hair felt. Insulation material shall be fixed with galvanized steel wire, and insulation joints shall be filled with mastic insulation material. Insulation shall be covered by aluminum jacketing.

(11) The Contractor shall submit the insulation proposed for boiler, turbine, heater, etc., to the Owner and the Engineer for approval.

(12) The insulation shall be applied after the piping system has been hydrostatically tested.

(13) Where single layer insulation is specified, the end joints

shall be firmly butted to adjoining sections of the molded sectional insulation.

Mastic insulation materials or material of equivalent quality shall be filled in each joint.

(14) Equipment insulation shall include the insulation of associated drain lines and other accessory piping connected to equipment. The type and thickness of insulation shall be adequate for the service of specified working temperature, and shall be in accordance with "Recommended Insulation Thickness".

(15) Prior to applying the insulation materials, all surfaces shall be thoroughly cleaned of all rust, grease and other foreign matter by wirebrushing.

(16) Where insulation is applied to equipment having bolted or screwed heads which may be removed periodically for inspection and maintenance, the part of fastening of equipment shall be left, and insulation shall be applied in such a manner that it may not be damaged by removal of bolts, screws, heads, covers or plates.

(17) All hot surfaces of the equipment shall be insulated with single layer block or combinations of high and low temperature block insulation, or with the materials specified for piping insulation. Blocks shall be finished and shaped to fit the contours of the surface, and the end joints shall be coated with insulating cement.

(18) On high vertical vessels, insulation support angles or plate rings shall be provided to support the insulation.

(19) On irregular shaped equipment areas, such as heater heads and pumps, special provisions shall be made for securing the tie wires supporting block insulation. In order to secure the tie wires, galvanized steel wire netting shall be placed around the shell of the vessel.

(20) For vessels that are not stress relieved, nuts may be tack welded to the surface to be insulated.

(21) Electrically welded insulation studs may be placed where required so as to wire the block in place.

(22) The top surface of equipment, such as flue and air ducts upon which operators frequently walk, shall be insulated by silica board and be covered by lagging of 1.2 mm thickness. The bottom or side surfaces of equipment, such as flue ducts, shall be covered by lagging of 1 mm thickness.

(23) The lagging and jacketing for the top surface of equipment shall be fixed by bolting or screw setting.

(24) The supporting rods which directly contact pipings or equipment shall be insulated by the equivalent insulation materials with a maximum 65 mm in thickness, and shall be five times the length of thickness of piping insulation.

(25) The insulation for steam generator, steam turbine, feedwater heater, boiler feed pump, heat exchanger, etc., shall be executed in accordance with the recommended manufacturer's practices, and the said practices shall be approved by the Owner and the Engineer.

(26) The test well on piping for thermometer or thermocouple shall not be concealed under the insulation.

(27) The bricks shall be placed, without gaps. Mastic insulation materials for brick shall be sintered with material equivalent to the brick.

(28) Valves for drain, vent, blow-off and instruments, including their secondary valves, shall be insulated by the equivalent insulation as their main piping.

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1.12 PAINTING

1.12.1 SCOPE OF SUPPLY

(1) The Contractor shall furnish the paint, scaffolding, cleaning materials and other pertinents required to satisfactorily complete the work.

(2) The painting for piping and equipment shall include the followings.

(a) Steam generator and auxiliary equipment

(b) Steam turbine and auxiliary equipment

(c) Generator and auxiliary equipment

(d) Control panels, board, cabinets and boxes

(e) Tanks and yard facilities

(f) Piping and hangers

(g) Auxiliary supports and beams

(h) Electrical facilities

(i) All other equipment comprising the plant, unless otherwise specified.

(3) The Contractor shall paint color bands, flow direction arrow marks and names of fluids on the piping, and shall indicate the names of the auxiliaries.

(4) Finishing coat of paint shall be applied on equipment after repairing any damaged part of primer coating.
The repairing of finish coating painted at shop shall be carried out.
Painting damaged or rusted during erection shall be repaired after necessary treatment of the surface by the appropriate tools or means approved by the Owner and the Engineer.

(5) The Contractor shall under his own responsibility and expense repaint equipment and pipings, should the Engineer deem it necessary.

1.12.2 DESIGN SPECIFICATION

(1) In the case that the plant is located in a tropical area, all paint shall be of the type which can sufficiently resist tropical conditions.

(2) The mixture of paint shall be prepared at the shop in accordance with the specified Munsell Color Code.

(3) All paint shall be classified as follows, and shall be applied for the intended purpose by taking into account the working temperature and acid and caustic conditions.

(a) Primer coating

Primer coating shall be as follows.

Primer A ..... Basic red lead, or equivalent primer coating

Primer B ..... Special primer coating for rusted steel surfaces

Primer C ..... Galvanized steel or iron primer

Primer D ..... Hot surface primer up to 260°C

Primer E ..... Hot surface primer up to 650°C

Primer F ..... For non-metallic surface

Primer G ..... Acid and caustic resistant paint/primer

(b) Finish coating

Finish M ..... Engine or machinery enamel

Finish N ..... Structure steel enamel

Finish O ..... Galvanized steel finish coating

Finish P ..... Hot surface finish up to 260°C

Finish Q ..... Hot surface finish up to 650°C

Finish R ..... Non-metallic or flexible surfaces finish

Finish S ..... Acid and caustic resistant paint/finish

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(4) Painting color codes

The following painting color codes shall be used in selecting or indicating finish coating colors.

Code No.	Color	Munsell color Code No.
1	RED	7.5R 4/14
2	"	7.5R 3/6
3	"	5R 4/13
4	YELLOW-RED	2.5YR 6/13
5	"	2.5YR 7/6
6	"	7.5YR 5/6
7	YELLOW	2.5Y 8/12
8	"	2.5Y 8/2
9	GREEN-YELLOW	10GY 8/4
10	"	10GY 6.5/6
11	"	7GY 6/7
12	GREEN	10G 7/0.5
13	"	8.3G 6.10/0.54
14	"	2.5G 2/4
15	BLUE-GREEN	7.5BG 5/1.5
16	"	7.5BG 3/3.5
17	BLUE	10B 3/5
18	"	5B 7/2
19	"	5B 5/0.5
20	PURPLE-BLUE	2.5PB 5/6
21	PURPLE	2.5P 5/4
22	WHITE	N 9.5
23	GRAY	N 7
24	BLACK	N 1.5
25	ALUMINUM	———
26	SILVER	———

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(5) Color bands and direction arrow codes for piping.

The size and location of color bands and direction arrow marks as well as color selection will be specified by the Owner and the Engineer.

(6) Lettering for the names of fluids and equipment.

Letter color	Black (Munsell color Code No. N1.5)
Letter styles	Italics
Letter size	to be specified by the Owner and the Engineer
Notation	to be specified by the Owner and the Engineer

(7) Except for special painting, the specification of field painting shall be as follows.

(A) Color band, flow direction arrow marks and name for outdoor or indoor equipment and pipings

(a) Material — Tropical paint

(b) Number of paint coats — Two (2) coats

(c) Thickness of painting — 40 micron minimum

(B) Exterior surface of indoor and outdoor equipment, tanks, pipings, etc.

