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SAFETY DEMONSTRATION TEST (S1C-2/S2C-1) PLAN USING THE HTTR (CONTRACT RESEARCH)

August 2003

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Safety Demonstration Test (S1C-2/S2C-1) Plan using the HTTR
(Contract Research)

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Safety demonstration tests using the HTTR are now underway in order to verify the inherent safety features and to improve the safety design and evaluation technologies for HTGRs, as well as to contribute to research and development for the VHTR, which is one of the Generation IV reactors. The first phase of the safety demonstration tests includes reactivity insertion tests by means of control-rod withdrawal and coolant flow reduction tests by tripping of gas circulators. In the second phase, accident simulation tests will be conducted.

This paper describes the coolant flow reduction tests planned in the fiscal year 2003 with detailed test method, procedure and results of pre-test analysis. From the analytical results, it was found that the negative reactivity feedback of the core brings the reactor power safely to a stable level without a reactor scram in the case of a rapid decrease of the coolant flow rate after tripping of gas circulators.

Keywords: Safety Demonstration, Inherent Safety, Gas Circulator Trip, Accident Simulation, Safety Design, Safety Evaluation, Generation IV, HTGR, VHTR, HTTR

Present Study is entrusted from Ministry of Education, Culture, Sports, Science and Technology of Japan.

HTTR 安全性実証試験（S1C-2/S2C-1）の試験計画
（受託調査）

日本原子力研究所大洗研究所高温工学試験研究炉開発部
坂場　成昭・中川　繁昭・高田　英治・橘　幸男・齋藤　賢司
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（2003 年 7 月 18 日受理）

高温ガス炉固有の安全性を定量的に実証し、また第 4 世代原子炉（Generation IV）の候補のひとつである VHTR の研究開発に資するため、HTTR（高温工学試験研究炉）を用いた安全性実証試験が実施されている。安全性実証試験のうち第 1 期の試験では、異常な過渡変化に相当するものとして、制御棒の引抜き試験および 1 次冷却材流量の低下を模擬した試験を実施し、第 2 期の試験では、事故を模擬した試験を重点的に実施する計画である。

本報は、2003 年度に計画している循環機停止試験の試験内容、試験条件、事前解析結果等について述べたものである。事前解析の結果、循環機停止後、負の反応度フィードバック特性により原子炉出力が低下し、原子炉が安定に所定の状態に落ち着くことが明らかとなった。

本報告書は、文部科学省からの受託事業「高温ガス炉固有の安全性の定量的実証」の成果である。
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1. Introduction

Safety demonstration tests using the HTTR[1] (High Temperature Engineering Test Reactor) are now underway in order to verify the inherent safety features and to improve the safety design and evaluation technologies for HTGRs (High Temperature Gas-cooled Reactors). The HTTR, which is the first HTGR in Japan with thermal power of 30MW and 950°C maximum reactor outlet coolant temperature, was constructed at the Oarai Research Establishment of JAERI (Japan Atomic Energy Research Institute) for the purpose of establishing and improving technologies of HTGRs as well as nuclear heat utilisation. The HTTR attained its first criticality in November 1998. The rise-to-power tests were started in September 1999 and at the fourth phase of the tests, the HTTR reached its full power of 30MW with reactor outlet coolant temperature of 850°C in December 2001[2][3]. In March 2002, JAERI received a certificate of the pre-operation test, which is an operation permit of the HTTR at the rated operation mode (operation at a reactor outlet coolant temperature of 850°C), from the government. In the fiscal year 2003 it is planned to operate in high temperature operation mode[4] with a reactor outlet coolant temperature of 950°C.

In safety demonstration tests using the HTTR, anticipated operational occurrences (AOOs) and accidents will be simulated mostly without scrams, though most of the postulated AOOs and accidents for the HTTR safety evaluation initiate scrams. The safety demonstration tests are conducted to demonstrate inherent safety features of the HTGRs as well as to obtain the core and plant transient data for validation of safety analysis codes and for establishment of safety design and evaluation technologies of the HTGRs.

This paper describes the plan of coolant flow reduction tests by tripping the gas circulators (one and two out of three gas circulators) planned in the fiscal year 2003 with detailed test method, test conditions, and pre-test analysis. Also the measurement locations are shown in the Appendix. In these tests, one and two out of three gas circulators will be tripped with the reactor power at 60% and 30%, respectively. The previous coolant flow reduction test by tripping one gas circulator[5] was conducted with the reactor power at 30% in March 2003.

2. Summary of HTTR and Program of Overall Safety Demonstration Test

2.1 Outline of HTTR

The main specification of the HTTR is shown in Table 2.1 and the vertical cross section of the HTTR reactor is shown in Fig. 2.1.

The reactor consists of a reactor pressure vessel, fuel elements, replaceable and permanent reflector blocks, core restraint mechanism, control-rods, etc. Thirty columns of fuel blocks and seven columns of control-rod guide blocks form the reactor core, called the fuel region, which is surrounded by replaceable reflector blocks and large-scale permanent reflector blocks. The fuel element of the HTTR is a pin-in-block type. Enrichment of U-235 is 3 to 10 (average 6) wt%. Sixteen pairs of control-rods in the fuel and replaceable reflector regions of the core control reactivity of the HTTR. A control-rod drive mechanism drives each pair of control-rods using an AC motor. At a reactor scram, electromagnetic clutches of the control-rod drive mechanisms are separated, and the control-rods fall into holes in the control-rod guide blocks by the force of gravity at a constant speed, shutting down the reactor safely.

As shown in Fig. 2.2, the cooling system of the HTTR consists of a main cooling system operating at normal operation; and an auxiliary cooling system and a vessel cooling system, the engineered safety features, operating after a reactor scram to remove residual heat from the core. The main cooling system, which consists of a primary cooling system, a secondary helium cooling system, and a pressurised water cooling system, removes heat generated in the core and dissipates it to the atmosphere by a pressurised water air cooler. The primary cooling system consists of an intermediate heat exchanger (IHX), a primary pressurised water cooler (PPWC), a primary concentric hot gas duct, etc. Primary coolant of helium gas from the reactor at 950°C maximum flows inside the inner pipe of the primary concentric hot gas duct to the IHX and PPWC. The primary helium is cooled to about 400°C by the IHX and PPWC and returns to the reactor flowing through the annulus between the inner and outer pipes of the primary concentric hot gas duct. The HTTR has two operation modes. One is the single loaded operation mode using the PPWC for the primary heat exchange, and the other is the parallel loaded operation mode using the PPWC and IHX. In single loaded operation mode the PPWC removes 30MW of heat and in parallel loaded operation mode the PPWC and IHX remove 20MW and 10MW, respectively. The auxiliary cooling system, consisting of an auxiliary helium cooling system, an auxiliary water cooling system, a concentric hot gas duct, etc. is in stand-by during normal operation and starts up to remove residual heat after a reactor scram. The vessel cooling system cools the biological concrete shield surrounding the reactor pressure vessel at normal operation, and removes heat from the core by natural convection and radiation outside the reactor pressure vessel under 'accident without forced cooling' conditions such as a rupture of the primary concentric hot gas duct, when neither the main cooling system nor the auxiliary cooling system can cool the core effectively.

