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ROSA-III SYSTEM DESCRIPTION

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ROSA-III System Description

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The ROSA-III system and its instrumentations are described. The informations are necessary to understand and analyze the experimental data obtained from loss-of-coolant experiments (LOCES) conducted in the ROSA (Rig of Safety Assesment)-III facility.

Keywords : LOCE, ROSA-III Facility, BWR, System Description
Instrumentation

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ROSA - III 装置の概要

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この資料は、沸騰水型原子炉の冷却材喪失事故の模擬実験であるROSA - III計画の実験解析を行うさいに必要な基本的な情報、即ちROSA - III装置の概要と計測についてまとめたものである。

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ABBREVIATIONS

ADS	Automatic Depressurization System
AT	Air Tank
AV	Air Actuation Valve
(2)B	(2) inches Pipe of Schedule 80
BN	Boron Nitride
BWR	Boiling Water Reactor
CA	Chromel-Alumel
CHV	Check Valve
CV	Control Valve
CWT	Cooling Water Tank
D	Differential Pressure
DF	Density of Fluid
DL(+100)	Elevation (+100 mm) from the bottom of PV
ECCS	Emergency Core Cooling System
ESF	Engineered Safety Features
F	Flow Rate
Fig.	Figure
FS	Full Scale
FWP	Feed Water Pump
FWT	Feed Water Tank
HPCS	High Pressure Core Spray
HPCSP	High Pressure Core Spray Pump
HPCST	High Pressure Core Spray Tank
HPWP	High Pressure Water Pump
ID	Inner diameter
INC 600	Inconel 600
JP	Jet Pump
K	Kelvin

kg	Kilogram
kPa	Kilopascal
kW	Kilowatt
L	Liquid Level
ℓ	Liter
LB	Liquid Level in Channel Box
LBWR	Large Boiling Water Reactor
LL	Liquid Level in the Lower Plenum
LOCA	Loss-of-Coolant Accident
LOCE	Loss-of-Coolant Experiment
LP	Lower Plenum
LPCI	Low Pressure Coolant Injection
LPCIP	Low Pressure Coolant Injection Pump
LPCIT	Low Pressure Coolant Injection Tank
LPCS	Low Pressure Core Spray
LPCSP	Low Pressure Core Spray Pump
LPCST	Low Pressure Core Spray Tank
M	Momentum Flux
m	Meter
mm	Milimeter
MLHR	Maximum Linear Heat Rate
MPa	Megapascal
MRP	Main Recirculation Pump
MW	Megawatt
N	Rotation Speed
OR	Orifice
P	Pressure
PV	Pressure Vessel
PWT	Pure Water Tank

QOBV	Quick Opening Blowdown Valve
QSV	Quick Shut-off Valve
RCN	Rapid Condencer
ROSA	Rig of Safety Assessment
rpm	Revolution per Minute
S	Signal
s	Second
Sch	Schedule
SUS	Stainless Steel
T	Temperature
T/C	Thermocouple
TC	Temperature of Fluid
TF	Temperature of Fuel
TS	Temperature of Structure Material
V	Valve
VF	Void Fraction
W	Power
W	Watt
WL	Water Level
WSP	Water Supply Pump

1. INTRODUCTION

The ROSA (Rig of Safety Assessment)-III Program is one of several water reactor research test programs conducted by JAERI (Japan Atomic Energy Research Institute).

The ROSA-III facility is a volumetrically scaled (1/424) boiling water reactor (BWR) system with electrically heated core designed to study the response of the engineered safety features (ESF) in commercial BWR systems during the postulated loss-of-coolant accident (LOCA). With recognition of the differences in commercial BWR designs and inherent distortions in reduced scale systems, the design objective for the ROSA-III facility was to produce the significant thermal-hydraulic phenomena that would occur in commercial BWR systems in the same sequence and with approximately the same time frames and magnitudes. The objectives of the ROSA-III experimental program are:

- (1) To provide data required to evaluate the adequacy and improve the analytical methods currently used to predict the LOCA response of large BWRs. The performance of the ESFs, with particular emphasis on emergency core cooling systems (ECCSs), and the quantitative margins of safety inherent in performance of the ESF are of primary interest.
- (2) To identify and investigate any unexpected event(s) or threshold(s) in the response of either the plant or the ESF and develop analytical techniques that adequately describe and account for such unexpected behavior.

The information acquired from loss-of-coolant experiments (LOCEs) is thus used for evaluation and development of LOCA analytical methods and

assessment for the quantitative margins of safety of ESFs in response to a LOCA.

In order to meet the program objectives, test plans have been made and several tests were already performed since the initiation of the ROSA-III program in 1978. The objectives of this document is to provide system informations to interpret the ROSA-III test data. This document describes the ROSA-III test facility and instrumentations in detail.

2. ROSA-III TEST FACILITY

The test assembly consists of four major subsystems which have been instrumented such that desirable system parameters can be measured and recorded during a LOCE. The subsystems include: (a) the pressure vessel, (b) the steam line and the feedwater line, (c) the coolant recirculation system, and (d) the ECCS. System instrumentation is discussed in Section 3. The ROSA-III major components and the pressure vessel internal structures are shown schematically in Fig. 2.1 and 2.2, respectively. Coolant flow directions in the vessel during steady state operation is shown schematically in Fig. 2.3 along with ECCS and feed water flow directions. The ROSA-III piping system is shown in Fig. 2.4 and the major characteristics of the ROSA-III test facility are compared with those of a LBWR in Table 2.1.

2.1 Pressure Vessel

The pressure vessel (see Fig. 2.5) simulates the pressure vessel of a BWR. It has a simulated core, a lower plenum, an upper plenum, an annular downcomer, a steam separator, a simulated steam dryer plate, and a steam dome. It should be noted in this figure that the jet pumps are not placed in the vessel. The downcomer gap is extremely narrow to maintain the volumetric scaling ratio and relative elevation of downcomer top and bottom. It is difficult to install extremely small jet pumps in such narrow downcomer space, therefore, it was decided to install the jet pumps outside the pressure vessel.

The detail of the pressure vessel is shown in Fig. 2.6. Overall height of the vessel is approximately 6m. Elevation of the jet pump suction nozzle was chosen so that the core can be reflooded as an actual BWR after ECCS activation.

The core is consisted of four half-length simulated fuel assemblies and a control rod simulator. Each fuel assembly contains 62 fuel rods and two water rods which are spaced and supported in a square (8 x 8) array by upper tie plate (Fig. 2.7) and lower tie plate (Fig. 2.8). The simulated fuel rod (Fig. 2.9) is heated electrically with chopped-cosine axial power distribution (Fig. 2.10). The effective heated length is 1880 mm, one half of the active length of a BWR fuel rod. The simulated water rod (Fig. 2.11) is used to measure fluid temperature and void fraction in the core. These rods are spaced by the spacers (Fig. 2.12) and connected by the connectors (Fig. 2.13) at the top of the core. The orifice at the core inlet (Fig. 2.14) simulates the flow resistance of the nuclear core.

The details the lower plenum are shown in Fig. 2.15. It should be noticed that lead rods to the fuel rods penetrate through the lower plenum and a grid (Fig. 2.16) is used to prevent vibration of the lead rods. The volume of the lower plenum contains the volume of the control rod guide tube. The holes for core bypass flow are dimensioned so that approximately 10 percent of total flow will bypass the core region. The rest of the flow will enter the core region through the core inlet orifices.

The upper plenum configuration is shown in Fig. 2.17. The HPCS and the LPCS spargers and LPCI nozzle are arranged as shown in this figure.

The downcomer is annular (Fig. 2.18) and filler blocks are used to fill the gap between the square core-shroud and the circular vessel wall simulating the volume and geometry of an annular downcomer.

The steam separator (Fig. 2.19) is designed to simulate function of an actual steam separator of a BWR while the steam dryer plate (Fig. 2.20) simulates the flow resistance only.

2.2 Steam Line and Feed Water Line

The steam line and the feedwater line simulate those of a BWR. However the steam line and feed water line are independent open loops for the ROSA-III test. Steam is discharged into the atmosphere through the steam line connected to the steam dome. The steam line has three branches as shown in Figure 2.21. The first branch has a control valve (CV 130) to control the steady state steam dome pressure before blowdown. The second branch simulates the automatic depressurization system (ADS). The third branch has an orifice to simulate the flow resistance of a steam turbine-generator. Immediately after the blowdown initiation, the steam line is changed from the steady branch to the transient one. The closure of valves in the steam line takes a few seconds. Table 2.2 shows these valve characteristics along with orifice diameters in the steam line. The piping layout of the steam line is shown in Fig. 2.22.

The feed water line (Fig. 2.23) is connected to the feed water sparger (Fig. 2.24) located above the downcomer region. The feed water conditions are controlled by the feed water tank (FWT) and the heat exchangers (EX1 and EX2).

2.3 Coolant Recirculation System

The coolant recirculation system (Fig. 2.25) simulates the BWR recirculation loop. The system consists of two loops provided with a recirculation pump and two jet pumps in each loop. Characteristics of these pumps are discussed in section 2.6. One of recirculation loops is the intact loop which simulates the unbroken loop of a BWR and the other is the broken loop which simulates the broken loop of a BWR.

The broken loop has two break simulators and a quick shutoff valve (QSV) to simulate a double-ended shear break or a split break. Each break simulator is composed of an orifice (Fig. 2.26) or a nozzle (Fig. 2.27) which determines the break area and a quick opening blowdown valve (QOBV) (Fig. 2.28). The break type, position, and area are experimental variables. The standard break condition is a 200 % double-ended shear break at the recirculation pump inlet side with the orifice diameter of 26.2 mm.

Details of piping dimensions in recirculation loops are shown in Fig. 2.29 through Fig. 2.39.

2.4 Emergency Core Cooling System

The ECCS of ROSA-III simulate those of a BWR. The ECC systems include HPCS, LPCS, LPCI and ADS. The pipings of the ECC systems are shown schematically in Fig. 2.40. The spray systems, the HPCS (Fig. 2.41) and the LPCS (Fig. 2.42), spray the emergency core cooling water on the top of the core. The LPCI system (Fig. 2.43) supplies the emergency core cooling water into the core-bypass region directly (See Fig. 2.17). Each ECCS is provided with a tank, a pump, a valve, and a control system to control the valve trip delay, valve opening speed, and the flow rate. The flow rates of HPCS, LPCS and LPCI are shown as a function of pressure vessel pressure in Fig. 2.44, 2.45, and 2.46, respectively, comparing with the data for a BWR/6 ⁽¹⁾.

2.5 Power Curve for Simulated Fuel Rods

The power curve⁽²⁾ for simulated fuel rods in the ROSA-III test is shown in Fig. 2.47 and Table 2.3 comparing with the calculated results for the BWR/6⁽¹⁾ plant. The ROSA-III facility has heater rods in the core for fuel rod simulation, therefore, it is quite important for ROSA-III tests to give appropriate power transient to heater rods, because there are large differences in thermal characteristics between nuclear fuel rod and heater rod. Especially there is large difference in the heat capacity or the stored heat.

The power curve of ROSA-III simulates the average heat transfer rate in a BWR/6 core neglecting the stored heat of ROSA-III heater rods. The power transferred to the coolant in a BWR core is consisted of delayed-neutron fission power, decay power of fission products and actinides, and the stored heat release from the fuel. The ROSA-III heater power is varied following the pre-determined time transient curve in Fig. 2.47 without considering the feedbacks from the changes in the heat transfer mode during experiment.

For the first 50 s after the initiation of blowdown the heat transfer rate in the BWR core was calculated by the RELAP4J⁽³⁾ code assuming a 200 % double-ended break at the recirculation pump suction. Moderator density feedback, Doppler feedback, and scram worth were considered in the calculation of fission power. The power curve was obtained by using the data at the lower portion of the core because there was no abrupt change in the heat transfer rate due to DNB or rewetting. The ROSA-III core is consisted of four half-length fuel bundles corresponding to 9 MW steady state power. However, the power supply to heater rods of ROSA-III is limited to 4.4 MW, therefore, the power is kept constant for the first 7.5s until the normalized heat transfer rate in the core decreases to 0.49 (=4.4 MW / 9 MW).

Between 50 and 260 s after the initiation of blowdown stored heat release rate was calculated assuming fuel temperature equals to saturation temperature. Decay power of fission products and actinides was calculated by the proposed ANS 5.1⁽⁴⁾ standard assuming thermal neutron fission of ^{235}U and production rate of ^{239}U per fission to be 0.59. Delayed-neutron fission power is negligible after 50 s.

After 260 s stored heat release also becomes negligible and the heat transfer rate to coolant was calculated as the decay power of fission products and actinides.

2.6 Characteristics of Jet Pump and Recirculation Pump

2.6.1 Jet Pump Characteristics

As described previously, four jet pumps are placed outside of the vessel, two in broken loop and the others in intact loop. Therefore, the jet pumps need additional pipings connecting to the downcomer and the lower plenum. The jet pump characteristics and the pressure drop across the pipings under the reverse flow condition are described in this section.

The jet pump for the ROSA-III consists of an inlet mixer, a driving flow nozzle and a diffuser, as shown in Fig. 2.48. Details of the driving flow nozzle are shown in Fig. 2.49.

The operation principle of the jet pump is the conversion of momentum to pressure. The efficiency η , the ratio of the total energy increase of the suction flow to the total energy decrease of the driving flow is given in the following equation.

$$\eta = \frac{G_2}{G_1} \cdot \frac{H_d - H_2}{H_1 - H_d}$$

, where G and H represent the mass flow and the head, respectively, and the subscripts 1, 2, and " d " refer to the driving flow, suction flow, and discharge flow, respectively.

The flow ratio M is defined as

$$M = \frac{G_2}{G_1} \approx \frac{Q_2}{Q_1}$$

, where the mass flow (G) ratio is approximated to the volumetric flow (Q) ratio because the fluid densities of the driving flow and suction flow are nearly the same.

The head ratio N is defined as

$$N = \frac{H_d - H_2}{H_1 - H_d}$$

Thus the efficiency can be written as

$$\eta = M \cdot N$$

Experimental results of jet pump characteristics in the ROSA-III test is shown in Fig. 2.50, comparing with the reference data for a LBWR⁽⁵⁾.

When the driving flow stops and the flow in the jet pump reverses from the diffuser to inlet mixer, the jet pump is only the piping with flow resistance. The pressures drop across the jet pump and additional pipings were measured under the reverse flow condition. The results are shown in figures 2.51, 52, and 53 as a function of flow rate at the jet pump diffuser. Distribution of the flow resistance in the jet pumps and additional pipings is summarised in Table 2.4. The friction factors are shown in Table 2.5.

2.6.2 Recirculation Pump Characteristics

The recirculation pump for the ROSA-III is non-seal type vertical centrifugal pump with design value shown in Table 2.6.

The single-phase pump head curve for the ROSA-III pump is shown in Fig. 2.54. The following definitions refer to this figure.

$$\text{head ratio} : h = H / H_R$$

$$\text{speed ratio} : \alpha = \omega / \omega_R$$

$$\text{Flow ratio} : v = Q / Q_R$$

, where H , ω and Q represent the head, angular speed and volumetric flow rate, respectively, and the subscript " r " denote the rated operating value.

The curves consist of 8 segments corresponding to the operation region as,

1	normal pump	h / v^2 ($\alpha > 0, v > 0, \alpha / v < 1$)
2	normal pump	h / α^2 ($\alpha > 0, v > 0, \alpha / v > 1$)
3	energy dissipation	h / v^2 ($\alpha > 0, v < 0, \alpha / v < 1$)
4	energy dissipation	h / α^2 ($\alpha > 0, v < 0, \alpha / v > 1$)
5	normal turbine	h / v^2 ($\alpha < 0, v < 0, \alpha / v < 1$)
6	normal turbine	h / α^2 ($\alpha < 0, v < 0, \alpha / v > 1$)
7	reverse pump	h / v^2 ($\alpha < 0, v > 0, \alpha / v < 1$)
8	reverse pump	h / α^2 ($\alpha < 0, v > 0, \alpha / v > 1$)

The single-phase homologous head curves can be used for the ROSA-III system analysis code (such as RELAP4/MOD5).

3. INSTRUMENTATION

The instrumentation system of the ROSA-III was designed to obtain thermo-hydraulic data in a BWR LOCE to contribute to assess the analytical code. The channel assignment for the instrumentation differs following the renewal of the simulated fuel assembly or remodeling of the loop system. The measurement list for the latest fuel assembly (No.3) is shown in Table 3.1. Locations of instrumentation are shown in Fig. 3.1 through Fig.3.7 and Table 3.2 presents thermocouple locations in the fuel assembly No.3.

Measured quantities in the ROSA-III test are pressure, differential pressure, flow rate, electric power, pump revolution, signals, fluid temperature, liquid level, fluid density and momentum flux of coolant flow.

Pressure measurements are done with semi-conductor transducers measuring the piezoelectric resistance. The detector is cooled by water for the protection from high temperature environment.

Differential pressure transducers with two direct current cables convert displacement of a diaphragm to electric charge and then to proportional voltage. The pressure lead pipes are dual circular pipes for circulating cooling water to eliminate flashing of the fluid.

Flow rate is measured by orifice, venturi, turbine or electro-magnetic flow meters depending on the fluid condition and the measurement location.

Electric power for simulated fuel rods is controlled by the predetermined function of time and it is measured by fast response electric power meter.

Pump revolution speed is measured by electromagnetic counter on the pump shaft.

On-off signals such as valve position, pump revolution direction, blowdown initiation and pump power supply are converted to voltage or current and recorded in respective channels in order to specify the exact time of the signal.

Temperature of fluid, structure materials and fuel rods are measured with Chromel-Alumel thermocouples (CA T/C) of 1.6 mm ϕ or 1.0 mm ϕ .

Liquid levels are measured by means of needle type electrical conductivity probes developed in the ROSA-III program. The probes are attached on the walls of core barrel and channel boxes at several elevations and detect the existence of water or vapor at each level.

Fluid density in the pipe is measured by means of a gamma-ray densitometer. Each gamma-ray densitometer has two or three beams to estimate the flow regime. The gamma source is ^{137}Cs (~ 20 Ci) and the detector is a NaI scintillator which is cooled by water.

Momentum flux is measured by a drag disk, and the combination of two signals from a drag disk, a turbine meter and a gamma-ray densitometer is used to determine two-phase flow conditions.

In addition to the instrumentations described above, measurement technique of void fraction measurement and flow direction measurement are under development and prototypes of such detectors are being tested in the test facility.

The data acquisition system consists of DATAC-2000B and FACOM M200 system computer. The DATAC 2000B records measured data on a magnetic tape up to 750 channels and the data tape is processed by the FACOM M200 system computer at JAERI by off line. After the evaluation of each data by comparing the initial and the final values with the standard values of the pressure, for example, the data are re-processed using the correct conversion factors determined from the consistency examination.

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Table 2.1 Primary Characteristics of BWR6 and ROSA-III

a) Comparison of Major Design Parameters

	BWR6 (251/848)	ROSA-III	Ratio ($\frac{\text{BWR6}}{\text{ROSA-III}}$)
Reactor Type	BWR	Simulated BWR	
Number of			
Recirc. Loops	2	2	1
Steam Lines	4	1	4
Jet Pumps	24	4	6
Separators	212	1	212
Core Heat Generation	Nuclear Fission	Electric Heater	
Total Power (kW)	3.80×10^5	< 4450	> 854
Active Fuel Length (m)	3.759	1.880	2
Number of Fuel Assemblies	848	4	212
Total Volume (m ³)	621	1.42	437
Operating Conditions			
Pressure (MPa)	7.27	7.27	
Core Flow (kg/s)	1.54×10^4	< 3.64	> 424
Steam Flow (kg/s)	2.06×10^3	< 4.86	> 424
Recirc. Pump Flow Rate per 1 Pump (kg/s)	2.24×10^3	< 5.26	> 424
Feed Water Temp. (K)	489	489	1

Table 2.1 (continued)

b) ECCS Conditions

	BWR6(251/848)	ROSA-III	Ratio($\frac{\text{BWR6}}{\text{ROSA-III}}$)
HPCS			
Number of Lines	1	1	
Injection Flow Rate(m ³ /s)			
at 7.90MPa	0.104	0.425 x 10 ⁻³	} 424* See Fig.2.44
at 1.38MPa	0.442	0.820 x 10 ⁻³	
Water Temp.(K)	300 ~ 344	up to 393	
Injection Location	upper plenum	upper plenum	
LPCS			
Number of Lines	1	1	
Injection Flow Rate(m ³ /s)			
at 0.84MPa	0.442	0.94 x 10 ⁻³	424* See Fig.2.45
Water Temp.(K)	300 ~ 344	up to 393	
Injection Location	upper plenum	upper plenum	
LPCI(RHR)			
Number of Lines	3	1	
Injection Flow Rate(m ³ /s/pump)			
at 0.14MPa	0.470	4.27 x 10 ⁻³	424* See Fig.2.46
Water Temp.(K)	300 ~ 344	up to 393	
Injection Location	in-shroud	in-shroud	c.f.Fig.2.17

Note: * Design scaling ratio

Table 2.1 (continued)

c) Volume Distribution and Main Component Dimension

Item	BWR6(251/848)	ROSA-III	Ratio($\frac{\text{BWR6}}{\text{ROSA-III}}$)
Lower Plenum & Guide Tubes m ³	123	0.259	473
Lower Plenum m ³	79.0	0.188	420
Guide Tubes m ³	43.8	0.0714	614
Core m ³	59.8	0.134	446
Core in Channels m ³	35.4	0.0814	435
Core Bypass m ³	24.4	0.0524	465
Upper Plenum & Steam Separators m ³	80.5	0.185	435
Upper Plenum m ³	52.5	0.124	423
Steam Separators m ³	28.0	0.0610	459
Steam Dome *1) m ³	206	0.439	468
Downcomer *2) m ³	123	0.233*3)	528
Above Jet Pump Suction m ³	74.2*	0.164*4)	452
Between Jet Pump Suction and Recirculation Outlet m ³	36.8*	0.0600*3)	613
Below Recirculation Outlet m ³	12.2	0.00900	1360
Recirculation Loops & Jet Pumps m ³	29.6	0.171*4)	173
Total Volume m ³	621	1.421	437
Pressure Vessel Dimension			
Inner Height m	22.3*	6.01	3.71
Inner Diameter m	6.38*	0.492*5)	13.0
Water Level m	14.1*	4.62	3.04
Jet Pump Suction Level m	8.28*	2.82	2.93
Lower Core End Level m	5.49*	1.60*6)	3.43
Recirculation Line Level m	3.88*	0.938	4.13
Recirculation Loop Pipe Inner Diameter m	0.54	≤0.0495	

- Note : * BWR 5
 *1)above normal water level
 *2)below normal water level
 *3)include jet pump suction lines
 *4)not include jet pump suction lines
 *5)out diameter of lower downcomer
 *6)bottom of active fuel

Table 2.1 (continued)
d) Thermal Characteristics

	BWR6(251/848)	ROSA-III	Ratio($\frac{\text{BWR6}}{\text{ROSA-III}}$)
Active Core Length (m)	3.708	1.880	1.972
Number of Fuel Rods	52576	248	212
Number of Water Rods	1696	8	212
Rods Array	8 x 8 square	8 x 8 square	
Fuel Rod O.D (mm)	12.27	12.27	1
Cladding Thickness (mm)	0.864	1.3	0.665
Fuel Rod Pitch (mm)	16.16	16.16	1
Total Fuel Heat Transfer Area (m ²)	7.515 x 10 ³	1.797 x 10 ¹	418
Cladding Material	Zircalloy	Inconel 600	
Average Linear Rod Power (kW/m)	19.49	≤ 9.54	≥ 2.04
Core Average Heat Flux (kW/m ²)	505.7	≤ 247.6	≥ 2.04
Core Coolant Flow Rate* (kg/s)	1.54 x 10 ⁴ ***	< 36.4	> 424
Core Inlet Velocity** (m/s)	2.16***	1.11	1.95
Total Core Flow Area (m ²)	8.56***	0.0392	218
Peaking Factor			
Local P.F.	1.18	1.0	1.18
Axial P.F.	1.30	1.40	0.929
Radial P.F.	1.35	1.40	0.964
Gross P.F.	1.8	1.96	0.918
Total P.F.	2.1	1.96	1.07

* Include core bypass

** Exclude core bypass flow rate assuming it as 10% of core coolant flow rate

*** Current 8 x 8 fuel rods

Table 2.2 Valve Characteristics of Steam Discharge Line

Valve	Close to Open (s)	Open to Close (s)
AV165 (MSIV Valve)	0.1	1.5
AV168 (Steady State Line)	-	0.1
AV169 (ADS Valve)	0.3	2.0

Orifice	Diameter (mm)	Area (mm ²)
OR3	Not Used	-
OR4	15.5	188.7
OR5	16.8	221.7

Table 2.3 Power Curve for ROSA-III

No.	time BWR ROSA-III (s)	P / P ₀	No.	time BWR ROSA-III (s)	P / P ₀
00010	0.0	1.0000	00610	6.0	0.5662
00020	0.1	0.9800	00620	6.1	0.5606
00030	0.2	0.9664	00630	6.2	0.5551
00040	0.3	0.9529	00640	6.3	0.5497
00050	0.4	0.9393	00650	6.4	0.5443
00060	0.5	0.9257	00660	6.5	0.5389
00070	0.6	0.9121	00670	6.6	0.5336
00080	0.7	0.8985	00680	6.7	0.5284
00090	0.8	0.8849	00690	6.8	0.5232
00100	0.9	0.8713	00700	6.9	0.5181
00110	1.0	0.8577	00710	7.0	0.5130
00120	1.1	0.8441	00720	7.1	0.5080
00130	1.2	0.8305	00730	7.2	0.5030
00140	1.3	0.8169	00740	7.3	0.4980
00150	1.4	0.8033	00750	7.4	0.4931
00160	1.5	0.7897	00760	7.5	0.4883
00170	1.6	0.7761	00770	7.6	0.4835
00180	1.7	0.7625	00780	7.7	0.4788
00190	1.8	0.7489	00790	7.8	0.4741
00200	1.9	0.7353	00800	7.9	0.4694
00210	2.0	0.7217	00810	8.0	0.4648
00220	2.1	0.7081	00820	8.1	0.4601
00230	2.2	0.6945	00830	8.2	0.4552
00240	2.3	0.6809	00840	8.3	0.4509
00250	2.4	0.6673	00850	8.4	0.4516
00260	2.5	0.6537	00860	8.5	0.4484
00270	2.6	0.6401	00870	8.6	0.4452
00280	2.7	0.6265	00880	8.7	0.4420
00290	2.8	0.6129	00890	8.8	0.4388
00300	2.9	0.5993	00900	8.9	0.4357
00310	3.0	0.5857	00910	9.0	0.4326
00320	3.1	0.5721	00920	9.1	0.4295
00330	3.2	0.5585	00930	9.2	0.4264
00340	3.3	0.5449	00940	9.3	0.4234
00350	3.4	0.5313	00950	9.4	0.4203
00360	3.5	0.5177	00960	9.5	0.4173
00370	3.6	0.5041	00970	9.6	0.4143
00380	3.7	0.4905	00980	9.7	0.4114
00390	3.8	0.4769	00990	9.8	0.4084
00400	3.9	0.4633	01000	9.9	0.4055
00410	4.0	0.4497			
00420	4.1	0.4361			
00430	4.2	0.4225			
00440	4.3	0.4089			
00450	4.4	0.3953			
00460	4.5	0.3817			
00470	4.6	0.3681			
00480	4.7	0.3545			
00490	4.8	0.3409			
00500	4.9	0.3273			
00510	5.0	0.3137			
00520	5.1	0.3001			
00530	5.2	0.2865			
00540	5.3	0.2729			
00550	5.4	0.2593			
00560	5.5	0.2457			
00570	5.6	0.2321			
00580	5.7	0.2185			
00590	5.8	0.2049			
00600	5.9	0.1913			

Table 2.3 (Continued)

No.	time (s)	P / P ₀
01610	16.0	0.2554
01620	16.1	0.2552
01630	16.2	0.2539
01640	16.3	0.2527
01650	16.4	0.2515
01660	16.5	0.2502
01670	16.6	0.2490
01680	16.7	0.2478
01690	16.8	0.2466
01700	16.9	0.2454
01710	17.0	0.2442
01720	17.1	0.2430
01730	17.2	0.2419
01740	17.3	0.2407
01750	17.4	0.2395
01760	17.5	0.2383
01770	17.6	0.2372
01780	17.7	0.2360
01790	17.8	0.2349
01800	17.9	0.2337
01810	18.0	0.2326
01820	18.1	0.2314
01830	18.2	0.2301
01840	18.3	0.2272
01850	18.4	0.2256
01860	18.5	0.2239
01870	18.6	0.2222
01880	18.7	0.2205
01890	18.8	0.2188
01900	18.9	0.2171
01910	19.0	0.2155
01920	19.1	0.2138
01930	19.2	0.2122
01940	19.3	0.2106
01950	19.4	0.2090
01960	19.5	0.2074
01970	19.6	0.2058
01980	19.7	0.2042
01990	19.8	0.2026
02000	19.9	0.2011

No.	time (s)	P / P ₀
01010	10.0	0.4026
01020	10.1	0.3997
01030	10.2	0.3969
01040	10.3	0.3940
01050	10.4	0.3912
01060	10.5	0.3884
01070	10.6	0.3854
01080	10.7	0.3824
01090	10.8	0.3795
01100	10.9	0.3765
01110	11.0	0.3736
01120	11.1	0.3707
01130	11.2	0.3679
01140	11.3	0.3650
01150	11.4	0.3622
01160	11.5	0.3594
01170	11.6	0.3566
01180	11.7	0.3539
01190	11.8	0.3511
01200	11.9	0.3484
01210	12.0	0.3457
01220	12.1	0.3430
01230	12.2	0.3404
01240	12.3	0.3378
01250	12.4	0.3351
01260	12.5	0.3326
01270	12.6	0.3300
01280	12.7	0.3274
01290	12.8	0.3249
01300	12.9	0.3224
01310	13.0	0.3199
01320	13.1	0.3173
01330	13.2	0.3158
01340	13.3	0.3138
01350	13.4	0.3118
01360	13.5	0.3098
01370	13.6	0.3079
01380	13.7	0.3059
01390	13.8	0.3040
01400	13.9	0.3020
01410	14.0	0.3001
01420	14.1	0.2982
01430	14.2	0.2963
01440	14.3	0.2944
01450	14.4	0.2925
01460	14.5	0.2907
01470	14.6	0.2888
01480	14.7	0.2870
01490	14.8	0.2852
01500	14.9	0.2834
01510	15.0	0.2815
01520	15.1	0.2798
01530	15.2	0.2780
01540	15.3	0.2762
01550	15.4	0.2744
01560	15.5	0.2727
01570	15.6	0.2710
01580	15.7	0.2693
01590	15.8	0.2676
01600	15.9	0.2659

Table 2.3 (Continued)

No.	time (s)	P / P ₀	No.	time (s)	P / P ₀
02010	20.0	0.2095	02610	26.0	0.1511
02020	20.1	0.2020	02620	26.1	0.1511
02030	20.2	0.2085	02630	26.2	0.1492
02040	20.3	0.2050	02640	26.3	0.1474
02050	20.4	0.2035	02650	26.4	0.1465
02060	20.5	0.2020	02660	26.5	0.1457
02070	20.6	0.2011	02670	26.6	0.1448
02080	20.7	0.2002	02680	26.7	0.1439
02090	20.8	0.1993	02690	26.8	0.1430
02100	20.9	0.1984	02700	26.9	0.1422
02110	21.0	0.1975	02710	27.0	0.1413
02120	21.1	0.1966	02720	27.1	0.1405
02130	21.2	0.1958	02730	27.2	0.1396
02140	21.3	0.1949	02740	27.3	0.1388
02150	21.4	0.1940	02750	27.4	0.1379
02160	21.5	0.1932	02760	27.5	0.1371
02170	21.6	0.1923	02770	27.6	0.1363
02180	21.7	0.1914	02780	27.7	0.1354
02190	21.8	0.1906	02790	27.8	0.1346
02200	21.9	0.1897	02800	27.9	0.1338
02210	22.0	0.1889	02810	28.0	0.1330
02220	22.1	0.1880	02820	28.1	0.1322
02230	22.2	0.1872	02830	28.2	0.1315
02240	22.3	0.1864	02840	28.3	0.1307
02250	22.4	0.1855	02850	28.4	0.1300
02260	22.5	0.1847	02860	28.5	0.1293
02270	22.6	0.1839	02870	28.6	0.1285
02280	22.7	0.1830	02880	28.7	0.1277
02290	22.8	0.1822	02890	28.8	0.1270
02300	22.9	0.1814	02900	28.9	0.1262
02310	23.0	0.1806	02910	29.0	0.1254
02320	23.1	0.1798	02920	29.1	0.1247
02330	23.2	0.1790	02930	29.2	0.1239
02340	23.3	0.1782	02940	29.3	0.1231
02350	23.4	0.1774	02950	29.4	0.1224
02360	23.5	0.1766	02960	29.5	0.1216
02370	23.6	0.1758	02970	29.6	0.1208
02380	23.7	0.1750	02980	29.7	0.1200
02390	23.8	0.1742	02990	29.8	0.1192
02400	23.9	0.1734	03000	29.9	0.1184
02410	24.0	0.1726			
02420	24.1	0.1718			
02430	24.2	0.1710			
02440	24.3	0.1702			
02450	24.4	0.1694			
02460	24.5	0.1686			
02470	24.6	0.1678			
02480	24.7	0.1670			
02490	24.8	0.1662			
02500	24.9	0.1654			
02510	25.0	0.1646			
02520	25.1	0.1638			
02530	25.2	0.1630			
02540	25.3	0.1622			
02550	25.4	0.1614			
02560	25.5	0.1606			
02570	25.6	0.1598			
02580	25.7	0.1590			
02590	25.8	0.1582			
02600	25.9	0.1574			

Table 2.3 (Continued)

No.	time (s)	P / P ₀
03010	30.0	0.1280
03020	30.2	0.1275
03030	30.4	0.1271
03040	30.6	0.1267
03050	30.8	0.1262
03060	31.0	0.1258
03070	31.2	0.1253
03080	31.4	0.1249
03090	31.6	0.1244
03100	31.8	0.1240
03110	32.0	0.1236
03120	32.2	0.1231
03130	32.4	0.1227
03140	32.6	0.1223
03150	32.8	0.1218
03160	33.0	0.1214
03170	33.2	0.1210
03180	33.4	0.1206
03190	33.6	0.1201
03200	33.8	0.1197
03210	34.0	0.1193
03220	34.2	0.1189
03230	34.4	0.1185
03240	34.6	0.1180
03250	34.8	0.1176
03260	35.0	0.1172
03270	35.2	0.1168
03280	35.4	0.1164
03290	35.6	0.1156
03300	35.8	0.1152
03310	36.0	0.1148
03320	36.2	0.1144
03330	36.4	0.1140
03340	36.6	0.1136
03350	36.8	0.1132
03360	37.0	0.1128
03370	37.2	0.1124
03380	37.4	0.1120
03390	37.6	0.1116
03400	37.8	0.1112
03410	38.0	0.1108
03420	38.2	0.1104
03430	38.4	0.1100
03440	38.6	0.1096
03450	38.8	0.1092
03460	39.0	0.1088
03470	39.2	0.1085
03480	39.4	0.1081
03490	39.6	0.1077
03500	39.8	0.1073
03510	40.0	0.1069
03520	40.2	0.1066
03530	40.4	0.1062
03540	40.6	0.1058
03550	40.8	0.1055
03560	41.0	0.1051
03570	41.2	0.1047
03580	41.4	0.1043
03590	41.6	0.1040
03600	41.8	0.1040
03610	42.0	0.1036
03620	42.2	0.1033
03630	42.4	0.1029
03640	42.6	0.1025
03650	42.8	0.1022
03660	43.0	0.1018
03670	43.2	0.1014
03680	43.4	0.1011
03690	43.6	0.1007
03700	43.8	0.1004
03710	44.0	0.1000
03720	44.2	0.0997
03730	44.4	0.0993
03740	44.6	0.0990
03750	44.8	0.0986
03760	45.0	0.0983
03770	45.2	0.0979
03780	45.4	0.0976
03790	45.6	0.0973
03800	45.8	0.0969
03810	46.0	0.0966
03820	46.2	0.0962
03830	46.4	0.0959
03840	46.6	0.0955
03850	46.8	0.0952
03860	47.0	0.0949
03870	47.2	0.0945
03880	47.4	0.0943
03890	47.6	0.0939
03900	47.8	0.0936
03910	48.0	0.0932
03920	48.2	0.0929
03930	48.4	0.0926
03940	48.6	0.0922
03950	48.8	0.0919
03960	49.0	0.0916
03970	49.2	0.0913
03980	49.4	0.0911
03990	49.6	0.0906
04000	49.8	0.0903
04010	50.0	0.0900
04020	60.0	0.0795
04030	70.0	0.0740
04040	80.0	0.0690
04050	90.0	0.0647
04060	100.0	0.0610
04070	200.0	0.0383
04080	300.0	0.0282
04090	400.0	0.0287
04100	500.0	0.0272
04110	600.0	0.0258
04120	700.0	0.0245
04130	800.0	0.0233
04140	900.0	0.0221
04150	1000.0	0.0210
04160	2000.0	0.0195
04170	3000.0	0.0182
04180	4000.0	0.0166

Table 2.4 Pressure drop across the jet pumps and additional pipings under the reverse flow condition ($Q = 200 \text{ l/min}$).

