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SYSTEM DESCRIPTION FOR ROSA-IV
TWO-PHASE FLOW TEST FACILITY
(TPTF)

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System Description for ROSA-IV
Two-Phase Flow Test Facility (TPTF)

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This report describes system of the Two-Phase Flow Test Facility (TPTF) and its instrumentation. The information is necessary to understand and analyze the separate-effect experimental data for light water reactors obtained from the TPTF thermohydraulic experiments under two-phase flow conditions at steady state.

Keywords: SBLOCA, LWR, ROSA-IV, Two-Phase Flow Heat Transfer, System Description, Instrumentation.

T P T F (小型定常二相流試験装置) の概要

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軽水炉の二相流現象を解明するための分離効果実験装置である T P T F (小型定常二相流試験装置) の概要と計測についてまとめたものである。本稿の内容は、実験データの理解および解析のため不可欠である。

CONTENTS

1. Introduction	1
1.1 ROSA-IV Program	1
1.2 Design Phylosophy of TPTF	1
2. Experimental Facility	4
2.1 General System Arrangement	4
2.2 Pressure Vessel	5
2.3 Fuel Assembly	5
2.4 Horizontal Pipe Test Section	8
2.5 Pumps	8
2.6 Steam Drum and Air Condenser	8
3. Instrumentation	10
3.1 Physical Quantities and Methods of Measurements	10
3.1.1 Pressure	10
3.1.2 Differential Pressure	10
3.1.3 Temperature	11
3.1.4 Fluid Flow Rate	11
3.1.5 Liquid Level	12
3.1.6 Power Supply	12
3.1.7 Data Acquisition System	13
3.1.8 Two-phase Flow Instruments of Horizontal Pipe Test Section	13
3.2 Instrument Locations	14
Acknowledgement	15
References	15
Tables and Figures	16

目 次

1. 序	1
1.1 ROSA - IV 計画	1
1.2 TPTF の設計方針	1
2. 実験装置	4
2.1 全体配置	4
2.2 圧力容器	5
2.3 燃料集合体	5
2.4 水平管試験部	8
2.5 ポンプ	8
2.6 蒸気ドラムおよび空冷凝縮機	8
3. 計 装	10
3.1 測定項目および測定方法	10
3.1.1 圧 力	10
3.1.2 差 圧	10
3.1.3 溫 度	11
3.1.4 流体流量	11
3.1.5 水 位	12
3.1.6 電 力	12
3.1.7 データ収録装置	13
3.1.8 水平管試験部での二相流計装	13
3.2 計測位置	14
謝 辞	15
参考文献	15
図 表	16

List of Tables

Table 1. 1	Flow Rates through Test Section of TPTF at 12MPa
Table 2. 1	Major Specifications of Pressure Vessel
Table 2. 2(a)	Major Specifications of Fuel Assembly A
Table 2. 2(b)	Major Specifications of Fuel Assembly B
Table 2. 3	Major Specifications of Horizontal Pipe Test Section
Table 2. 4	Major Specifications of Steam Pump
Table 2. 5	Major Specifications of Circulation Pump
Table 2. 6	Major Specifications of Steam Drum
Table 2. 7	Major Specifications of Air Condenser
Table 3. 1	Specifications and Performance of Electronic Pressure Transmitters
Table 3. 2	Specifications and Performance of Electronic High Pressure DP Transmitters
Table 3. 3	Thermocouple Specifications
Table 3. 4(a)	Specifications and Calculations of Orifices to Measure High Range Liquid Flow (FE-1-A and FE-1-B)
Table 3. 4(b)	Specifications and Calculations of Orifices to Measure Low Range Liquid Flow (FE-101-A and FE-101-B)
Table 3. 5(a)	Specifications and Calculations of Orifices to Measure High Range Steam Flow (FE-2)
Table 3. 5(b)	Specifications and Calculations of Orifices to Measure Low Range Steam Flow (FE-102-A and FE-102-B)
Table 3. 6	Major Specifications and Performance of Data Logger (DA-8500)
Table 3. 7(a)	Specifications and Performance of DC Amplifiers for Temperature Measurement Systems (6B06YD)
Table 3. 7(b)	Specifications and Performance of DC Amplifiers for Conduction Probes (6L71YP)
Table 3. 7(c)	Specifications and Performance of DC Amplifiers for Pressure, Differential Pressure, Flow and Fuel Assemblies Power Measurement Systems (6B06, WDA-103)
Table 3. 8	Specifications and Performance of Electronic Temperature Transducers
Table 3. 9	Specifications of Signal Distributer
Table 3.10	Specifications of Signal Isolater
Table 3.11	Specifications of Electric Zero Contact (Microfreezer)
Table 3.12	TPTF Measurement List

- Table 3.13 Major Specifications of Pitot Tube
- Table 3.14(a) Major Specifications of
Traversing Beam Type Three-beam γ -Densitometer
- Table 3.14(b) Major Specifications of
Fixed Beam Type Three-beam γ -Densitometer
- Table 3.15 Major Specifications of
Full-flow Type Drag Screen Flow Meter

List of Figures

- Figure 2. 1 Flow Diagram of TPTF
 Figure 2. 2 Isometric Drawing of TPTF
 Figure 2. 3 Plan View of TPTF (FL + 0)
 Figure 2. 4 Plan View of TPTF (FL + 3000)
 Figure 2. 5 Plan View of TPTF (FL + 6000)
 Figure 2. 6 Plan View of TPTF (FL + 9000)
 Figure 2. 7 Section View of TPTF (View A-A)
 Figure 2. 8 Section View of TPTF (View B-B)
 Figure 2. 9 Electrical Equipment Layout of TPTF
 Figure 2.10 Pressure Vessel (PV-101)
 Figure 2.11 Pressure Vessel Mixer (MX-102)
 Figure 2.12 Fuel Assembly and Pressure Vessel
 Figure 2.13 Simulated Fuel Rod of TPTF
 Figure 2.14(a) Axial Power Distribution of Heater Rod of
 Fuel Assembly A
 Figure 2.14(b) Axial Power Distribution of Heater Rod of
 Fuel Assembly B
 Figure 2.15 Fuel Assembly Spacer
 Figure 2.16 Fuel Assembly Tie Plate
 Figure 2.17 Fuel Assembly Lower Support
 Figure 2.18 Fuel Assembly Upper Support
 Figure 2.19 Fuel Assembly Set Flange
 Figure 2.20 Fuel Assembly Instrumentation
 Figure 2.21 Installation of Thermocouples for
 Channel Box Fluid Temperature Measurement
 Figure 2.22 Channel Box Wall Instrumentation
 Figure 2.23 Dummy Heater
 Figure 2.24 Horizontal Pipe Test Section (TS-3)
 Figure 2.25(a) Horizontal Pipe Test Section Mixer (MX-2)
 Figure 2.25(b) Mixer 1
 Figure 2.26 Horizontal Pipe Test Section Sight Glass
 Figure 2.27 Steam Pump (SP-2)
 Figure 2.28 Circulation Pump (CP-1)
 Figure 2.29 Steam Drum (SD-1)
 Figure 2.30 Steam Drum Heater (SDH-1-A,B,C)
 Figure 2.31 Air Condenser

- Figure 3. 1 Pressure and Differential Pressure Measurement System Block Diagram
- Figure 3. 2 Temperature Measurement System Block Diagram
- Figure 3. 3(a) Liquid Flow Rate Orifice Sizes
- Figure 3. 3(b) Steam Flow Rate Orifice Sizes
- Figure 3. 4(a) Liquid Flow Rate Measurement System Block Diagram
- Figure 3. 4(b) Steam Flow Rate Measurement System Block Diagram
- Figure 3. 5 Mixture Level Measurement System Block Diagram
- Figure 3. 6(a) Fuel Assembly Power Supply Block Diagram
- Figure 3. 6(b) Steam Drum Heater (A),(B),(C) Power Supply Block Diagram
- Figure 3. 7 Schematic of Two-Phase Flow Instrument Arrangement in Horizontal Pipe Test Section
- Figure 3. 8 TPTF Instrumentation Location

1. Introduction

1.1 ROSA-IV Program

A great deal of attention has been centered on small break loss-of-coolant accidents (SBLOCAs) and anticipated operational transients since the TMI-2 accident⁽¹⁾. The Japan Atomic Energy Research Institute (JAERI) has started the Rig of Safety Assessment Number 4 (ROSA-IV) program for studying SBLOCAs and anticipated operational transients.

ROSA-IV program⁽²⁾ is consisted of three features. They are the system effect tests with the large scale test facility (LSTF)⁽³⁾, the separate effect tests with the two-phase flow test facility (TPTF) and the development of a SBLOCA analysis code using the test data from LSTF and TPTF. At present, LSTF is under construction which simulates a large pressurized water reactor (LPWR) of 3423 MWe and construction is scheduled to be completed in 1984.

1.2 Design Philosophy of TPTF

The primary objectives of TPTF test are to obtain the fundamental data on the thermalhydraulic behavior which occurs in LPWR components including the core, the steam generator (SG) and the horizontal and vertical pipes. The test data are used for computer code development for a SBLOCA and an operational transient. The technical subjects which will be investigated in TPTF are:

- (1) Heat transfer in uncovered core
 - a. Heat transfer in low flow rate region
 - b. Steam cooling with moisture and flow
 - c. Natural convection heat transfer by stagnant steam
- (2) Two phase flow in horizontal pipe

- a. Slug and stratified flow in a horizontal hot leg
- (3) Heat transfer in SG
- a. Steam condensation and counter current flow limiting (CCFL) in SG primary side
 - b. Liquid level effect on heat transfer in SG secondary side
 - c. Effect of location of auxiliary feedwater (FW) inlet
- (4) Calibration of two-phase flow instruments to be used in LSTF
- For these purposes, the design philosophy and the primary characteristics of TPTF were fixed as follows.
- (1) To achieve the two-phase fluid condition in a LPWR the maximum operating pressure and temperature of TPTF are 12 MPa and 598K, respectivery.
 - (2) Saturated steam and water are generated in the steam drum and supplied separately by a steam pump and a circulation pump to the mixer at the inlet of the test section, the desired two-phase flow conditions such as flow rate and the quality at the inlet of test section can be achieved by controlling the saturated steam and water flow rate separately. The two-phase fluid returns to the original steam drum after testing to manitain steady state test conditions.
 - (3) The minimum and the maximum flow rates in the holizontal pipe test section for the hot-leg two-phase flow test and the vertical pressure vessel test section for the core heat transfer test are given in Table 1.1. These values were decided to fulfill the low flow vate conditions in a horizontal pipe and core of a PWR during a SBLOCA.
 - (4) The hot leg diameter of LSTF is approximately one third of that of a PWR, therefore, the two-phase flow conditions in the hot leg of LSTF can be considered to be representative of those of a PWR. The inner diameter of the horizontal pipe test section of TPTF is same as that of the hot leg (HL) of LSTF, therefore, the two-phase flow conditions in the HL of LSTF can be clarified in TPTF spearate effect test.

(5) The heat flux can be varied between 0 and 82W/cm² at the surface of the heater rod installed in the vertical pressure vessel test section of TPTF and it can simulate the steady state heat flux in the core of a PWR.

The heater rod is heated by indirect electrical heating.

At present, the vertical pressure vessel with the fuel assembly for the heat transfer test in the core and the horizontal pipe test section are attached to the loop. A SG test assembly will be added in the future.

The test data are obtained under steady state fluid condition to increase the accuracy of the test data.

This report gives the specifications of TPTF for analyzing the test data from TPTF.

2. Experimental Facility

2.1 General System Arrangement

The flow diagram of TPTF is shown in Fig. 2.1. Water in the steam drum is heated to produce high temperature, high pressure steam and water.

When the two-phase flow pattern in a horizontal pipe is to be investigated or instruments for two-phase flow are to be calibrated, steam is fed to the mixer, MX-2, by the steam pump, SP-2, and water is pumped to the mixer by the circulation pump, CP-1. The water and steam flow rates are adjusted to give the desired two-phase fluid mixture quality at the outlet of the mixer. After passing through the horizontal pipe (test section TS-3) the fluid returns to the steam drum.

When heat transfer in the core is to be investigated, steam and water from the steam drum are sent to the mixer, MX-102, by the steam pump, SP-2, and the circulation pump, CP-1. The water and steam flow rates are adjusted to give the desired two-phase fluid mixture quality at the outlet of the mixer. The fluid then flows into the pressure vessel, PV-101, where heat transfer in a core subjected to two-phase fluid conditions is investigated. The fluid then returns to the steam drum after leaving the pressure vessel.

In the future, the test section, TS-3, will be replaced by the steam generator test assembly to study heat transfer under two-phase fluid conditions.

A water treatment system will also be supplied for TPTF. Figure 2.2 is an isometric drawing of TPTF and the length of each pipe is shown in the figure. Figures 2.3 through 2.6 are plan views of TPTF floors while Figs. 2.7 and 2.8 are section views of TPTF. Figure 2.9 shows the electrical equipment layout.

2.2 Pressure Vessel

Figure 2.10 shows the pressure vessel which will be used for the investigation of heat transfer in a core under two-phase fluid conditions. A 5x5 fuel bundle will be inserted in the pressure vessel and the mixer is to be installed just upstream of the pressure vessel. Water flows into the mixer through nozzle N-2 and steam flows into the mixer through nozzle N-3. Both fluids are combined in the mixer to give a two-phase fluid of the desired quality. The fluid then flows into the core where the heat transfer from a fuel pin can be investigated. (The details of the fuel assembly are described in Section 2.3.) After passing through the core the fluid flows out from nozzle N-3 and returns to the steam drum. Thermocouple locations for the fluid temperature and the fuel pin temperature measurements are shown in Section 2.3. The major specifications of the pressure vessel are given in Table 2.1.

Figure 2.11 shows the structure of the pressure vessel mixer MX-102. The mixer consists of 30 mixing tubes with holes on the surface and tie plates and a tie rod for supporting the mixing tubes. The steam from nozzle N-3 in Fig. 2.10 flows into the mixing tubes and out through the holes mixing with the water entering the mixer from nozzle N-2. Each tube has 16 holes with a 25mm pitch.

2.3 Fuel Assembly

Figures 2.12 to 2.22 show the structure of the TPTF fuel assembly. The fuel assembly inserted in the pressure vessel is shown in Fig. 2.12. The fuel assembly consists of 25 indirect electrically heated fuel rods installed in a channel box. The fuel rods are arrayed with a 16.16mm pitch and supported by the upper and lower tie plates and 9 spacers. Section view

AA shows the set flange through which the fuel rod and instrument leads exit from the pressure vessel. Section view BB shows the flow channels in the pressure vessel. The channel box with 25 fuel rods is fixed by supports to the pressure vessel shell. The fluid flows in the channel box but is stagnant in the region surrounding the channel box. Section view CC shows the arrangement of the fuel rods in the channel box.

Figure 2.13 shows a simulated fuel rod. Section view AA shows the cross section of the non-heating section of each fuel rod. The insulator used is MgO. Section view BB shows the cross section of the non-heating section just above the heating section. Section view CC shows the cross section of heating portion of the fuel rod. The core insulator for the heater element is sintered BN and the insulator between the heater element and the rod sheath is packed BN. Thermocouples to measure the fuel rod surface temperature are embedded in the sheath. The azimuthal orientation of the thermocouples is shown in this figure and axial location in the fuel assembly is shown in Fig. 2.20.

TPTF has two types of fuel assemblies. One is fuel assembly A which gives the flat axial power profile shown in Fig. 2.14(a) and another is fuel assembly B which gives the chopped cosine axial power profile shown in Fig. 2.14(b). The structure and the fuel rod of fuel assembly A are as same as those of fuel assembly B except for heater specification. The specifications for these two fuel assemblies are given in Tables 2.2 and 2.3, respectively.

Figure 2.15 shows the details of the spacer which is used in the TPTF fuel assemblies.

Figure 2.16 shows the tie plate of the TPTF fuel assemblies. There are four types of flow pathes in the TPTF fuel assembly tie plate. The total flow area of the tie plate is shown in Fig. 2.16.

Figure 2.17 shows the lower part of the pressure vessel. In the figure, ④ is a ground connection plate for support of fuel rods.

Figure 2.18 shows the upper part of the pressure vessel. Non-heating sections of the fuel rods and sleeves for instrument lead lines penetrate the upper tie plate and the set flange.

The set flange of the pressure vessel is shown in Fig. 2.19. A water-tight seal is made here by the sleeves which are installed around the fuel rods and instrument leads.

The locations of the thermocouples and conduction probe type void sensors in the pressure vessel are shown in Fig. 2.20. Ninety-nine thermocouples are installed on the fuel rod surfaces, forty thermocouples measure the fluid temperature, ten thermocouples measure the channel box surface temperature and twenty-four void probes are installed for water level measurement. The thermocouple is made of Chromel-Alumel (CA) and the measurement grade class is 0.4. Specifications of thermocouples are given in Table 3.3.

The details of the fluid temperature thermocouple installation are shown in Fig. 2.21. The protector for the thermocouple is held by the fuel assembly grid spacer, and the thermocouple is installed inside the protector. The top of the protector is plugged and the fluid flows into the protector through two holes on the protector surface. Measuring the fluid temperature inside the protector eliminates the effect of radiation from the surrounding structures.

Figure 2.22 shows the method of installing conduction-probe type void sensors on the channel box surface. The locations are shown in Fig. 2.20.

The dummy heaters shown in Fig. 2.23 are installed in the water pool outside the pressure vessel. They are necessary because the 25 fuel rods in the channel box are heated with a three phase electricity source. The heating capacity, and electrical resistance, of the dummy heater is same as that of a fuel rod in the channel box.

2.4 Horizontal Pipe Test Section

The horizontal pipe section is pictured in Fig. 2.24. The test section consists of five pipe components of 2m in length and made of 8B sch120 SUS304TPS and inlet mixer. In the future, the instrumentation needed to investigate the two-phase flow pattern in a horizontal pipe will be added to this test section. Also, the test assembly needed to calibrate two-phase flow instruments to be used in LSTF will be added. The major specifications are given in Table 2.4.

The inlet mixer to the horizontal pipe test section is shown in Fig. 2.25. The mixer consists of fifty-four mixing tubes and their associated support structures. Each tube has twenty holes with a 25mm pitch. The steam flows out through the holes mixing with the water.

Figure 2.26 shows the sight glass on the horizontal pipe test section. It will enable visual observation of two-phase flow pattern in the pipe.

2.5 Pumps

Figure 2.27 shows the steam pump. It was developed for TPTF so that the high flow rate steam could be transported at high pressure and temperature. The specifications are given in Table 2.5. The water circulation pump is shown in Fig. 2.28. The specifications are given in Table 2.6.

2.6 Steam Drum and Air Condenser

The steam drum is shown in Fig. 2.29. Heaters are installed in the drum to heat-up the water and steam in it. The water is drawn out through nozzle N-2 by the circulation pump. The steam flows out to the steam pump

and the test section through the demister and nozzles N-1 and N-5. The specifications are given in Table 2.7.

Figure 2.30 shows the steam drum heater. It has 52 heater pins. The arrangement of the heater pins and the support rods is show in the section view CC.

Figure 2.31 shows the air condenser. It is used to provide a heat sink for the system to enable it to operate at steady state.

3. Instrumentation

3.1 Physical Quantities and Methods of Measurements

In this section, measurement parameters and methods to obtain thermal-hydraulic information are presented. Each data is measured by the instrument, converted to a voltage and recorded on magnetic tape by data acquisition system (DA-8500).

3.1.1 Pressure

Pressures at the inlet and outlet of both the pressure vessel and the horizontal test section and the inlets of the steam and liquid flow meters are measured by electronic pressure transmitters. Specifications of these transmitters are given in Table 3.1. A block diagram of the pressure measurement systems is shown in Fig. 3.1.

3.1.2 Differential Pressure

Differential pressure between the inlet and outlet of both the pressure vessel and the horizontal test section and across the orifices used to obtain steam and liquid flow rates are also measured by electronic pressure transmitters. The liquid head in the steam drum is measured, but not recorded, in order to control the drum liquid level. Specifications of these transmitters are given in Table 3.2. A block diagram of the differential pressure measurement systems is shown in Fig. 3.1.

3.1.3 Temperature

Fluid and wall surface temperatures are measured by SUS or inconel sheathed CA thermocouples. Thermocouple signals are processed in two ways;

- a) obtaining a thermoelectromotive force directly through zero contacts inserted in an electronic zero contact apparatus (microfreezer)
- b) obtaining temperature value by an electronic temperature transducer.

The former is applied to data recorded by the DA-8500 and the latter is applied to process systems either measuring liquid or steam flow rates or controlling the liquid level in the steam drum. The same materials as the CA thermocouple are used as the compensation lead wires for the fuel assembly heater thermocouples so as to suppress the increase of error. Figures 2.20, 2.21 and 2.22 show the instrumentation of the fuel assembly. Specifications of the thermocouples are given in Table 3.3. A block diagram of the temperature recording systems is shown in Fig. 3.2.

3.1.4 Fluid Flow Rate

Liquid and steam flow rates through circulation pump CP-1 and steam pump SP-2 are measured independently by means of a process computing system (HOMAC 500 Series) using differential pressures across orifices, fluid temperatures and pressures. Two orifices can be selected and installed in the measuring sections for the low range and high range flows to achieve the desired experimental flow rate. Information such as fluid temperatures, used to obtain fluid flow rates, as well as fluid flow rate data, are also recorded by the DA-8500. This is necessary since the liquid passing through the measuring section is saturated or slightly subcooled due to heat loss and the steam passing through the measuring section will be slightly

superheated by the steam pump head. To obtain the fluid condition at the outlet of the mixers, used on the pressure vessel and the horizontal test section, the heat loss between orifice and mixer should be measured for both the liquid and steam piping systems. Specification of these orifices are given in Fig. 3.3 and Tables 3.4 and 3.5. A block diagram of the flow rate measurement system is shown in Fig. 3.4.

3.1.5 Liquid Level

Conduction probes are installed on the channel box wall surface of the fuel assembly as shown in Fig. 2.22. Conduction probes give an ON signal when covered with liquid and OFF signal when covered with steam. These ON-OFF signals will be used to determine whether liquid is present or not. When probes are exposed to two-phase flows frequent oscillations between ON and OFF signals are obtained. A block diagram of the channel box liquid level measurement system is shown in Fig. 3.5.

Liquid level in the steam drum is measured (but not recorded) by the water head in the steam drum.

3.1.6 Power Supply

The power supplies for the fuel assembly, the steam drum heater, the circulation pump and the steam pump are independently controlled by Silicon Controlled Rectifier (SCR) and only the input power to the fuel assembly is recorded. Power supplied to the fuel assembly has a digital power set-up system to control the input power with the step-wise incremented of 1kW. The SCR power control system for the steam drum heater has the air condenser as a heat sink. Power to the steam drum heater, the circulation pump and the steam pump can also be controlled manually to an arbitrary power level.

Block diagrams of the power supply systems for the fuel assembly and the steam drum heater are shown in Figs. 3.6 (a) and (b), respectively.

3.1.7 Data Acquisition System

Measured data are converted to a voltage (2~10 V DC and 0~10 V DC) by various sensors and DC amplifiers before the input of the data logger (DA-8500). Thereafter, analog voltage data is converted to digital data and recorded on magnetic tape in the data logger. The experimental data recorded on magnetic tape are processed by the FACOM system computer in JAERI. Specifications of the data logger (DA-8500), DC amplifiers and other electronic devices used for data acquisition are given in Tables 3.6 through 3.11. Table 3.12 is a measurement list with the estimated accuracy of the data recorded on the magnetic tape.

3.1.8 Two-phase Flow Instruments of Horizontal Pipe Test Section

Fluid flow conditions in the horizontal piping, mainly flow pattern and interphasial drag of the two-phase flow, will be investigated with various two-phase flow instruments. Some of the devices to be mentioned below are still in the developmental stage. These instruments are located in the 2m pipe sections which are connected by Gray Locks to form a 10m horizontal pipe test section.

A Pitot tube and a correlation flow meter are used to measure the liquid and steam velocities. Five point CPT (conductivity probe with thermocouple) rakes and three-beam γ -densitometers (one fixed beam type and two traversing beam type) will be used to measure the liquid levels and the fluid density. The full-flow type drag screen flow meter combined with the fixed three-beam γ -densitometer is used to measure the mass flow rate in the pipe. A pair of

sight glasses installed perpendicularly to the pipe horizontal axis are used to observe directly the two-phase flow pattern. The schematics of device arrangement are shown in Fig. 3.7. Major specifications of the Pitot tube, γ -densitometers and the full-flow drag screen flow meter are given in Tables 3.13 through 3.15.

3.2 Instrument Locations

Figure 3.8 shows the instrument locations for TPTF. Symbols in the open circles correspond to those written in the measurement list of Table 3.12.

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Table 1. 1 Flow Rates through Test Section of TPTF at 12MPa

Test Section		Horizontal Pipe Test Section	Vertical Pressure Vessel
Steam flow rate	Min.	150.0 m ³ /h	2.86 m ³ /h
	Max.	700.0 m ³ /h	58.60 m ³ /h
Liquid flow rate	Min.	30.0 m ³ /h	0.305 m ³ /h
	Max.	170.0 m ³ /h	6.260 m ³ /h
ΔP^*		0.098 MPa	0.118 MPa
Remarks		Max. flow rates are same as that of the rated value of the pumps	Max. total mass flux $10^6 \text{ kg/m}^2\text{h}$

* Differential pressure between the inlet and the outlet of the test section

Table 2.1 Major Specifications of Pressure Vessel

- Type Vertical Cylinder
- Size 8^B Sch 160 × 5500 mm
- Volume 0.13 m³
- Max. Operating Pressure 12.7 MPa
- Max. Operating Temperature 603 K
- Material SUS 304

Table 2.2(a) Major Specifications of Fuel Assembly A

• Fluid	Water
• Heater Arrangement	5 × 5
• Heater Type	Indirect Electrical Heating, Ground
• Maximum Temperature	
Fluid	603 K
Sheath	1273 K (Surface)
• Electric Capacity	
MOD 1	37.04 kW/ROD (5×5 Heater Rods and 2 Dummy Heaters)
MOD 2	83.33 kW/ROD (3×3 Heater Rods)
• Power Distribution	
Axial	Flat
Radial	Flat
• Heating Length	3700 mm
• Heater Outer Diam.	Φ12.27 mm
• Heater Rod Pitch	16.16 mm
• Sheath Material	INCONEL 600
• Power Source	
MOD 1	AC 400 V 3φ Y connection
MOD 2	AC 600 V 3φ Y connection

Table 2.2(b) Major Specifications of Fuel Assembly B

• Fluid	Water
• Heater Arrangement	5 × 5
• Heater Type	Indirect Electrical Heating, Ground
• Max. Temperature	
Fluid	603 K
Sheath	1273 K (Surface)
• Electric Capacity	
MOD 1	37.04 kW/ROD (5×5 Heater Rods and 2 Dummy Heaters)
MOD 2	83.33 kW/ROD (3×3 Heater Rods)
• Power Distribution	
Axial	Chopped-cosine (7 steps, P.F. = 1.4)
Radial	Flat
• Heating Length	3700 mm
• Heater Outer Diam.	Φ12.27 mm
• Heater Rod Pitch	16.16 mm
• Sheath Material	INCONEL 600
• Power Source	
MOD 1	AC 400 V 3φ Y connection
MOD 2	AC 600 V 3φ Y connection

Table 2.3 Major Specifications of Horizontal Pipe Test Section

• Type	Horizontal Pipe divided into 5 parts connected by Gray Locks
• Size	8B Sch 120 (ID 179.9 mm) × 2000mm × 5
• Max. Operating Pressure	128 kg/cm ² G (12.65 MPa)
• Max. Operating Temperature	603 K
• Material	SUS 304

Table 2.4 Major Specifications of Steam Pump

• Type	Vertical Centrifugal Canned Motor Blower
• Gas Handled	Saturated Steam
• Capacity (Rated)	60067 Nm ³ /h
• Inlet Conditions (Rated)	
Inlet Volume	700 m ³ /h (2.47×10^4 ft ³ /h)
Pressure	120 kg/cm ² G (11.87 MPa)
Temperature	596 K
• Discharge Conditions (Rated)	
Pressure	122 kg/cm ² G (12.07 MPa)
Temperature	603 K
• Adiabatic Head (Rated)	288 kgm/kg (at 120 kg/cm ² G)
• Speed	
Max.	3600 RPM (at 60 Hz)
Min.	1800 RPM (at 30 Hz)
• Impeller Diam.	400 mm

Table 2.5 Major Specifications of Circulation Pump

• Type	Vertical Centrifugal Canned Motor Pump
• Fluid	Water
• Inlet Pressure (Rated)	120 kg/cm ² G (11.87 MPa)
• Discharge Pressure (Rated)	123 kg/cm ² G (12.16 MPa)
• Total Differential Head (Rated)	46 m
• Rated Flow	170 m ³ /h (6.000×10^3 ft ³ /h)
• Temperature (Rated)	597 K
• Motor Power (Rated)	3φ 400 V 50 Hz

Table 2.6 Major Specifications of Steam Drum

i) Drum

• Type	Vertical Cylinder
• Size	Φ1300 I.D. × 6000 mmH
• Volume	6.5 m ³
• Max. Operating Pressure	128 kg/cm ² G (12.65 MPa)
• Max. Operating Temperature	603 K
• Material	SS (SB 49) + 3t inner lining (SUS 304)

ii) Heater

• Fluid	Water
• Type	Indirect Electrical Heating, Ground
• Max. Operating Pressure	128 kg/cm ² G (12.65 MPa)
• Max. Operating Temperature	603 K
• Electric Capacity	620 kW Maximum 200 kW × 2 (ON-OFF Controlled) 220 kW × 1 (SCR Controlled)
• Input Power	AC 440 V 3φ Y connection × 2 AC 400 V 3φ Y connection × 1

Table 2.7 Major Specifications of Air Condenser

• Type	Natural Circulation with Forced Air Cooling	
• Fluid	Steam	
• Flow Rate	3000 kg/h	
• Operating Temperature		
Inlet	597.15 K	
Outlet	596.85 K	
• Operating Pressure	120 kg/cm ² G (11.87 MPa)	
• Pressure Loss	0.1 kg/cm ² (Allowed)	
• Total Area for Heat Transfer	155.7 m ²	
• Heat Radiation	8.6 × 10 ⁵ kcal/h (1 MW)	
• Logarithmic Average Temperature Difference	204.1 K	
• Total Heat Transfer Coefficient	27.1 kcal/m ² h K (31.5 W/m ² K)	
• Cooling Air		
Flow Rate	22760 kg/h (4.9 m ³ /s)	
Inlet Temp.	305.15 K	
Outlet Temp.	462.55 K	
Press. Loss	8.97 mmH ₂ O	

Table 3.1 Specifications and Performance of
Electronic Pressure Transmitters

- Measuring Span 150 kgf/cm² (14.8 MPa)
- Output Signal 4 ~ 20 mA DC
- Operating Temperature Range
 - Measuring Fluid 233 ~ 393 K
 - Transducer Ambient 243 ~ 373 K
- Power Supply 50 V DC (Max.)
- Performance Characteristics (Indicated in % of Full Span)
 - Accuracy ± 0.5%
 - Repeatability 0.05%
 - Dead Band 0.01% or less
- Ambient Temperature Effect
 - ± 0.5% / 40K on Zero Point
 - (at Full Span, 263 ~ 373 K)
- Power Supply Voltage Effect
 - ± 0.005%/v

Table 3.2 Specifications and Performance of
Electronic High Pressure DP Transmitters

- Measuring Span a) 2000 mm H₂O (19.6 kPa)
 b) 3000 mm H₂O (29.4 kPa)
 c) 5000 mm H₂O (49.0 kPa)
 d) 20000 mm H₂O (0.196 MPa)
- Operating Pressure -1 ~ +420 kgf/cm² (-0.2 MPa ~ +41.3 MPa)
- Operating Temperature Range
 - Measuring Fluid 233 ~ 393 K
 - Transducer Ambient 243 ~ 373 K
- Output Signal 4 ~ 20 mA DC
- Power Supply 50 V DC (Max.)
- Performance Characteristics (Indicated in % of Full Span)
 - Accuracy ± 0.5%
 - Repeatability 0.1%
 - Dead Band 0.05%
 - Ambient Temperature Effect
 - 0.5% / 50K on Zero Point
 - (at Full Span, 263 ~ 373K)
 - Static Pressure Effect
 - 0.2%/100 kgf/cm² (at Full Span)
 - Power Supply Voltage Effect
 - 0.005%/V
- Measurement Applications
 - a) Steam Drum Head
 - b) Orifice Measuring Liquid Flow (Low)
 - Orifice Measuring Steam Flow
 - c) Orifice Measuring Liquid Flow (High)
 - d) Differential Pressure between Inlet and Outlet of
Pressure Vessel and Horizontal Test Section

Table 3.3 Thermocouple Specifications

i) Fluid Temperature

- Element Chromel-Alumel
- Class 0.4
- Sheath Diam. $\phi 1.6$
- Sheath Material SUS 316
- Measurement Junction Ungrounded (J#9)
- Standard JIS C1602-1974
- Pairs Single or Double

ii) Fuel Assembly Heater Rod Surface Temperature

- Element Chromel-Alumel
- Class Special
- Sheath Diam. $\phi 0.5$
- Sheath Material INCONEL 600
- Measurement Junction Ungrounded (J#9)
- Standard ANSI C96.2-1973
- Measurement Points 11 / ROD

iii) Fuel Assembly Fluid Temperature

- Element Chromel-Alumel
- Class 0.4
- Sheath Diam. $\phi 0.65$
- Sheath Material INCONEL 600
- Measurement Junction Ungrounded (J#9)
- Standard JIS C1602-1974
- Pairs Single
- Measurement Points 8 x 5 / Fuel Assembly

iv) Wall Temperature of the Channel Box Inside of the Fuel Assembly

- Element Chromel-Alumel
- Class 0.4
- Sheath Diam. $\phi 1.6$
- Sheath Material INCONEL 600
- Measurement Junction Ungrounded (J#9)
- Standard JIS C1602-1974
- Pairs Single
- Measurement Points 7x2+10 / Fuel Assembly

Table 3.3 (Continued)

- v) Dummy Heater Surface Temperature
- Element Chromel-Alumel
 - Class 0.75
 - Sheath Dia. $\phi 0.5$
 - Sheath Material INCONEL 600
 - Measurement Junction Ungrounded (J^{#9})
 - Standard JIS C1602-1974
- vi) Steam Drum Heater Surface Temperature
- Element Chromel-Alumel
 - Class 0.75
 - Sheath Dia. $\phi 1.6$
 - Sheath Material INCONEL 600
 - Measurement Junction Ungrounded (J^{#9})
 - Standard JIS C1602-1974
 - Measurement Points 1 /Power Supply

Table 3.4(a) Specifications and Calculations of Orifices
to Measure High Range Liquid Flow (FE-1-A and FE-1-B)

i) Specifications

• Orifice

Shape	Edge Orifice
Pressure Taps	Corner Taps, 15A (Sch 160), PT 3/8
Material	SUS304
Drain Gas Hole	None.