The reactor power control device consists of control systems for the reactor power and reactor-outlet coolant temperature. These control systems are cascade-connected: the latter control system ranks higher to give demand to the reactor power control system. The signals from each channel of the power-range monitoring system are transferred to three controllers using microprocessors. In the event of a deviation between the process-value and set-value, a pair of control-rods is inserted or withdrawn at the speed from 1 to 10 mm/s according to the deviation. The relative position of 13 pairs of control-rods, except for three pairs of control-rods used only for a scram, are controlled within 20 mm of one another by the control-rod pattern interlock to prevent any abnormal power distribution. The plant control device controls plant parameters such as the coolant temperature of the reactor inlet, flow rate of the primary coolant, pressure of the primary coolant, and differential pressure between the primary cooling system and pressurised water cooling system. The schematic diagram of the plant control device is shown in Fig. 2.3.

2.2 Safety Demonstration Test Program

The safety demonstration tests are divided into two phases, the first phase (phase I) and second phase (phase II). In the phase I safety demonstration tests, AOO simulation tests without a reactor scram are conducted. The phase I tests consist of reactivity insertion tests by means of a pair of control-rods' withdrawal and coolant flow reduction tests by tripping of gas circulators. In the coolant flow reduction tests, primary coolant flow rate is reduced to 67% or 33% by running down one or two out of three gas circulators without a reactor scram. The phase I tests have already been licenced and are planned to be conducted from the fiscal year 2002 to 2005. Phase I test items are summarised in Table 2.2. The phase II tests, which are more severe than the phase I tests, will be performed after confirming safety features of the HTTR by the phase I tests and obtaining new licences. The phase II tests include reactivity insertion test (larger than the phase I test), loss of forced cooling test by trip of all gas circulators, loss of heat removal test by stop of secondary cooling system, all blackout test by stopping of the vessel cooling system, and depressurisation test [6]. The measurement locations in the safety demonstration tests are shown in the Appendix.

The reactivity insertion test by control-rod withdrawal will demonstrate that in the case of a rapid increase of the reactor power, the negative reactivity feedback effect of the core brings the reactor power safely to a stable level without operating a reactor power control system, and the fuel temperature transient is slow. The Coolant flow reduction tests by tripping gas circulators will demonstrate as follows:

(a) The negative reactivity feedback effect of the core brings the reactor power safely to a stable level without a reactor scram, and

(b) The temperature transient of the fuel is slow in the case of a rapid decrease of the coolant flow rate.

Obtained test data will be utilised for development and validation of codes for the safety evaluation of HTGRs.

In the loss of forced cooling test, all the three gas circulators will be run down without a reactor scram, and loss of forced cooling will be simulated. In the all blackout test, the vessel cooling system, the engineered safety feature having two independent systems, will be shut down in addition to the stopping of all three gas circulators. This test simulates an accident that all the cooling systems are run down without a reactor scram. In the depressurisation test, primary coolant pressure will be reduced by removing primary coolant of helium gas to its storage tanks in addition to the stop of all the three gas circulators simulating a loss of coolant accident.

Table 2.1 Major specification of HTTR

Item	Specification
Thermal power	30 MW
Coolant	Helium gas
Reactor outlet coolant temperature	850 °C (Rated operation mode) 950 °C (High temperature test operation mode)
Reactor inlet coolant temperature	395 °C
Primary coolant pressure	4.0 MPa
Primary coolant flow rate	12.4 kg/s (Rated operation mode) 10.2 kg/s (High temperature test operation mode)
Core structures	Graphite
Core height	2.9 m
Core diameter	2.3 m
Power density	2.5 MW/m^3
Fuel	Low enriched UO_2
Enrichment	3～10 wt% (avg. 6 wt%)
Fuel element type	Prismatic block
Pressure vessel	Steel (2·1/4Cr – 1Mo)
Number of main cooling loop	1

Table 2.2 Items of phase I safety demonstration test

Test item	Test conditions	Data to be obtained
Reactivity insertion test - Control-rod withdrawal test	• Rated operation mode • Single loaded operation mode • Reactor power : 30%～80% • Central pair of control-rods are withdrawn • Control-rods withdrawal rate : 1 or 5 mm/s • Control-rods withdrawal distance : 50mm (max.) • Control-rods' positions will be maintained except the operating one.	Transient data • Reactor power • Reactivity • Primary coolant temperatures • Temperatures of reactor internals, etc.
Coolant flow reduction test - Partial loss of coolant flow test	• Rated operation mode • Single loaded operation mode • Reactor power : 30%～100% • Parameters : change of primary coolant flow rate and rate of change • All of the control systems are operating.	Transient data • Reactor power • Reactivity • Primary coolant temperatures • Primary coolant flow rate, etc.
Coolant flow reduction test - Gas circulators trip test	• Rated operation mode • Single loaded operation mode • Reactor power : 30%～100% • Gas circulators to be stopped : one or two out of three at the primary pressurised water cooler • Each control-rod power supply is intercepted.	Transient data • Reactor power • Reactivity • Primary coolant temperatures • Primary coolant flow rate • Temperature of reactor internals, reactor pressure vessel, etc.