Pipings	Pressure drop (kg/cm^2)	Rate (%)
Jet Pump Discharge to Suction	0.45	56.0
Jet Pump Suction to Downcomer	0.29	36.5
Y Branch	0.06	7.5
Total	0.8	100.0

Table 2.5 Friction factor of the jet pumps and additional pipings under the reverse flow condition.

Pipings	Inner Diameter (mm)	Friction Factor
Jet Pump Discharge to Suction	19.3 (throat)	$0.63 < K < 0.89$
Jet Pump Suction to Downcomer	38.4 ($1 \frac{1}{2} \text{B}$)	$6.2 < K < 9.3$
	62.0 ($2 \frac{1}{2} \text{B}$)	$42 < K < 63$
Y Branch	49.5 (2B)	$3.5 < K < 6.5$
	62.0 ($2 \frac{1}{2} \text{B}$)	$8.5 < K < 16$
	73.9 (3B)	$17 < K < 31$

Table 2.6 Design parameters of ROSA-III recirculation pump

Items	Design Value
Rated Flow (l/min)	450
Rated Head (m)	262
Rated Velocity (rpm)	3600
Fluid Temperature (K)	555
NPSH (m)	4
Moment of Inertia (kgm^2)	1.7
Rated Torque (kgm)	18.8
Impeller Diameter (mm)	315

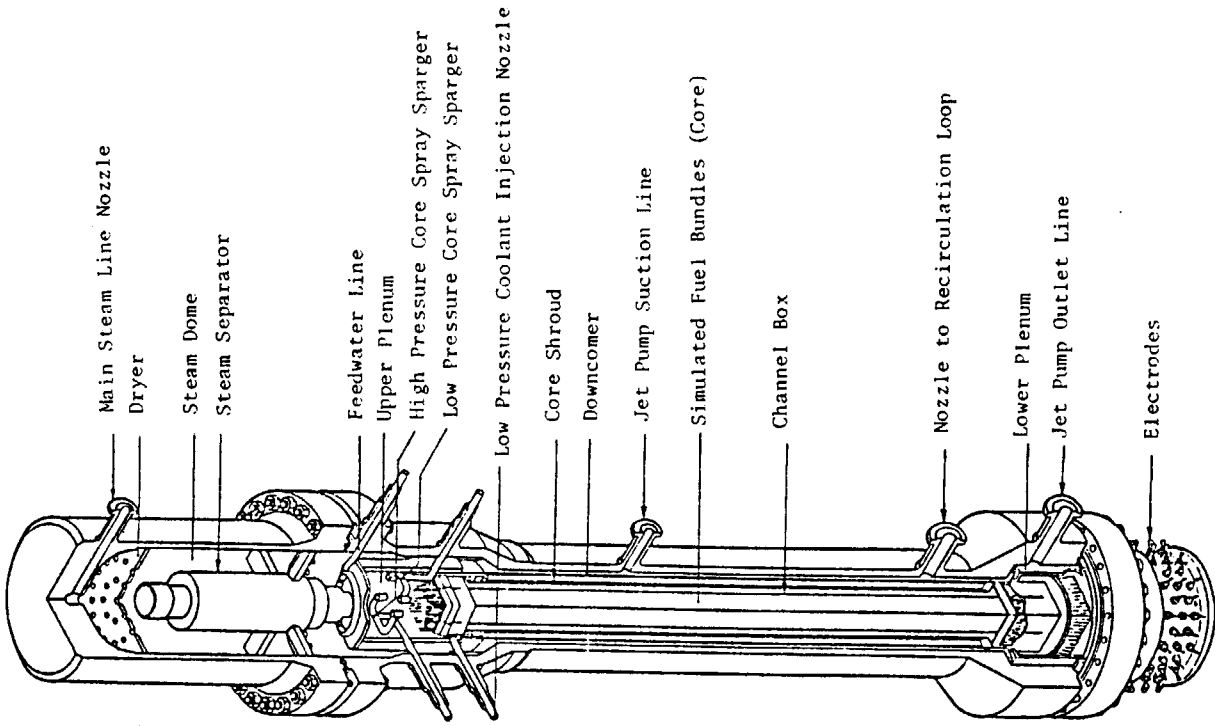


Fig. 2.2 Internal Structure of Pressure Vessel of ROSA-III.

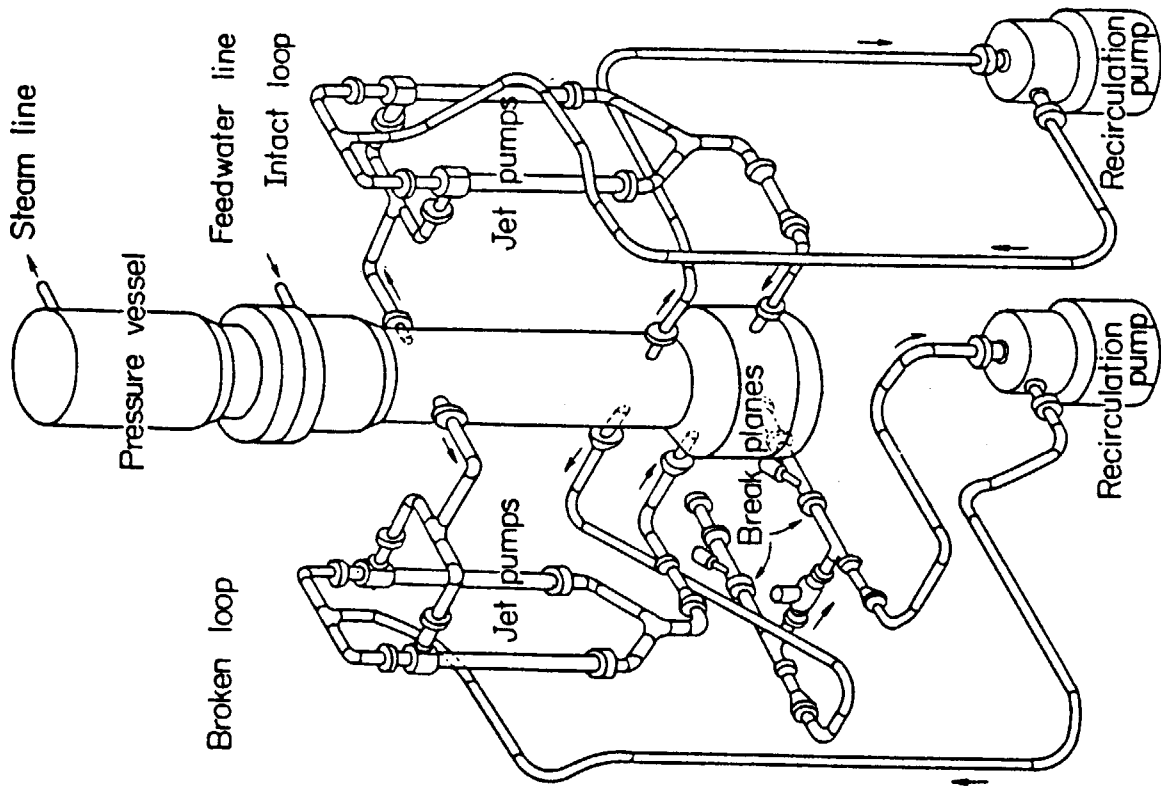


Fig. 2.1 Schematic Diagram of ROSA-III Test Facility.

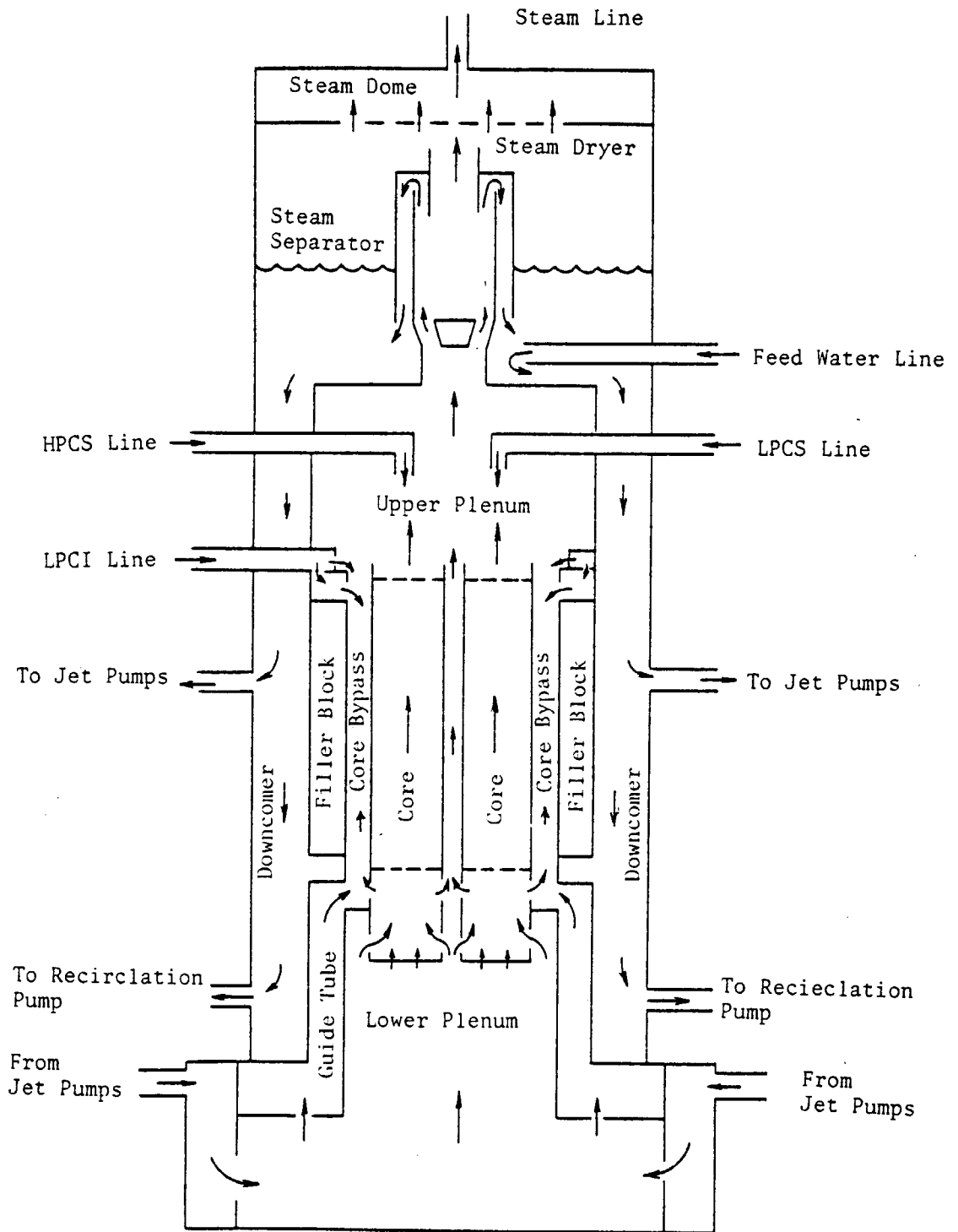


Fig. 2.3 Steady State Coolant Flow in the Vessel and ECC Flow During LOCA.

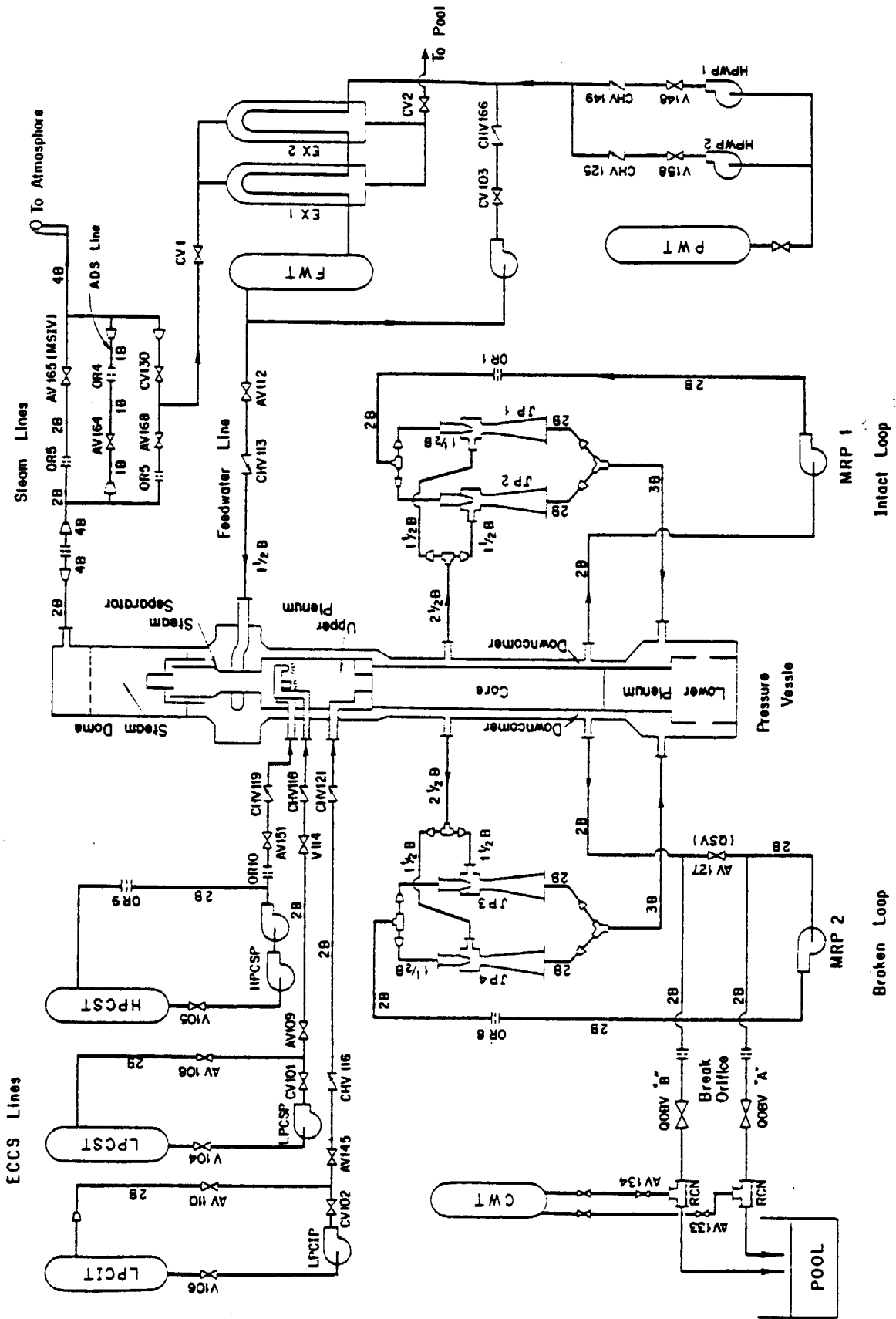


Fig.2.4 ROSA - III Piping Schematic

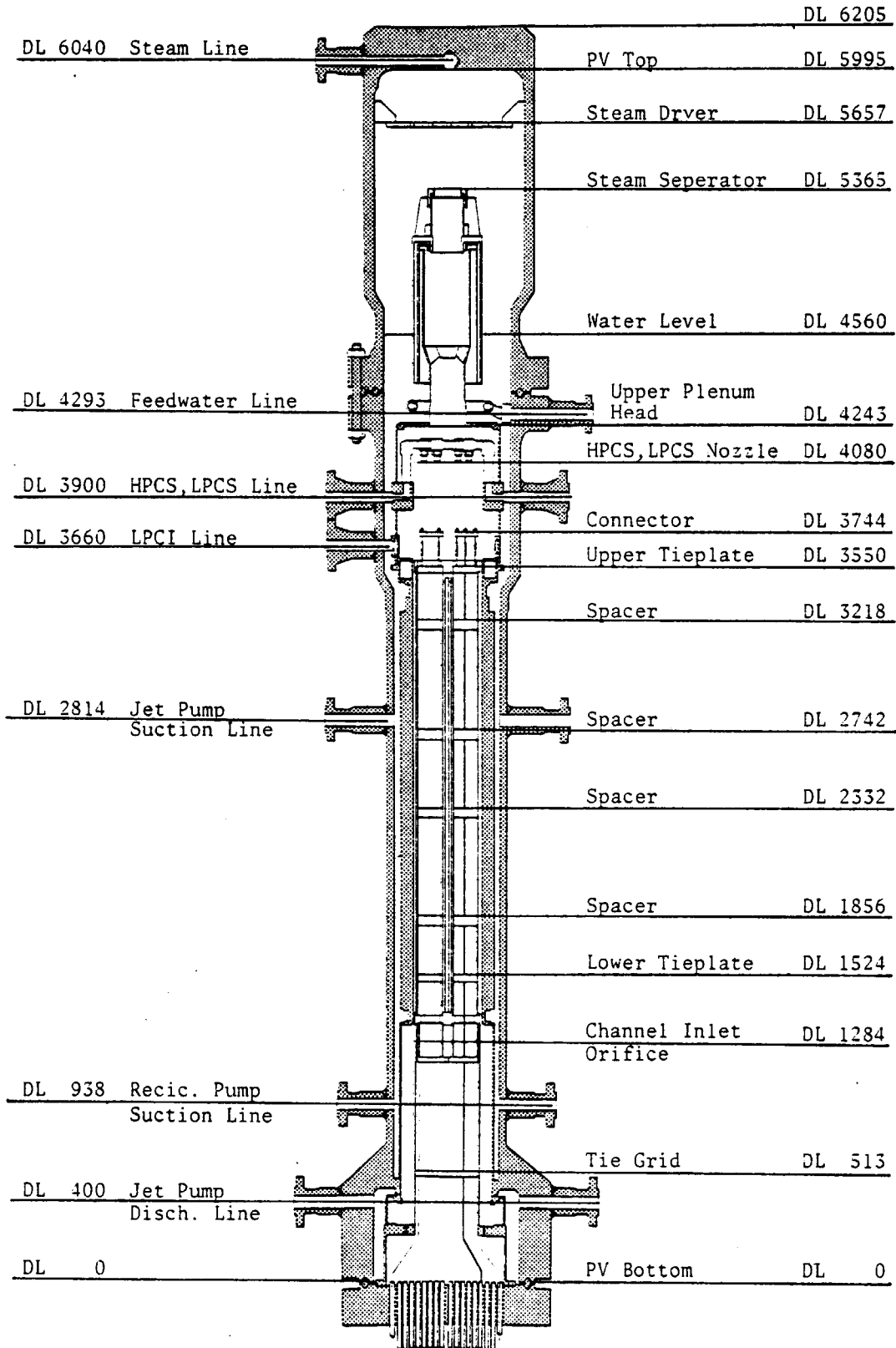


Fig. 2.5 Pressure Vessel Internals Arrangement.

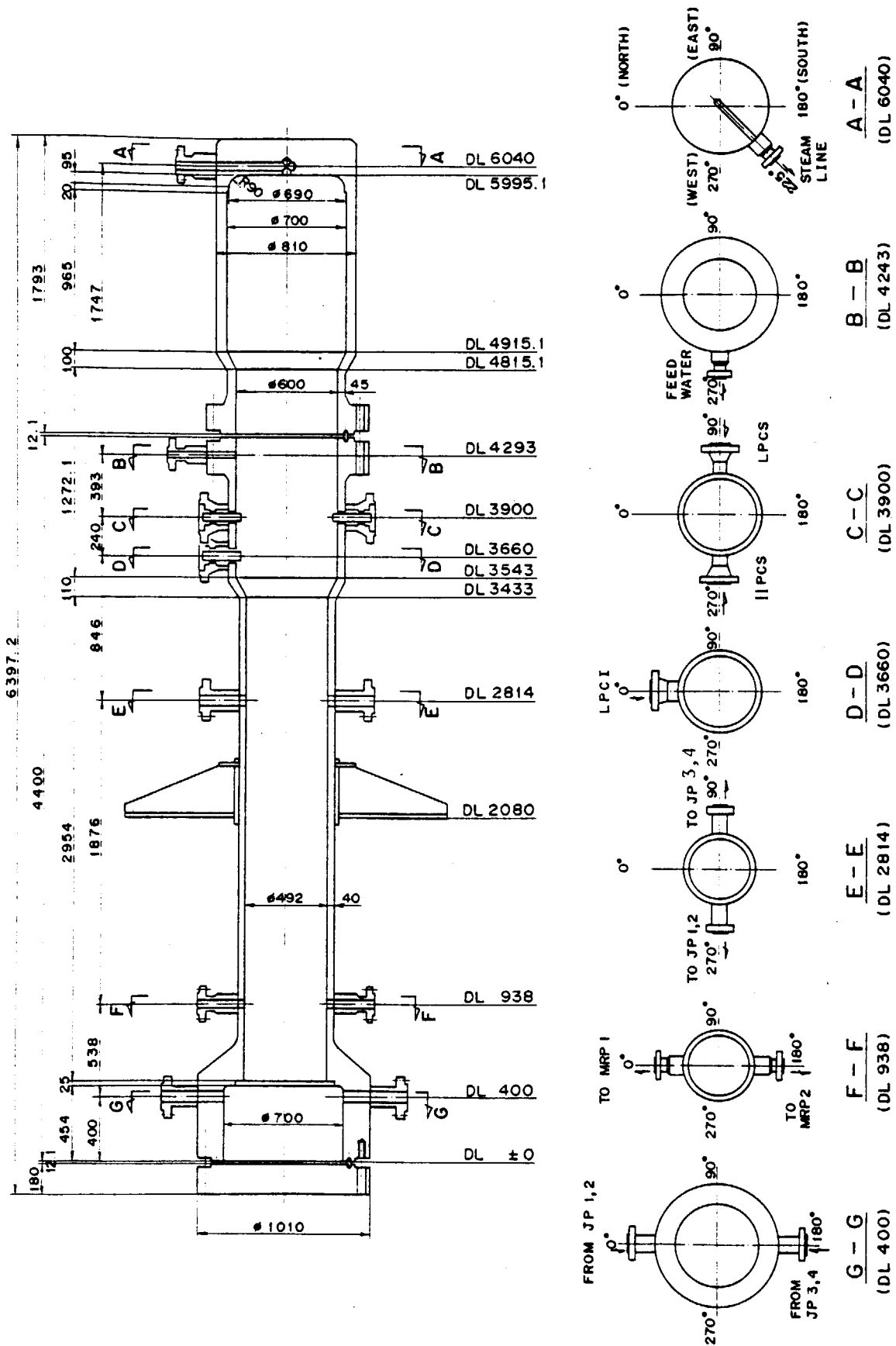


Fig. 2.6 Pressure Vessel with Nozzles.

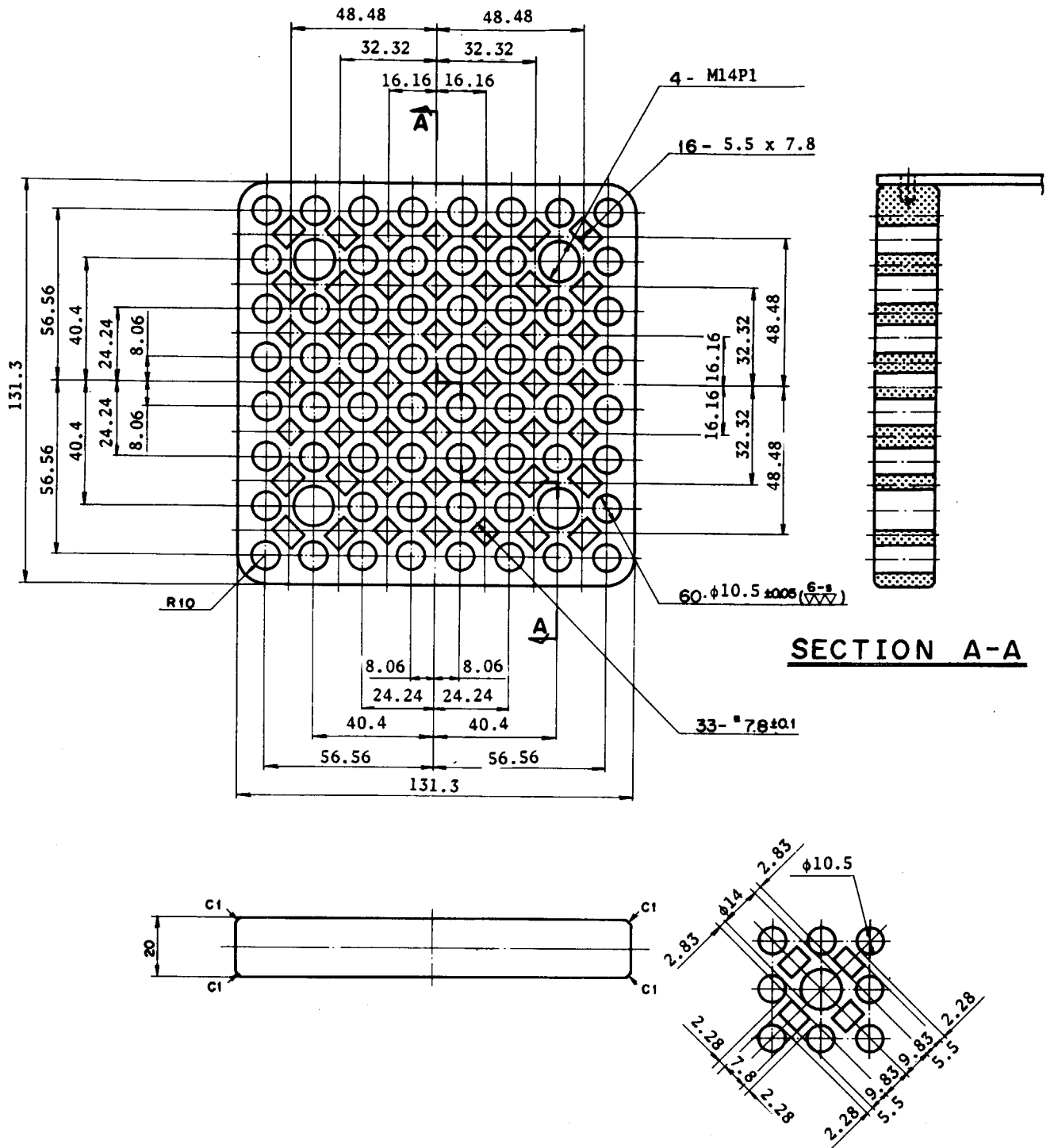


Fig. 2.7 Upper Tie Plate.

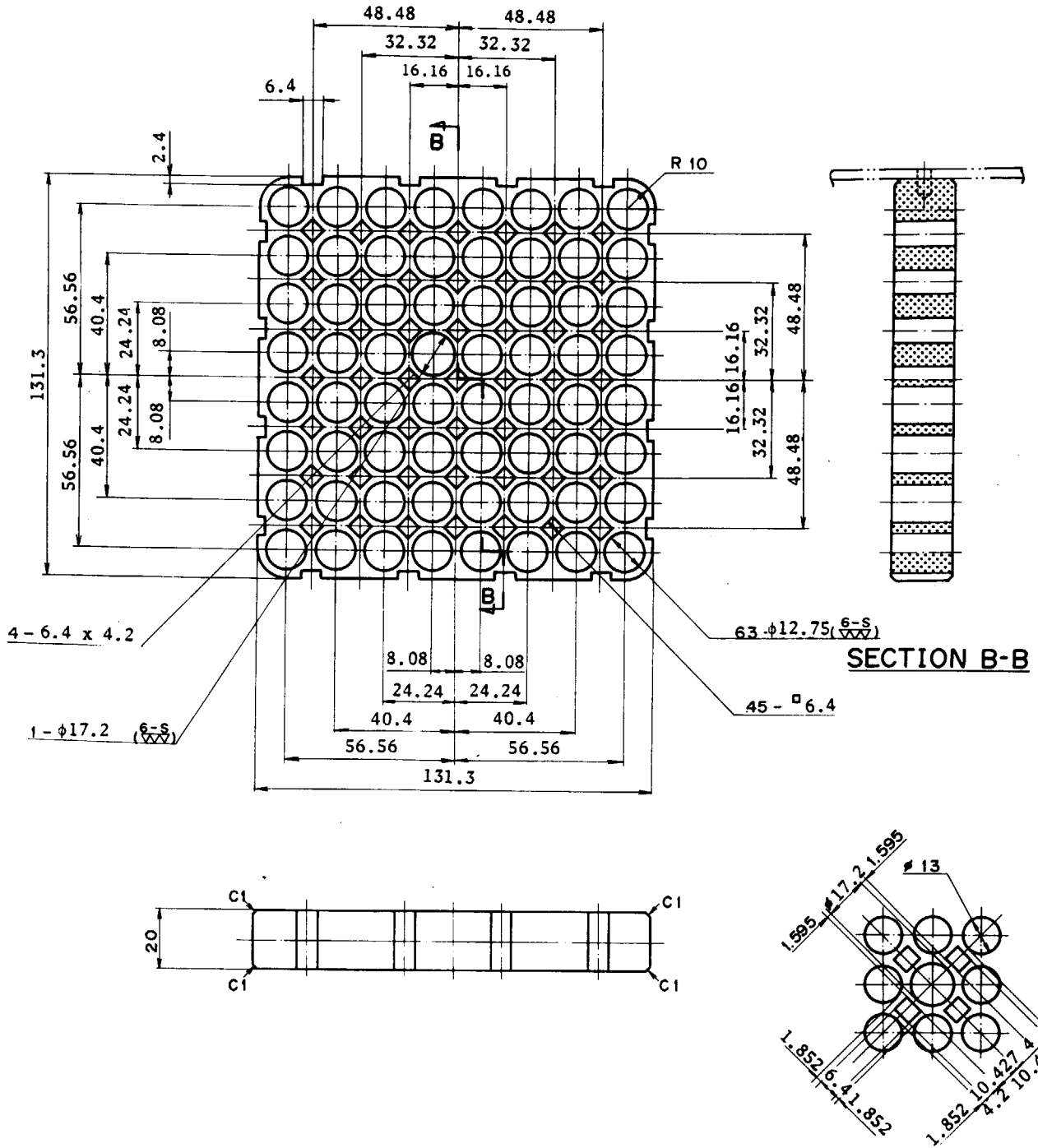
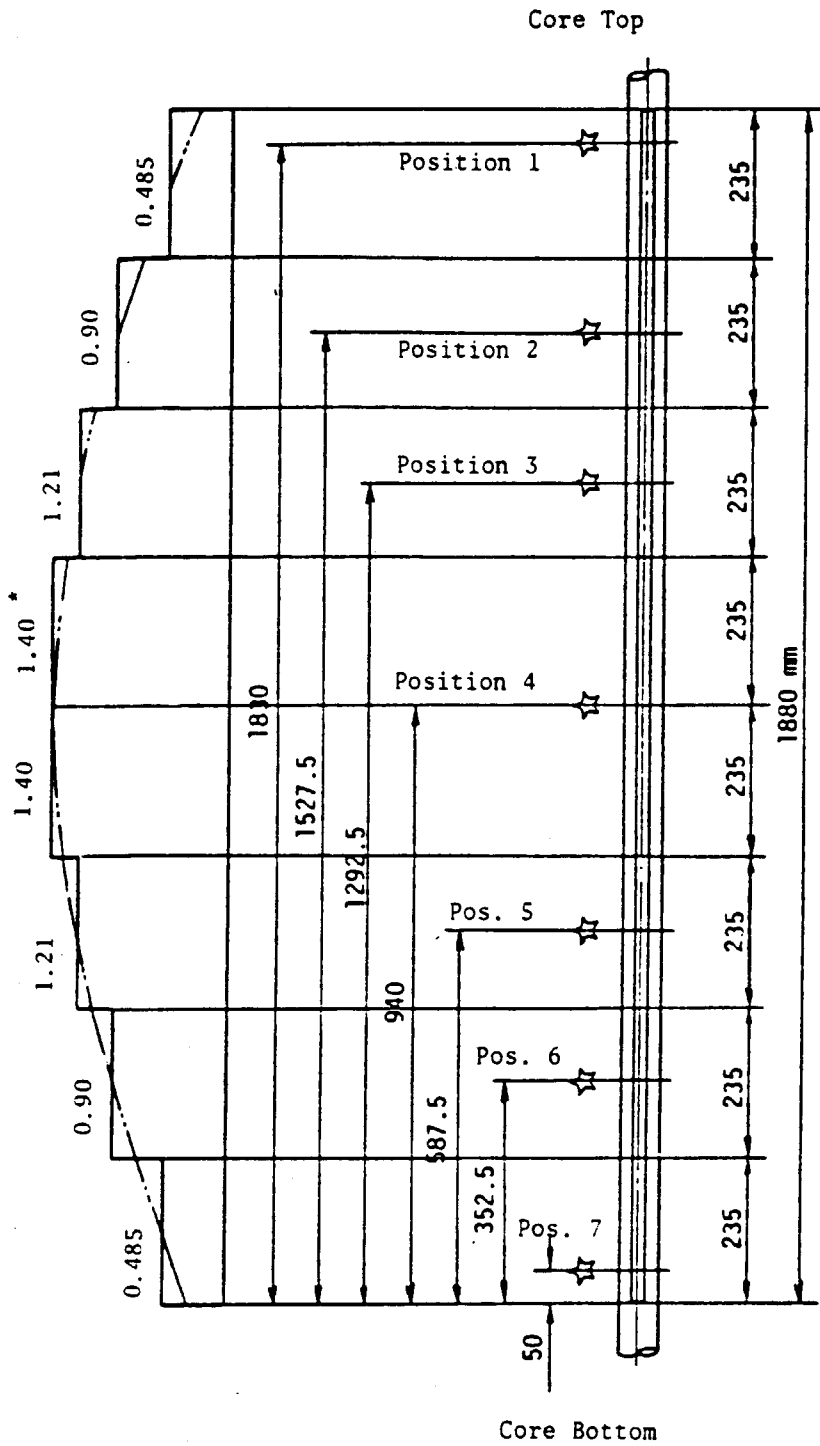
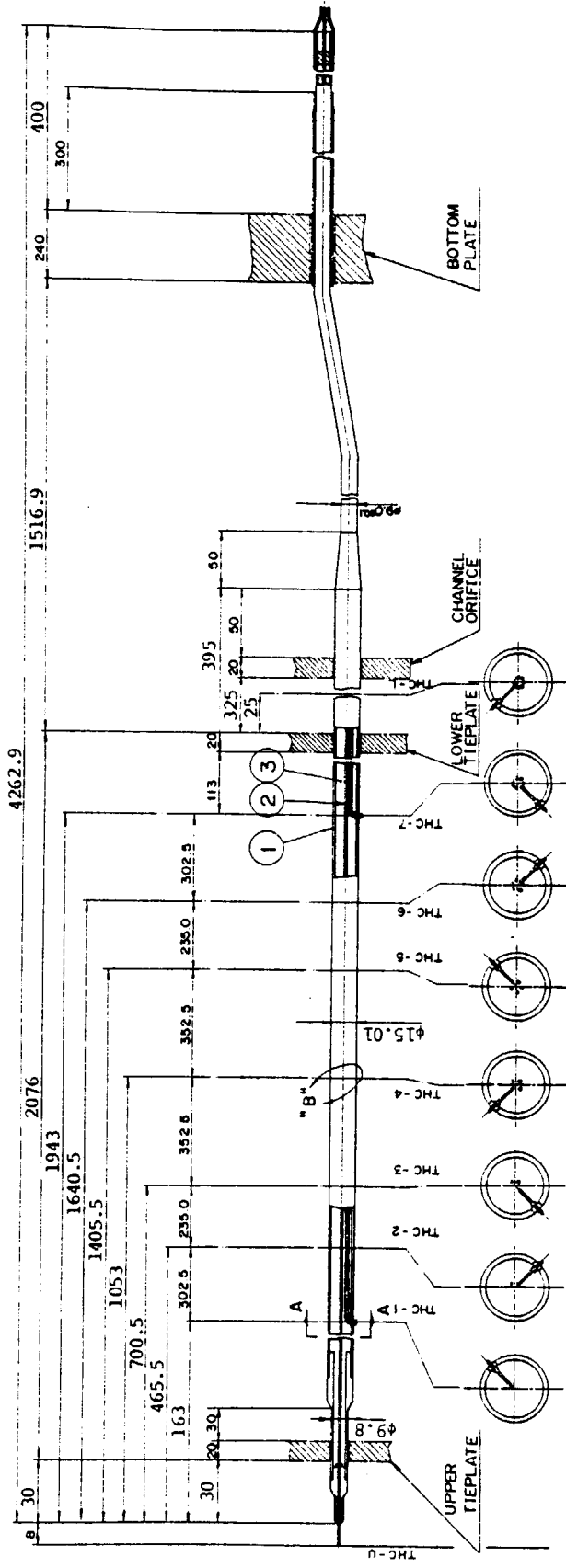


Fig. 2.8 Lower Tie Plate.



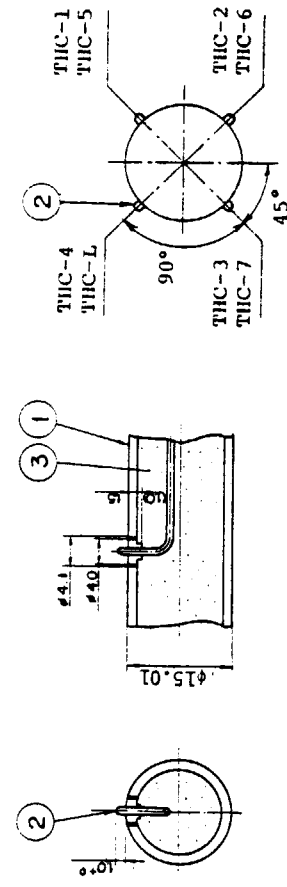
☆ indicates position of thermocouple. * Axial Peaking Factor

Fig. 2.10 Axial Power Distribution of Heater Rod.