(a) Material — Tropical paint (long-use oil phthalic resin or phenolated alkyd resin)

(b) Number of paint coats

Primer — Two (2) coats

Finish — Three (3) coats

(c) Thickness of painting minimum — 30 micron per each layer in

Total 150 micron in minimum

1.12.3 TECHNICAL INFORMATION

(1) Primer and finished coatings for panels, instruments, motors and other equipment and facilities shall be approved by the Owner and the Engineer, and shall be applied in the shop.

(2) The paint color will be specified by the Owner at a later date.

(3) Equipment and pipings insulated and finished with aluminum jacketing shall not require finish painting. However, the color bands, flow direction arrows, names of the fluids for the piping and names of the equipment shall be indicated on the piping and equipment.

(4) All bare (non-insulated) pipings of indoor or outdoor use shall be painted, including piping in pits and trenches.

(5) All hangers and supports shall be painted, except sliding surfaces, springs and adjustable or movable parts.

(6) All bare (non-insulated) equipment of indoor or outdoor use shall be painted, including motor base plate, stop valves and others.

(7) Certain parts of machinery such as shafts, glass gauges and valve stems, shall not be painted, and the Contractor shall exercise special care in the painting of equipment with which these items are concerned.

(8) Parts of tanks, vessels, etc., which are made of stainless steel or are non-metallic shall not be painted, but color band, flow direction arrow marks and name for equipment and pipings shall be given.

(9) Underground pipings asphalt coated for corrosion protection

and certain parts of asphalt coated pipe exposed above ground or above floors shall be painted.

In general, asphalt coating shall not be removed but shall be thoroughly cleaned by brushing, washing and/or chipping, as necessary. Compatible primer and paints shall be used.

(10) Color band, flow direction arrows and names of fluids shall be located on piping systems immediately adjacent to all operating accessories such as valves, regulators, strainers, and other devices, including points where pipes branch or pass through wall, floors or partitions.

The final location of color bands, arrow marks and names shall be adjusted according to the instructions of the Engineer at site considering the actual service operation.

(11) The name of major equipment, auxiliaries and tanks shall be indicated on the surface of tank, pump or motor bodies, etc.

For example:

1A - FDF 1B - FDF 1A - CWP 1B - CWP

1A - BFP 1B - BFP 1C - BFP

Letter color shall be black (N1.5).

The final size, location and lettering style shall be adjusted according to the instructions of the Engineer.

(12) Prefinished items as listed below shall not be painted but shall be masked and covered with transparent vinyl sheets, bags or covers for protection during painting work.

Masking shall be neatly done with masking tape to obtain workmanlike edges of painted work without spotting or

damage to the protected items.

Items to be protected shall be as follows.

(a) Nameplates, tags and labels

(b) Instruction and warning sign plates

(c) Locally mounted and panel mounted instruments, switches, escutcheoned stainless steel, plated, plastic or non-ferrous hardware such as door handles, knobs, hinges, locks, plated bolts, screws and nuts

(d) Windows and glass gauges

(e) Identification, code and inspection stampings

(f) Galvanized materials such as grating, cable trays, conduits, etc. However, cut, burned or damaged surfaces shall be cleaned and painted.

(g) Aluminum, copper, brass, bronze and stainless steel materials

(h) Copper, brass and stainless steel piping, tubing and fittings

(i) Electrical cables, electrical insulators, bare electrical conductors of all kinds, station battery and accessories

(13) During field painting, equipment which is not to be painted shall be protected from paint marks and smears.
The Contractor shall be required to remove any paint marks or to repaint the smeared object at his own responsibility and expense.

(14) The Contractor shall submit the painting schedule for each equipment which shall include information of surface

preparation, painting before shipping, painting at site, color code, etc. to the Owner and the Engineer.

2. ELECTRICAL PART

2.1 PANELS AND BOARDS

This design standards shall be applied to design the distribution panel or board and control panel or board, such as the transmission line panel or board, BTG board, power distribution panel, local control panel and so on, which are to be used for the thermal power station and for convenience, they are collectively called as the panels or boards.

2.1.1 TECHNICAL INFORMATION

2.1.1.1 OPERATING CONDITION

Normal operating conditions 30°C are regarded as a standard, but depending upon the locations, the following special operating conditions shall be considered.

- Salt contamination
- Excessive dust
- Vibration
- Earthquake
- Wind velocity
- High temperature

2.1.1.2 RATING

The control power source of the panels or board shall be DC and/or AC of which voltage is to be specified as follows.

(1) Rated voltage and frequency

Rated voltage	DC circuit	220V, 24V
	AC circuit	Control circuit 110V
		PT secondary 110V
		CT secondary 5A
		(Especially 1A for substation)
Rated frequency		50 Hz

(2) Allowable variation in the voltage and frequency

The performance of those panels or board shall not be hampered with the following voltage variations in the power source.

Direct current voltage	-20% to +30% of the rated voltage
Alternate current voltage	-15% to +15% of the rated voltage
Frequency	50 Hz ±5%

Notes: An allowable variation of +30% for the DC circuit is provided to uniformly charge the battery, but it will be very seldom to have a variation of +30% because the counter battery is generally provided in the DC circuit. Therefore, the +30% limitation is to be provided for the DC circuit with the possible malfunction on the counter battery and/or with no counter battery. Therefore, if it is impossible to make the continuous rating of 130%, the rating shall be determined by mutual agreement.

2.1.1.3 Type shall be in accordance with the table below, unless otherwise specified.

Type	Mounting	Application
Bench Type	Self Standing	BTG Board
Vertical Type	Self Standing	Metalclad Switchgear, Power Center, Control Center, Excitation Cubicle, Auxiliary Panel, Line Panel, Line Relay Panel, Local Control Panels
Box Type	Self Standing or Wall Hanging	Local Control Panels

2.1.1.4 PERFORMANCE OF THE PANEL

(1) Insulation resistance

Unless otherwise specified, the insulation resistance shall be follows;

Measuring Point	Insulation Resistance (at 20°C)
Wiring of one (1) panel to ground	Not less than 2 Megohms

Notes: It is anticipated that the insulation resistance could be below 2 Megohms depending upon the size of the panel and/or the degree of the circuit complexity.

In this case, the insulation resistance shall be determined by mutual agreement.

(2) Insulation strength

Insulation strength shall be as follows, unless otherwise specified.

Circuit or Voltage	Method for Applying Voltage	Insulation Strength with Commercial Frequency
Control	Circuit to Ground	1,500 V/minute
6.6 kV	"	10,400 V/minute
400 V	"	1,500 V/minute
220 V	"	1,500 V/minute

Note: If there is any special instrument and relay which do not withstand a commercial frequency insulation strength of 1,500V, such equipment shall be clarified in the specifications or be notified by a separate.

2.1.2 CONSTRUCTION OF PANELS OR BOARDS

2.1.2.1 MATERIAL AND THICKNESS

Material shall be of the polished steel plate and thickness shall be 3.2 mm in principle, but with the prior approval by the Owner and the Engineer, a thickness of 4.5 mm, 2.3 mm, 1.6 mm and so on can be used.

2.1.2.2 COATING AND INSTRUMENT COLOR

Coating and instrument color shall be in accordance with the table below.