Rated operation mode: Operation at reactor outlet temperature of 850°C

Single loaded operation mode: Operation using primary pressurised water cooler for primary heat exchange

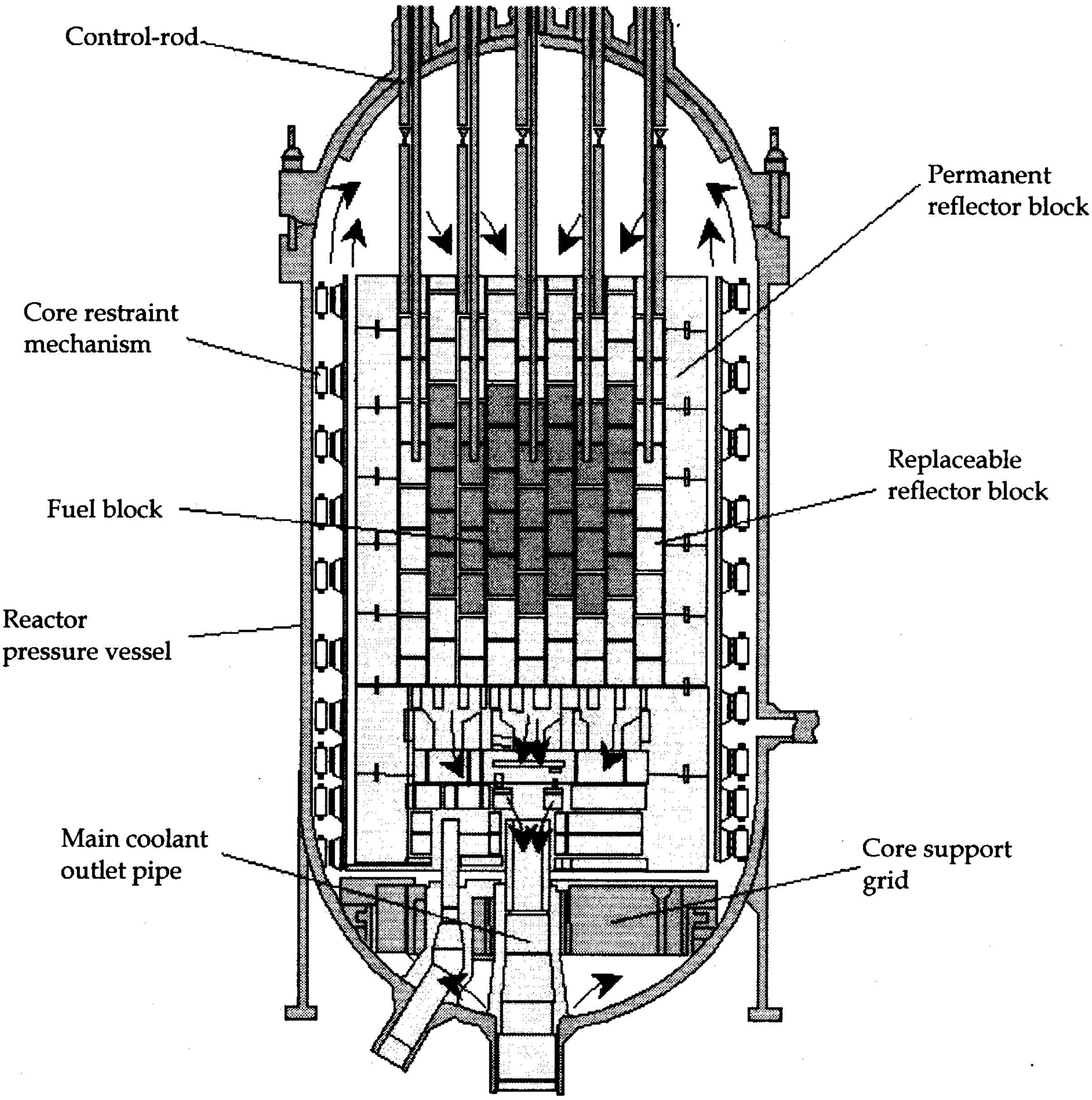

Fig. 2.1 Vertical cross section of HTTR reactor

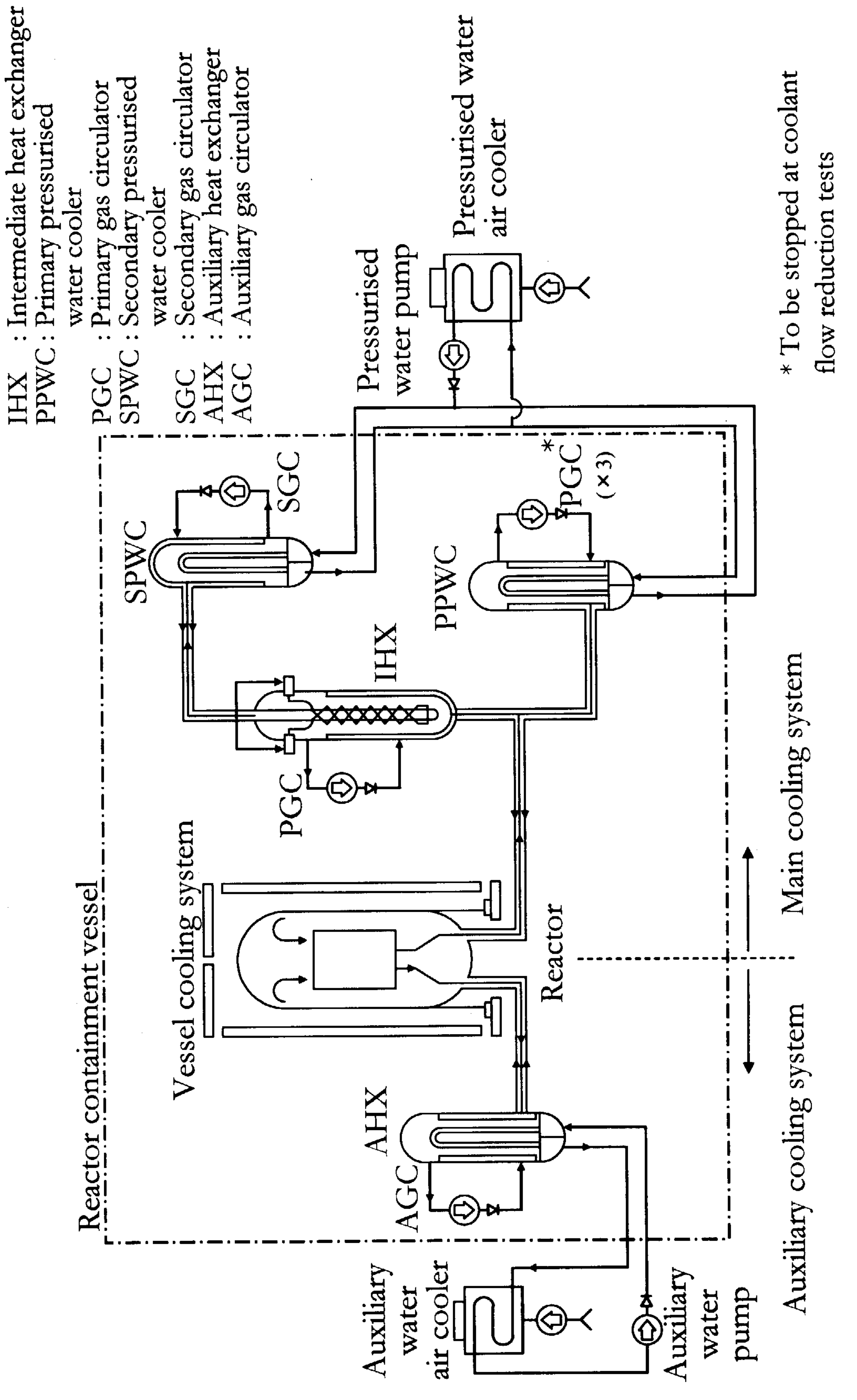

Fig.2.2 Schematic diagram of reactor cooling systems consisting main cooling system, auxiliary cooling system and vessel cooling system