CORE OUTLET (DL 3660) Pos. 1 Pos. 2 Pos. 3 Pos. 4 Pos. 5 Pos. 6 Pos. 7 CORE INLET (DL 1479)

THERMOCOUPLE POSITION



NO	PARTS	MATERIAL
1	SHEATH	INCONEL 600
2	THERMOCOUPLE	CA/INC. 600
3	INSULATOR	MgO

DETAIL B

SECTION A-A

Fig. 2.11 Water Rod Simulator.

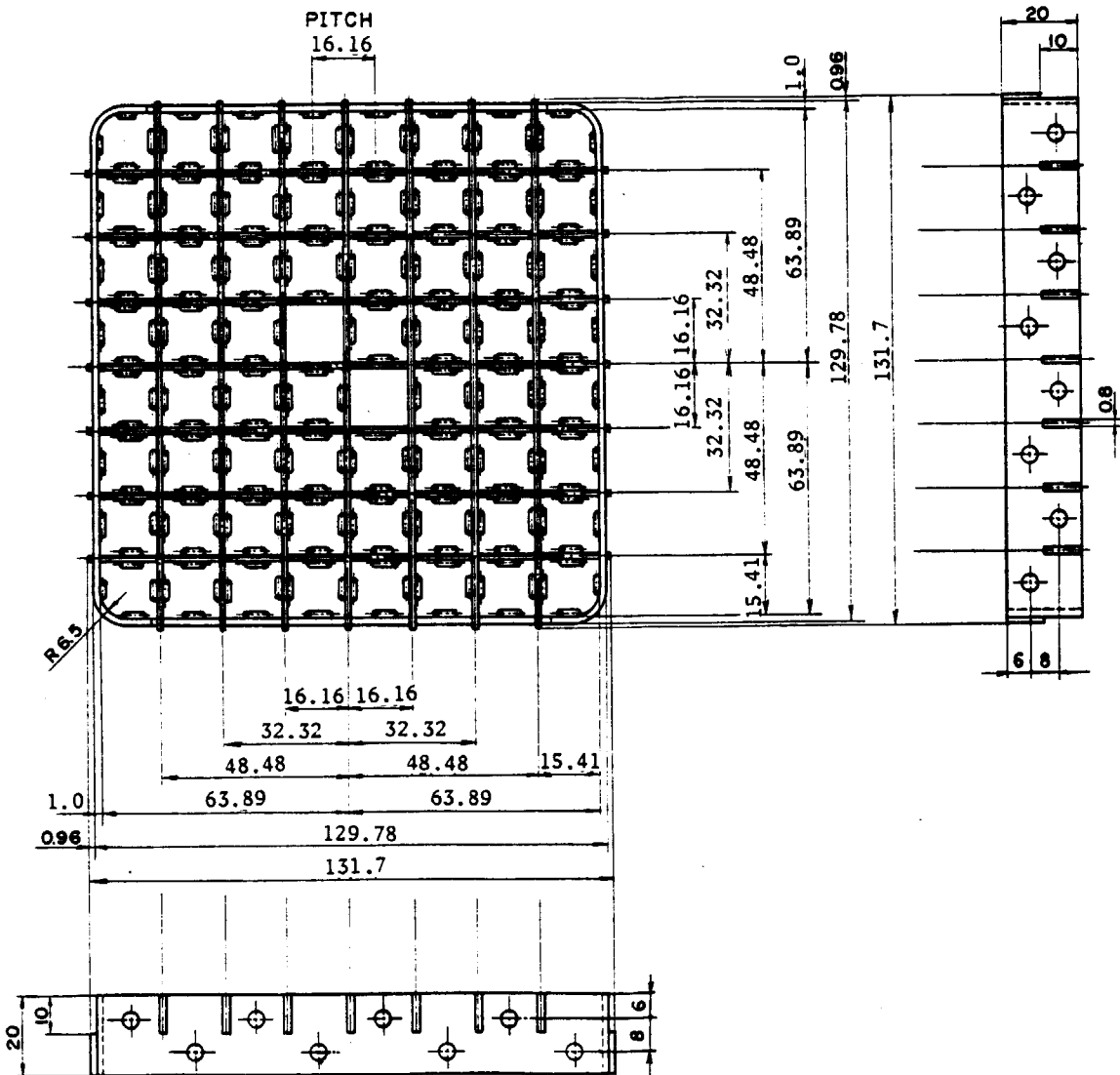
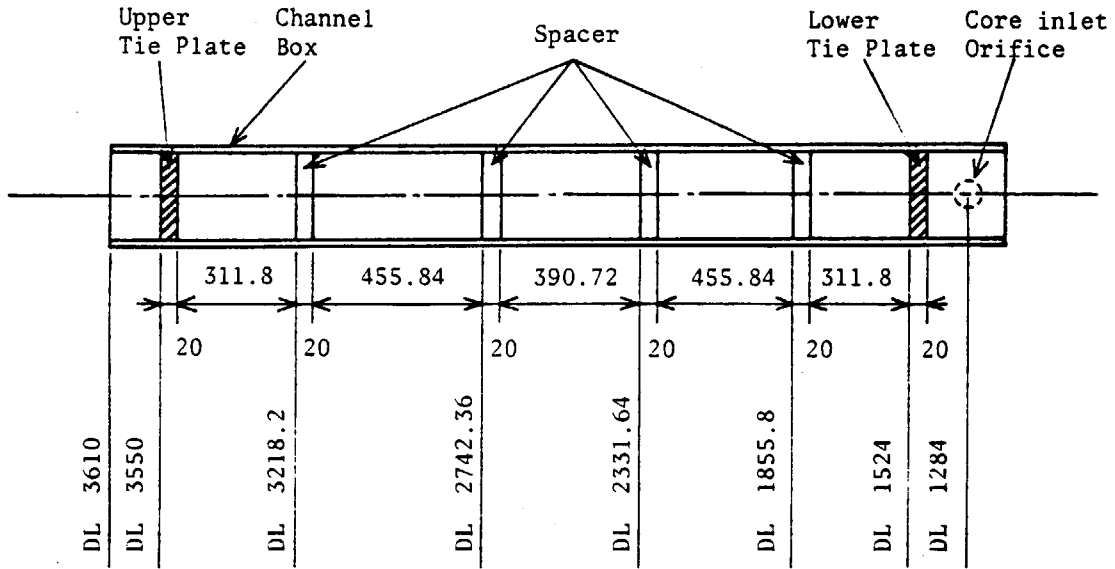


Fig. 2.12 Spacer for Heater Rods.

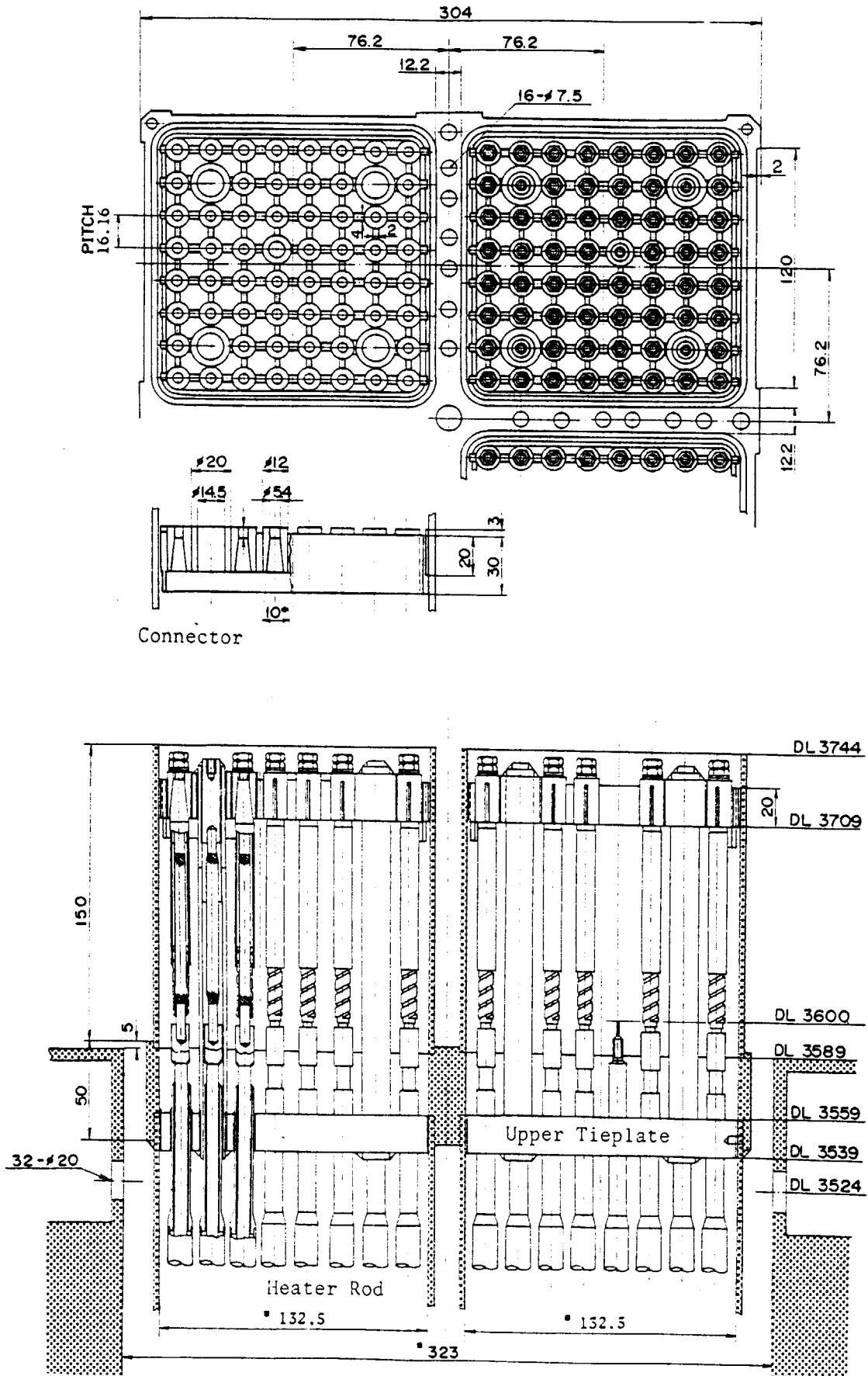
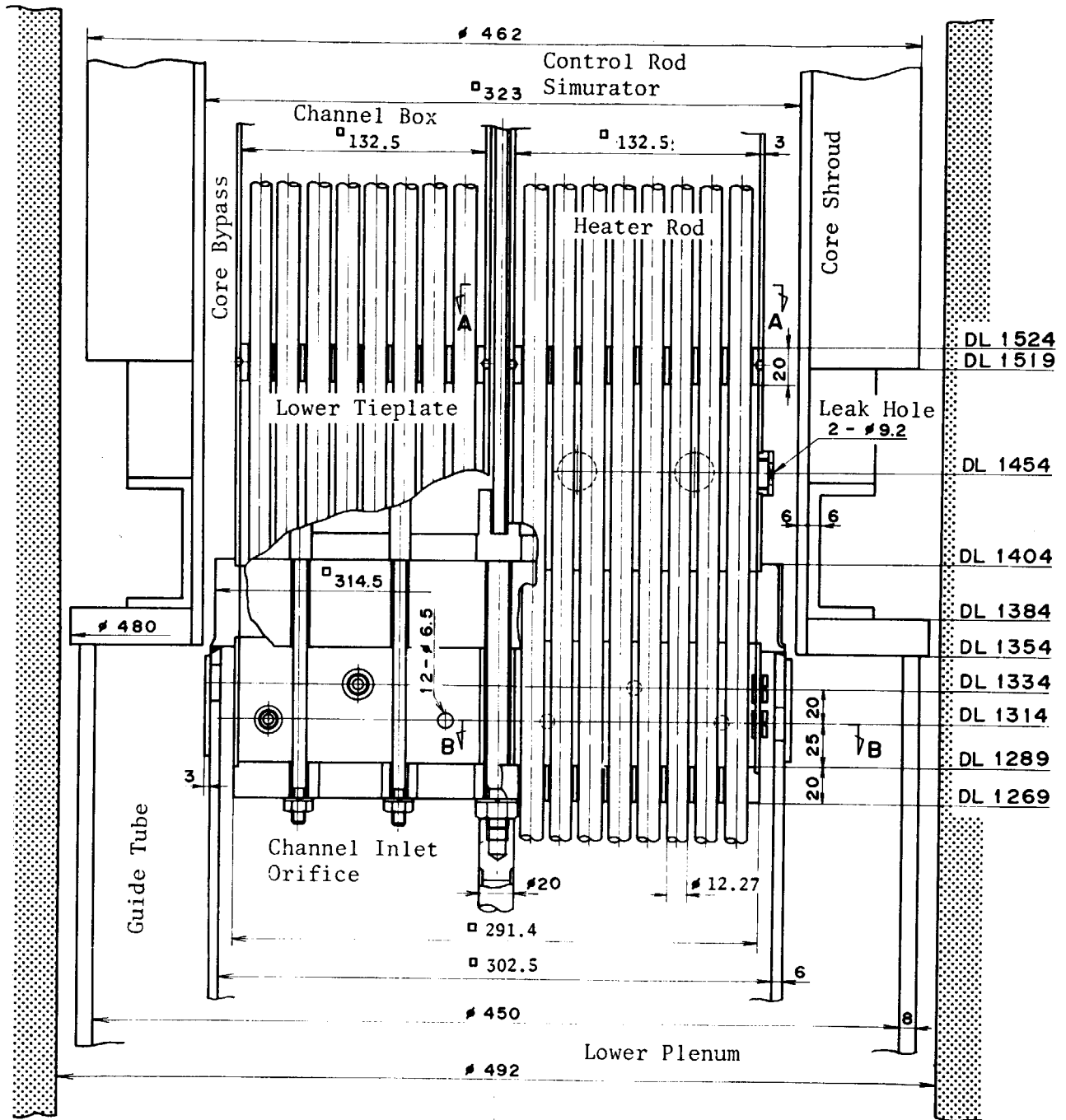
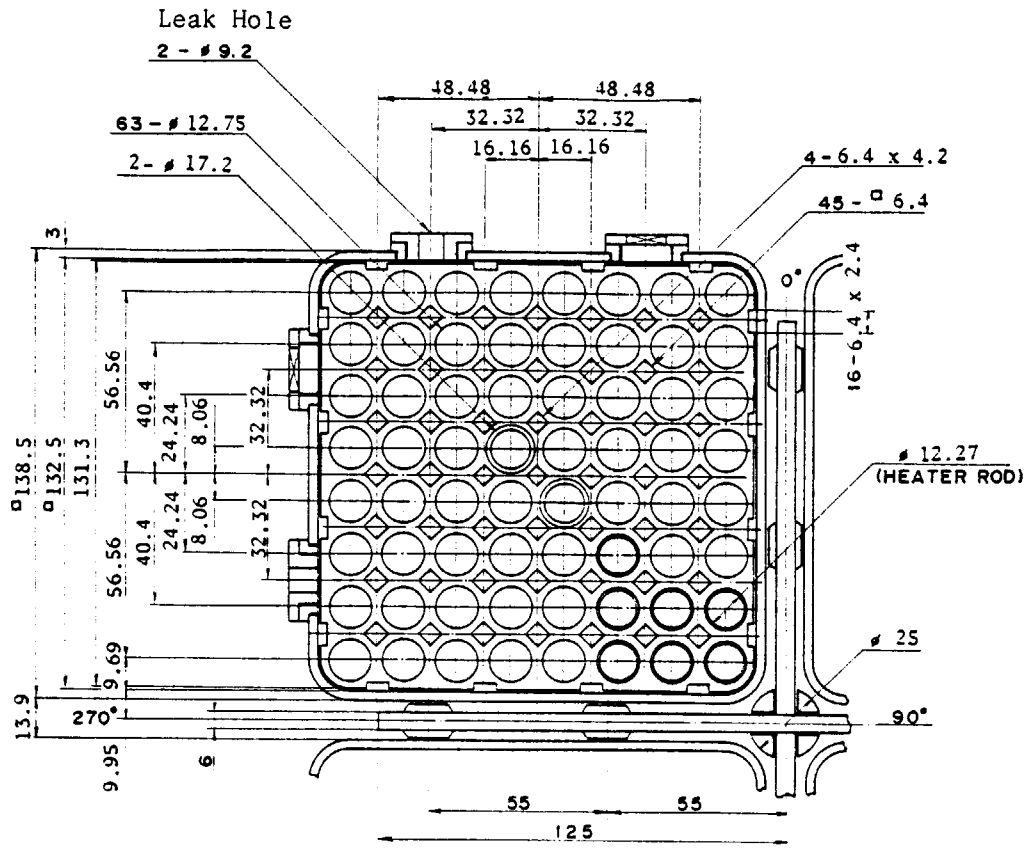


Fig. 2.13 Top connectors of Heater Rods.

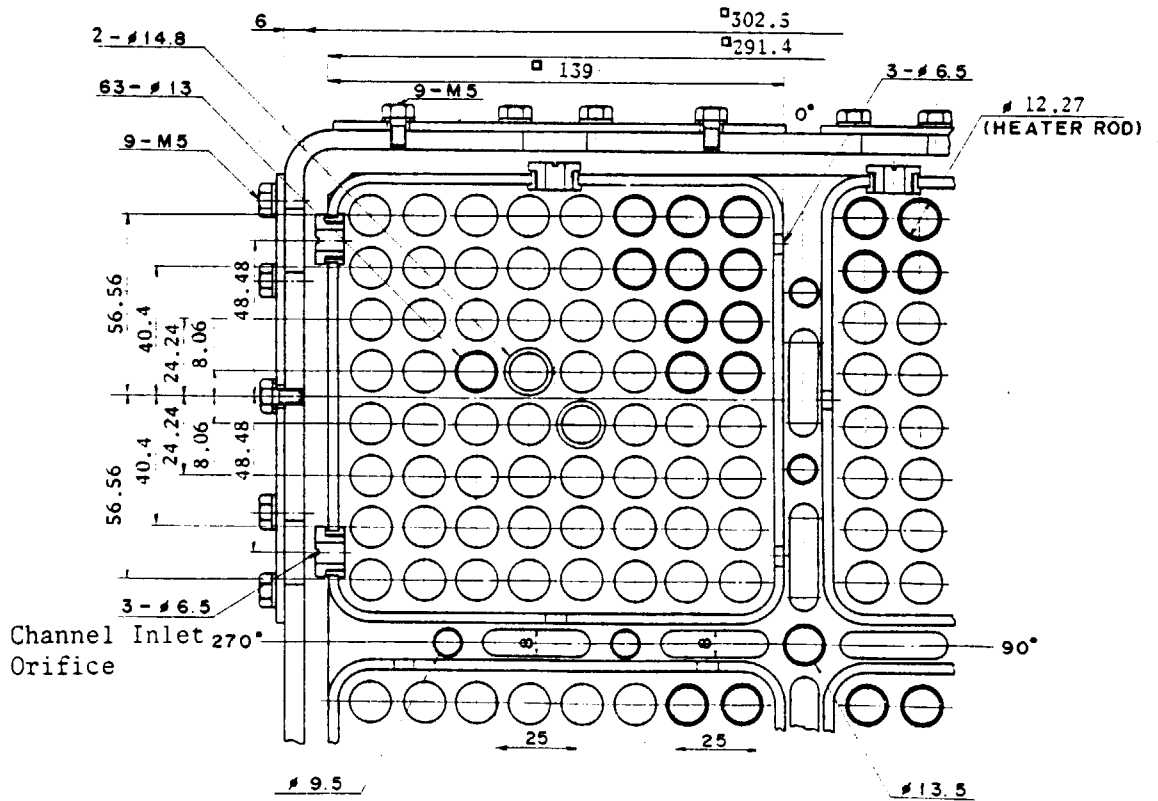


(a) Elevation.

Fig. 2.14 Core Inlet Orifice.



SECTION A - A



SECTION B - B

Fig.2.14 (b) Sections.

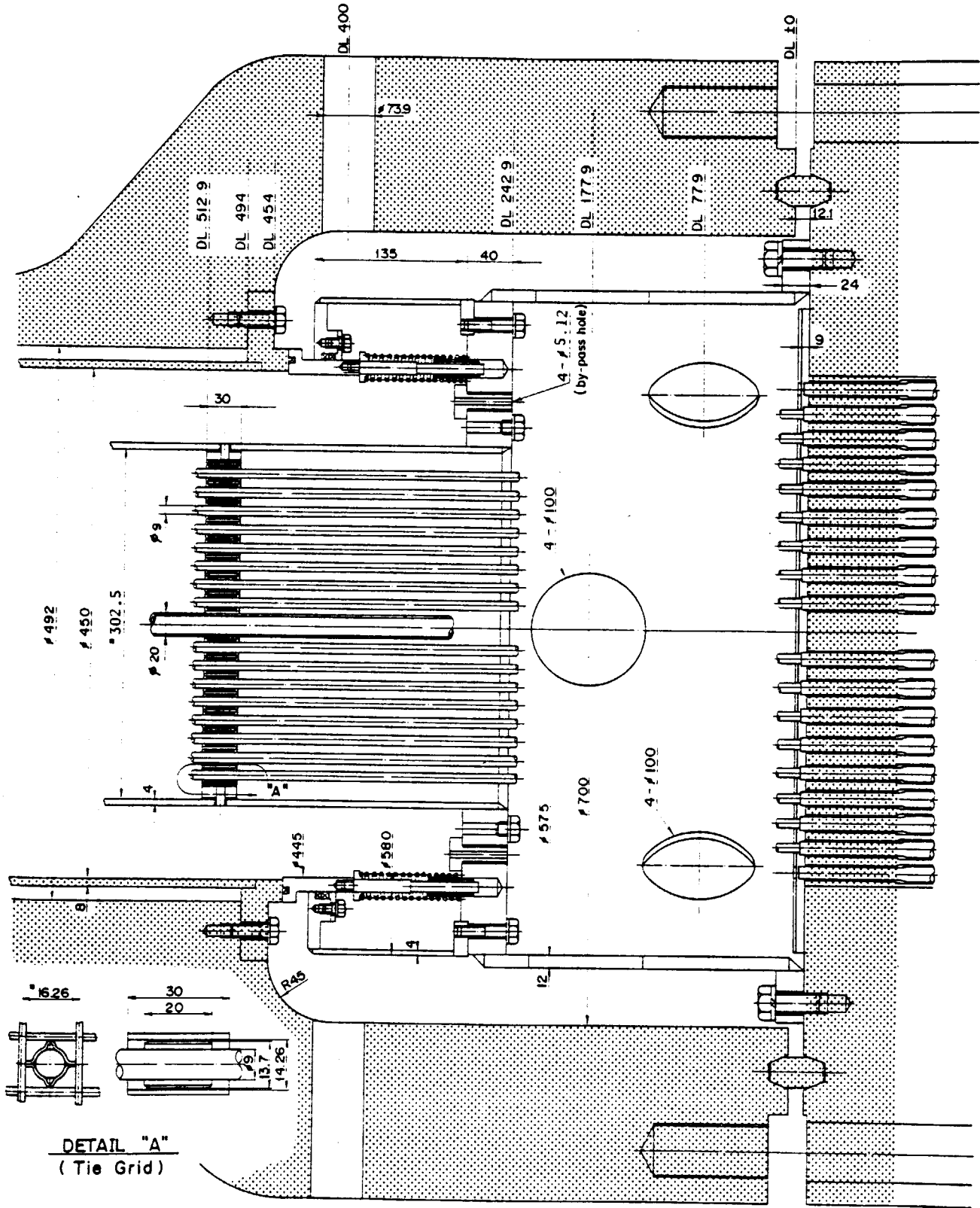


Fig. 2.15 Lower Plenum.

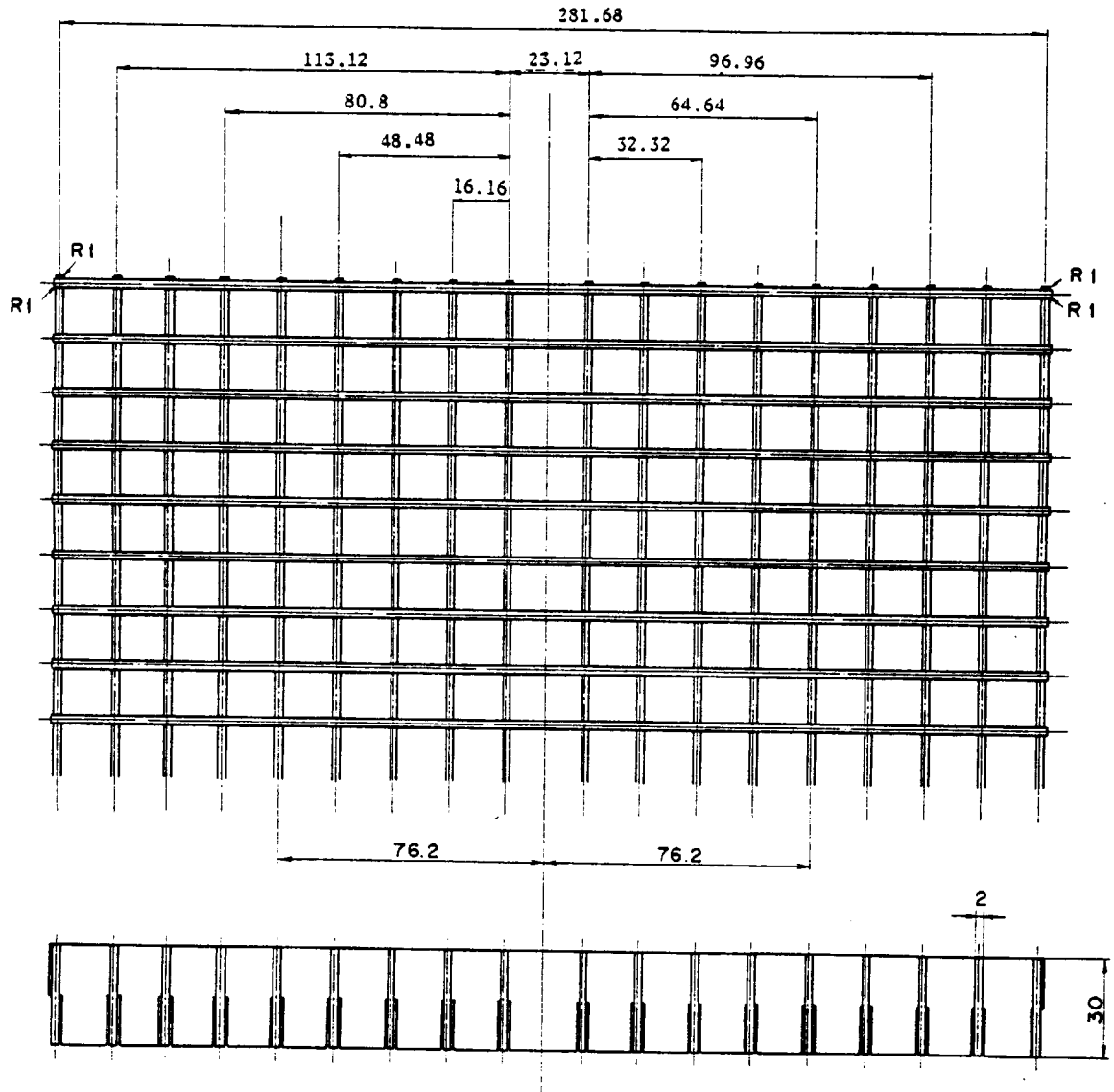
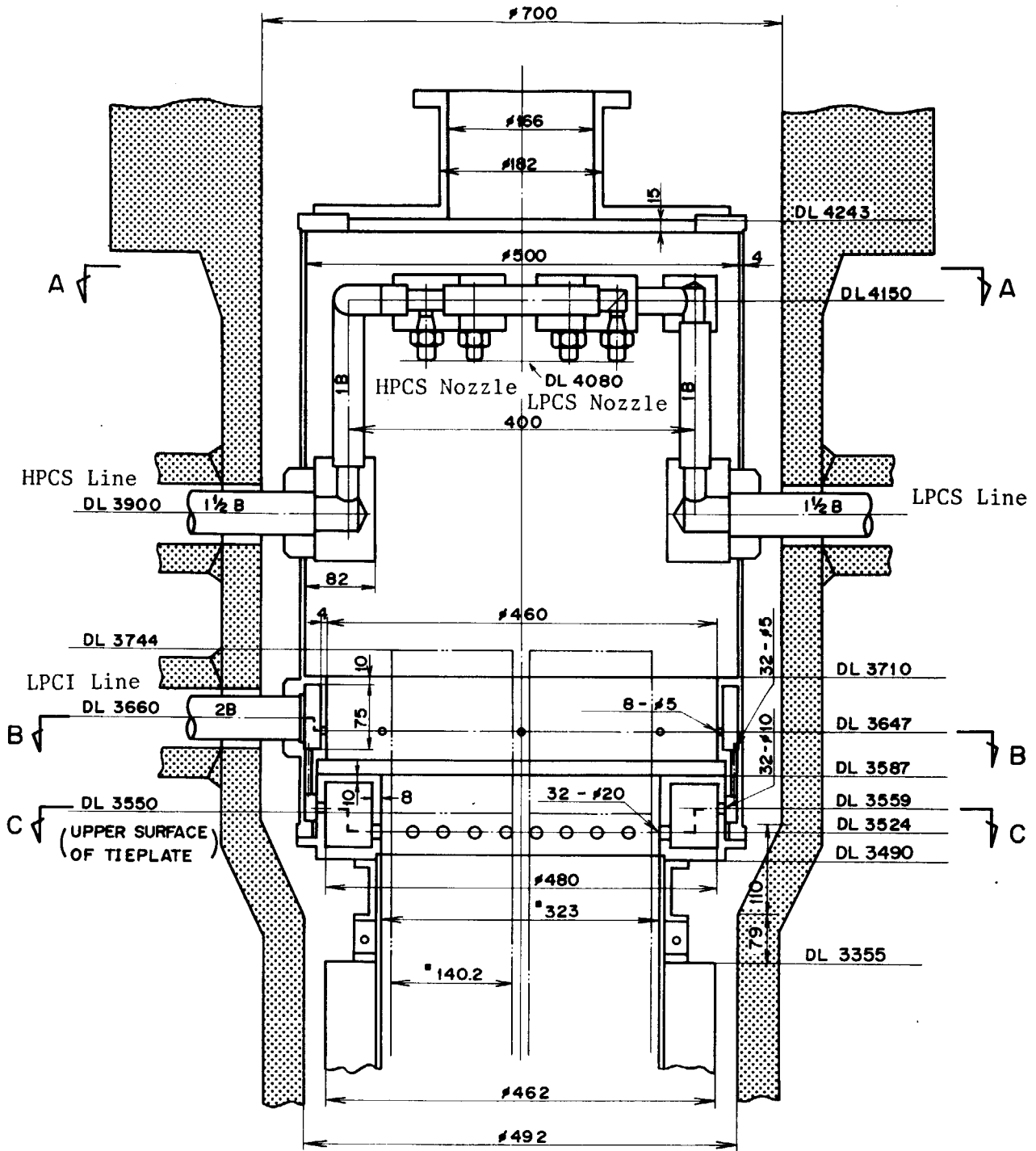


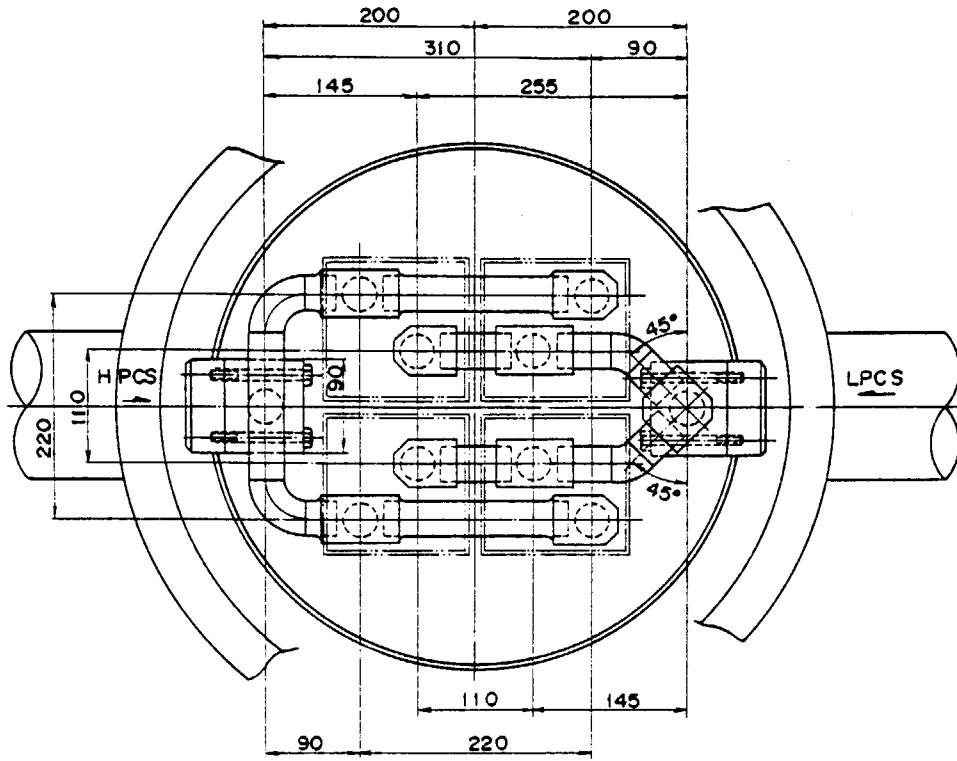
Fig. 2.16 Tie Grid.



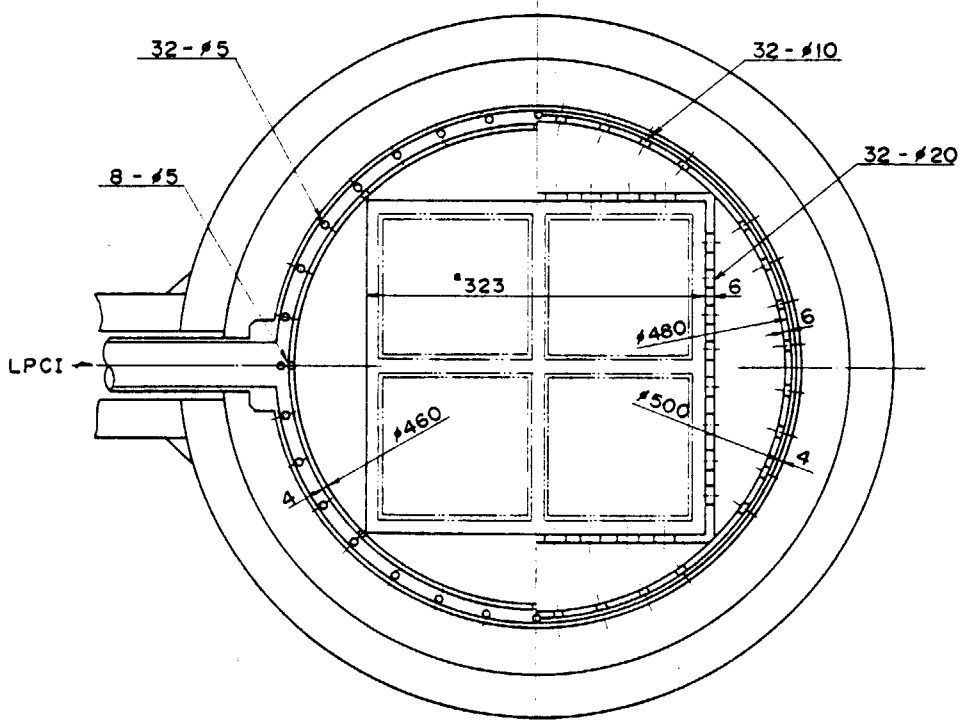
(a) Elevation.

Fig. 2.17 Upper Plenum.

