2.1.5 LOCAL CONTROL PANEL

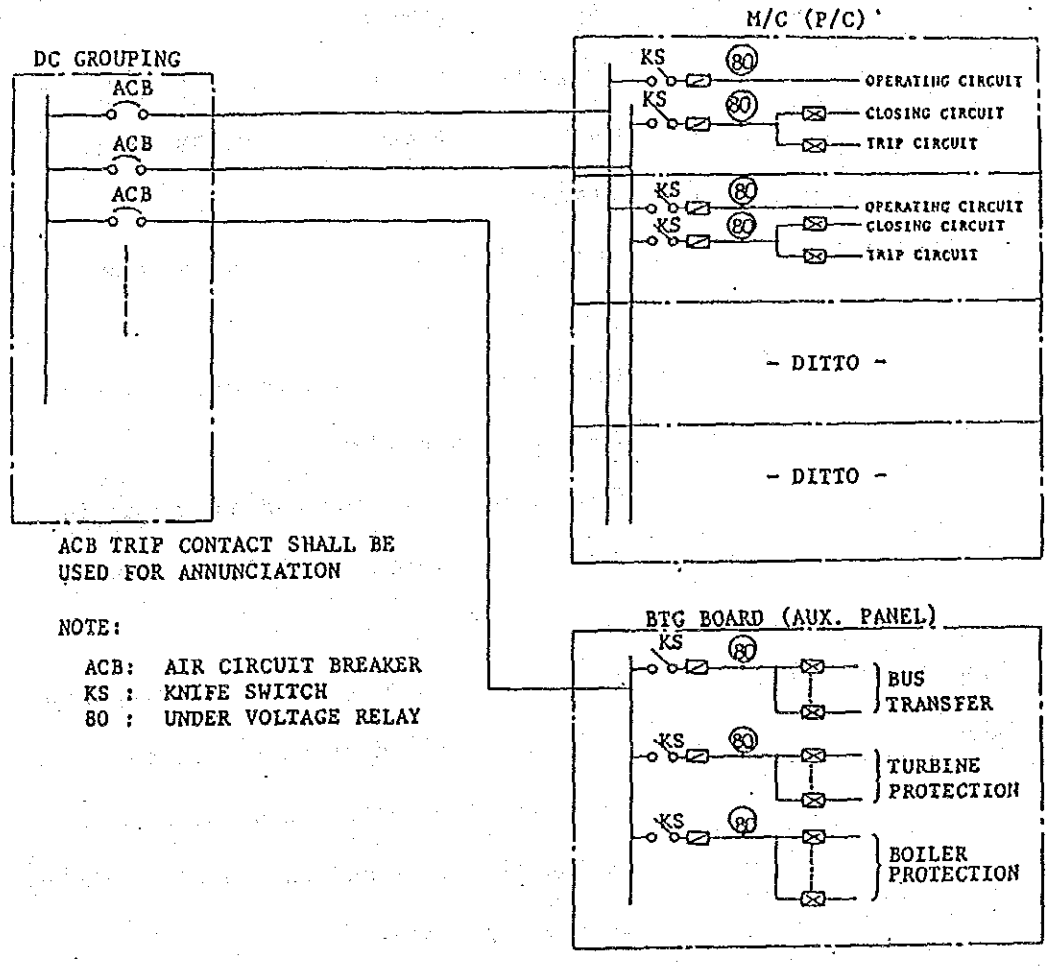
List of Specifications

Item	Specifications
Indoor use type	Some are double door construction with glass window Components to be mounted on the front door ..... Name plate Components to be mounted on the inside door ..... (Lamp, CS, COS, PB, name plate)
Outdoor use type	Double door construction with water proof glass window Components to be mounted on the front door .... Name plate Components to be mounted on the inside door ..... (Lamp, CS, COS, PB, name plate)
Supporting method	Wall hanging type or self-standing type
Door	To be of double door construction. Both doors shall be provided with the hinge at the left side and the handle with key at the right side
Grounding terminal	To be provided
Key	Keys shall be provided for both outdoor and indoor use

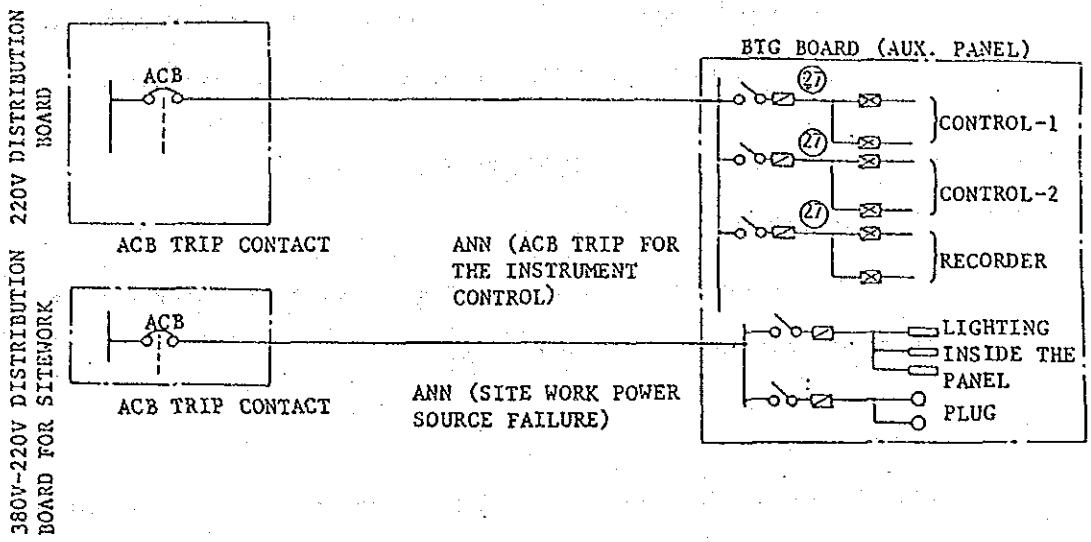
2.1.6 GROUPING OF THE CONTROL POWER SOURCE

Grouping of the DC and AC control power sources shall be, in principle, based on the following examples.

Example - 1



Example - 2



80 ANN (Loss of DC Control Power Source)

27 ANN (Loss of AC Control Power Source)

Enclosed fuse

Section plug

Notes: (1) Current limit fuse with the melting indications shall be used.

(2) ACB on the distribution board is to be provided for the short-circuit protection and, therefore, it shall withstand the short-circuit current of the circuit.

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(3) Current rating of the fuse shall be determined so as to provide sufficient margin to the rating current of the circuit. (Two (2) kinds of fuses shall be used, one for the closing circuit of M/C and P/C and the other for the other control circuits).

2.1.7 PIPING AND TUBING FOR INSTRUMENTATION

2.1.7.1 PRIMARY PIPING

Primary piping shall be in conformity with "Primary Piping for Instrumentation" in Clause 9.11.

2.1.7.2 TUBING

(1) Material for pneumatic signal tubing shall be as follows.

(a) Material: Soft annealed, seamless, PVC covered copper tube

(b) Size (mm):

Outer diameter	6.0	10.0	12.0
Wall thickness	1.0	1.0	1.2

(c) Fitting: Flared brass fitting

(2) Internal tubing method

Internal tubing of panel and board shall be cheat tubing and/or bundle tubing. Tubing shall be aimed at the easy maintenance and beatiful appearance.

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2.2 STANDARDS OF ELECTRIC MOTOR

These standards are applicable for general purpose motors to be used in a thermal power station, and are not applicable for special motors such as miniature motors for control equipment.

2.2.1 TECHNICAL INFORMATION

2.2.1.1 SELECTION OF SPECIFICATION

Selection of specification for motors to be used in a thermal power station shall be made in good coordination with driven equipment and with other electric facilities to improve reliability of the entire plant and to demonstrate highest function of the plant.

2.2.1.2 RATING

(1) Kind of rating

The rating of all motors shall be based upon continuous operation.

Regarding the rating of motors operating only a short time such as for the motors furnished to the valves can be based upon short time operation (15 minutes in minimum). The final time shall be decided after discussion between the Engineer and the Contractor.

(2) Ambient temperture

Indoor $40^{o}C$

Outdoor $50^{o}C$

(3) Voltage classification by capacity

Capacity, voltage, and phase of motors to be used are as follows:

Kind of Source	Capacity Classification	Voltage (V)	Phase	remarks
AC	150 kW or larger (Note-1)	6,600 V	3	
	Less than 150 kW and 1 kW or larger All motor operated valve	380 V	3	
	Less than 1 kW	220 V (Note-2)	1	
DC		220 V	1	

Note - 1

As a general rule a motor of 150 kW or larger shall be fed by high voltage power supply, but a motor of less than 150 kW may be fed by high voltage supply in case that the motor is located for distant from low voltage supply source and larger size of cables and conduits to be used do not justify use of lower voltage against use of higher voltage.

A motor of 150 kW or larger may be fed from high voltage power supply in case that the motor is located outdoors very near to 380V power supply source while no higher voltage power supply is available in the area.

In this case, bordar line of 150 kW shall be decided considering above matter and best and proper selection can be made by the Contractor and shall be got approval of the the Owner and the Engineer.

Note - 2

In general, a motor of less than 1 kW shall be fed by 220V power supply source but a motor of less than 1 kW to be fed by an emergency diesel engine generator bus shall be rated at 380V and careful attention has to be paid on selection of motor voltages.

(4) Insulation class

Above 1 kW B or F (Temp. rise B)

Below 1 kW B or E

In general, insulation class to be used is either B or E. The motor to be located at the place of high temperature shall adopt higher class of insulation than specified in this standard.

(5) Type of enclosure

Kind of Source	Capacity Classification	Type of Enclosure and Type of Protection	
		Place of Installation	Type
AC	150 kW or larger	Outdoor	Totally enclosed
		Indoor	Drip proof protected
	Less than 150 kW and 1 kW or larger	Outdoor	Totally enclosed
		Indoor	Drip proof protected
	Less than 1 kW and motor operated valve	-	Totally enclosed
DC		-	Totally enclosed

(6) Space heater

A space heater shall be furnished for all motors of 75 kW or larger.

A space heater shall also be furnished for a motor of less than 75 kW, if the motor is to drive an auxiliary equipment normally stand still and located outdoors.

(7) Basic specification

Basic specification of AC motors are as follows:

Phase : three-phases

Type : Squirrel cage type induction motor or Special cage type induction motor

Starting method : Full voltage line start

A squirrel cage type or a special cage type induction motor shall be used as standard and a wounded rotor type induction motor shall not be used for general purpose except for over head crane application etc. where speed control feature is required.

There is no standard for motors for instrumentation, those for control and DC motors, and specification for those motors shall be determined on case by case basis.

(8) Noise level

So far as there is not specially described, noise level of all motors shall be less than values shown in the following.

Sound pressure level shall be measured by equivalence A scale and its level shall be less than 90 dB(A) at point where located at the distance of one (1) meter for horizontal direction from the surface of motor casing, and 1.5 meters high floor level.

2.2.1.3 STARTING UP CHARACTERISTICS

Starting up current of an induction motor shall be less than 650% of rated current as a general rule.

As for starting current of a larger motor such as 1,000 kW or larger, and high voltage motor starting up current is required to be in the order of magnitude of 400 to 500% of the rated current to keep voltage drop within a proper limit, and a specific percentage figure for each larger motor shall be decided after discussion between the Engineer and the Contractor on case by case basis.

Sufficient torque shall be provided to control the valve against maximum differential pressure and static pressure at 90% of the rated voltage.

A motor for thermal power station application shall be designed and manufactured to withstand thermal and mechanical shock due to rushing current which occurs at instantaneous interruption of power supply during transfer or change over of power supply source.

Starting current of DC motor shall be kept less than 150 to 200% of rated current by using a starter.

As it takes some definite time for a DC motor to reach rated speed, a designer is required to carefully determine to specify and to design a starting up control circuit so that the DC motor reaches the speed which driven equipment requires within a time required by the purpose.

Special attention in this regard shall be paid for a DC motors to be used for safety protection of plant equipment during forced shut down of the entire plant such as an emergency bearing oil pump.