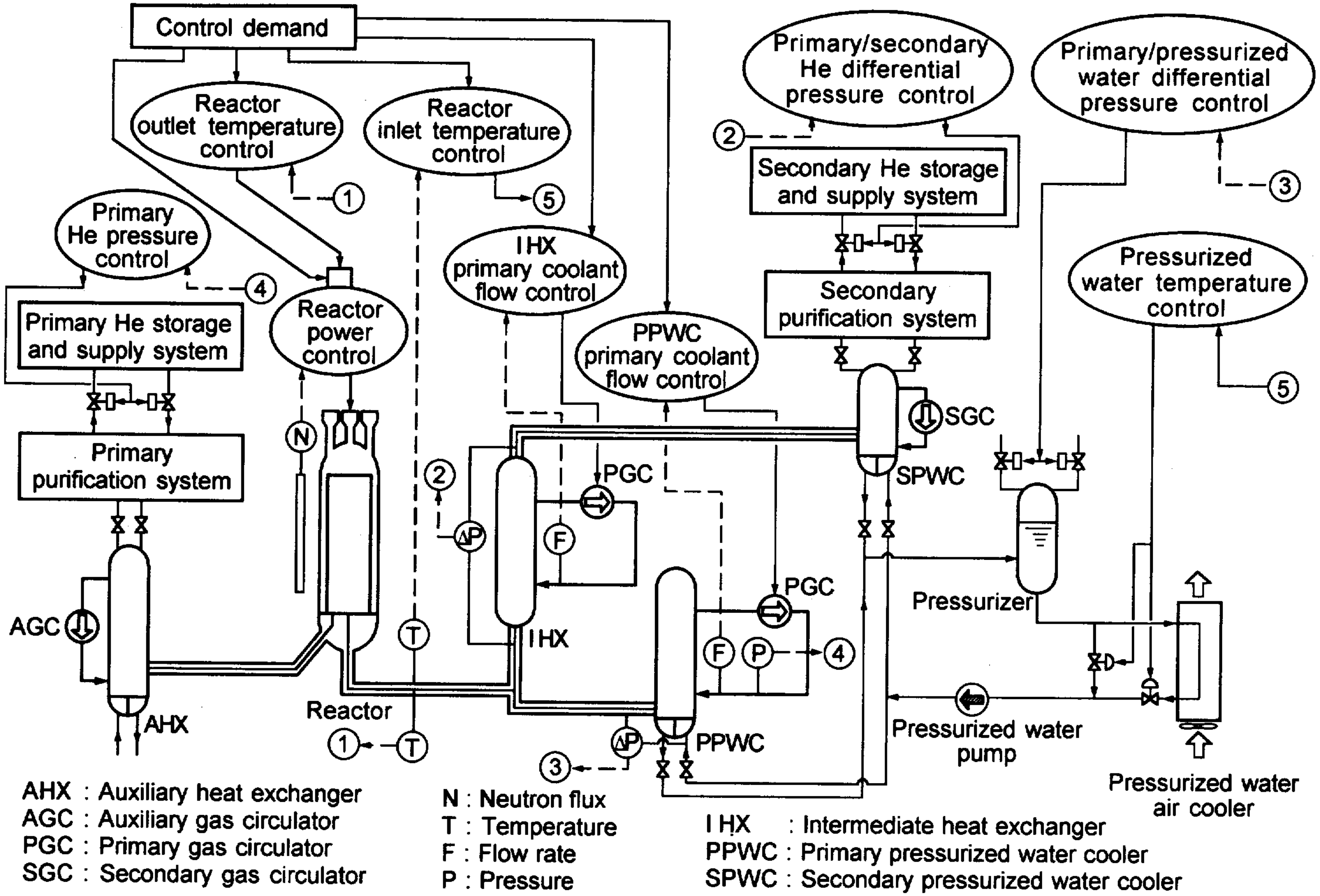

Fig.2.3 Plant control device of HTTR

3. Gas Circulator Trip Test (S1C-2/S2C-1)

3.1 Test Program

The coolant flow reduction test by tripping gas circulators (S1C-2; Safety demonstration test of One out of three gas circulator trip test -2, S2C-1; Safety demonstration test of Two out of three gas circulators trip test -1) demonstrates that the negative reactivity feedback effect of the core brings the reactor power safely to a stable level without a reactor scram, and that the temperature transient of the reactor core is slow in a rapid decrease of the coolant flow rate.

3.2 Test Condition

The test conditions of the S1C-2 and S2C-1 are shown in Table 3.1. In the tests, the primary coolant flow rate is reduced by running down one and two out of three gas circulators without operating the reactor power control system. For the test, some scram levels are changed automatically and the plant condition will be an anticipated transient without scram condition (cf. following 3.4). At the end of this test, the reactor is shut down by manual scram.

3.3 Test Method

Steady state and transient behaviours of the reactor and plant are measured by a plant computer, reactivity measurement instrumentation, TETRIS (High Temperature Engineering Test Reactor Emergency Response Information System), etc. The main items to be measured in the gas circulator trip tests are as follows:

- Reactor Power (Power range monitoring)
- Reactivity
- Reactor core differential pressure
- Coolant flow rate
- Inlet temperature of the core
- Coolant temperature at hot plenum
- Permanent reflector block temperature
- Plenum block temperature

3.4 Test Procedure

(1) Initial Test Condition

When the primary coolant flow-rate decreases by tripping of gas circulators, reactor scram could be caused by the shutdown signal: ‘primary coolant flow rate of PPWC is low’ or ‘core differential pressure is low’. Also reactor scram could be caused by the shutdown signal: ‘reactor outlet coolant temperature is high’ by the increasing of reactor outlet coolant temperature due to the stop of gas circulators. To avoid the possibility of a reactor scram by the above three shutdown signals, the scram signal values will be changed automatically by synchronising of the operation-mode selection equipment as well as preventing wrong operation by an operator.