JAERI-M 9243



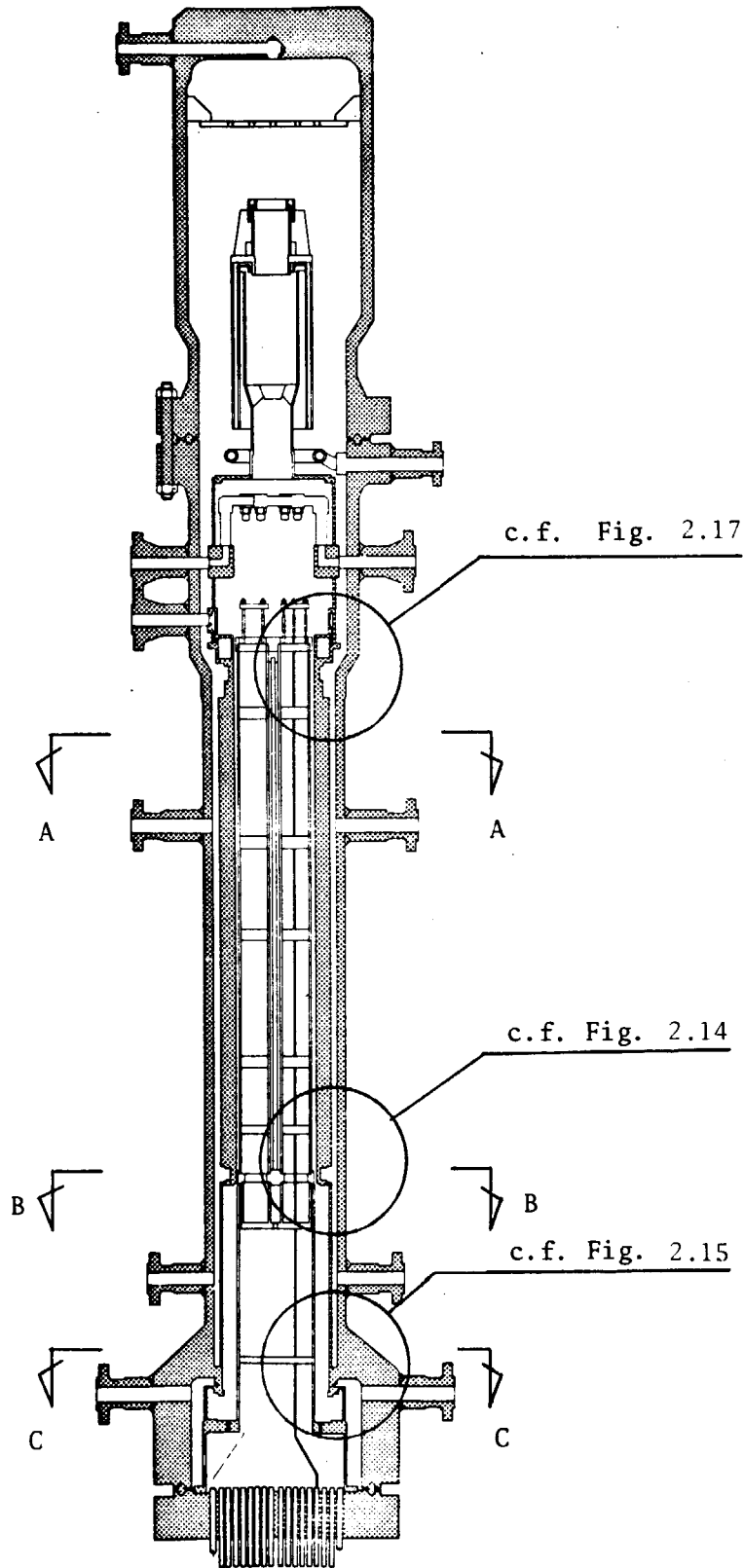
VIEW A-A



SECTION B-B

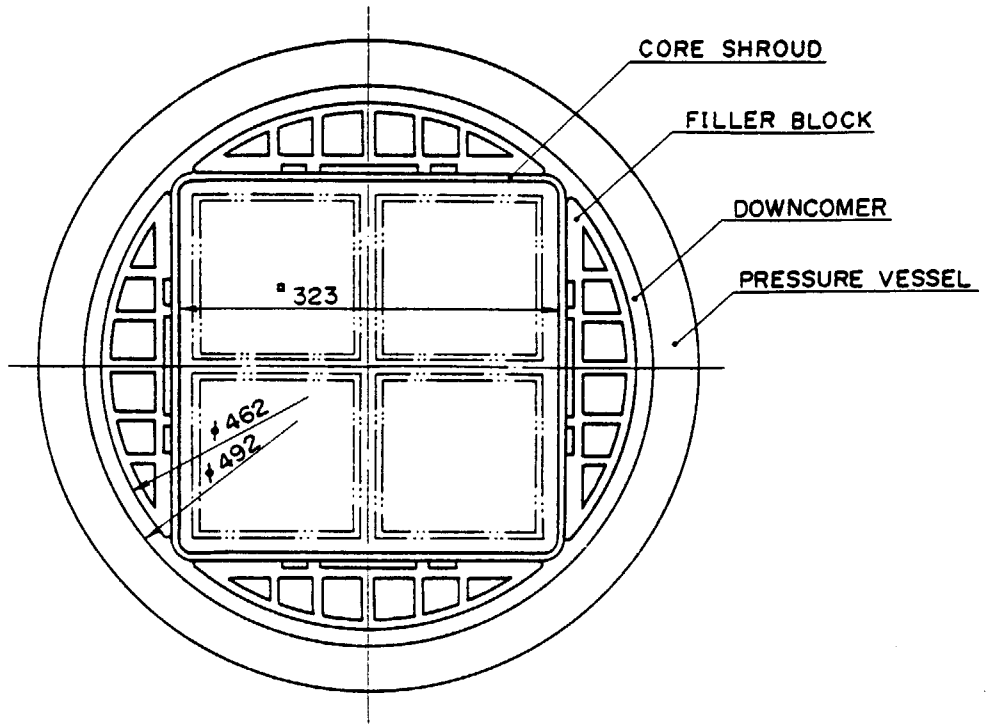
SECTION C-C

Fig. 2.17 (b) Sections.

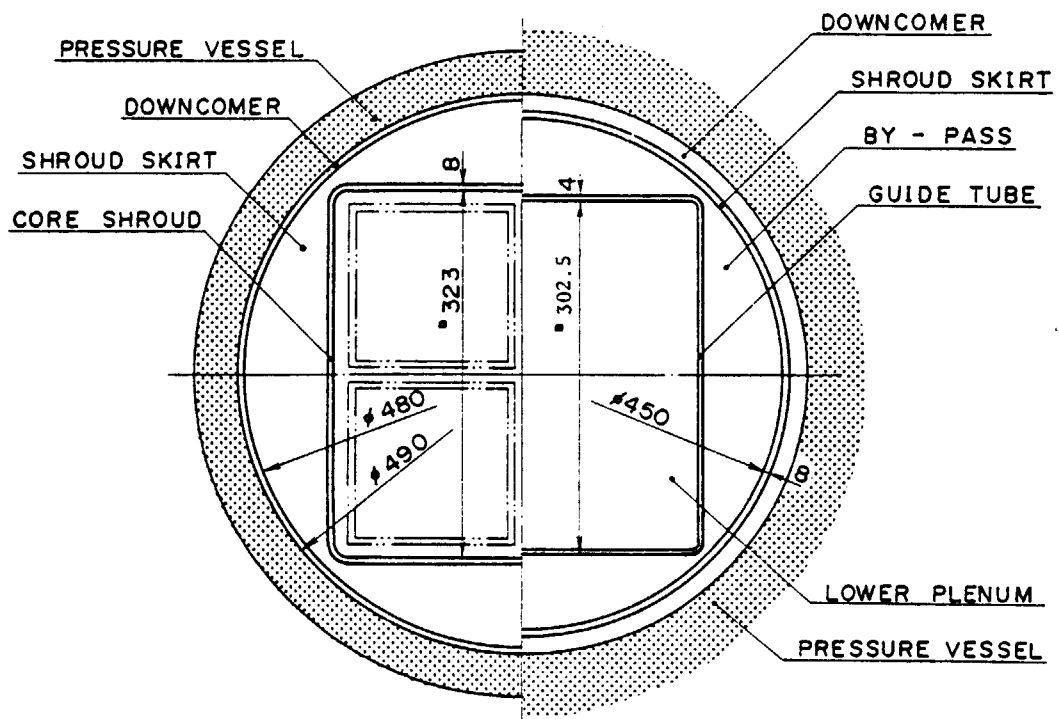


(a) Elevation.

Fig. 2.18 Downcomer.



SECTION A - A



SECTION B - B

SECTION C - C

Fig. 2.18 (b) Sections.

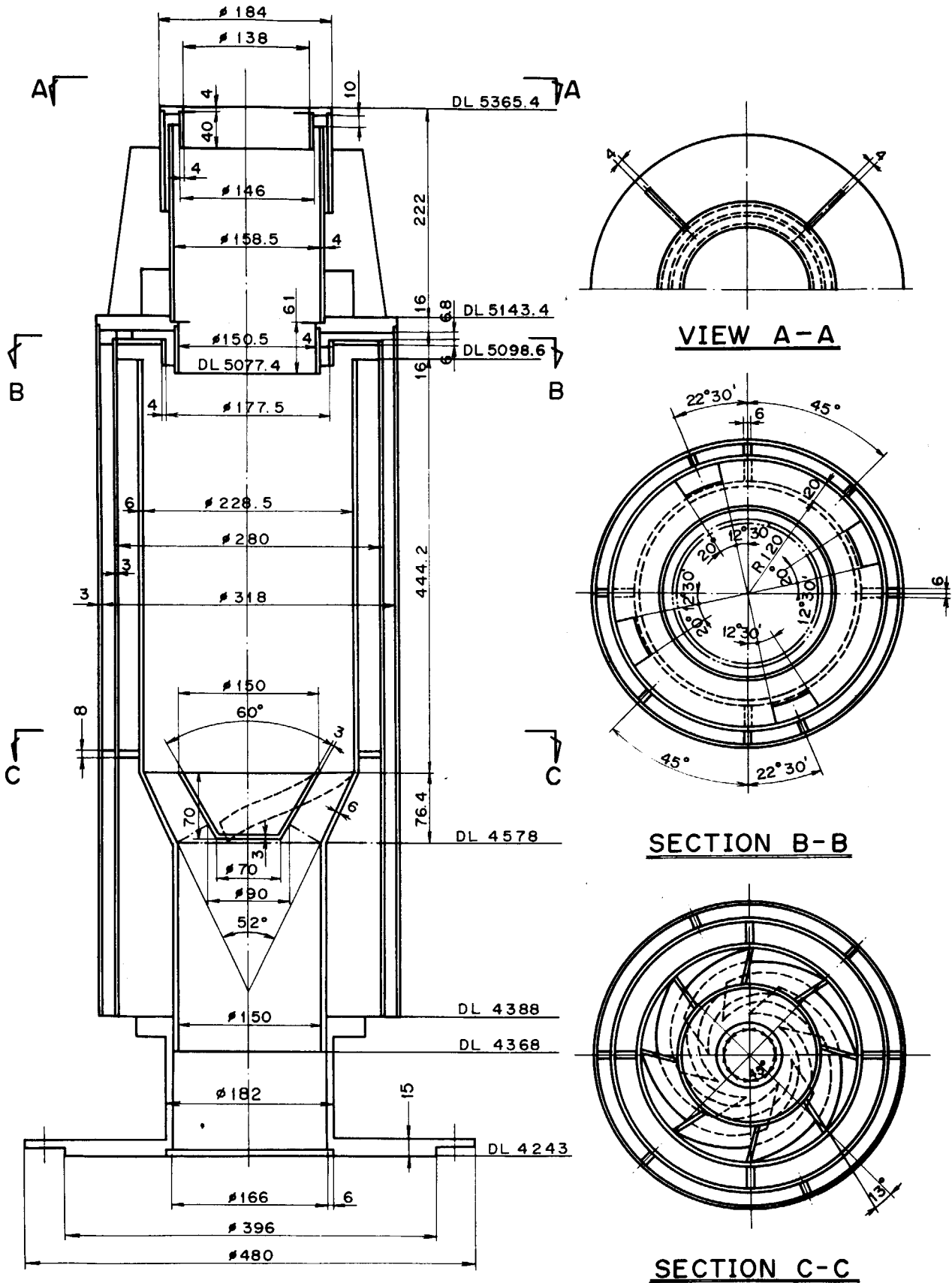


Fig. 2.19 Steam Separator.

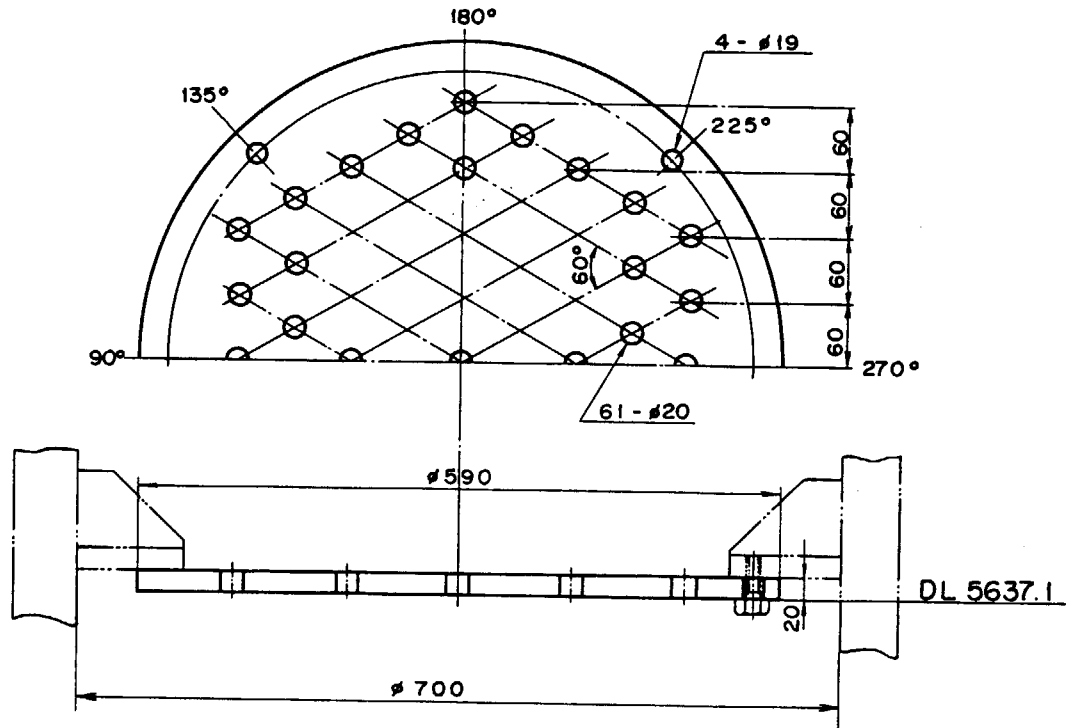


Fig. 2.20 Steam Dryer Plate

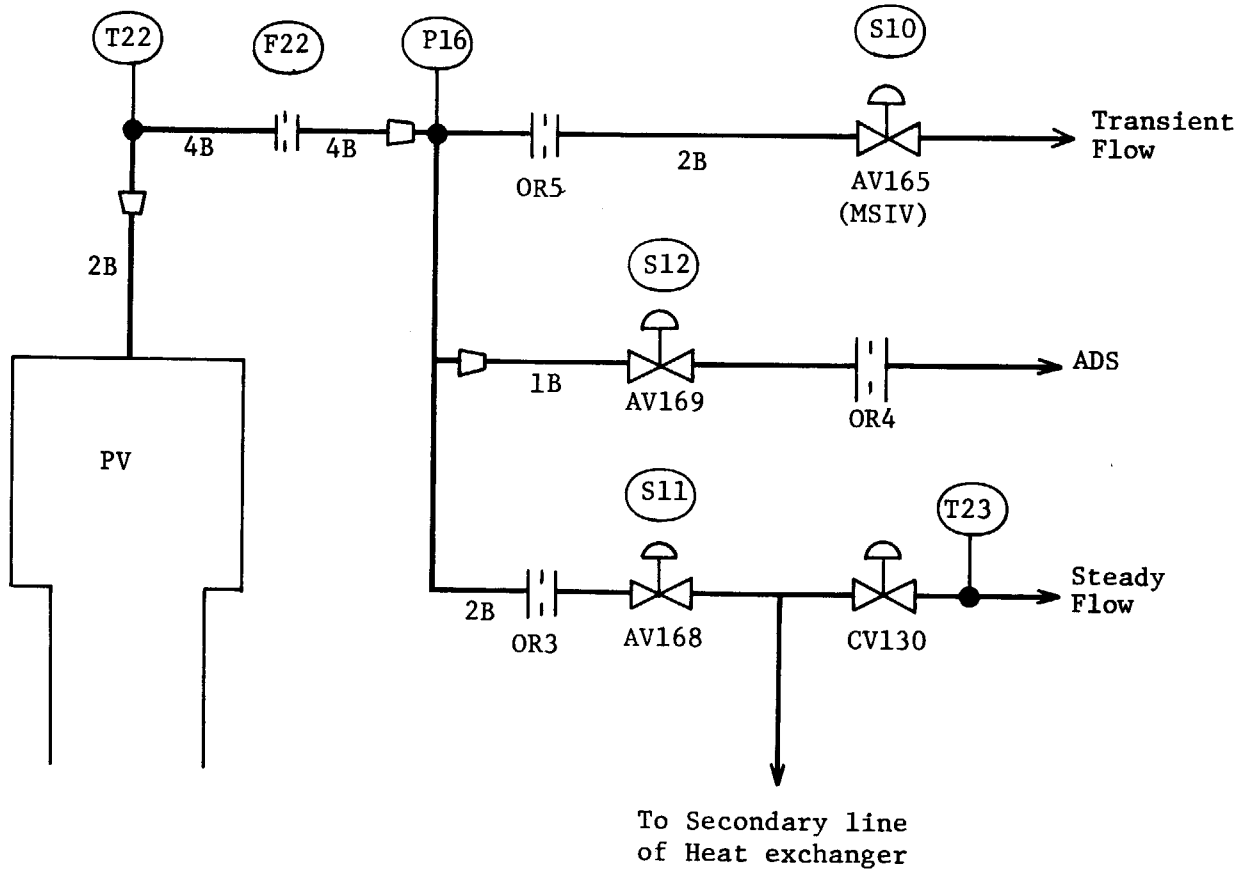


Fig. 2.21 Main Steam Line Schematic

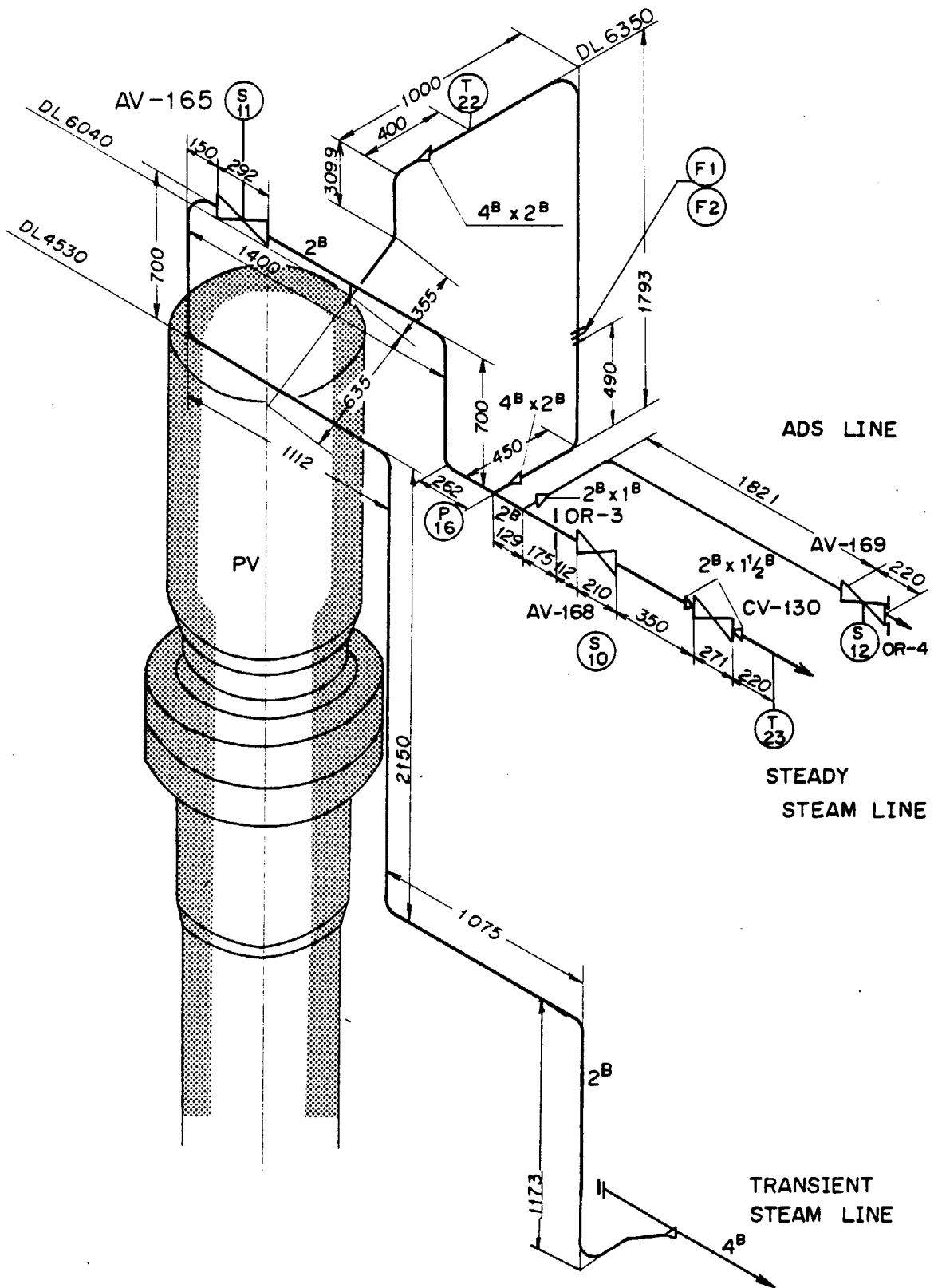


Fig. 2.22 Main Steam Line Piping Layout.

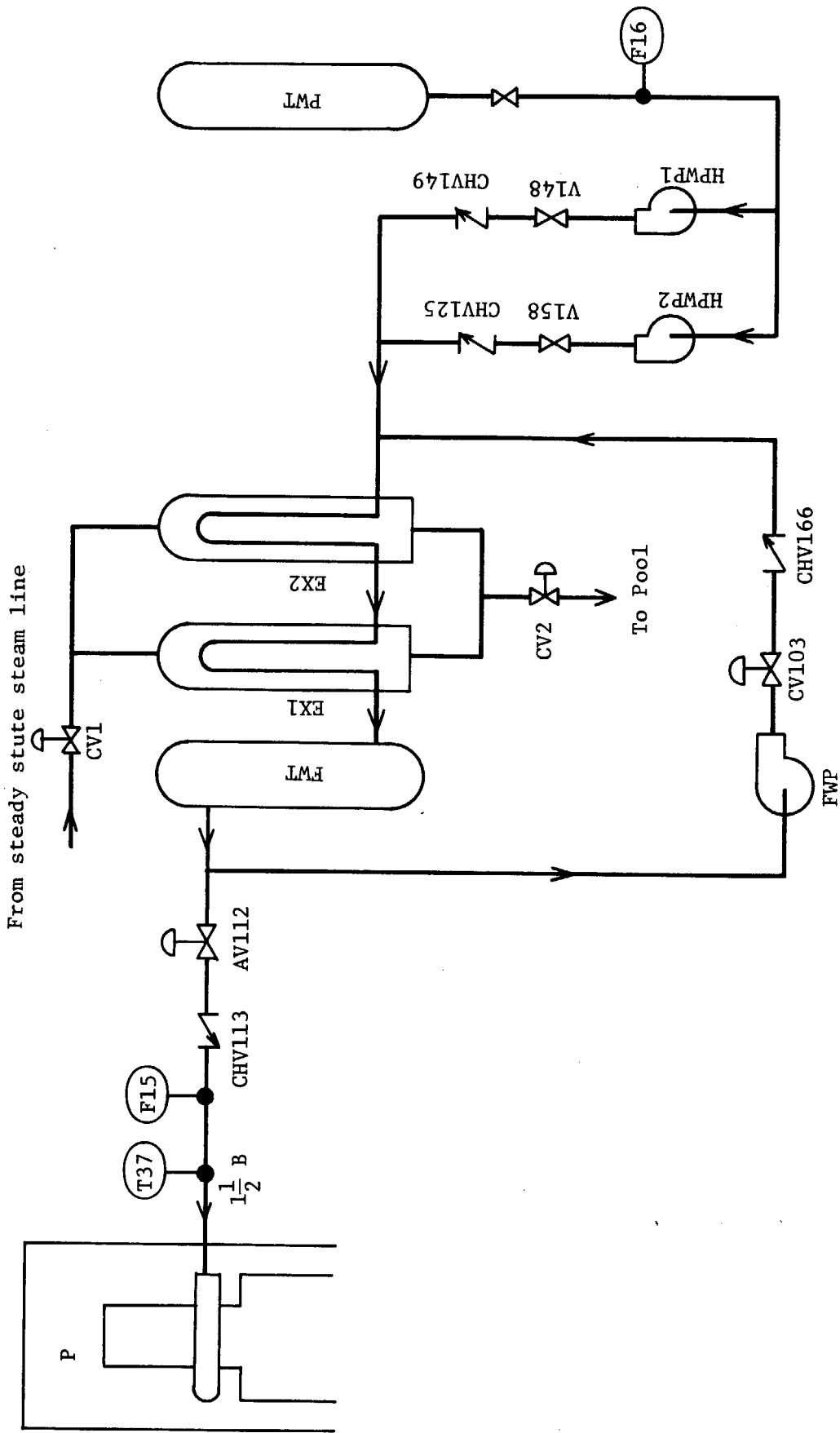


Fig. 2.23 Feed Water Line Schematic

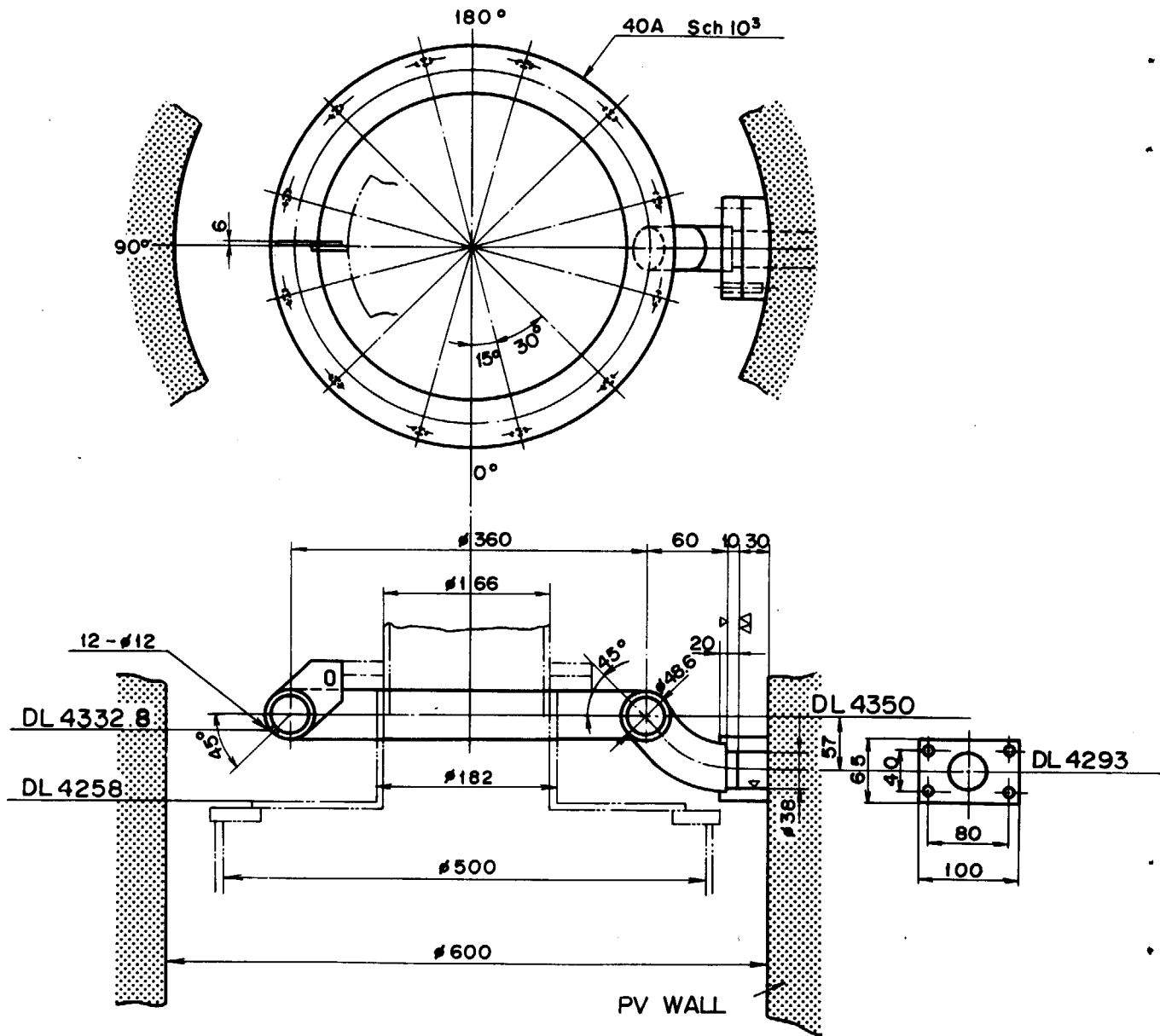
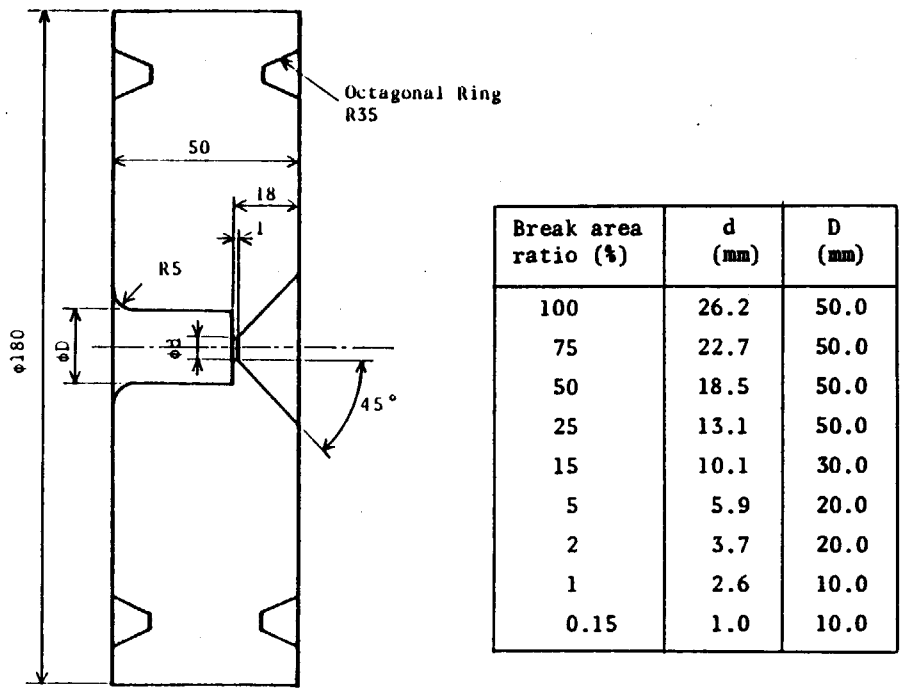
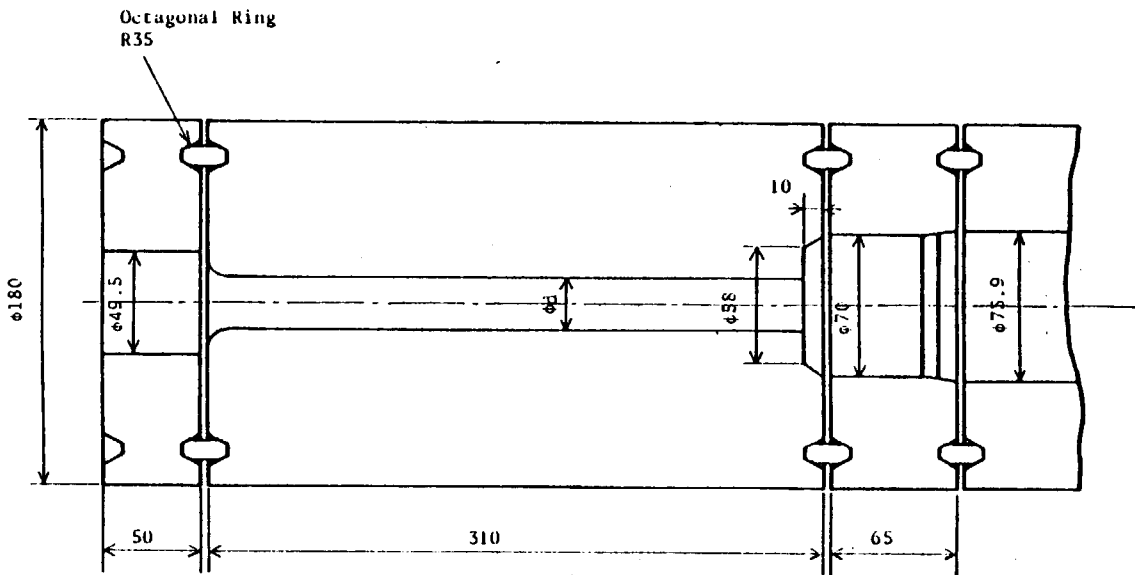


Fig. 2.24 Feed Water Sparger.



Material SUS304
Dimension in mm

Fig. 2.26 Break Orifice Details.



Material SUS304
Dimension in mm

Break area ratio (%)	d (mm)
100	26.2
15	10.1

Fig. 2.27 Break Nozzle Details.

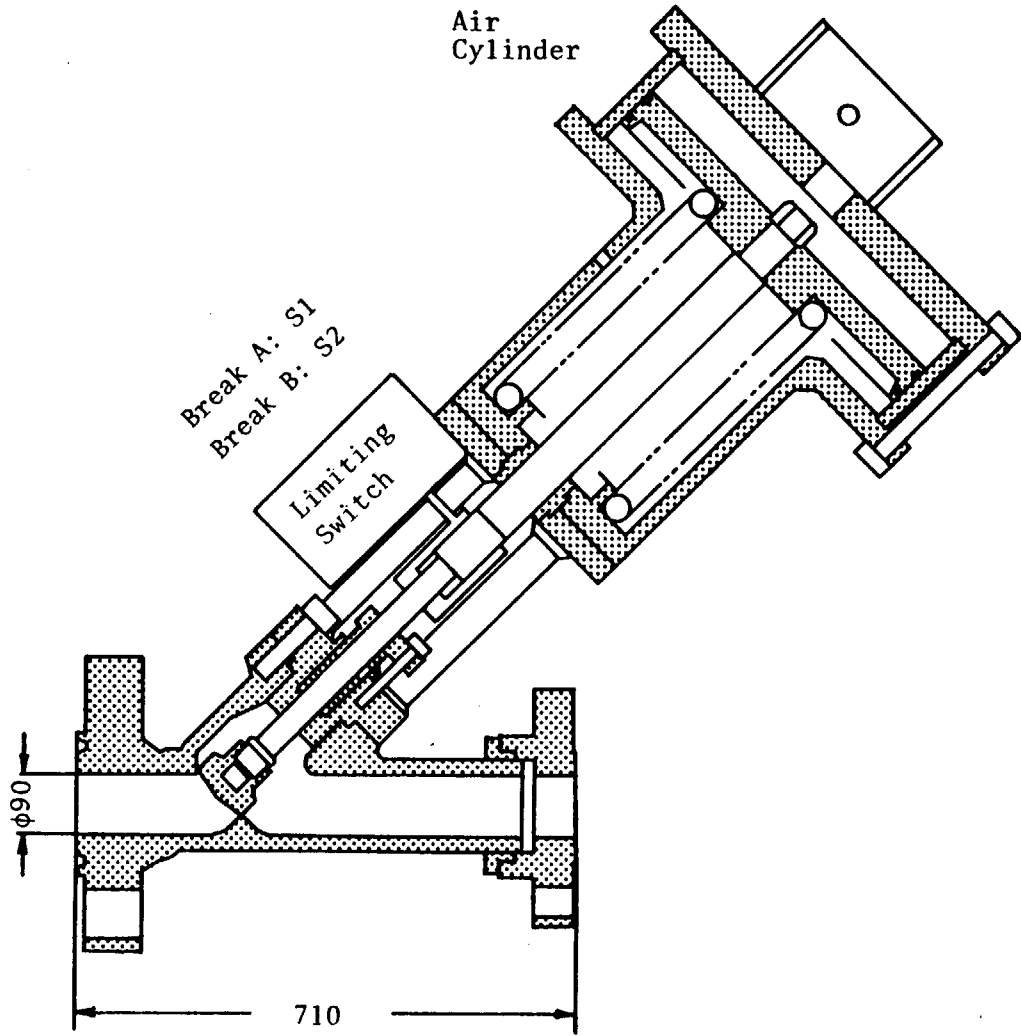


Fig. 2.28 Quick Opening Blowdown Valve.