When a motor is started, especially during rainy season, resistance of field winding is relatively small due to lower temperature of winding, and therefore larger which results in lower speed.

As motor temperature goes up after startup, resistance of field winding increases and accordingly becomes smaller which causes rotating speed to increase.

A totally enclosed self cooled type motor has thermal time constant of about one (1) hour or longer and therefore time required for a DC motor to reach constant speed is one (1) hour or longer.

As a DC motor for safety protection of equipment is required to demonstrate it's function fully while the entire plant is forced to be shut down, the motor shall not be tripped out by over load, but an alarm shall be initiated by a thermal switch as an indication of over load.

2.2.1.4 CRITICAL SPEED

The critical speed of induction motor shall be out of range ±20% rated speed.

2.2.1.5 MOTOR OPERATED VALVE

These specifications are applicable to motor's and auxiliaries for motor operated valves.

These electric motors shall be designed especially for heavy-duty service in a power plant.

The motor shall be equipped with limit switch box and push-button station.

2.2.1.6 CRANE MOTOR

Motors shall be of alternating-current wound rotor type, in principle.

This specification shall apply to the crane installed indoor only.

Motor intermittent time rating shall be not less than 60 minutes or not less than 25% of load time rate (ED), motor horsepower required to drive the furnished equipment at the maximum design point of the equipment shall be decided at 95% voltage of the rated voltage.

Speed rating shall be applied in accordance with the standard as specified.

Wound rotor secondary voltage shall be in accordance with the standard.

2.2.2 ACCESSORY

2.2.2.1 TERMINAL BOX

(1) Terminal Box

A separate terminal box shall be furnished for main power circuit and for space heater circuit respectively.

Construction of a terminal box shall meet the following equipments, in principle.

More than four surfaces out of six (6) of a high voltage terminal box can be removed as part of a cover for easier installation and maintenance.

A terminal box shall be so constructed that it can be installed in the field in any one directin of vertical up, vertical down, horizontally right or horizontally left.

A terminal box for indoor installation shall also be water proof construction against pouring of large amount of water from above even in the case it is installed vertical up direction.

Lead wires of a motor shall be sufficient in length to make easier connection with outside cables. Lead wires of a high voltage motor shall be fixed firmly by a support.

2.2.2.2 OUTSIDE CABLE CONNECTION TERMINAL

A motor shall have clamp type terminals for connection with outside cables. The terminal sizes shall be decided after discussion between the Engineer and the Contractor.

2.2.2.3 A THREADED HOLE FOR CONNECTION WITH A CONDUIT

A threaded hole for connection with a conduit shall be furnished for each terminal box and it's size shall be decided after discussion between the Engineer and the Contractor.

2.2.2.4 GROUNDING TERMINAL

A grounding terminal shall be a fastening type and it's size shall be as shown below.

Voltage	Size of Groundihng Wire		Number of Grounding Wire
220 V	Less than 11 kW	38 mm^2	One
380 V	11 kW - 29 kW	60 mm^2	One
	Larger than 30 kW	100 mm^2	
6.6 kV		250 mm^2	Two
DC 220 V	Less than 1 km	5.5 mm^2	One
	Larger than 1 kW	38 mm^2	

Both a motor frame and a terminal box for 6.6 kV shall be grounded seriously connected.

Cable sheath is grounded in a metal clad switchgear or in panels or boards, therefore no grounding terminal for a cable sheath is required in a motor terminal box.

2.2.2.5 COOLING SYSTEM

The cooling system for motor shall be air cooled type.

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2.2.2.6 SPACE HEATER

A space heater shall be sized to keep inner temperature of a motor well above dew point while motor is shut down and shall be installed easy for inspection and replacement work.

Terminal voltage of a space heater shall be 220V.

2.2.2.7 TEMPERATURE INDICATOR

A dial type temperature indicator for bearing and stator winding temperture measurement shall be furnished for all high voltage motor. The sensor of stator winding shall be placed in slot portion two sets per phase.

2.2.2.8 NAME PLATE

A motor shall have its own name plate and a marking plate showing direction of rotation.

A name plate showing details at rating shall be of black characters on silver background and it's item shall be as follows.

A marking plate showing direction of rotation shall be of a black arrow showing direction of rotation on silver background.

Material of these plates shall be stainless steel for outdoor installation and manufacturer's standard material for indoor installation.

Name and number of phase

Type

Output

Kind of rating

Insulation class

Speed

Frequency

Number of pole

Voltage

Secondary voltage

(In case of wound motor)

Current

Secondary current (In case of wound motor)

Number of manufacturing

Date of manufacturing

Manufacturer

Code

Excited system (In case of DC motor)

2.2.2.9 LADDER AND PLATFORM

A ladder or a platform shall be furnished for a motor if such is found out to be necessary for maintenance and checking of operating condition.

2.2.2.10 BRUSH AND BRUSH HOLDER

Brush shall be carbon type suitable to rotation speed, current density etc. Spare brush shall be furnished for at least five (5) years operation, unless otherwise specified. Brush holder shall be fabricated of insulation material and be arranged to be easy maintenance for brush.

2.2.2.11 BRAKE

Motor shall have a automatic brake which has sufficient brake torque capability based on the motor maximum torque.
(In case of over head crane)

2.2.3 INSTRUCTION BOOK

Instruction book shall include at least following items.

(1) Outline of the specification

(2) Condition of operation (Ambient condition, frequency of start and stop etc.)

(3) Special treatment done before shipment

(4) Ventilating system and its explanation with illustration

(5) Outline specification of screens and filters

(6) Types of bearings and their catalog numbers

(7) Guaranteed life of the ball bearing or the roller bearing used

(8) Type of lubrication, method to supply lubricant, recommended inspection method of lubricant, recommended frequency of replacing lubricant, and specification of lubricant

(9) Shaft axial clearance

(10) For a motor with pressurized oil lubrication system, following shall be included.

Design oil pressure in operating condition at bearing inlet.

Oil temperature rise while lubricating oil goes through a bearing

(11) If a bearing temperature relay is furnished, explanation on relay contact action and shall be included.

(12) If a motor is of special design, full explanation on special features shall be included.

(13) If a motor is of DC type, type of brushes, name of brush supplier and allowable operating time without brush replacement shall be included.

(14) Other recommendation and information for maintenance

2.2.4 DATA AND DRAWING

Data and drawings to be submitted.

Following data and drawings shall be submitted with the proposal and with supply of a motor.

Kind	Name	Remarks
With a proposal	List of outline specification	Refer item (1)
For approval before	List of detailed information on motors	Refer item (2)
Final drawings for manufacture	Motor outline drawing	Applicable for DC motor
	Terminal box drawing	
	Connection diagram	

2.2.4.1 LIST OF OUTLINE SPECIFICATION

No.		T-1
Purpose		Boiler feedwater pump
Quantity		4
Outline Specification	Output	500 kW
	Voltage	6,600 V
	Frequency	50 Hz
	Speed	1,500 rpm
	Type of Enclosure and protection	Drip proof weather protected
	Indoor or outdoor	Indoor
	Vertical or Horizontal	Horizontal
	Type of rotor	Special cage
	Rating	Continuous
	Type of Insulation	F (B, Temp. rise)
	Starting method	Directo on line start
	Space heater	Yes
	Manufacturer	
	Weight	27,000 kg
Remarks		

2.2.4.2 LIST OF DETAILED INFORMATION ON MOTORS

No.	Item	Unit	(Example)
1.	Purpose		Air preheater oil pump
2.	Quantity		4
3.	Frame No.		8,760
4.	Type outdoor/indoor Type of enclosure and of protection		Outdoor Totally enclosed Deep slot squirrel cage
5.	Rated output	kW	0.75
6.	Rated voltage	V	380
7.	Rated frequency	Hz	50
8.	Numbers of phases		3
9.	Starting method		Direct on line start
10.	Numbers of poles		6
11.	Rated rotating speed		991
12.	Hourly rating		Continuous
13.	Type of insulation		B
14.	Maximum allowable	deg C	70 (Thermometer)
15.	Rated current	A	34
16.	No load current	%	25
17.	Starting current	%	500
18.	Starting torque	%	205
19.	Maximum torque	%	290
20.	Power factor at rated load	%	85
21.	Efficiency at rated	%	80.0
22.	Slip at rated load	%	4.4

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No.	Item	Unit	(Example)
23.	Rated torque	kg-m	50
24.	Direction of rotation (viewed from driven equipment)		Clockwise
25.	Reverse rotation		Possible
26.	Space heater voltage, capacity		None
27.	Location of terminal box viewed from driven equipment		None
28.	Type of terminal box for conduit connection		Right
29.	Size of cable connecting terminal		
	Main lead	mm^2	8
	Heater lead	"	None
	Lead for temperature detection		None
30.	Size of grounding terminal	mm^2	38
31.	Type and number of bearing		Sealed ball bearing No. 63305
32.	Specification of lubricating oil or grease		Grease #1
33.	Required oil quqantity	l/min	None
34.	required cooling water	l/min	None
35.	Connection with driven equipment		Direct coupled

No.	Item	Unit	(Example)
36.	Bearing axial clearance	mm	
37.	Size of main lead	mm^2	8
38.	Air gap	mm	1.5
39.	Allowable locked rotor Stand still	sec.	8
40.	Allowable locked rotor In Operation		5
41.	Moment of inertia motor	$kg\text{-}m^2$	50
42.	Time required for acceleration (coupled with driven equipment)	sec.	3
43.	Allowable frequency		Once in every 15 minutes
44.	Weight	kg	50
45.	Noise	dB(A)	72
46.	Manufacturer		
47.	Standards based		IEC
48.	Power supply source		
49.	Remarks		

Rated field current shall also be shown in "Item-15 Rated current" if the motor is DC type. Type and name of manufacturer of special spare parts such as carbon brushes shall be mentioned in "Item-49 Remarks".

Rivised list shall be submitted when specifications originally intended are modified, changed or revised.

NEMA's or equivalent standard Frame Size shall be used to fill out "Item-3 Frame No.".

Manufacturer's frame size may be used, if a manufacturer has its own frame size and a list of frame sizes is submitted to the Owner and the Engineer.

A vertical type motor shall positively identify itself. Manufacturer's proper description on location of a terminal box for a vertical motor shall be used to fill out "Item-27 Location of Terminal Box".

For "Item -43 Allowable Frequency of Start and Stop", it is preferable that allowable rotor temperature, on which allowable frequency of start and stop are figured out, is also mentioned in this item.

2.3 CABLE AND WIRE

2.3.1 TECHNICAL INFORMATION

The specification of various cables and details applied shall be, in principle, in accordance with "Selection of Cable and Wire" in the attached sheet and "Cable Specifications" in Item 2.3.2.

In selecting the type, cross sectional area, and number of cores of power cable, decision shall be made based upon the ambient temperature, laying method, length and load capacity, and short circuit capacity. However, the voltage drop in the power cable shall not exceed 2.5% against the rated voltage at a rated current, and the power cable shall a size in order to sufficiently withstand the fault current within the time when the fault is removed by the function of the main protection.

Selection of Cable and Wire

Kind	Use	Nominal voltage	Specification	Number of core	Remarks
Power circuit	4,160 volt power	6,000V	High-voltage cross-linked polyethylene insulated vinyl sheathed cables (hereinafter CV)	1, 3	
	460, 220, 110 volt power	600V	Cross-linked polyethylene insulated vinyl sheathed cables (CV)	1, 2, 3	Min. 5.5 mm^2
Control and Auxiliary circuit	Control	600V	Polyvinyl chloride insulated and sheathed control cables (hereinafter CVV)	2,3,4, 5,6,7, 9,12	Min. 2 mm^2 Min. 3.5 mm^2 (Important circuit)
	Panel and board	600V	Polyvinyl chloride insulated wire (hereinafter IV)	-	Min. 2 mm^2
	Lighting	600V	Heat resistance polyvinyl insulated wire (hereinafter HIV)	-	Min. 2 mm^2

Kind	Use	Nominal voltage	Specification	Number of core	Remarks
Communi-cation Circuit	Paging		Polyethylene insulated polyvinyle insulated-chloride jacketed with shield	-	Speaker Min. 0.75 mm
			Polyethylene insulated, multi-pair polyvinyle-chloride jacketed with shield	-	Hand set Min. 0.75 mm
	Telephone		Twisted, single conductor, polyethylene insulated, multi-pair, polyvinyle-chloride jacketed, color-coded with shield (hereinafter CPEVS)	-	0.9 mm
Special Circuit	Less than 220°C	600V	600V tefulon insulated wire		Min. 3.5 mm^2 Soot blower, igniter, turbine safety valve, etc.