To maintain the control-rods' positions during the tests, the selection equipment of the operation-mode is regulated such that the control system of the reactor power is manual mode. The function of the selection equipment of the operation-mode is shown in Table 3.2. After turning on the 'operation-mode (i)' shown in Table 3.2, the each control-rod power supply is intercepted. Then, the gas circulator trip test can be conducted as an anticipated transient without scram.

(2) Test Procedure

The test procedure of the gas circulator trip test is shown in Fig. 3.1. The test mode is selected after the confirmation of initial conditions. At the one gas circulator trip test, the No. A gas circulator at the PPWC is stopped and at the two gas circulators trip test, the No. A and No. C are stopped. After measuring of the neutron flux, reactor outlet coolant temperature, primary circuit flow rate and pressure, etc, the reactor is shut down by a manual scram.

3.5 Pre-test Analysis

(1) Analytical Conditions

Pre-test analysis of the gas circulator trip test was conducted using the core and plant dynamics analysis code 'ACCORD' developed by JAERI[7]. The characteristics of the code are:

(a) Plant system can be analysed for over several thousand seconds after an event occurrence by modelling the heat capacity of the core,
(b) In-core and plant dynamics of any plant system can be analysed by rearranging packages which simulate plant system components one by one, and
(c) Thermal hydraulics can be analysed for each component from fluid flow calculation for helium and pressurised water systems.

The coefficients of fuel temperature and moderator temperature used for the analysis are the following values:

One out of three gas circulator trip test with the reactor power at 60%

- Coefficient of fuel temperature $-4.3\times10^{-5}\ \Delta k/k/\ ^{\circ}C$ at 600K
- Coefficient of moderator temperature $-3.0\times10^{-5}\ \Delta k/k/\ ^{\circ}C$ at 450K

Two out of three gas circulators trip test with the reactor power at 30%

- Coefficient of fuel temperature $-5.4\times10^{-5}\ \Delta k/k/\ ^{\circ}C$ at 600K
- Coefficient of moderator temperature $-5.7\times10^{-5}\ \Delta k/k/\ ^{\circ}C$ at 450K

The reactor kinetics parameters of the effective delayed neutron fraction and prompt neutron lifetime used for the analysis are the following values(8):

- Effective delayed neutron fraction 5.43×10^{-3}
- Prompt neutron lifetime 6.78×10^{-4} s

The decrease flow-rate characteristics of the primary helium gas circulator are the measured data of the previous test with the reactor power at 30% obtained in March 2002.

(2) Analytical Results

The transients of the reactor power and primary coolant flow rate at the one gas circulator trip test with the reactor power at 60% (18MW) and the two gas circulator trip test with the reactor power at 30% (9MW) are shown in Fig. 3.2 and Fig.3.3, respectively.

The flow rate of the primary circuit decreases immediately within 10 seconds after tripping one or two gas circulators. The reactor power is diminished due to the increase of reactor core temperature caused by decreasing of the reactor coolant flow-rate. After several hours have elapsed, the reactor power reaches a stable condition. Since the remaining gas circulator(s) operates continuously with its flow rate control devices, the flow rate becomes 66% of initial flow rate at tripping of one gas circulator and 33% of tripping of two gas circulators. Due to the rapid change of the reactor power, a negative reactivity is inserted.

Table 3.1 Test Condition of Gas Circulators Trip Test

	One gas circulator trip test	Two gas circulators trip test
Operation mode	Rated operation mode, Single loaded operation mode	
Initial Reactor power	60% (18MW)	30% (9MW)
Reactor outlet temperature	Below 850°C (Initial)	
	Below 950°C (During the test)	
HGC to be stopped	One	Two
	HGC for PPWC No. A	HGC for PPWC No. A and C

HGC	Helium Gas Circulator
PPWC	Primary Pressurised Water Cooler
Rated operation mode	Operation at reactor outlet coolant temperature of 850°C
Single loaded operation mode	Operation using primary pressurised water cooler for primary heat exchange

Table 3.2 Function of operation-mode selection equipment

Test item	Turning on conditions	Turning off conditions	Functions after turning on	Mode number
Reactivity insertion test - Control-rod withdrawal test	(1) Rated operation mode (2) Single loaded operation mode (3) Reactor power 30% – 80%	The difference between the set-value of measured-value of the reactor power control system is in the regulated value.	(1) Change of the pattern-interlock set-value of the centre control-rod (2) Movement of the control-rods (15 pairs) except the centre control-rod is prevented.	(iii)
Coolant flow reduction test - Partial loss of coolant flow test	(1) Rated operation mode (2) Single loaded operation mode	None	At the 850 °C operation, the set-value of primary coolant flow rate cannot change to the value below the set-value of reactor scram.	(ii)
Coolant flow reduction test - Gas circulators trip test	(1) Rated operation mode (2) Single loaded operation mode	The difference between the set-value and measured-value of the reactor power control system is in the regulated value.	(1) Movement of the control-rod (16 pairs) is prevented. (2) The set-values of the scram of "primary coolant flow rate of PPWC low", "core differential pressure low" and "reactor outlet coolant temperature high" are changed.	(i)

Rated operation mode — Operation at reactor outlet coolant temperature of 850°C

Single loaded operation mode — Operation using primary pressurised water cooler for primary heat exchange