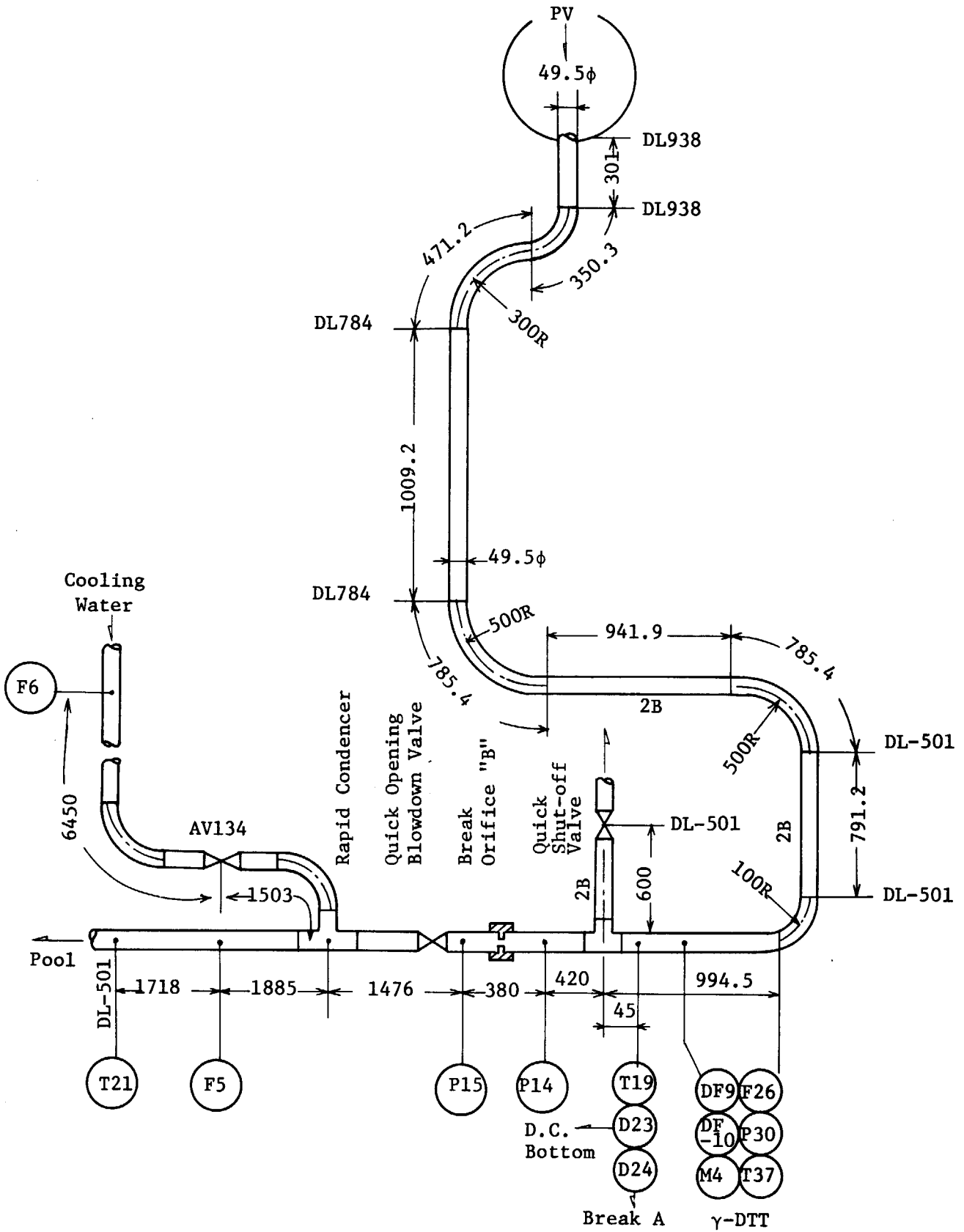


Fig. 2.29 Piping from Pressure Vessel to Break B.

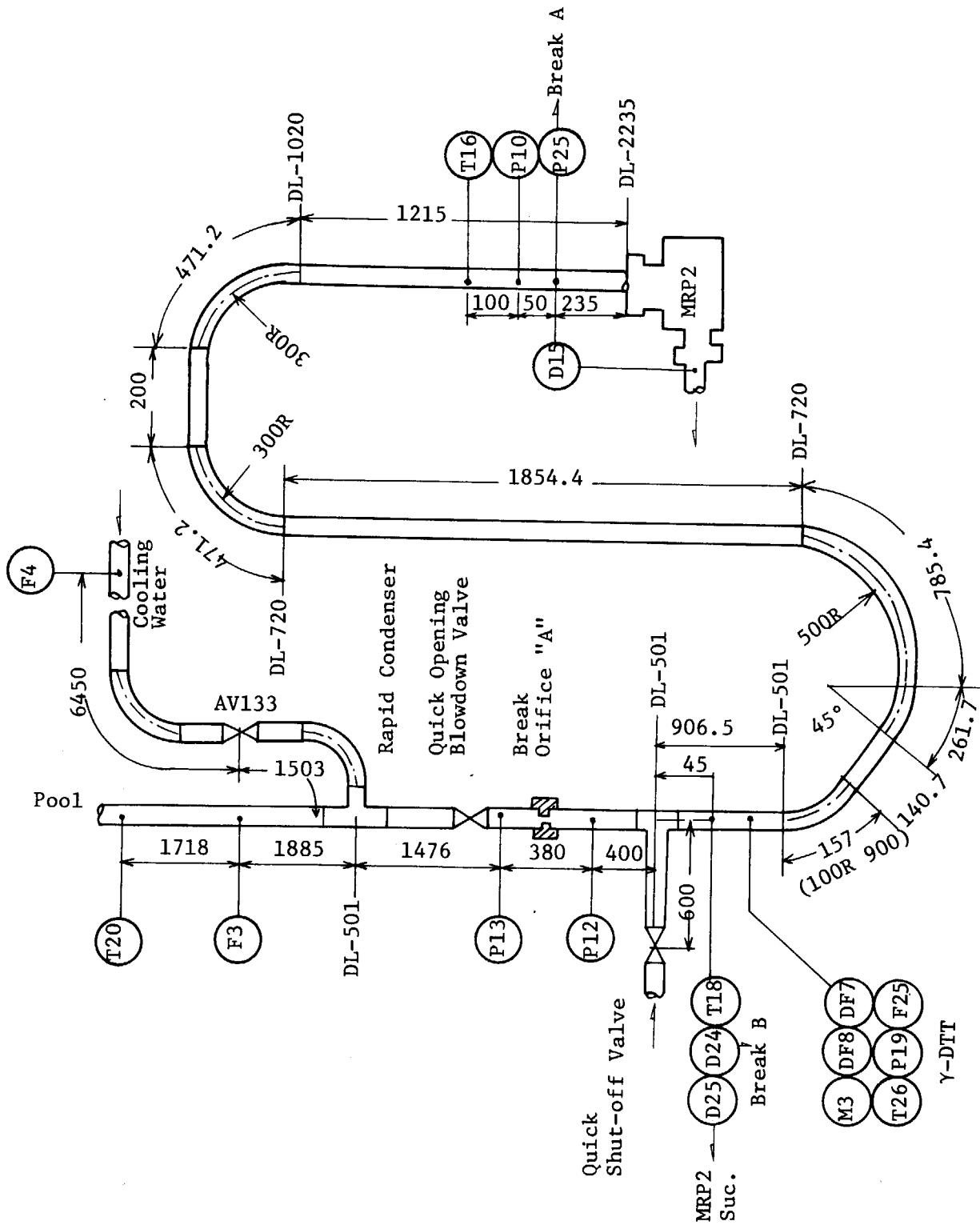


Fig. 2.30 Piping from Blowdown Loop Recirculation Pump (MRP2) to Break A.

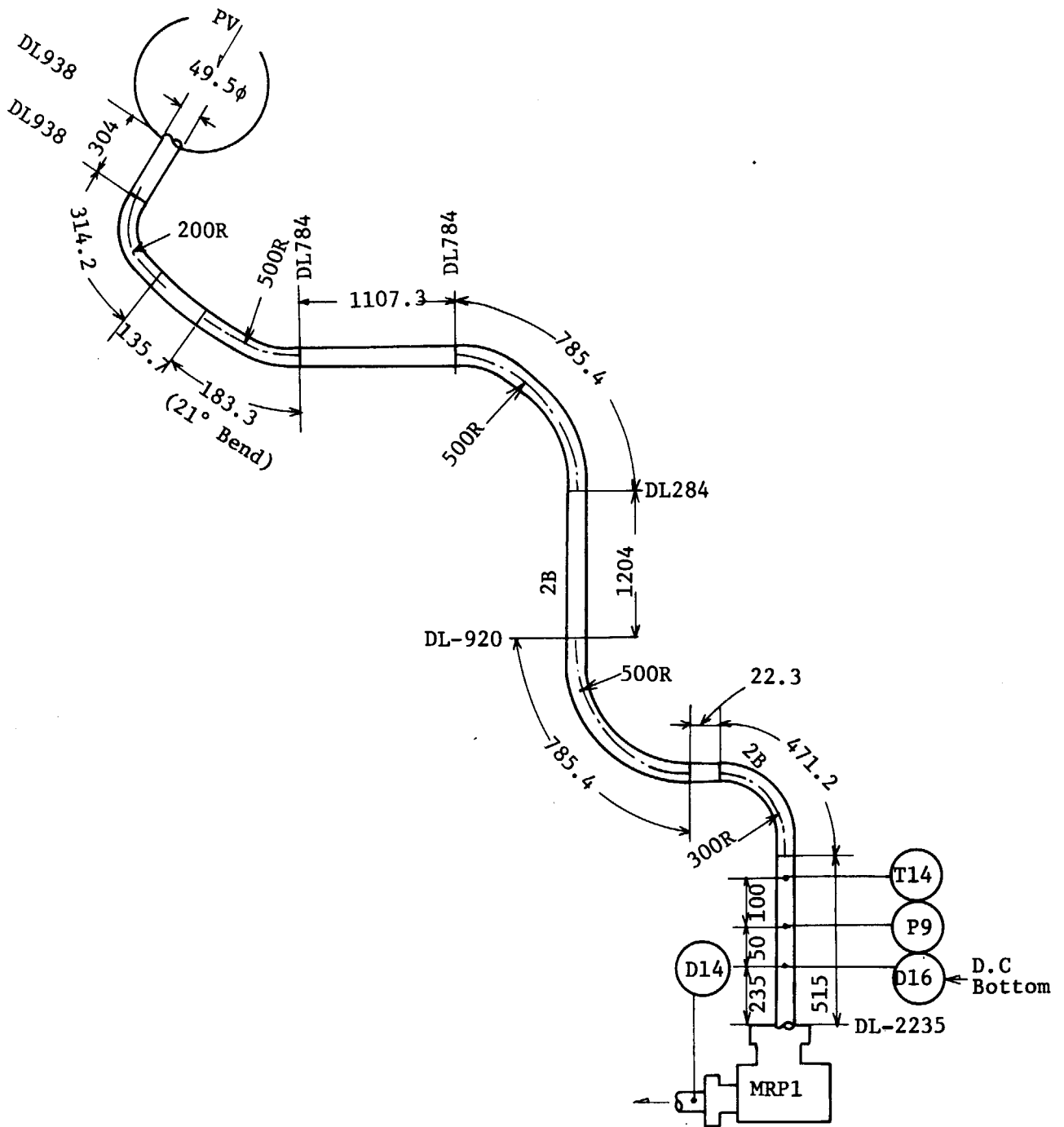


Fig. 2.31 Piping from Pressure Vessel to Intact Loop Recirculation Pump (MRP1).

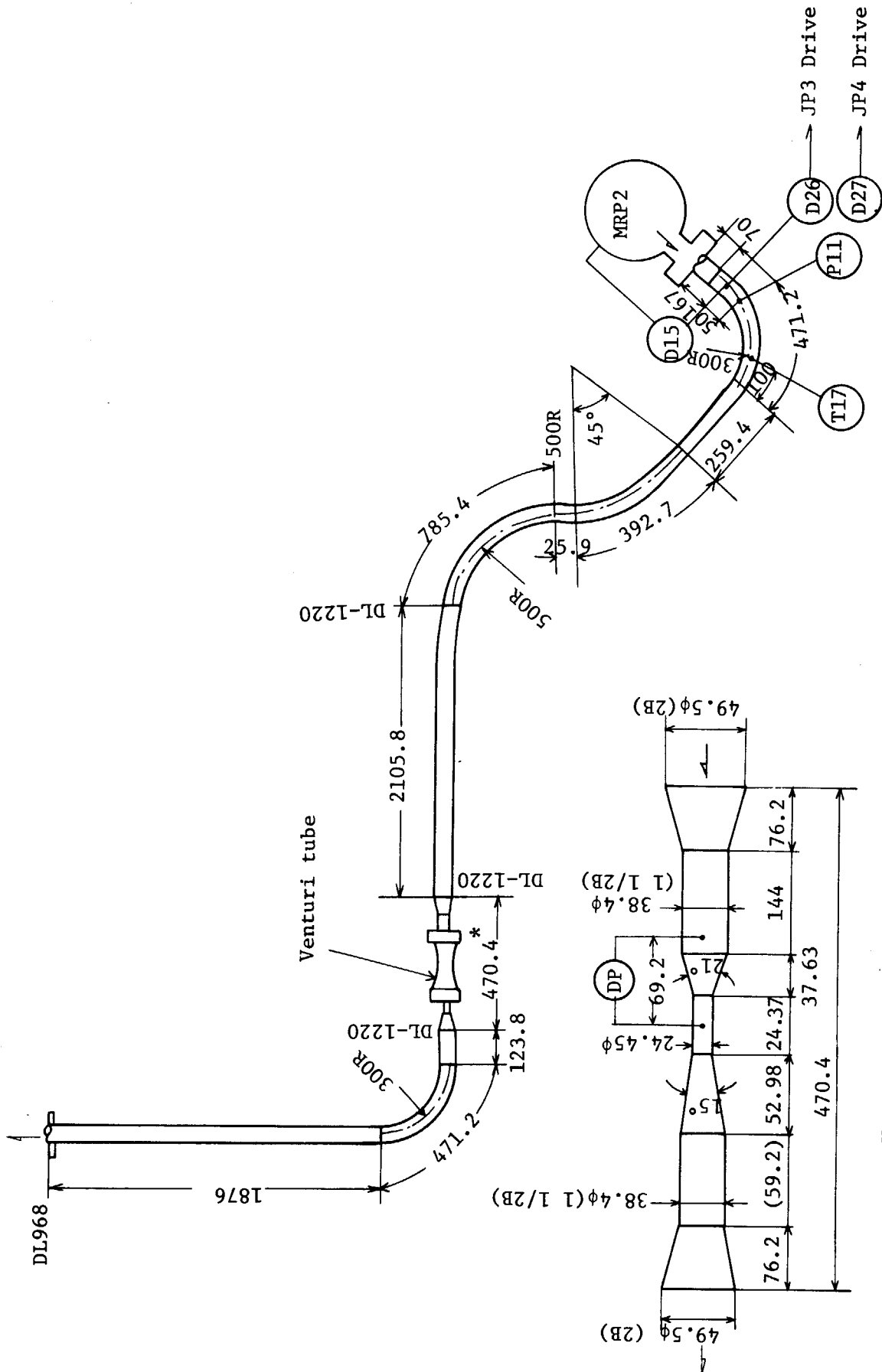


Fig. 2.32

Fig. 2.32 Piping from Blowdown Loop Recirculation Pump (MRP2) to Venturi Flow Meter.

Venturi tube detail

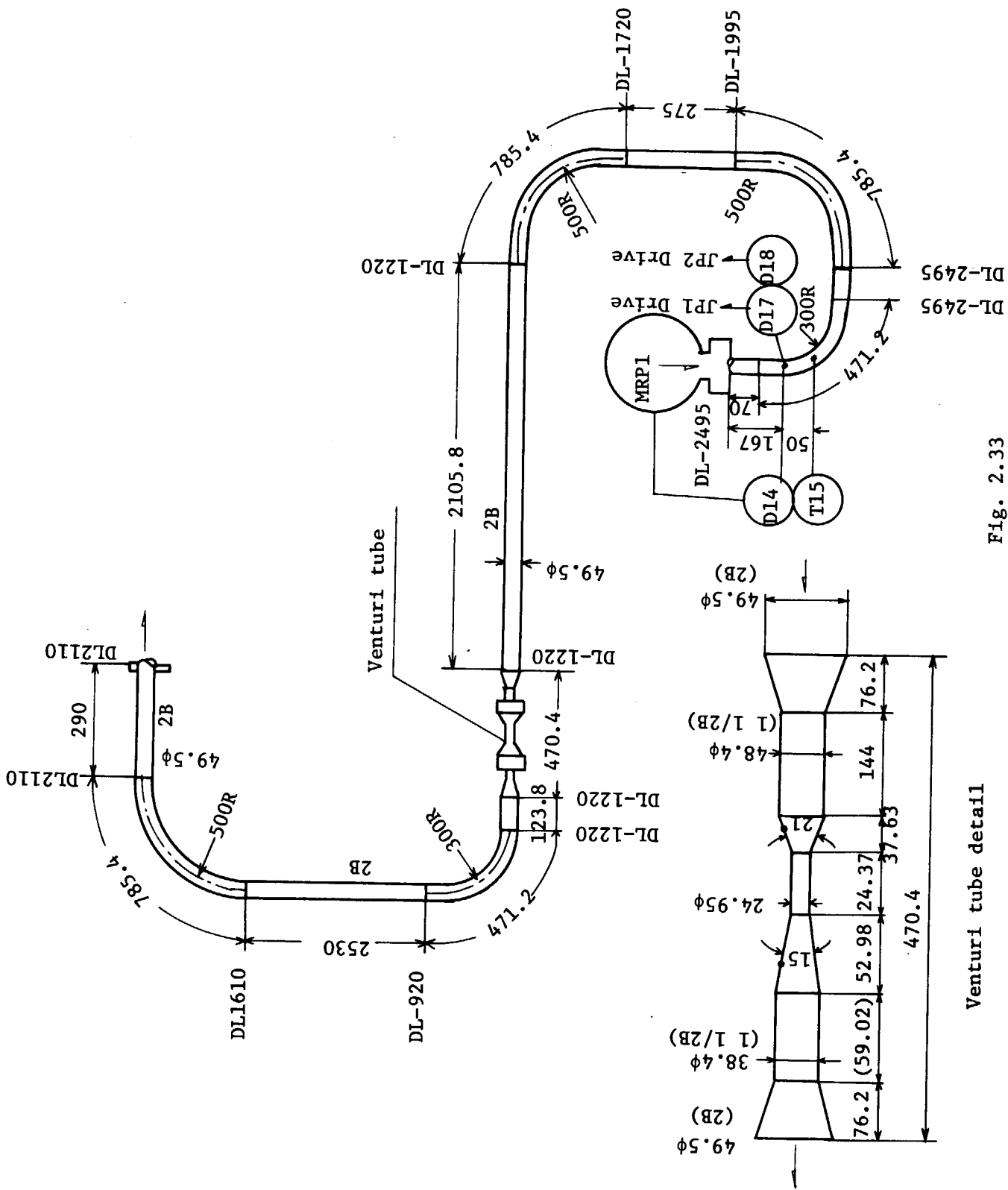


Fig. 2.33

Fig. 2.33 Piping from Intact Loop Recirculation Pump (MRP1) to Venturi Flow Meter.

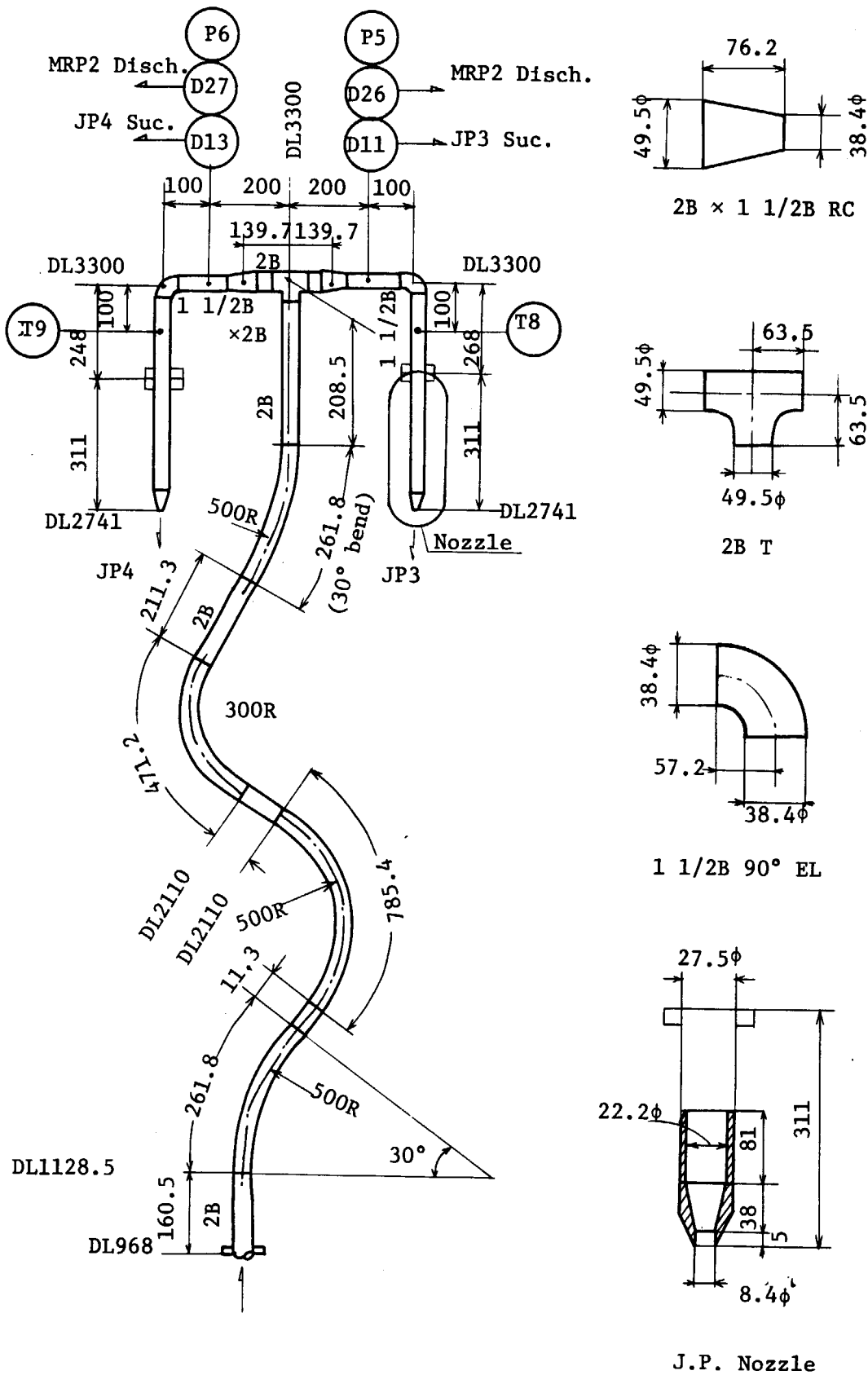


Fig. 2.34 Piping to Blowdown Loop Jet Pump Drive Nozzles (JP3,JP4).

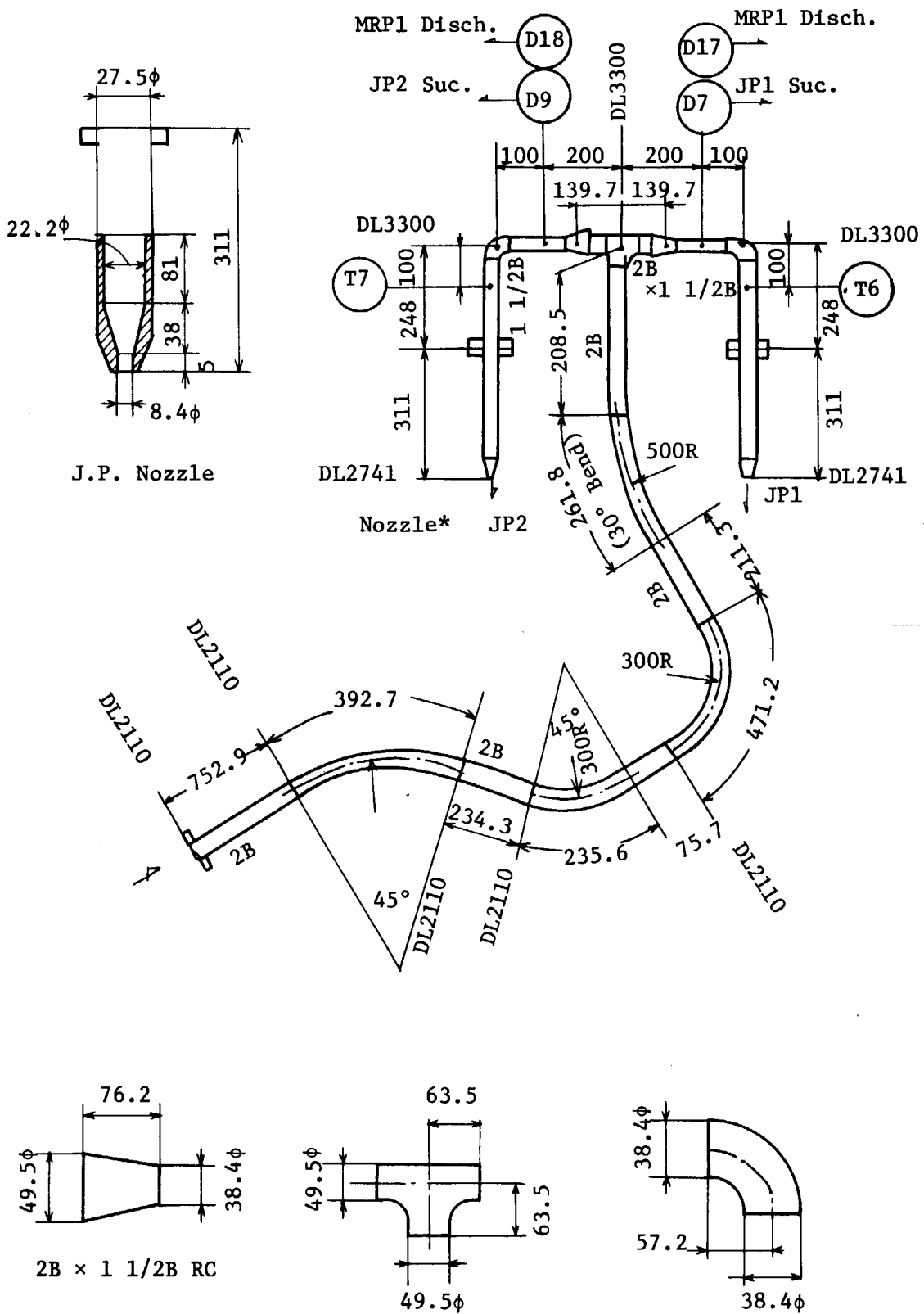


Fig.2.35 Piping to Intact Loop Jet Pump Drive Nozzles (JP1,JP2).

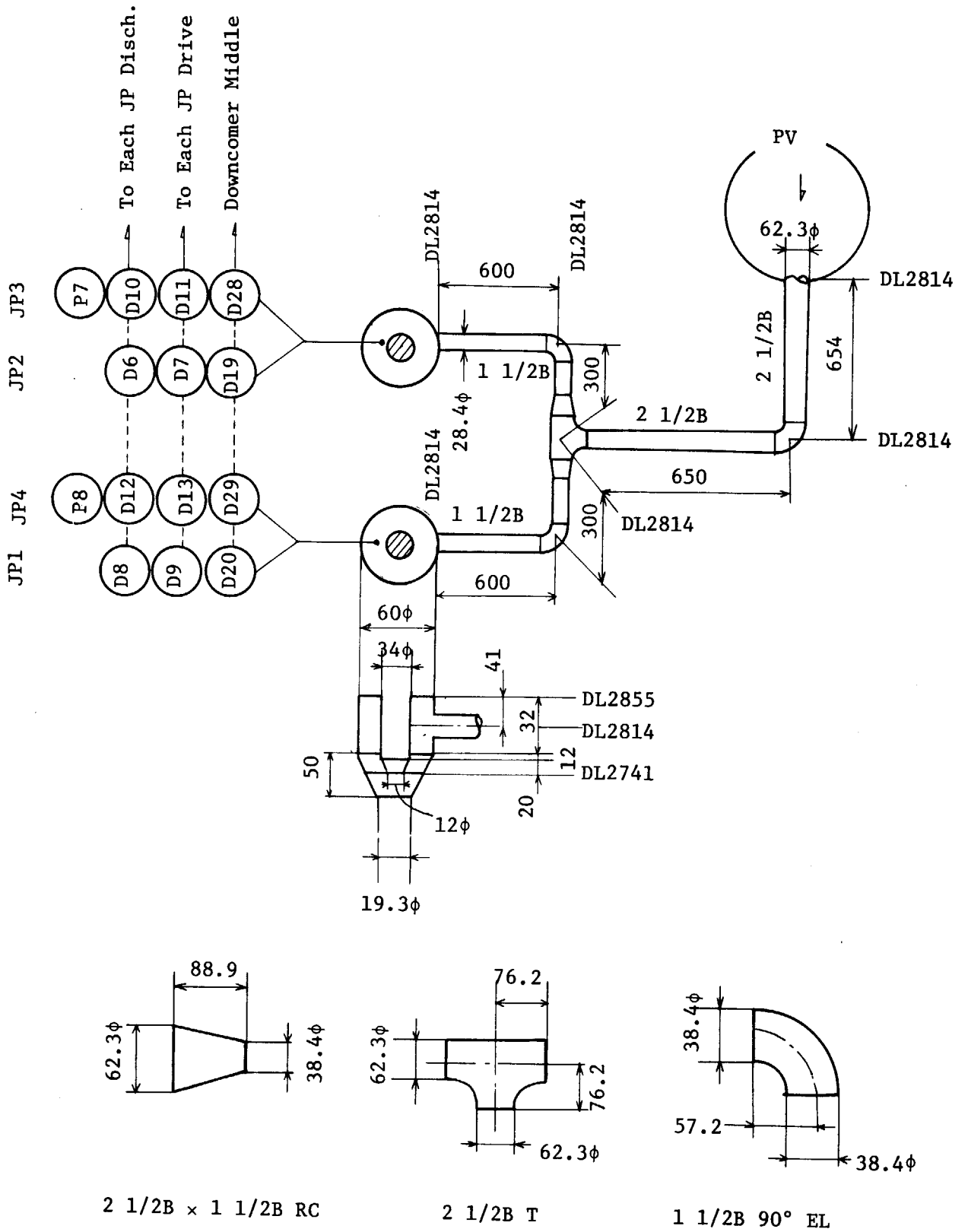


Fig.2.36 Jet Pump Suction Line.

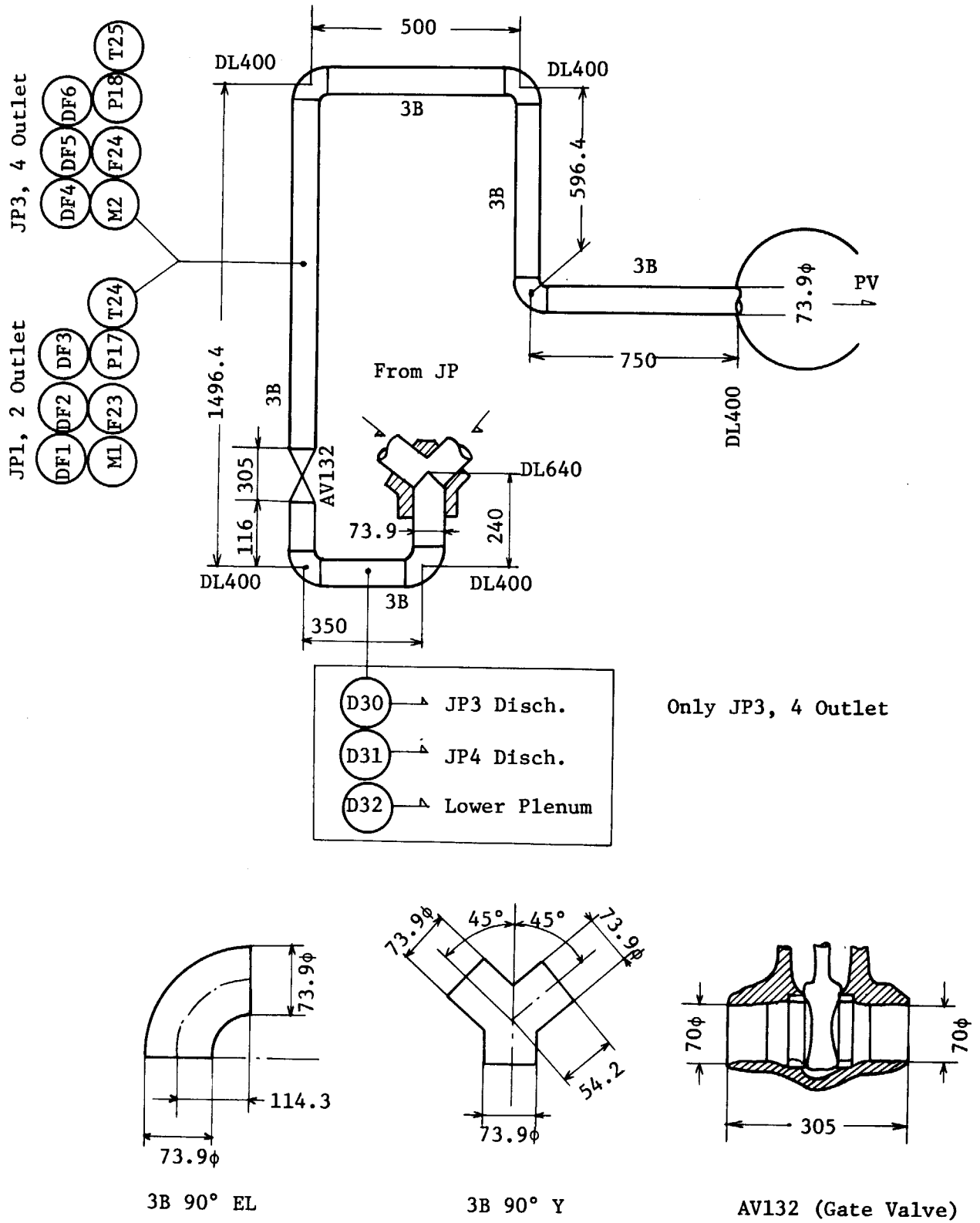


Fig.2.37 Piping from Jet Pump Discharge to Lower Plenum.

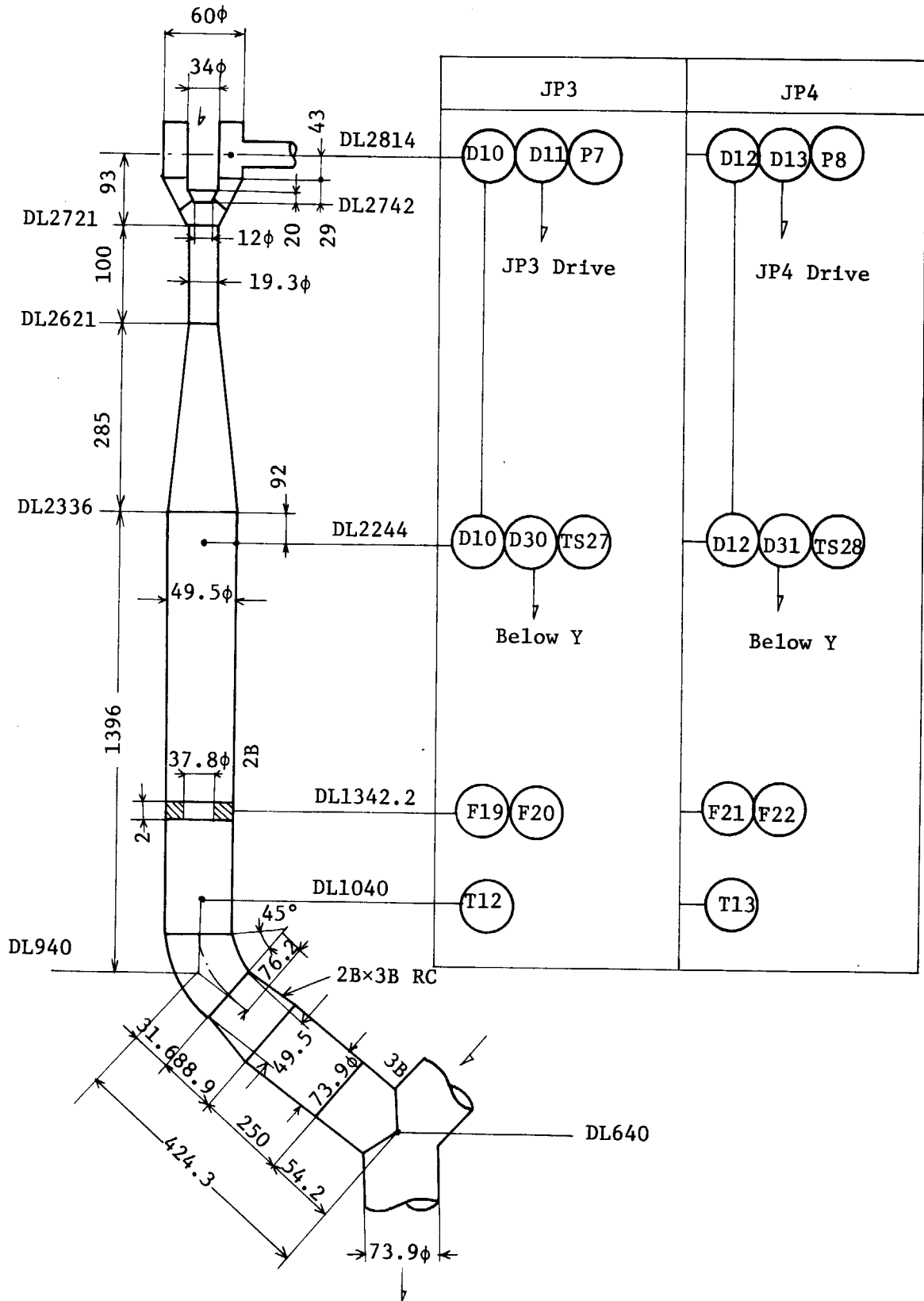


Fig. 2.38 Blowdown Loop Jet Pump Piping.