Kind	Use		Nominal voltage	Specification	Number of core	Remarks
Special Circuit	Shield	Electro. stic shield	600V	Copper shield cable (hereinafter CVVS)		154 kV switchyard
		Mag- netic sheild	600V	Copper and iron shield cable (CVVS)		PD auxiliary circuit be- tween 154 kV switchyard and power station
	Instru- ment and computer		600V	Thermocouple com- pensating wire with copper or aluminum shield		Special metering
			600V	Polyethylene insu- lated twisted pair core shield cable		Special instrument
Ground- ing	Grounding		-	Bare annealed stranded copper wire		

2.3.2 CABLE SPECIFICATION

2.3.2.1 POWER CABLE

(1) Conductor

The conductor shall be the one made by twisting together the annealed copper wire.

(2) Insulating material

As insulating material, cross-linked polyethylene shall be as far as possible uniformly sheathed over the conductor. In regard to the thickness of the insulating material, the average of the values measured at several points of a same section shall be more than 90% of the value prescribed in standard.

However, the minimum thickness shall be more than 80% of the value prescribed in standard.

(3) Quantity of cable cores

The quantity of cable cores shall be single core, double core and triple core.

(4) Identification of cores

Single core	Red
Double core	Blown, blue
Triple core	Red, yellow, blue

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(5) Sheath

In regard to the thickness of the sheath, the average of values measured at several spots of a same section shall be more than 90% of the value prescribed in standard. However, the minimum thickness shall be more than 85% of the value prescribed in standard.

The color of the sheath shall be black for low voltage and red for high voltage as a standard.

The sheath of 6 kV cable shall be non-combustible.

2.3.2.2 CONTROL CABLE

(1) Conductor

The conductor shall be the one made by twisting together the annealed copper wire.

(2) Insulating material

As an insulating material, polyvinyl chloride shall be as far as possible uniformly sheathed over the conductor.

In regard to the thickness of the insulating material, the average of values measured at several points of a same section shall be more than 90% of the value prescribed in standard.

However, the minimum thickness shall be more than 80% of the value prescribed in standard.

(3) Quantity of cable cores

The quantity of cable cores shall be 2, 3, 4, 5, 6, 7, 9 and 12 cores as a standard. However, special heat-resisting cables shall have cores of less than 6.

(4) Identification of core

The identification of cores shall be provided in accordance with the following.

(a) The cable with less than 6 cores shall be identified by coloring the insulating materials or the surfaces of the insulating materials as a standard, in accordance with the following:

Single core	Black
Double core	Black, white
Triple core	Black, white, red
Four core	Black, white, red, green
Five core	Black, white, red, green, yellow
Six core	Black, white, red, green, yellow, brown
Seven core	Black, white, red, green, yellow, brown, blue

(b) Identification of the cables with nine or twelve cores shall be provided by the spiral marking method indicated below:

Order of cores	Color	Remarks
1	Black	
2	White	Spiral marking method
3	Red	
4	Green	
5	Yellow	
6	Brown	
7	Blue	
8	Balck spiral on a white ground	
9	Red spiral on a white ground	
10	green spiral on a white ground	
11	Yellow spiral on a white ground	
12	Brown spiral on a white ground	

(5) Sheath

In regard to the thickness of the sheath, the average of values measured at several points of a same section shall be more than 90% of the value prescribed in standard. However, the minimum thickness shall be more than 85% of the value prescribed in standard.

The color of the sheath shall be black as a standard.

2.3.2.3 COMMUNICATION CABLE

Communication Cable for Paging System and telecontrol system, etc.

(1) Conductor

The conductor shall be the one made by stranding the annealed copper wire.

(2) Insulating material

As insulating material, cross-linked polyethylene shall be sheathed over the conductor as uniformly as possible.

In regard to the thickness of the insulating material, the average of the values measured at several points of a same section shall be more than 90% of 1 mm.

However, the minimum thickness shall be more than 80% of 1 mm.

(3) Color identification of insulating materials

In order to make it possible to identify the respective cable conductor cores, the respective cores shall be color-identified as specified in the following table:

	Color of cores		
	1st pair	2nd pair	3rd pair
Two cores x 1 pair	Red and white		
Two cores x 2 pairs	Red and white	Blue and white	
Two cores x 3 pairs	Red and white	Blue and white	Green and white

(4) Pair of stranded cable

A pair of cores shall be stranded in a clockwise direction. In order to finish the stranded cables into a round form, an appropriate intermediary material shall be provided. Then, the stranded cables shall be winded with plastic tape.

(5) Electrostatic shielding

Electrostatic shielding braiding shall be provided uniformly with tinned soft copper cable.

Density of braiding: about 70%

(6) Fabrication

Required number of cores shall be stranded clockwise and winded with plastic tape. Moreover, in order to finish the cable into a round form, an appropriate intermediary material shall be provided.

(7) Sheath

In regard to the thickness of the sheath, the average of values measured at several spots of a same section shall be more than 90% of 2 mm. However, the minimum thickness shall be more than 85% of 2 mm.

(8) Color of sheath

The color of sheath shall be yellow.

2.4 CABLE TRAY

2.4.1 DESIGN

In designing the route and capacity of the cable tray, due consideration shall be given to the design of a more economical route and capacity by sufficiently studying the layout of equipment and the cable schedule as well as sufficiently adjusting the route of machinery piping, etc. However, in case of special conditions where the cable tray is complete to be installed side by side with a high power current circuit or pass through a high temperature part, countermeasures shall be taken in each case.

The occupying ratio, X shall be designed based on upon the following as a standard.

Main line route	70%	Around the central control room 70% - 80%
Branch line route	60%	

$$X\ (\%) = \frac{D^2 \times n}{S} \times 100$$

D : Standard cable size diameter

n : Quantity of cables

S : Effective sectional area of tray

2.4.2 SPECIFICATION

2.4.2.1 KIND

Use	Kind	Mark and arrangement from up to below, in principle.
Power (Including 220 kV, 132 kV, 11 kV)	Ladder type tray	PT
Control	Ladder type tray	CT
Communication instrument and computer	Metal enclosure with cover type tray	CIT

2.4.2.2 MATERIAL

Excellent steel materials shall be applied, and the all cable tray shall be hot-dipped galvanized material with high purity zinc after processing, or press machining galvanized steel plate shall be applied.

2.4.2.3 STANDARD DIMENSIONS

Width (mm)	Hight (mm)	Length (mm)
(200)	--- (100)	
300	(150) 100	1,800
450	150 100	or
600	150 ---	2,400
900	150 ---	
(1,200)	150 ---	

In principle, the tray shall be in accordance with the above standard dimensions. The figures in parentheses are not standard dimensions. However, the data can be applied when they are considered more economical.

2.4.2.4 STRENGTH

The cable tray shall have a strength met the following conditions:

The cable tray shall withstand the concentrated load of 300 kg/m of maximum distributing load and 75 kg of a workman.

The deflection of the tray under the above load shall be within 1/200 of the maximum supporting span, and the tray shall not be deformed under the maximum distributing load.

The cover and accessories of the outdoor tray shall not be dispersed and the tray shall not be deformed due to the maximum wind velocity of 30 m/sec.

All steel used to hang the tray shall function harmoniously with the tray body.

2.4.2.5 CONNECTING METHOD OF CABLE TRAY

Connection of the cable tray with other trays shall be carried out by connecting the side channel with fishplate and round-head square bolts.

2.4.2.6 PAINTING

The all cable tray shall be hot-dipped galvanized material with high purity zinc, or shall be manufactured using galvanized steel plate.

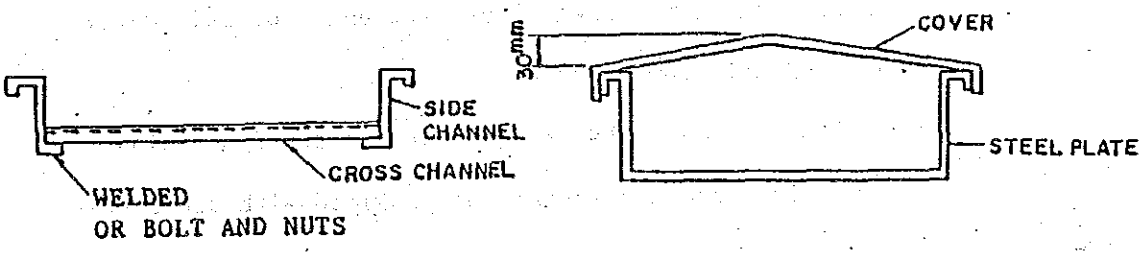
In regard to the painting, two coats of zinc-enriched paint shall be applied.

The connecting bolts and nuts for the tray, fishplates, etc., shall be carried out in accordance with the same specifications as those of the tray.

2.4.3 CONSTRUCTION

2.4.3.1 LADDER TYPE TRAY

(1) The shape of the tray shall be in accordance with the figures below, and the tray shall consist of a cross channel and side channels. The cross channel and the side channels shall be assembled by welding or bolts with nuts and the distance between the cross channels shall be 300 mm as a standard.



(2) The side channel inside the bilge of the tray shall be machined for bending and the bending radius shall not be less than 300 mm.

(3) On each spot where the cable may possibly be damaged due to dropping of objects, a cover shall be attached.

(4) For further details, refer to the attached drawing.

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2.4.3.2 METAL ENCLOSURE TRAY

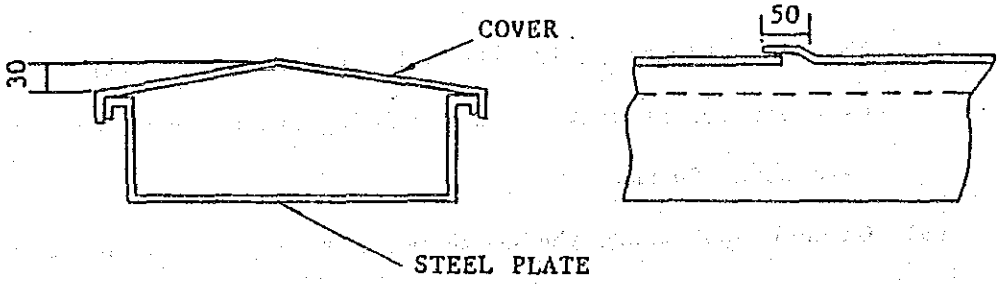
(1) The metal enclosure tray shall consist of a duct made by press-working of steel plate and a cover, as illustrated in the following diagram.

(2) The outdoor tray cover shall have a slope, and the cover center shall be about 30 cm higher than the lowermost slope, as illustrated in the diagram below.

(3) The tray cover shall be of steel plate construction with both ends bent, and the portion to be exposed outdoors shall be fastened with bolts and sealed with hoops.

(4) The outdoor tray to be provided in front of the penetrating part of the exterior wall of the Main Building shall be of a construction permitting drainage of rain water which enters the tray. Moreover, all appropriate measures shall be taken to prevent entry of rain water into the main power house.

The indoor tray to be provided at the portion rising upward from the panel shall be provided with drain holes.



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2.4.3.3 SHAFT

(1) The shaft shall have a cover, and the cover shall be of a removable construction. A handle shall be attached on each cover.

(2) The cable fixing metals shall be attached inside the shaft at a maximum interval of 1,500 mm.

(3) The connection between the vertical shaft and the horizontal tray shall be carried out by utilizing the curved plate.

As the cable at the shaft is more likely to be deflected than the cable at the horizontal part, the shaft part shall have an area ratio 1.5 times greater than that of the horizontal part.

(4) The shaft shall separately be provided each for the power cable and the control cable. In case both of the cables should unavoidably be inserted inside the same shaft, a separator shall be set up.

(5) For further details, refer to the attached drawing.