• Ring

Tap Connection	Screwed Type
Ring No.	R46
Flange Rating	JPI (ANSI) CL. 1500
Fluid	Water

• Flow Rate

Full Scale (Opr.)	200 m ³ /h (A), 50 m ³ /h (B)
Normal	170 m ³ /h (A), 30 m ³ /h (B)

• Pressure

Normal	120 kg/cm ² G (11.87 MPa)
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• Temperature

Normal	597.15 K
--------	----------

• Pipe

Size	6B (Sch 120)
Roughness	0.05 mm

• Differential Pressure 5000 mmH₂O (49.0 kPa)

ii) Calculation

$$W = 0.01252 \cdot \epsilon \cdot \alpha \cdot \beta_t^2 \cdot D_t^2 \cdot \sqrt{\Delta P \cdot r_f}$$

Calculation Data

• Orifice Dia. (at 293.15K)	d	φ92 mm(A), 48.67mm(B)
(at Opr. Temp.)	d _t	φ92.51mm(A), 48.95mm(B)
• Pipe Inner Dia. (at Opr. Temp)	D _t	φ137.36mm(A,B)
• Diameter Ratio d _t /D _t	β _t	0.6735(A), 0.3563(B)
• Flow Coefficient	α	0.6766(A), 0.6045(B)
• Expansion Factor	ε	1.0000 (A,B)
• Reynolds Number (at Nor. Flow Rate)	RED	3309461 (A), 584023 (B)
• Max. Pressure Loss	PL	2652 mmH ₂ O(A), 4287 mmH ₂ O(B)

Table 3.4(a) (continued)

• Tap Location (Up)	Xu	0 mm (A, B)
(Down)	Xd	0 mm (A, B)
• Weight Flow Rate	W	131440kg/h(A), 32860kg/h(B)
• Differential Pressure	ΔP	5000 mmH ₂ O (A, B)
• Specific Weight (at Opr. Temp.)	r _f	657.2 kg/m ³
• Viscosity	μ	0.087 cp
• Flow Range*		4 - 100%
• Standard		
Corner Taps/Flange Taps		JIS Z 8762-1969 (ISO R541)
Fluid Meters		1971 (ASME)

* Deviation of the flow coefficient is within ±0.5% in the Flow Range

Table 3.4(b) Specifications and Calculations of Orifices
to Measure Low Range Liquid Flow (FE-101A and FE-101B)

i) Specifications

- Orifice

Shape	Edge Orifice
Pressure Taps	Corner Taps, 15A (Sch 160), PT 3/8
Material	SUS 304
Drain Gas Hole	None

- Ring

Tap Connection Screwed Type
Ring No. R24

- Flange Rating JPI (ANSI) CL. 1500

- Fluid Water

- Flow Rate

Full Scale (opr.) 10 m³/h (A), 2 m³/h (B)
 Normal 5 m³/h (A), 1.5 m³/h (B)

- Pressure

Normal $120 \text{ kg/cm}^2\text{G}$ (11.87 MPa)

- Temperature

Normal 597.15 K

- Pipe

- S

- Roughness 0.05 mm
• Differential Pressure 3000 mm H₂O (29.4 kPa)

ii) Calculation

$$W = 0.01252 \cdot \epsilon \cdot \alpha \cdot \beta_t^2 \cdot D_t^2 \cdot \sqrt{\Delta P \cdot r_f}$$

Calculation Data

Table 3.4(b) (continued)

• Tap Location (Up)	Xu	0 mm (A, B)
(Down)	Xd	0 mm (A, B)
• Weight Flow Rate	W	6572kg/h(A), 1314.4kg/h(B)
• Differential Pressure	ΔP	3000 mmH ₂ O (A, B)
• Specific Weight (at Opr. Temp.)	r _f	657.2 kg/cm ³
• Viscosity	μ	0.087 cp
• Flow Range*		10 - 100%
• Standard		
Corner Taps/Flange Taps		JIS Z 8762-1969 (ISO R541)
Fluid Meters		1971 (ASME)

* Deviation of the flow coefficient is within ±0.5% in the Flow Range

Table 3.5(a) Specifications and Calculations of Orifice
to Measure High Range Steam Flow (FE-2)

i) Specifications

- Orifice

Shape	Edge Orifice
Pressure Taps	Corner Taps, 15A (Sch 160), PT 3/8
Material	SUS 304
Drain Gas Hole	None
- Ring

Tap Connection	Screwed Type
Ring No.	R50
- Flange Rating JPI (ANSI) CL. 1500
- Fluid Saturated Steam
- Flow Rate

Full Scale (Opr.)	800 m ³ /h
Normal	500 m ³ /h
- Pressure

Normal	120 kg/cm ² G (11.87 MPa)
--------	--------------------------------------
- Temperature

Normal	596.95 K
--------	----------
- Pipe

Size	8B (Sch 120)
Roughness	0.05 mm
- Differential Pressure 3000 mmH₂O (29.4 kPa)

ii) Calculation

$$W = 0.01252 \cdot \epsilon \cdot \alpha \cdot \beta_t^2 \cdot D_t^2 \cdot \sqrt{\Delta P \cdot r_f}$$

Calculation Data

- Orifice Dia. (at 293.15K) d φ119.49 mm
(at Opr. Temp.) d_t φ120.16 mm
- Pipe Inner Dia. (at Opr. Temp.) D_t φ180.91 mm
- Diameter Ratio d_t/D_t β_t 0.6642
- Flow Coefficient α 0.6721
- Expansion Factor ε 0.9995
- Reynolds Number (at Nor. Flow Rate) RED 3134412
- Max. Pressure Loss PL 1628 mmH₂O

Table 3.5(a) (continued)

• Tap Location (Up)	Xu	0 mm
(Down)	Xd	0 mm
• Weight Flow Rate	W	55311.6 kg/h
• Differential Pressure	ΔP	3000 mmH ₂ O
• Specific Weight (at Opr. Temp.)	r _f	69.1396 kg/m ³
• Viscosity	μ	0.0216 cp
• Flow Range*		3 - 100%
• Standard		
Corner Taps/Flange Taps		JIS Z 8762-1969 (ISO R541)
Fluid Meters		1971 (ASME)

* Deviation of the flow coefficient is within ±5% in the Flow Range

Table 3.5(b) Specifications and Calculations of Orifices
to Measure Low Range Steam Flow (FE-102A and FE-102B)

i) Specifications

• Orifice

Shape	Edge Orifice
Pressure Taps	Corner Taps, 15A (Sch 160), PT 3/8
Material	SUS 304
Drain Gas Hole	None

• Ring

Tap Connection	Screwed Type
Ring No.	R35

• Range Rating

JPI (ANSI) CL. 1500

• Fluid

Saturated Steam

• Flow Rate

Full Scale (Opr.)	100 m ³ /h (A), 20 m ³ /h (B)
Normal	80 m ³ /h (A), 18 m ³ /h (B)

• Pressure

Normal	120 kg/cm ² G (11.87 MPa)
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• Temperature

Normal	596.95 K
--------	----------

• Pipe

Size	3B (Sch 80)
Roughness	0.05 mm

• Differential Pressure 3000 mmH₂O (29.4 kPa)

ii) Calculation

$$W = 0.01252 \cdot \epsilon \cdot \alpha \cdot \beta_t^2 \cdot D_t^2 \cdot \sqrt{\Delta P \cdot r_f}$$

Calculation Data

• Orifice Dia. (at 293.15K) (at Opr. Temp.)	d _t	Φ43.15mm (A), Φ19.99mm (B) Φ43.39mm (A), Φ20.10mm (B)
• Pipe Inner Dia. (at Opr. Temp.)	D _t	Φ74.31mm (A, B)
• Diameter Ratio d _t /D _t	β _t	0.5839
• Flow Coefficient	α	0.6444 (A), 0.6004 (B)
• Expansion Factor	ε	0.9992 (A), 0.9991 (B)
• Reynolds Number (at Nor. Flow Rate)	RED	1220851 (A), 274692 (B)
• Max. Pressure Loss	PL	1919mmH ₂ O(A), 2748mmH ₂ O(B)

Table 3.5(b) (continued)

• Tap Location (Up)	Xu	0 mm (A, B)
(Down)	Xd	0 mm (A, B)
• Weight Flow Rate	W	6913.95kg/h(A), 1382.79kg/h(B)
• Differential Pressure	ΔP	3000 mmH ₂ O (A, B)
• Specific Weight (at Opr. Temp.)	ρ _f	69.1396 kg/m ³
• Viscosity	μ	0.0216 cp
• Flow Range*		6 - 100%
• Standard		
Conner Taps/Flange Taps		JIS Z 8762-1969 (ISO R541)
Fluid Meters		1971 (ASME)

* Deviation of the flow coefficient is within ±0.5% in the Flow Range

Table 3.6 Major Specifications and Performance of
Data Logger (DA-8500)

1) Analog Input (Multiplexer and A/D Converter)

• Type	Unbalanced Input (Single-ended)
• Volt Range	+($10 - 1\text{LSB}$)V, 10V ($\text{LSB} = 10/2048$ (Resolution of ADC))
• Gain	1
• Impedance	$1 \text{ M}\Omega$ (at Power ON) 330Ω (at Power OFF)
• Conversion Speed	$10 \mu\text{s}$ (Maximum)
• Conversion Data	S+11 bit (Minus is complement of 2)
• Accuracy	Accuracy $\pm 0.2\%$ of FS (at $293 \pm 5\text{K}$) Temp. Coeff. $\pm 130 \text{ PPM}$ of FS/K
• Number of Channels	64×4

2) Analogue Output (D/A Converter)

• Input Type	Unbalanced Input (Single-ended)
• Input Data	S+11 bit (Minus is complement of 2)
• Output Volt Range	+($10 - 1\text{LSB}$)V, -10V
• Output Impedance	600Ω
• Settling Time	$5 \mu\text{s}$
• Accuracy	$\pm 0.5\%$ of FS (at $293 \pm 5\text{K}$)
• Glitch	$50 \mu\text{s}$ or more
• Number of Channels	4

3) Control Unit

• Function	Data Record Data Replay (Search or Next) Data Number List Data Delete Sample Check Diagnosis
• Display	9 inch CRT
• Key Board	0 ~ 9, A ~ F, Function
• Sampling Speed	30 kHz (MT: 1600BPI, Simultaneous, 1 ch recording)
• Sampling Type	Sequential or Simultaneous

Table 3.6 (continued)

4) External Control

- Input Type TTL Level
- Signal LOAD, START, STOP
- Logical Polality ON lower than 0.8V Logic "1"
 OFF Free Logic "0"
- Signal Span Limited by MT control

5) External Clock

- Input Type TTL Level
- Frequency 30 kHz (Maximum)
- Logical Polality "Low" Level (0 ~ +0.8V)
 "High" Level (+2.4 ~ +5V)

6) Magnetic Tape Recording Unit

- Record Density 1600 BPI or 800 BPI
- Record Type PE, NRZI
- Label Standard Label
- Tape Speed 75 inch/s (Rated)
- Data Trans. Speed 120 Kbyte/s (1600 BPI)
 60 Kbyte/s (800 BPI)
- IBG 0.6 inch
- Scue 4.7 μ m (3 μ s) by IBM Scue Tape
- Tracks 9
- Tape Length 2400 ft or less
- Tape Width 1/2 inch
- Tape Reel 10 1/2 or 8 1/2 inch IBM hub
 less than 120s (at 2400 ft Tape)

7) Input Signal Switching Unit

- Number of Units 8
- Input Signals 64 ch/Unit
- Output Signals 32 ch/Unit
- Input Connector BNC
- Output Connector Multi (16 ch) \times 2
- Switching 32 ch together
- Switching Contact DC 200V 0.5 A (Rated)
- Monitor 1 ch out of 32 ch output
- Power Requirement +48V DC

Table 3.6 (continued)

8) General Performance

- Accuracy $\pm 0.25\%$ FS at $20 \pm 5^\circ\text{C}$
 (Input Signal Switching Unit + Interface Unit)
- Power Requirement AC $100\text{V} \pm 10\%$, $50/60\text{ Hz}$
- Power Consumption 1 KVA
- Operating Temperature $278 \sim 313\text{ K}$
- Operating Humidity $30 \sim 80\% \text{ RH}$

Table 3.7(a) Specifications and Performance of DC Amplifiers
for Temperature Measurement Systems (6Bφ6YD)

• Input	
Type	Floating Input (Single ended input also possible)
Impedance	10 MΩ + 10 MΩ
• Gain Control	
Steps	1000, 500, 250, 100, 50, 1 and OFF
Accuracy	± 0.05%
Stability	± 0.01%/K
Fine Adjusting Control	Gain Step × 1^3
• Linearity	± 0.01% FS
• Frequency Response	DC to 50 KHz, +1dB, -3dB
• Output Filter	
Type	3-pole Bessel low-pass filter
Passband	DC to 2Hz, DC to 10Hz, DC to 100Hz, DC to 1KHz, DC to 5KHz and Wide Band
• Common-mode Rejection Ratio (with 1KΩ signal source unbalance)	110 dB at 50Hz, 150 dB at DC
• Common-mode Voltage	± 600 V DC or Peak AC
• Allowable Differential Voltage Input	Not broken down with ±40V at maximum gain
• Drift	2 µV/K after 1 hour warm-up and with input shortcircuited (Referred to input at maximum gain)
• Noise	30 µV _{P-P} RTI + 5 mV _{P-P} RTO (at DC to 5 KHz Passband)
• Settling Time	100 µsec is required for output to reach 99.9% of final value with application of fullscale step input (at Wide Band Passband)
• Overload Recovery Time	Within 1 msec (at Wide Band Passband)

Table 3.7(a) (continued)

• Output

Voltage	±10 V
Current	±100 mA
Impedance	0.1Ω
Capacitive Load	Stable Operation Obtainable with up to 0.1μF
Reproducibility	±0.05%/FS

• Operating Temperature Range

268 ~ 313 K

• Operating Humidity Range

30 ~ 90% RH

• Calibration Voltage

Range	0, 20, 40 mV
Accuracy	±0.05%
Stability	50 PPM/K, 1000 PPM/3 months.

• Power Requirements AC 100V ± 10% 18 VA 50/60 Hz

Table 3.7(b) Specifications and Performance of DC Amplifiers
for Conduction Probes (6L71YP)

• Input	
Type	Floating Input (Single-ended input also possible)
Impedance	10 MΩ + 10 MΩ
Voltage	± 10 mV to ± 10 V
• Gain Control	
Steps	1000, 500, 250, 100, 50, 1 and OFF
Accuracy	± 0.2%
Stability	± 0.05%/K
• Fine Adjusting Control	Gain Step × 1~3
• Linearity	± 0.1% FS
• Frequency Response	DC to 2.5 KHz, +5%, -10%
• Output Filter	
Type	3-pole Bessel low-pass filter
Passband	DC to 2 Hz, DC to 10 Hz, DC to 100 Hz DC to 1 KHz and Flat
Characteristics	-3 dB ± 1 dB at Cut-off frequency, -18 dB/oct
• Common-mode Rejection Ratio (with 500Ω signal source unbalance)	110 dB at 50 Hz, 150 dB at DC
• Common-mode Voltage	± 300V DC or peak AC
• Allowable Differential Voltage Input	40 V (DC or AC)
• Drift	2 μV/K _{P-P} RTI + 500 μV/K _{P-P} RTO
• Noise	30 μV/K _{P-P} RTI + 5 mV/K _{P-P} RTO
• Output	
Voltage	± 10 V
Current	± 50 mA
Impedance	0.1Ω + 200 μH series
Capacitive Load	0.5 μF
• Calibration Voltage	
Range	0, -50 mV, +50 mV
Accuracy	± 0.5%
Stability	100 PPM/K, 1000 PPM/3 months

Table 3.7(b) (continued)

- Operating Temperature Range
268 ~ 313 K
- Operating Humidity Range
30 ~ 80 %RH
- Power Requirements AC 100V ± 10% 50/60 Hz

Table 3.7(c) Specifications and Performance of DC Amplifiers
 for Pressure, Differential Pressure, Flow and Fuel
 Assemblies Power Measurement Systems (6B06, WDA-103)

• Input	
Type	Floating Input (Single-ended input also possible)
Impedance	5 MΩ + 5 MΩ
• Gain Control	
Steps	1000, 500, 200, 100, 50, 20, 10, 5, 2, 1 and OFF
Accuracy	± 0.1%
Stability	± 0.01%/K
Fine Adjusting Control	Continuously variable between calibration gain steps
• Linearity	± 0.01% FS
• Frequency Response	DC to 50 KHz, +1dB, -3dB
• Output Filter	
Type	3-pole Bessel low-pass filter
Passband	DC to 10Hz, DC to 100Hz, DC to 1KHz, DC to 10 KHz and wide band
• Common-mode Rejection Ratio (with 1 KΩ signal source unbalanced)	
	120 dB at 50 Hz
	160 dB at DC
• Common-mode Voltage	±300V DC or peak AC
• Allowable Differential Voltage Input	Not broken down with ± 40 V at maximum gain
• Drift	2 μV/K after 1 hour warm-up and with input shortcircuited (Referred to input at maximum gain)
• Noise	60 μV peak to peak with input shortcircuited (Referred to input at maximum gain)
• Overload Recovery Time	Within 1 msec

Table 3.7(c) (continued)

- Settling Time 100 μ sec is required for output to reach 99.9% of final value with application of fullscale step input
- Output
 - Voltage \pm 10 V
 - Current \pm 100 mA
 - Impedance 0.1 Ω
 - Capacitive Load Stable operation obtainable with up to 0.1 μ F
 - Reproducibility \pm 0.05% FS
- Operating Temperature Range
 273 ~ 313 K
- Operating Humidity Range
 20 ~ 90% RH
- Power Requirement AC 100V \pm 10% 50/60 Hz

Table 3.8 Specifications and Performance of
Electronic Temperature Transducers

• Input	Thermocouple CA (Type K)
• Temperature Range*	0 ~ 400°C (273 ~ 313 K) 0 ~ 500°C (273 ~ 323 K)
• Output	4 ~ 20 mA DC (Load resistance, 0 ~ 500 Ω)
• Accuracy	± 0.5% FS
• Response Time	3 sec or less (time required for 0-95% response of the output with 100% step input)
• Burn-out time	30 sec or less
• Output ripple	50 mV P-P (maximum)
• Ambient Temp. Effect	
Zero Point	(0.2% + 3μV + 0.3K) / 10K
Span	0.2% / 10K
• Zero Point Shift Due to Variation of Signal Source Resistance	0.3 μV/Ω
• Power Supply Voltage Effect	±0.3% / 10% change
• Linearizer	Required
• Power Supply	24 V DC

Table 3.9 Specifications of Signal Distributer

- Input Signal 4 ~ 20 mA DC
- Output Signal 1 ~ 5 V DC
- Accuracy $\pm 0.1\%$ FS (for input)
- Operating Temperature 263 ~ 318 K

Table 3.10 Specifications of Signal Isolator

- Input Signal 4 ~ 20 mA DC (Input resistance 100 Ω) or
 1 ~ 5 V DC (Input resistance 1 M Ω or more)
- Voltage Drop across Terminals
 2 V or less
- Allowable Voltage Supplied between Input & Output
 100 V AC or less
 (Both (+) and (-) input terminals are
 isolated from other circuits)
- Output Signal 1 ~ 5 V DC (Load resistance, 250 K Ω or more)
 (Output resistance 1 K Ω , approx.)
- Insulation Resistance 20 M Ω (minimum)
- Accuracy $\pm 0.2\%$ FS
- Ambient Temperature Effect
 0.1% / 10K
- Power Supply Voltage Effect
 0.1% / $\pm 10\%$

Table 3.11 Specifications of Electric Zero Contact (Microfreezer)

• Type	Thermoelectric Freezing of Water
• Temperature Basis	0°C (273.15 K)
• Accuracy	273.15 K ± 0.3 K
• Available Ambient Temperature Range	275 ~ 308 K
• Preparation Time VS. Ambient Temperature	
	45 min. at 293 K
	60 min. at 298 K
	85 min. at 303 K
• Power Supply	AC 100 V ± 10%

Table 3.12 TPTF Measurement List

< TPTF Vert. Press. Vessel >						
Ch.	Item	Symbol	Location	Range (SI)	Unit	Accuracy
1	Pressure	PX-	2 Circulation Pump Outlet	1.01325E-01 <=>	1.48113E+01 MPa	6.100E-01XFS
2	Pressure	PX-	3 Steam Pump Outlet	1.01325E-01 <=>	1.48113E+01 MPa	6.100E-01XFS
3	Pressure	PX-101	Pressure Vessel Inlet	1.01325E-01 <=>	1.48113E+01 MPa	6.100E-01XFS
4	Pressure	PX-102	Pressure Vessel Outlet	1.01325E-01 <=>	1.48113E+01 MPa	6.100E-01XFS
5	Diff. Pressure	FX-101	Orifice (Liquid) (Low)	0.0 <=>	2.94200E-02 MPa	6.100E-01XFS
6	Diff. Pressure	FX-102	Orifice (Steam) (Low)	0.0 <=>	2.94200E-02 MPa	6.100E-01XFS
7	Diff. Pressure	dPX-101	Press. Vessel In.- Outlet	0.0 <=>	6.100E-01XFS	6.100E-01XFS
8	Fluid Temp.	TE-	2 Circulation Pump Outlet	2.73150E+02 <=>	7.58150E+02 K	4.820E-01XFS
9	Fluid Temp.	TE-	3 Steam Pump Outlet	2.73150E+02 <=>	7.58150E+02 K	4.820E-01XFS
10	Fluid Temp.	TE-107	Orifice Inlet (Liquid)	2.73150E+02 <=>	7.58150E+02 K	4.820E-01XFS
11	Fluid Temp.	TE-108	Orifice Inlet (Steam)	2.73150E+02 <=>	7.58150E+02 K	4.820E-01XFS
12	Fluid Temp.	TE-105	Mixer Inlet (Liquid)	2.73150E+02 <=>	7.58150E+02 K	4.820E-01XFS
13	Fluid Temp.	TE-106	Mixer Inlet (Steam)	2.73150E+02 <=>	7.58150E+02 K	4.820E-01XFS
14	Fluid Temp.	TE-101	Pressure Vessel Inlet	2.73150E+02 <=>	7.58150E+02 K	4.820E-01XFS
15	Fluid Temp.	TE-102	Pressure Vessel Outlet	2.73150E+02 <=>	7.58150E+02 K	4.820E-01XFS
16	Vol. Flow Rate	FR-101	Liquid Flow Meter (Low)	0.0 <=>	2.77778E-03 m**3/s	1.460E+00XFS
16	Vol. Flow Rate	FR-102	Steam Flow Meter (Low)	0.0 <=>	5.55556E-04 m**3/s	1.460E+00XFS
17	Vol. Flow Rate	FR-102	Steam Flow Meter (High)	0.0 <=>	2.77778E-02 m**3/s	1.460E+00XFS
18	Void Fraction	VE-	1 Circulation Pump Inlet	0.0 <=>	5.55556E-04 m**3/s	1.460E+00XFS
19	Electric Power	KWR-101	Fuel Assembly Power	0.0 <=>	1.20000E+03 kW	1.400E+00XFS
20			*** Blank Channel ***			
21			*** Blank Channel ***			
22	Diff. Pressure	FX-	1 Orifice (Liquid) (High)	0.0 <=>	4.90333E-02 MPa	6.100E-01XFS
23	Diff. Pressure	FX-	2 Orifice (Steam) (High)	0.0 <=>	2.94200E-02 MPa	6.100E-01XFS
24	Fluid Temp.	TE-	20 Orifice Inlet (Liquid)	2.73150E+02 <=>	7.58150E+02 K	4.820E-01XFS
25	Fluid Temp.	TE-	21 Orifice Inlet (Steam)	2.73150E+02 <=>	7.58150E+02 K	4.820E-01XFS
26	Vol. Flow Rate	FR-	1 Liquid Flow Meter (High)	0.0 <=>	5.55556E-02 m**3/s	1.460E+00XFS
26	Vol. Flow Rate	FR-	2 Steam Flow Meter (High)	0.0 <=>	1.38889E-02 m**3/s	1.460E+00XFS
27	Vol. Flow Rate	FR-	2 Stream Flow Meter (High)	0.0 <=>	2.22222E-01 m**3/s	1.400E+00XFS
28			*** Blank Channel ***			
29			*** Blank Channel ***			
30			*** Blank Channel ***			
31			*** Blank Channel ***			
32	Rod Surf. Temp.	TF-	1 Heater Rod Surf.	2.73150E+02 <=>	1.24065E+03 K	4.620E-01XFS
33	Rod Surf. Temp.	TF-	2 Heater Rod Surf.	1-B 2.73150E+02 <=>	1.24065E+03 K	4.620E-01XFS
34	Rod Surf. Temp.	TF-	3 Heater Rod Surf.	1-D 2.73150E+02 <=>	1.24065E+03 K	4.620E-01XFS
35	Rod Surf. Temp.	TF-	4 Heater Rod Surf.	1-E 2.73150E+02 <=>	1.24065E+03 K	4.620E-01XFS
36	Rod Surf. Temp.	TF-	5 Heater Rod Surf.	1-F 2.73150E+02 <=>	1.24065E+03 K	4.620E-01XFS
37	Rod Surf. Temp.	TF-	6 Heater Rod Surf.	1-G 2.73150E+02 <=>	1.24065E+03 K	4.620E-01XFS
38	Rod Surf. Temp.	TF-	7 Heater Rod Surf.	1-H 2.73150E+02 <=>	1.24065E+03 K	4.620E-01XFS
39	Rod Surf. Temp.	TF-	8 Heater Rod Surf.	1-I 2.73150E+02 <=>	1.24065E+03 K	4.620E-01XFS
40	Rod Surf. Temp.	TF-	9 Heater Rod Surf.	1-J 2.73150E+02 <=>	1.24065E+03 K	4.620E-01XFS
41	Rod Surf. Temp.	TF-	10 Heater Rod Surf.	2.73150E+02 <=>	1.24065E+03 K	4.620E-01XFS
42	Rod Surf. Temp.	TF-	11 Heater Rod Surf.	1-L 2.73150E+02 <=>	1.24065E+03 K	4.620E-01XFS
43	Rod Surf. Temp.	TF-	12 Heater Rod Surf.	7-A 2.73150E+02 <=>	1.24065E+03 K	4.620E-01XFS
44	Rod Surf. Temp.	TF-	13 Heater Rod Surf.	7-B 2.73150E+02 <=>	1.24065E+03 K	4.620E-01XFS
45	Rod Surf. Temp.	TF-	14 Heater Rod Surf.	7-D 2.73150E+02 <=>	1.24065E+03 K	4.620E-01XFS
46	Rod Surf. Temp.	TF-	15 Heater Rod Surf.	7-E 2.73150E+02 <=>	1.24065E+03 K	4.620E-01XFS
47	Rod Surf. Temp.	TF-	16 Heater Rod Surf.	7-F 2.73150E+02 <=>	1.24065E+03 K	4.620E-01XFS
48	Rod Surf. Temp.	TF-	17 Heater Rod Surf.	7-G 2.73150E+02 <=>	1.24065E+03 K	4.620E-01XFS
49	Rod Surf. Temp.	TF-	18 Heater Rod Surf.	7-H 2.73150E+02 <=>	1.24065E+03 K	4.620E-01XFS
50	Rod Surf. Temp.	TF-				

Table 3.12 (continued)