Item	Color in Mansell Code	
	Indoor Application	Outdoor Application
Surface of panel	N7	5Y 6/9
Major components inside the panel such as bracket, Tr. PT and so on.	N7	7.5BG 6/1.5
Interior Surface	N9.5	N9.5
Instrument Relay Frame	N1	N1
Control Switch Handle	N1.5	N1.5
Emergency Control Switch Handle	5R 4/13	5R 4/13
Test Terminal	N1.5	N1.5
Lockout Terminal	5R 4/13	5R 4/13

Notes: (1) The integral part of the equipment shall be colored in the same color as that of the corresponding equipment. (For instance, the instrument panel to be provided in the seal oil system shall be in same color as that of the seal oil system.)

(2) The components inside the panel other than the aforementioned can be colored in the manufacturer's standard color.

2.1.2.3 ARRANGEMENT OF THE COMPONENTS AND CONDUCTORS

Phases (AC) and Polarity (DC) of the Components and conductor on the panels or board, shall be arranged, facing to the panel, in accordance with the table below.

Item	Left and Right	Top and Bottom	Near and Far
Arrangement by Phases of AC	R, S, T, Neutral Phases from Left (R, S, T, N)	R, S, T, Neutral Phases from Top (R, S, T, N)	R, S, T, Neutral Phases from Near (R, S, T, N)
Arrangement by Polarity of DC	Right + Left -	Top + Bottom -	Near + Far -

2.1.2.4 DEFINITION OF CIRCUIT

The circuit shall be classified in to the following manners:

(Primary circuit) All the circuits except for Secondary Circuit, Accessory Circuit and Grounding bus circuit specified hereunder.

(Secondary circuit) Operation control circuit, Secondary and tertiary windings of the instrument transformer and the measuring circuit.

(Accessory circuit)	All the circuits which are proper circuit to the metalclad switchgear, cubicle, distribution panel, switch terminal box and so on, but not affect the other equipment, instrument and so on. Namely, these are lighting circuit inside the panel, space heater circuit, resistance measuring circuit and so on.
(Grounding bus circuit)	All the grounding bus circuits.

2.1.2.5 CEILING

The ceiling of the indoor panels or board shall be of the drip-proof type and the dust-proof construction.

The ceiling of the outdoor panels shall be of water-proof and dust-proof construction.

2.1.2.6 SIDE PANEL

The both end of panels or board are composed by accessary panel.

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2.1.2.7 DOOR

(1) Construction: In principle, the construction shall be of bag type, hinge type with a sufficient space for operation, maintenance and inspection.

(2) Stopper: In principle, the stopper shall be provided to secure the open and closed positions.

(3) Handle: The handle with key shall be provided to open and close the door and in principle, it shall be on the right side with the hinge on the left side, facing to the door. The handle and hinge for the outdoor application shall be made of the stainless steel.

(4) Hang up type door: For the specially designated places, such as the screen room and so on where the space to open the door is limited, the hang up type door with the following constructions shall be used.
The weight of the door shall not be heavy enough to hang up or remove.

The door shall be of the construction which prevents it from being fallen off at the closed position due to the vibrations. When removing the door, its tightening and mounting fittings shall not be fallen off. The handle for hanging up and removing the door shall be provided.

(5) Locking device: The locking device shall be provided with all doors.

(6) Electrical components to be mounted on the door

When the panel construction necessitates its operation with the door open, the door shall be of the construction which shall never allow the operator to be exposed to the bare conductor of the electrical component to be mounted on its surface.

2.1.2.8 KINDS AND COLOR CODING OF THE ELECTRICAL WIRE AND CONDUCTOR IN THE PRIMARY CIRCUIT

(1) Electrical wire

In principle, cross linked polyethylene insulation wire shall be used and the color of the insulation material shall be yellow with the following discrimination by color at the end portion and/or at some portion of the wire.

AC circuit

I. (R) phase ..... Red

II. (S) phase ..... Yellow

III. (T) phase ..... Blue

Neutral (N) phase and

Grounding phase ..... Green

DC circuit

+ Polarity ..... Brown

- Polarity ..... Blue

(2) Conductor

It shall be the insulated conductor with the insulation treatment to the insulation level corresponding to the voltage to be applied and shall never be bare conductor. Discrimination by color at the end portion and/or at some portion shall be same as above (1).

(3) Size of electrical wire

In principle, it shall be of the stranded wire with a size over 5.5 mm^2.

2.1.2.9 *KINDS OF ELECTRICAL WIRE AND CONDUCTOR TO BE USED FOR THE SECONDARY CIRCUIT*

Following table shall be referred to.

Circuit	Kinds
PT Secondary Circuit CT Secondary Circuit DC and A.C. Control Circuit	Stranded wire of the mild copper with a size more than 2 mm^2
CT and PT Secondary Grounding Circuit	Stranded wire of the mild copper with a size more than 5.5 mm^2

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Note 1: Size of the wire to be used for the secondary circuit of the current transformer with a large over current strength and the AC and DC circuit with a large passing current shall be over 3.5 mm^2.

Note 2: Wire to be connected with the terminal which is subject to be heated up shall be of the heat-proof type.

Note 3: When a wire size below 2 mm^2 is used for the small current circuit, it shall be necessary to notify beforehand.

2.1.2.10 COLOR CODING OF THE ELECTRICAL WIRE AND CONDUCTOR IN THE SECONDARY CIRCUIT

(1) Color coding of the insulation wire is as follows:

Circuit	Color Coding
Potential Transformer	Red
Current Transformer	Black
DC Circuit	Blue
AC Circuit	Yellow
Grounding Circuit	Green
Instrumentation Measuring circuit	White

(2) Color coding by phases for AC and polarity for DC

Phase or Polarity			Color Coding
AC	(R)	Phase	Red
	(S)	Phase	Yellow
	(T)	Phase	Blue
	(N)	Phase	Green
DC		+	Brown
		-	Blue

Note: The color coding for the transfer circuit between AC and DC shall be +(Brown) and -(Blue) for both AC and DC.

2.1.2.11 ACCESSORY CIRCUIT

(1) The color coding for the conductor and its end portion shall be in accordance with that for the secondary circuit.

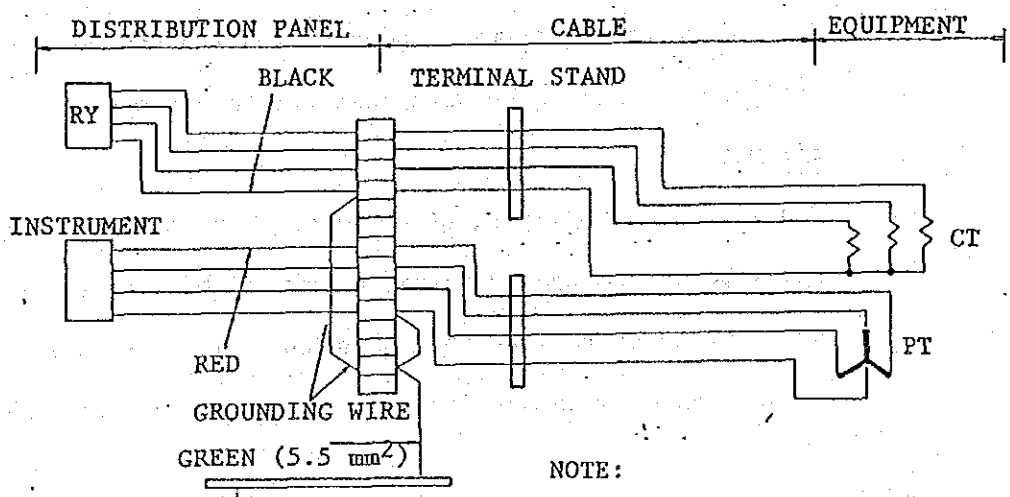
(2) The wiring method, wire size and circuit configuration shall be determined by mutual agreement between Engineer and Contractor but the portion other than these shall be in accordance with standards for the secondary circuit.