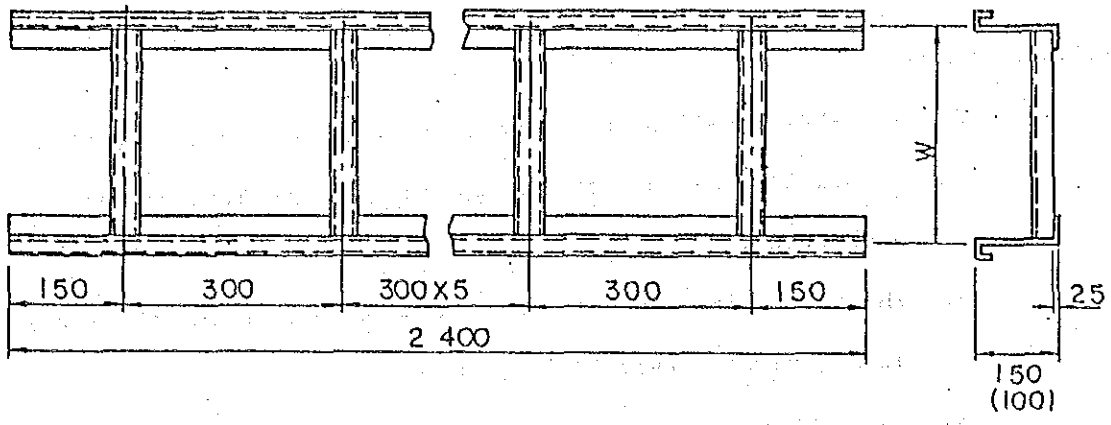
(6) Others

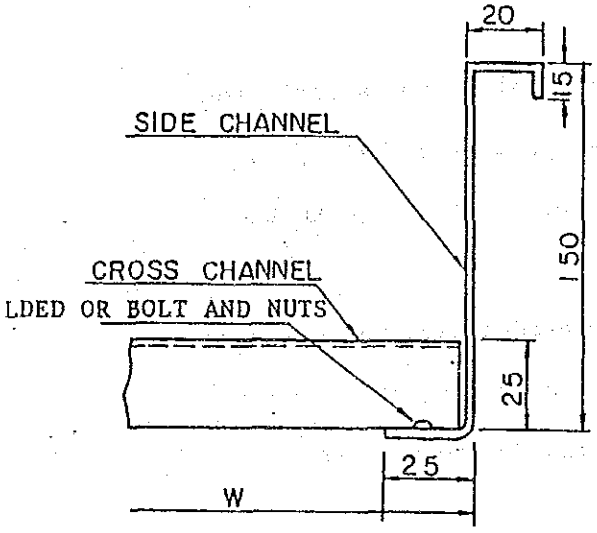
For details regarding each part of the tray, refer to the attached drawing.

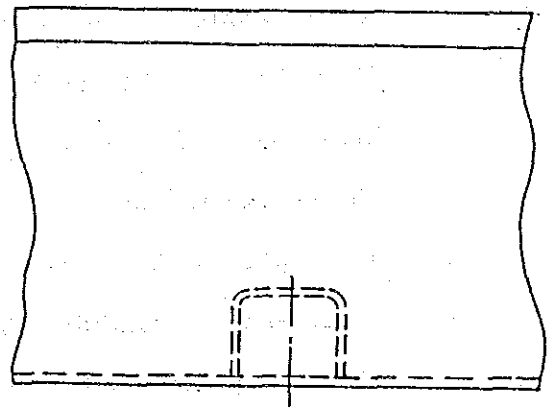
2.4.4 GROUNDING OF CABLE TRAY

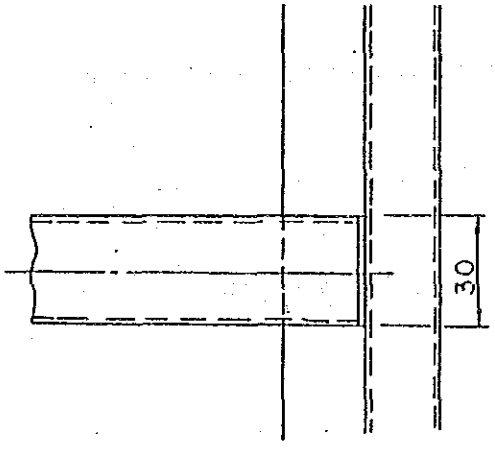
The cable tray shall be grounded and welded to the steel structure.

LADDER TRAY









THICKNESS

W	SIDE	CROSS
MORE THAN 600	2.3 mm	3.2 mm
LESS THAN 450	2.3	2.3

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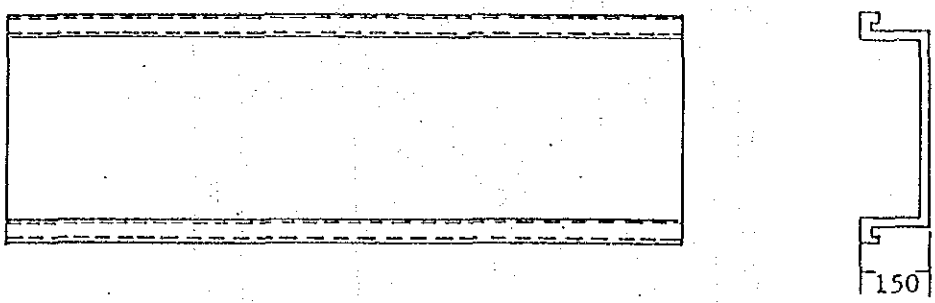
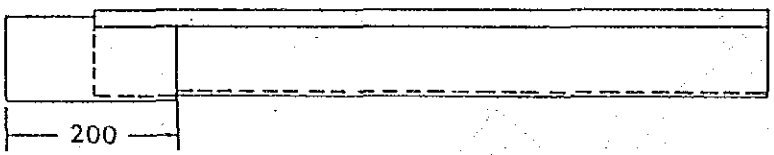
STEEL ENCLOSURE TRAY

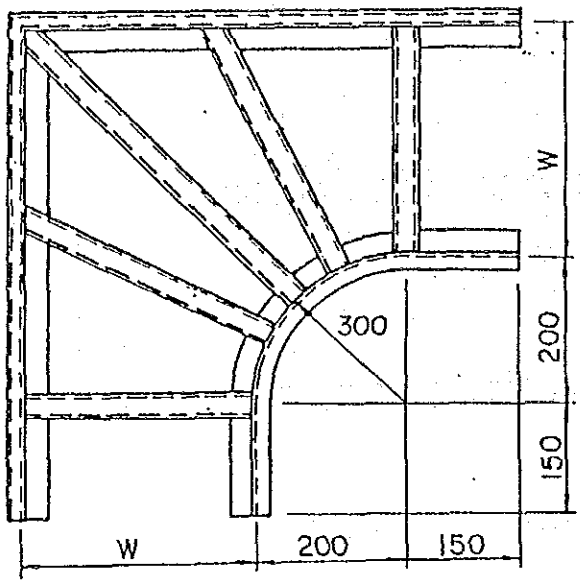


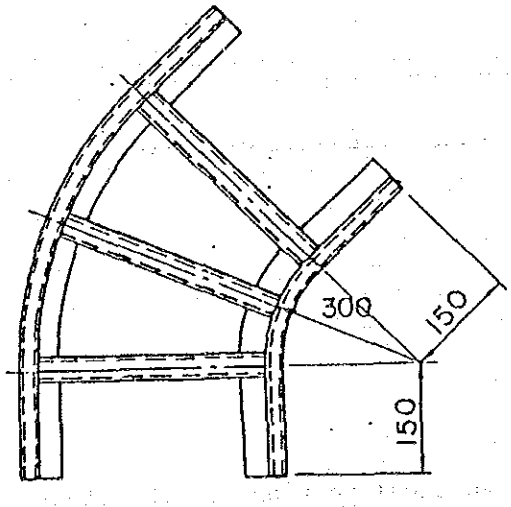
W	Thickness mm
900	3.2
600	3.2
450	2.3
300	2.3



The horizontal portions and vertical portions of the steel plate cable tray shall be protected by means of non-combustible materials.

TRAY CURVE





45°

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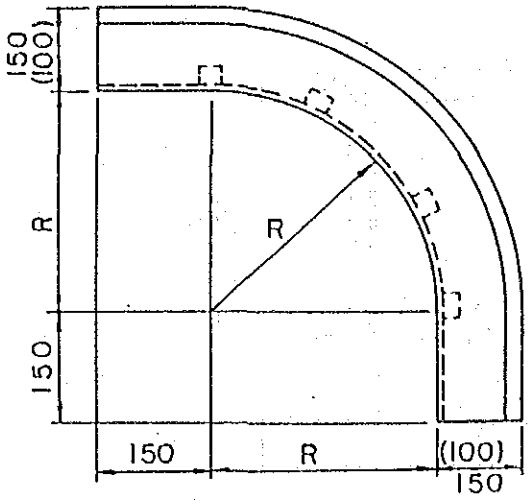
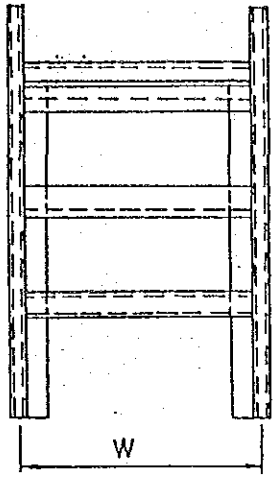
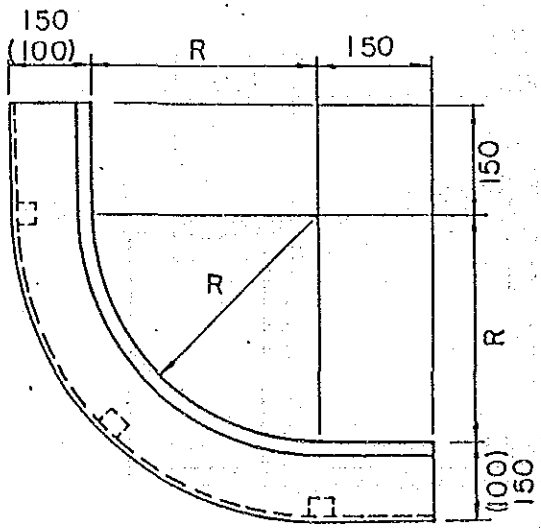
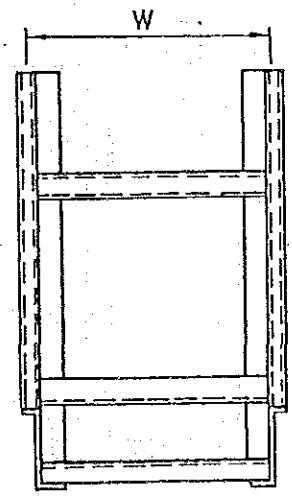
TRAY UP DOWN