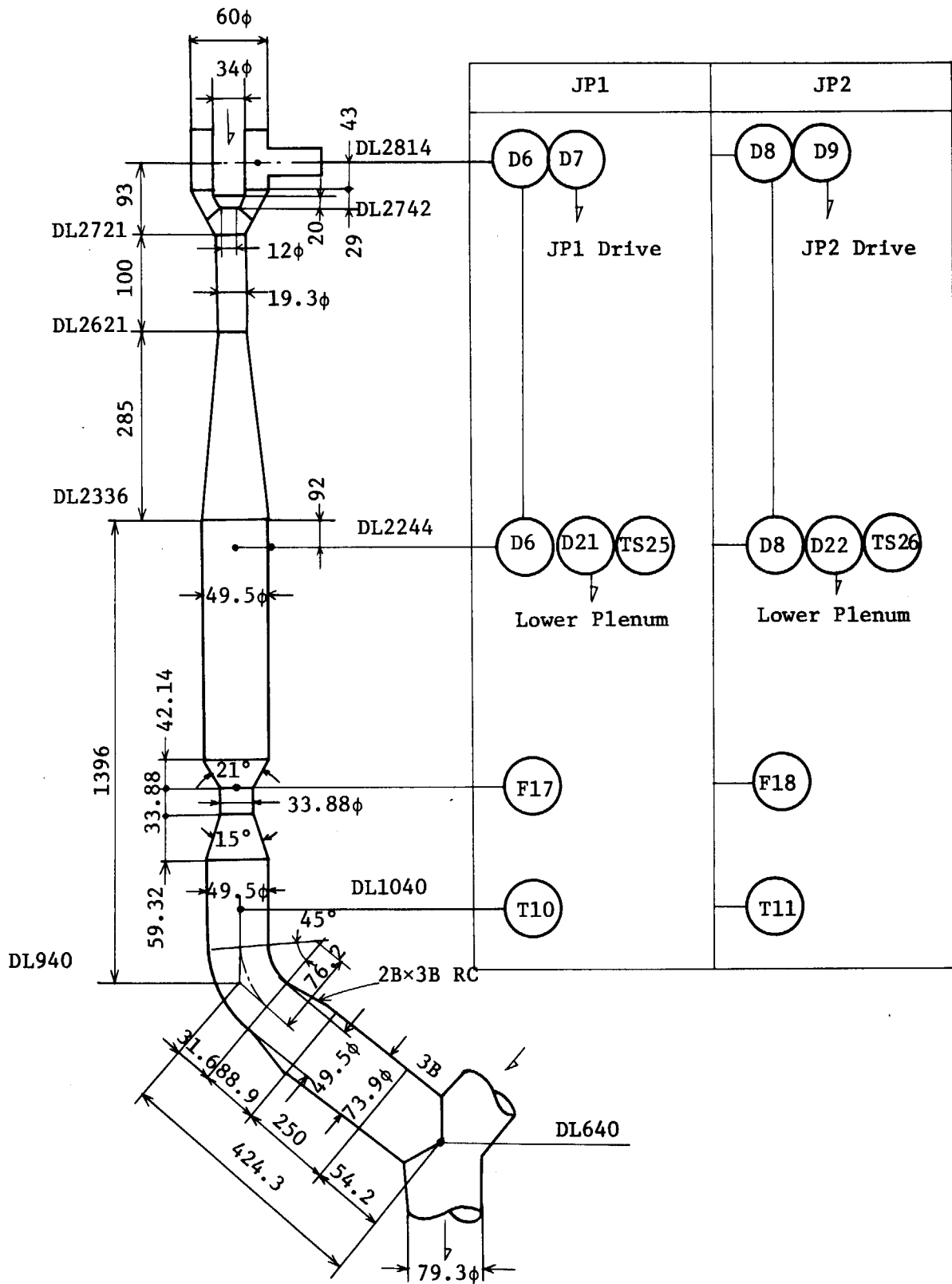


Fig.2.39 Intact Loop Jet Pump Piping.

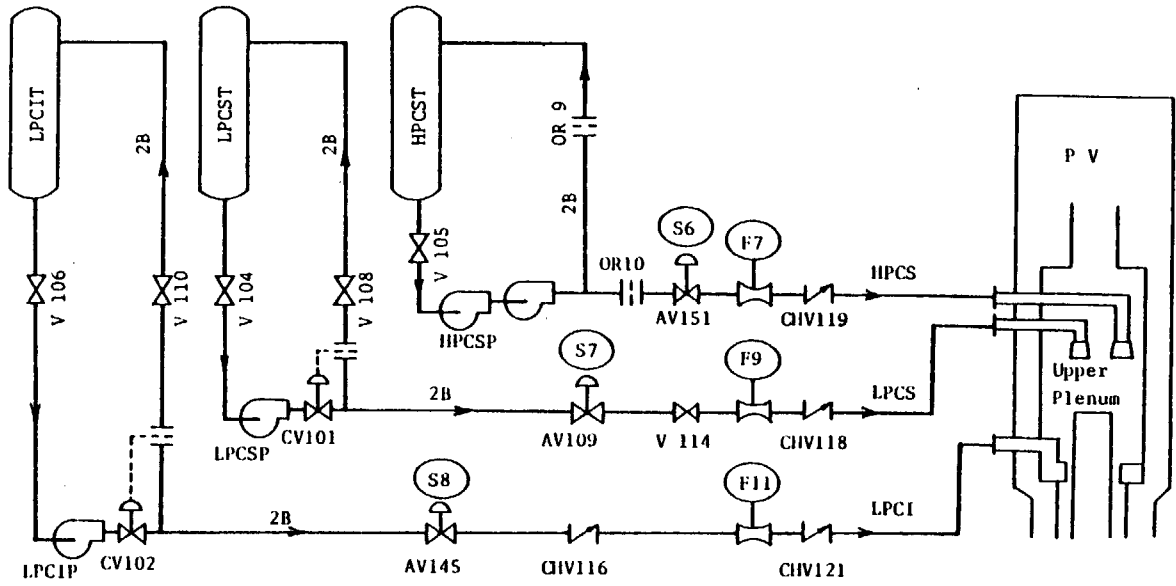


Fig. 2.40 ECC Systems Piping Schematic.

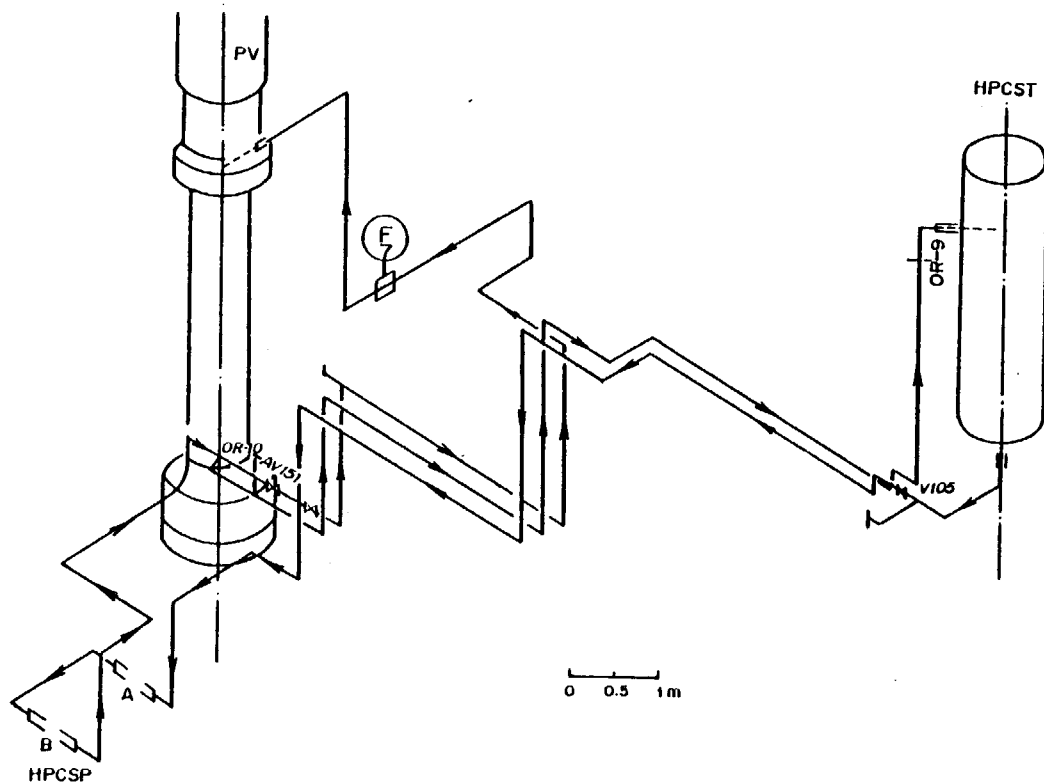


Fig. 2.41 HPCS System Piping Layout.

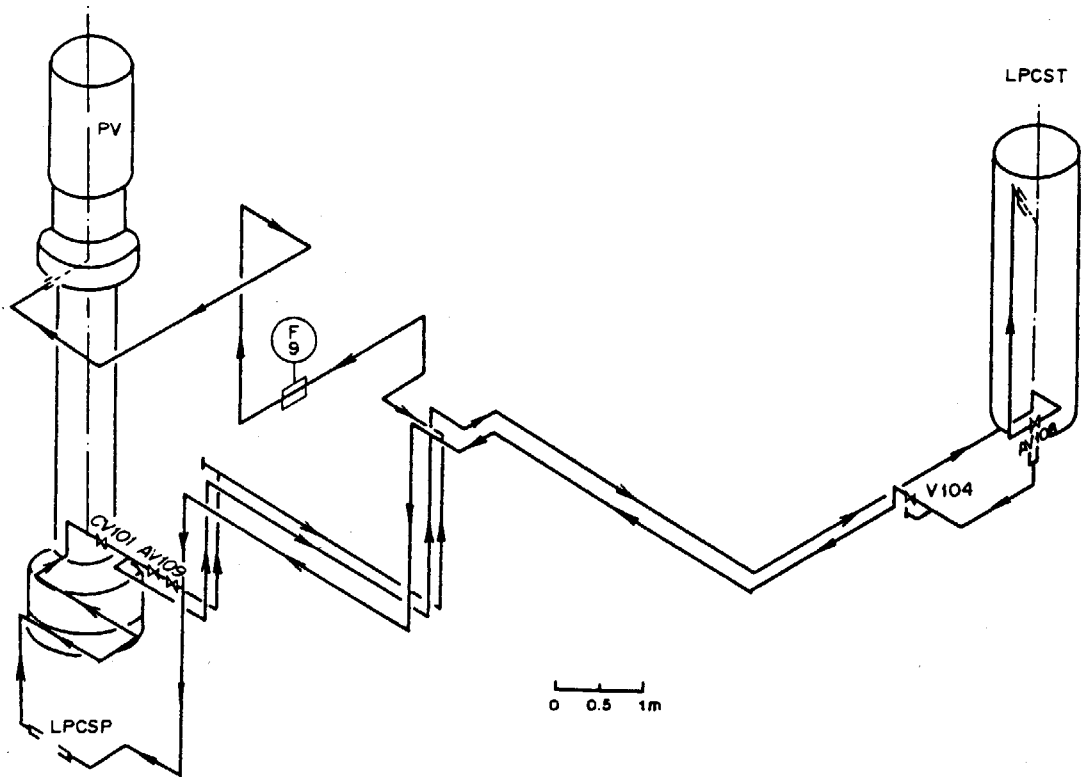


Fig. 2.42 LPCS System Piping Layout.

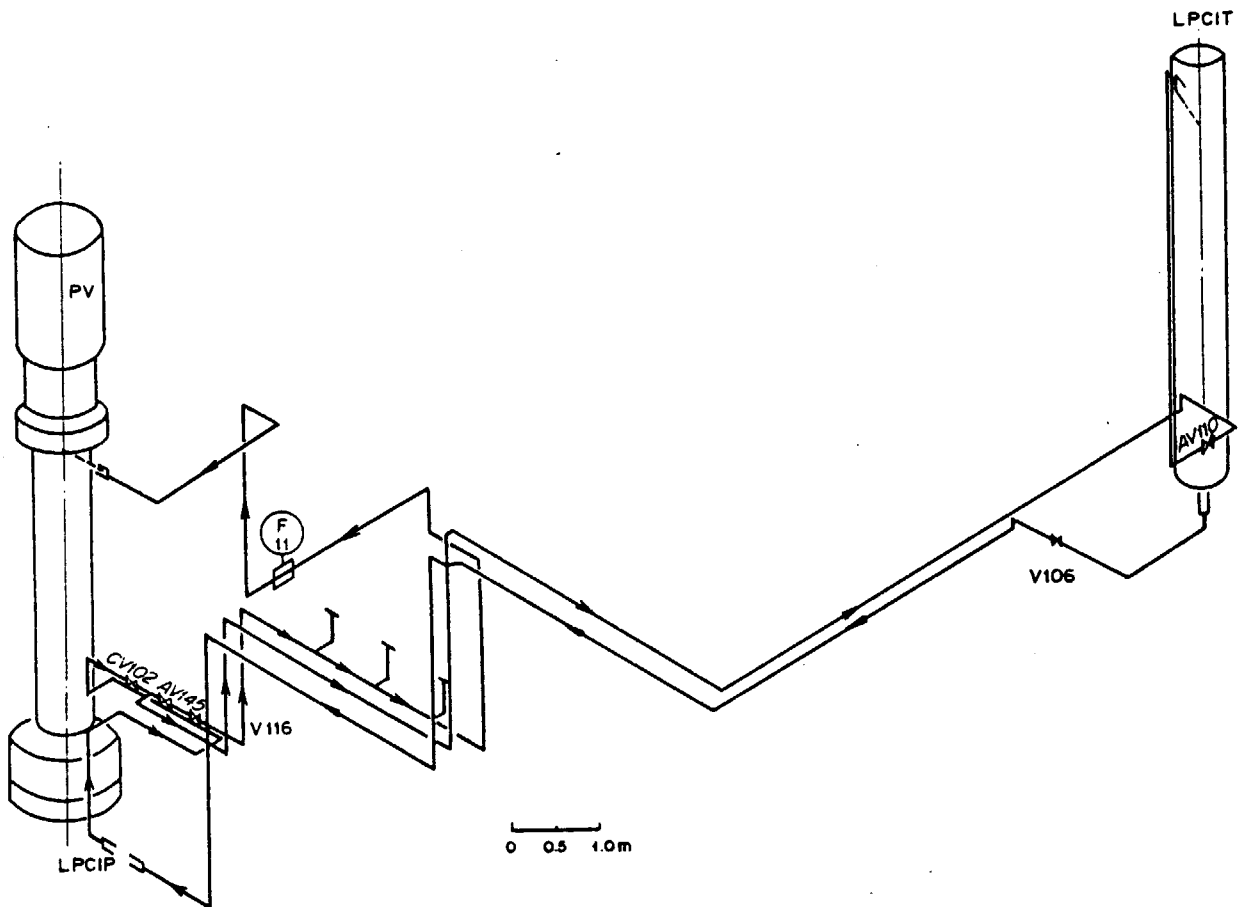


Fig. 2.43 LPCI System Piping Layout.

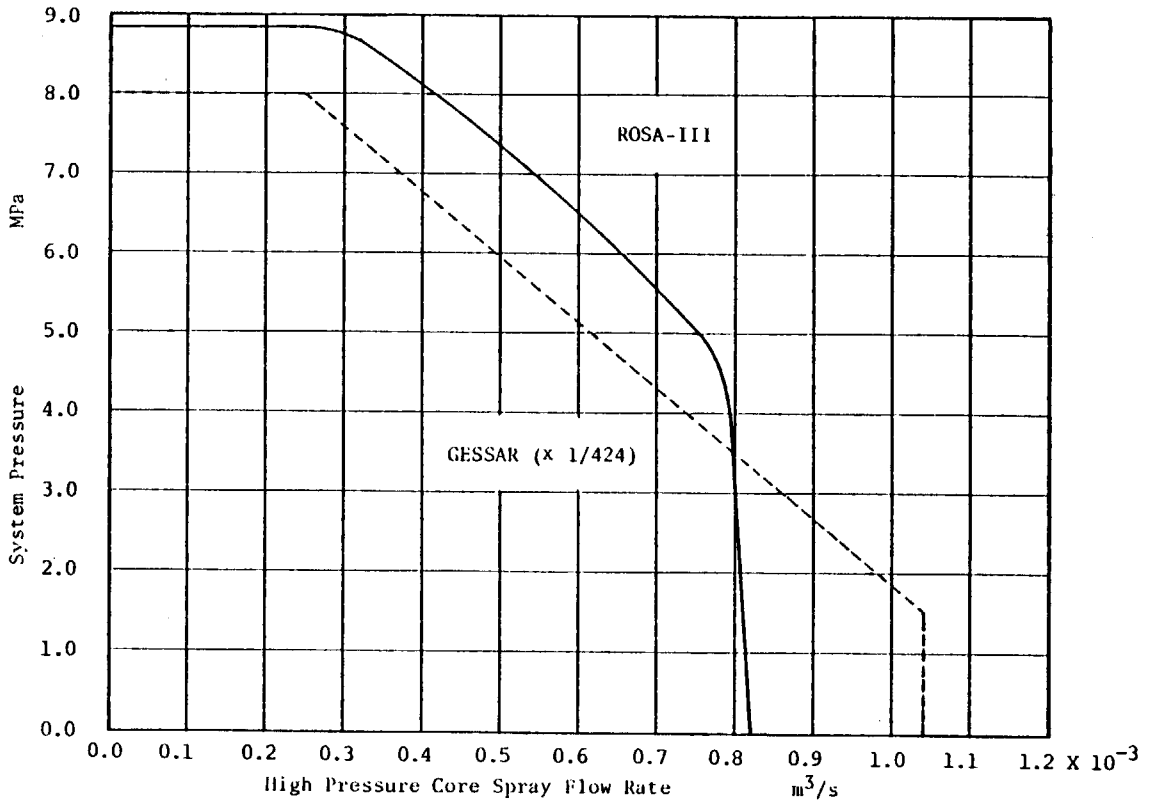


Fig. 2.44 HPCS Flow versus System Pressure.

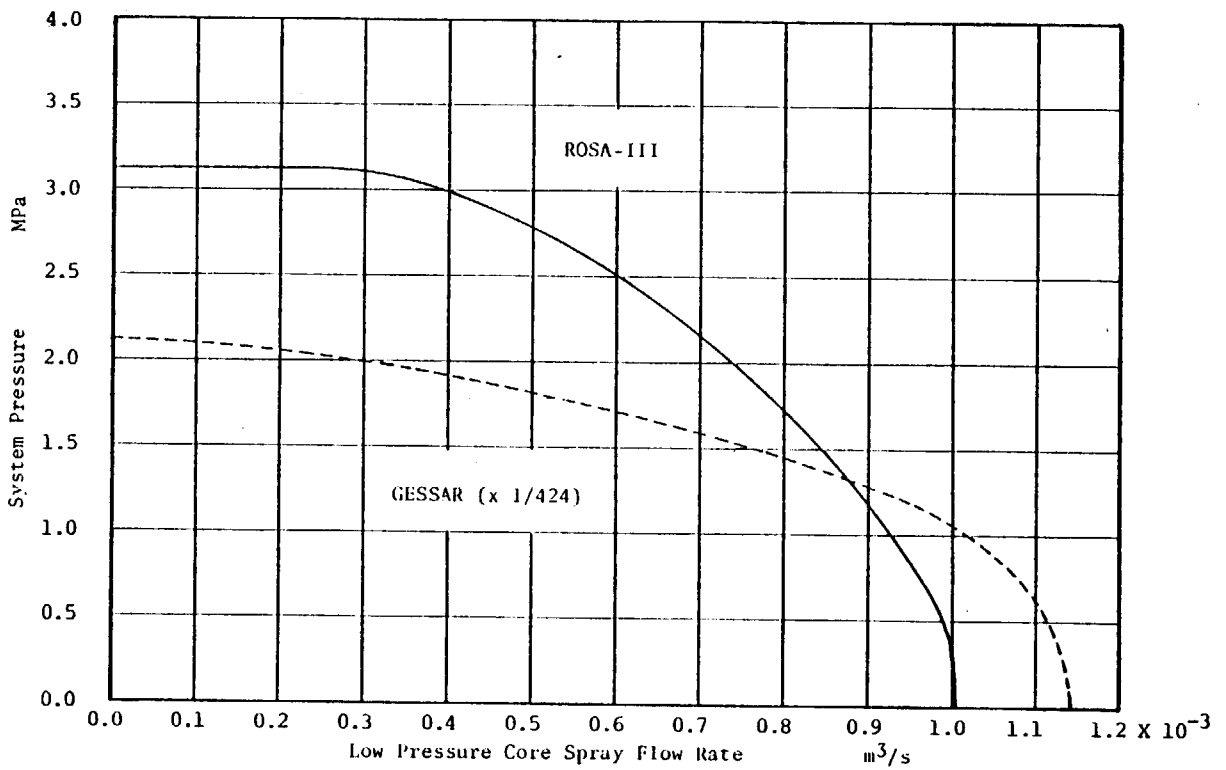


Fig. 2.45 LPCS Flow versus System Pressure.

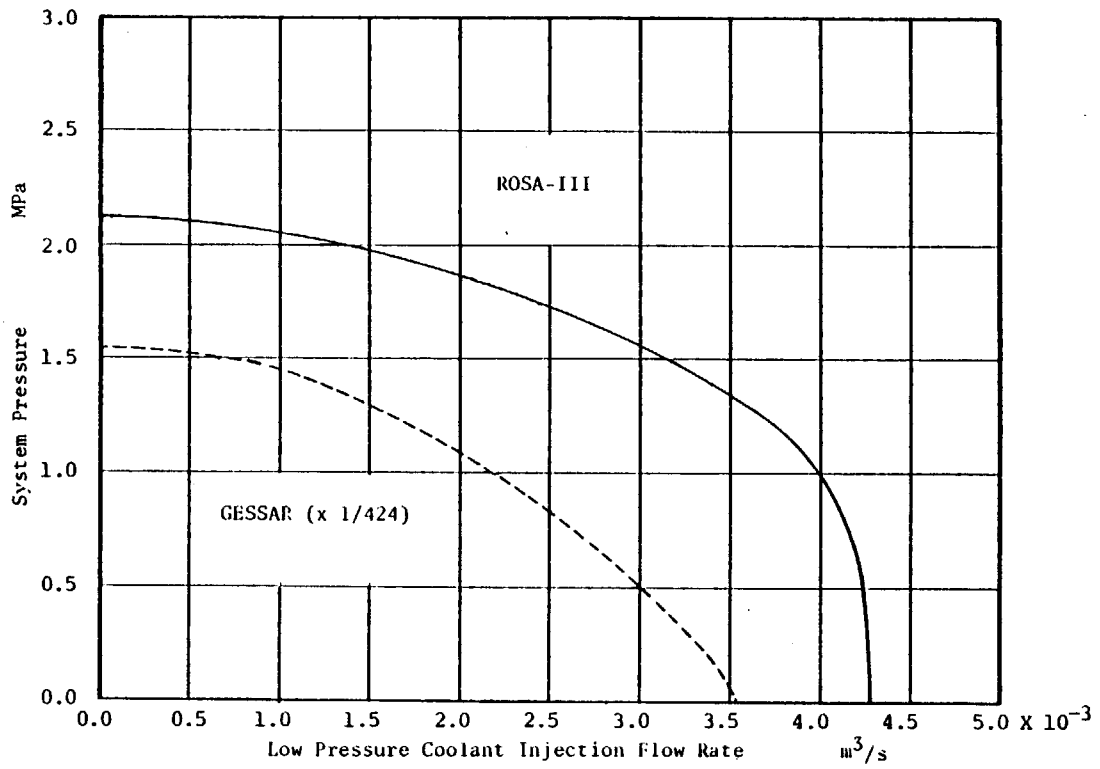


Fig. 2.46 LPCI Flow versus System Pressure.

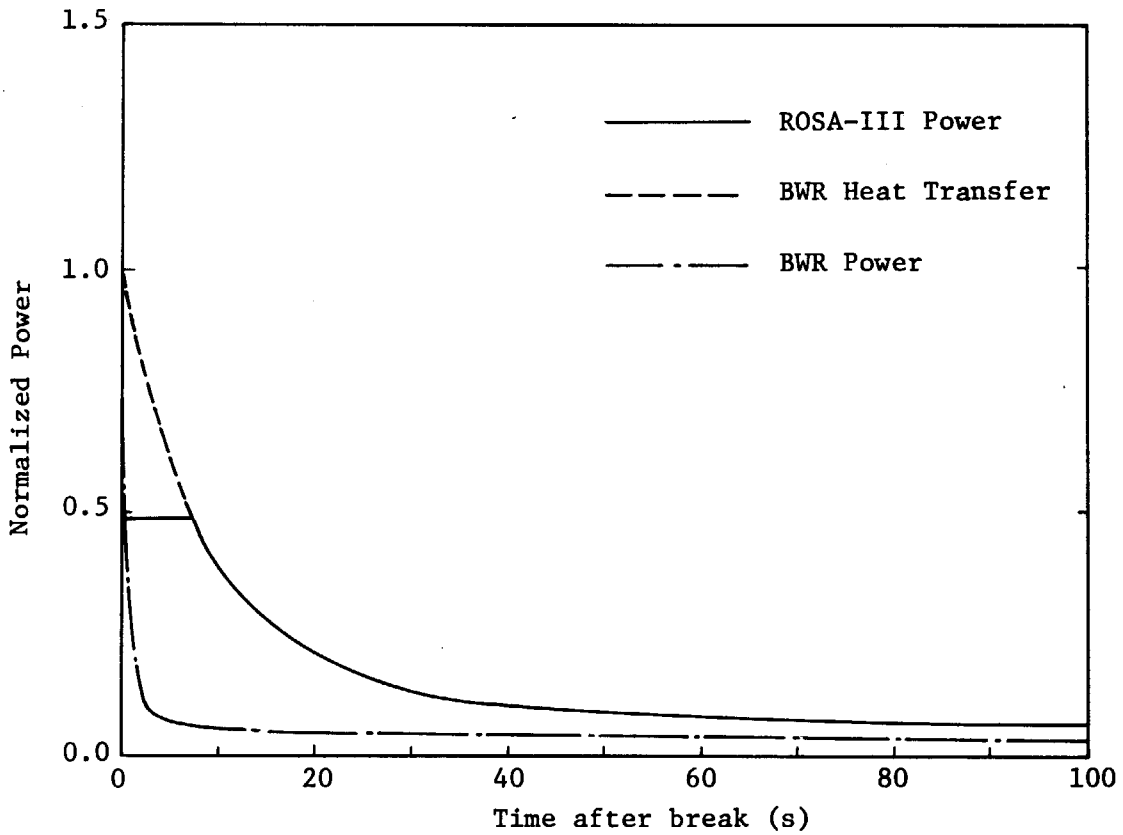
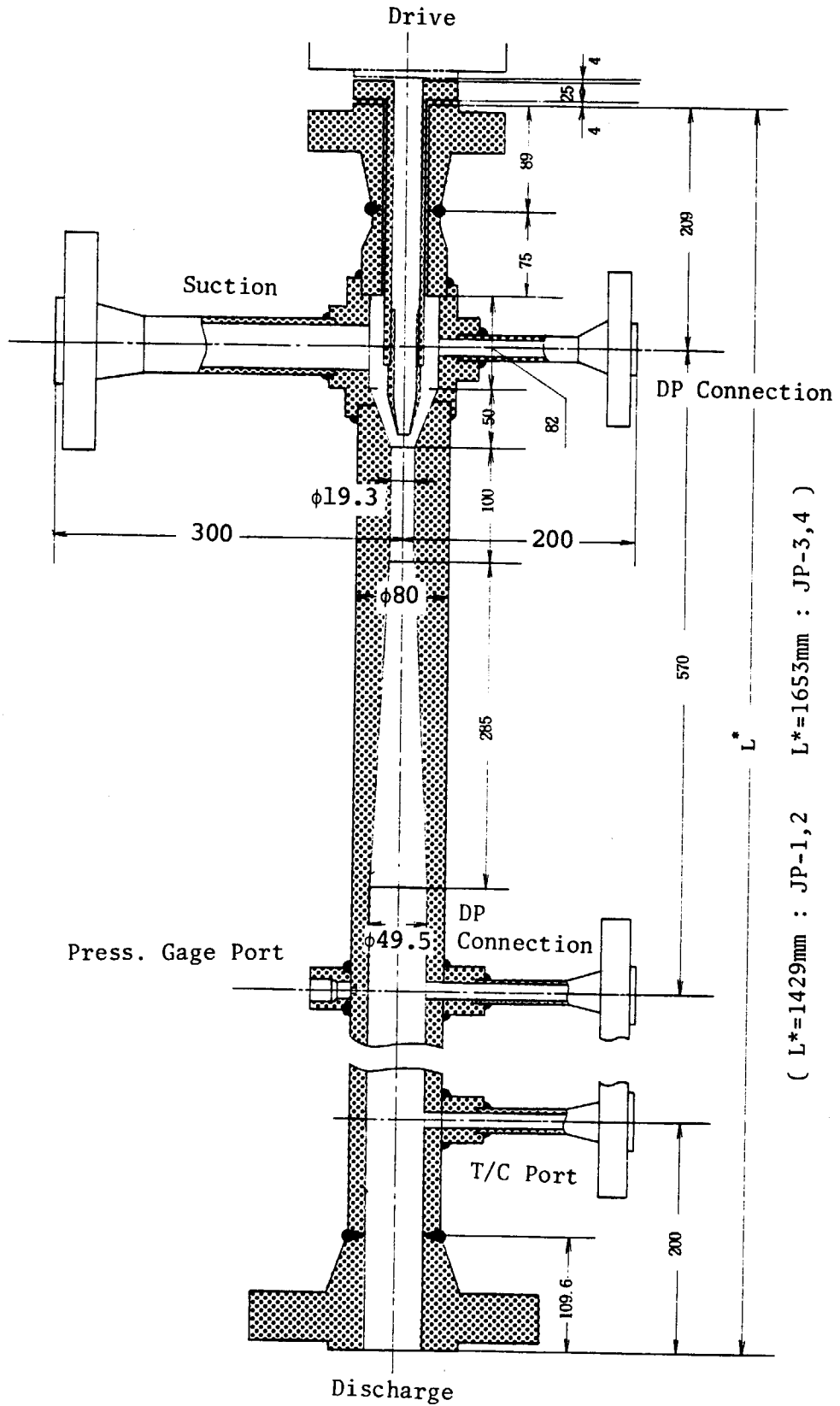


Fig. 2.47 Normalized Power Transient in BWR and ROSA-III



(L* = 1429mm : JP-1,2 L* = 1653mm : JP-3,4)

Fig. 2.48 Jet Pump.

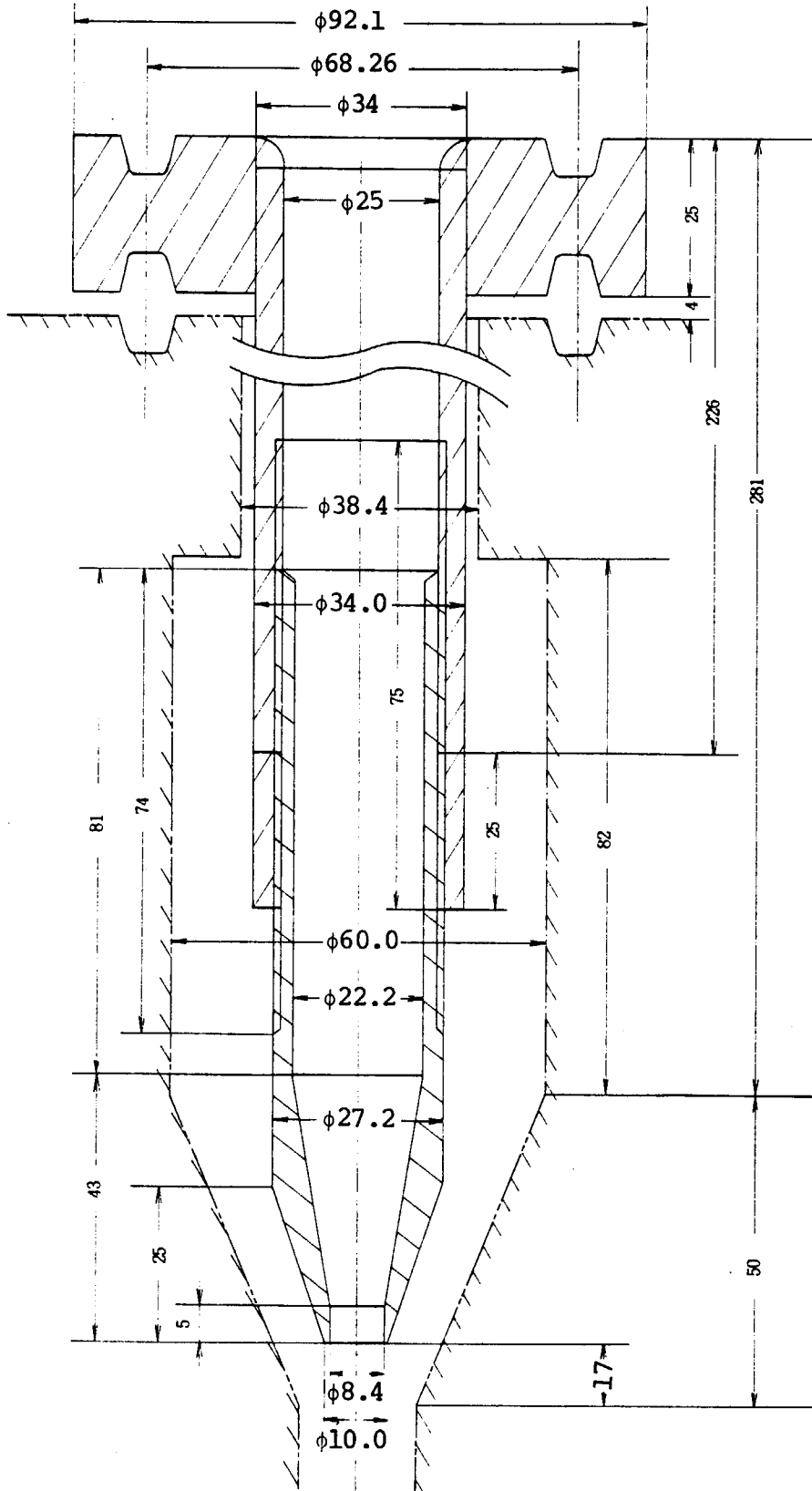


Fig. 2.49 Jet Pump Driving Flow Nozzle Details.

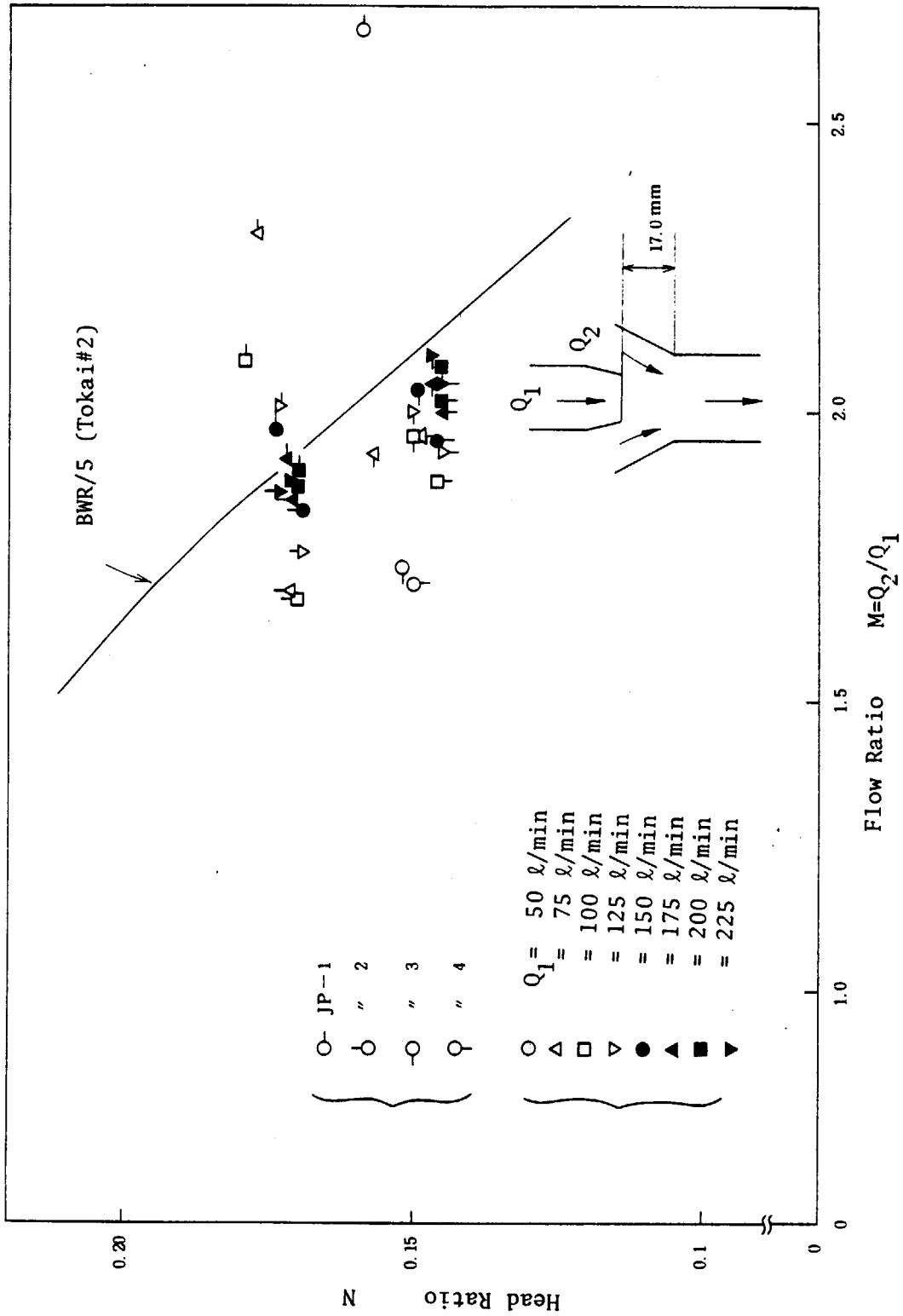


Fig. 2.50 Characteristic of Jet Pump in ROSA-III and BWR.