2.1.2.12 GROUNDING BUS CIRCUIT

(1) The grounding bus shall be perfectly connected to each panel electrically and phisically. When plural panels are to be lined up, the grounding bus shall be supported individually for each panel and at the same time, each grounding bus shall be connected firmly enough.

(2) The bus size shall be bigger than the grounding wire size for the panels to be specified by the grounding wire standards.

(3) Wiring diamgram from the terminal stand to the grounding bus is as follows:



NOTE:

CT: CURRENT TRANSFORMER
PT: POTENTIAL TRANSFORMER
RY: RELAY

2.1.2.13 METHOD FOR BACK WIRING

(1) Kind of the wiring methods

The back wiring of the panels or board shall be either cleat wiring, bundle wiring and/or duct wiring and its selection shall be aimed at the easy maintenance of the panels or board and the beautiful appearance and shall be approved by the Owner and the Engineer.

(2) Isolation of primary circuit

The primary circuit including the equipment, the components and wirings connected to the primary circuit shall be isolated from the circuits other than the primary circuit including the equipment, the components and wirings connected to these circuits so as not to affect each other on the failure.

(3) Construction of the wire support

The metal portion shall never press the wire directly at the support of the back wiring.

(4) Construction of the moving portion of the wiring

The jumper wire for the sleeved panel and/or door shall be of the bundle type which is treated by the flexible coating.

(5) Support of the external connecting cable and wire

The external connecting cable and wire shall be equipped with the support and clamping fixture.

(6) Terminal and connecting method of the wiring

The cramp type terminal and plus screw shall be used at the terminal portion of the wiring. The crimped portion of the terminal and the bare portion of the lead wire shall be covered by the insulated coating.

The cramp type terminal shall be of the ring type when the special terminal other than the ring type terminal above is to be used, it is necessary to obtain the approval by the Owner and the Engineer.

The wire to be used for the circuit with a very small current in the order of milli-ampere is to be connected by winding method and when the soldering connection is used, it shall be determined by mutual agreement between the Engineer and the Contractor.

The connection between the internal wiring and the external wiring or the wire connection between the panels shall be done at the terminal stand with the terminal number.

(7) Branching of the wiring

The wiring shall be branched at the terminal (including the terminal attached to the instrument) and when the branching is to be made at the terminal stand, it shall not be permitted to tighten the wires more than three at one terminal.

(8) Wiring mark and insulation

At the terminal connecting portion of the wiring, the mark band with the wiring number and the insulated color coding for phase and polarity of the wiring shall be provided. The mark band of the wiring shall be of the plastic with the construction which prevents it from being fallen off easily and further prevent the mark from being erased easily.

When the mark band made of cloth is to be used, it shall be determined by mutual agreement by the Engineer and the Contractor.

(9) Cable support

The cable support shall be provided at the place where the cable is to stand up to the terminal stand.

(10) Terminal for the outgoing wiring

All the outgoing wiring shall be provided with the terminal with the following classifications:

For the control cable,		Cramp type with the insulation cover
For the power cable,	over 125 mm^2	Compression type
	125 mm^2 and less	Cramp type with the insulation cover
For the grounding wire,	over 125 mm^2	Compression type
	125 mm^2 and less	Cramp type with the insulation cover

2.1.2.14 CHANNEL BASE

Channel base for the self standing panel as specification shall be furnished.

Material	Steel channel
Size	100mm x 50mm x 5mm

2.1.3 ATTACHMENT

2.1.3.1 INSTRUMENT

(1) Indicating electrical instrument

The indicating electrical instrument shall be in accordance with Item 2.1.4 "Standard of Electrical Indicating Instruments for panels or boards".

(2) AC ammeter for the motor

The AC ammeter to be used for the motor shall be sealed up 500% of the rated value to be indicated by a red line and extended scaling shall be done in red so as to discriminate from the other scale.

(3) Integrating instrument

The integrating instrument shall be applied in accordance with the following classification.

Generator watthour meter:	Special precision class, with pulse transmitters, flush mounting fixed type accuracy class 0.3.
Other Station auxiliary watthour meter:	Precision class with pulse transmitter, flush mounting drawout type, with reverse protection for bus tie application.
Generator VAR hour meter:	Precision class with pulse transmitter, flush mounting drawout type, with reverse protection only for lag phase.

(4) The other instruments to be mounted on the panels or board.

The other instruments such as the position indicator, the telemeter for the pressure gauge, the digital indicator and recorder shall be manufactured in accordance with JIS regulations and the scaling method of the indicator shall be made in according with agreement by the Engineer and the Contractor.

In principle, the recorder shall be driven by the synchronous motor and chart shall be of folding type.

Note:

It cannot help using the coiling type chart for the high speed and/or the small size instruments, but for the easier handling, it is strongly requested to use the folding type.

2.1.3.2 RELAY

In principle, the relay shall be of the flush mounting drawout type and of the plug-in type.

The following are the major precautions in designing the relay.

It shall not malfunction due to the vibration of the equipment and an earthquake.

The action and reset values shall not change due to the increase in the temperature by self-over-heating and/or the change in the ambient temperature.

The main protective relays shall be provided with the target.

In principle, all attachments for main relays shall be mounted in the relay box.

The power consumption (VA) shall not be excessive.

The portion (such as the setting tap) where could be touched by the bare hand shall not be left bare.

The relay with no test terminal shall provide the separate test terminal.

2.1.3.3 COLOR CODING OF THE PHASE OF RELAY

(1) Location

The sequence mark and color coding of the phase shall be indicated at the following locations.

At the name plate of the relay proper or any other appropriate place

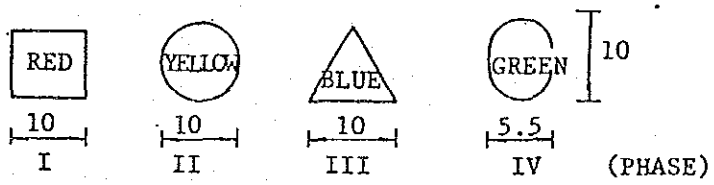
At the bottom center position on the relay surface glass

At the inside of the relay casing

(only for the draw-out type)

At the rear surface of the relay casing

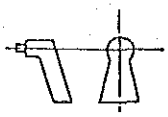
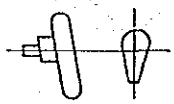
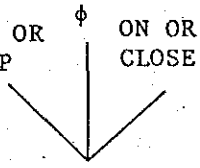
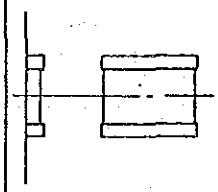
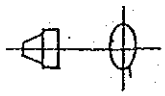
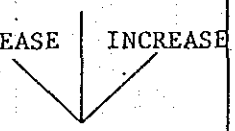
(2) Shape of the mark (unit in mm)