*** TPTF Measurement List ***							(TPTF Vert. Press. Vessel)		
Ch.	Item	Symbol	Location	Range	(SI)	Unit	Accuracy		
51	Rod Surf. Temp.	TF- 19	Heater Rod Surf.	7-I	2.73150E+02	K	4.620E-01%FS		
52	Rod Surf. Temp.	TF- 20	Heater Rod Surf.	7-J	2.73150E+02	K	4.620E-01%FS		
53	Rod Surf. Temp.	TF- 21	Heater Rod Surf.	7-K	2.73150E+02	K	4.620E-01%FS		
54	Rod Surf. Temp.	TF- 22	Heater Rod Surf.	7-L	2.73150E+02	K	4.620E-01%FS		
55	Rod Surf. Temp.	TF- 23	Heater Rod Surf.	8-A	2.73150E+02	K	4.620E-01%FS		
56	Rod Surf. Temp.	TF- 24	Heater Rod Surf.	8-B	2.73150E+02	K	4.620E-01%FS		
57	Rod Surf. Temp.	TF- 25	Heater Rod Surf.	B-D	2.73150E+02	K	4.620E-01%FS		
58	Rod Surf. Temp.	TF- 26	Heater Rod Surf.	B-E	2.73150E+02	K	4.620E-01%FS		
59	Rod Surf. Temp.	TF- 27	Heater Rod Surf.	B-F	2.73150E+02	K	4.620E-01%FS		
60	Rod Surf. Temp.	TF- 28	Heater Rod Surf.	B-G	2.73150E+02	K	4.620E-01%FS		
61	Rod Surf. Temp.	TF- 29	Heater Rod Surf.	B-H	2.73150E+02	K	4.620E-01%FS		
62	Rod Surf. Temp.	TF- 30	Heater Rod Surf.	8-I	2.73150E+02	K	4.620E-01%FS		
63	Rod Surf. Temp.	TF- 31	Heater Rod Surf.	8-J	2.73150E+02	K	4.620E-01%FS		
64	Rod Surf. Temp.	TF- 32	Heater Rod Surf.	8-K	2.73150E+02	K	4.620E-01%FS		
65	Rod Surf. Temp.	TF- 33	Heater Rod Surf.	8-L	2.73150E+02	K	4.620E-01%FS		
66	Rod Surf. Temp.	TF- 34	Heater Rod Surf.	11-A	2.73150E+02	K	4.620E-01%FS		
67	Rod Surf. Temp.	TF- 35	Heater Rod Surf.	11-B	2.73150E+02	K	4.620E-01%FS		
68	Rod Surf. Temp.	TF- 36	Heater Rod Surf.	11-D	2.73150E+02	K	4.620E-01%FS		
69	Rod Surf. Temp.	TF- 37	Heater Rod Surf.	11-E	2.73150E+02	K	4.620E-01%FS		
70	Rod Surf. Temp.	TF- 38	Heater Rod Surf.	11-F	2.73150E+02	K	4.620E-01%FS		
71	Rod Surf. Temp.	TF- 39	Heater Rod Surf.	11-G	2.73150E+02	K	4.620E-01%FS		
72	Rod Surf. Temp.	TF- 40	Heater Rod Surf.	11-H	2.73150E+02	K	4.620E-01%FS		
73	Rod Surf. Temp.	TF- 41	Heater Rod Surf.	11-I	2.73150E+02	K	4.620E-01%FS		
74	Rod Surf. Temp.	TF- 42	Heater Rod Surf.	11-J	2.73150E+02	K	4.620E-01%FS		
75	Rod Surf. Temp.	TF- 43	Heater Rod Surf.	11-K	2.73150E+02	K	4.620E-01%FS		
76	Rod Surf. Temp.	TF- 44	Heater Rod Surf.	11-L	2.73150E+02	K	4.620E-01%FS		
77	Rod Surf. Temp.	TF- 45	Heater Rod Surf.	12-A	2.73150E+02	K	4.620E-01%FS		
78	Rod Surf. Temp.	TF- 46	Heater Rod Surf.	12-B	2.73150E+02	K	4.620E-01%FS		
79	Rod Surf. Temp.	TF- 47	Heater Rod Surf.	12-D	2.73150E+02	K	4.620E-01%FS		
80	Rod Surf. Temp.	TF- 48	Heater Rod Surf.	12-E	2.73150E+02	K	4.620E-01%FS		
81	Rod Surf. Temp.	TF- 49	Heater Rod Surf.	12-F	2.73150E+02	K	4.620E-01%FS		
82	Rod Surf. Temp.	TF- 50	Heater Rod Surf.	12-G	2.73150E+02	K	4.620E-01%FS		
83	Rod Surf. Temp.	TF- 51	Heater Rod Surf.	12-H	2.73150E+02	K	4.620E-01%FS		
84	Rod Surf. Temp.	TF- 52	Heater Rod Surf.	12-I	2.73150E+02	K	4.620E-01%FS		
85	Rod Surf. Temp.	TF- 53	Heater Rod Surf.	12-J	2.73150E+02	K	4.620E-01%FS		
86	Rod Surf. Temp.	TF- 54	Heater Rod Surf.	12-K	2.73150E+02	K	4.620E-01%FS		
87	Rod Surf. Temp.	TF- 55	Heater Rod Surf.	12-L	2.73150E+02	K	4.620E-01%FS		
88	Rod Surf. Temp.	TF- 56	Heater Rod Surf.	13-A	2.73150E+02	K	4.620E-01%FS		
89	Rod Surf. Temp.	TF- 57	Heater Rod Surf.	13-B	2.73150E+02	K	4.620E-01%FS		
90	Rod Surf. Temp.	TF- 58	Heater Rod Surf.	13-C	2.73150E+02	K	4.620E-01%FS		
91	Rod Surf. Temp.	TF- 59	Heater Rod Surf.	13-D	2.73150E+02	K	4.620E-01%FS		
92	Rod Surf. Temp.	TF- 60	Heater Rod Surf.	13-E	2.73150E+02	K	4.620E-01%FS		
93	Rod Surf. Temp.	TF- 61	Heater Rod Surf.	13-F	2.73150E+02	K	4.620E-01%FS		
94	Rod Surf. Temp.	TF- 62	Heater Rod Surf.	13-G	2.73150E+02	K	4.620E-01%FS		
95	Rod Surf. Temp.	TF- 63	Heater Rod Surf.	13-H	2.73150E+02	K	4.620E-01%FS		
96	Rod Surf. Temp.	TF- 64	Heater Rod Surf.	13-I	2.73150E+02	K	4.620E-01%FS		
97	Rod Surf. Temp.	TF- 65	Heater Rod Surf.	13-K	2.73150E+02	K	4.620E-01%FS		
98	Rod Surf. Temp.	TF- 66	Heater Rod Surf.	13-L	2.73150E+02	K	4.620E-01%FS		
99	Rod Surf. Temp.	TF- 67	Heater Rod Surf.	15-A	2.73150E+02	K	4.620E-01%FS		
100	Rod Surf. Temp.	TF- 68	Heater Rod Surf.	15-B	2.73150E+02	K	4.620E-01%FS		

Table 3.12 (continued)

*** TPTF Measurement List ***						
Ch.	Item	Symbol	Location	Range (SI)	Unit	Accuracy
101	Rod Surf. Temp.	TF- 69	Heater Rod Surf.	15-D 15-E	2.73150E+02 2.73150E+02	<=> <=>
102	Rod Surf1. Temp.	TF- 70	Heater Rod Surf.	15-F	2.73150E+02	1.24065E+03
103	Rod Surf. Temp.	TF- 71	Heater Rod Surf.	15-G	2.73150E+02	1.24065E+03
104	Rod Surf. Temp.	TF- 72	Heater Rod Surf.	15-H	2.73150E+02	1.24065E+03
105	Rod Surf. Temp.	TF- 73	Heater Rod Surf.	15-I	2.73150E+02	1.24065E+03
106	Rod Surf. Temp.	TF- 74	Heater Rod Surf.	15-J	2.73150E+02	1.24065E+03
107	Rod Surf. Temp.	TF- 75	Heater Rod Surf.	15-K	2.73150E+02	1.24065E+03
108	Rod Surf. Temp.	TF- 76	Heater Rod Surf.	15-L	2.73150E+02	1.24065E+03
109	Rod Surf. Temp.	TF- 77	Heater Rod Surf.	19-A	2.73150E+02	1.24065E+03
110	Rod Surf. Temp.	TF- 78	Heater Rod Surf.	19-B	2.73150E+02	1.24065E+03
111	Rod Surf. Temp.	TF- 79	Heater Rod Surf.	19-C	2.73150E+02	1.24065E+03
112	Rod Surf. Temp.	TF- 80	Heater Rod Surf.	19-D	2.73150E+02	1.24065E+03
113	Rod Surf. Temp.	TF- 81	Heater Rod Surf.	19-E	2.73150E+02	1.24065E+03
114	Rod Surf. Temp.	TF- 82	Heater Rod Surf.	19-F	2.73150E+02	1.24065E+03
115	Rod Surf. Temp.	TF- 83	Heater Rod Surf.	19-G	2.73150E+02	1.24065E+03
116	Rod Surf. Temp.	TF- 84	Heater Rod Surf.	19-H	2.73150E+02	1.24065E+03
117	Rod Surf. Temp.	TF- 85	Heater Rod Surf.	19-I	2.73150E+02	1.24065E+03
118	Rod Surf. Temp.	TF- 86	Heater Rod Surf.	19-J	2.73150E+02	1.24065E+03
119	Rod Surf. Temp.	TF- 87	Heater Rod Surf.	19-K	2.73150E+02	1.24065E+03
120	Rod Surf. Temp.	TF- 88	Heater Rod Surf.	19-L	2.73150E+02	1.24065E+03
121	Rod Surf. Temp.	TF- 89	Heater Rod Surf.	25-A	2.73150E+02	1.24065E+03
122	Rod Surf. Temp.	TF- 90	Heater Rod Surf.	25-B	2.73150E+02	1.24065E+03
123	Rod Surf. Temp.	TF- 91	Heater Rod Surf.	25-D	2.73150E+02	1.24065E+03
124	Rod Surf. Temp.	TF- 92	Heater Rod Surf.	25-E	2.73150E+02	1.24065E+03
125	Rod Surf. Temp.	TF- 93	Heater Rod Surf.	25-F	2.73150E+02	1.24065E+03
126	Rod Surf. Temp.	TF- 94	Heater Rod Surf.	25-G	2.73150E+02	1.24065E+03
127	Rod Surf. Temp.	TF- 95	Heater Rod Surf.	25-H	2.73150E+02	1.24065E+03
128	Rod Surf. Temp.	TF- 96	Heater Rod Surf.	25-I	2.73150E+02	1.24065E+03
129	Rod Surf. Temp.	TF- 97	Heater Rod Surf.	25-J	2.73150E+02	1.24065E+03
130	Rod Surf. Temp.	TF- 98	Heater Rod Surf.	25-K	2.73150E+02	1.24065E+03
131	Rod Surf. Temp.	TF- 99	Heater Rod Surf.	25-L	2.73150E+02	1.24065E+03
132	Slab Surf. Temp.	TC- 1	Box Surface	I-B	2.73150E+02	1.24065E+03
133	Slab Surf. Temp.	TC- 2	Box Surface	I-D	2.73150E+02	1.24065E+03
134	Slab Surf. Temp.	TC- 3	Box Surface	I-F	2.73150E+02	1.24065E+03
135	Slab Surf. Temp.	TC- 4	Box Surface	I-H	2.73150E+02	1.24065E+03
136	Slab Surf. Temp.	TC- 5	Box Surface	I-I	2.73150E+02	1.24065E+03
137	Slab Surf. Temp.	TC- 6	Box Surface	I-J	2.73150E+02	1.24065E+03
138	Slab Surf. Temp.	TC- 7	Box Surface	I-K	2.73150E+02	1.24065E+03
139	Slab Surf. Temp.	TC- 8	Box Surface	J-B	2.73150E+02	1.24065E+03
140	Slab Surf. Temp.	TC- 9	Box Surface	J-D	2.73150E+02	1.24065E+03
141	Slab Surf. Temp.	TC- 10	Box Surface	J-F	2.73150E+02	1.24065E+03
142	Slab Surf. Temp.	TC- 11	Box Surface	J-H	2.73150E+02	1.24065E+03
143	Slab Surf. Temp.	TC- 12	Box Surface	J-I	2.73150E+02	1.24065E+03
144	Slab Surf. Temp.	TC- 13	Box Surface	J-J	2.73150E+02	1.24065E+03
145	Slab Surf. Temp.	TC- 14	Box Surface	J-K	2.73150E+02	1.24065E+03
146	Slab Surf. Temp.	TC- 15	Box Surface	K-A	2.73150E+02	1.24065E+03
147	Slab Surf. Temp.	TC- 16	Box Surface	K-B	2.73150E+02	1.24065E+03
148	Slab Surf. Temp.	TC- 17	Box Surface	K-D	2.73150E+02	1.24065E+03
149	Slab Surf. Temp.	TC- 18	Box Surface	K-E	2.73150E+02	1.24065E+03
150	Slab Surf. Temp.	TC- 19	Box Surface	K-F	2.73150E+02	1.24065E+03

Table 3.12 (continued)

*** TPTF Measurement List ***				(TPTF Vert. Press. Vessel)				151Ch.- 200Ch.			
Ch.	Item	Symbol	Location			Range (SI)	Unit			Accuracy	
151	Slab Surf. Temp.	TC-20	Ch. Box Surface	K-G	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
152	Slab Surf. Temp.	TC-21	Ch. Box Surface	K-H	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
153	Slab Surf. Temp.	TC-22	Ch. Box Surface	K-I	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
154	Slab Surf. Temp.	TC-23	Ch. Box Surface	K-J	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
155	Slab Surf. Temp.	TC-24	Ch. Box Surface	K-K	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
156	Fluid Temp.	TB-1	Ch. Box Liquid	A-C	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
157	Fluid Temp.	TB-2	Ch. Box Liquid	A-E	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
158	Fluid Temp.	TB-3	Ch. Box Liquid	A-G	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
159	Fluid Temp.	TB-4	Ch. Box Liquid	A-I	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
160	Fluid Temp.	TB-5	Ch. Box Liquid	A-K	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
161	Fluid Temp.	TB-6	Ch. Box Liquid	B-C	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
162	Fluid Temp.	TB-7	Ch. Box Liquid	B-E	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
163	Fluid Temp.	TB-8	Ch. Box Liquid	B-G	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
164	Fluid Temp.	TB-9	Ch. Box Liquid	B-I	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
165	Fluid Temp.	TB-10	Ch. Box Liquid	B-K	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
166	Fluid Temp.	TB-11	Ch. Box Liquid	C-C	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
167	Fluid Temp.	TB-12	Ch. Box Liquid	C-E	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
168	Fluid Temp.	TB-13	Ch. Box Liquid	C-G	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
169	Fluid Temp.	TB-14	Ch. Box Liquid	C-I	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
170	Fluid Temp.	TB-15	Ch. Box Liquid	C-K	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
171	Fluid Temp.	TB-16	Ch. Box Liquid	D-C	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
172	Fluid Temp.	TB-17	Ch. Box Liquid	D-E	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
173	Fluid Temp.	TB-18	Ch. Box Liquid	D-G	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
174	Fluid Temp.	TB-19	Ch. Box Liquid	D-I	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
175	Fluid Temp.	TB-20	Ch. Box Liquid	D-K	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
176	Fluid Temp.	TB-21	Ch. Box Liquid	E-C	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
177	Fluid Temp.	TB-22	Ch. Box Liquid	E-E	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
178	Fluid Temp.	TB-23	Ch. Box Liquid	E-G	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
179	Fluid Temp.	TB-24	Ch. Box Liquid	E-I	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
180	Fluid Temp.	TB-25	Ch. Box Liquid	E-K	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
181	Fluid Temp.	TB-26	Ch. Box Liquid	F-C	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
182	Fluid Temp.	TB-27	Ch. Box Liquid	F-E	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
183	Fluid Temp.	TB-28	Ch. Box Liquid	F-G	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
184	Fluid Temp.	TB-29	Ch. Box Liquid	F-I	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
185	Fluid Temp.	TB-30	Ch. Box Liquid	F-K	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
186	Fluid Temp.	TB-31	Ch. Box Liquid	G-C	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
187	Fluid Temp.	TB-32	Ch. Box Liquid	G-E	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
188	Fluid Temp.	TB-33	Ch. Box Liquid	G-G	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
189	Fluid Temp.	TB-34	Ch. Box Liquid	G-I	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
190	Fluid Temp.	TB-35	Ch. Box Liquid	G-K	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
191	Fluid Temp.	TB-36	Ch. Box Liquid	H-C	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
192	Fluid Temp.	TB-37	Ch. Box Liquid	H-E	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
193	Fluid Temp.	TB-38	Ch. Box Liquid	H-G	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
194	Fluid Temp.	TB-39	Ch. Box Liquid	H-I	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
195	Fluid Temp.	TB-40	Ch. Box Liquid	H-K	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS		
196	Liquid Level	LC-1	Ch. Box Surface	L-B	***	Arbitrary	Unit ***				
197	Liquid Level	LC-2	Ch. Box Surface	L-D	***	Arbitrary	Unit ***				
198	Liquid Level	LC-3	Ch. Box Surface	L-F	***	Arbitrary	Unit ***				
199	Liquid Level	LC-4	Ch. Box Surface	L-H	***	Arbitrary	Unit ***				
200	Liquid Level	LC-5	Ch. Box Surface	L-I	***	Arbitrary	Unit ***				

Table 3.12 (continued)

Ch.	Item	Symbol	Location	Range (Si)	Unit	Accuracy
*** IPTF Measurement List ***						
201	Liquid Level	LC- 6	Ch. Box Surface	***	Arbitrary	Unit ***
202	Liquid Level	LC- 7	Ch. Box Surface	***	Arbitrary	Unit ***
203	Liquid Level	LC- 8	Ch. Box Surface	***	Arbitrary	Unit ***
204	Liquid Level	LC- 9	Ch. Box Surface	***	Arbitrary	Unit ***
205	Liquid Level	LC-10	Ch. Box Surface	***	Arbitrary	Unit ***
206	Liquid Level	LC-11	Ch. Box Surface	***	Arbitrary	Unit ***
207	Liquid Level	LC-12	Ch. Box Surface	***	Arbitrary	Unit ***
208	Liquid Level	LC-13	Ch. Box Surface	***	Arbitrary	Unit ***
209	Liquid Level	LC-14	Ch. Box Surface	***	Arbitrary	Unit ***
210	Liquid Level	LC-15	Ch. Box Surface	***	Arbitrary	Unit ***
211	Liquid Level	LC-16	Ch. Box Surface	***	Arbitrary	Unit ***
212	Liquid Level	LC-17	Ch. Box Surface	***	Arbitrary	Unit ***
213	Liquid Level	LC-18	Ch. Box Surface	***	Arbitrary	Unit ***
214	Liquid Level	LC-19	Ch. Box Surface	***	Arbitrary	Unit ***
215	Liquid Level	LC-20	Ch. Box Surface	***	Arbitrary	Unit ***
216	Liquid Level	LC-21	Ch. Box Surface	***	Arbitrary	Unit ***
217	Liquid Level	LC-22	Ch. Box Surface	***	Arbitrary	Unit ***
218	Liquid Level	LC-23	Ch. Box Surface	***	Arbitrary	Unit ***
219	Liquid Level	LC-24	Ch. Box Surface	***	Arbitrary	Unit ***
220	Electric Power	KWR-101	Fuel Assembly Power	N-J	***	Not Measured ***
221			*** Blank Channel	***		
222			*** Blank Channel	***		
223			*** Blank Channel	***		
224			*** Blank Channel	***		
225			*** Blank Channel	***		
226			*** Blank Channel	***		
227			*** Blank Channel	***		
228			*** Blank Channel	***		
229			*** Blank Channel	***		
230			*** Blank Channel	***		
231			*** Blank Channel	***		
232			*** Blank Channel	***		
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243			*** Blank Channel	***		
244			*** Blank Channel	***		
245			*** Blank Channel	***		
246			*** Blank Channel	***		
247			*** Blank Channel	***		
248			*** Blank Channel	***		
249			*** Blank Channel	***		
250			*** Blank Channel	***		

Table 3.12 (continued)

Ch.	Item	Symbol	Location	(TPIF Vert. Press. Vessel)		Range	< S1 >	Unit	251Ch.-300Ch.	
				(TPIF Measurement List ***)					Accuracy	
251			*** Blank Channel ***							
252			*** Blank Channel ***							
253			*** Blank Channel ***							
254			*** Blank Channel ***							
255			*** Blank Channel ***							
256			*** Blank Channel ***							

Table 3.12 (continued)

*** TPTF Measurement List ***						(TPTF Horiz. Test Section)		1Ch. - SOCh.	
Ch.	Item	Symbol	Location	Range (SI)	Unit	Accuracy			
1	Pressure	PX-	2 Circulation Pump Outlet	1.01325E-01	<=>	1.48113E+01	MPa	6.100E-01XFS	
2	Pressure	PX-	3 Steam Pump Outlet	1.01325E-01	<=>	1.48113E+01	MPa	6.100E-01XFS	
3	Pressure	PX-	5 Test Section Inlet	1.01325E-01	<=>	1.48113E+01	MPa	6.100E-01XFS	
4	Pressure	PX-	4 Test Section Outlet	1.01325E-01	<=>	1.48113E+01	MPa	6.100E-01XFS	
5	Diff. Pressure	FX-	1 Orifice (Liquid) (High)	0.0	<=>	4.90335E-02	MPa	6.100E-01XFS	
6	Diff. Pressure	FX-	2 Orifice (Steam) (High)	0.0	<=>	2.94200E-02	MPa	6.100E-01XFS	
7	Diff. Pressure	dPX-	1 Test Section In.- Outlet	0.0	<=>	1.96133E-01	MPa	6.100E-01XFS	
8	Fluid Temp.	TE-	2 Circulation Pump Outlet	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS	
9	Fluid Temp.	TE-	3 Steam Pump Outlet	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS	
10	Fluid Temp.	TE-	20 Orifice Inlet (Liquid)	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS	
11	Fluid Temp.	TE-	21 Orifice Inlet (Steam)	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS	
12	Fluid Temp.	TE-	18 Mixer Inlet (Liquid)	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS	
13	Fluid Temp.	TE-	19 Mixer Inlet (Steam)	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS	
14	Fluid Temp.	TE-	4 Pressure Vessel Inlet	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS	
15	Fluid Temp.	TE-	5 Pressure Vessel Outlet	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS	
16	Vol. Flow Rate	FR-	1 Liquid Flow Meter (High)	0.0	<=>	5.55556E-02	***3/s	1.460E+00XFS	
17	Vol. Flow Rate	FR-	2 Steam Flow Meter (High)	0.0	<=>	1.38889E-02	***3/s	1.460E+00XFS	
18	Void Fraction	VE-	1 Circulation Pump Inlet	0.0	<=>	2.22222E-01	***3/s	1.400E+00XFS	
19	*** Blank Channel ***						Arbitrary Unit ***		
20	*** Blank Channel ***						Arbitrary Unit ***		
21	Diff. Pressure	FX-101	Orifice (Liquid) (Low)	0.0	<=>	2.94200E-02	MPa	6.100E-01XFS	
22	Diff. Pressure	FX-002	Orifice (Steam) (Low)	0.0	<=>	2.94200E-02	MPa	6.100E-01XFS	
23	Fluid Temp.	TE-107	Orifice Inlet (Liquid)	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS	
24	Fluid Temp.	TE-108	Orifice Inlet (Steam)	2.73150E+02	<=>	7.58150E+02	K	4.820E-01XFS	
25	Vol. Flow Rate	FR-101	Liquid Flow Meter (Low)	0.0	<=>	2.77778E-03	***3/s	1.460E+00XFS	
26	Vol. Flow Rate	FR-102	Steam Flow Meter (Low)	0.0	<=>	5.55556E-04	***3/s	1.460E+00XFS	
27	*** Blank Channel ***						Arbitrary Unit ***		
28	*** Blank Channel ***						Arbitrary Unit ***		
29	*** Blank Channel ***						Arbitrary Unit ***		
30	*** Blank Channel ***						Arbitrary Unit ***		
31	*** Blank Channel ***						Arbitrary Unit ***		
32	*** Blank Channel ***						Arbitrary Unit ***		

Table 3.13 Major Specifications of Pitot Tube

• Type	Water Purge
• Pressure	
Max.	175 kg/cm ² G (17.26 MPa)
Operating	128 kg/cm ² G (12.65 MPa)
• Temperature	
Max.	350°C (623 K)
Operating	328°C (601 K)
• Flow Speed (Liquid)	
Low Range	0 ~ 1 m/s
High Range	0 ~ 10 m/s

Table 3.14(a) Major Specifications of Traversing Beam
Type Three-beam γ -Densitometer

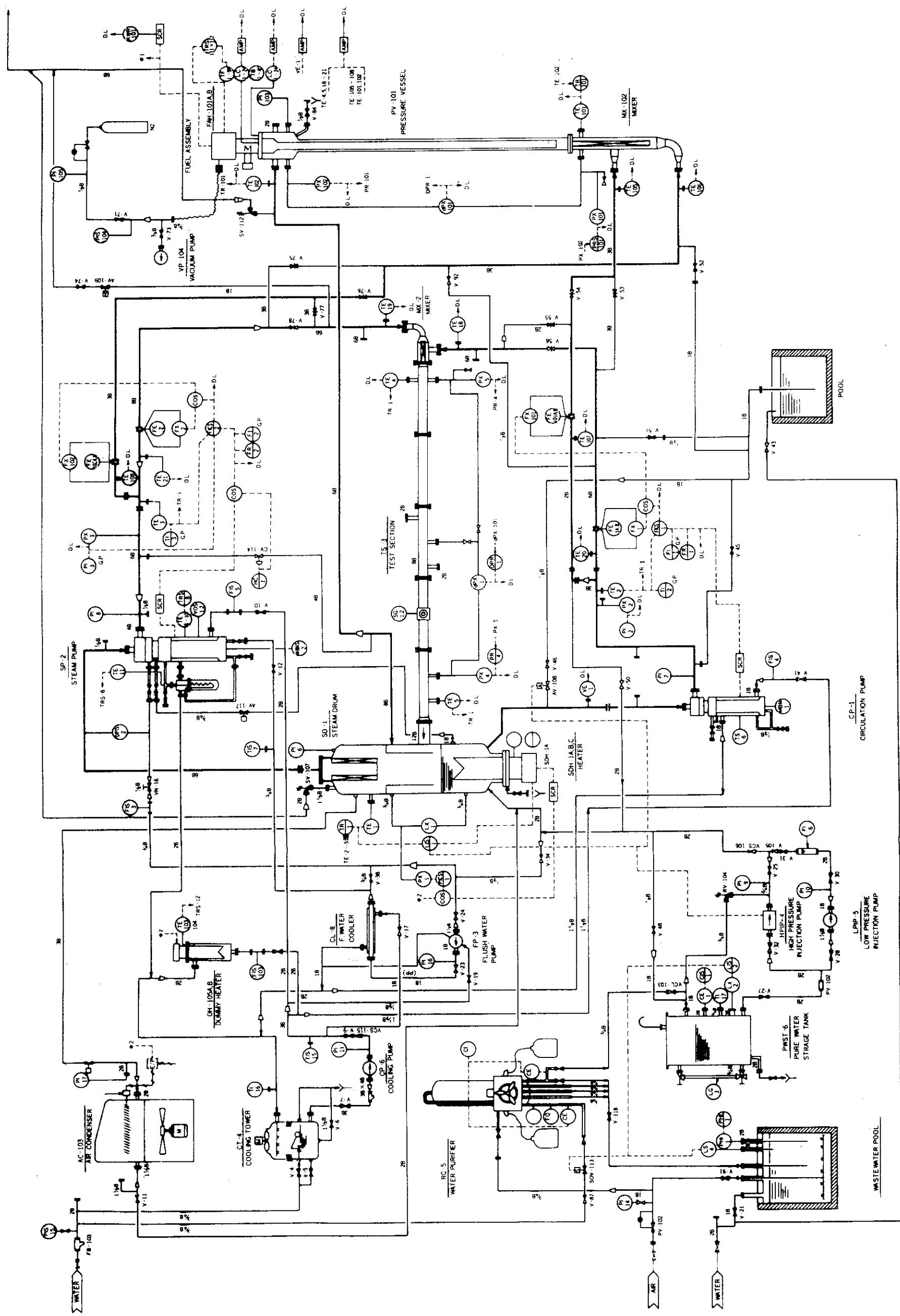
• γ -Source	
Isotope	¹³⁷ Cs
Activity	20 Ci
• Detector	
Type	NaI(Tl) Scintillation Counter
High Voltage Supply	~600 V
• Beam Angle	-15°/0/+15° vs. Vertical
• Traverse Length	± 250 mm
• Resolution	± 0.01 g/cm ³
• System Noise	± 1 mV r.m.s.