90° DOWN





90° UP

R=MORE THAN 300 mm

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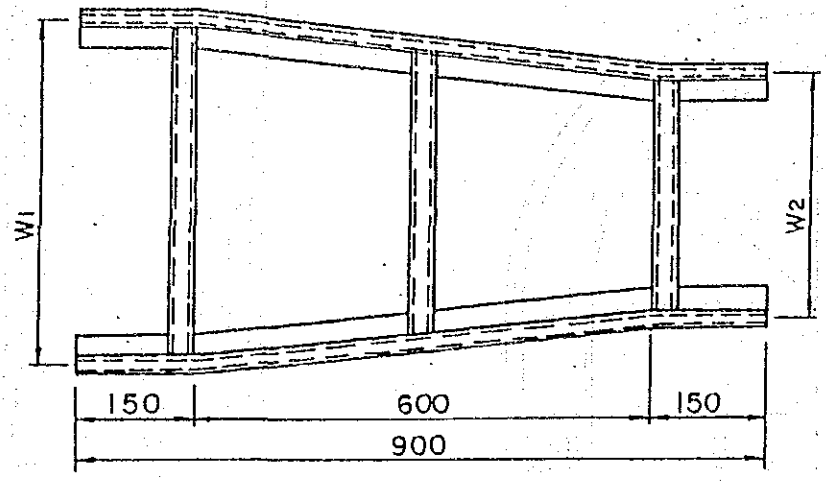
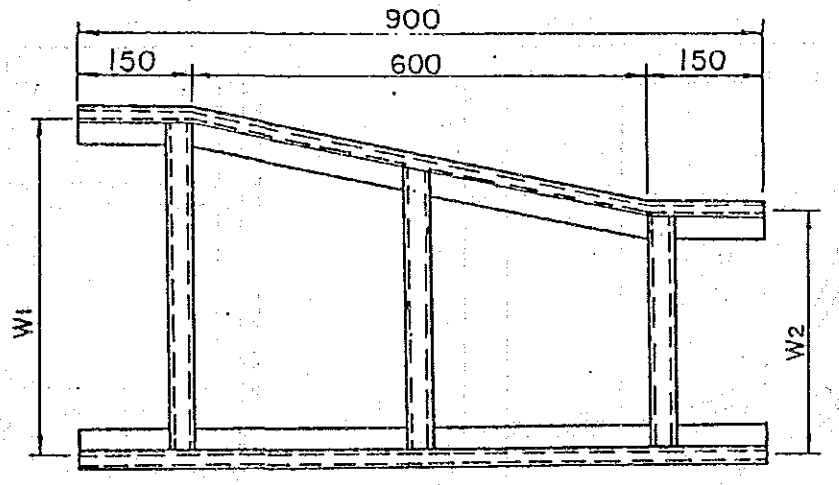
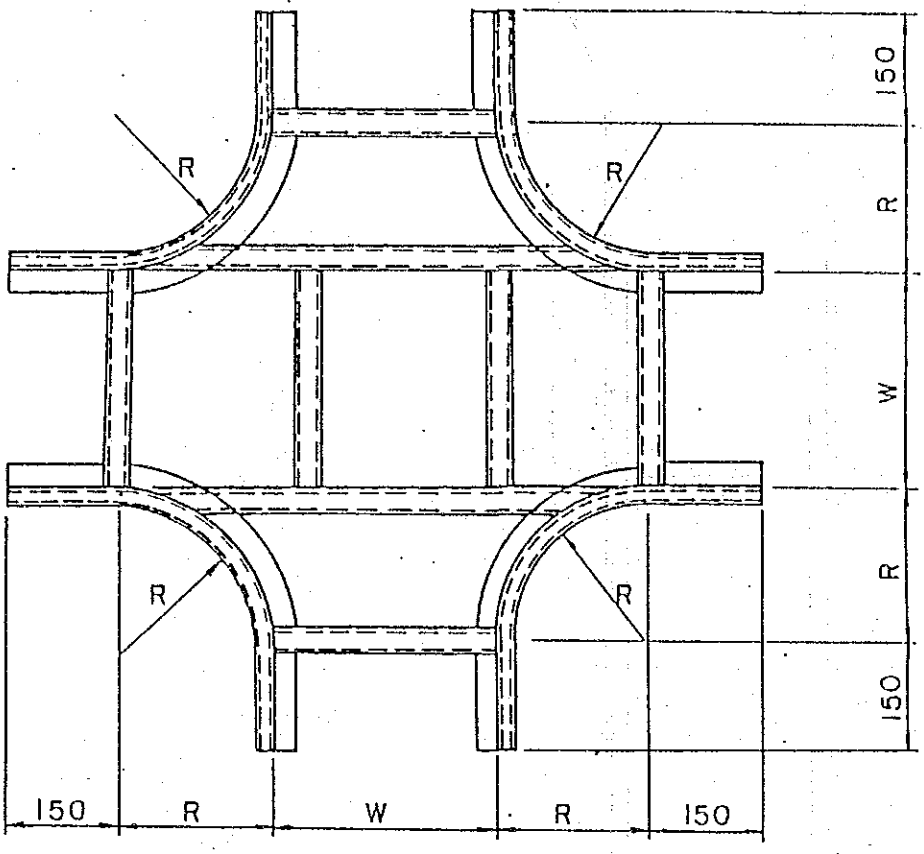
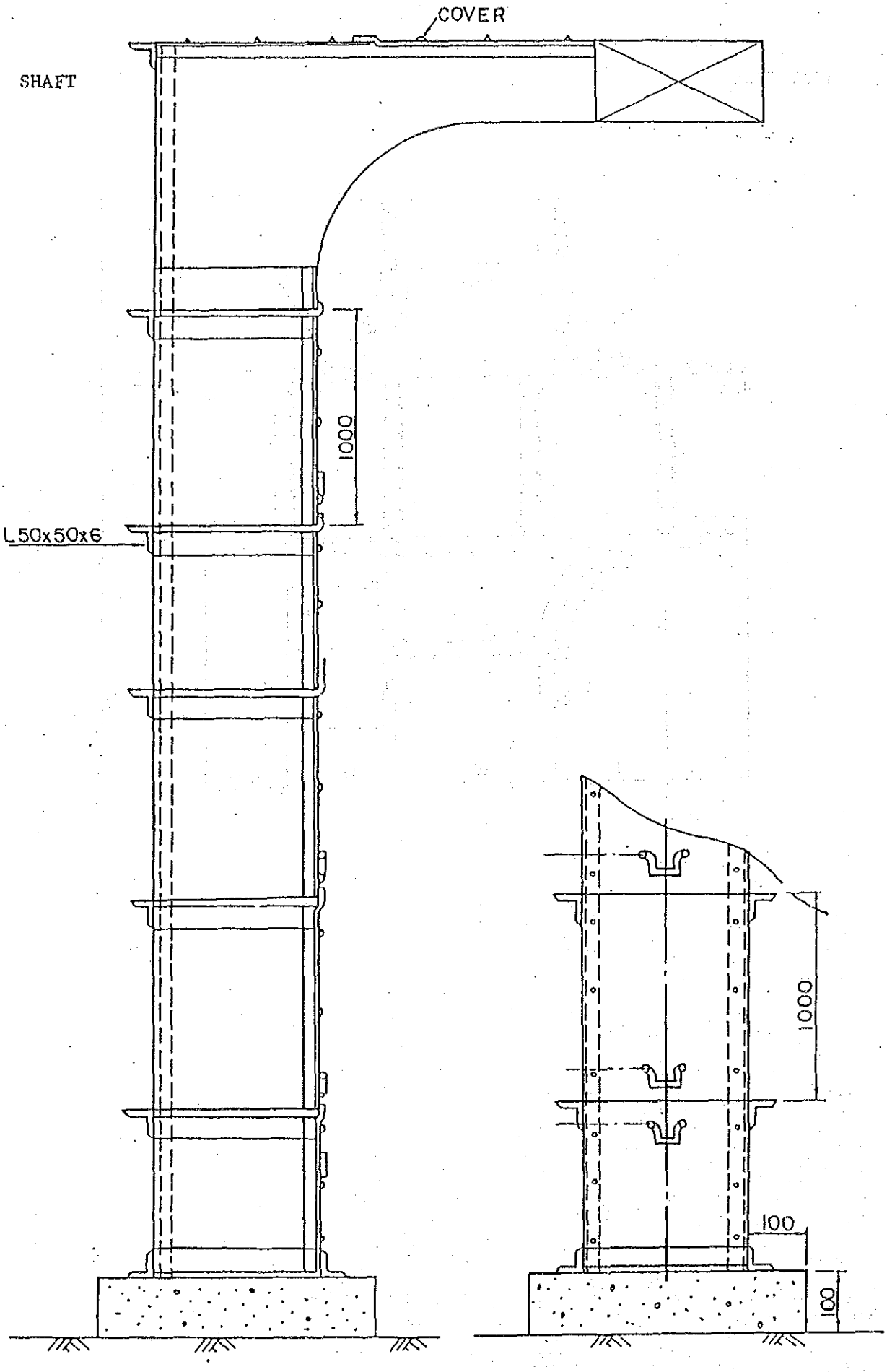
TRAY REDUCER





TRAY CROSS





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3. INSTRUMENT AND CONTROL

3.1 INSTRUMENT AND CONTROL APPARATUS

3.1.1 GENERAL REQUIREMENT

(1) This specification stipulates that all instrumentation and controls of the Plant shall consist of pneumatic or electric system except in special cases.

Instruments and control apparatus shall be designed based on the following conditions.

Power source	o Electric power supply	AC 220V 50Hz DC 220V
	o Instrument air supply	7.0 kg/cm^2g
Signal	o Electric signal	4 - 20 mA 1 - 5 V Contact on/off pulse
	o Pneumatic signal	0.2 - 1.0 kg/cm^2g

(2) The instruments and control apparatus furnished under this specification must be supplied by a recognized manufacturer having wide experience in the manufacuture, application, and installation of equipment and systems to power plant of similar size.

(3) The instruments and control apparatus to be furnished under this specification shall be compatible with the equipment and facilities furnished for the power plant described hereinafter.

(4) All instruments and control apparatus shall be protected from adverse climatic conditions at the site.

(5) The instruments and control apparatus shall be in accordance with Clause 5 of "Applicable Standards and Codes" in Part I.

(6) All documents, instructions, legends, charts, scales and name plates shall be in the English language, and all instruments, chart, scale and gauge data shall be furnished, calibrated and shown in metric systems.

(7) The grouping of recording points, as well as the scale ranges for all recorders, indicators, transmitters, etc., shall be subject to change upon determination of final equipment requirements.

(8) All instruments, controllers relays, valves, transmitters, positioners, etc., shall be provided with the tag number in accordance with the Engineer's numbering system which will be decided after contract signing.

(9) The Contractor shall submit the instrument list in accordance with the form prepared by the Owner and the Engineer for approval.

(10) Complete connection diagram for each instrument and control system showing the internal connection of each instrument and interconnections between instruments, control, sensing elements and associated equipment shall be furnished by the Contractor.

(11) All instruments and devices shall be furnished with a identification tag before shipment. This tag number shall comply with the number in the instrument list and drawings. These tags on panel mounted items shall be readily accessible from inside the panel.

(12) All instruments and control apparatus shall be designed and constructed to operate accurately and safely under the operating conditions described or implied in this specification, without undue strain, wear, heating, vibration, corrosion or other operating trouble.

(13) All parts subject to high pressures and temperatures or other severe duties shall be of the best materials for the service.

(14) Parts subject to wear, corrosion or other deterioration or requiring adjustment, inspection or repair shall be made accessible and capable of convenient removal when required. Where practicable, parts subject to wear shall have means of adjustment.

(15) Parts subject to substantial temperature changes shall be designed and supported to permit free expansion and contraction without resulting in fluid leakage, misalignment, loss of accuracy and availability, harmful distortion and excessive maintenance.

(16) Each system shall be furnished complete with sensors, transmitters, converters, receivers, controllers, final control elements, meters, relays and all required accessories.

(17) All instruments and control apparatus shall have dust tight, rodent proof cases, covers or housings. All instruments for outdoor service shall be weather proofed. All equipment for indoor service may have drip proof cases.

(18) All panel mounted instruments including switches and indicating lamps shall be of the flush mounting type.

(19) Where more than one control system requires the use of the same measurement or control signal, the transmitters or other components shall be fully equipped to provide all signal requirements.

The system shall be arranged so that failure of any recorder, indicator or control component shall not open the loop, thereby causing a complete loss of signal to all other receivers connected to this transmitter. (refer Fig-3)

The Employer shall be able to remove from service any indicating or recording device which is connected in parallel with the control system, without upsetting the control system or requiring readjustment of the transmitter output signal.

(20) All equipment, both pneumatic and electronic, shall be designed and applied for fail safe operation. "Fail Safe" is defined to mean the loss of excitation or power supply, the failure in abnormal operation of any component,and the occurrence or development of a condition detrimental to the safety of the personnel, equipment, plant and environs.

(21) All recorders shall be provided with an indicating scale calibrated in the units of the principle medium being recorded.

(22) Each device, external to control panels requiring an air supply shall be furnished with its own pressure filter regulator. Within the control panels, one pressure filter regulator shall be used to serve a group of devices, provided the maximum total air consumption does not exceed the capabilities of the pressure filter regulator. Each pressure regulator output shall have a pressure gauge.

(23) No primary fluid lines shall be brought into the central control room.