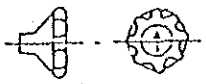
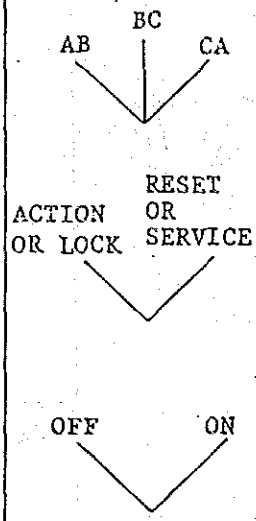
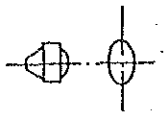
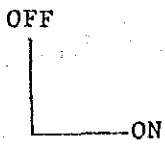
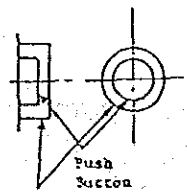


2.1.3.4 CONTROL SWITCH

The control switch shall be of the rotary type and/or the push button type and its shape and operation shall be in accordance with the provisions on the table below, but JIS C0601 (Operation of Handles and Indication of Electric Installation) shall be referred to for the basic matter.

The moving and stationary contacts of the rotary type switch shall be of the metal with anti-wear, anti-corona and anti-corrosion characteristics and good conductivity and further to avoid the deterioration in the contact pressure as the time passes, the contacts shall be of the spring supported type (Anti-corrosive spring).

Kinds of Switch	Purpose	Shape of Handle	Operation	Remarks
Control switch	Circuit breaker	Pistol shape 	OFF OR TRIP ← ϕ → ON OR CLOSE  ϕ: SPRING RETURN TO ϕ	To be with cover made of plastic in order to prevent of misoperation To specify the Pull-lock type as required
Control switch	Disconnecting switch	Stick Type 	OFF OR TRIP ← ϕ → ON OR CLOSE  ϕ: SPRING RETURN TO ϕ	To be with cover made of plastic in order to prevent of misoperation . To specify the Pull-lock type as required
Button switch with indication lamps	Mode select	Square Type 	Push Button	YAMATAKE HONOYWELL Series II or equivalent
Adjustment Control switch	Adjustment Control	Egg Type 	DECREASE ← → INCREASE  ϕ: SPRING RETURN TO ϕ	To specify the pull-lock type as required To be with cover.

Kinds of Switch	Purpose	Shape of Handle	Operation	Remarks
Transfer Switch	Transfer	Octavo Type  White color stamp with an arrow mark		The legend of COS for the potentiometer shall be [AB-BC-CA]
Plug for Synchronization Check	Sychronization Check	Egg Type 		The construction of the plug shall be in such a manner that the handle can be pulled out only when it is in the "OFF" position
Button Switch	Control Selection Alarm Stop, On, Off and so on	Button Type  Preventive Devices for misoperation	Push Button	For the emergency purpose, the cover shall be provided

Notes: (1) In an inevitable case such as the limited space to mount the components, the pick up type switch (Signal Lamp Combined Type) can be used after the approval of the Owner and the Engineer.

(2) The legend on the name plate shall be approved by submitting the Drawing for approval.

(3) The button of the push-button switch without square type shall be colored in black for the general use and in red for the emergency use.

(4) This standard shall not be applied to the switches with a small current (Maximum 1A) for the remote control, the boiler automatic control circuit.

2.1.3.5 KNIFE SWITCH

Knife Switch with Cover shall be selected according to the relevant standard.

2.1.3.6 ALARM INDICATOR

(1) Kinds

Flashing light type : This type shall be used for the panels or boards to be located in the central control room (BTG Board, and so on) with the bell provided.

Target type : This type shall be used for the local panel other than the above.
(Main transformer cooler control panel, Hydrogen gas cubicle and so on)

(2) Flashing light type indications : This type shall be used for the milky white resin and the legend shall be stamped with a die in the black color round-shaped Gothic letter.

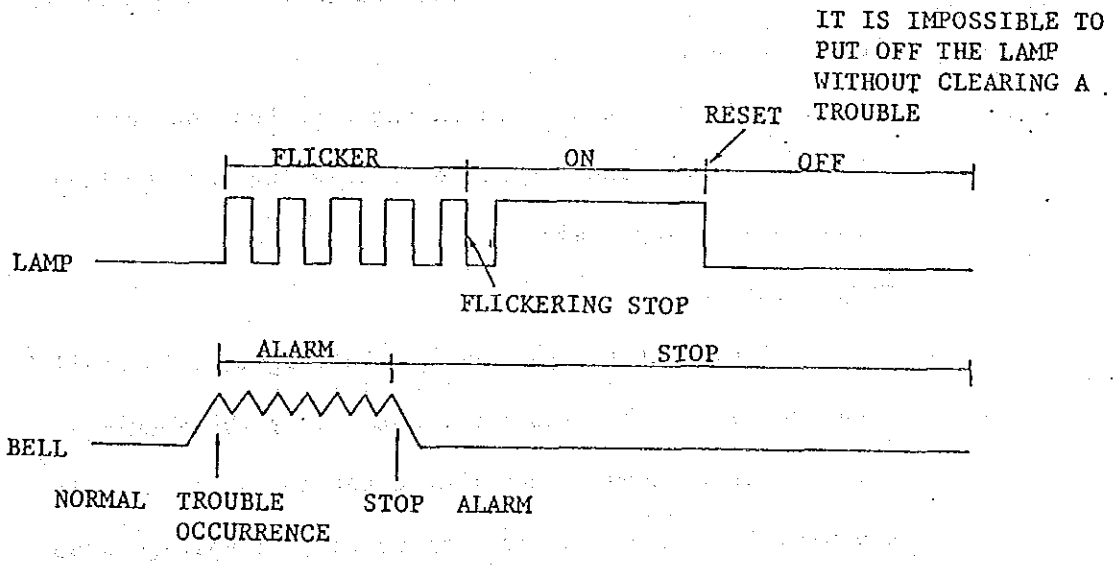
Dimensions : The flashing area per each window shall be 50mm width and 40 mm height as a standard.

Lamp : This lamp shall be used for flashing indication window and can be replaced from the surface. At least two (2) lamps in parallel shall be used per window and the lamp shall be bright enough to enable the operator to discriminate "ON" and/or "OFF" in the room of which brightness is 1,000 lux.

Construction : This type shall be used for the alarm indicator and shall contain the auxiliary relays and/or the modules in the individual unit and it is desirable to use the later and each unit shall be of the plug-in type.

Method : Alarm, Recognition, Stop, Manual Reset

Above system shall be used, in principle.



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When but the trouble reoccurs before resetting, flickering of the lamp and alarming of the bell shall not be initiated again.

Push button : The following actions shall be initiated with the push button.

1) Bell stop
2) Flickering stop
3) Lamp reset
4) Lamp test

Legend : The legend on the indicator shall be approved by the submitted drawing for approval.

(3) Re-annunciation system

An announciater window is connected with a common circuit with several contacts branched, that contact would detect fault accured.

If the next trouble accured on the branched contacts then, the lamp of the window shall be flickering and the bell shall be alarming again.