Table 3.14(b) Major Specifications of Fixed Beam Type
Three-beam γ -Densitometer

• γ -Source	
Isotope	^{137}Cs
Activity	Less than 10Ci
• Detector	
Type	NaI(Tl) Scintillation Counter
• Beam Angle	30°/40°/55° vs. Vertical
• Resolution	—
• System Noise	Less than 7 mV P-P

Table 3.15 Major Specifications of Full-flow
Type Dry Screen Flow Meter

• Type	Perforated Dray Screen with LVDT Transducer
• Fluid	Water and Steam
• Measuring Span	
Liquid Flow	$2.78 \times 10^{-3} \text{ m}^3/\text{s}$
Steam Flow	$1.94 \times 10^{-1} \text{ m}^3/\text{s}$
Momentum Flux	$2.0 \times 10^2 \sim 10^4 \text{ kg/m} \cdot \text{s}^2$
• Voil Fraction	$0 \sim 1$
• Pipe	8B Sch 120
• Maximum Opr. Press.	17.26 MPa (175 kg/cm ² G)
• Maximum Opr. Temp.	623.15 K (350°C)



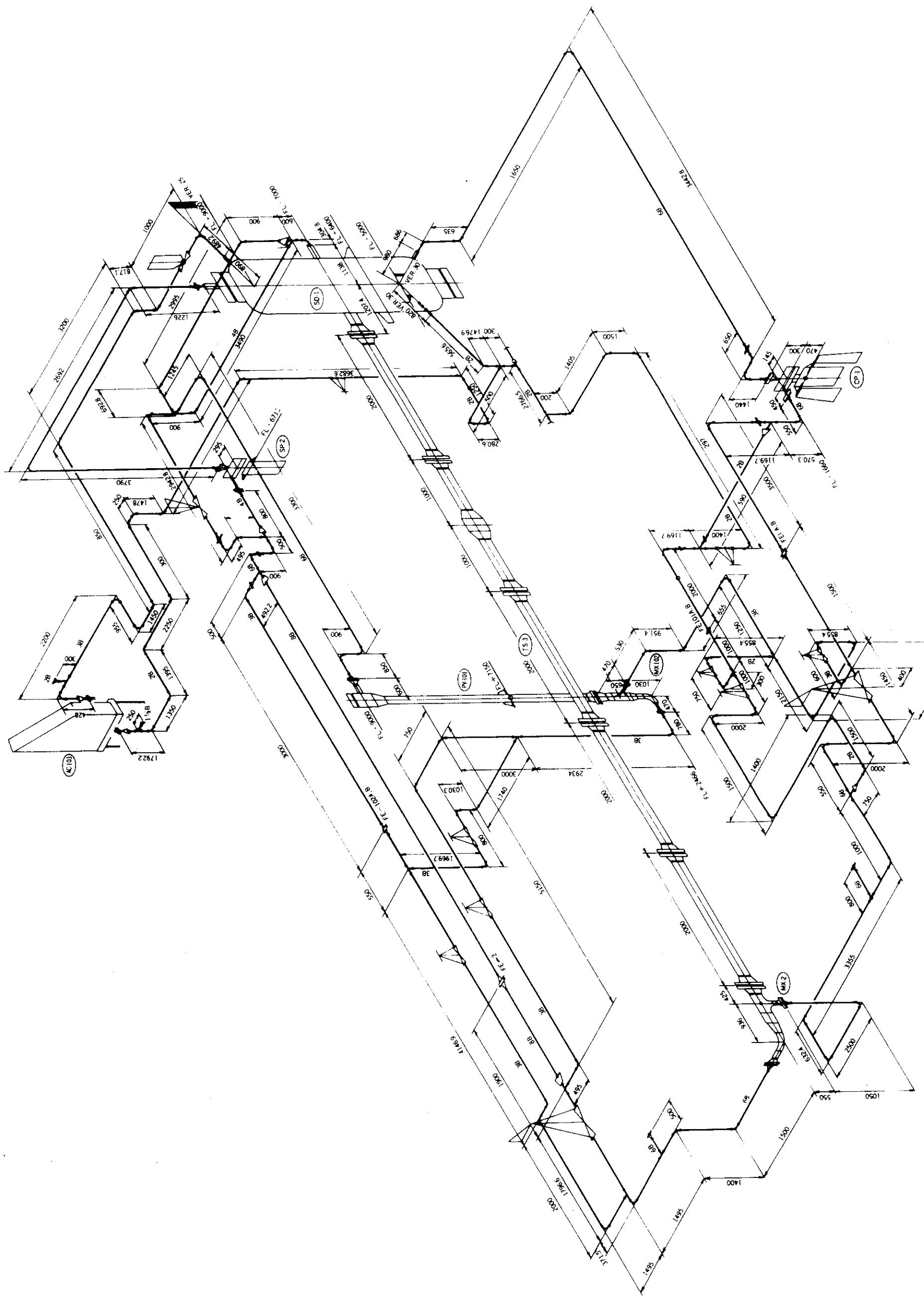


Figure 2. 2 Isometric Drawing of TPTF

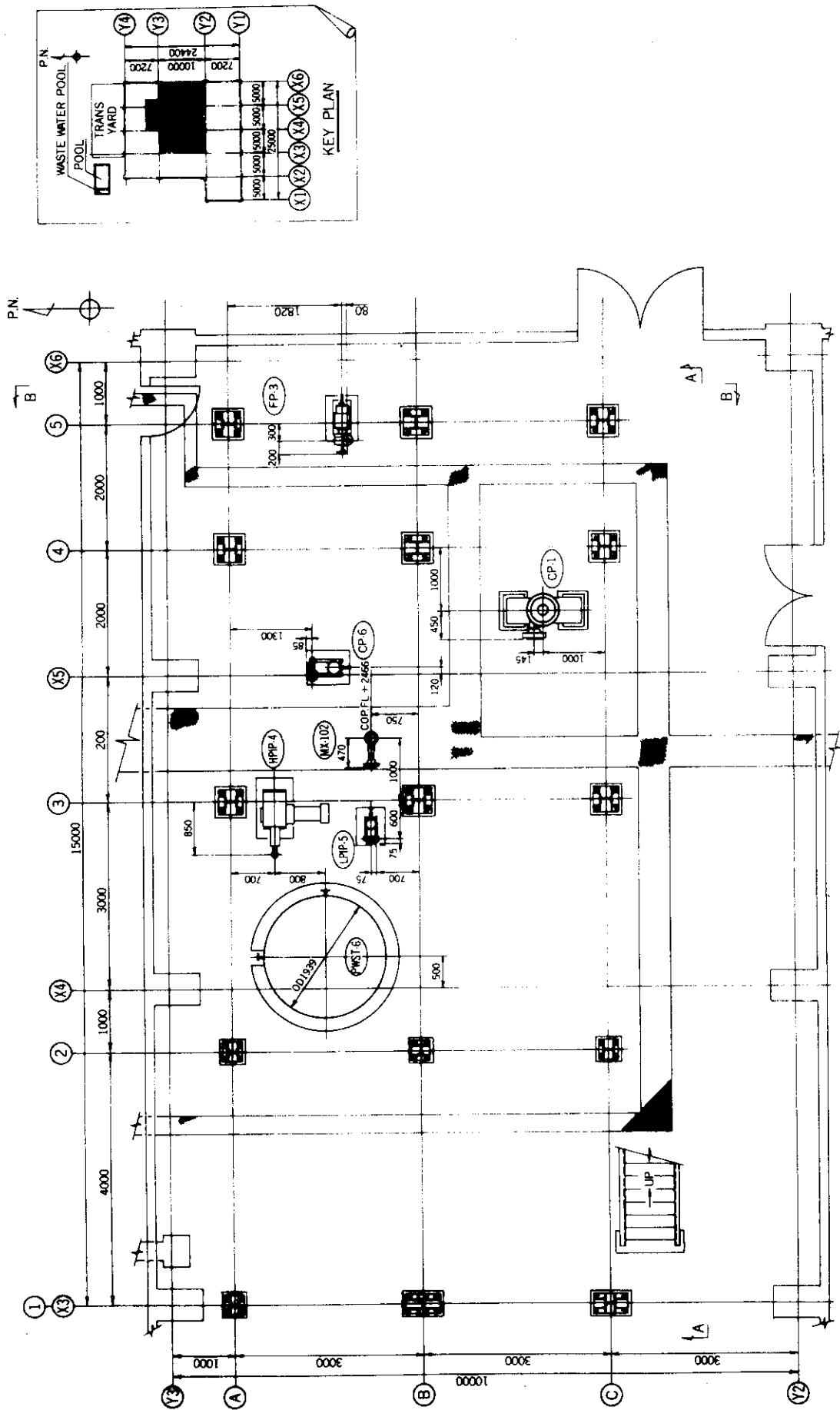


Figure 2. 3 Plan View of TPTF (FL + 0)

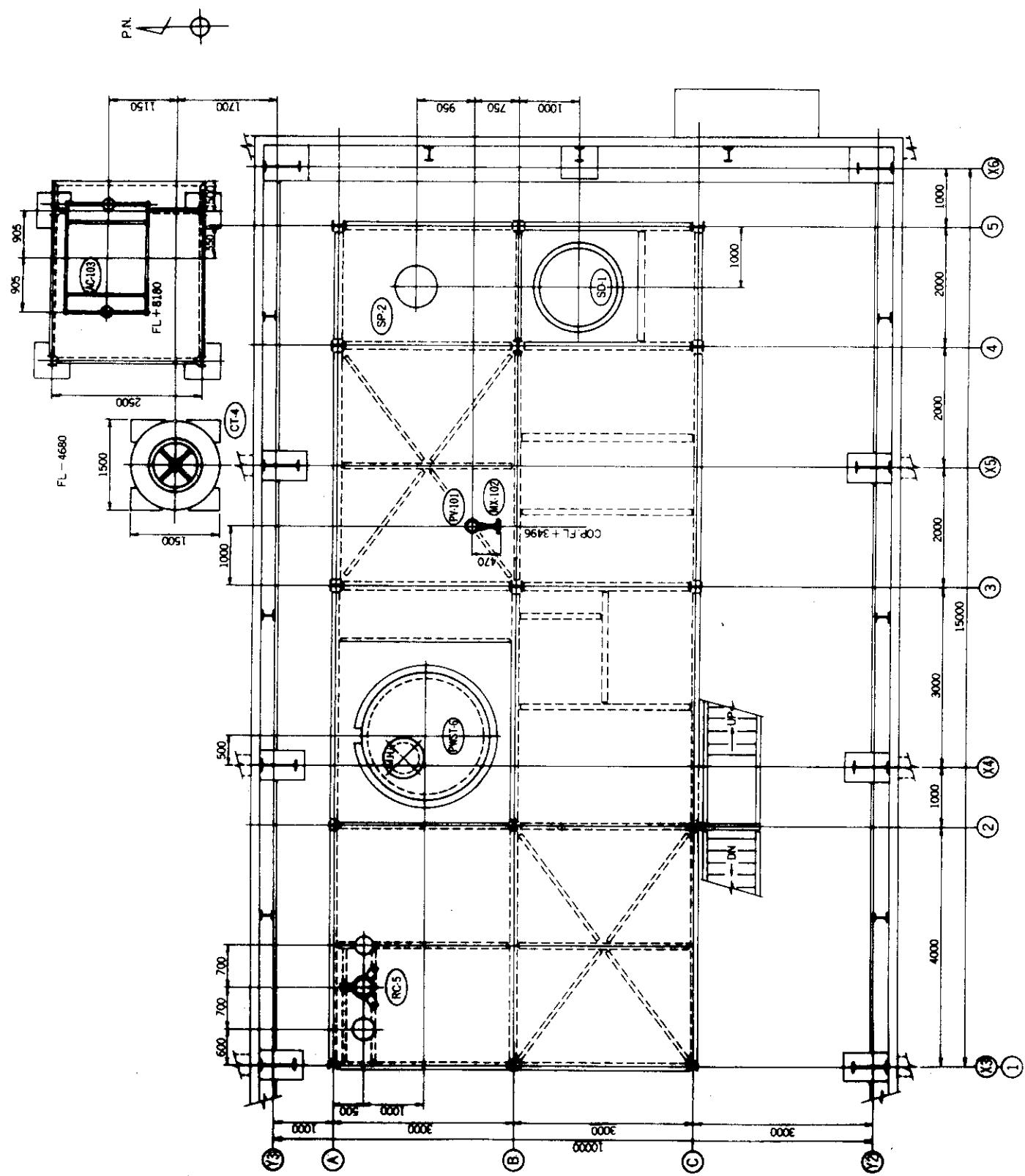


Figure 2. 4 Plan View of TPTF (FL + 3000)

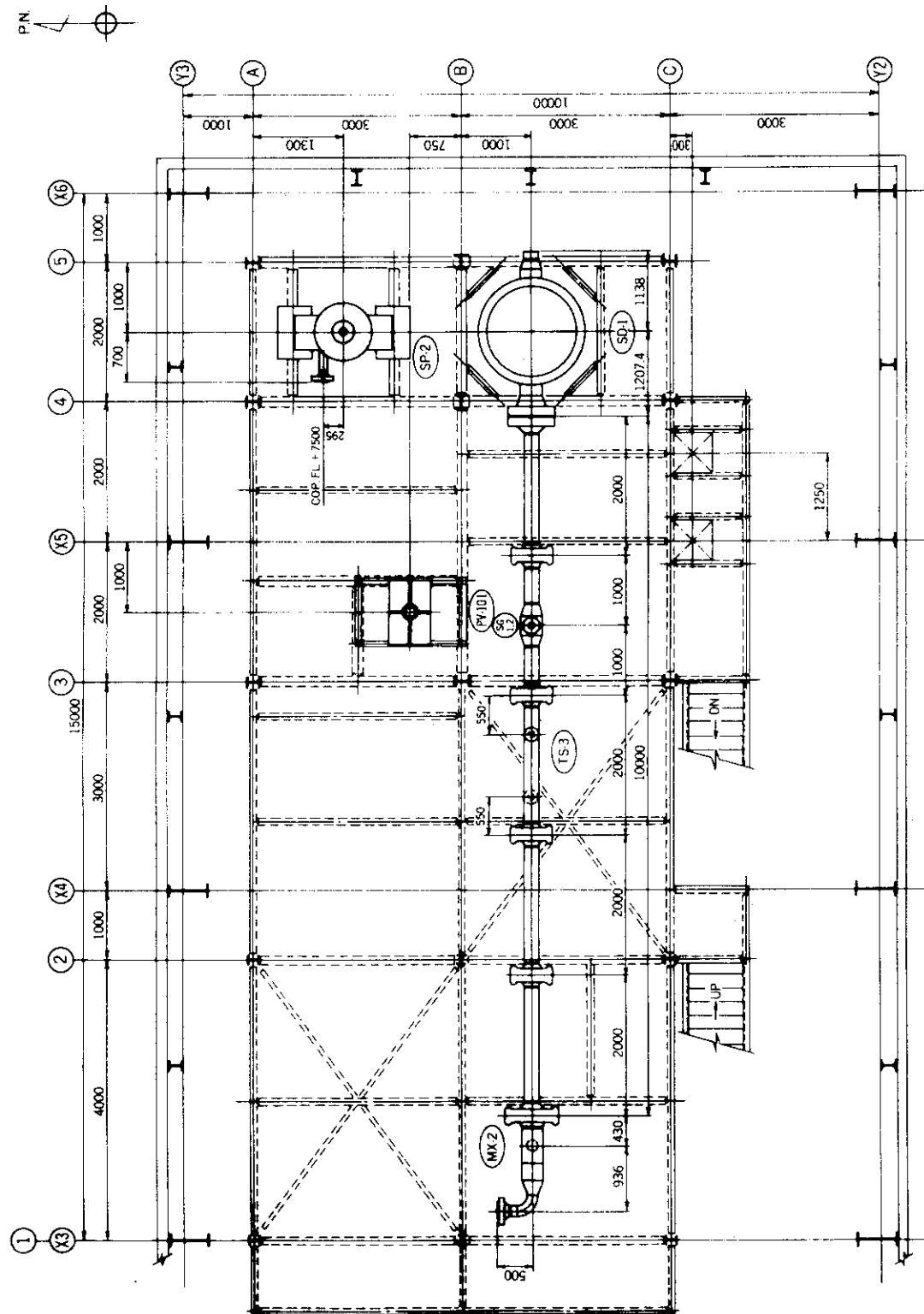


Figure 2. 5 Plan View of TPTF (FL + 6000)

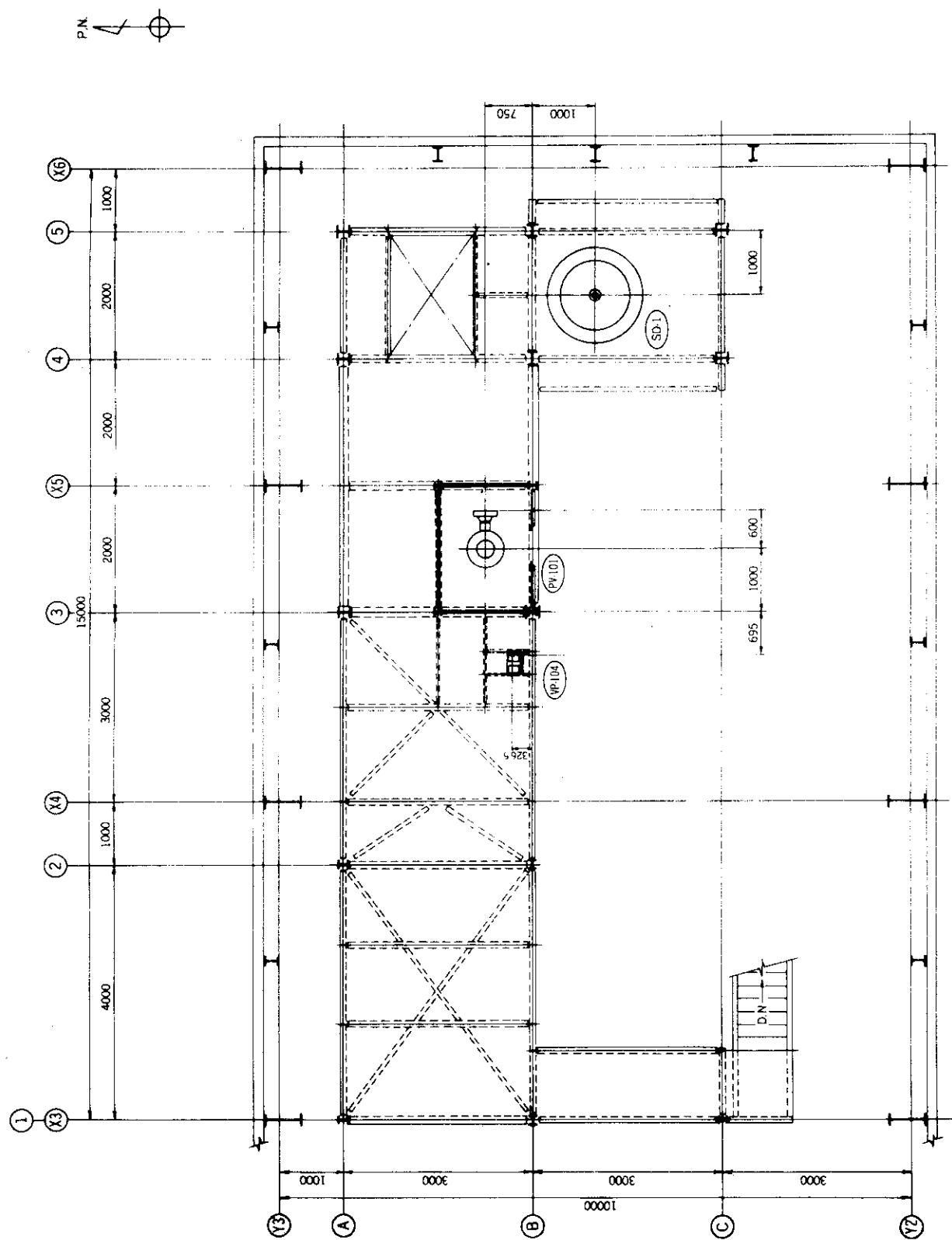


Figure 2. 6 Plan View of TPTF (FL + 9000)

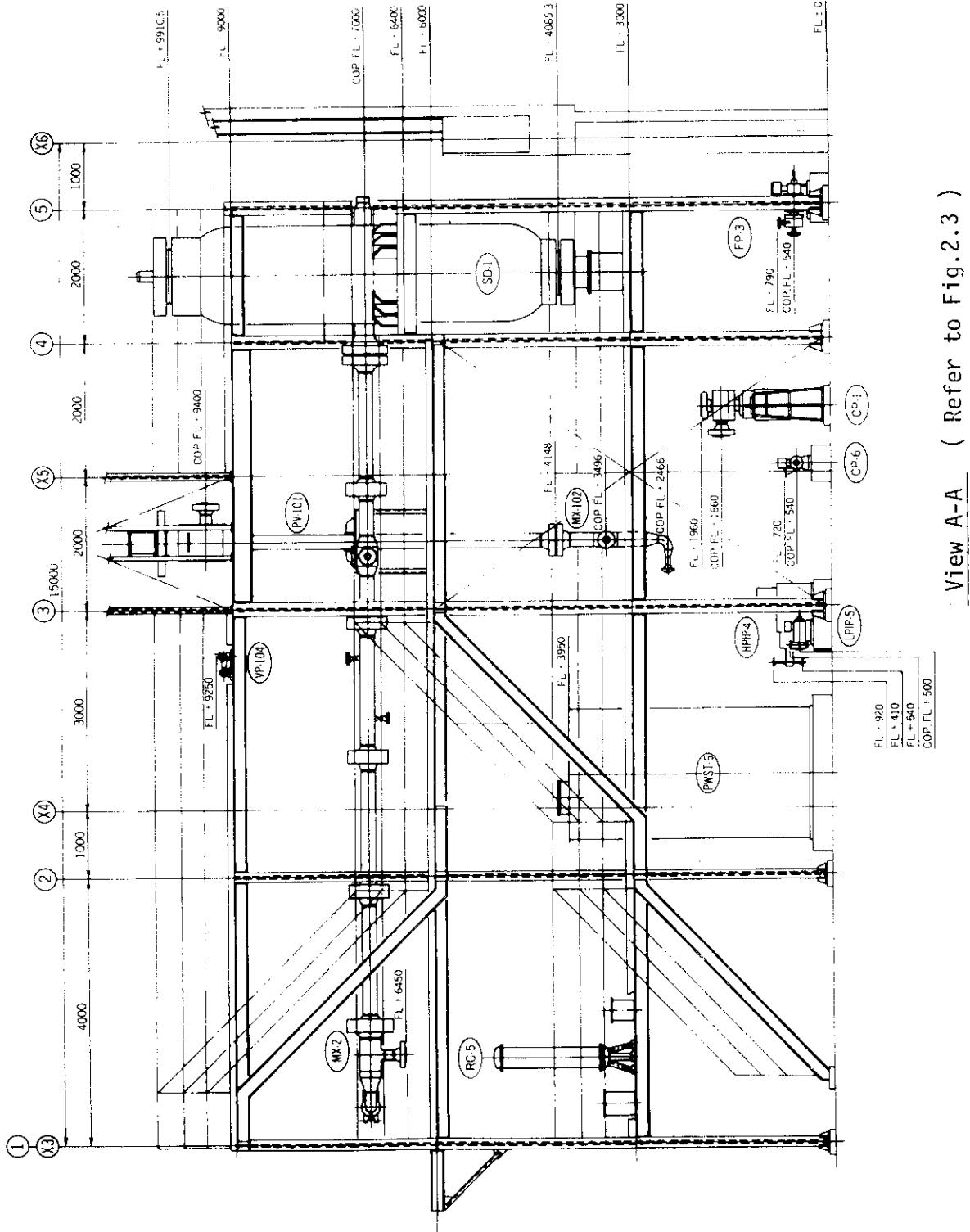
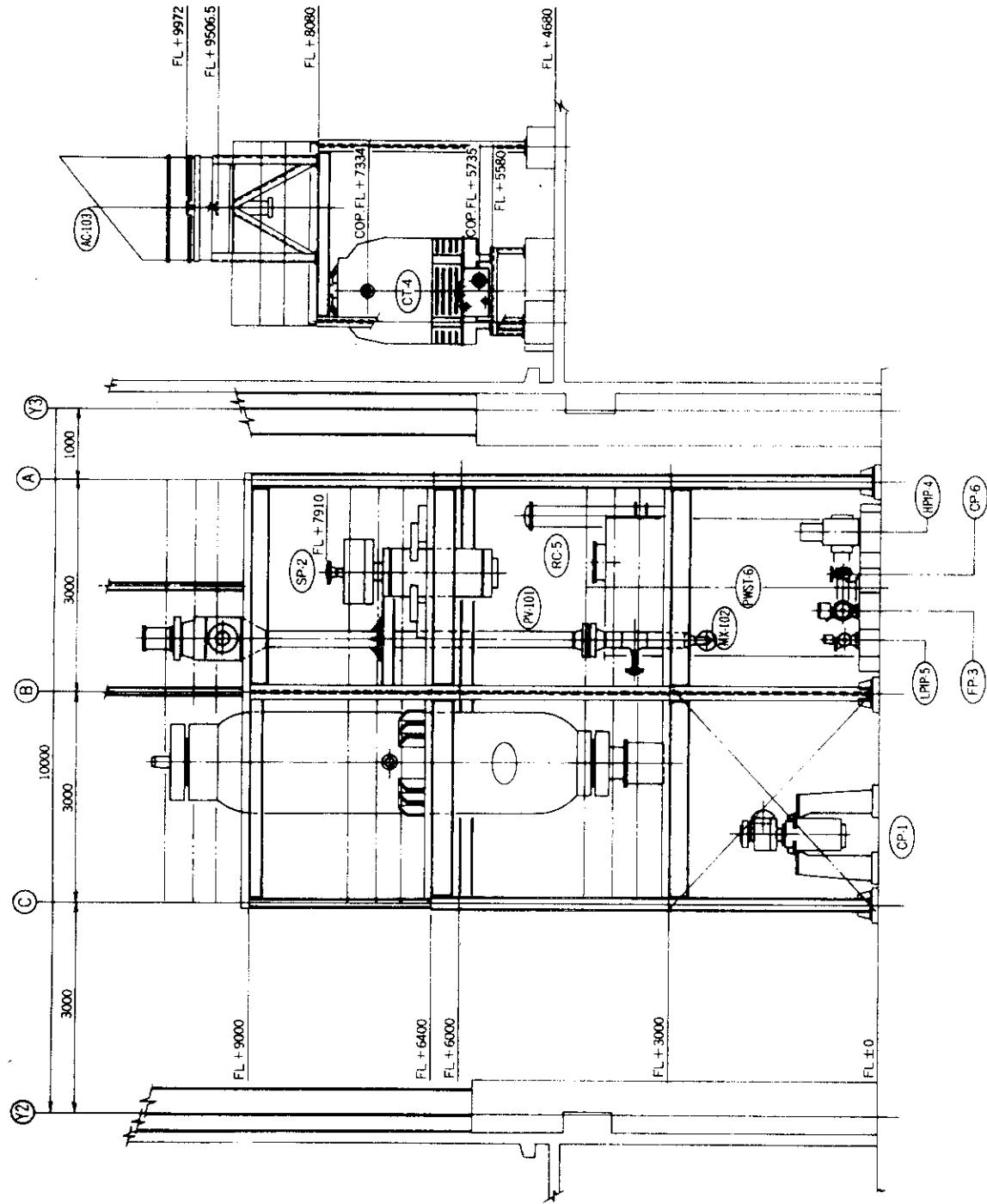
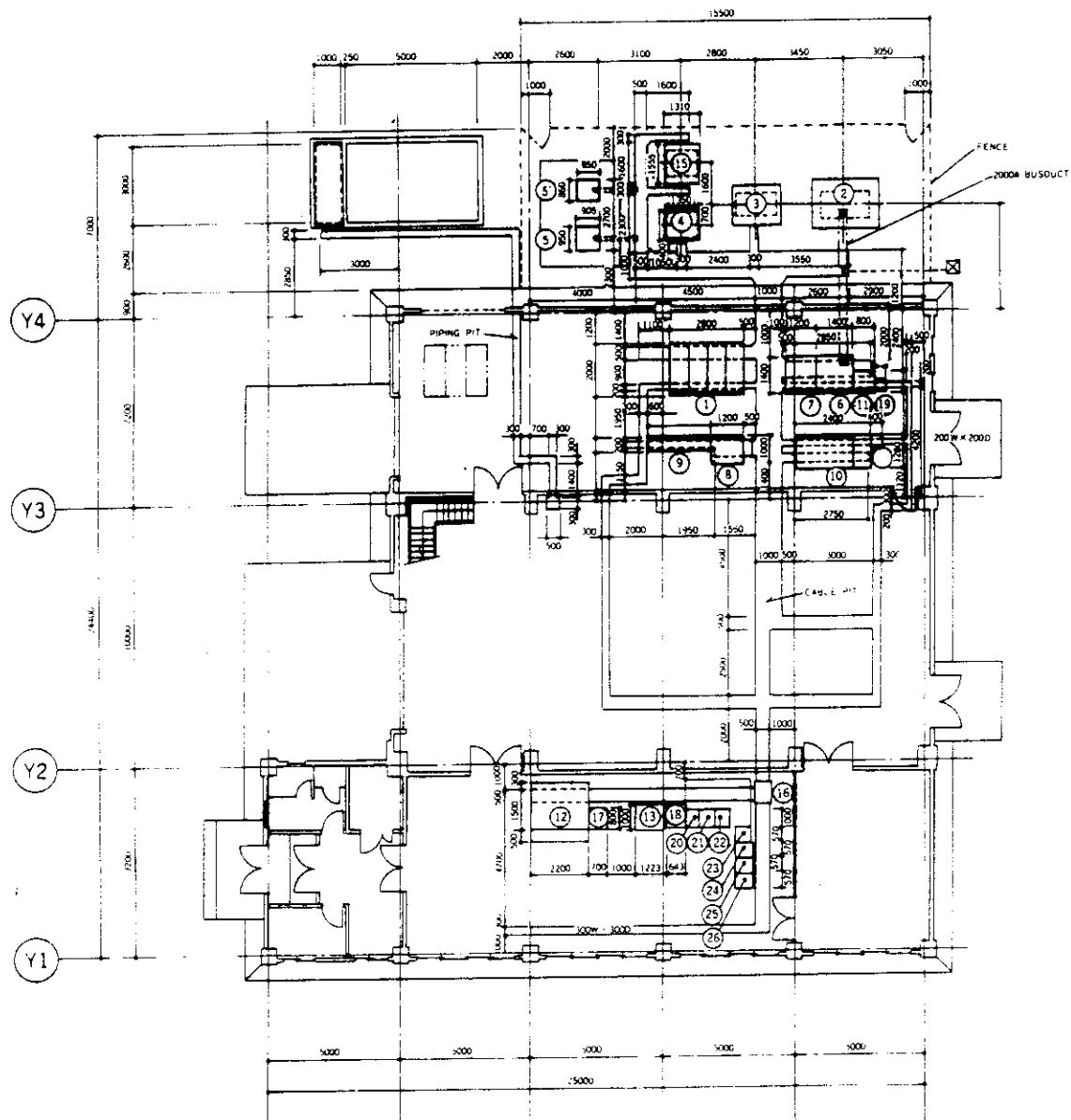


Figure 2. 7 Section View of TPTF



View B-B (Refer to Fig.2.3)

Figure 2. 8 Section View of TPTF



MARK	DESCRIPTION	SIZE
①	6.6KV HIGH VOLTAGE SWITCHBOARD	2800W × 2350H × 2200D
②	6.6KV/660V 1700KVA TRANSFORMER	2600W × 2200H × 1950D
③	6.6KV/440V 750KVA TRANSFORMER	1850W × 2000H × 1500D
④	6.6KV/440V 500KVA TRANSFORMER	1350W × 1750H × 1200D
⑤	NO.5 HARMONIC FILTER	950W × 2135H × 950D
⑥	NO.7 HARMONIC FILTER	860W × 2040H × 850D
⑦	FUEL ASSEMBLY POWER CONTROLLER	1400W × 2350H × 1400D
⑧	STEAM DRUM HEATER POWER CONTROLLER	1200W × 2350H × 1400D
⑨	LOW VOLTAGE SWITCHBOARD	1200W × 2350H × 1000D
⑩	CONTROL CENTER CUBICLE	2400W × 2350H × 500D
⑪	STEAM PUMP SPEED CONTROLLER	2910W × 2650H × 1280D
⑫	CIRCULATION PUMP SPEED CONTROLLER	800W × 2465H × 800D
⑬	MAIN CONTROL PANEL	2200W × 2600H × 2300D
⑭	DATA LOGGER	1223W × 1845H × 915D
⑮	POWER SUPPLY FOR INSTRUMENTATION	600W × 1100H × 600D
⑯	400/440/440V 400 200 200KVA TIE TRANSFORMER	1310W × 1890H × 1555D
⑰	C.A. TERMINAL	600W × 1850H × 800D
⑱	FUEL ASSEMBLY TEMPERATURE MONITOR	700W × 1850H × 800D
⑲	D.C. AMPLIFIER	643W × 1845H × 805D
⑳	TRANSFORMER FOR INSTRUMENTATION	400W × 650H × 400D
㉑ - ㉖	D.C. AMPLIFIER	570W × 1845H × 700D

Figure 2. 9 Electrical Equipment Layout of TPTF

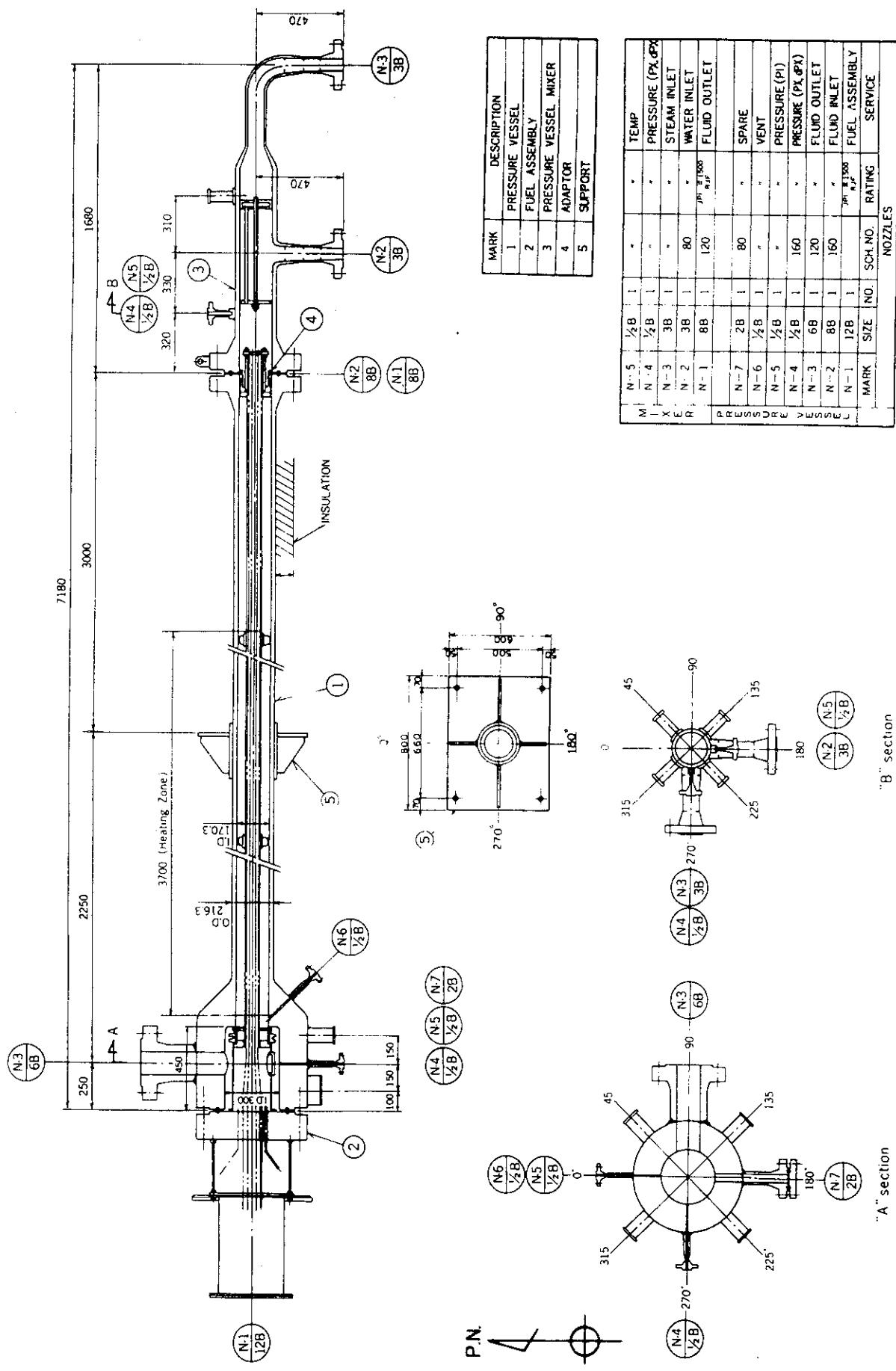


Figure 2.10 Pressure Vessel (PV-101)