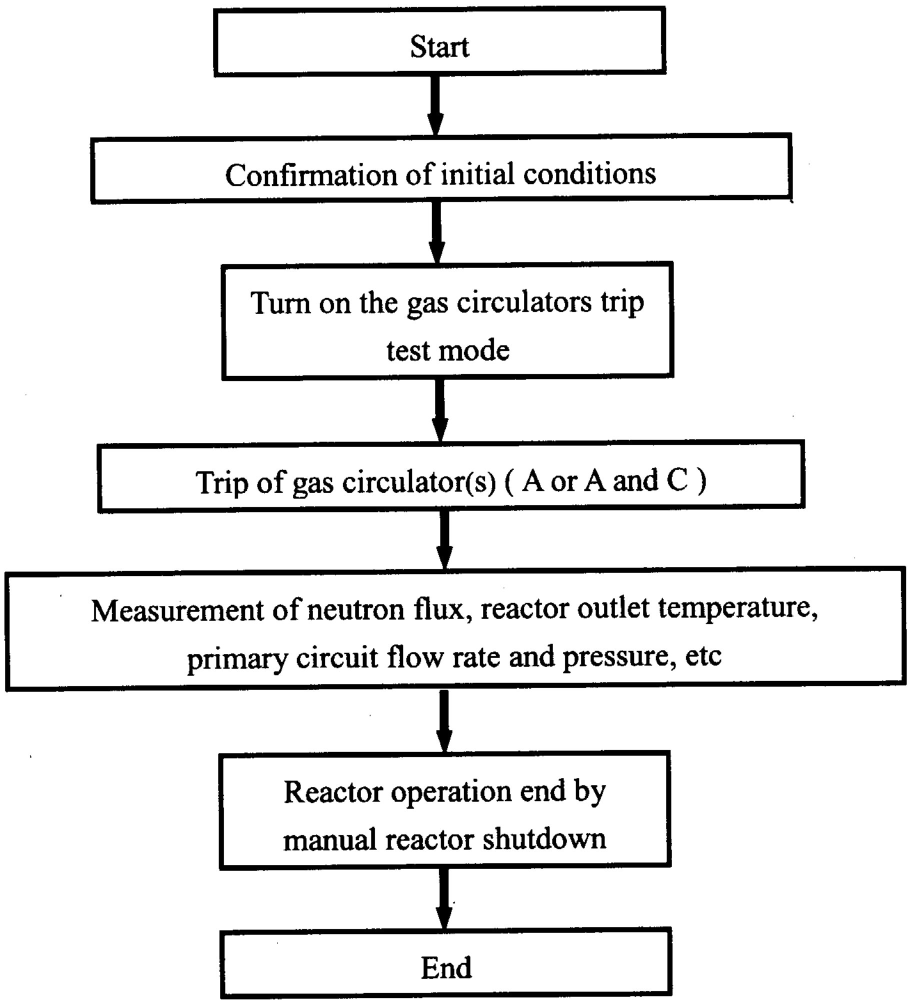

Fig.3.1 Test procedure of coolant flow reduction test - Gas circulators trip test -

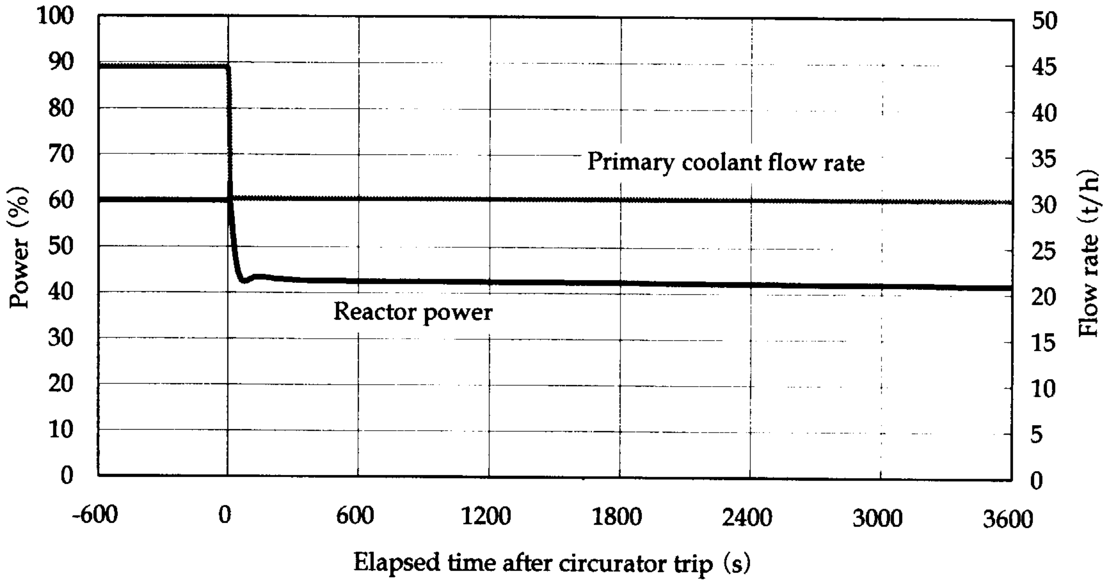

Fig 3.2 Calculated result of one out of three gas circulators trip test
- Transient of reactor power and primary coolant flow rate -

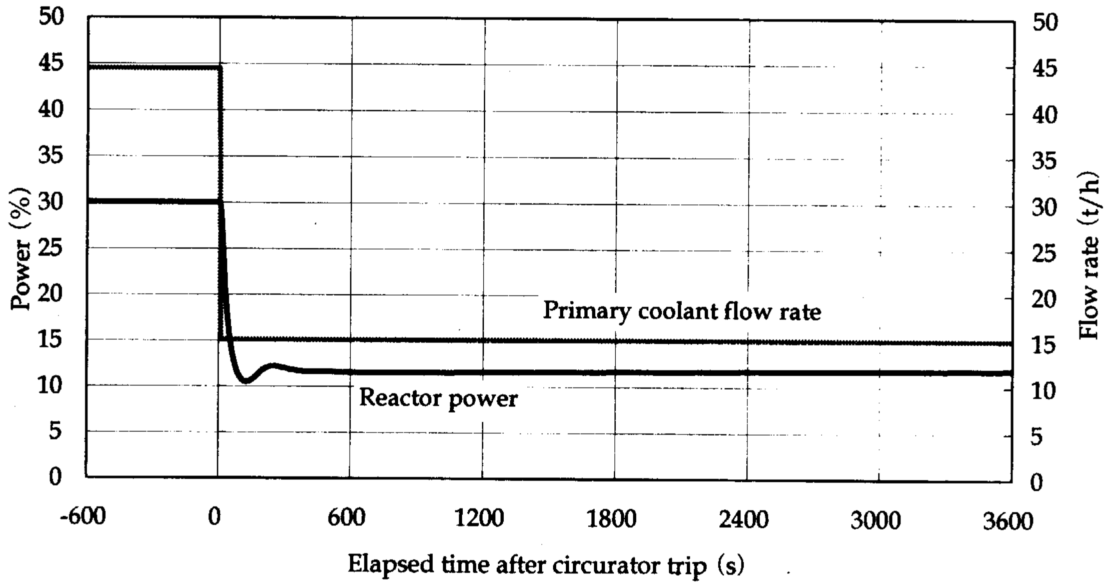

Fig 3.3 Calculated result of two out of three gas circulators trip test
- Transient of reactor power and primary coolant flow rate -

4. Concluding Remarks

The coolant flow reduction tests by tripping of gas circulators, one out of three gas circulators trip with the reactor power at 60% and two out of three gas circulators with the reactor power at 30%, are planned in the fiscal year 2003. Their test method, procedure and results of pre-test analysis are described in this report. From the analytical results of the steady state and transient behaviours of the reactor and plant of the HTTR, it was found that in the case of a rapid decrease of the coolant flow rate, the negative reactivity feedback effect of the core brings the reactor power safely to a stable level without a reactor scram, and that the temperature transient of the reactor core is slow.