(4) Target method

For the important relays, the double target coils shall be used, while for the less important relays the single target coil is used. When the target coils of the relay are used in series, considerations for the voltage drop and the operating current shall be paid so as not to cause any difficulties with its performance.

(5) When the flashing light type is used for the local panel which required no continuous monitoring by operator, the bell circuit shall not be provided.

2.1.3.7 INDICATING LAMP

(1) Kinds: The following are major ones.

Open/close indicating lamp on the control switch Disconnecting switch, circuit breaker:	Red lamp "ON" when CB or DS on closed.
	Green lamp "ON" when CB or DS on open.
Pumps and Fans:	Red lamp "ON" when CB on.
	Green lamp "ON" when CB off.
Valves and Regulators:	Green lamp "OFF" with full open
	Green lamp "OFF" at upper limit.
	Red lamp "OFF" when full close.
	Red lamp "OFF" at lower limit.
	Both Green and Red lamps "ON" at the intermediate positions.

Lock-out Indicating Lamp

White lamp is to be lit with reset and the provision shall be made so that bulb and coil failures can be continuously monitored.

Trouble indicating lamp

If necessary, orange color lamp on power center or control center is to be lit on failure.

Power supply indicating lamp, Grounding indicating lamp, permissibles establishment confirmation lamp such as purge system and spring charge and so on shall be white lamp.

(2) Shape and Construction

In principle, the indicating lamp shall be mounted in the control the following are major one.

Indicating lamp

LED lamp shall be used as a standard

Lamp cap

Material : Synthetic resin molding

Color : Shall not change or deteriorate when used for a long period of time.

2.1.3.8 Mimic Bus

(1) Material : Synthetic resin (Frosted)

(2) Dimensions : Thickness 3 mm

Width	20 mm	Main steam pipe
	13 mm	Electrical System (Main Circuit)
	10 mm	Fuel oil pipe, Light oil pipe, Feed and Condensate water pipe, Electrical System (Aux. Bus)
	6.5 mm	Electrical System (Branching Circuit such s neutral point)

(3) Color coding

(Electric circuit)

220 kV and 132 kV circuit	- Red	13mm
Generator voltage circuit	- Dark gray	
Field circuit	- Black	
6,900V circuit	- Yellow	10mm
400V circuit	- Blue	
Neutral point circuit	- Light green	6.5mm

(Mechanical piping)

Main steam pipe	- White	13mm
Feedwater, Condensate pipe	- Dark green	10mm
Fuel oil, Light oil	- Brown	

Above color coding is for the reference, and the final color coding will be determined by the Owner later on. The other shall be determined by the mutual agreement by the Engineer and the Contractor.

2.1.3.9 TERMINAL BOARD

The terminal board shall be the synthetic resin molding and of the fabricated type with the partition between the terminals. The tightening screw for the terminal shall be plus screw made of the brass with nickel plated, of which diameter shall be over 4 mm and it shall be provided with the spring washer and cramp type terminal. Further the flame resisting and transparent removable cover shall be provided.

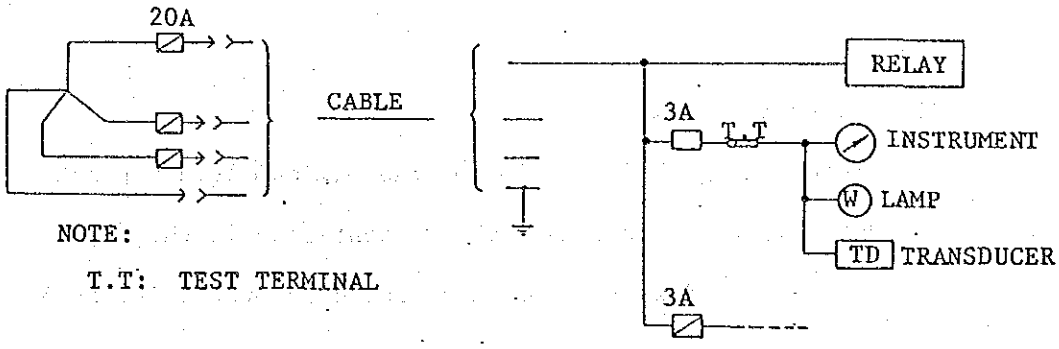
Note: The spare terminals more than 15% of the total number of the terminal shall be prepared for the panels or board.

2.1.3.10 FUSE

Low-voltage Cartridge Fuses and Low-voltage Plug Fuses shall be referred to and its applications are as follows:

(1) Instrument transformer secondary

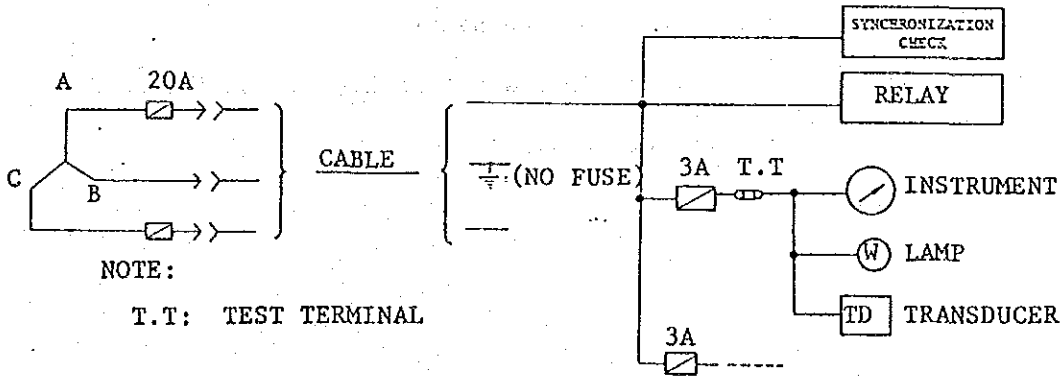
In case of the neutral point grounding



NOTE:

T.T: TEST TERMINAL

In case of B phase grounding

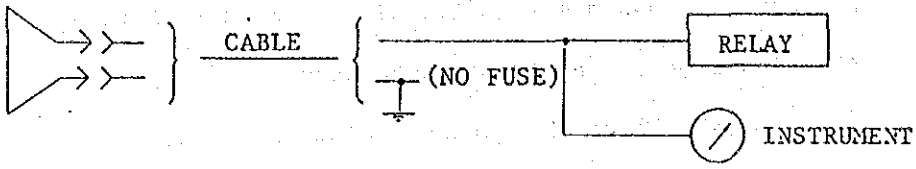


NOTE:

T.T: TEST TERMINAL

3-24P

(2) Instrument transformer tertiary



(3) Control circuit

Fuse rating shall be 200% of the maximum load current.

Note 1: When the PT and CT are contained in the metal clad switchgear, the grounding of the 2ry or 3ry circuit is to be done at the metal clad switchgear, but for the individual synchronization checking circuit, the grounding is to be done at the control panel.

Note 2: When the instruments to be connected with a PT are mounted on the several panels, 3A fuse shall be provided on each panel.

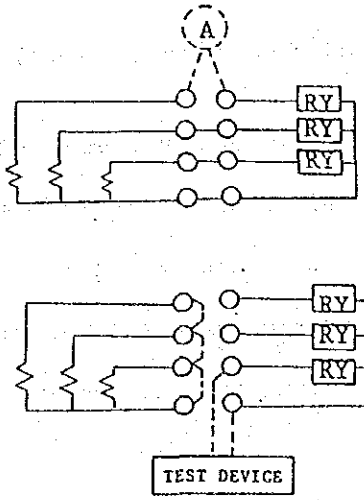
Note 3: the test terminal shall be located at the load side of the fuse.