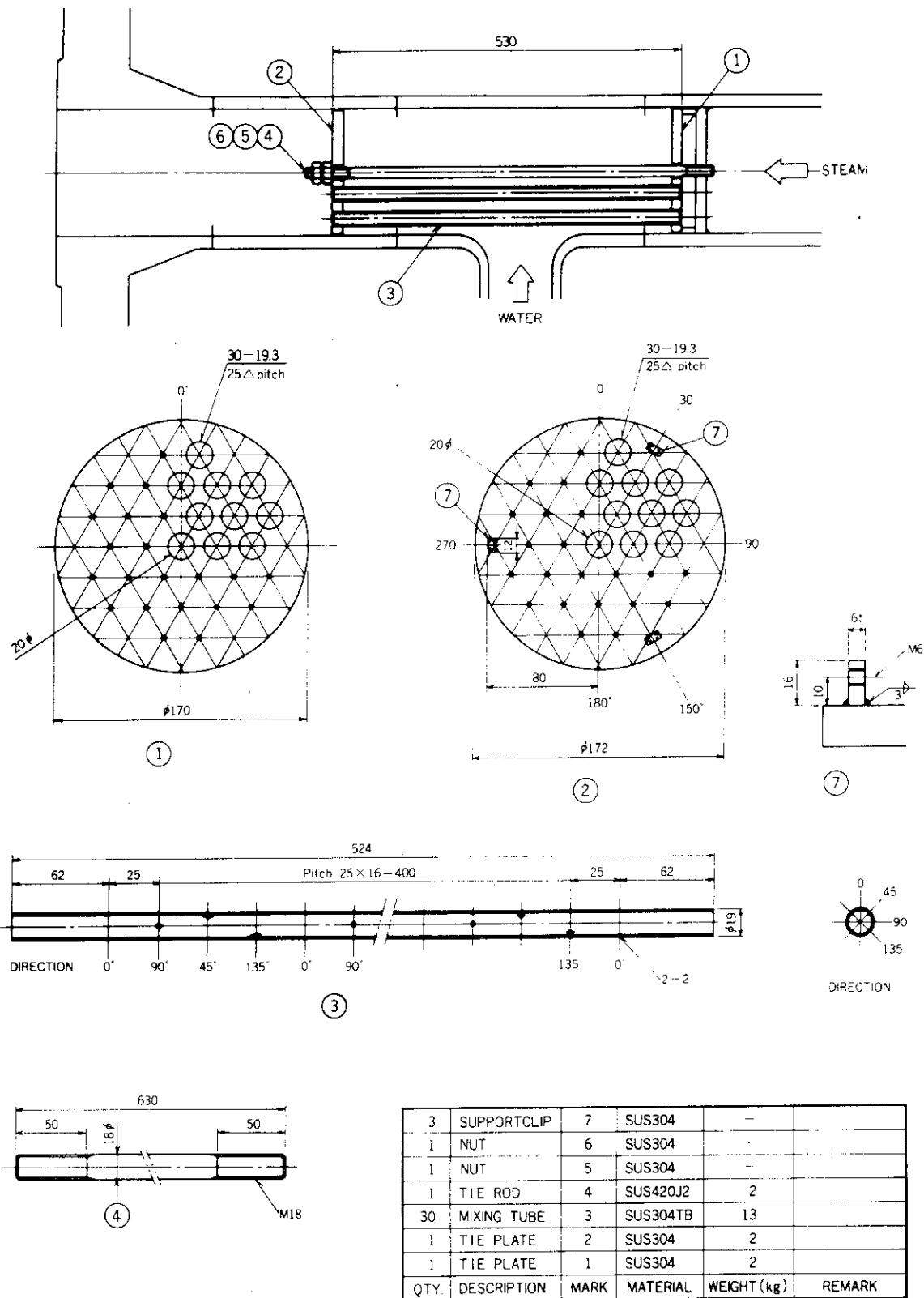


Figure 2.11 Pressure Vessel Mixer (MX-102)

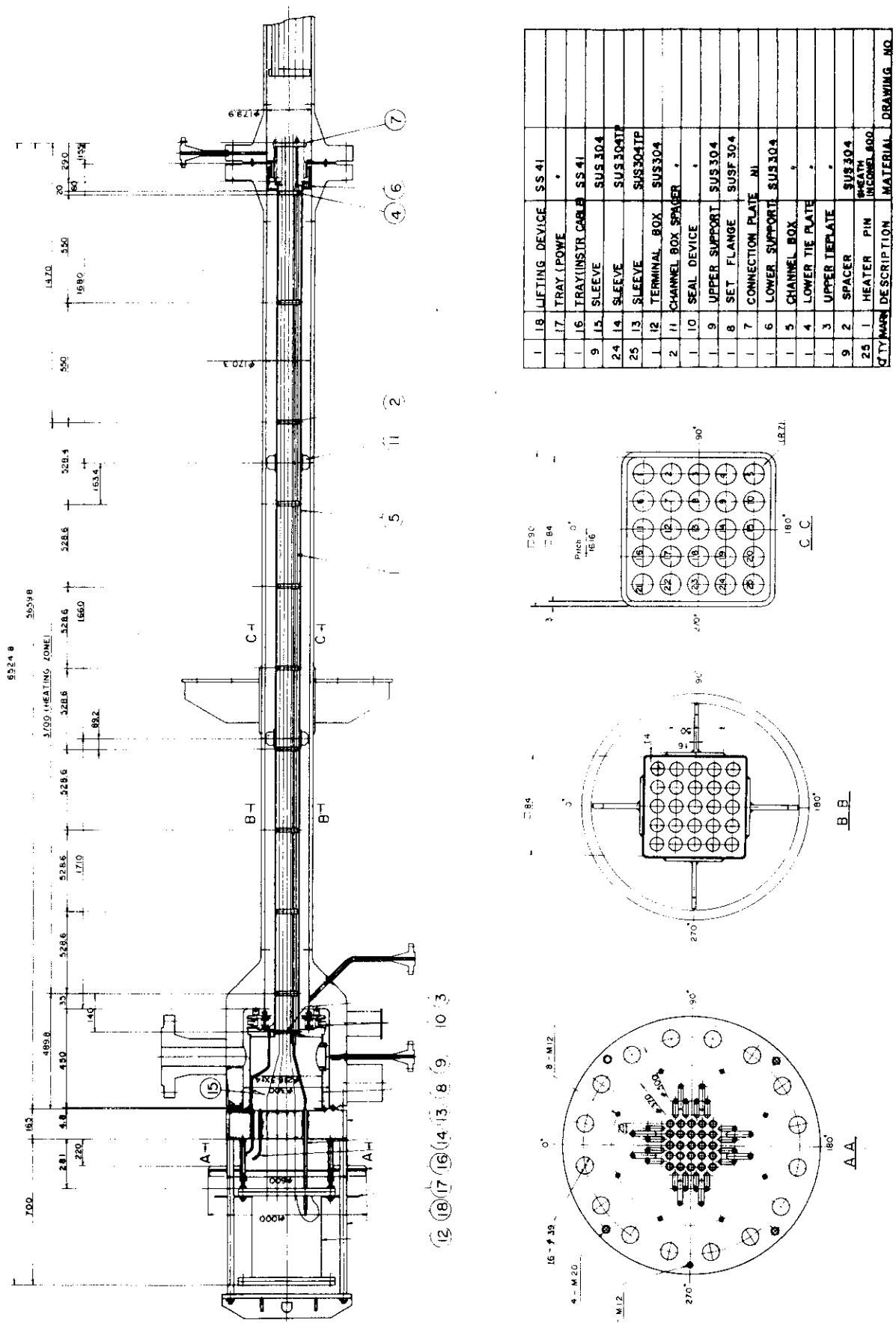


Figure 2.12 Fuel Assembly and Pressure Vessel

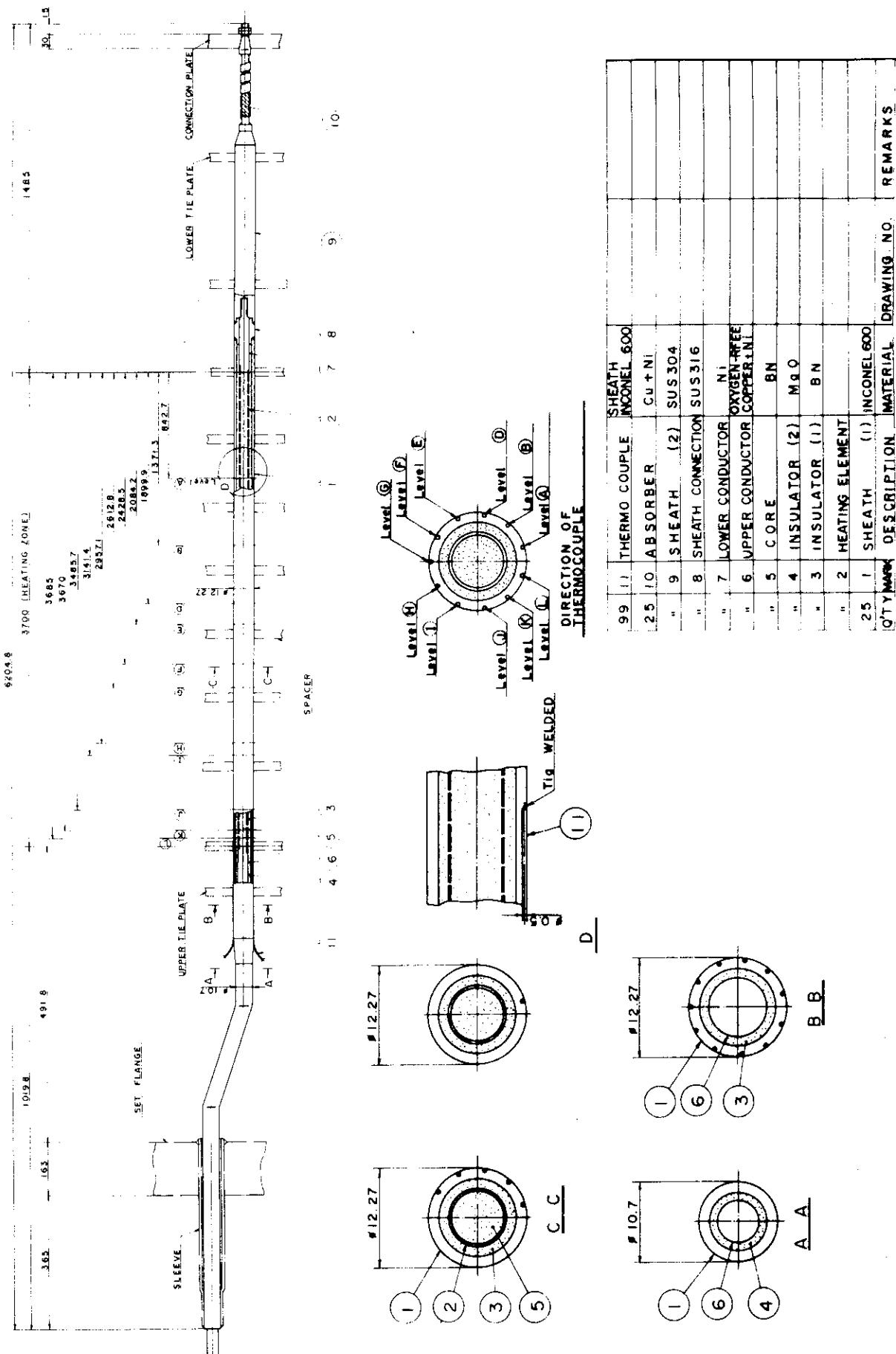
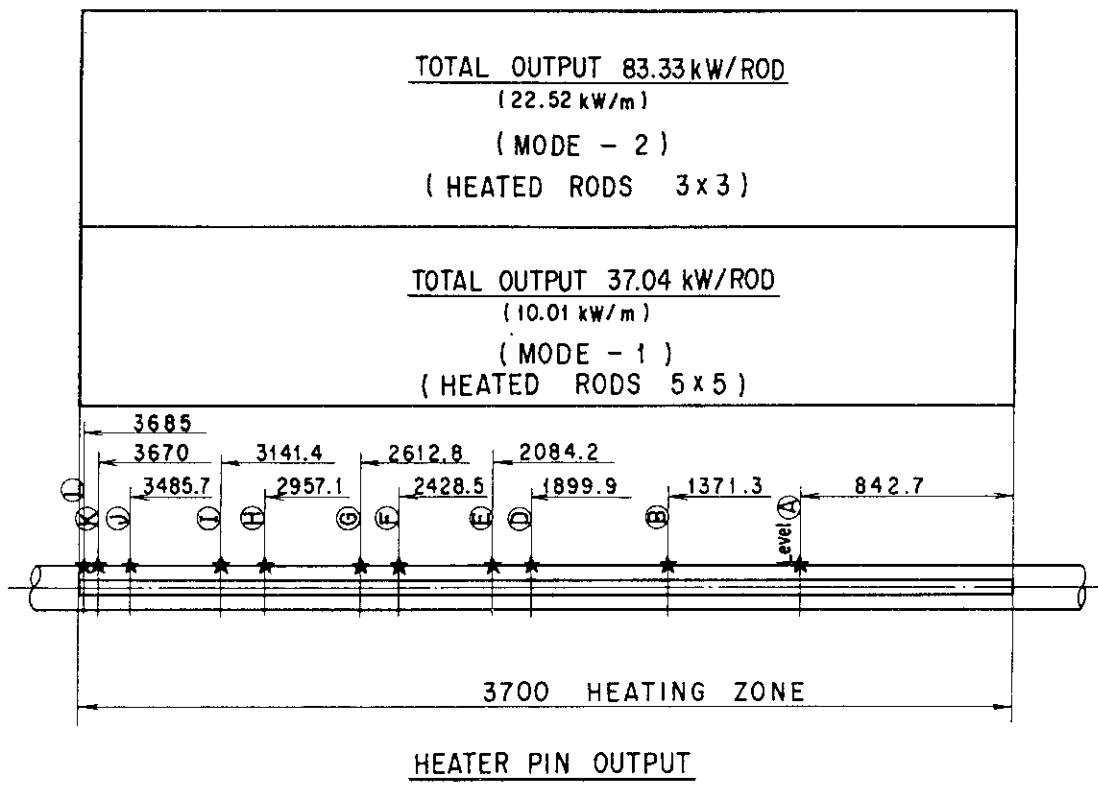


Figure 2.13 Simulated Fuel Rod of TPTF

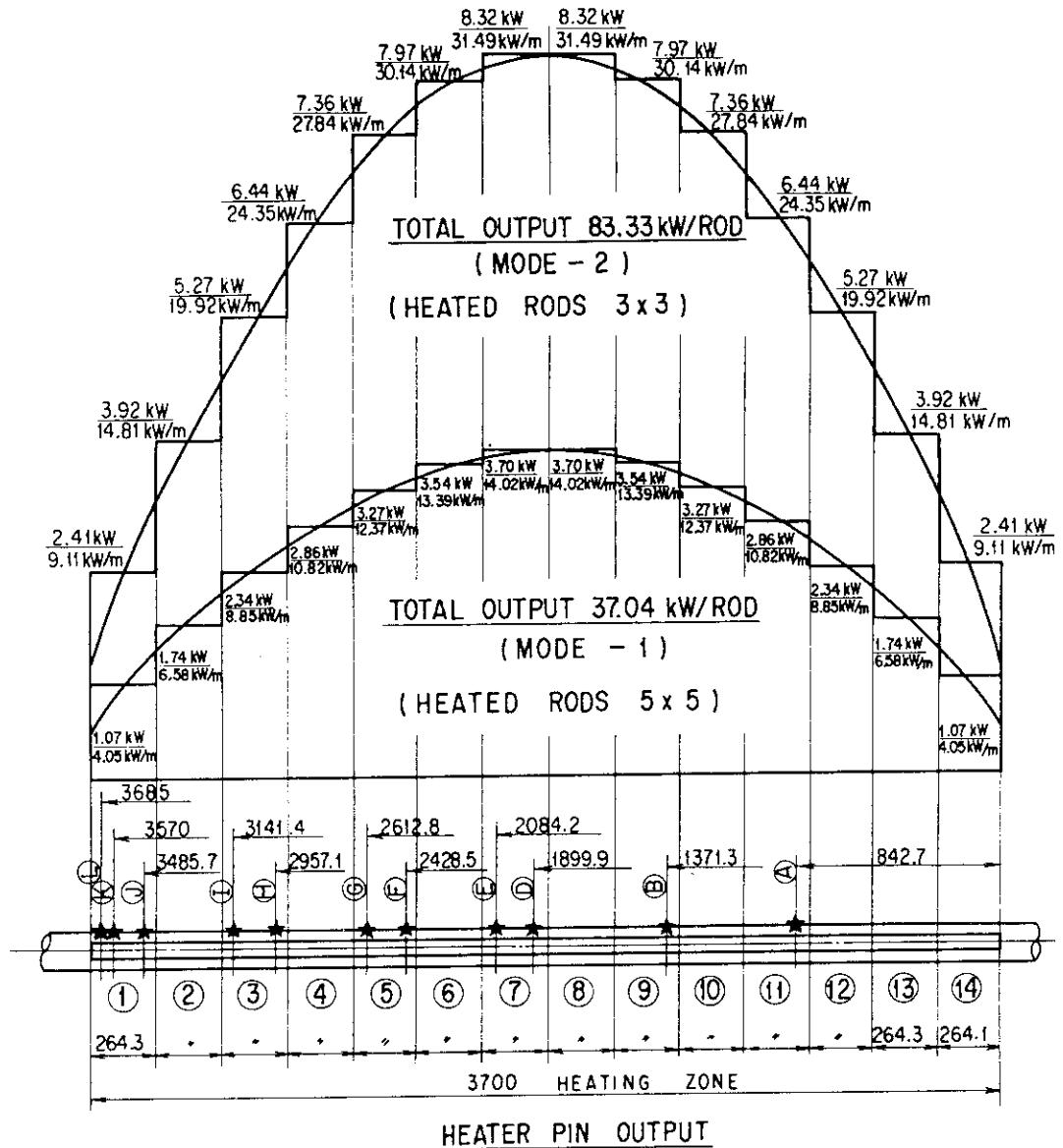
37.04 kW/ROD (MODE-1) SPECIFICATION

OUTPUT 37.04 kW
HEAT-FLUX 26.0 W/cm²
RESISTANCE (DESIGN) 1.4398Ω RATED
POWER SOURCE AC400V 3φ Y CONNECTION

83.33 kW/ROD (MODE-2) SPECIFICATION

OUTPUT 83.33 kW
HEAT-FLUX 58.4 W/cm²
RESISTANCE (DESIGN) 1.4398Ω RATED
POWER SOURCE AC600V 3φ Y CONNECTION

Figure 2.14(a) Axial Power Distribution of Heater Rod of Fuel Assembly A

**37.04 kW/ROD(MODE-1) SPECIFICATION**

DIVISION		DESIGN VALUES		
OUTPUT RATIO	OUTPUT (kW)	HEAT FLUX (W/cm²)	RESISTANCE (Ω)	
① ⑭	0.405	1.07	10.5	0.0416
② ⑬	0.659	1.74	17.1	0.0676
③ ⑫	0.885	2.34	23.0	0.0910
④ ⑪	1.082	2.86	28.1	0.1112
⑤ ⑩	1.236	3.27	32.1	0.1271
⑥ ⑨	1.339	3.54	34.7	0.1376
⑦ ⑧	1.400	3.70	36.3	0.1438
TOTAL	—	37.04	AVERAGE 26.0 W/cm²	1.4398

(POWER SOURCE AC400V 3Φ Y CONNECTION)

83.33 kW/ROD(MODE-2) SPECIFICATION

DIVISION		DESIGN VALUES		
OUTPUT RATIO	OUTPUT (kW)	HEAT FLUX (W/cm²)	RESISTANCE (Ω)	
① ⑭	0.405	2.41	23.6	0.0416
② ⑬	0.659	3.92	38.4	0.0676
③ ⑫	0.885	5.27	51.7	0.0910
④ ⑪	1.082	6.44	63.2	0.1112
⑤ ⑩	1.236	7.36	72.2	0.1271
⑥ ⑨	1.339	7.97	78.2	0.1376
⑦ ⑧	1.400	8.32	81.7	0.1438
TOTAL	—	83.33	AVERAGE 58.4 W/cm²	1.4398

(POWER SOURCE AC600V 3Φ Y CONNECTION)

Figure 2.14(b) Axial Power Distribution of Heater Rod of Fuel Assembly B

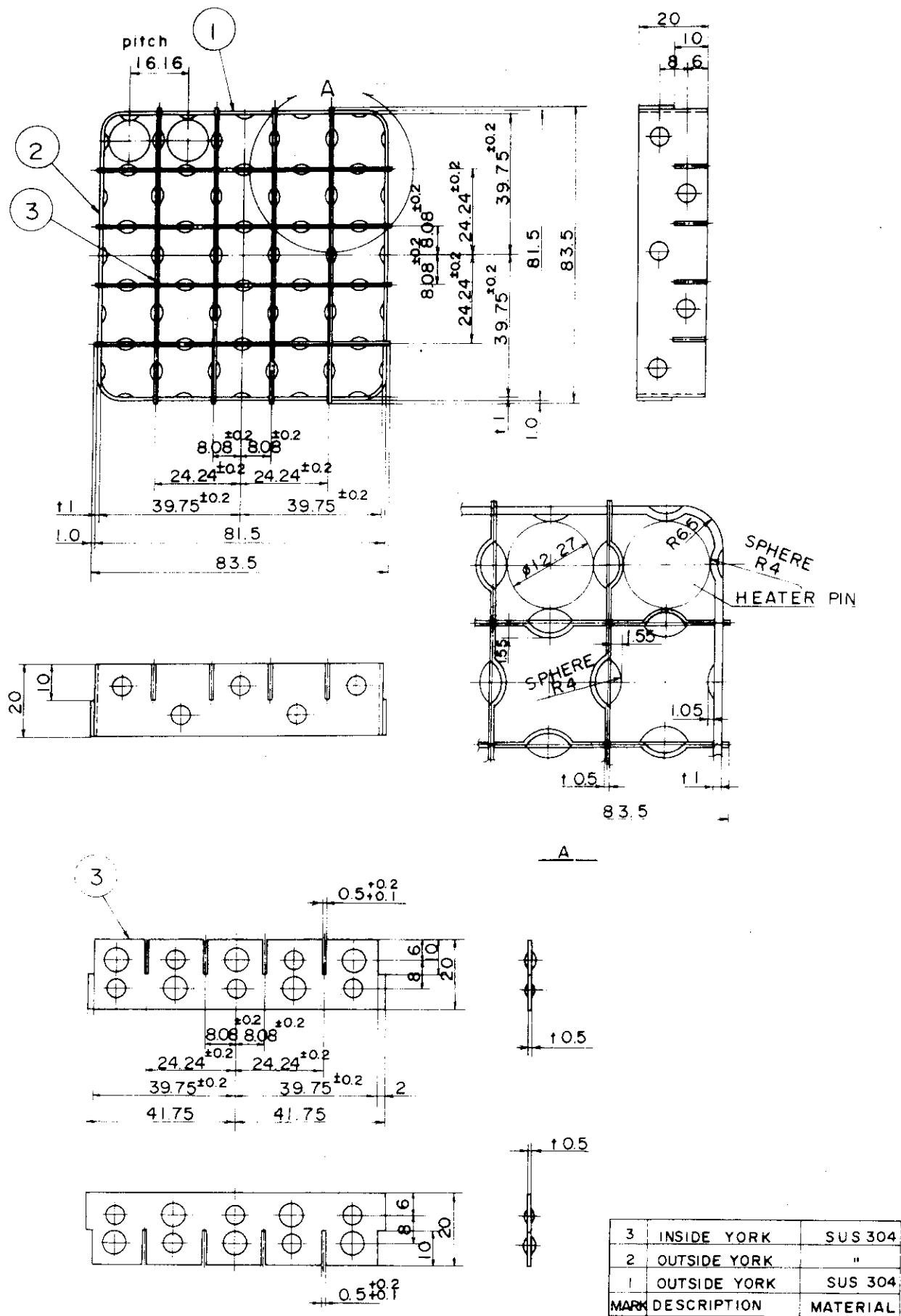
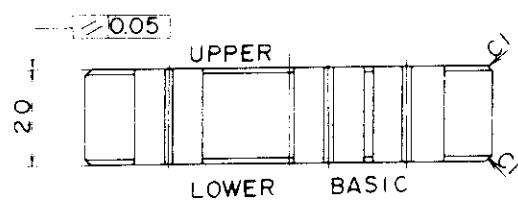
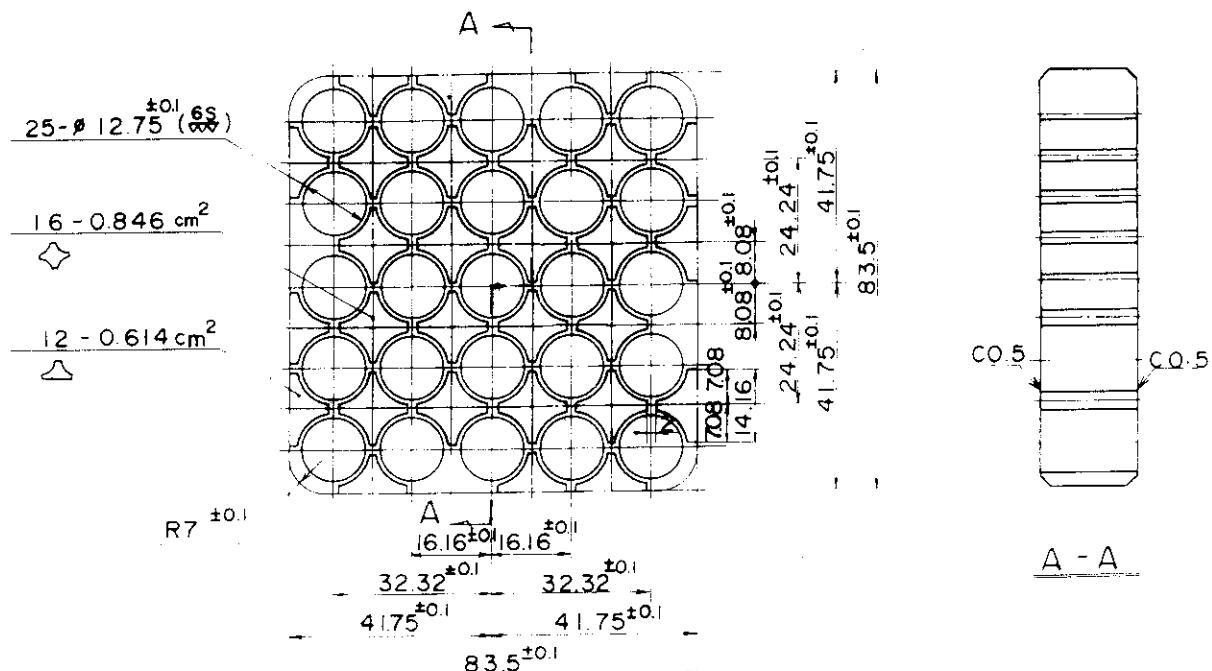