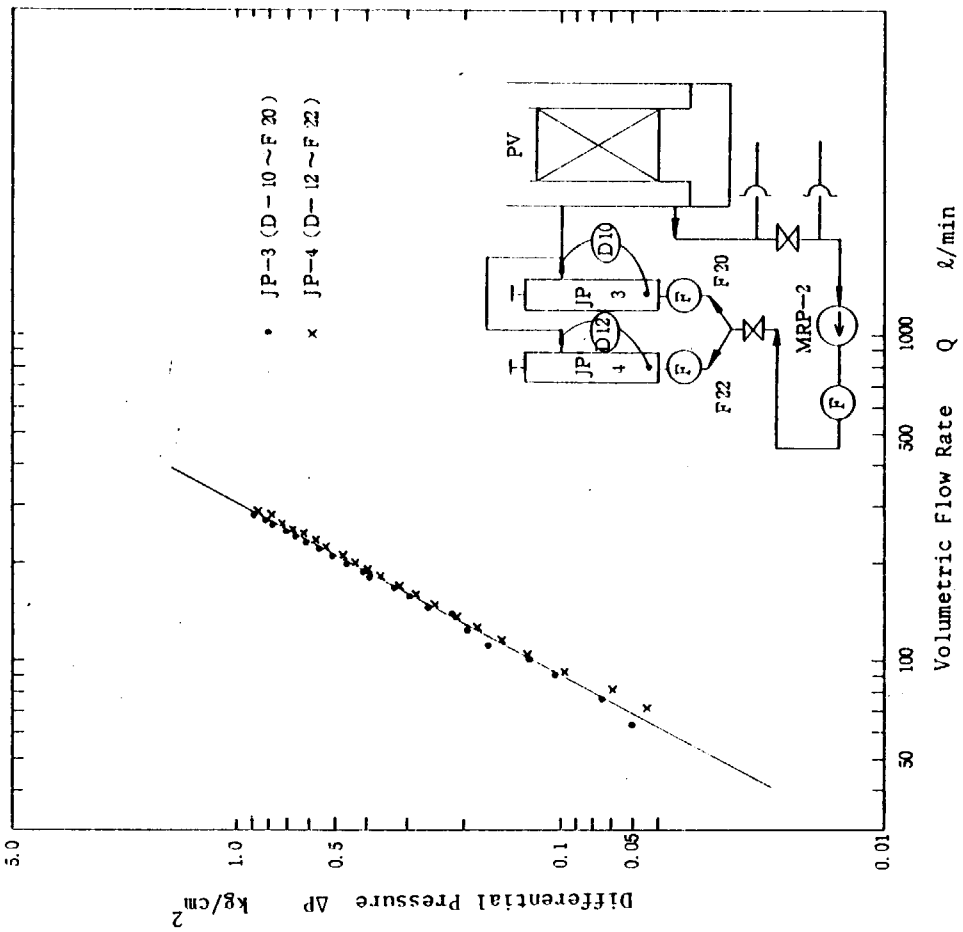


Fig. 2.51 Pressure Drop across the Jet Pump under the Reverse Flow Condition.

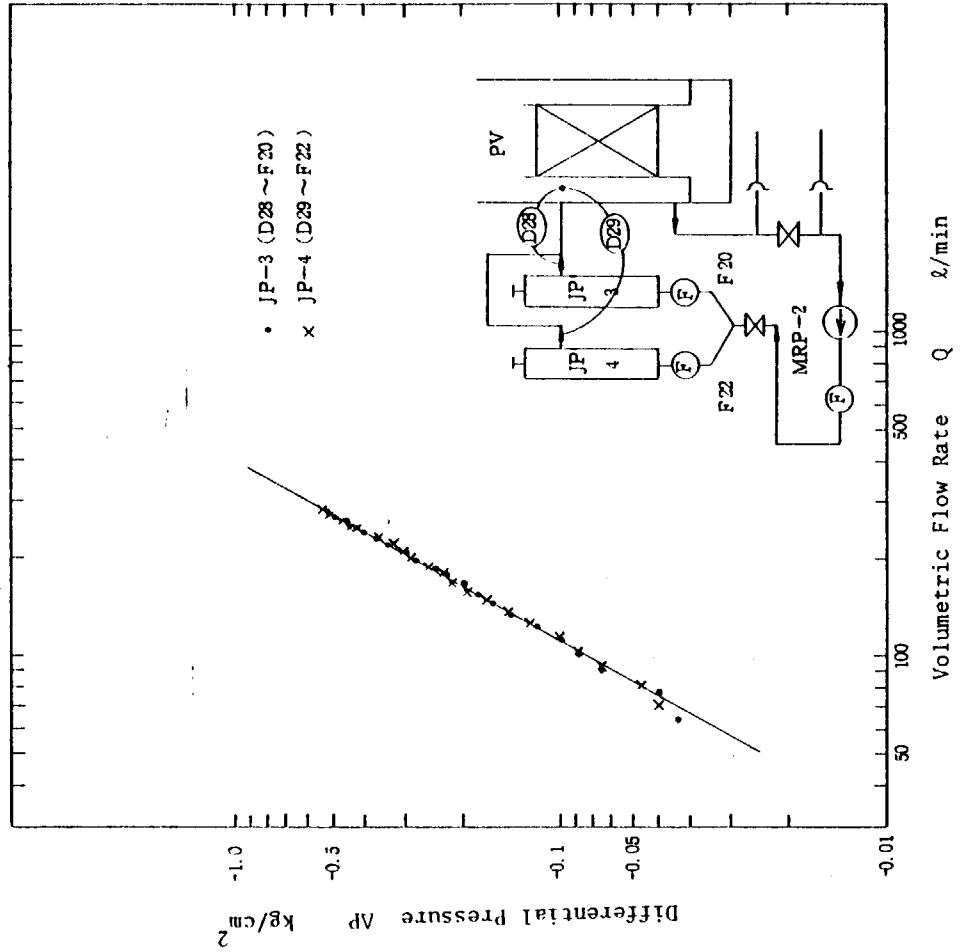


Fig. 2.52 Pressure Drop across the Jet Pump Suction Line under the Reverse Flow Condition.

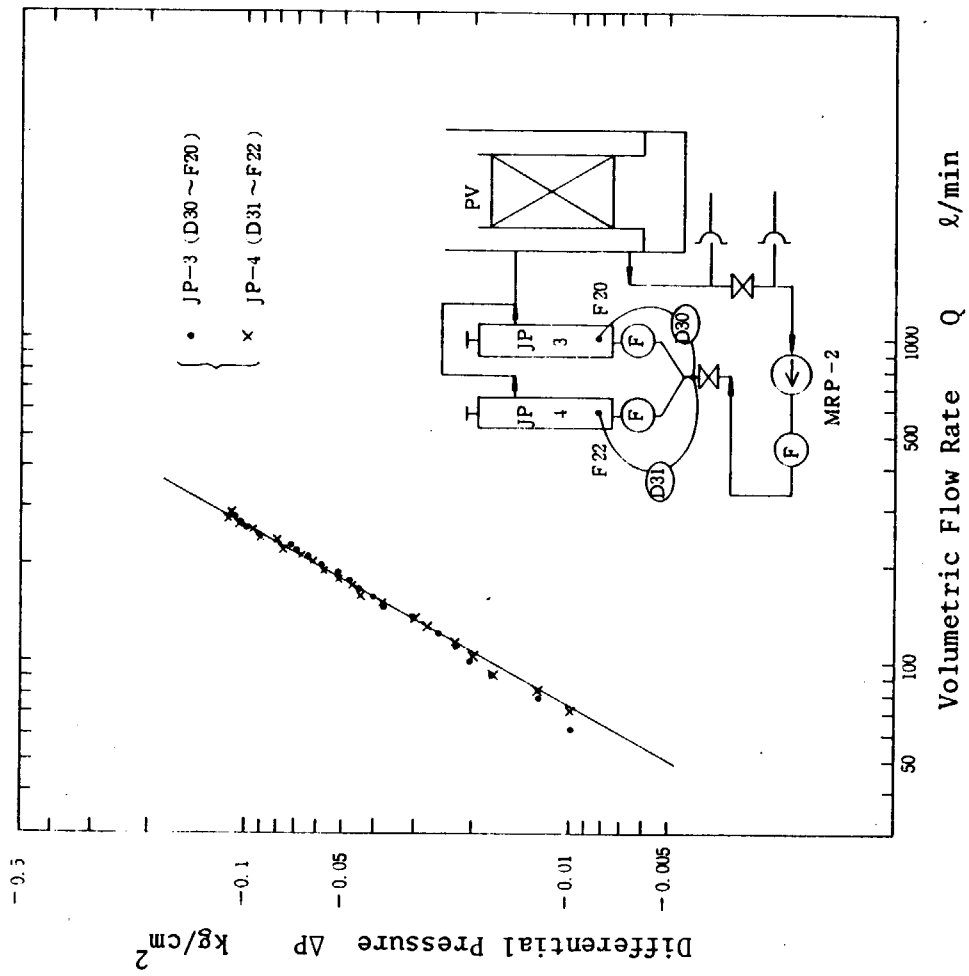


Fig. 2.53 Pressure Drop across the Y Branch under the Reverse Flow Condition.

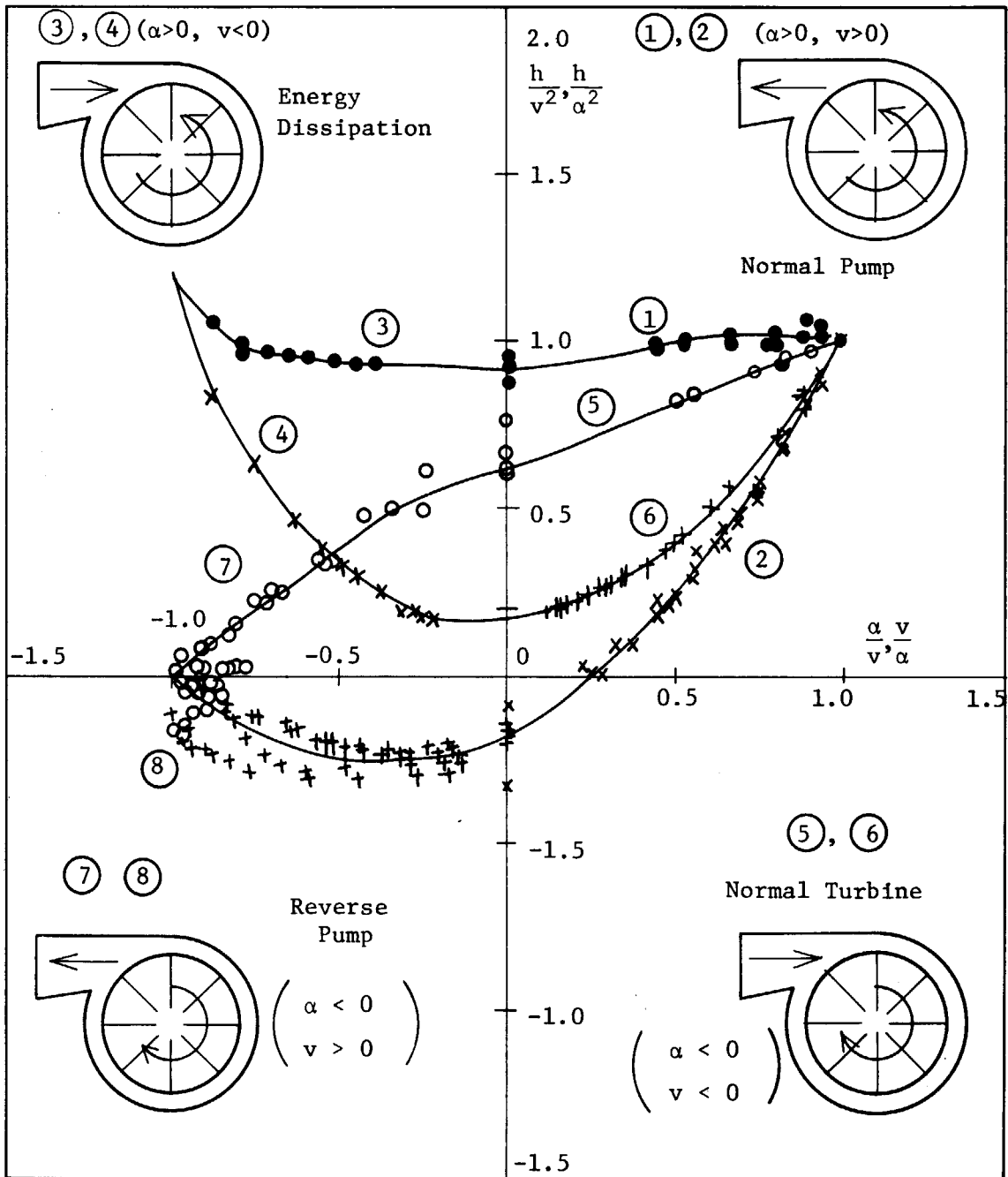


Fig. 2.54 Single-phase Homologous Head Curve for the ROSA-III Recirculation Pump.

$Q_R = 450 \text{ l/min}, \quad v = Q/Q_R$

$\omega_R = 3600 \text{ rpm}, \quad \omega = \omega/\omega_R$

$H_R = 262 \text{ m}, \quad h = H/H_R$

Table 3.1 ROSA-III MEASUREMENT LIST 3

Ch. 1 ~ Ch. 100

Ch. NO.	Item	Symbol	Location	Range	Ch. NO.	Item	Symbol	Location	Range
1	Press.	P- 1	Lower Plenum	0 ~ 100 kg/cm ²	51	Diff.P.	D-31	JP-4 Disch. - Below Y	-1.0 ~ 1.0 kg/cm ²
2		P- 2	Upper Plenum	"	52		D-32	Below Y - Lower Plenum	-0.5 ~ 0.5 kg/cm ²
3		P- 3	Steam Dome	"	53		D-33	Lower Pl. - DC Middle	-2.5 ~ 2.5 kg/cm ²
4		P- 4	Downcomer Bottom	"	54		D-34	Lower Pl. - DC Bottom	"
5		P- 5	JP-3 Drive *2)	"	55		D-35	DC Bottom - DC Middle	-0.5 ~ 0.5 kg/cm ²
6		P- 6	JP-4 Drive *2)	"	56		D-36	DC Middle - Steam Dome	"
7		P- 7	JP-3 Suction	"	57		D-37	Lower Pl. Mid. - Upper Pl.	0 ~ 2.5 kg/cm ²
8		P- 8	JP-4 Suction	"	58		D-38	Lower Pl. Bottom - Middle	0 ~ 0.5 kg/cm ²
9		P- 9	MRP-1 Suction *3)	"	59		D-39	Upper Plenum Head	0 ~ 0.2 kg/cm ²
10		P-10	MRP-2 Suction *4)	"	60		D-40	Channel Orifice A	0 ~ 1.0 kg/cm ²
11		P-11	MRP-2 Delivery	"	61		D-41	Channel Orifice B	"
12		P-12	Break A Upstream *5)	"	62		D-42	Channel Orifice C	"
13		P-13	Break A Downstream	"	63		D-43	Channel Orifice D	"
14		P-14	Break B Upstream *6)	"	64		D-44	Bypass Hole	0 ~ 2.0 kg/cm ²
15		P-15	Break B Downstream	"	65	Mass Flow	F- 1	Main Steam Line	0 ~ 15 kg/s
16		P-16	Steam Line	"	66		F- 2	ADS Steam Line	0 ~ 3.0 kg/s
17		P-17	JP-1,2 Outlet Spool*1)	"	67		F- 3	RCN A Condensed Water	0 ~ 250 kg/s
18		P-18	JP-3,4 Outlet Spool	"	68		F- 4	RCN A Cooling Water	"
19		P-19	Break A Spool Piece	"	69		F- 5	RCN B Condensed Water	"
20		P-30	Break B Spool Piece	"	70		F- 6	RCN B Cooling Water	"
21	Diff.P.	D- 1	Lower Pl. - Upper Pl.	-0.5 ~ 3.5 kg/cm ²	71	Vol. Flow	F- 7	HPCS (Upper Plenum)	0 ~ 150 l/min
22		D- 2	Upper Pl. - Steam Dome	-0.1 ~ 0.9 kg/cm ²	72		F- 9	LPCS (Upper Plenum)	"
23		D- 3	Lower Plenum Head	0 ~ 1.5 kg/cm ²	73		F-11	LPCI (In-Schlaud)	0 ~ 500 l/min
24		D- 4	Downcomer Head	0 ~ 1.0 kg/cm ²	74		F-15	Feed Water	0 ~ 600 l/min
25		D- 5	PV Bottom - Top	-1.0 ~ 9.0 kg/cm ²	75		F-17	JP-1 Discharge	0 ~ 1000 l/min
26		D- 6	JP-1 Disch. - Suction	-1.0 ~ 3.0 kg/cm ²	76		F-18	JP-2 Discharge	"
27		D- 7	JP-1 Drive - Suction	0 ~ 25 kg/cm ²	77		F-19	JP-3 Disch. Positive	"
28		D- 8	JP-2 Disch. - Suction	-1.0 ~ 3.0 kg/cm ²	78		F-20	JP-3 Disch. Negative	0 ~ 300 l/min
29		D- 9	JP-2 Drive - Suction	0 ~ 25 kg/cm ²	79		F-21	JP-4 Disch. Positive	0 ~ 1000 l/min
30		D-10	JP-3 Disch. - Suction	-1.0 ~ 3.0 kg/cm ²	80		F-22	JP-4 Disch. Negative	0 ~ 300 l/min
31		D-11	JP-3 Drive - Suction	-5.0 ~ 25 kg/cm ²	81	Mass Flow	F-23	JP-1,2 Outlet Spool	0 ~ 30 kg/s
32		D-12	JP-4 Disch. - Suction	-1.0 ~ 3.0 kg/cm ²	82		F-24	JP-3,4 Outlet Spool	"
33		D-13	JP-4 Drive - Suction	-5.0 ~ 25 kg/cm ²	83		F-25	Break A Spool Piece	"
34		D-14	MRP-1 Deliv. - Suction	-1.0 ~ 25 kg/cm ²	84		F-26	Break B Spool Piece	"
35		D-15	MRP-2 Deliv. - Suction	"	85	Power	W- 1	550 kW Power Supplier	0 ~ 550 kW
36		D-16	DC Bottom - MRP-1 Suc.	-0.5 ~ 0.5 kg/cm ²	86		W- 2	1800 kW Power Supplier	0 ~ 1700 kW
37		D-17	MRP1 Deliv. - JP1 Drive	0 ~ 2.5 kg/cm ²	87		W- 3	2100 kW Power Supplier	0 ~ 2100 kW
38		D-18	MRP1 Deliv. - JP2 Drive	"	88	Rev.	N- 1	MRP-1	0 ~ 5000 rpm
39		D-19	DC Middle - JP1 Suc.	"	89		N- 2	MRP-2	"
40		D-20	DC Middle - JP2 Suc.	"	90	Signal	S- 1	Break Signal A	close-open
41		D-21	JP1 Disch. - Lower Pl.	-1.0 ~ 1.0 kg/cm ²	91		S- 2	Break Signal B	"
42		D-22	JP2 Disch. - Lower Pl.	"	92		S- 3	QSV Signal	"
43		D-23	DC Bottom - Break B	0 ~ 20 kg/cm ²	93		S-10	MSIV Signal	"
44		D-24	Break B - Break A	0 ~ 1.0 kg/cm ²	94		S-11	Steam Line Valve	"
45		D-25	Break A - MRP2 Suction	-5.0 ~ 1.0 kg/cm ²	95		S-12	ADS Valve	"
46		D-26	MRP2 Deliv. - JP3 Drive	-5.0 ~ 5.0 kg/cm ²	96	Fluid Temp.	T- 1	Lower Plenum	0 ~ 400 °C
47		D-27	MRP2 Deliv. - JP4 Drive	"	97		T- 2	Upper Plenum	"
48		D-28	DC Middle - JP3 Suc.	-2.5 ~ 2.5 kg/cm ²	98		T- 3	Steam Dome	"
49		D-29	DC Middle - JP4 Suc.	"	99		T- 4	Upper Downcomer	"
50		D-30	JP3 Disch. - Below Y	-1.0 ~ 1.0 kg/cm ²	100		T- 5	Lower Downcomer	"

Table 3.1 (Continued)

CH. 101 ~ CH. 200

CH. NO.	Item	Symbol	Location	Range	CH. NO.	Item	Symbol	Location	Range
101	Fluid Temp.	T- 6	JP-1 Drive	0 ~ 400 °C	151	Slab Temp.	TF3-30	A15 Fuel Rod Pos. 4	0 ~ 1000 °C
102		T- 7	JP-2 Drive	"	152		31	A17 Fuel Rod Pos. 1	"
103		T- 8	JP-3 Drive	"	153		32	4	"
104		T- 9	JP-4 Drive	"	154		33	A22 Fuel Rod Pos. 1	"
105		T-10	JP-1 Discharge	"	155		34	2	"
106		T-11	JP-2 Discharge	"	156		35	3	"
107		T-12	JP-3 Discharge	"	157		36	4	"
108		T-13	JP-4 Discharge	"	158		37	5	"
109		T-14	MRP-1 Suction	"	159		38	6	"
110		T-15	MRP-1 Delivery	"	160		39	7	"
111		T-16	MRP-2 Suction	"	161		40	A23 Fuel Rod Pos. 1	"
112		T-17	MRP-2 Delivery	"	162		41	2	"
113		T-18	Break A Upstream	"	163		42	3	"
114		T-19	Break B Upstream	"	164		43	4	"
115		T-20	RCN A Condensed Water	"	165		44	5	"
116		T-21	RCN B Condensed Water	"	166		45	6	"
117		T-22	Discharged Steam	"	167		46	7	"
118		T-24	JP-1,2 Outlet Spool	"	168		47	A24 Fuel Rod Pos. 1	"
119		T-25	JP-3,4 Outlet Spool	"	169		48	2	"
120		T-26	Break A Spool Piece	"	170		49	3	"
121		T-37	Break B Spool Piece	"	171		50	4	"
122	Slab Temp.	TF3- 1	A11 Fuel Rod Pos. 1	0 ~ 1000 °C	172		51	5	"
123		2	2	"	173		52	6	"
124		3	3	"	174		53	7	"
125		4	4	"	175		54	A26 Fuel Rod Pos. 1	"
126		5	5	"	176		55	4	"
127		6	6	"	177		56	A28 Fuel Rod Pos. 1	"
128		7	7	"	178		57	4	"
129		8	A12 Fuel Rod Pos. 1	"	179		58	A31 Fuel Rod Pos. 1	"
130		9	2	"	180		59	4	"
131		10	3	"	181		60	A33 Fuel Rod Pos. 1	"
132		11	4	"	182		61	2	"
133		12	5	"	183		62	3	"
134		13	6	"	184		63	4	"
135		14	7	"	185		64	5	"
136		15	A13 Fuel Rod Pos. 1	"	186		65	6	"
137		16	2	"	187		66	7	"
138		17	3	"	188		67	A34 Fuel Rod Pos. 1	"
139		18	4	"	189		68	2	"
140		19	5	"	190		69	3	"
141		20	6	"	191		70	4	"
142		21	7	"	192		71	5	"
143		22	A14 Fuel Rod Pos. 1	"	193		72	6	"
144		23	2	"	194		73	7	"
145		24	3	"	195		74	A35 Fuel Rod Pos. 1	"
146		25	4	"	196		75	4	"
147		26	5	"	197		76	A37 Fuel Rod Pos. 1	"
148		27	6	"	198		77	4	"
149		28	7	"	199		78	A42 Fuel Rod Pos. 1	"
150		29	A15 Fuel Rod Pos. 1	"	200		79	4	"

Table 3.1 (Continued)

CH. 201 ~ CH. 300

Ch. NO.	Item	Symbol	Location	Range	Ch. NO.	Item	Symbol	Location	Range
201	Slab Temp.	TF3-80	A45 Fuel Rod Pos. 1	0 ~ 1000 °C	251	Slab Temp.	TF3-130	B53 Fuel Rod Pos. 4	0 ~ 1000 °C
202		81	4	"	252		131	B85 Fuel Rod Pos. 1	"
203		82	A46 Fuel Rod Pos. 1	"	253		132	2	"
204		83	4	"	254		133	3	"
205		84	A48 Fuel Rod Pos. 1	"	255		134	4	"
206		85	4	"	256		135	5	"
207		86	A51 Fuel Rod Pos. 1	"	257		136	6	"
208		87	4	"	258		137	7	"
209		88	A53 Fuel Rod Pos. 1	"	259		138	C11 Fuel Rod Pos. 4	"
210		89	4	"	260		139	C13 Fuel Rod Pos. 4	"
211		90	A54 Fuel Rod Pos. 1	"	261		140	C15 Fuel Rod Pos. 4	"
212		91	A57 Fuel Rod Pos. 1	"	262		141	C31 Fuel Rod Pos. 4	"
213		92	4	"	263		142	C33 Fuel Rod Pos. 1	"
214		93	A62 Fuel Rod Pos. 1	"	264		143	2	"
215		94	4	"	265		144	3	"
216		95	A64 Fuel Rod Pos. 1	"	266		145	4	"
217		96	4	"	267		146	5	"
218		97	A67 Fuel Rod Pos. 1	"	268		147	6	"
219		98	4	"	269		148	7	"
220		99	A68 Fuel Rod Pos. 1	"	270		149	C35 Fuel Rod Pos. 4	"
221		100	4	"	271		150	C51 Fuel Rod Pos. 4	"
222		101	A71 Fuel Rod Pos. 1	"	272		151	C53 Fuel Rod Pos. 4	"
223		102	4	"	273		152	C77 Fuel Rod Pos. 1	"
224		103	A73 Fuel Rod Pos. 1	"	274		153	2	"
225		104	4	"	275		154	3	"
226		105	A75 Fuel Rod Pos. 1	"	276		155	4	"
227		106	4	"	277		156	5	"
228		107	A77 Fuel Rod Pos. 1	"	278		157	6	"
229		108	4	"	279		158	7	"
230		109	A82 Fuel Rod Pos. 1	"	280		159	D11 Fuel Rod Pos. 4	"
231		110	4	"	281		160	D13 Fuel Rod Pos. 4	"
232		111	A84 Fuel Rod Pos. 1	"	282		161	D27 Fuel Rod Pos. 1	"
233		112	4	"	283		162	2	"
234		113	A86 Fuel Rod Pos. 1	"	284		163	3	"
235		114	4	"	285		164	4	"
236		115	A88 Fuel Rod Pos. 1	"	286		165	5	"
237		116	4	"	287		166	6	"
238		117	B11 Fuel Rod Pos. 4	"	288		167	7	"
239		118	B13 Fuel Rod Pos. 4	"	289		168	D31 Fuel Rod Pos. 4	"
240		119	B15 Fuel Rod Pos. 1	"	290		169	D33 Fuel Rod Pos. 4	"
241		120	2	"	291		170	D35 Fuel Rod Pos. 4	"
242		121	3	"	292		171	D51 Fuel Rod Pos. 4	"
243		122	4	"	293		172	D53 Fuel Rod Pos. 4	"
244		123	5	"	294		173	D88 Fuel Rod Pos. 1	"
245		124	6	"	295		174	2	"
246		125	7	"	296		175	3	"
247		126	B31 Fuel Rod Pos. 4	"	297		176	4	"
248		127	B33 Fuel Rod Pos. 4	"	298		177	5	"
249		128	B35 Fuel Rod Pos. 4	"	299		178	6	"
250		129	B51 Fuel Rod Pos. 4	"	300		179	7	"

Table 3.1 (Continued)

Ch. 301 ~ Ch. 400

Ch. NO.	Item	Symbol	Location	Range	Ch. NO.	Item	Symbol	Location	Range
301	Fluid Temp.	TF3-180	A44 Tie Rod Pos. 1	0 ~ 500 °C	351	Slab Temp.	TB-15	C.B.Inner Surface B-1	0 ~ 500 °C
302		181	2	"	352		TB-16	B-2	"
303		182	3	"	353		TB-17	B-3	"
304		183	4	"	354		TB-18	B-4	"
305		184	5	"	355		TB-19	B-5	"
306		185	6	"	356		TB-20	B-6	"
307		186	7	"	357		TB-21	B-7	"
308		187	B44 Tie Rod Pos. 1	"	358		TB-22	C.B.Inner Surface C-1	"
309		188	2	"	359		TB-23	C-2	"
310		189	3	"	360		TB-24	C-3	"
311		190	4	"	361		TB-25	C-4	"
312		191	5	"	362		TB-26	C-5	"
313		192	6	"	363		TB-27	C-6	"
314		193	7	"	364		TB-28	C-7	"
315		194	C44 Tie Rod Pos. 1	"	365		TB-29	C.B.Inner Surface D-1	"
316		195	2	"	366		TB-30	D-2	"
317		196	3	"	367		TB-31	D-3	"
318		197	4	"	368		TB-32	D-4	"
319		198	5	"	369		TB-33	D-5	"
320		199	6	"	370		TB-34	D-6	"
321		200	7	"	371		TB-35	D-7	"
322		201	D44 Tie Rod Pos. 1	"	372		TP- 1	Lower Pl.North High	"
323		202	2	"	373		TP- 2	Middle	"
324		203	3	"	374		TP- 3	Low	"
325		204	4	"	375		TP- 4	Lower Pl.South High	"
326		205	5	"	376		TP- 5	Middle	"
327		206	6	"	377		TP- 6	Low	"
328		207	7	"	378	Fluid Temp.	TP- 7	Lower Pl.Center Low	"
329		TC- 1	Channel Box A Outlet	"	379		TP- 8	Bottom	"
330		TC- 2	Channel Box A Inlet	"	380		TP- 9	L.P.Guide Tube High	"
331		TC- 3	Channel Box B Outlet	"	381		TP-11	Low	"
332		TC- 4	Channel Box B Inlet	"	382		TG- 1	Upper Tieplate A Up.1	"
333		TC- 5	Channel Box C Outlet	"	383		TG- 2	2	"
334		TC- 6	Channel Box C Inlet	"	384		TG- 3	3	"
335		TC- 7	Channel Box D Outlet	"	385		TG- 4	4	"
336		TC- 8	Channel Box D Inlet	"	386		TG- 5	5	"
337	Slab Temp.	TB- 1	C.B.Inner Surface A-1	"	387		TG- 6	6	"
338		TB- 2	A-2	"	388		TG- 7	7	"
339		TB- 3	A-3	"	389		TG- 8	8	"
340		TB- 4	A-4	"	390		TG- 9	9	"
341		TB- 5	A-5	"	391		TG-10	10	"
342		TB- 6	A-6	"	392		TG-11	Upper Tieplate A Low.1	"
343		TB- 7	A-7	"	393		TG-12	2	"
344		TB- 8	C.B.Inner Surface A-8	"	394		TG-13	3	"
345		TB- 9	A-9	"	395		TG-14	4	"
346		TB-10	A-10	"	396		TG-15	5	"
347		TB-11	A-11	"	397		TG-16	6	"
348		TB-12	A-12	"	398		TG-17	7	"
349		TB-13	A-13	"	399		TG-18	8	"
350		TB-14	A-14	"	400		TG-19	9	"

Table 3.1 (Continued)

CH. 401 ~ CH. 500

CH. NO.	Item	Symbol	Location	Range	CH. NO.	Item	Symbol	Location	Range
401	Fluid Temp.	TG-20	Upper Tieplate A Low.20	0 ~ 500 °C	451	Liquid Level	LL- 6	Lower Pl.North Bottom	ON - OFF
402	Liquid Level	LB- 1	C.B.Liquid Level A1-1	ON - OFF	452		LL- 7	Lower Pl.South Low	"
403		LB- 2	2	"	453		LL- 8	Bottom	"
404		LB- 3	3	"	454	Void	VF- 1	A55 Tie Rod Pos. 1	0 ~ 1.0
405		LB- 4	4	"	455		VF- 2	2	"
406		LB- 5	5	"	456		VF- 3	3	"
407		LB- 6	6	"	457		VF- 4	4	"
408		LB- 7	7	"	458		VF- 5	5	"
409		LB- 8	C.B.Liquid Level A2-1	"	459		VF- 6	6	"
410		LB- 9	2	"	460		VF- 7	7	"
411		LB-10	3	"	461		VF-15	C55 Tie Rod Pos. 1	"
412		LB-11	4	"	462		VF-16	2	"
413		LB-12	5	"	463		VF-17	3	"
414		LB-13	6	"	464		VF-18	4	"
415		LB-14	7	"	465		VF-19	5	"
416		LB-15	C.B.Liquid Level B-1	"	466		VF-20	6	"
417		LB-16	2	"	467		VF-21	7	"
418		LB-17	3	"	468		VE- 1	Lower Pl. North	"
419		LB-18	4	"	469		VE- 2	Center	"
420		LB-19	5	"	470		VE- 3	South	"
421		LB-20	6	"	471		VE- 4	Channel A Outlet	"
422		LB-21	7	"	472		VE- 5	"	"
423		LB-22	C.B.Liquid Level C-1	"	473		VE- 6	"	"
424		LB-23	2	"	474		VE- 7	Channel B Outlet	"
425		LB-24	3	"	475		VE- 8	"	"
426		LB-25	4	"	476		VE- 9	"	"
427		LB-26	5	"	477		VE-10	Channel C Outlet	"
428		LB-27	6	"	478		VE-11	"	"
429		LB-28	7	"	479		VE-12	"	"
430		LB-29	C.B.Liquid Level D-1	"	480		VE-13	Channel D Outlet	"
431		LB-30	2	"	481		VE-14	"	"
432		LB-31	3	"	482		VE-15	"	"
433		LB-32	4	"	483		VP- 1	Lower Plenum 1-1	"
434		LB-33	5	"	484		VP- 2	1-2	"
435		LB-34	6	"	485		VP- 3	2-1	"
436		LB-35	7	"	486		VP- 4	2-2	"
437		L - 1	Downcomer D 1	"	487	Density	DF- 1	JP-1,2 Outlet Beam 1	0 ~ 1000 kg/m ³
438		L - 2	D 2	"	488		DF- 2	Beam 2	"
439		L - 3	D 3	"	489		DF- 3	Beam 3	"
440		L - 4	D 4	"	490		DF- 4	JP-3,4 Outlet Beam 1	"
441		L - 5	D 5	"	491		DF- 5	Beam 2	"
442		L - 7	Downcomer B 2	"	492		DF- 6	Beam 3	"
443		L - 8	B 3	"	493		DF- 7	Break A Beam 1	"
444		L - 9	B 4	"	494		DF- 8	Beam 2	"
445		L - 10	B 5	"	495		DF- 9	Break B Beam 1	"
446		LI- 1	Lower Pl.Center High	"	496		DF-10	Beam 2	"
447		LI- 2	Middle 1	"	497	Moment Flux	M - 1	JP-1,2 Outlet Spool	0 ~ 1.5x10 ⁵ kg/m ²
448		LI- 3	Middle 2	"	498		M - 2	JP-3,4 Outlet Spool	"
449		LI- 4	Low	"	499		M - 3	Break A Spool Piece	"
450		LI- 5	Lower Pl.North Low	"	500		M - 4	Break B Spool Piece	"

Table 3.1 (Continued)