2.1.3.11 TEST TERMINAL

(1) Kinds: To be plug-in type

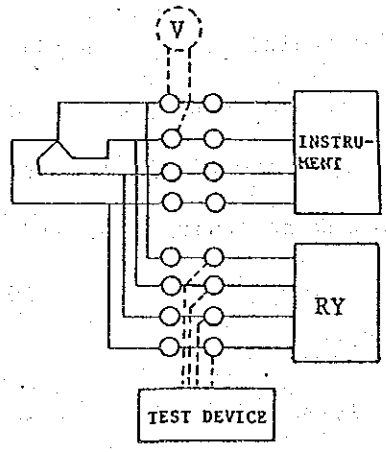
(2) Application: The test terminal shall be arranged so that the following test can be carried out.

CT Circuit



NOTE
RY : RELAY
A : AMMETER

PT Circuit



NOTE:
RY : RELAY
V : VOLTMETER

(3) Arrangement

In case of vertical arrangement:

Upper side - For PT

Lower side - For CT

In case of horizontal arrangement:

Left side - For PT

Right side - For CT

(4) Name plate for each test terminal shall be provided.

2.1.3.12 CARD HOLDER, NAME PLATE AND SEQUENCE MARK, DRAWING POCKET

All the components installed on the surface and inside of the panel shall be provided with the card holder or the name plate depending on the use and the component for which the sequence mark is specified shall indicate the sequence mark.

(1) Card holder

The card holder shall be made of the synthetic resin and shall not used the metal.

(2) Name plate

The name plate shall be made of the metal (for the outdoor use, the stainless steel shall be used) with the silver background, the round gothick black letter and black framing. The size of the name plate shall be in accordance with the following standards.

Group name plate	100 mm x 500 mm
Panel name plate	63 mm x 315 mm
Unit name plate	31.5 mm x 100 mm
Component name plate	16 mm x 50 mm

The name plate shall be held in place with the screw, but the unit name plate and the component name plate can be adhered, provided it is equally durable and good looking than the former.

(3) Drawing pocket

The drawing Pocket shall be made of the metal, and provided inside of the door, the drawing card holder which shall be made of the synthetic resin furnished in to the pocket.

drawing Pocket (l x w x d) standard 400 x 300 x 35 (m/m)

2.1.3.13 LIGHTING INSIDE THE PANEL AND RECEPTACLE

The panel shall be provided with lighting and the receptacle as follows.

(1) Lighting inside the panel

One 20 watts fluorescent lamp shall be provided per the panel width of 1,200 mm - 1,500 mm, which can be lit from near both doors on the right and left sides.

The lamp shall be fed from the 220 V power source, unless otherwise specified.

(In any event, the branching from the control power source shall not be done)

(2) Receptacle

The receptacle shall be of the twist lock type and that for the site works shall be provided with the grounding terminal.

Quantity and location shall be determined later.

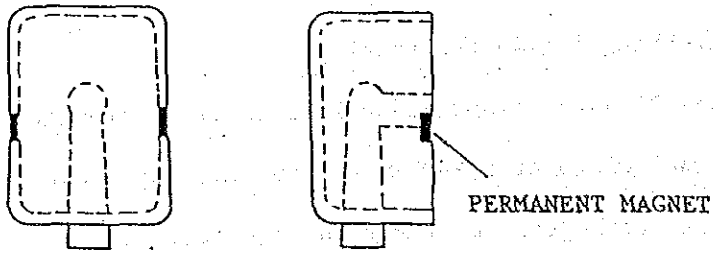
2.1.3.14 PROTECTIVE COVER

The components to be provided inside the panels which have the walk inside (BTG board and its relay panel and so on) such as PT, CT and the bare conductor connected to the DC trip circuit shall be covered by the insulation cap or the protective cover of synthetic resin.

2.1.3.15 CONTROL SWITCH COVER

The control switch, such as for the disconnecting switch, circuit breaker and the auxiliary equipment shall be covered by the transparent cover of synthetic resin with permanent magnet and its construction shall be as follows:

Example



2.1.3.16 SPACE HEATER

Space heater shall be furnished in all panels and board for Outdoor Use except BTG board, auxiliary relay panel and so on to be installed the air conditioning room.

Space heater having temperature adjuster and change over switch shall be capacity to keep of panel inner temperature in order to prevent moisture and dripping inside a panel.

Setting value of thermostat is as follows:

Thermostat on $25^{o}C$

Thermostat off $30^{o}C$

2.1.4 STANDARD OF ELECTRICAL INDICATING INSTRUMENTS FOR PANELS OR BOARDS

2.1.4.1 GENERAL RULES

(1) Scope of application

This standard shall be applied to DC or AC electrical indicating instruments (hereinafter referred to as "Instruments") shown in Table 1 which are used on the panels or board in power stations and substations. Therefore, the indicating resistance thermometers for other than electrical equipment use shall be excluded.

(2) General provision

Regarding the provisions which are not described in this standard, all shall be in accordance with relavent standard.

(3) Application condition

The Instruments shall be applied under the following regular application conditions unless specified otherwise.

Altitude	:	Sea level
Ambient Temperature	:	$40^{o}C$, maximum Minus $10^{o}C$, minimum

2.1.4.2 TYPE OF INSTRUMENT

The type of instruments shall be in accordance with the provisions shown in Table 1.

Table 1

Kind of Instrument	Grade (Class)	Indicating Method	Phase Number	Kind	Remarks
Voltmeter	1.5	Pointer Type	Single	KW3a, KW6	
Ammeter	1.5	"	"	"	
Wattmeter	1.5	"	Three	"	
Reactive Power Meter	1.5	"	"	"	
Frequency Meter	1.0	"	"	"	
Maximum Indicating Voltmeter	**	"	Single	"	DC Electro-magnetic Reset Type
Maximum Indicating Ammeter	"	"	"	"	"
Synchroscope	"	"	-	"	
Fault Time Meter	-	"	-	"	
Indicating Resistance Thermometer	1.0	"	-	"	

** Refer to Clause 9.6.5.5(2)

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Note: (1) Regarding the size of instruments, KW3c Instruments can be used only in a special case.

(2) The mark "KW" in the column of kind indicates square drum-embedded type (wide angle scale). 3a and 3c indicate 110 mm square, and 6 indicates 80 mm square, respectively.

2.1.4.3 RATING

(1) Rated voltage and current of AC instrument

(a) Instruments used in combination with the instrument transformer.

Rated voltage of instrument : 100V

Rated current of instrument : 5A and 1A

(b) Instruments connected directly to the circuits.

Rated voltage of instrument : 150V, 300V, 600V

Rated current of instrument : In accordance with (6)(b) and (6)(i)

(2) Rated voltage and rated current of DC instruments

Rated voltage of instrument : 220V

Rated voltage of instrument : In accordance with with (6)(b) and (6)(i)

(3) Rated frequency

Rated frequency of AC instruments shall be 50 Hz.