Figure 2.15 Fuel Assembly Spacer



1. MATERIAL SUS 304
2. Q'TY 4
3. AREA FOR FLUID
SUM 24.10 cm^2

Figure 2.16 Fuel Assembly Tie Plate

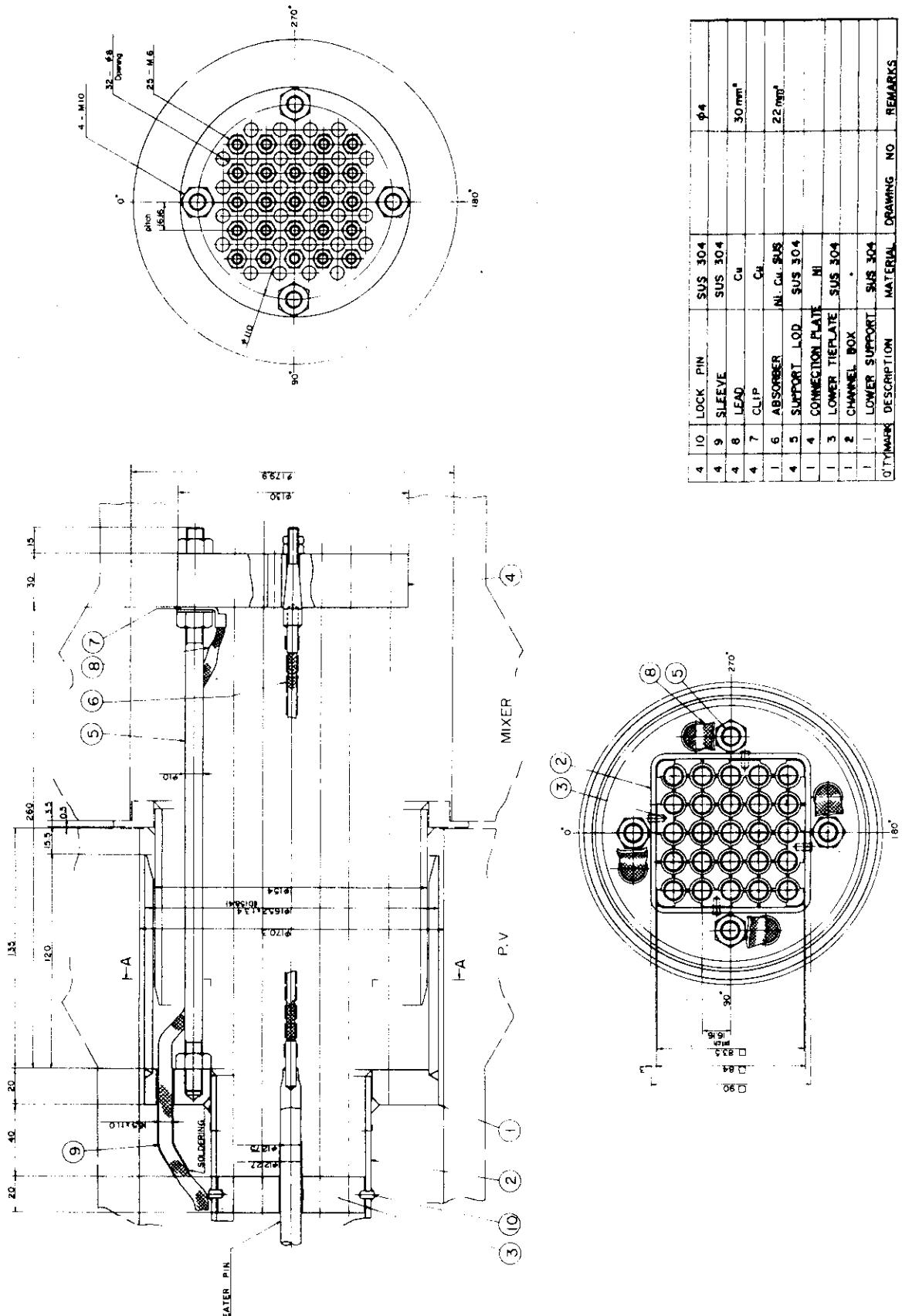


Figure 2.17 Fuel Assembly Lower Support

A-A

JAERI-M 83-042

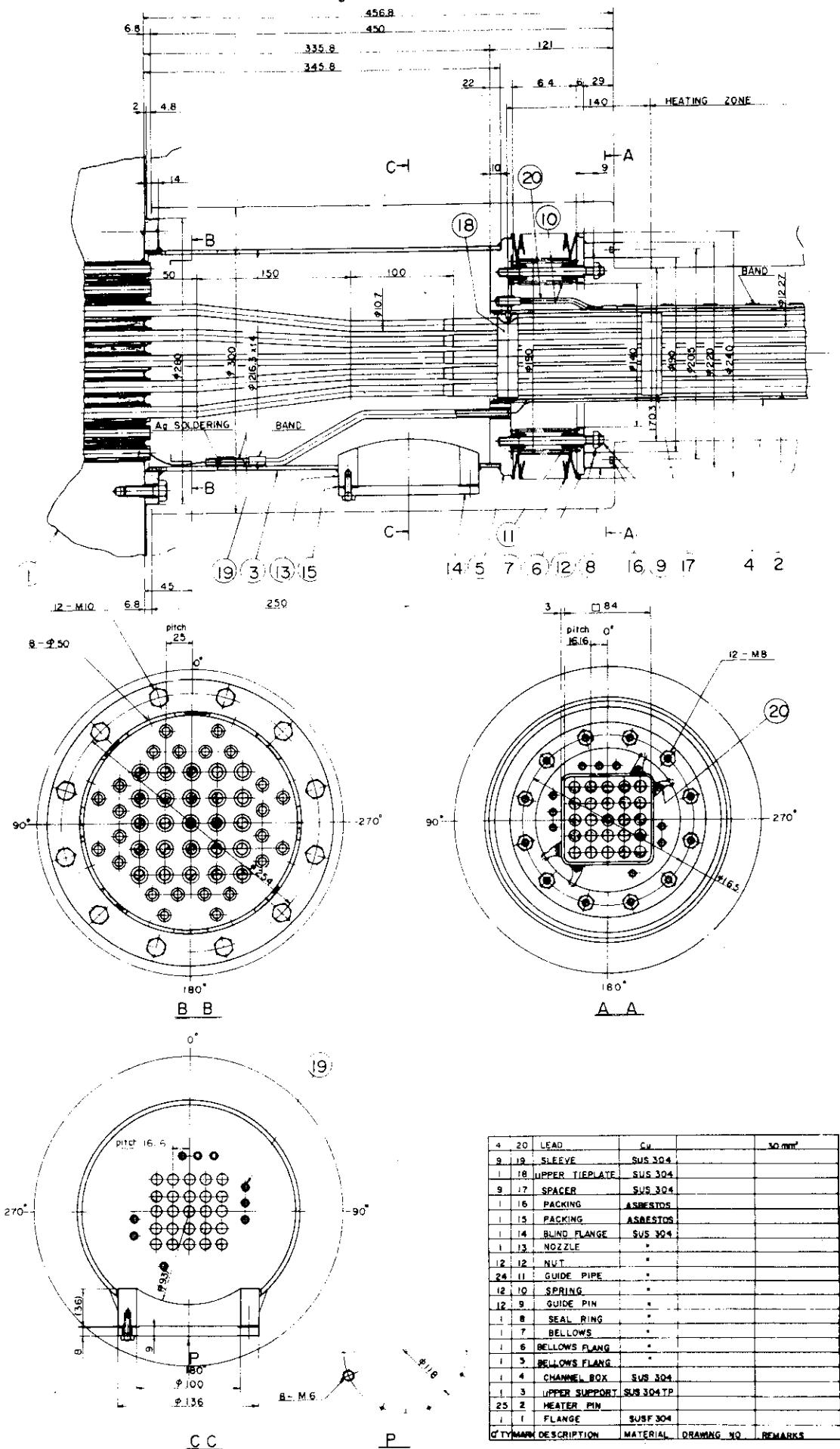


Figure 2.18 Fuel Assembly Upper Support

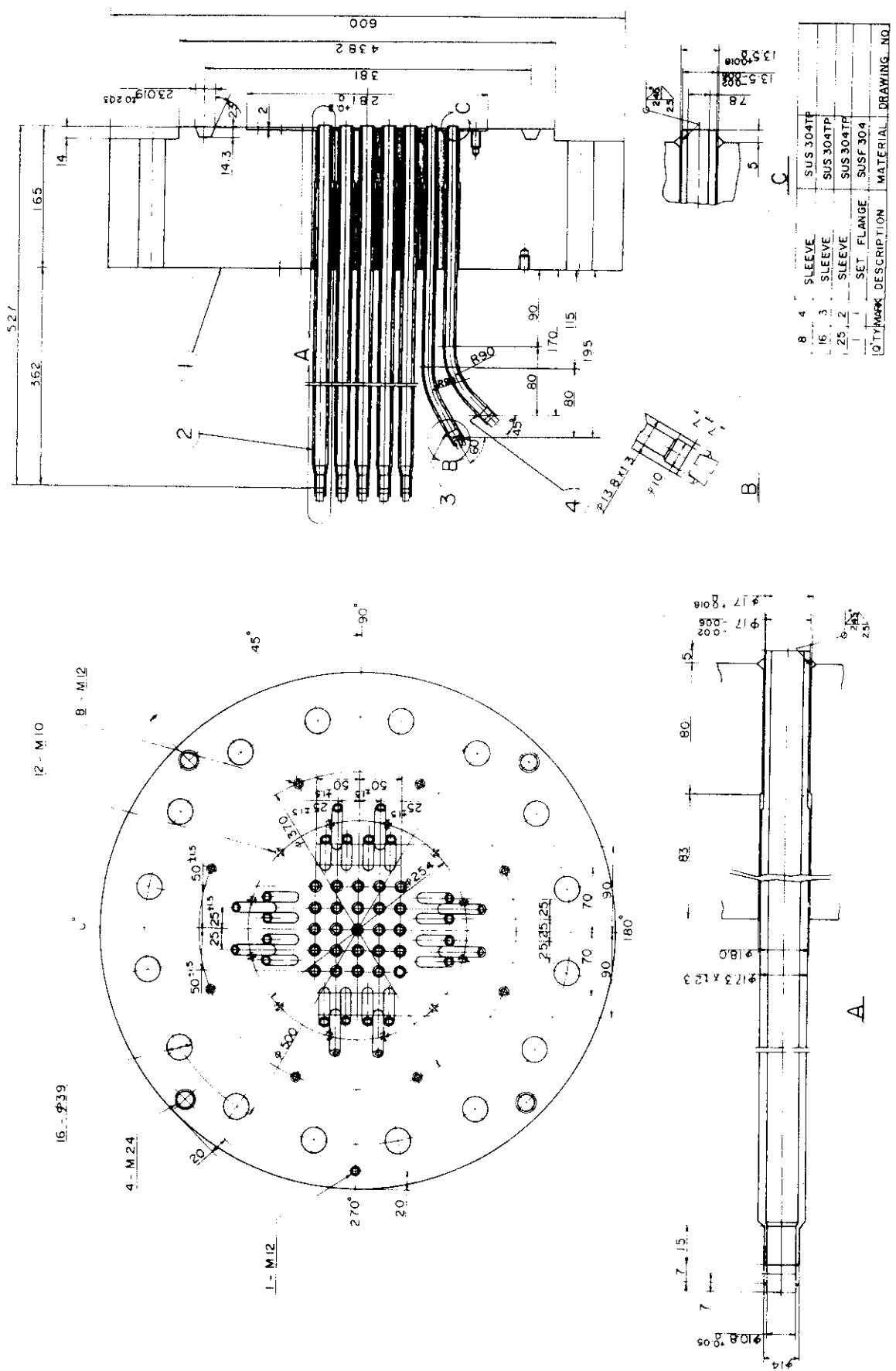


Figure 2.19 Fuel Assembly Set Flange

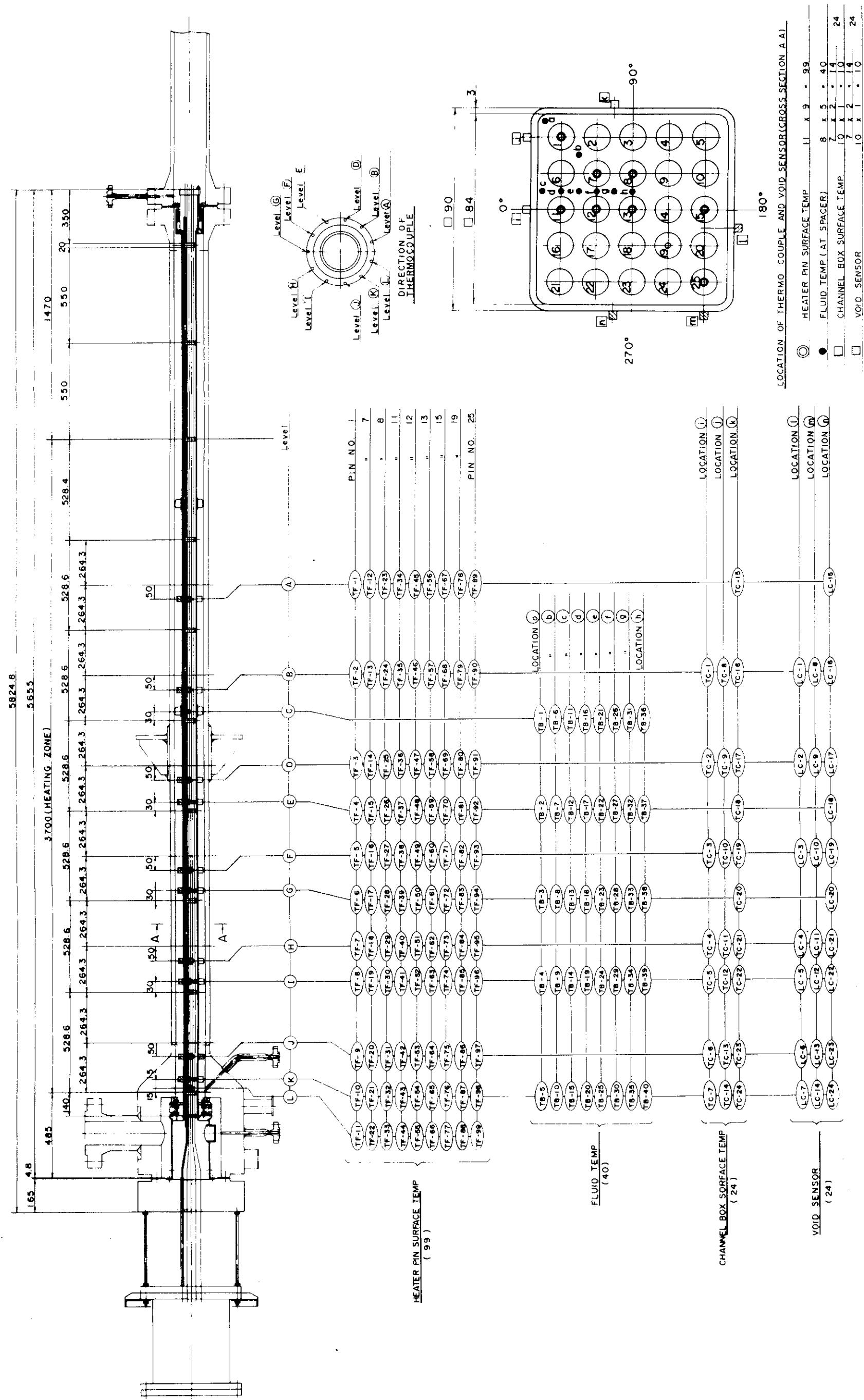


Figure 2.20 Fuel Assembly Instrumentation

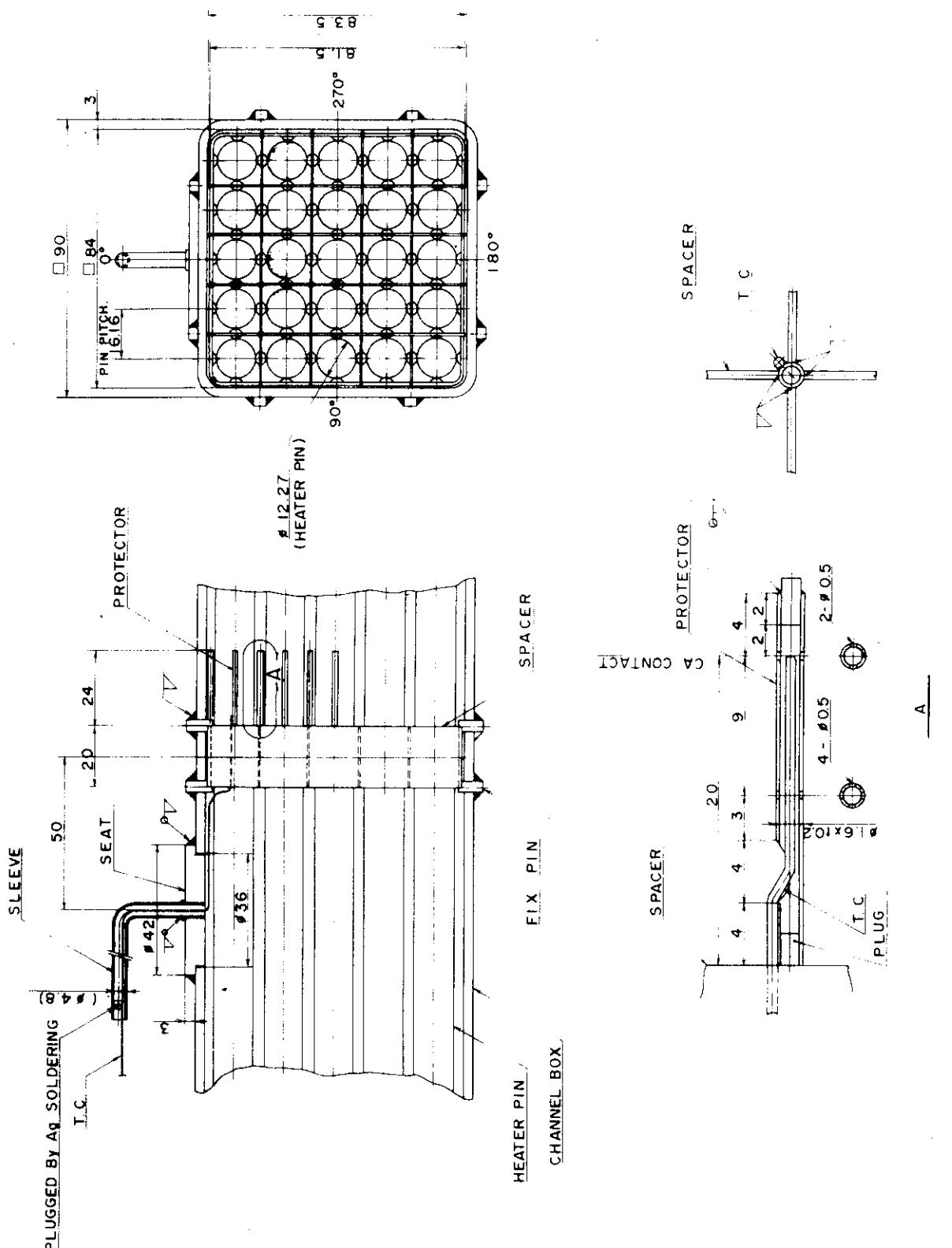


Figure 2.21 Installation of Thermocouples for Channel Box Fluid Temperature Measurement

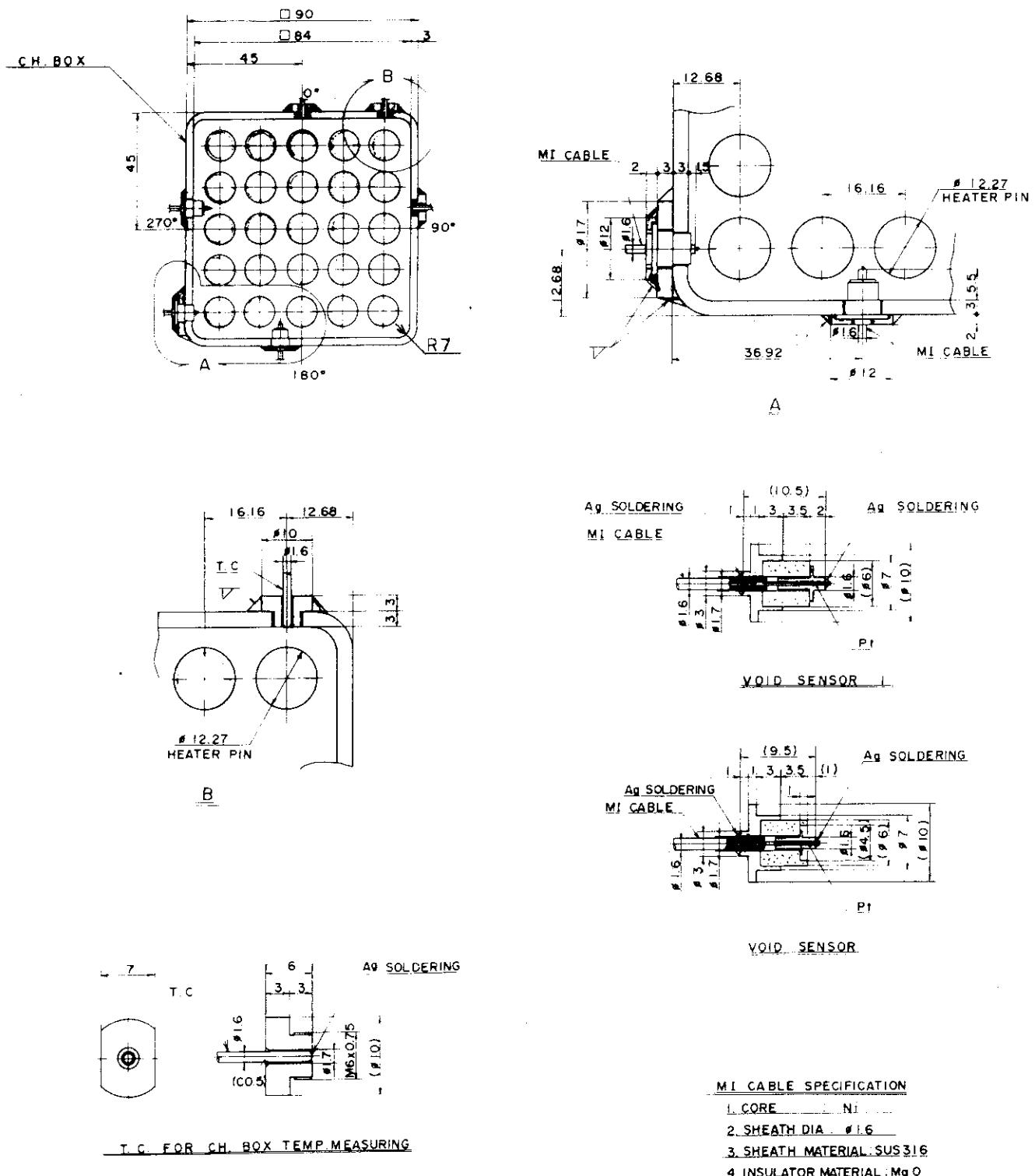


Figure 2.22 Channel Box Wall Instrumentation

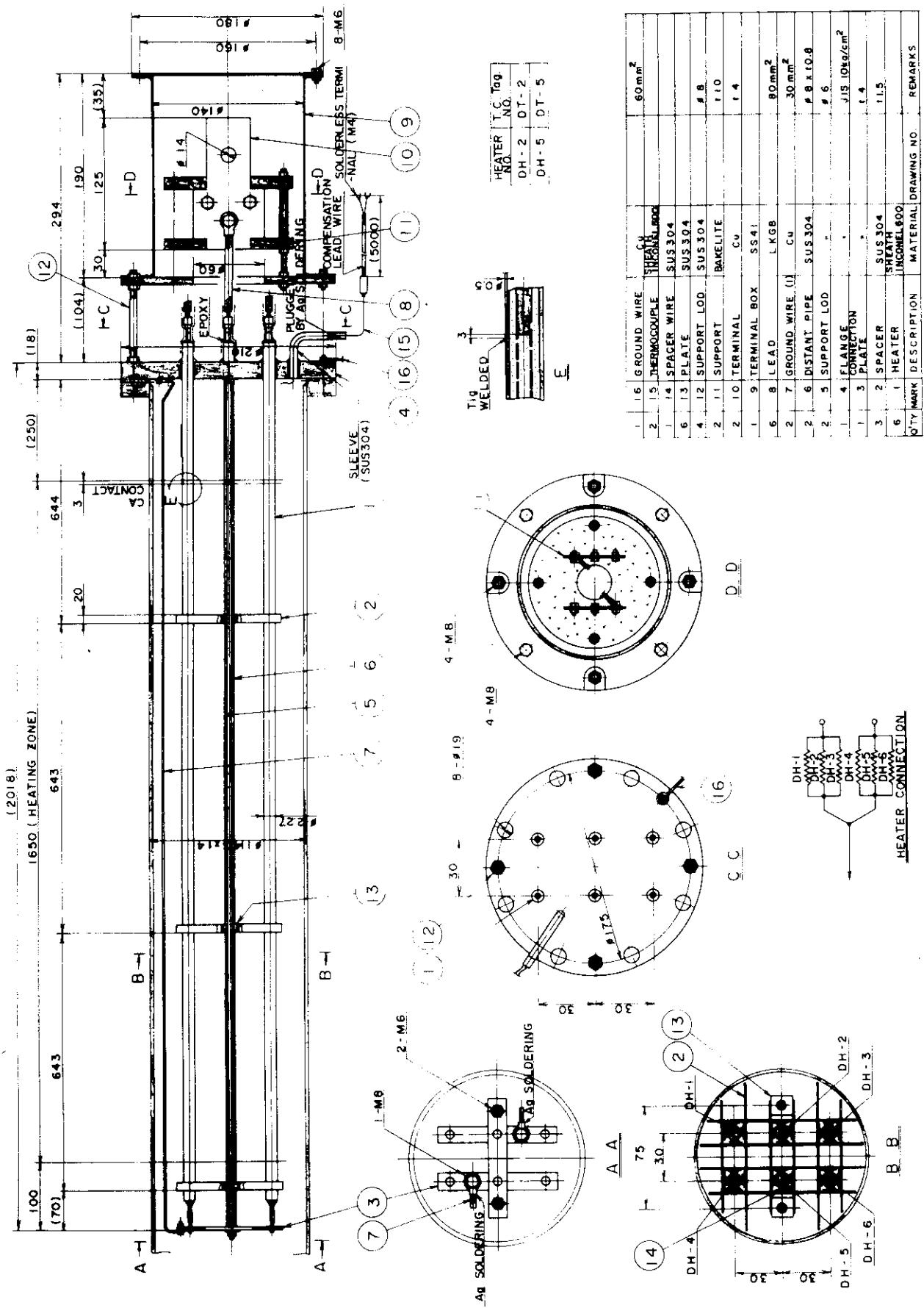


Figure 2.23 Dummy Heater

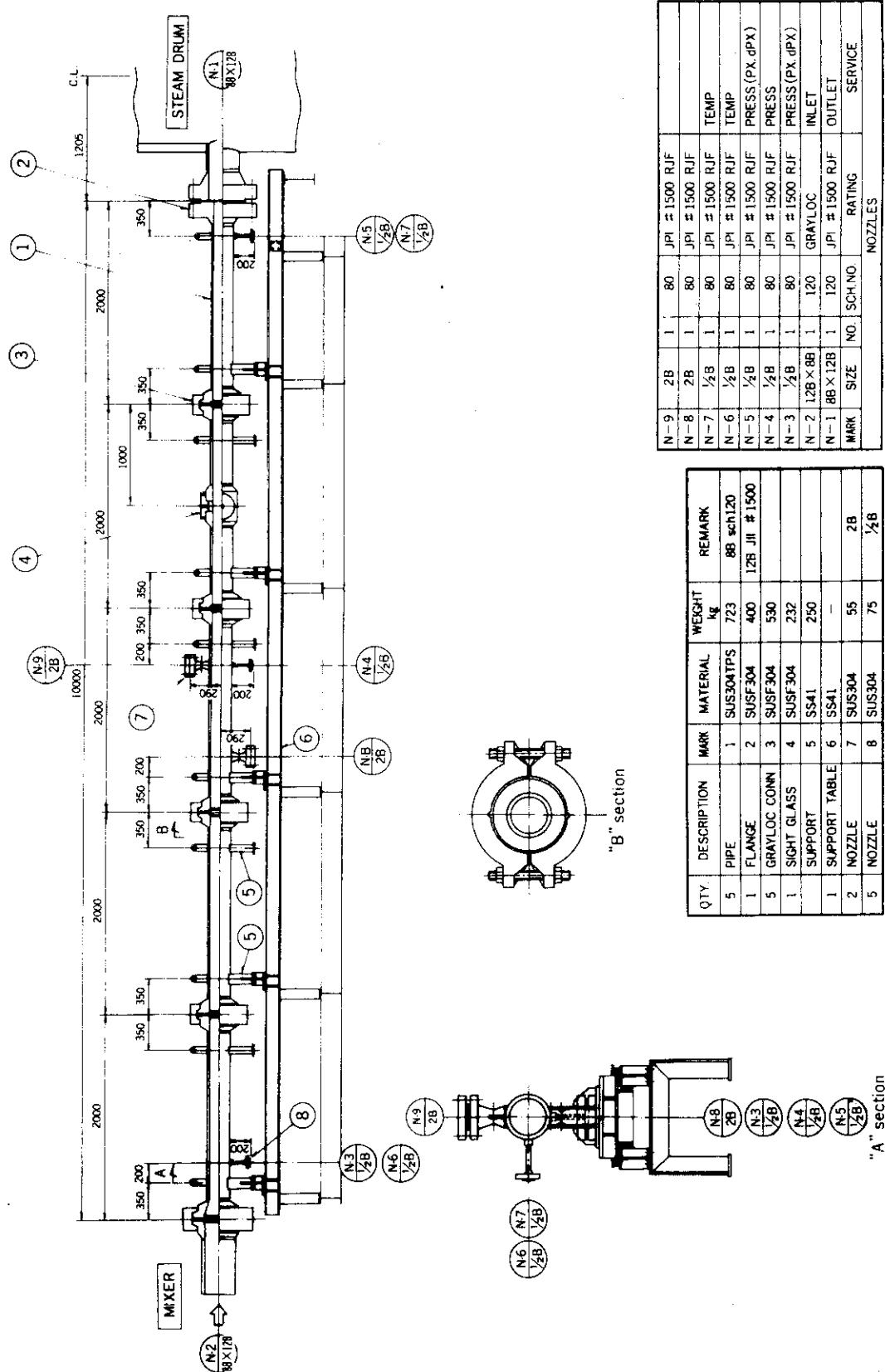


Figure 2.24 Horizontal Pipe Test Section (TS-3)