(24) The interior temperature of instrument cubicles and housings shall be maintained at a proper value for optimum performance of the contained instrument. Satisfactory operation shall be attained under the maximum and normal ambient conditions specified. The Contractor shall provide instruments which do not require fans or other internal or external air conditioning devices to meet this requirement.

(25) All solenoids shall have sufficient thermal capacity for continuous energization.

(26) All instruments and control apparatus shall be provided with all necessary special tools and standard spare parts.

(27) Shop test data of each equipment shall be submitted to the Employer and the Engineer.

(28) Instruments and control apparatus shall have the same functions and characteristics so as to be in uniformity with the existing instruments and apparatuses wherever possible.

(29) The local control system shall adopt a pneumatic control system except for the common auxiliary equipment, which shall be furnished with a single loop digital controller.

(30) The grounding wire for electronic control system shall be provided, and shall have an insulated wire for exclusive use.

(31) Electronic control equipment, panel and board shall be placed in anti-vibration rubber mounts.

(32) The electric control signal and the measurement signal wire shall be set in a tray for exclusive use.

3.1.2 PRESSURE INSTRUMENT

(1) All pressure guages located at piping or vessel containing the monitored fluid shall comply with the following, except for gauges mounted on the equipment or components standardized by the manufacturer.

(2) All pressure gauges, unless otherwise specified shall have a accuracy within ±1.0% of full span for 150 mm dial size and within ±1.5% of full span for 100 mm.

(3) The scale range shall be approx. 1.5 times the maximum operating pressure or over.

(4) Pressure gauges type shall be of as follows.

Dial size		150 mm or 100 mm
Connection	PF 15mm or 10mm	Bottom connection Back connection for panel mount
Color	Case	Black
	Dial	White
	Figure	Black
	Graduation	Black (Red in vacuum zone)
	Pointer	Black

(5) All pointers shall be accessible from the front of the gauge for adjustment.

(6) All cases shall be of metal.

(7) Materials, other than those in cases, shall be made suitable for monitored fluid and the environment.

(8) The movement parts shall be of the stainless steel precision geared type.

(9) Pressure switches shall be of the adjustable differential type.

(10) Pressure gauge, switch and transmitter which are used for containing a corrosive or solidifying fluid shall be provided with a diaphragm seal or seal pot filled glycerine or ethylene glycol.

(11) Diaphragm seals and seal pot shall be provided with a clean out connection.

(12) Snubbers, capillary tubes and syphons shall be furnished as required.

3.1.3 TEMPERATURE INSTRUMENT

(1) Primary element of temperature transmitters, controllers and recorders shall be of the thermocouple, resistance temperature detector or filled system type.

(2) All thermal sensors shall be provided with protection wells.

(3) All sensors shall be tagged.

(4) Thermocouples shall comply with ISA standards.

(5) Thermocouple compensating lead wire shall comply with ISA standards.

(6) Thermocouple compensating lead wire used at a temperature of 220°C or more shall be of the heat resistant type.

(7) All thermometers shall be of the filled system. However, other types may be acceptable for equipment and components standardized by the manufacturer.

(8) All thermometers shall have an accuracy within ±1.5% of full span.

(9) Capillary tubing of the filled system thermometer shall be of the flexible armored type, and full temperature compensation shall be made where required by length.

(10) Filled system thermometer shall be as follows.

Dial size	150 mm or 100 mm	
Color		
	Case	Black
	Dial	White
	Figure	Black
	Graduation	Black
	Pointer	Black

(11) Reference (cold) junction temperature compensation shall be provided for temperature measurement using thermocouple.

(12) Pointer of filled system thermometer shall be accessible for adjustment from the front of the meter.

(13) All temperature switches shall be of the filled system type.

(14) Temperature switches shall have two pointers for indication of set point and actual value.

3.1.4 FLOW INSTRUMENT

(1) Flow element shall be selected from among the following types.

Flow nozzle type ---	For high pressure, large flow, accuracy within ±0.5%
Flow orifice type --	For replacement, accuracy within ±0.5%
Positive displacement type ----------	For oil, water flow, accuracy within ±0.5%
Area meter type ----	For oil flow, accuracy within 2%

(2) Flow elements in this specification shall be furnished with certification reports by an authorized party.

(3) Reservoirs shall in principle be furnished for steam elements and water elements shall be provided for use at 120°C or more.

3.1.5 LEVEL INSTRUMENT

(1) Level sensor shall be selected from amoung the following types

Float type with extension tape or wire	For tanks
Differential head type	For high pressure vessel
Displacement type	For low pressure vessel
Bubble type	For cooling water & contaminated water
Glass gauge type	For all small size vessels and tanks

(2) Level switches, wherever possible, shall be of the external float cage type and furnished with a valved drain and plugged vent.

(3) For low pressure tanks, float type level indicator with contacts for alarm shall be furnished.

(4) Glass gauges for high temperature use shall be provided with mica coating.

3.1.6 CHEMICAL INSTRUMENT

(1) The chemical instruments shall be of simple design and high reliability.

(2) The chemical instruments shall be designed to permit easy operation and maintenance.

(3) The chemical analyzer shall be provided with control equipment to maintain constant temperature of sample water.

(4) The chemical instrument sensors shall have the ability to prevent attachment of dissolved solids in sample water.

(5) The chemical instrument transmitters shall have an output signal for the computer input signal.

(6) The specifications of pH meter shall be as follows.

Type	Glass cell with temperature compensation
Measuring range	Standard pH 0 - 14
	Semi standard pH 2 - 12, 4 - 14
Accuracy	±0.2 pH
Output signal	DC 4 - 20 mA, 1 - 5 V
Temperature compensation range	0° C - 50°C

(7) The specifications of conductivity meters shall be as follows.

Type	Solution with temperature compensation
Measuring range	Micromlro/cm 0 - 2, 0 - 20, 0 - 100,
	0 - 500
Accuracy	Full sca ±1%
Output signal	DC 4 - 20 mA, 1 - 5 V
Temperature compensation range	Base temperature ±20°C

(8) The specifications of hydrazine meter shall be as follows.

Type	Oxidation reduction cell
Measuring range	0 - 50 ppb, 0 - 200 ppb
Accuracy	Full scale ±4%
Output signal	DC 4 - 20 mA, 1 - 5 V

(9) The specifications of dissolved oxygen meter shall be as follows.

Type	Gas transfer method or diaphragm galvanic method
Measuring range	0 - 20 ppb, 0 - 200 ppb
Accuracy	Full scale ±5%
Output signal	DC 4 - 20 mA, 1 - 5 V

(10) The specification of silica meter shall be as follows.

Type	Colorimetry by molybdenum blue method
Measuring range	0 - 100 ppb
Accuracy	Full scale ±3%
Output signal	4 - 20 mA, 1 - 5 V

3.1.7 TRANSMITTER

(1) All transmitters and transducers shall be coordinated with their corresponding receiving instruments and control devices.

(2) Standard transmitted signal range shall be as follows.

Pneumatic type	0.2 - 1.0 kg/cm^2g
Electric type	4 - 20 mA DC

(3) Accuracy of transmitted signal shall be less than ±0.5% for full span, except for span between zero and 10% of flow transmitter.

(4) Shop tests data with instruments shall be submitted.

(5) Each transmitter shall include distributor, distribution panel and wires.

(6) All transmitters shall contain integral indicators or, if required a separate indicator shall be furnished for each blind transmitter. Indicator scales shall be calibrated in secondary units and shall have the same range as the associated receivers. They shall also have an integral booster unit.

(7) All parts subjected to fluid monitoring shall be fabricated of materials suitable for the service.

(8) Flow, pressure, differential pressure and level transmitters shall be of the electronic type, unless specified otherwise, and shall be furnished with all required flow elements, instrument valves, blowdown valves, manifold piping, condensate reservoirs, nipples, welding adaptors and other necessary pertinents.

(9) All indicating scales shall be calibrated on the same units as the receiver to which it transmits.

(10) Primary and secondary shutoff valves, reservoirs, etc., shall be furnished under this specification for installation of piping.

(11) Special tools for adjustment and maintenance shall be furnished with instruments.

3.1.8 CONTROLLER

(1) Remote controller

All selector stations shall be suitable for flush mounting on panel and each shall provide an indication to show the relative position of the factors under control whether manual or automatic. Indicating scales shall also be provided on the selector stations to show loading pressure from the controls preceding it, together with an indication of the pressure to be transferred when going from manual to automatic, or vice versa. By means of the control selector stations, the operator shall be able to transfer from automatic to manual or vice versa without disturbing the control operation.

(2) Local controller

(a) All controllers shall be provided with adjustable "proportional" and "reset" action. Applications for temperature and long time lags shall have "rate" action.

(b) All controllers shall have indications of setting value and actual value.

3.1.9 CONTROL VALVE

(1) All control valves shall be of the pneumatic type, except for control valves furnished with special function.

(2) Electro/pneumatic, pneumatic/electro converter shall be furnished, if required.

(3) Control valve bodies shall be one size larger (minimum) than the inner valve, and the control valve body size shall be 2.5 mm (minimum), unless otherwise specified.

(4) All control valves shall have bolted bonnets, unless otherwise specified. For valves operating at temperature of 230°C and over, the bonnets shall be aircooled.

(5) The body material for all control valves shall never be a lower alloy than the line in which it is to be installed. Carbon steel shall be the minimum acceptable body material.

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

(7) All pressure reducing valves in steam shall be of the single seated tight shutoff type.

(8) Double seated valves shall be top and bottom guided.

(9) Full bored stellited seat, full-faced stellited plug and guides, or approved equal, shall be furnished for steam pressure reducing, feedwater and flushing condensate.

(10) Control valves shall be equipped with an actuater capable of opening and closing the valve against full upstream pressure with full vacuum on the downstream side.

(11) Control valve connection to piping shall be by means welding, except for air and low pressure water.

(12) All control valves for modulating control shall have a positioner unit.

(13) Control valves welded in piping shall be of a design to permit removal of plugs and seats without removing the control valve from the line.

(14) Air supply for power actuator shall be as follows, unless otherwise specified.

Air supply pressure 7 kg/cm^2g

(15) Major control valves shall have an air-failure lock system.

(16) Hand wheel operator and stem travel indicator shall be furnished with each control valve.

(17) All control valves shall be sized for a flow which includes an allowance of at least 20% excess over the expected normal maximum, unless otherwise specified.

(18) Solenoid valves shall be yoke or diaphragm mounted complete with interconnecting brass pipe or copper tubing between the solenoid valve, diaphragm and positioner.

(19) Solenoid valves shall have brass bodies and soft seats to ensure tight shutoff.

3.1.10 CONTROL DRIVE

(1) Control drives shall be of the pneumatic type and enclosed.

(2) Control drives for vanes and dampers shall be equipped with an air-failure locking system.

(3) Control drives for position control of regulating vanes, damper, etc., shall include positioner, an appropriate position transmitter and all other accessories required or desirable for use in conjunction with the selector station.

(4) Air supply for power actuator shall be the following, unless otherwise specified.

Air supply pressure 7 kg/cm^2g

(5) All control drives shall indlude the following integral features and accessories.

(a) Direct manual operation and access to the handwheel shall not require opening or removal of the enclosure.

(b) Position indicator located outside the cover in full view of the operator.

(c) Adjustable minimum and maximum stops.

(d) Device to accommodate interlock circuit where required.

(e) Supply shut off and bypass valve and air pressure filter regulator.

(6) Solenoid valves shall be mounted within the drive enclosure.

(7) Solenoid valves and space heaters, if required, shall be wired to a terminal block within the drive enclosure.

(8) All connecting linkage with necessary devices or drag links between the drive and the equipment to be operated (damper, vane, etc.) shall be furnished.

3.1.11 SOLENOID VALVE

(1) Solenoid valves shall be of adequate size to ensure proper operation.

(2) Solenoid valves shall have soft seats to ensure tight shut off.

(3) Material shall be suitable for service fluid.

(4) Solenoids shall have sufficient thermal capacity for continuous energization.

3.1.12 RECORDER

(1) Roll and zigzag strip chart recorders shall be provided.

(2) Strip chart type recorders shall be as follows.

(a) 100mm, 150mm and 250mm chart wide shall be acceptable.