(4) Rated power factor and rated reactive factor

The rated power factor of the AC wattmeter and the reactive factor of the reactive power meter shall be 1.0 unless specified otherwise.

(5) The response time of maximum indicating voltmeter and ammeter

The response time shall, in principle, be 0.1 seconds.

(6) Maximum scale value

The maximum scales shall, in principle, be in accordance with the following:

(a) Voltmeter : 150V, 300V, 600V, 9 kV, 300 kV

(b) Ammeter (General): 50A, 100A, 150A, 200A, 300A, 400A, 600A, 800A, 1kA, 1.2kA, 2kA, 3kA, 4kA

(c) Maximum indicating ammeter: 150A, 300A, 450A, 600A, 900A (shall be 1.5 times the CT primary current)

(d) Wattmeter : Shall be the value in (i) which is close to the value multiplied by the transformation ratio of PT or CT by 1kW or 1 MW. However, the scale of -100% - 0 - 100% shall be applied at the place where the direction of power flow is expected to change.

(e) Reactive power meter: Shall be the value which is close to the value multiplied by the transformation ratio of PT or CT by 1kVar or 1MVar.

However,

For generator: -40% ∿ 0 ∿ 100%

At the place where the direction of power tidal current is expected to change:

-50% ∿ 0 ∿ 50%

(f) Frequency meter : 45 to 55 Hz

(g) Fault time meter : 3 sec

(h) Indicating resistance thermometer:

0 to 100°C

(i) Standard maximum scale value in case the above values are difficult to be applied:

Shall be 1, 1.5, 2, 2.5, 3, 4, 5, 7.5 or the values multiplied by their integral times of 10. However, in case of wattmeter and reactive power meter, the above values, and 1.2, 1.25, 2.4, 4.5, 4.8, 6, 8 and the values multiplied by their power times of integer of 10, shall be applied.

(7) Extension scale

The ammeter (maximum indicating ammeter is excluded), wattmeter and reactive power meter shall be the extension scale of 30% of the maximum scale due to designation. However, the extension scale of ammeter for the motor shall be 100% of the maximum scale unless specified otherwise.

2.1.4.4 CONSTRUCTION

(1) General

Instruments shall have constructions suitable for respective purposes, be strong enough mechanically, electrically and thermally, and shall have durability characteristics.

The measuring elements shall be accommodated in a suitable outside box in order to protect them from incoming of rust and damage due to foreign matters, and their front glass can easily be removed and exchanged.

(2) Scale

(a) Dial: For the dial, aluminium or materials of similar property or one having superior properties shall be applied, and the surface shall be white or silver and shall not be discolored. The scale marks shall be black-colored. However, the extension scale mark shall be red-colored.

(b) Number of scales and reading of a scale: The total numbers of scales of instruments (extension scales are not included) shall be 20 to 100, and reading of a scale shall be 1, 2, 5 or the values multiplied by their power times of integer of 10.

(c) Width of division: The width of a division shall be more than 0.8 mm within the effective measuring range of Instruments. However, the width of a division for a frequency meter shall be more than 1.0 mm.

(d) How to mark the scale:

For the figures on the scales of Instruments, numbers of less than four (4) figures shall be used. The figures shall be easy to read and be positioned in such a way that the figure can clearly be distinguished from those between the figure.

those between the figure.

The values in the scale shall be of single and double scale type, and the figures on the scale shall be black-colored. However, the figures on the extension scale shall be red-colored.

The scales of a wattmeter and a reactive power meter which are used in combination with a transfer shall be graduated up to the nearest value to the rated current of the instruments, and the values on the scales shall be in accordance with (6)(i).

Example: Regarding the method of graduating the scale of the rated 100V.5A three-phase wattmeter of PT6,900/100V and CT600/5A: the scale is graduated up to 55MW and the values on the scope are indicated up to 50MW since the product of transformation ratio to three-phase becomes approximately 55MW.

The scale of the synchroscope shall be graduated 0 at the top center, and ±30 degrees shall be graduated at intervals of 5 degrees.

(e) Direction of swing

The scale of instruments shall be, in principle, graduated in such a way that the measuring value may increase from left to right facing the instrument or from bottom to Top. The scales of the wide angle meters shall be graduated so that the value increases in a clockwise direction.

In the case of scales of instruments which do not have 0 at the end, the clockwise or upward direction facing the instruments shall be positive.

In the case of scales of reactive power meter, the left side and the right side facing the meters shall be lead and lag, respectively.

(f) Extension scale

The extension scales shall be graduated with red scale marks and red scale figures.

(3) Pointer

For the materials of pointers, aluminium or materials of higher quality than aluminium shall be applied, and the shape shall be, in principle, of spear type. The pointer shall be black-colored, and the maximum indicating laid needle and the minimum indicating laid needle shall be red-colored and green-colored, respectively.

(4) Intervals (distance) between pointer and dial

(a) The interval between pointer and dial shall not exceed 3 mm. However, the interval between the pointer of Instruments with laid needle and its laid needle shall be less than 1.5 mm.

(b) The interval between the inside wall of the stepped dial and the pointed head of the pointer shall not exceed 4% of the length of the pointer. However, the interval shall not necessarily be made less than 1.5 mm.

(5) Zero adjuster

For the Instruments having control springs, zero adjustment shall be safely and completely provided without removing the outside box.

Therefore, the Instruments shall be completely insulated from the electric circuit, and the adjustable range shall be 10% each of the length of the scale toward both sides of the zero position.

(6) Laid needle return mechanism

The laid needle shall easily be returned from the front manually, and at the same time, an electromagnetic return mechanism shall be provided. The power source for the electromagnetic return mechanism shall, in principle, be DC 220V, and it shall work without any trouble though the value may change within the range of 80% to 130%.

(7) Front glass

The surface shall be such that rust shall not adhere to it, and the glass shall be of a shape which shall not allow reflection of rays.

(8) Terminal mark

The mark shall be indicated on the terminal or near the terminal in accordance with the following instructions so as to make clear the connecting position.

(a) In the case of AC instrument of two (2) terminals, the terminal on the right side or upper part looking from the front of the instrument shall be the positive electrode. + and - shall be marked on the positive and negative electrode of the terminals, respectively.

(b) In the case of wattmeter, $\pm$ or other appropriate marks shall be put on the coil-side terminal of the voltage circuit terminal and the current circuit terminal having an identical polarity with the above voltage circuit.

(c) In the case of polyphase instruments and instruments having more than two (2) kinds of measuring range, marks shall be put on the terminals or other appropriate spots, and a connection diagram or instruction manual shall be attached in order to make clear the application method.

(d) In the case of shunt and multiplier which are specified to be combined or have an impedance box annexed, marks shall be put on in order to make clear the connecting method of the terminal to the instrument.

(9) Coating of the frame of isntruments

The frame of the Instrument shall be of frosted finishing, and the color grades shall be in accordance with N1.

(10) AC external shunt and multiplier

The grade of shunt and multiplier to which any combination with special Instrument is not specified, shall be 0.5 class. In case they are used in combination, the grade applicable to the conditions specified in this Standard shall be applied.

(11) Resistance temperature detector (RTD)

For the RTD which is combined with the instrument of indicating resistance thermometer, an RTD of more than 1.0 class shall be used.

(12) Shape and dimension

The instruments shall, in principle, be square drum-embedded type (wide angle scale).