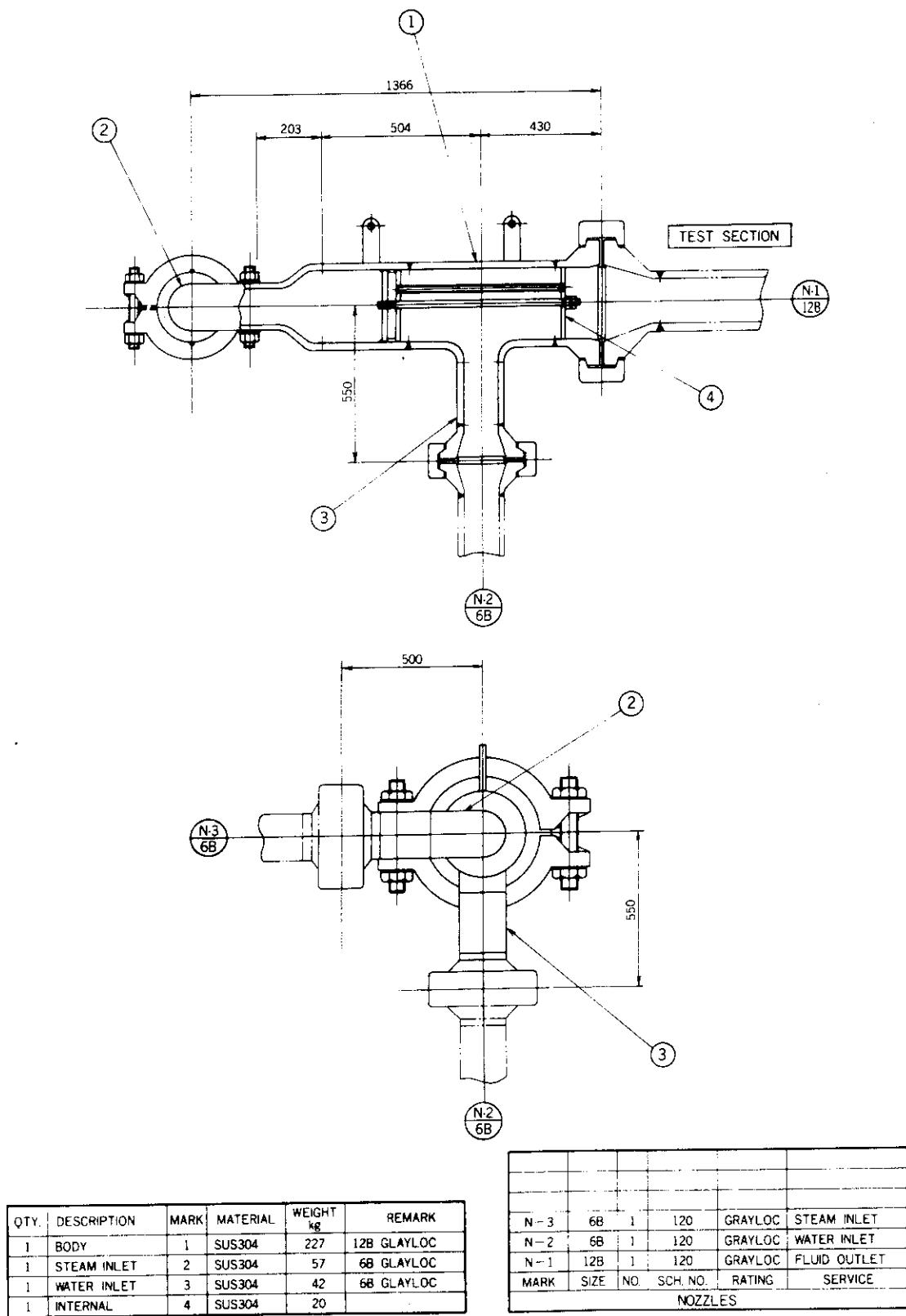
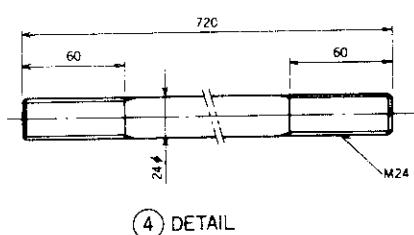
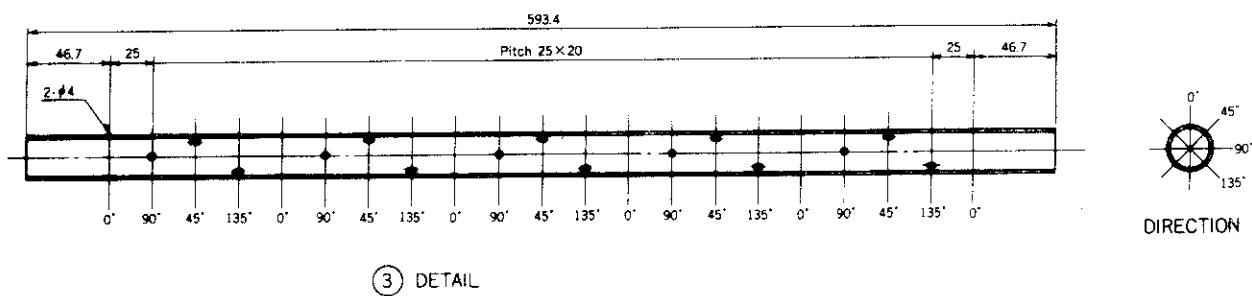
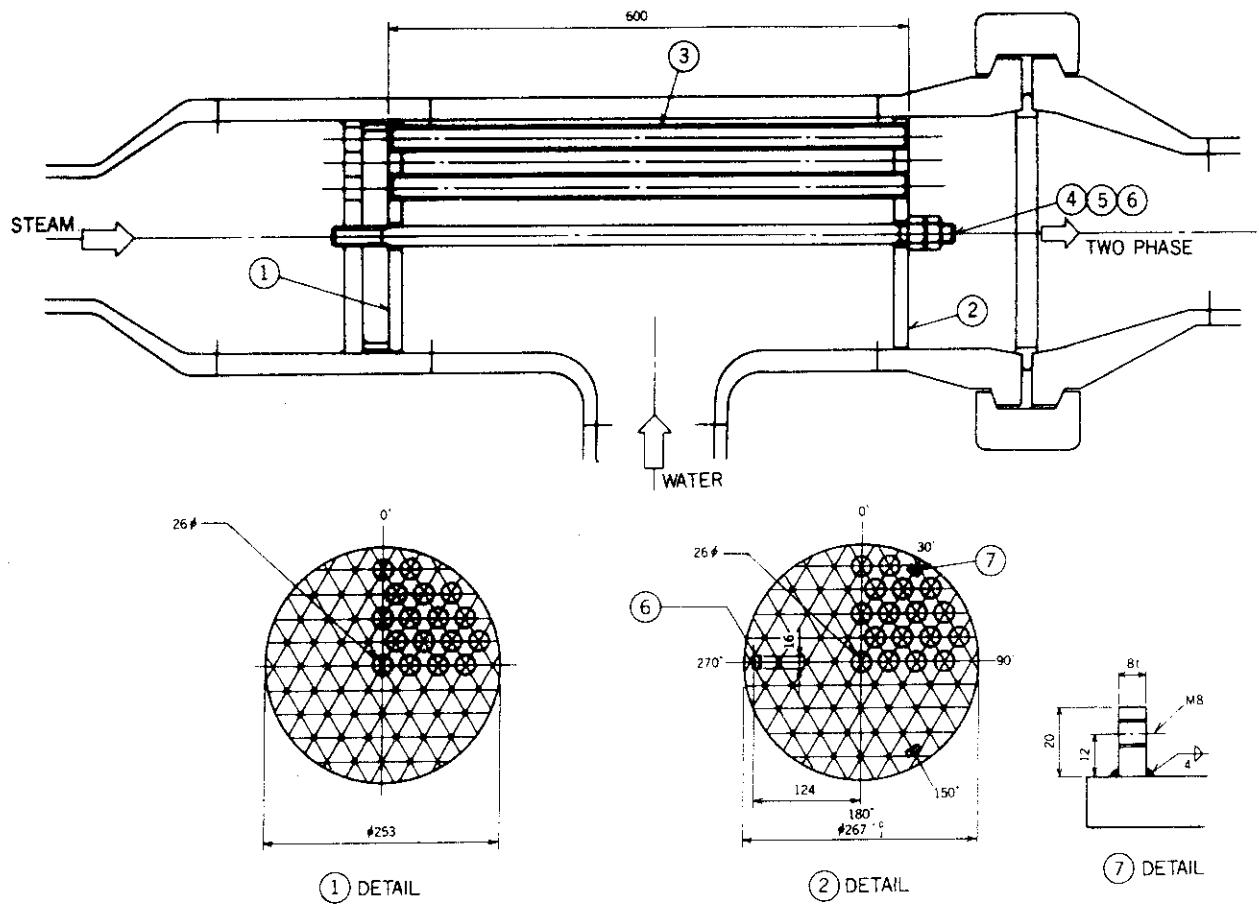
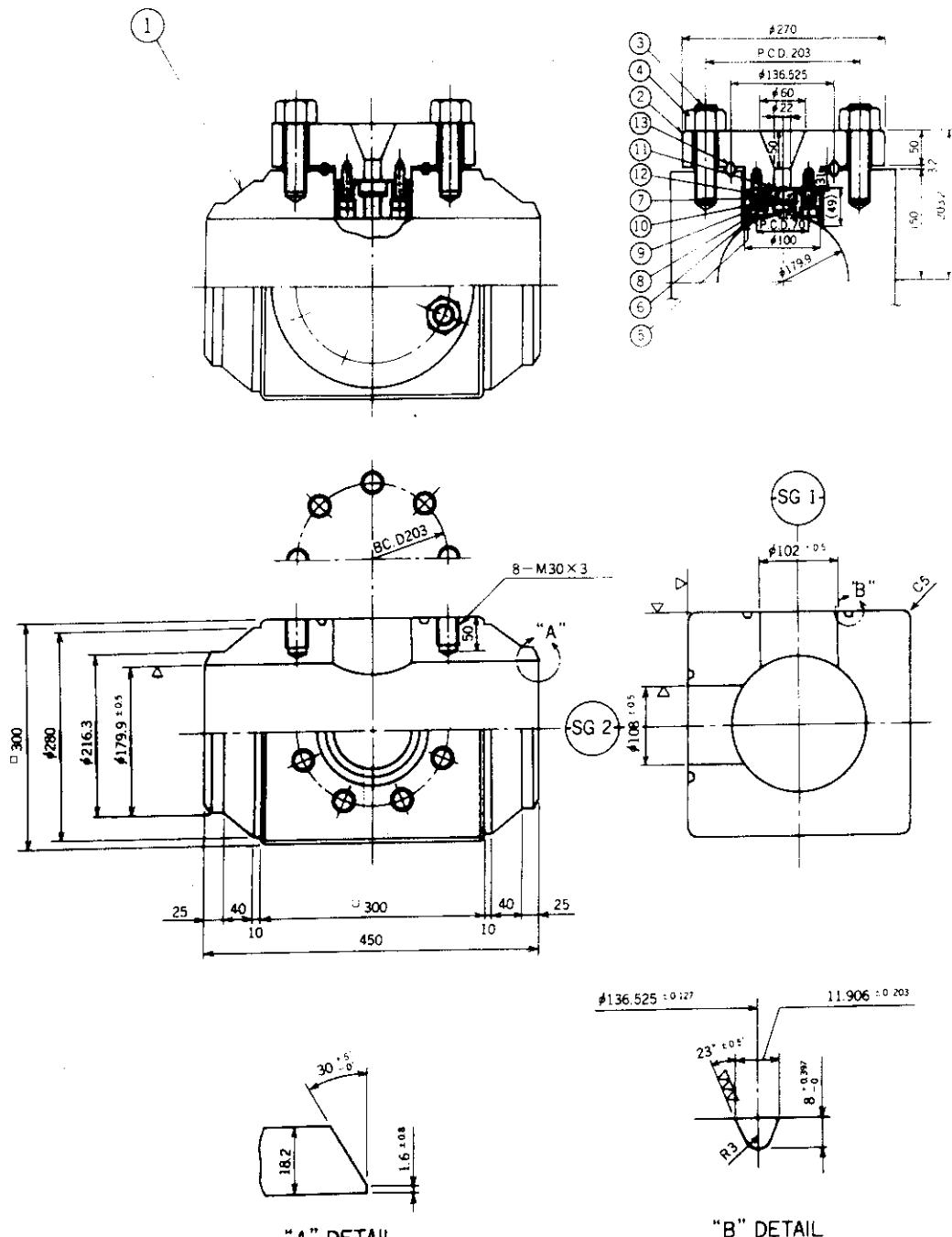


Figure 2.25(a) Horizontal Pipe Test Section Mixer (MX-2)



QTY.	DESCRIPTION	MARK	MATERIAL	WEIGHT (kg)	REMARK
1	TIE PLATE	1	SUS304	3	PL15×#253
1	TIE PLATE	2	SUS304	3	PL15×#267
54	MIXING TUBE	3	SUS304TB	42	#25.4×2.3t×593.4f
1	TIE ROD	4	SUS420J2	5	M24×720f
1	NUT	5	SUS304	—	M24
1	NUT	6	SUS304	—	M24
3	SUPPORT CLIP	7	SUS304	—	PL8×20×16
					W = 53kg

Figure 2.25(b) Mixer 1



QTY	DESCRIPTION	MARK	MATERIAL	WEIGHT kg	REMARK
1	BODY	1	SUSF304	150	
2	COVER FLANGE	2		44	
16	BOLT	3	SNB7	15	M30 · 3
16	NUT	4	S45C	6	M30 · 3
2	GLASS COVER	5	SUS304	15	
8	BOLT	6	SUS630	1.14 · 2	
2	GLASS	7	ALUMINO SILICATE	0.34 · 1t	
2	GASKET	8	GRAPHITE	0.34 × 0.22 × 1.6t	
2	GASKET	9	GRAPHITE	0.34 × 0.22 × 0.76t	
2	GASKET	10	MICA	0.34 · 0.7t	
2	GASKET	11	GRAPHITE	0.50 × 0.22 × 1.6t	
2	PACKING STRIP	12	ASBESTOS	1.05 · W16 × 1.6t	
2	RING GASKET	13	SUS304L	2	R35
					W - 232kg

Figure 2.26 Horizontal Pipe Test Section Sight Glass

JAERI-M 83-042

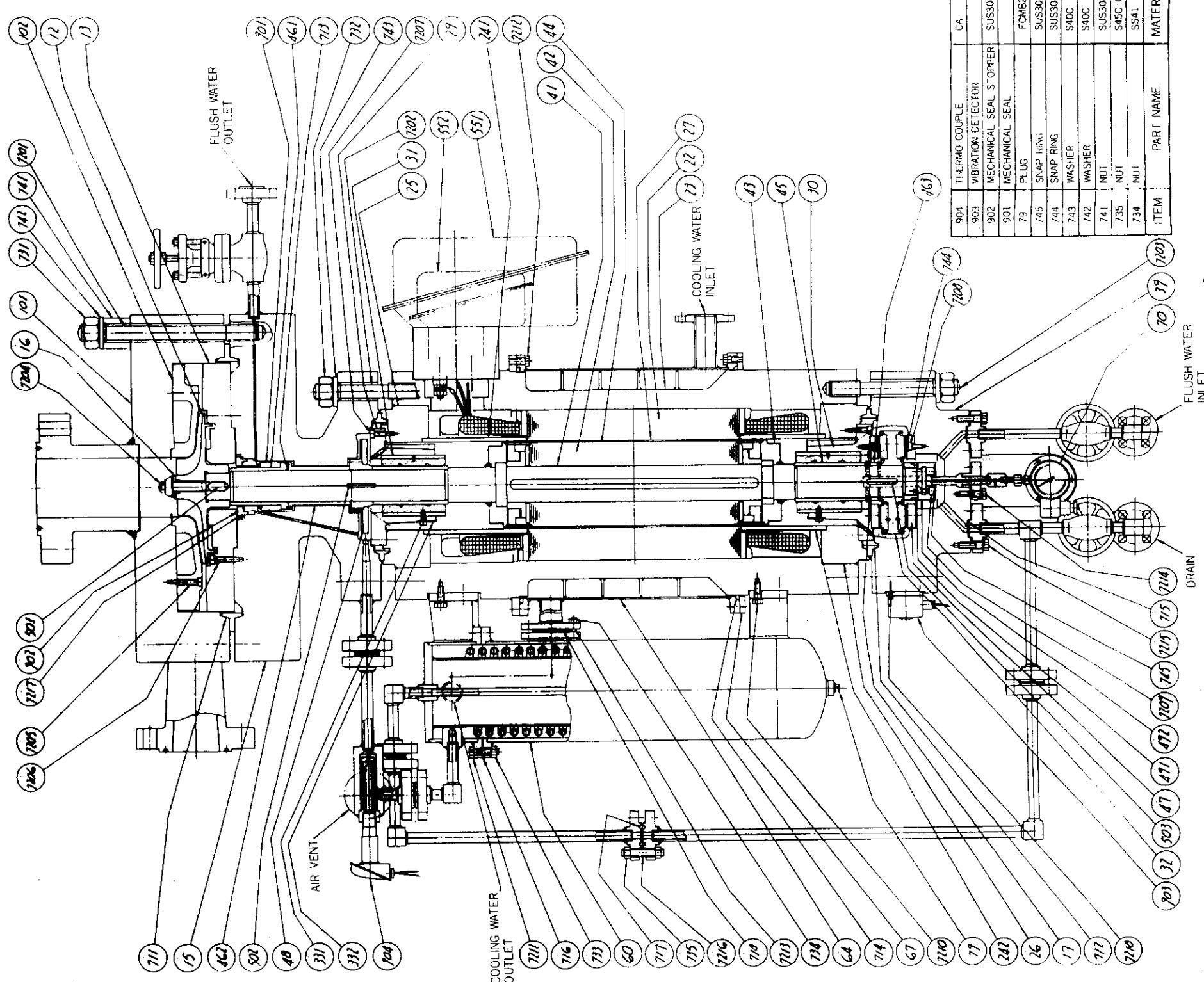
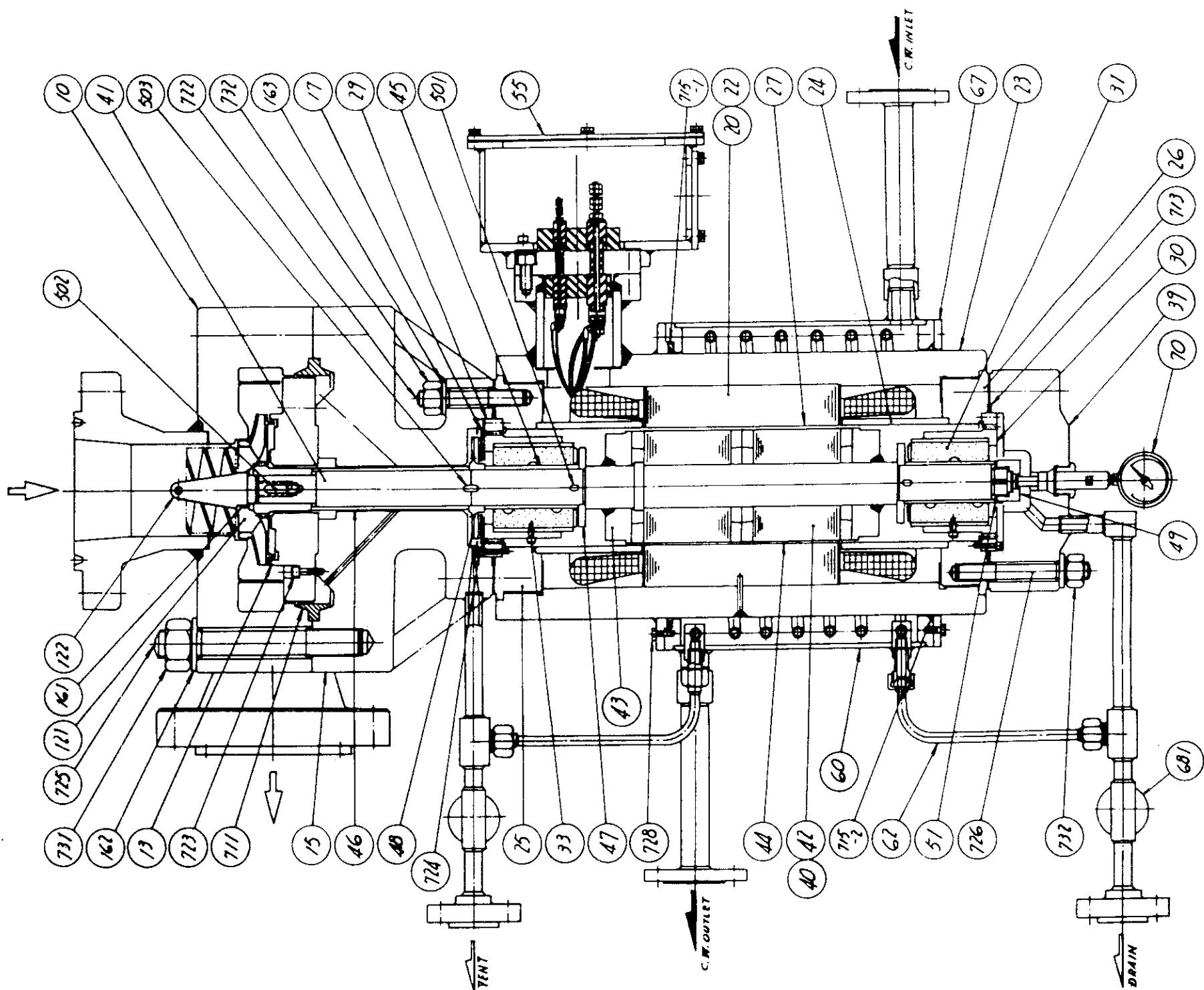


Figure 2.27 Steam Pump (SP-2)

ITEM	PART NAME	MATERIAL	QTY	ITEM	PART NAME	MATERIAL	QTY	REMARKS
733	NUT	S45C QT	12	16J				
732	NUT	SCM3 QT	32	(M42)				
731	NUT	SCM3 QT	24	(M45)				
7218	BOLT	S341	3	(M6)				
7217	BOLT	SUS316	4	(M6)				
7216	BOLT	SMB7 QT	20	(M20)				
7215	BOLT	SMB7 QT	8	(M18)				
7214	BOLT	SMB7 QT	4	(M16)				
7213	BOLT	S341	8	(M16)				
7212	BOLT	S341	32	(M16)				
7211	BOLT	SMB7 QT	12	(M16)				
7210	BOLT	S45C QT	8	(M16)				
7209	BOLT	HC	4	(M10)				
7208	BOLT	SUS316	8	(M10)				
7207	BOLT	SUS316	16	(M10)				
7206	BOLT	SUS316	6	(M10)				
7205	BOLT	SUS316	6	(M10)				
7204	BOLT	SUS316	1	(M24)				
7203	BOLT	SUS630-H1075	16	(M42)				
7202	BOLT	SUS630-H1075	16	(M42)				
7201	BOLT	SUS630-H1075	24	(M45)				
718	GASKET	ASBESTOS	2					
717	GASKET	SUS304	5					
716	GASKET	ASBESTOS	1					
715	GASKET	SUS304 ASBESTOS	2					
714	O RING	CR	2	CR				
713	O RING	PTFE	1					
712	SEAL RING	SUS360 PT-24	2	PT-24				
711	SEAL RING	SUS630 PT-24	1	PT-24				
70	BEARING MONITOR	SUS316	1					
67	COVER PLATE	S341	1					
64	JACKET	S341	1					
60	HEAT EXCHANGER	SUS316 STPG38	1					
552	T.C. CONNECTION BOX	—	1					
551	POWER CONNECTION BOX	—	1					
503	THRUST BEARING KEY	SUS316	2					
502	AUX. IMPELLER KEY	SUS316	2					
501	IMPELLER KEY	SUS316	2					
492	NUT STOPPER	HC	1					
491	SLEEVE LOCK NUT	SUS304	1					
48	AUXILIARY IMPELLER	SCS14	1					
47	THRUST WASHER	SUS316 HCR	2	HCR HARD CHROME PLATING				
463	ADJUST COLLAR	SUS304	1					
462	SPACER	SUS304	1					
461	SPACER	SUS304	1					
45	SHAFT SLEEVE	SUS316 HCR	2	HCR				
44	ROTOR SLEEVE	HC	1	HC				
43	END COVER	SUS304	2					
42	ROTOR	—	1					
41	SHAFT	SUS304	1					
39	REAR COVER	SUSF304	1					
332	STOPPER	HC	4	HC				
331	BEARING LOCK NUT	SUS316	4					
32	THRUST BEARING	CG2 SUS316	1	CG2 CARBON GRAPHITE				
31	BEARING	CG2 SUS316	2	CG2				
30	REAR BEARING HOUSING	SCS13	1					
29	FRONT REARING HOUSING	SCS13	1					
27	STATOR LINER	HC	1	HC				
26	REAR END BELL	SUSF304	1					
25	FRONT END BELL	SUS304	1					
242	BACK UP SLEEVE	SUS304	1					
241	BACK UP SLEEVE	SUS304	1					
23	STATOR BAND	SF45	1					
79	PLUG	F CHMB28	1	(PT ₁ 2)	22	STATOR	1	
745	SNAP RING	SUS304	1	17	GUIDE DISK	SUS304	1	
744	SNAP RING	SUS304	8	16	WASHER	SUS304 HC	1	HC
743	WASHER	S40C	32	15	ADAPTOR	SUSF304	1	
742	WASHER	S40C	24	13	LINER DISK	SUSF304	1	
741	NUT	SUS304	24	12	IMPELLER	SCS13	1	
735	NUT	S45C QT	40	102	VOLUTE DISK	SCS13	1	
734	NUT	S341	16	101	CASING	SUSF304	1	



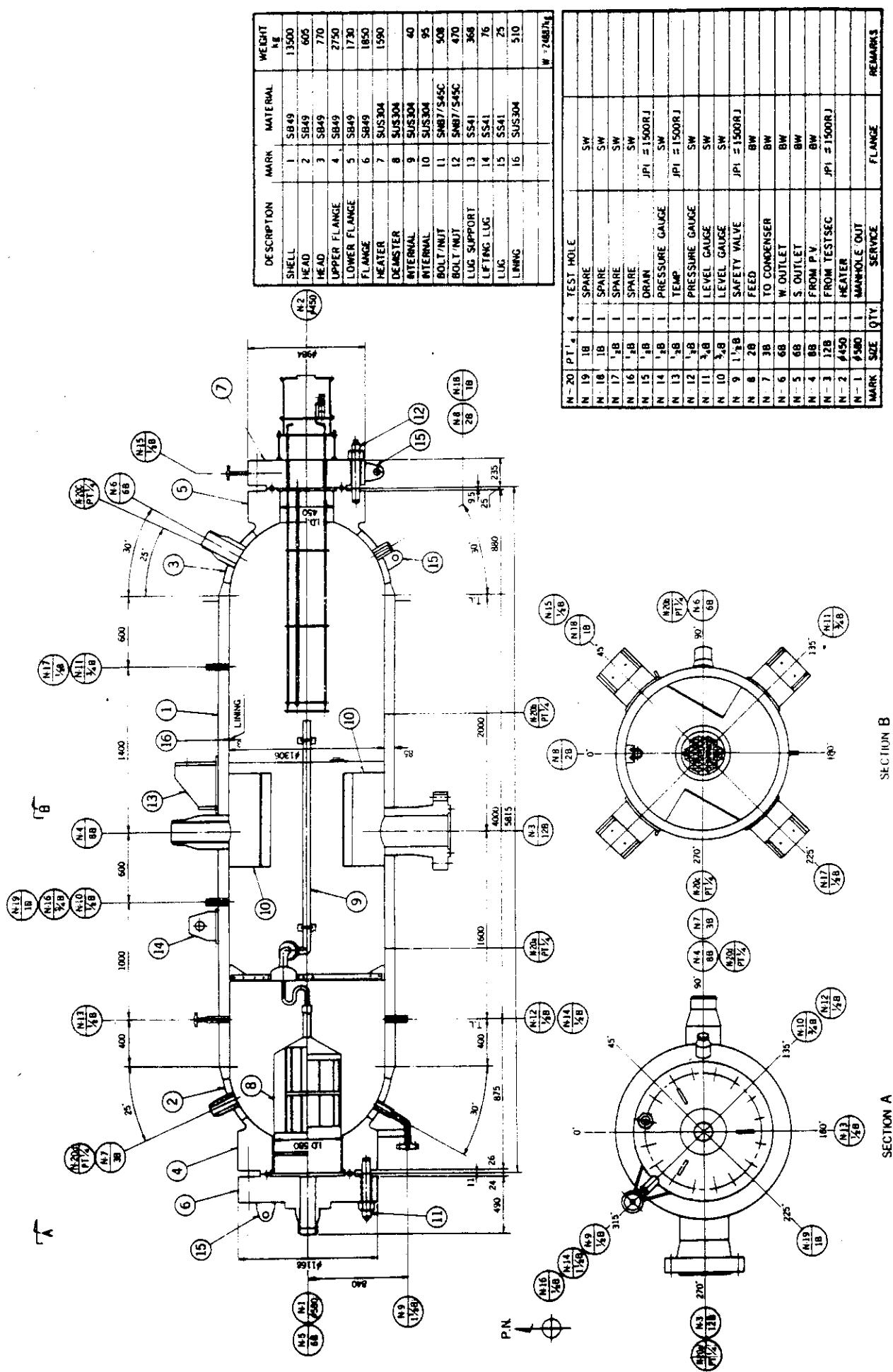


Figure 2.29 Steam Drum (SD-1)

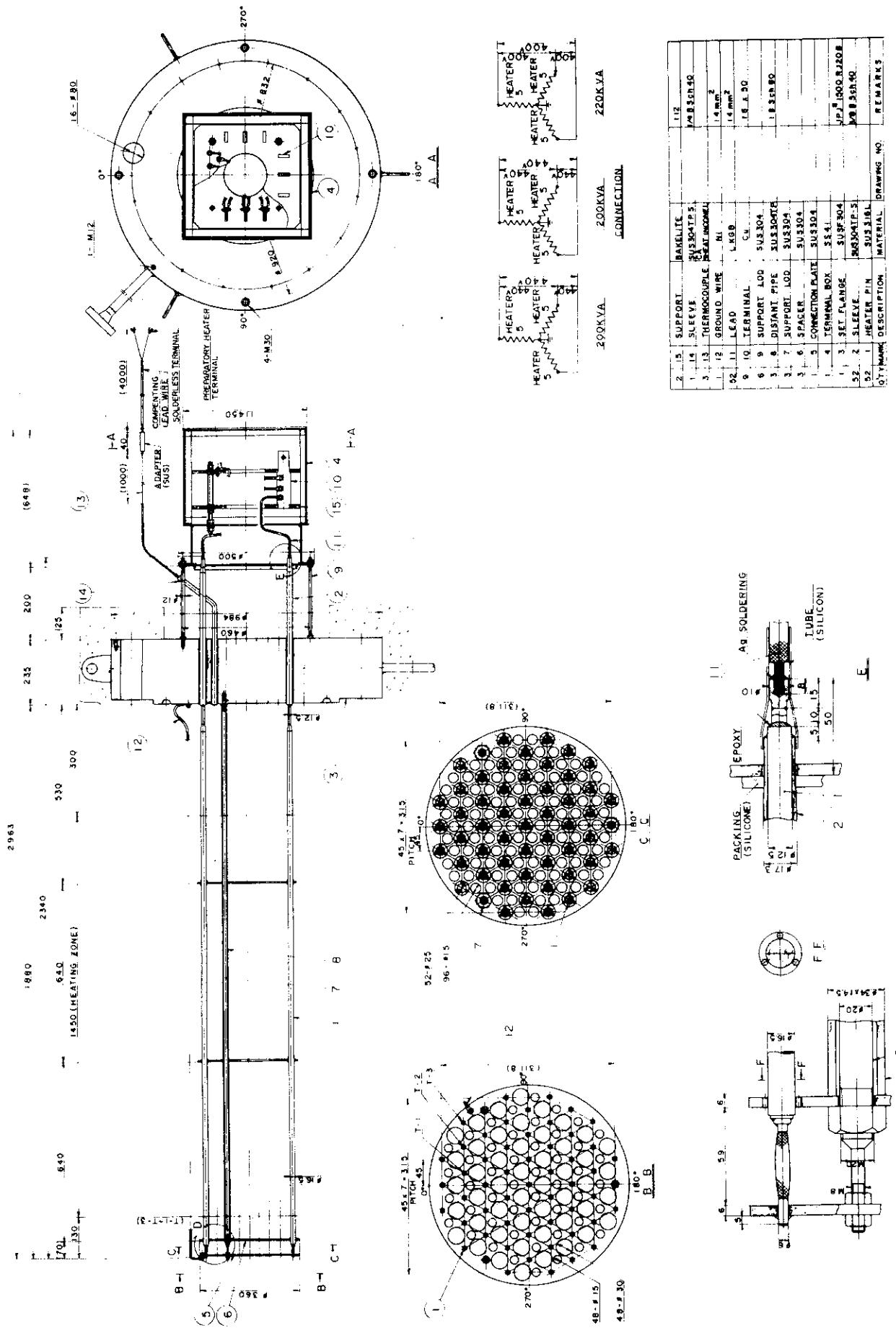


Figure 2.30 Steam Drum Heater (SDH-1-A,B,C)

PART NO.	NAME	MATERIAL	Q.TY	REMARKS	
				SET 1	SET 2
1	TUBE BUNDLE	SUS304 TP	2	100A SCH 160	
1	HEADER	SUS304 TB	60	\$55.4 × 8WKG (13MM)	
1	FIN TUBE	SS41	1		
1	LOUVER		1		
1	CYLINDER ACTUATOR		1		
	STRUCTURE			SET 1	
2	COLUMN	SS41	4	L100 × 100 × 10	
2	PANEL	SS41	4	L45	
2	BRACE	SS41	8	L65 × 65 × 6	
2	FAN RING	SS41	1	L150 × 50 × 4.5	
	DRIVE UNIT			SET 1	
3	MOTOR		1	1.5KW-6P	
3	FAN		1	L 36	
3	SUSPENSION		1		
3	FAN GUARD		1		

N-2 OUTLET N-1 INLET NO. NAME
1 1/2" JPI # 1500 RJ-WN
2 - JPI # 1500 RJ-WN
SIZE _____
NOZZLE LIST

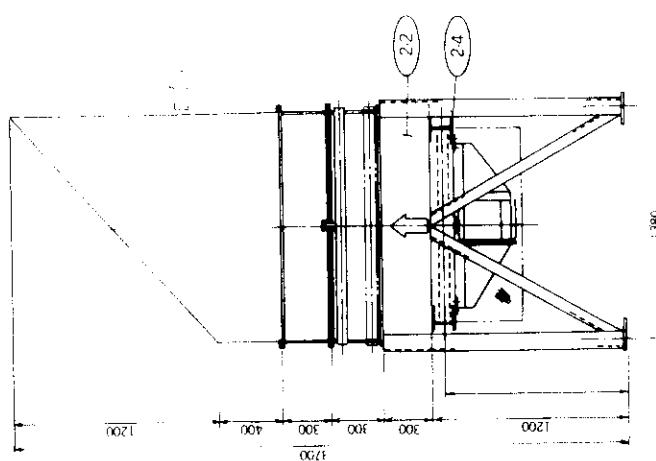
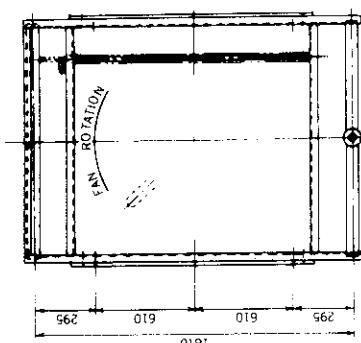
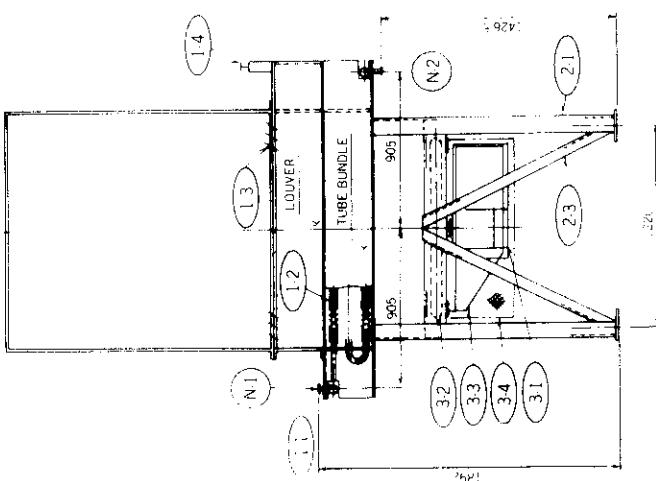