The Phase I safety demonstration tests will continue until the fiscal year 2005. The reactivity insertion tests by a pair of control-rods' withdrawal with the reactor power at 60% will be conducted in 2003, and 80% in 2004. In 2005, 50% tests will be performed again for investigating effects of burn-up of fuel and irradiation of graphite components on reactor transient. The coolant flow reduction tests by tripping of one and two out of three gas circulators with the reactor power at 80% will be conducted in the fiscal year 2004, and 100% in 2005. In 2005, 30% tests will be performed again to compare with the results of the previous tests confirmed in March 2003.

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Appendix Measurement Location

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Existing instrumentation for safety demonstration test in HTTR

PID No.	Measurement parameter	Measurement range	Accuracy	Location of Measurement element
13A000	Temperature 1 of RPV top cover	0-600°C	±1.4%FS	Fig. 1
13A001	Temperature 2 of RPV top cover	0-600°C	±1.4%FS	Fig. 1
13A002	Temperature 3 of RPV top cover	0-600°C	±0.8%FS	Fig. 1
13A003	Temperature of RPV top cover flange	0-600°C	±0.8%FS	Fig. 1
13A004	Temperature 1 of RPV stud bolt	0-600°C	±0.8%FS	Fig. 1
13A005	Temperature 2 of RPV stud bolt	0-600°C	±0.8%FS	Fig. 1
13A006	Temperature of RPV cylinder flange	0-600°C	±0.8%FS	Fig. 1
13A007	Temperature 1 of RPV cylinder	0-600°C	±0.8%FS	Fig. 1
13A008	Temperature 2 of RPV cylinder	0-600°C	±0.8%FS	Fig. 1
13A009	Temperature 3 of RPV cylinder	0-600°C	±0.8%FS	Fig. 1
13A010	Temperature 4 of RPV cylinder	0-600°C	±0.8%FS	Fig. 1
13A011	Temperature 1 of RPV bottom cover	0-600°C	±0.8%FS	Fig. 1
13A012	Temperature 2 of RPV bottom cover	0-600°C	±0.8%FS	Fig. 1
13A013	Temperature 3 of RPV bottom cover	0-600°C	±0.8%FS	Fig. 1
13A014	Temperature 4 of RPV bottom cover	0-600°C	±0.8%FS	Fig. 1
13A015	Temperature 1 of RPV skirt	0-600°C	±0.8%FS	Fig. 1
13A016	Temperature 2 of RPV skirt	0-600°C	±0.8%FS	Fig. 1
13A080	Primary coolant flow rate 1	0-51t/h	±1.2t/h	Fig. 2
13A081	Primary coolant flow rate 2	0-51t/h	±1.2t/h	Fig. 2
13A082	Primary coolant flow rate 3	0-51t/h	±1.2t/h	Fig. 2
13A083	Bypass coolant flow rate in IHX	0-1t/h	±0.03t/h	Fig. 2
13A130	Reactor inlet coolant temperature	0-500°C	±5°C	Fig. 2
13A131	Reactor outlet coolant temperature	0-1200°C	±20°C	Fig. 2
13A406	Primary coolant pressure 1	0-5MPa	±0.08MPa	Fig. 2
13A407	Primary coolant pressure 2	0-5MPa	±0.08MPa	Fig. 2
13A408	Primary coolant pressure 3	0-5MPa	±0.08MPa	Fig. 2
24A003	Reactor power 1	0-120%	±4%	Fig. 3
24A004	Reactor power 2	0-120%	±4%	Fig. 3
24A005	Reactor power 3	0-120%	±4%	Fig. 3
24A020	C control rod position	-345 - 5130mm	±5mm	Fig. 4

PID No.	Measurement parameter	Measurement range	Accuracy	Location of Measurement element
24A023	R1-1 control rod position	-345 - 5130mm	±5mm	Fig. 4
24A026	R1-2 control rod position	-345 - 5130mm	±5mm	Fig. 4
24A029	R1-3 control rod position	-345 - 5130mm	±5mm	Fig. 4
24A032	R1-4 control rod position	-345 - 5130mm	±5mm	Fig. 4
24A035	R1-5 control rod position	-345 - 5130mm	±5mm	Fig. 4
24A038	R1-6 control rod position	-345 - 5130mm	±5mm	Fig. 4
24A041	R2-1 control rod position	-345 - 5130mm	±5mm	Fig. 4
24A044	R2-2 control rod position	-345 - 5130mm	±5mm	Fig. 4
24A047	R2-3 control rod position	-345 - 5130mm	±5mm	Fig. 4
24A050	R2-4 control rod position	-345 - 5130mm	±5mm	Fig. 4
24A053	R2-5 control rod position	-345 - 5130mm	±5mm	Fig. 4
24A056	R2-6 control rod position	-345 - 5130mm	±5mm	Fig. 4
24A059	R3-1 control rod position	-345 - 5130mm	±5mm	Fig. 4
24A060	R3-2C control rod position	-345 - 5130mm	±5mm	Fig. 4
24A061	R3-3 control rod position	-345 - 5130mm	±5mm	Fig. 4
24A200	Differential pressure 1 between inlet and outlet of core	0-13kPa	±0.6%	Fig. 4
24A201	Differential pressure 2 between inlet and outlet of core	0-13kPa	±0.6%	Fig. 4
24A202	Differential pressure 3 between inlet and outlet of core	0-13kPa	±0.6%	Fig. 4
24A220	Coolant (helium) temperature 1A at core outlet plenum	0-1200°C	±11°C	Fig. 5 and Fig. 10
24A221	Coolant (helium) temperature 1B at core outlet plenum	0-1200°C	±11°C	Fig. 5 and Fig. 10
24A222	Coolant (helium) temperature 1C at core outlet plenum	0-1200°C	±11°C	Fig. 5 and Fig. 10
24A223	Coolant (helium) temperature 2A at core outlet plenum	0-1200°C	±11°C	Fig. 5 and Fig. 10
24A224	Coolant (helium) temperature 2B at core outlet plenum	0-1200°C	±11°C	Fig. 5 and Fig. 10
24A225	Coolant (helium) temperature 2C at core outlet plenum	0-1200°C	±11°C	Fig. 5 and Fig. 10
24A226	Coolant (helium) temperature 3A at core outlet plenum	0-1200°C	±11°C	Fig. 5 and Fig. 10
24A227	Coolant (helium) temperature 3B at core outlet plenum	0-1200°C	±11°C	Fig. 5 and Fig. 10
24A228	Coolant (helium) temperature 3C at core outlet plenum	0-1200°C	±11°C	Fig. 5 and Fig. 10
24A229	Coolant (helium) temperature 4A at core outlet plenum	0-1200°C	±11°C	Fig. 5 and Fig. 10
24A230	Coolant (helium) temperature 4B at core outlet plenum	0-1200°C	±11°C	Fig. 5 and Fig. 10
24A231	Coolant (helium) temperature 4C at core outlet plenum	0-1200°C	±11°C	Fig. 5 and Fig. 10
24A232	Coolant (helium) temperature 5A at core outlet plenum	0-1200°C	±11°C	Fig. 5 and Fig. 10
24A233	Coolant (helium) temperature 5B at core outlet plenum	0-1200°C	±11°C	Fig. 5 and Fig. 10