(b) Chart speed of 25 mm per hour.

(c) Number of recorders shall be multi pens for the continuous recording, and shall have a maximum 24 points for periodical dot printing.

(d) An indicating scale for the point being printed.

(e) Chart shall be multicolored, and dot printing shall have "colored numbers".

(f) Minimum interval for periodical dot printing shall be 5 seconds per point.

(g) A cast aluminum case with gasketed door, black case finish and glass window with internal illumination shall be provided. (Internal illumination is not required for 100 mm chart recorder).

(h) Internal mounted (visible through glass) legend showing service function and color for each point shall be provided.

(3) All recorders shall be suitable for flush mounting on the vertical panel.

(4) Accuracy shall be within ±0.5% of range.

(5) Power supply is as follows.

AC 220V, 50 Hz

(6) Charts, ink, ink pad and lubricants shall be furnished with each recorder.

(7) Special tools for adjustment and maintenance shall be furnished with recorder.

(8) Temperature recorders using thermocouples shall include cold junction temperature compensaters.

3.1.13 RECEIVER INDICATOR

(1) Dial indicators shall be as follows.

(a) 100 mm or 150 mm dial.

(b) Signal range: 0.2 - 1.0 kg/cm^2g

4 - 20 mA

1 - 5 V

(c) White dial with black figure, graduation and pointer.

(2) Vertical scale indicators shall be as follows.

(a) Signal range: 0.2 - 1.0 kg/cm^2g

4 - 20 mA

1 - 5 V

(b) White scale with black figure, graduation and pointer.

(3) The cases, mounting rings, bezels, etc., of all devices mounted on the panel surface shall be black in color.

(4) All indicators shall be suitable for flush mounting on the panel.

(5) All indicator accuracies shall be within $\pm$1.0% of range.

3.2 PRIMARY PIPING FOR INSTRUMENTATION

This specification is intended to standardize design basis, material selection and type of primary piping for instrumentation of the plant to improve reliability and to minimize maintenance requirements.

The "primary piping" includes valves, pipes, tubes, fittings, reservoirs, snubbers, hangers, supports and other necessary accessories required for connection of taps on main piping and instruments.

3.2.1 GENERAL REQUIREMENTS

(1) Primary piping bends shall be formed either by hot annealed bending method or by a pipe bender, except for pipes inside or around panels, which shall use elbows for bends.

(2) Minimum gradient (slope) of 1/12 shall be given to horizontal portions of primary piping.

(3) Sufficient provision for expansion shall be taken into consideration for a piping to absorb movement of main pipe and thermal expansion of primary piping while pipe undergoes blow out.

(4) Maximum distance between adjoining pipe supports shall be 1.5 m or less, except for pipe laid in ceilings or installed vertically.

Attention shall be given to properly distribute fixed and sliding supports over the pipe length so as to absorb expansion while the pipe undergoes blow out.

(5) All primary piping shall have blow out piping, except for those containing fuel oil and lubricating oil.
A screwed pipe thread (PT) plug shall be installed after blow valves.

(6) Blow pipe and a drain collector shall be arranged so that all drain is effectively collected to eliminate danger to operation personnel.

(7) One or more coats of anti-corrosive paint and one or more finishing coats of heat resistant silver paint shall be applied to primary piping.

(8) Primary piping for residual oil piping shall be provided with an oil separator, and shall be filled with ethyleneglycol to prevent corrosion residual oil from becoming solidified.

(9) Two series connected valves shall be provided as a root valve or as a blow valve for a primary piping whose main line has a design pressure equal to or higher than cold reheat steam pressure.

(10) The following provisions shall be made to prevent thermal shock in main line due to reverse flow of cooled drain in primary piping.

(a) Provision of tap on the side of a main pipe and application of thermal insulation on the portion of primary piping connecting a tap and a root valve.

(b) If temperature of fluid in main pipe is higher than 450°C, a portion of primary piping within 600 mm from the tap shall be laid along a main pipe, and both primary piping and main pipe shall be insulated togeter.

(c) If an instrument is located higher than the detection tap, primary piping connecting the tap to the instrument shall be lowered to form a loop seal before it reaches the instruments.

Note: Item (b) above shall be applied for a mercury type differential pressure gauge and for a flow meter. However, it may be omitted, if necessary, for instruments in which fluid in the primary pipe does not move such as pressure gauge or diaphragm type flow meter.

(11) A maximum three (3) branches from a tap is permitted, as a rule.

The tap of two values connected in series and used as a root valve, may be used in common for all branches except for valves serving as unit interlocks.

(12) A test tee shall be furnished for major pressure transmitter, flow transmitter, water level transmitter and differential pressure transmitter.

(13) A snubber, dampener or absorber shall be furnished for the detecting points where severe vibration is expected such as in the vicinity of pump discharge or where severe change in pressure of fluid occurs.

(14) A stop valve at the inlet of the instrument shall be provided for all instruments. However, in the case of primary piping having a length smaller than 1.5 m, a root valve and a stop valve may be used in common.

3.2.2 PRESSURE DETECTION PIPING

(1) The capillary tube shall be used for the pressure transmitter and pressure controller.

(2) The dampener or a snubber shall be furnished for the detecting point, where if necessary, such as in the vicinity of the pump discharge.

(3) A loop seal or a siphon shall be furnished for the pressure gauge or the pressure test tap directly mounted on a pipe if temperature of steam or fluid inside exceed 100°C.

(4) The connector for the pressure gauge shall be of reversed thread type, and that for the test tap shall be provided with plug. However, no connector is required if a siphon with union is used.

(5) The drain pot shall be furnished for the condenser vacuum detection pipe so that the pipe can be drained while the plant is in operation.

(6) The pressure detection tap of superheated steam piping shall be located on the side of the pipe, as a rule.

3.2.3 DIFFERENTIAL PRESSURE DETECTION PIPING (FLOW AND LEVEL)

(1) Care shall be taken to make temperature of primary piping on high pressure side and that on low pressure side equal.

(2) A reservoir shall be furnished on primary pipe line between the tap valve and the instrument if the fluid is steam or water having a temperature of 120°C or higher, except for diaphragm type differential pressure detector, bellows type differential pressure detector and a bourdon tube type differential pressure detector.

(3) Diameter of primary pipe for mercury type instrument shall be of size 20 mm (3/4B) or 25 mm (1B) to eliminate time delay in longer piping.

3.2.4 DRAFT DETECTION PIPING

(1) The draft detection pipe shall be 20 mm (3/4B) SGP white, and connection between pipes shall be made by socket weld, as a rule.

(2) A purge set shall be furnished for piping of the furnace and flue gas ducts.

(3) The detecting end of piping shall have a vertical portion of at least 2 m to prevent intrusion of ash into the pipe.

(4) An expansion provision shall be furnished to absorb movement of detection tap due to thermal expansion of the furnace wall, and a duct shall be providece to absorb vibration. Care shall be taken not to form a drain pocket in the expansion provision.

(5) Care shall be taken not to form a drain pocket or a low portion where drain is caught in the primary pipe line. Pipe of 500 mm or longer with plug at the end to contain drain shall be furnished at the lowest point, in case formation of lowest portion is unavoidable.

(6) Detecting tap shall be 50 mm (2B) stainless steel pipe.

3.2.5 MATERIAL SELECTION STANDARD OF PRIMARY PIPING

(1) A pipe connecting a root valve and an instrument stop valve shall be not less than 15 mm (1/2B) in size, as a rule.

(2) Size of detection tap and root valve to be used for main pipe, whose design pressure is either 60 kg/cm^2g or higher, or 425°C or higher, shall be 25 mm (1B) in size.

(3) Design condition of materials to be used for a primary piping shall be as follows.

(a) Water and steam system

o From detection tap to root valve including reservoir	Same design condition as a main pipe

o From root valve or reservoir to blow valve, and instrument stop valve, including plug after blow valve	Pressure: same as a main pipe Temperature: Design temperature of main pipe minus 25°C
o Root valve	Same design pressure and temperature as main pipe
o Blow valve	For steam ... Same design pressure as main pipe and saturation temperature for that pressure or critical temperature For water .... Same design pressure and temperature as main pipe
o Instrument stop valve.	Same as a blow valve
o Connector	Same design condition as pipe

(b) Heavy fuel oil system

o From a detection tap to an oil separator including an oil separator itself	Same design condition as main pipe
o From oil separator to instrument stop valve	Same design pressure as main pipe and ambient temperature
o Root valve	Same design pressure and temperature as main pipe
o Instrument stop valve	Same design pressure as main pipe and ambient temperature
o Connector	Same design condition as pipe

(c) Air system, diesel oil system and lubricating oil system

Same pressure and temperature as main pipe.

(4) Test tee shall have its own plug.

(5) A globe type 15 mm (1/2B) socket weld (SW) steel valve shall be used an instrument stop valve and for blow valve.

(6) A tie of 15 mm (1/2B) SW shall be used in pipe, as a rule.

(7) Tube fitting shall be of the grip type (Swagelok type or equivalent)

(8) Standard tube outer diameter and thickness shall be as follows, all tubes shall be of annealed material.

Copper Tube

working Pressure	Less than 35 kg/cm^2g	35 - 70 kg/cm^2g	70 - 100 kg/cm^2g	100 - 140 kg/cm^2g
Tube Outer Diameter	(500 psig)	(1,000 psig)	(1,500 psig)	(2,000 psig)
6.0 mm	1.0 mm	1.0 mm	1.2 mm	Cannot be used
10.0 mm	1.0 mm	1.2 mm	Cannot be used	Cannot be used
12.0 mm	1.2 mm	1.8 mm	Cannot be used	Cannot be used

Stainless Tube

Working Pressure	Less than 35 kg/cm^2g	35 - 70 kg/cm^2g	70 - 100 kg/cm^2g	100 - 140 kg/cm^2g
Tube Outer Diameter	(500 psig)	(1,000 psig)	(1,500 psig)	(2,000 psig)
6.35 mm	0.9 mm	0.9 mm	0.9 mm	0.9 mm
9.53 mm	0.9 mm	0.9 mm	0.9 mm	0.9 mm
12.7 mm	0.9 mm	0.9 mm	0.9 mm	1.25 mm

Working Pressure	35 - 70 kg/cm^2g	175 - 200 kg/cm^2g	200 - 280 kg/cm^2g
Tube Outer Diameter	(2,500 psig)	(3,000 psig)	(4,000 psig)
6.35 mm	0.9 mm	0.9 mm	1.25 mm
9.53 mm	1.5 mm	1.5 mm	Capillary tube
12.7 mm	1.85 mm	1.85 mm	Capillary tube

(9) For selection of material of primary pipe under each design condition, refer to Fig. 1 and Fig. 2 attached hereto.