Figure 2.31 Air Condenser

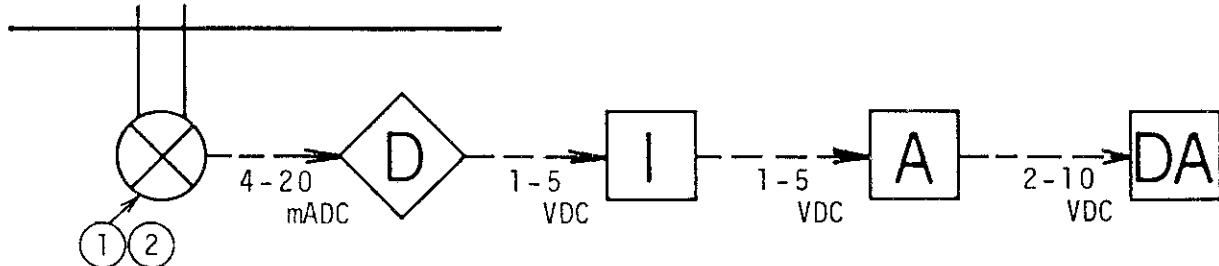


Figure 3.1 Pressure and Differential Pressure Measurement System Block Diagram

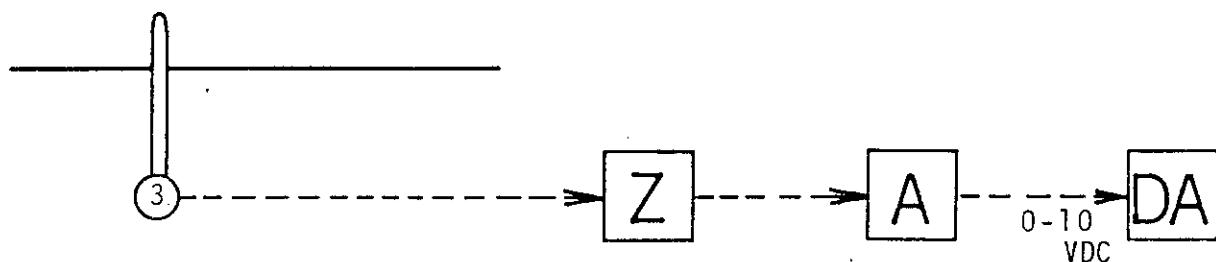
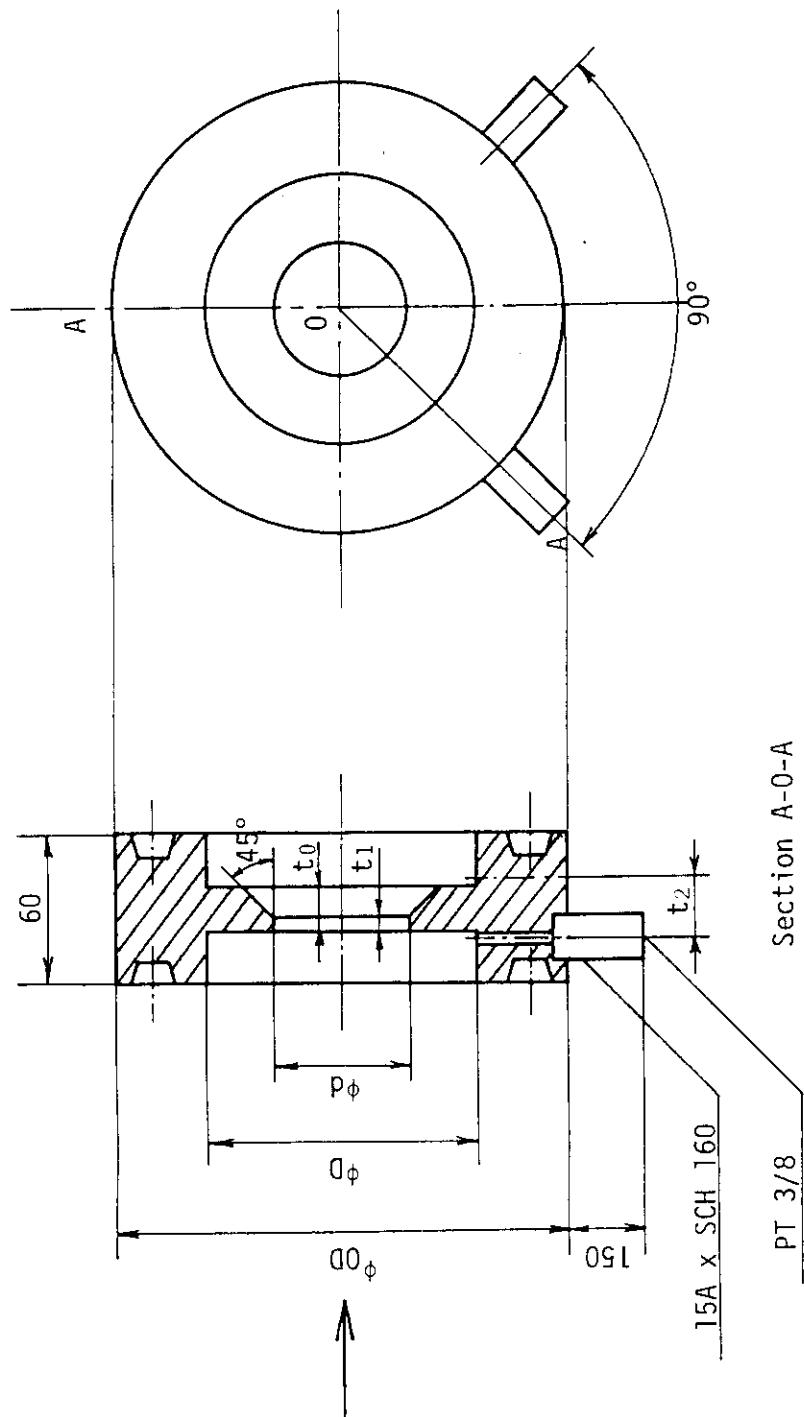


Figure 3.2 Temperature Measurement System Block Diagram

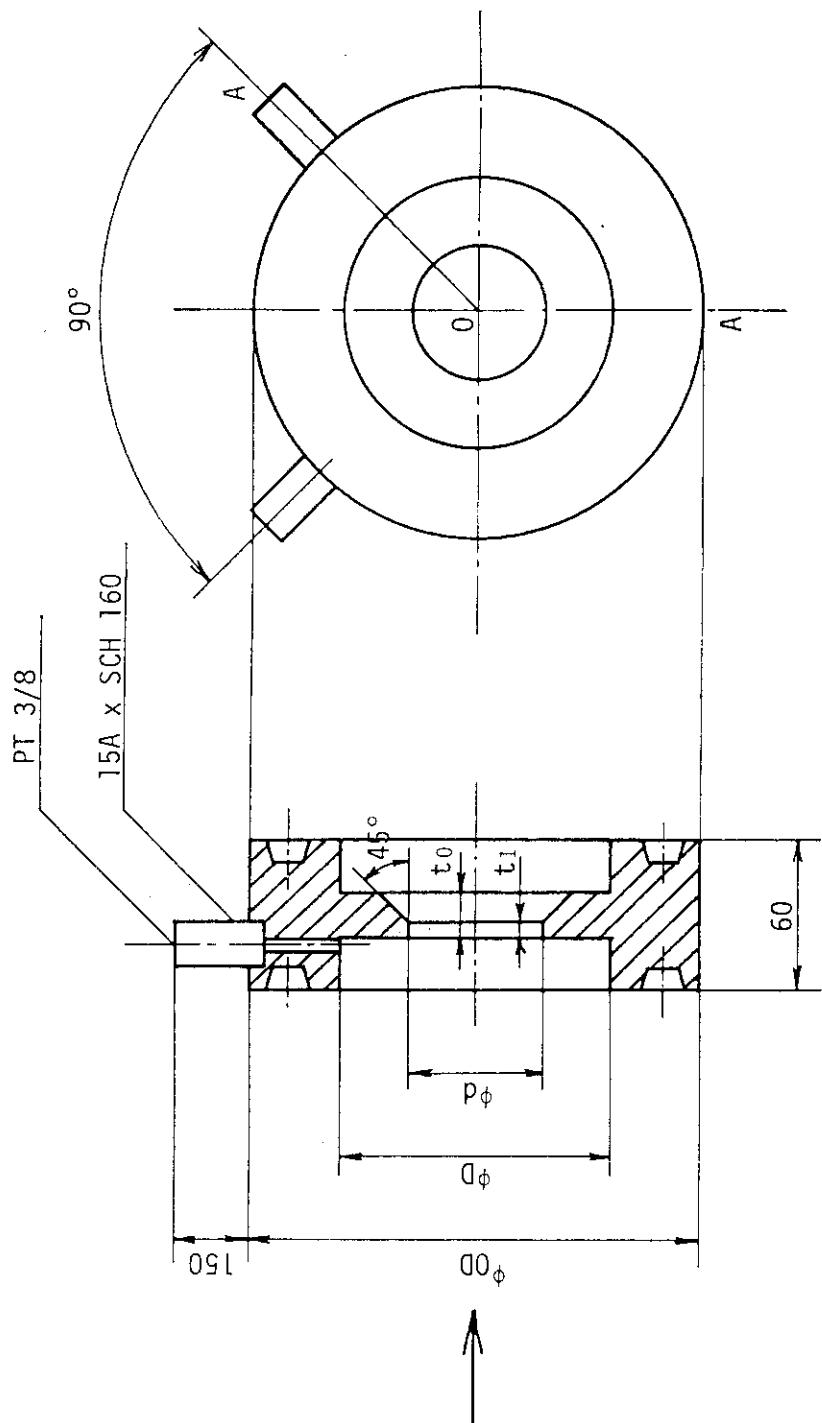
Notation (Figure 3.1 through Figure 3.6)

Symbol	Item
(1)	Electronic Pressure Transducer
(2)	Electronic Differential Pressure Transducer
(3)	Thermocouple
A	DC Amplifier
C	Operation Controller (HOMAC 500 Series, EKH311A)
D	Signal Distributer 4-20 mADC / 1-5 VDC
DA	Data Acquisition System (DA-8500)
I	Signal Isolater 1-5 VDC or 4-20 mADC / 1-5 VDC
L	Loop Module (HOMAC 500 Series, EKH320A System)
T	Electronic Temperature Transducer
Z	Electric Zero Contact (Microfreezer)



Tag No.	OD	D_t	d_t	t_0	t_1	t_2	Full Scale	Ring No.
FE- 1-A	282.6	137.36	92.51	5	2	14	$200 \text{ m}^3/\text{h}$	R46
FE- 1-B	282.6	137.36	48.95	5	2	14	$50 \text{ m}^3/\text{h}$	R46
FE-101-A	142.8	49.78	24.49	2.5	1	8.5	$10 \text{ m}^3/\text{h}$	R24
FE-101-B	142.8	49.78	11.18	2.5	1	8.5	$2 \text{ m}^3/\text{h}$	R24

Figure 3. 3(a) Liquid Flow Rate Orifice Sizes



Tag No.	OD	D _t	d _t	t ₀	t ₁	Full Scale	Ring No.
FE- 2	352.2	180.91	120.16	5	2	800 m ³ /h	R50
FE-102-A	174.4	74.31	43.39	3	1	100 m ³ /h	R35
FE-102-B	174.4	74.31	20.10	3	1	20 m ³ /h	R35

Figure 3. 3(b) Steam Flow Rate Orifice Sizes

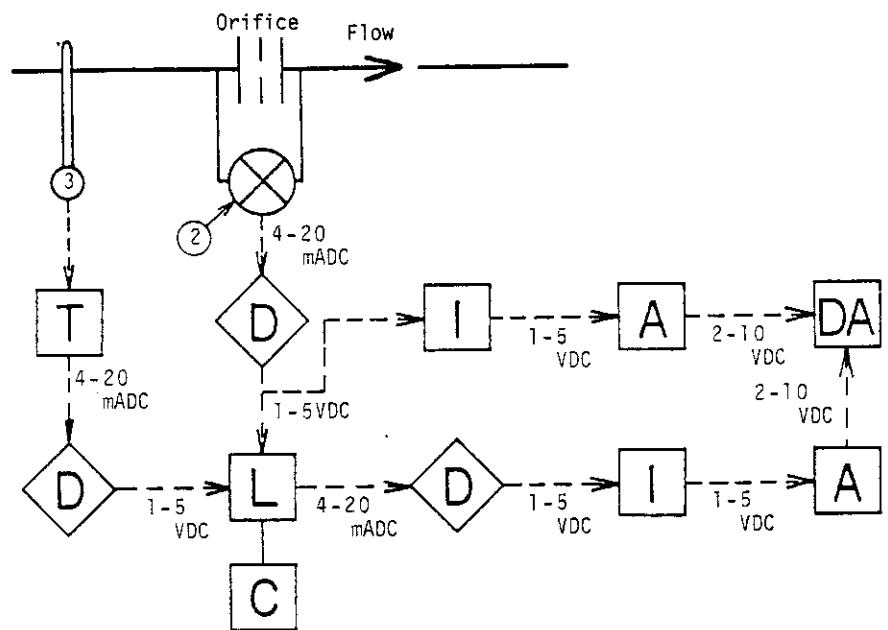


Figure 3. 4(a) Liquid Flow Rate Measurement System Block Diagram

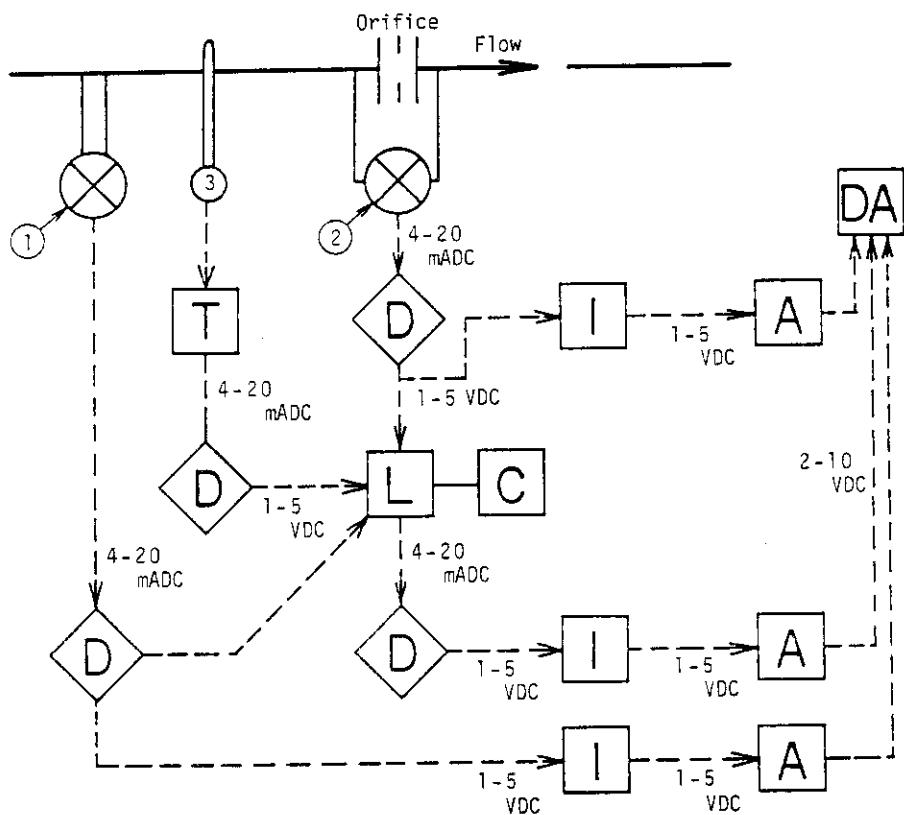


Figure 3. 4(b) Steam Flow Rate Measurement System Block Diagram

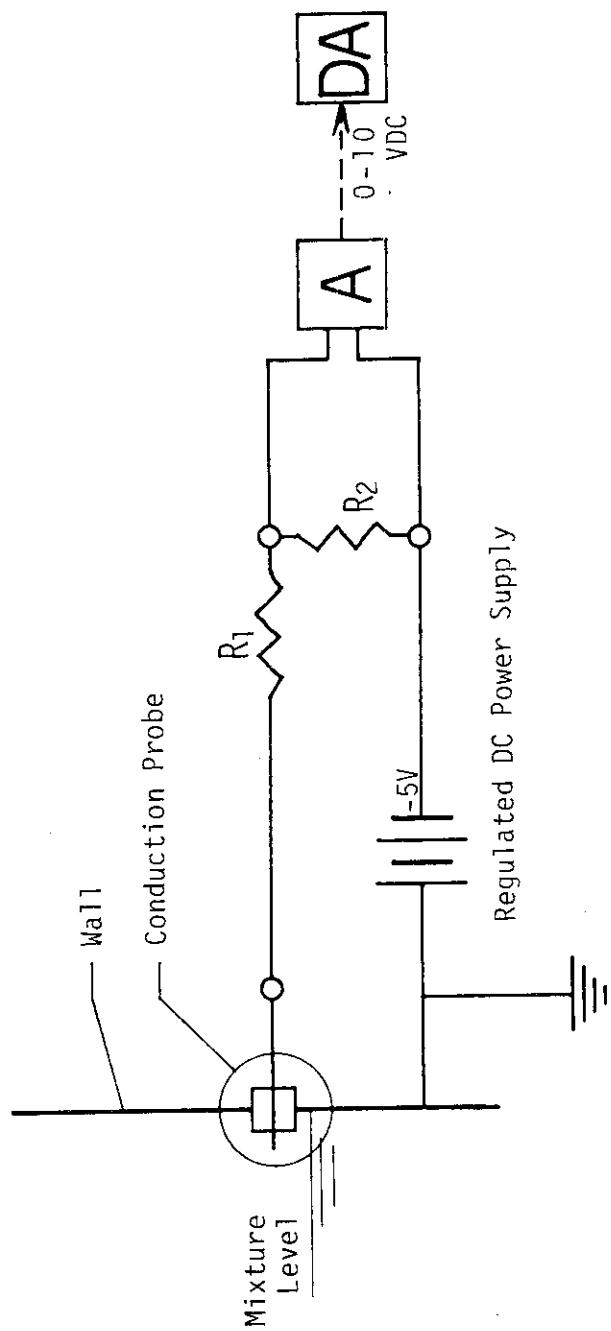


Figure 3.5 Mixture Level Measurement System Block Diagram

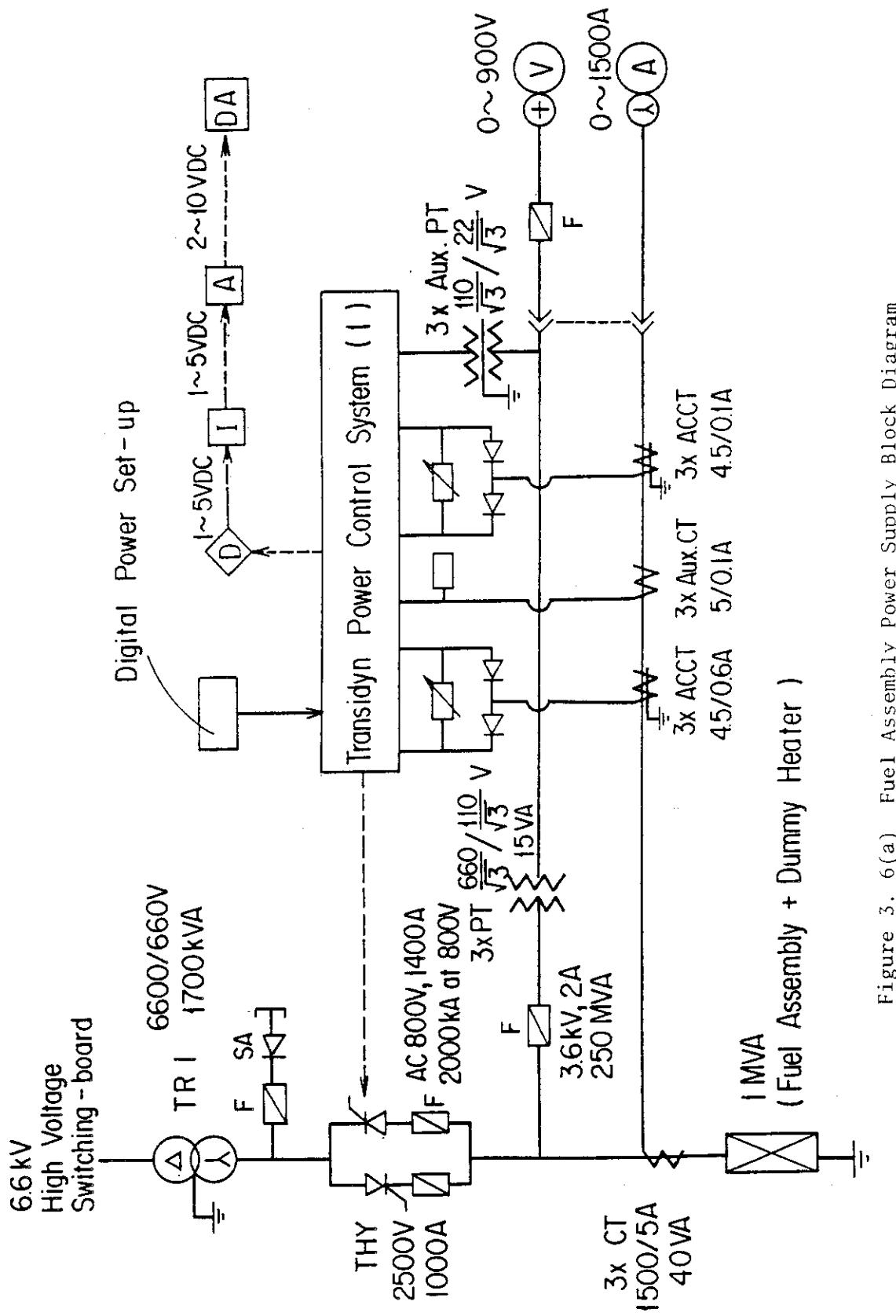


Figure 3, 6(a) Fuel Assembly Power Supply Block Diagram

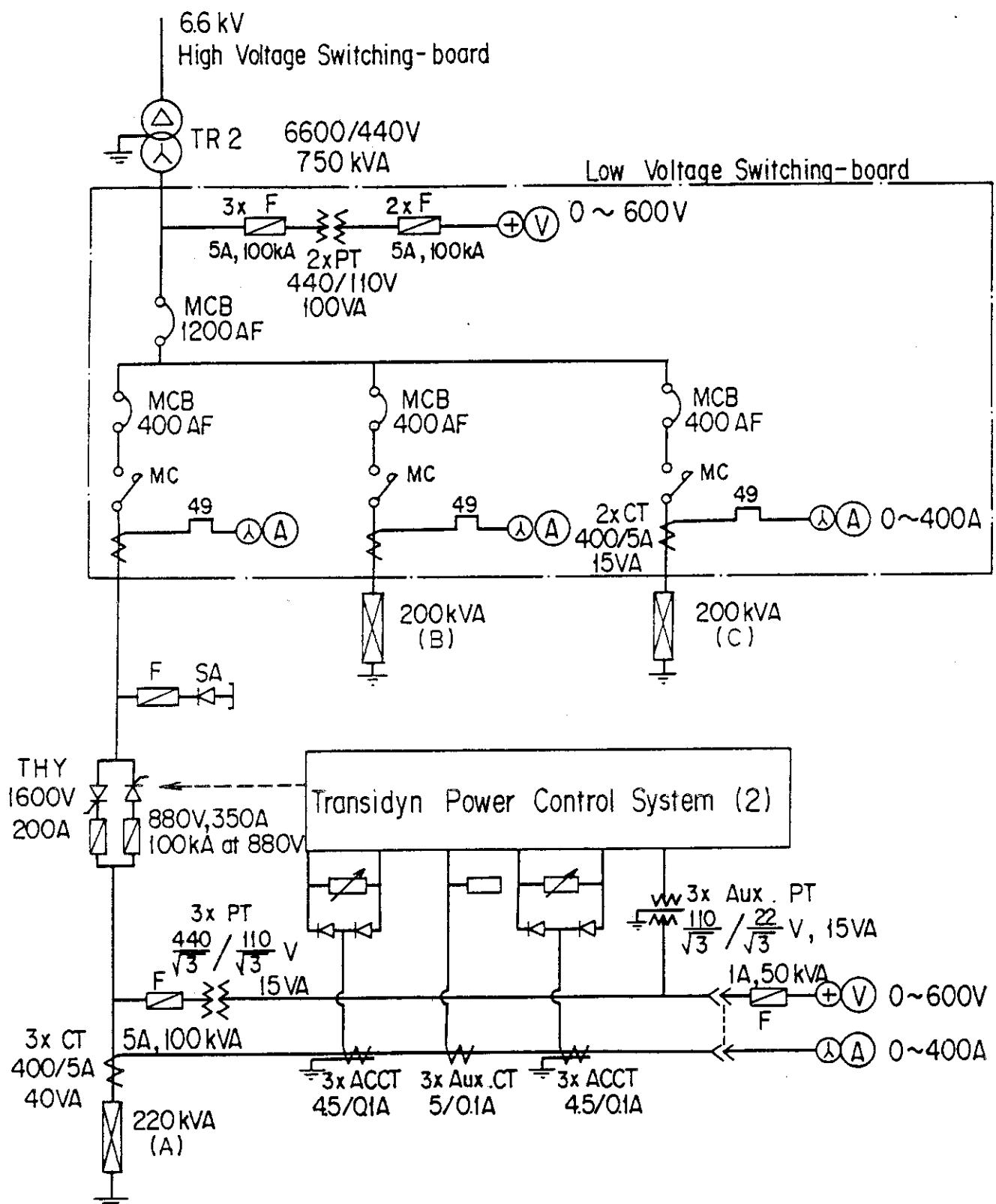
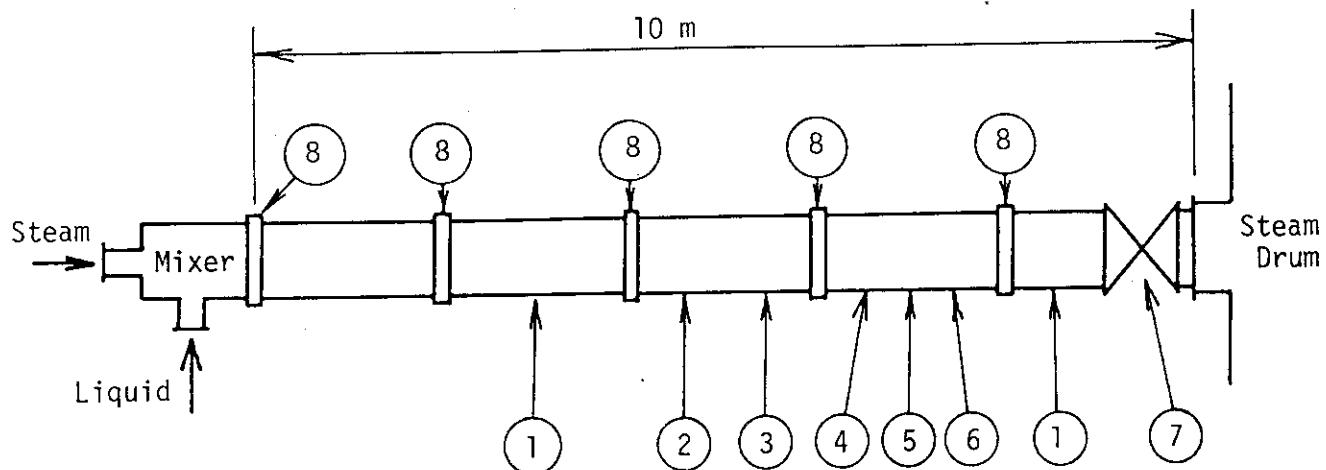


Figure 3. 6(b) Steam Drum Heater (A), (B), (C) Power Supply Block Diagram



No.	Item
1	Traversing Beam Type Three-beam γ -Densitometer
2	Pitot Tube
3	Correlation Flow Meter
4	Conduction Probes (Liquid Level Meter)
5	Fixed Beam Type Three-beam γ -Densitometer
6	Full-flow Type Drag Screen Flow Meter
7	Shut-off Valve
8	Glay Lock

Figure 3. 7 Schematic of Two-Phase Flow Instrument Arrangement in Horizontal Pipe Test Section

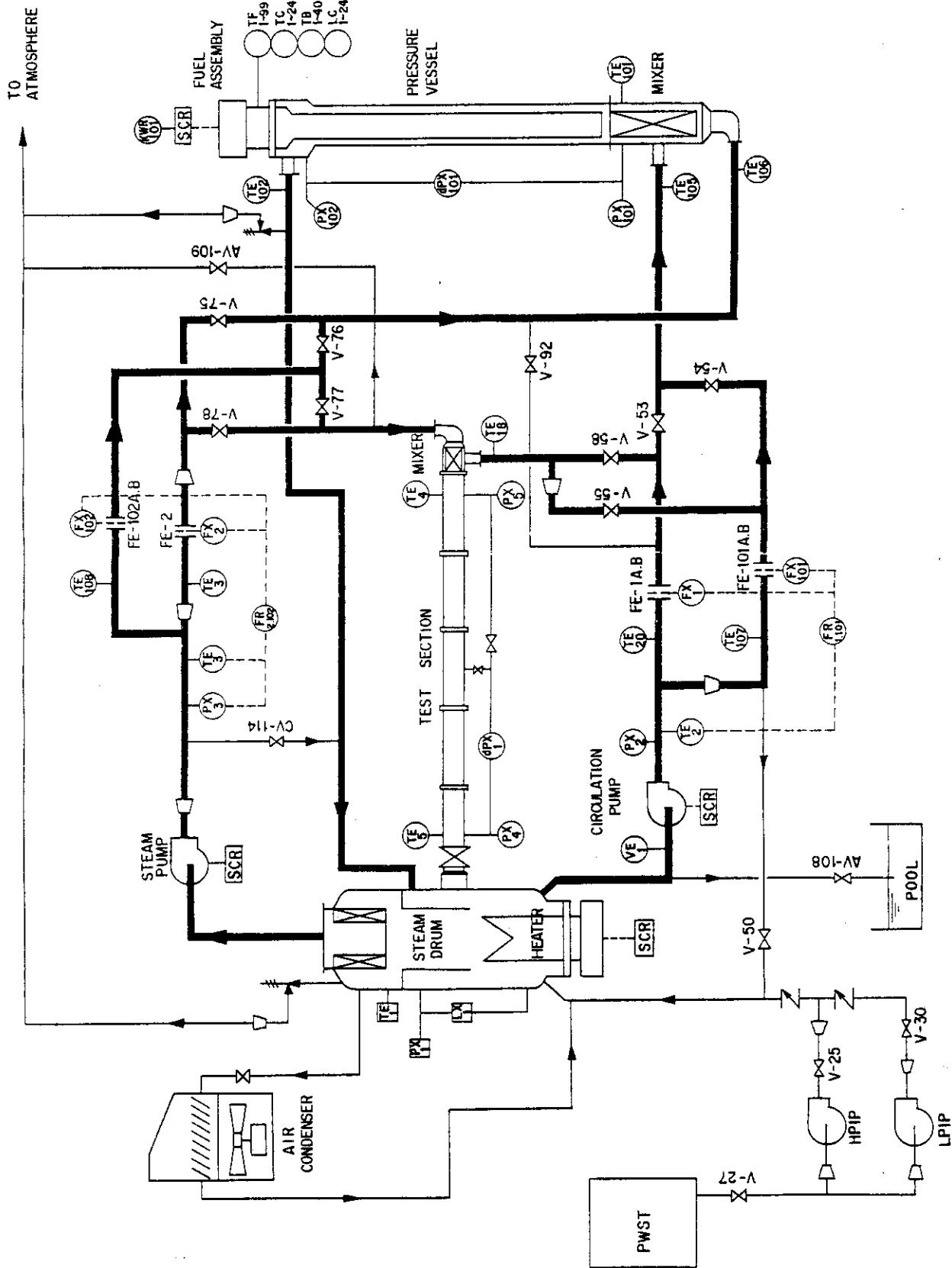


Figure 3. 8 TPTF Instrumentation Location