Ch. 501 ~ Ch. 600

Ch. NO.	Item	Symbol	Location	Range	Ch. NO.	Item	Symbol	Location	Range
501	Signal	S - 4	Cooling Water Valve A	Open ~ Close	551	Slab Temp.	TS-13	Filler Block C Pos. 1	0 ~ 400 °C
502		S - 5	B	"	552		TS-14	2	"
503		S - 6	HPCS Valve	"	553		TS-15	3	"
504		S - 7	LPCS Valve	"	554		TS-16	4	"
505		S - 8	LPCI Valve	"	555		TS-17	5	"
506		S - 9	Feed W. Control Limit	"	556		TS-18	6	"
507		S -13	MRP-1 Power Off	ON - OFF	557		TS-19	Filler Block A Pos. 1	"
508		S -14	MRP-2 Power Off	"	558		TS-20	2	"
509		RD- 1	MRP-1	Pos. - Neg.	559		TS-21	3	"
510		RD- 2	MRP-2	"	560		TS-22	4	"
511	Velocity	FE- 1	Channel A Outlet	0 ~ 3.0 m/s	561		TS-23	5	"
512		FE- 2	Channel B Outlet	"	562		TS-24	6	"
513		FE- 3	Channel C Outlet	"	563		TS-25	JP-1 Diffuser Wall	"
514		FE- 4	Channel D Outlet	"	564		TS-26	JP-2 Diffuser Wall	"
515	Flow Direc.	FD- 1	Channel A Outlet	Pos. - Neg.	565		TS-27	JP-3 Diffuser Wall	"
516		FD- 2	Channel B Outlet	"	566		TS-28	JP-4 Diffuser Wall	"
517		FD- 3	Channel C Outlet	"	567		TS-29	PV Wall Inside 1-1	"
518		FD- 4	Channel D Outlet	"	568		TS-30	PV Inner Surface 1-2	"
519	Press.	P -20	Break Nozzle A Pos. 1	0 ~ 100 kg/cm ²	569		TS-31	1-3	"
520		P -21	2	"	570		TS-32	PV Wall Inside 2	"
521		P -22	3	"	571		TS-33	3	"
522		P -23	4	"	572		TS-34	4	"
523		P -24	5	"	573		TS-35	L.P. Inner Surface	"
524		P -25	Break Nozzle B Pos. 1	"	574		TS-36	L.P. Wall Inside	"
525		P -26	2	"	575	Fluid Temp.	T -23	Steam Line Below Valve	"
526		P -27	3	"	576	Liquid Level	L - 6	Upper Plenum	ON - OFF
527		P -28	4	"	577	Vol. Flow	F - 8	HPCS (Lower Plenum)	0 ~ 150l/min
528		P -29	5	"	578		F -10	LPCS (Lower Plenum)	"
529	Fluid Temp.	T -27	Break Nozzle A Pos. 1	0 ~ 400 °C	579		F -12	LPCI (Lower Plenum)	0 ~ 500l/min
530		T -28	2	"	580		F -13	LPCI (MRP-2 Suction)	0 ~ 250l/min
531		T -29	3	"	581		F -14	LPCI (MRP-1 Suction)	"
532		T -30	4	"	582		F -16	Steady Feed Water	0 ~ 600l/min
533		T -31	5	"	583	Void	VF- 8	B55 Tie Rod Pos. 1	ON - OFF
534		T -32	Break Nozzle B Pos. 1	"	584		VF- 9	2	"
535		T -33	2	"	585		VF-10	3	"
536		T -34	3	"	586		VF-11	4	"
537		T -35	4	"	587		VF-12	5	"
538		T -36	5	"	588		VF-13	6	"
539	Slab Temp.	TS- 1	Core Barrel C Pos. 1	"	589		VF-14	7	"
540		TS- 2	2	"	590		VF-22	D55 Tie Rod Pos. 1	"
541		TS- 3	3	"	591		VF-23	2	"
542		TS- 4	4	"	592		VF-24	3	"
543		TS- 5	5	"	593		VF-25	4	"
544		TS- 6	6	"	594		VF-26	5	"
545		TS- 7	Core Barrel A Pos. 1	"	595		VF-27	6	"
546		TS- 8	2	"	596		VF-28	7	"
547		TS- 9	3	"	597				
548		TS-10	4	"	598				
549		TS-11	5	"	599				
550		TS-12	6	"	600				

Table 3.2 Core Instrumentation List

Item	Pos.	Core Outlet	Pos.1	Pos.2	Pos.3	Pos.4	Pos.5	Pos.6	Pos.7	Core Inlet
	Rod NO.									
		3660	3417	3114.5	2879.5	2527	2174.5	1939.5	1637	1454
Surface Temp.	A11		TF 1	TF 2	TF 3	TF 4	TF 5	TF 6	TF 7	
	A12		TF 8	TF 9	TF 10	TF 11	TF 12	TF 13	TF 14	
	A13		TF 15	TF 16	TF 17	TF 18	TF 19	TF 20	TF 21	
	A14		TF 22	TF 23	TF 24	TF 25	TF 26	TF 27	TF 28	
	A15		TF 29			TF 30				
	A17		TF 31			TF 32				
	A22		TF 33	TF 34	TF 35	TF 36	TF 37	TF 38	TF 39	
	A23		TF 40	TF 41	TF 42	TF 43	TF 44	TF 45	TF 46	
	A24		TF 47	TF 48	TF 49	TF 50	TF 51	TF 52	TF 53	
	A26		TF 54			TF 55				
	A28		TF 56			TF 57				
	A31		TF 58			TF 59				
	A33		TF 60	TF 61	TF 62	TF 63	TF 64	TF 65	TF 66	
	A34		TF 67	TF 68	TF 69	TF 70	TF 71	TF 72	TF 73	
	A35		TF 74			TF 75				
	A37		TF 76			TF 77				
	A42		TF 78			TF 79				
Fluid Temp.	A44	TC 1	TF180	TF181	TF182	TF183	TF184	TF185	TF186	TC 2
Surface Temp.	A45		TF 80			TF 81				
	A46		TF 82			TF 83				
	A48		TF 84			TF 85				
	A51		TF 86			TF 87				
	A53		TF 88			TF 89				
	A54		TF 90							
	A57		TF 91			TF 92				
	A62		TF 93			TF 94				
	A64		TF 95			TF 96				
	A66		TF 97			TF 98				
	A68		TF 99			TF100				
	A71		TF101			TF102				
	A73		TF103			TF104				
	A75		TF105			TF106				
	A77		TF107			TF108				

Table 3.2 (Continued)

Item	Pos.	Core Outlet	Pos. 1	Pos. 2	Pos. 3	Pos. 4	Pos. 5	Pos. 6	Pos. 7	Core Inlet
	Rod NO.									
		3660	3417	3114.5	2879.5	2527	2174.5	1939.5	1637	1454
Surface Temp.	A82		TF109			TF110				
	A84		TF111			TF112				
	A86		TF113			TF114				
	A88		TF115			TF116				
	B11					TF117				
	B13					TF118				
	B15		TF119	TF120	TF121	TF122	TF123	TF124	TF125	
	B31					TF126				
	B33					TF127				
	B35					TF128				
Fluid Temp.	B44	TC 3	TF187	TF188	TF189	TF190	TF191	TF192	TF193	TC 4
Surface Temp.	B51					TF129				
	B53					TF130				
	B85		TF131	TF132	TF133	TF134	TF135	TF136	TF137	
	C11					TF138				
	C13					TF139				
	C15					TF140				
	C31					TF141				
	C33		TF142	TF143	TF144	TF145	TF146	TF147	TF148	
C35					TF149					
Fluid Temp.	C44	TC 5	TF194	TF195	TF196	TF197	TF198	TF199	TF200	TC 6
Surface Temp.	C51					TF150				
	C53					TF151				
	C77		TF152	TF153	TF154	TF155	TF156	TF157	TF158	
	D11					TF159				
	D13					TF160				
	D27		TF161	TF162	TF163	TF164	TF165	TF166	TF167	
	D31					TF168				
	D33					TF169				
D35					TF170					
Fluid Temp.	D44	TC 7	TF201	TF202	TF203	TF204	TF205	TF206	TF207	TC 8
Surface Temp.	D51					TF171				
	D53					TF172				
	D88		TF173	TF174	TF175	TF176	TF177	TF178	TF179	

Table 3.2 (Continued)

Item	Pos.	Core Outlet	Pos.1	Pos.2	Pos.3	Pos.4	Pos.5	Pos.6	Pos.7	Core Inlet
	Rod NO.									
		3660	3417	3114.5	2879.5	2527	2174.5	1939.5	1673	1454
Void	A55		VF 1	VF 2	VF 3	VF 4	VF 5	VF 6	VF 7	
	B55		VF 8	VF 9	VF 10	VF 11	VF 12	VF 13	VF 14	
	C55		VF 15	VF 16	VF 17	VF 18	VF 19	VF 20	VF 21	
	D55		VF 22	VF 23	VF 24	VF 25	VF 26	VF 27	VF 28	
Channel Box Surface Temp.	A1*		TB 1	TB 2	TB 3	TB 4	TB 5	TB 6	TB 7	
	A2*		TB 8	TB 9	TB 10	TB 11	TB 12	TB 13	TB 14	
	B*		TB 15	TB 16	TB 17	TB 18	TB 19	TB 20	TB 21	
	C*		TB 22	TB 23	TB 24	TB 25	TB 26	TB 27	TB 28	
	D*		TB 29	TB 30	TB 31	TB 32	TB 33	TB 34	TB 35	
Liquid Level in the Channel Box	A1*		LB 1	LB 2	LB 3	LB 4	LB 5	LB 6	LB 7	
	A2*		LB 8	LB 9	LB 10	LB 11	LB 12	LB 13	LB 14	
	B*		LB 15	LB 16	LB 17	LB 18	LB 19	LB 20	LB 21	
	C*		LB 22	LB 23	LB 24	LB 25	LB 26	LB 27	LB 28	
	D*		LB 29	LB 30	LB 31	LB 32	LB 33	LB 34	LB 35	

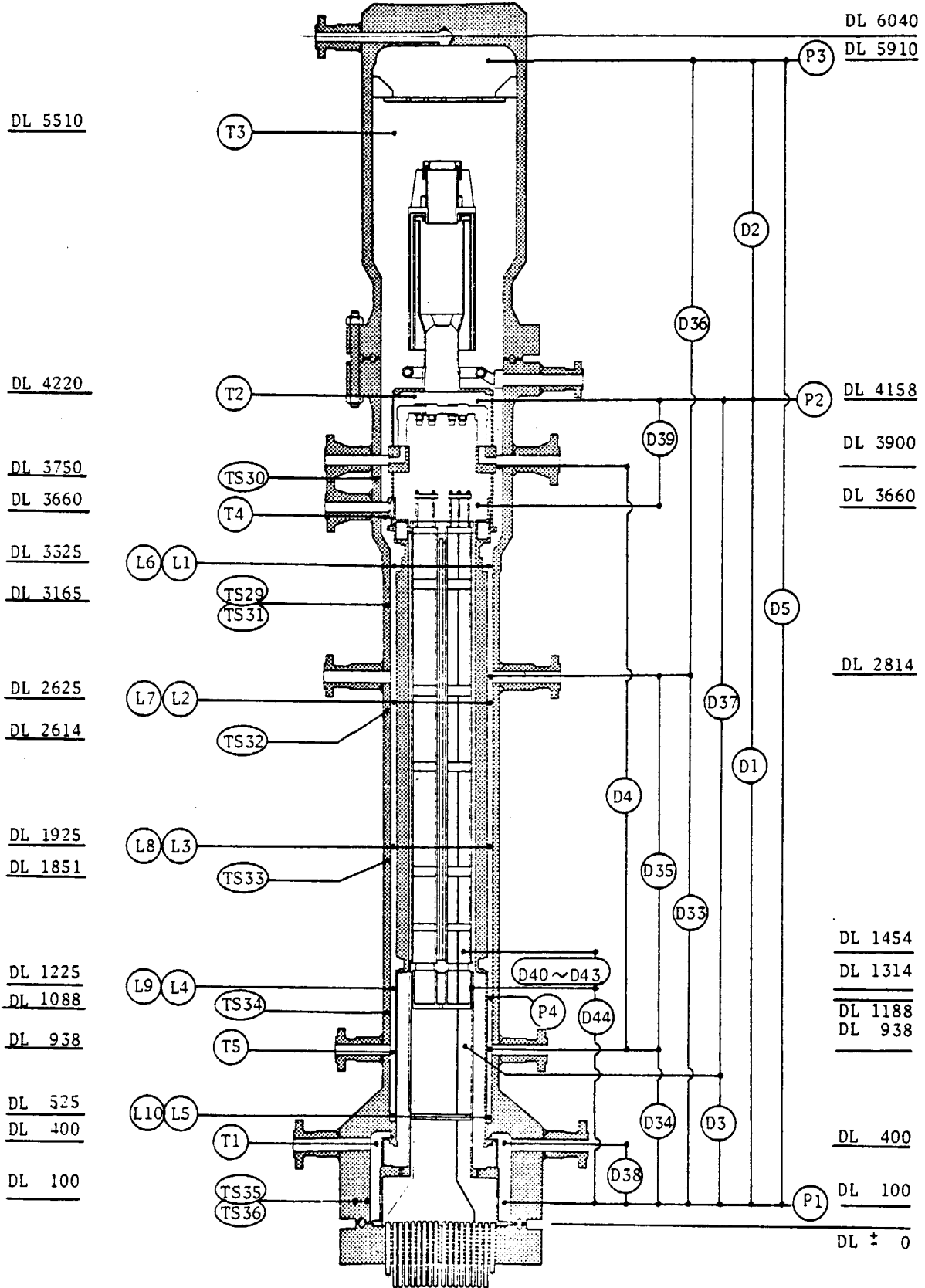


Fig. 3.1 Instrumentation in the Pressure Vessel

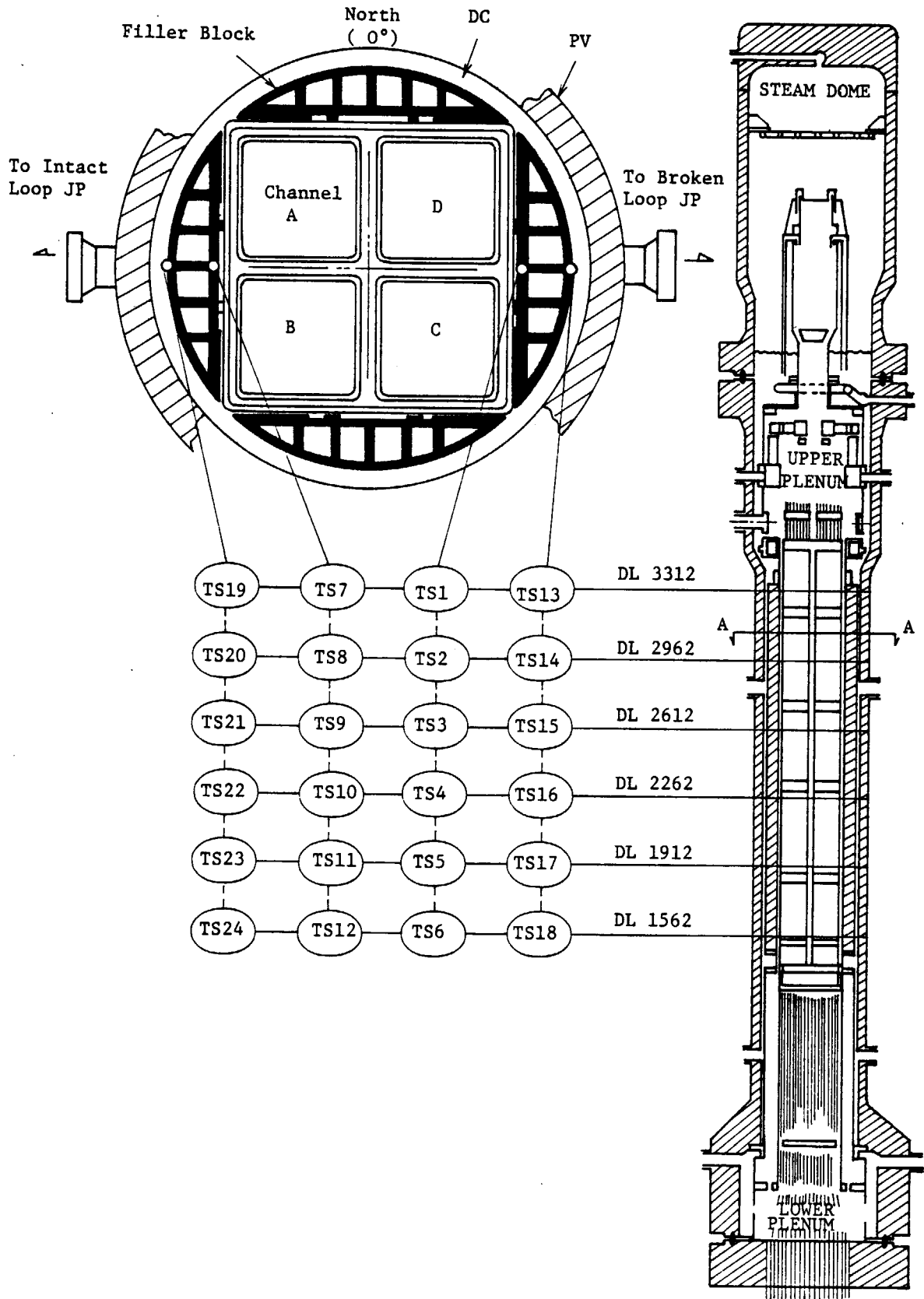


Fig. 3.2 Location of Thermocouples in Filler Block

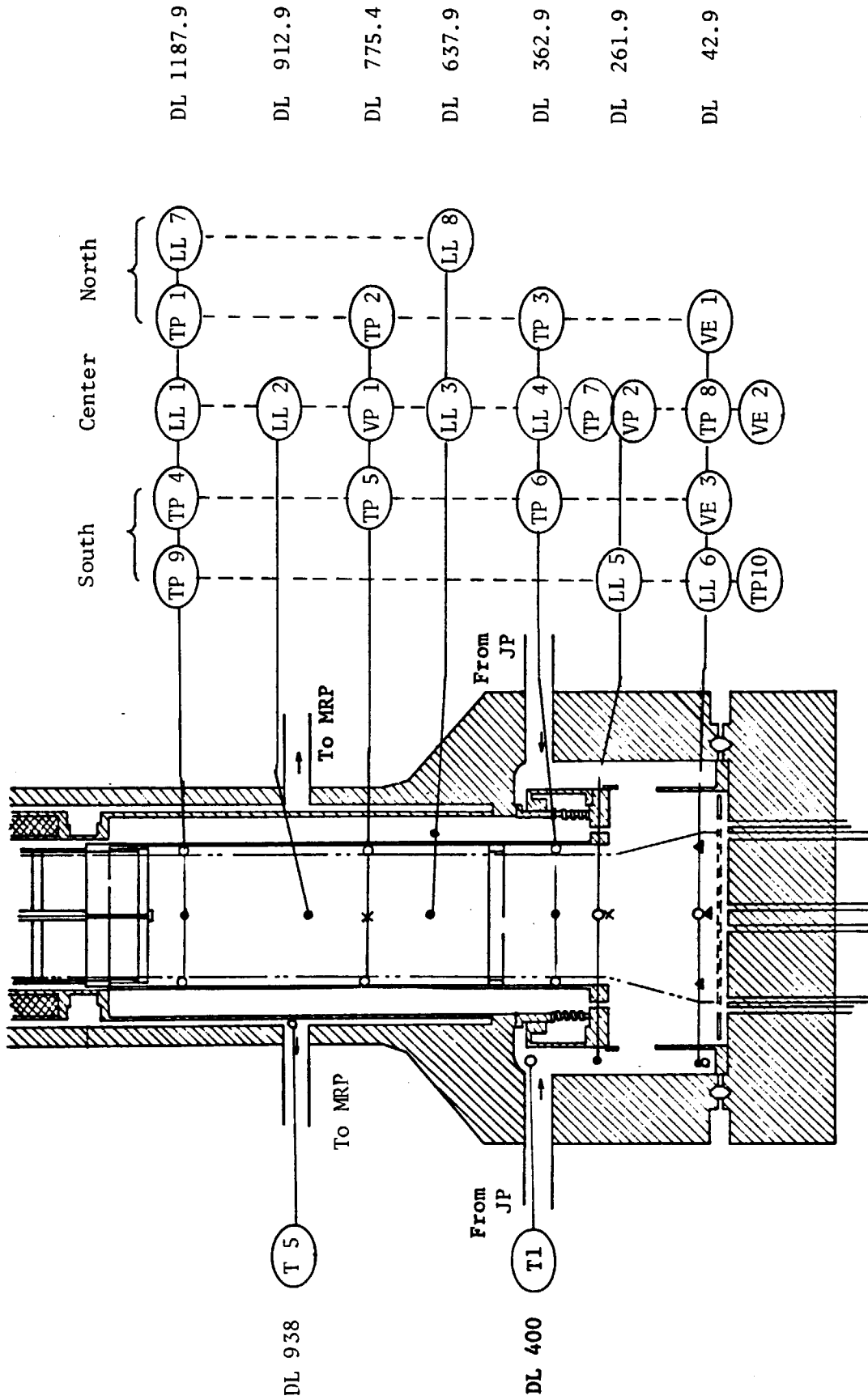
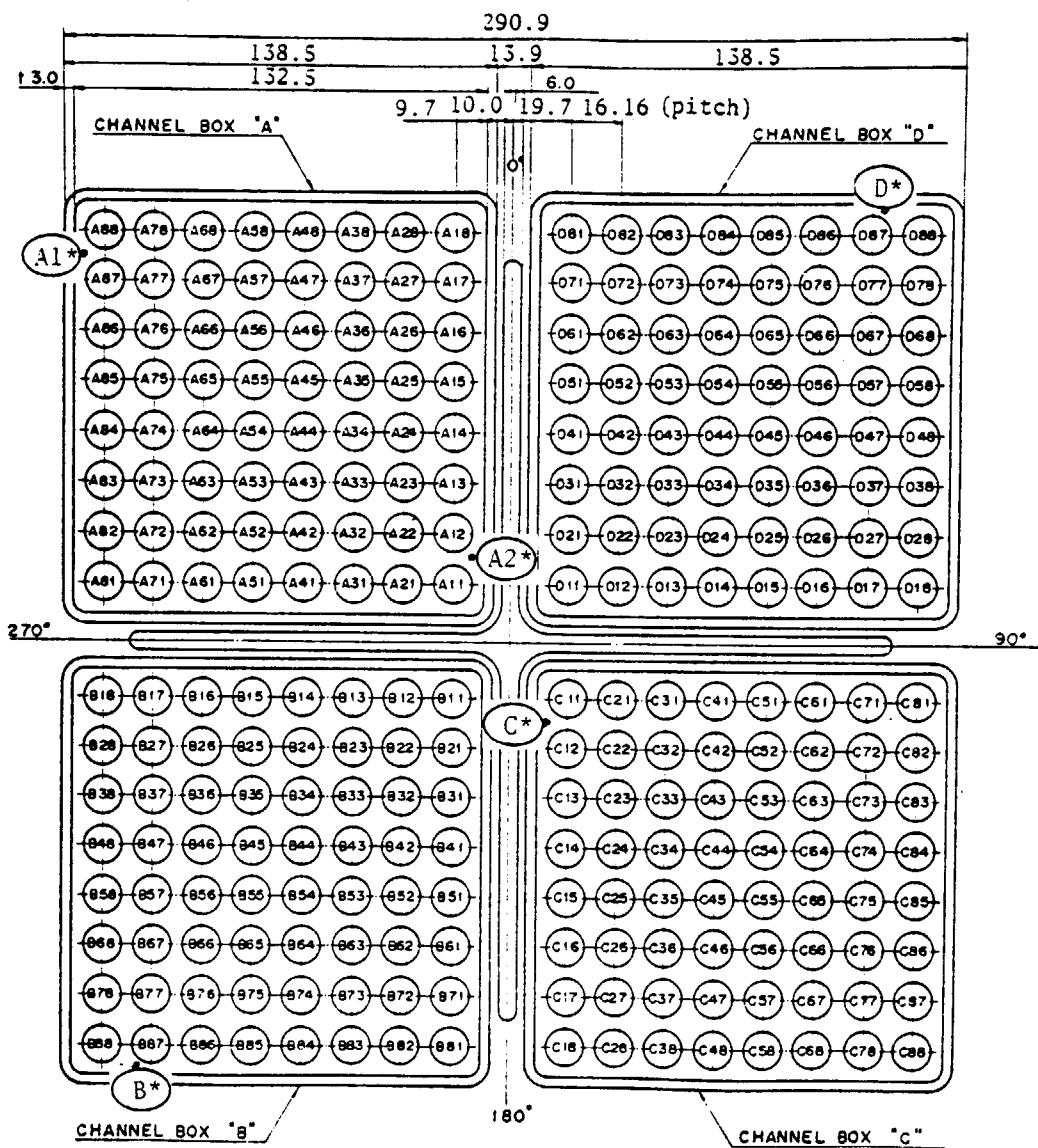
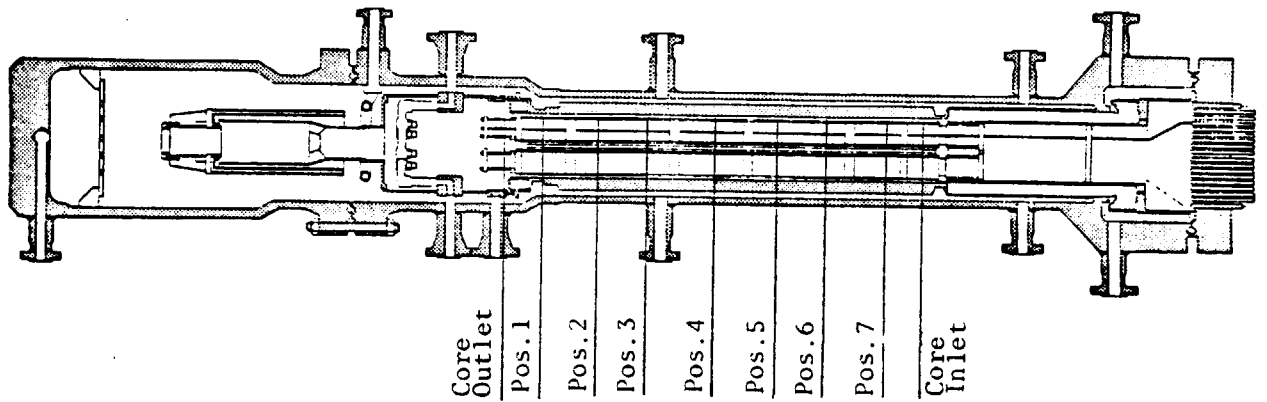


Fig. 3.3 Lower Plenum Instrumentations



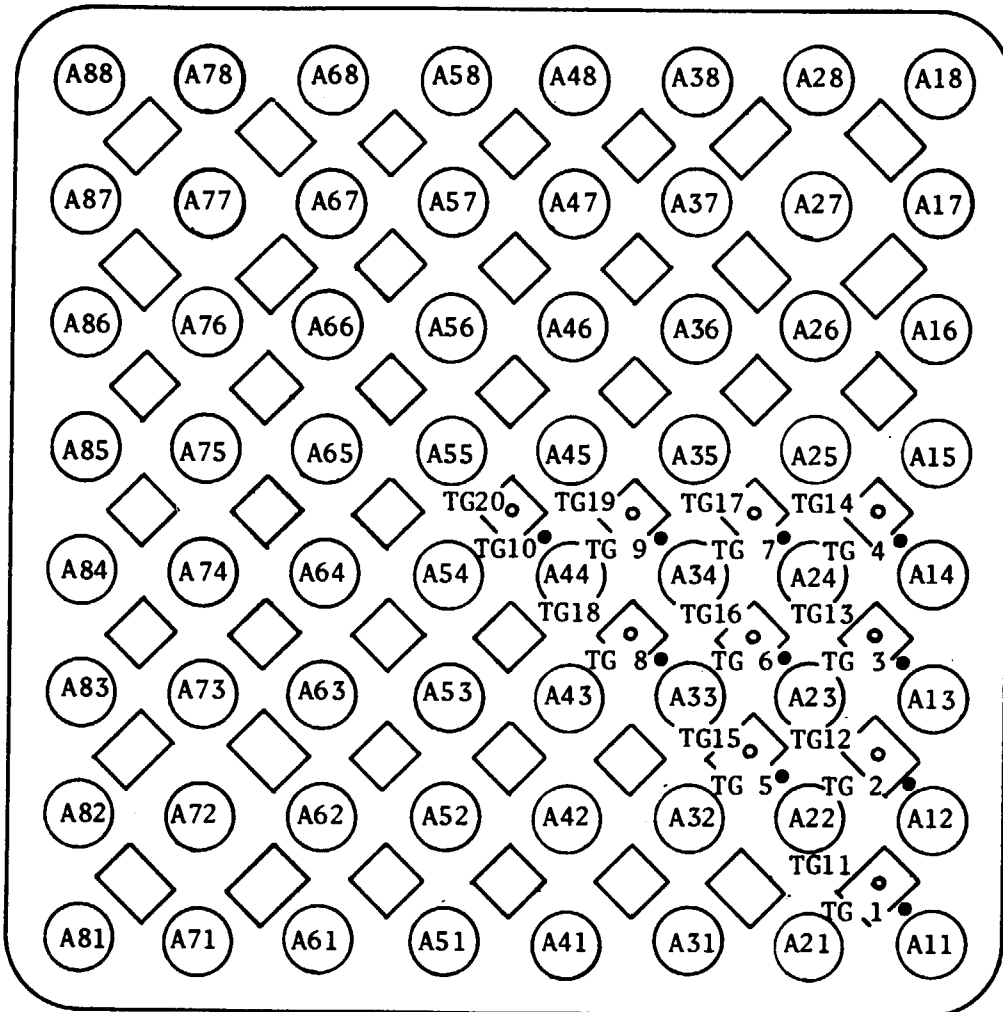
Peaking Factor ; A = 1.4, B = 1.0, C = 1.0, D = 1.0

Heater rod O.D. is 12.27 mm.

A44, A55, B44, B55, C44, C55, D44 and D55 are water rod simulators.

The O.D. is 15.01 mm.

Fig. 3.4 Core Instrumentations (cf. Table 3.1)



Thermocouples ;

- TG 1~TG10 : 3 mm above the UTP* upper surface
- TG11~TG20 : In the holes at the same level as the UTP* lower surface

* UTP : Upper Tieplate

Fig. 3.5 Upper Tie Plate Instrumentations

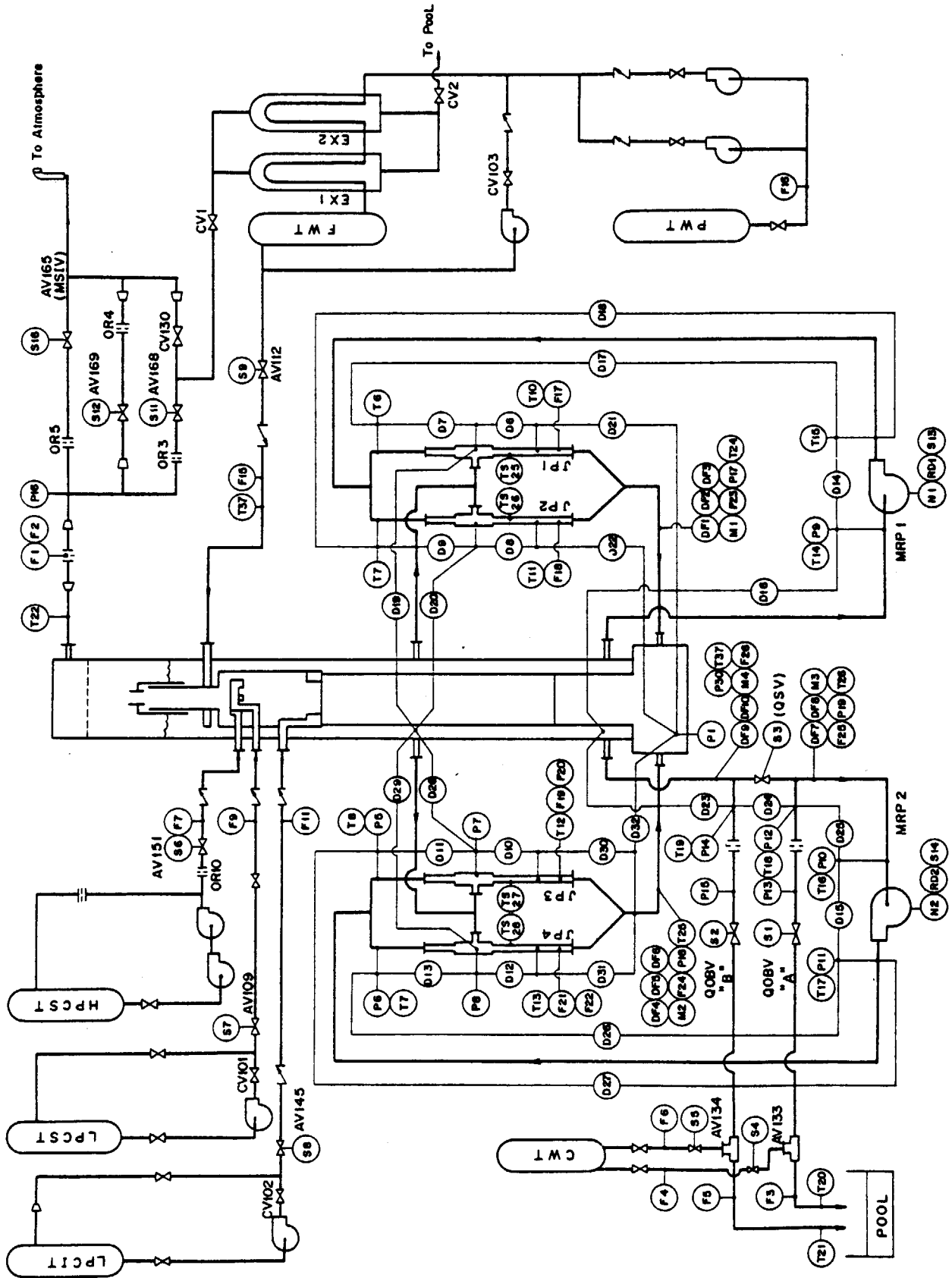


Fig. 3.6 Instrumentations of Recirculation Loops

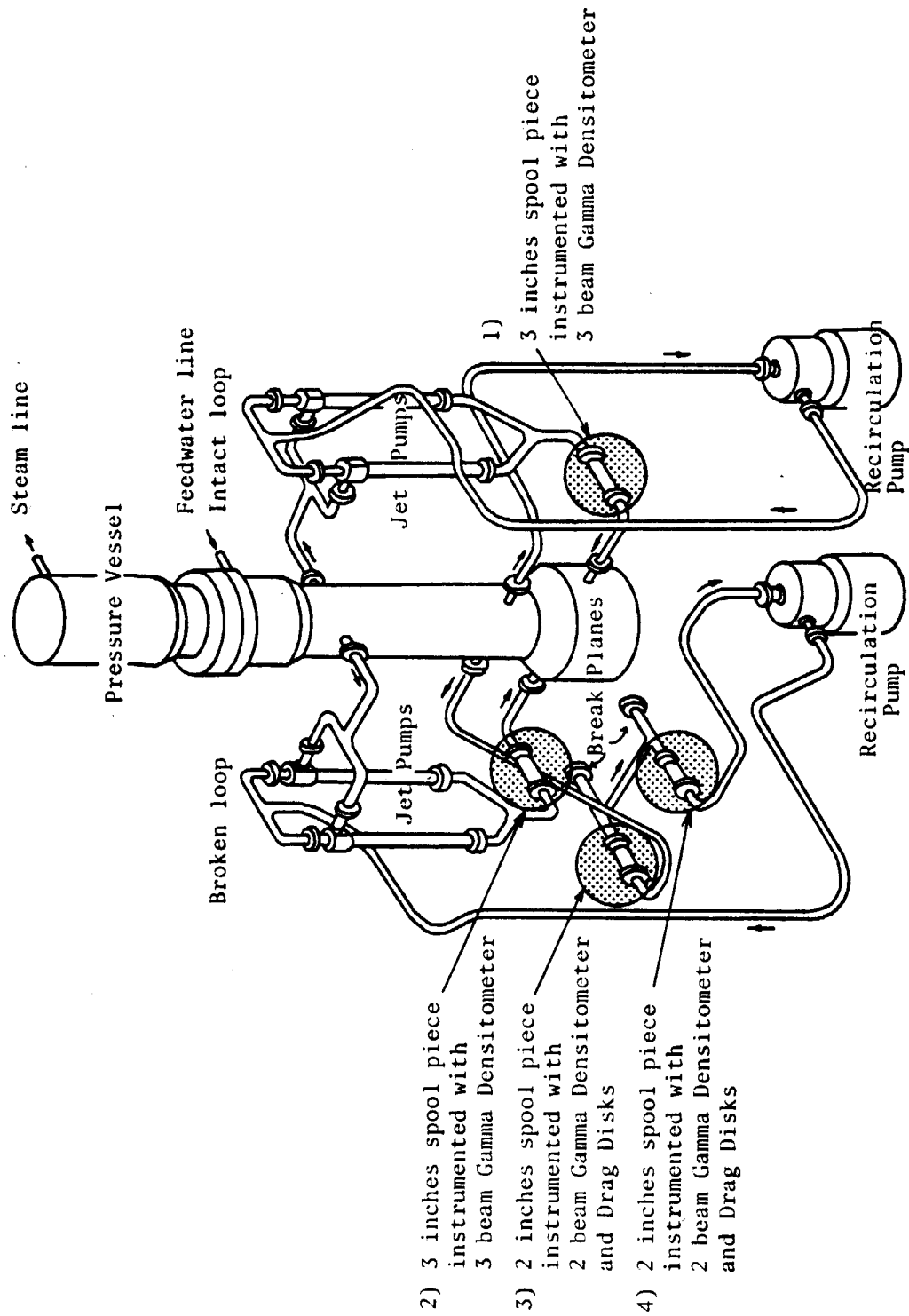


Fig. 3.7 Location of Two-phase Flow Measurement Spool Pieces