Fig. 1 Piping Material - 1

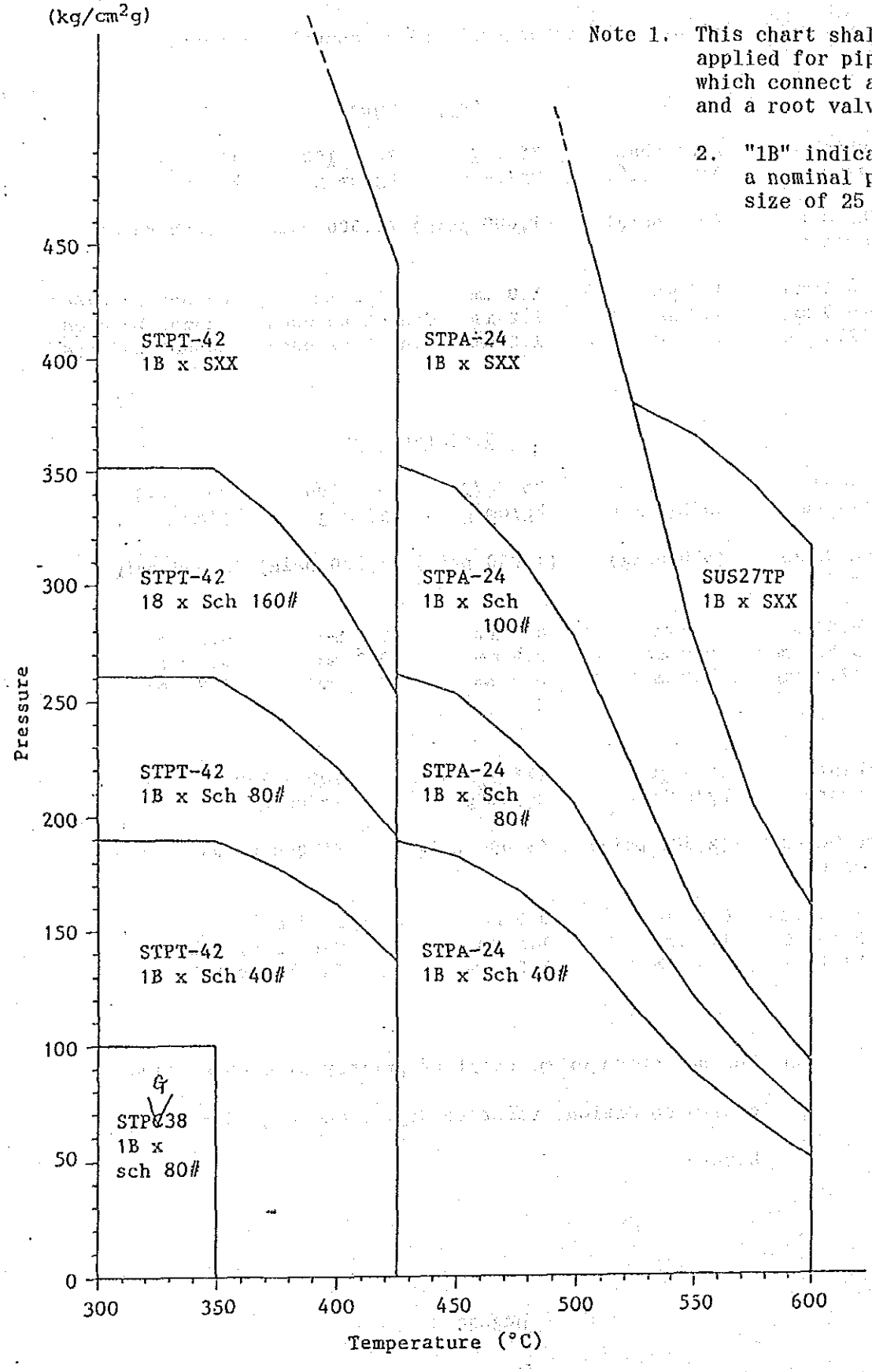


Fig. 2 Piping Material - 2

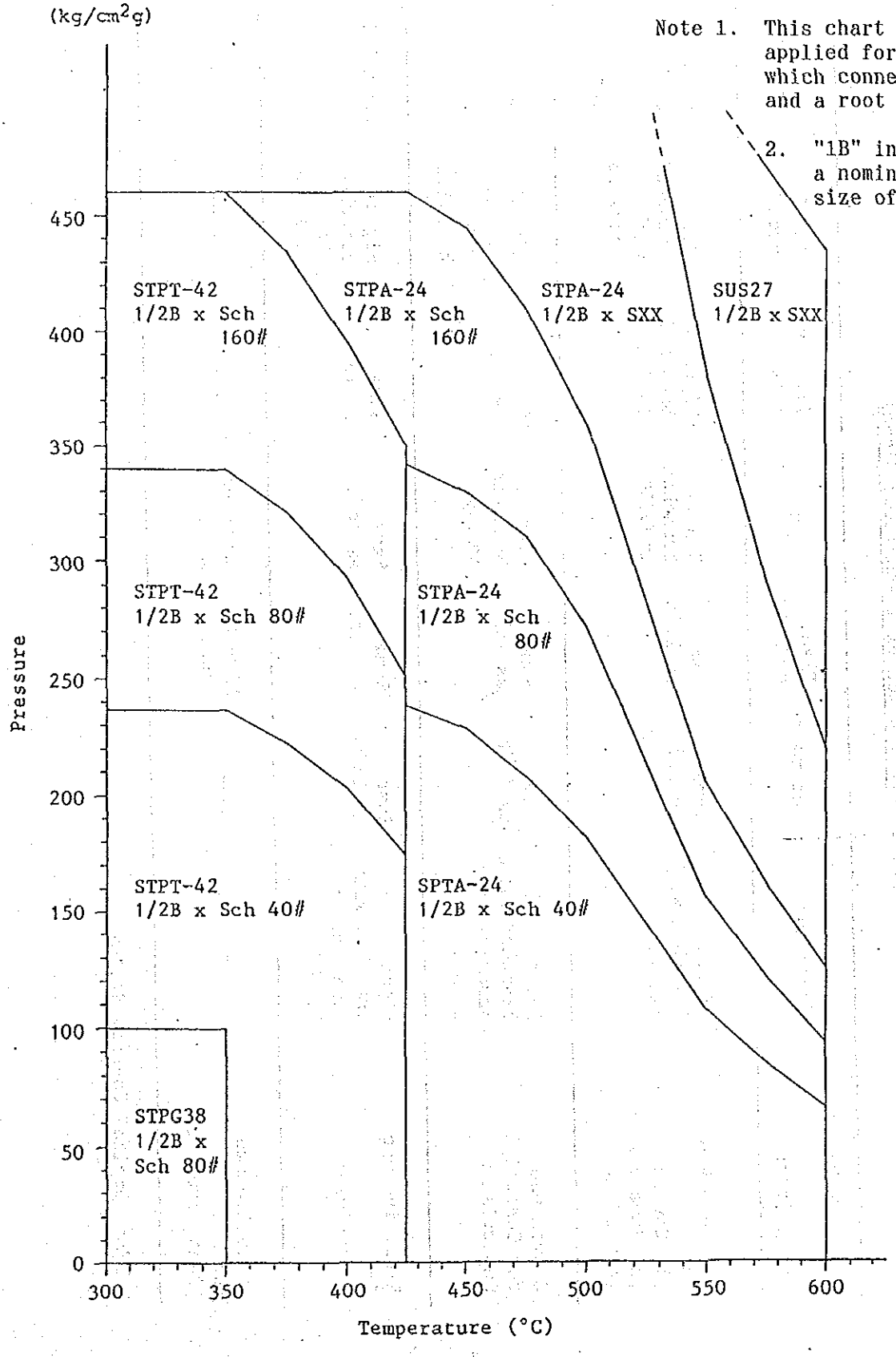
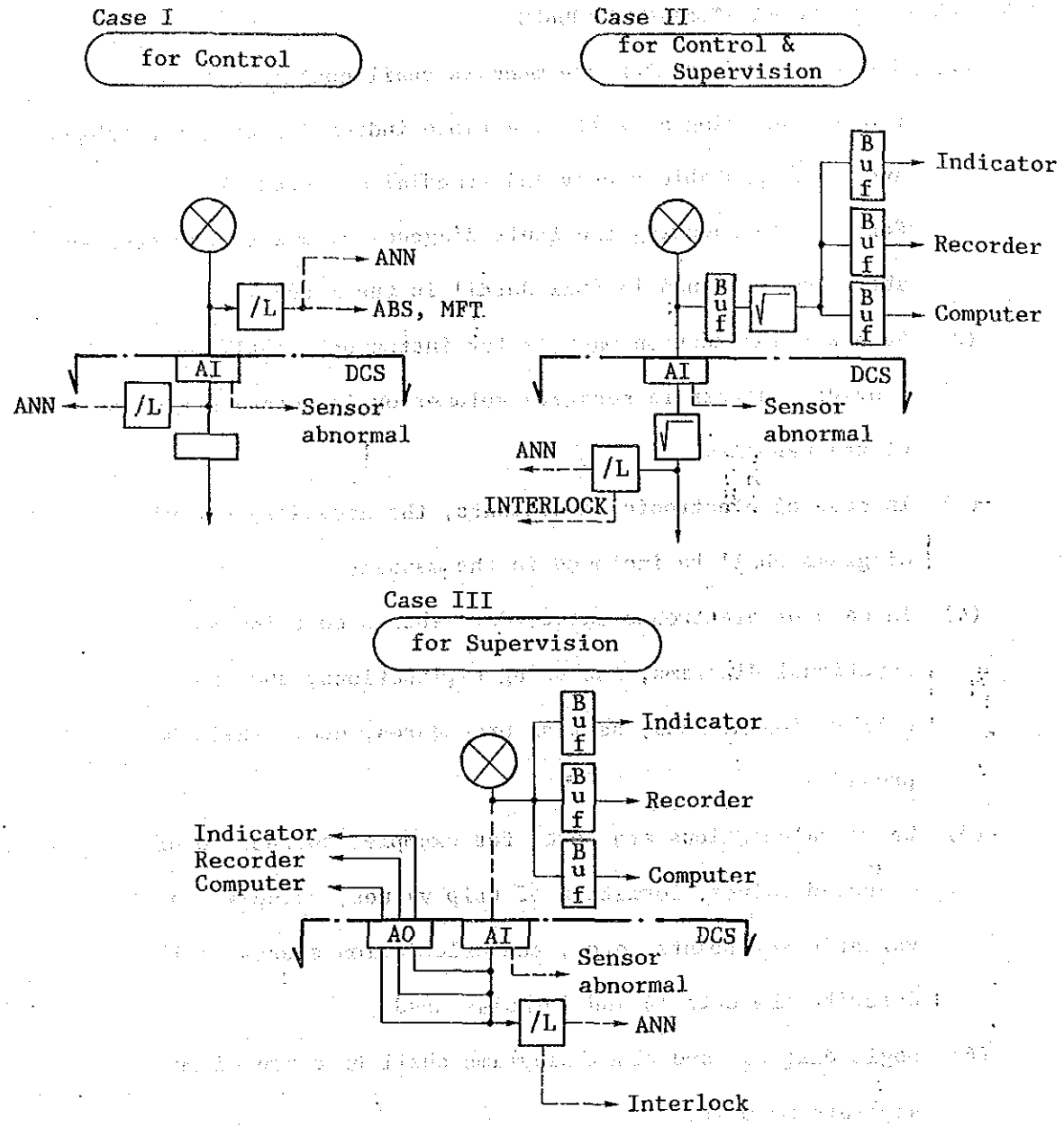


Fig. 3 Application of Transmitter Signal

Receiver / Transmitter	Indicator	Recorder	Plant computer	ANN	Process interlock	ANN & protection	Remarks
Separate use for: 1 Control 2 Supervision (4 - 20 mA)	Signal branched with hardwire	Same as left	Same as left	Signal branched in DCS*	Signal branched in DCS	Signal branched with hardwire	Case I or III
Common use for Control & Supervision	Signal with branched with hardwire or in DCS	Same as left	Same as left	Signal branched in DCS	Same as left	Signal branched with hardwire	Case II
Exclusive use for Supervision	Signal branched with hardwire or in DCS	Same as left	Same as left	Same as left	Same as left	Signal branched with hardwire	Case III
Exclusive use for plant computer	———	———	Direct input	Computer output	———	———	———

* DCS: Digital Control System



Notes: The ⊗ mark indicates sensor or signal source

Dual Sensor for Control System

1. MW transducer
2. Frequency converter
3. Drum level transmitter
4. Master pressure transmitter
5. 1st stage pressure transmitter

3.3 OPERATION AND MAINTENANCE MANUALS

(1) Operation and maintenance manuals shall contain methods of trouble-shooting as well as a table indicating common troubles and their probable causes and remedial measures.
For trouble-shooting and fault diagonosis, all error messages shall be explained in full detail in the manuals.

(2) Separate instruction manuals for instruments shall be provided, either in separate volumes or in separate sections of the manuals.

(3) In case of electronic instruments, the necessary circuit diagrams shall be included in the manuals.

(4) In case of electronic cards, data sheets covering the functional diagrams, including explanations, such as, calibration methods, setting procedures, etc., shall be provided.

(5) Where calculations are done, for example, correction of measured values, formation of trip values, calculation of variable set points, etc., the calculation sheets shall describe the details and formulas used.

(6) Logic diagrams and block diagrams shall be arranged in separate manuals.

(7) Wiring diagrams, measurement diagrams, measurement lists, cable lists, terminal lists, marshalling details and lists, etc., shall be submitted as heading drawings.