PID No.	Measurement parameter	Measurement range	Accuracy	Location of Measurement element
24A234	Coolant (helium) temperature 5C at core outlet plenum	0-1200°C	±11°C	Fig. 5 and Fig. 10
24A235	Coolant (helium) temperature 6A at core outlet plenum	0-1200°C	±11°C	Fig. 5 and Fig. 10
24A236	Coolant (helium) temperature 6B at core outlet plenum	0-1200°C	±11°C	Fig. 5 and Fig. 10
24A237	Coolant (helium) temperature 6C at core outlet plenum	0-1200°C	±11°C	Fig. 5 and Fig. 10
24A238	Coolant (helium) temperature 7A at core outlet plenum	0-1200°C	±11°C	Fig. 5 and Fig. 10
24A239	Coolant (helium) temperature 7B at core outlet plenum	0-1200°C	±11°C	Fig. 5 and Fig. 10
24A240	Coolant (helium) temperature 7C at core outlet plenum	0-1200°C	±11°C	Fig. 5 and Fig. 10
24A350	Temperature 1 of thermal insulator in RPV top cover	0-600°C	±0.8%FS	Fig. 1
24A351	Temperature 2 of thermal insulator in RPV top cover	0-600°C	±0.8%FS	Fig. 1
24A352	Inner temperature 1 of RPV cylinder	0-600°C	±0.8%FS	Fig. 1
24A353	Inner temperature 2 of RPV cylinder	0-600°C	±0.8%FS	Fig. 1
24A354	Inner temperature 3 of RPV cylinder	0-600°C	±0.8%FS	Fig. 1
24A355	Surface temperature 1 of core restraint ring	0-500°C	±0.75%FS	Fig. 6 and Fig. 10
24A356	Surface temperature 2 of core restraint ring	0-500°C	±0.75%FS	Fig. 6 and Fig. 10
24A357	Surface temperature 3 of core restraint ring	0-500°C	±0.75%FS	Fig. 6 and Fig. 10
24A358	Surface temperature 4 of core restraint ring	0-500°C	±0.75%FS	Fig. 7 and Fig. 10
24A359	Surface temperature 5 of core restraint ring	0-500°C	±0.75%FS	Fig. 7 and Fig. 10
24A360	Surface temperature 6 of core restraint ring	0-500°C	±0.75%FS	Fig. 7 and Fig. 10
24A361	Surface temperature 7 of core restraint ring	0-500°C	±0.75%FS	Fig. 8 and Fig. 10
24A362	Surface temperature 8 of core restraint ring	0-500°C	±0.75%FS	Fig. 9 and Fig. 10
24A363	Surface temperature 9 of core restraint ring	0-500°C	±0.75%FS	Fig. 9 and Fig. 10
24A364	Surface temperature 10 of core restraint ring	0-500°C	±0.75%FS	Fig. 9 and Fig. 10
24A365	Surface temperature 11 of core restraint ring	0-500°C	±0.75%FS	Fig. 8 and Fig. 10
24A366	Coolant (helium) temperature 1 at outer surface of core side shielding block	0-500°C	±0.75%FS	Fig. 6 and Fig. 10
24A367	Coolant (helium) temperature 2 at outer surface of core side shielding block	0-500°C	±0.75%FS	Fig. 6 and Fig. 10
24A368	Coolant (helium) temperature 3 at outer surface of core side shielding block	0-500°C	±0.75%FS	Fig. 6 and Fig. 10
24A369	Coolant (helium) temperature 4 at outer surface of core side shielding block	0-500°C	±0.75%FS	Fig. 7 and Fig. 10
24A370	Coolant (helium) temperature 5 at outer surface of core side shielding block	0-500°C	±0.75%FS	Fig. 7 and Fig. 10
24A371	Coolant (helium) temperature 6 at outer surface of core side shielding block	0-500°C	±0.75%FS	Fig. 7 and Fig. 10
24A372	Coolant (helium) temperature 7 at outer surface of core side shielding block	0-500°C	±0.75%FS	Fig. 9 and Fig. 10
24A373	Coolant (helium) temperature 8 at outer surface of core side shielding block	0-500°C	±0.75%FS	Fig. 9 and Fig. 10
24A374	Coolant (helium) temperature 9 at outer surface of core side shielding block	0-500°C	±0.75%FS	Fig. 9 and Fig. 10

PID No.	Measurement parameter	Measurement range	Accuracy	Location of Measurement element
24A375	Coolant (helium) temperature 1 at inner surface of core side shielding block	0-600°C	±0.75%FS	Fig. 6 and Fig. 10
24A376	Coolant (helium) temperature 2 at inner surface of core side shielding block	0-600°C	±0.75%FS	Fig. 6 and Fig. 10
24A377	Coolant (helium) temperature 3 at inner surface of core side shielding block	0-600°C	±0.75%FS	Fig. 6 and Fig. 10
24A378	Coolant (helium) temperature 4 at inner surface of core side shielding block	0-600°C	±0.75%FS	Fig. 7 and Fig. 10
24A379	Coolant (helium) temperature 5 at inner surface of core side shielding block	0-600°C	±0.75%FS	Fig. 7 and Fig. 10
24A380	Coolant (helium) temperature 6 at inner surface of core side shielding block	0-600°C	±0.75%FS	Fig. 7 and Fig. 10
24A381	Coolant (helium) temperature 7 at inner surface of core side shielding block	0-600°C	±0.75%FS	Fig. 9 and Fig. 10
24A382	Coolant (helium) temperature 8 at inner surface of core side shielding block	0-600°C	±0.75%FS	Fig. 9 and Fig. 10
24A383	Coolant (helium) temperature 9 at inner surface of core side shielding block	0-600°C	±0.75%FS	Fig. 9 and Fig. 10
24A384	Outer surface temperature 1 of core side shielding block	0-500°C	±0.75%FS	Fig. 6 and Fig. 10
24A385	Outer surface temperature 2 of core side shielding block	0-500°C	±0.75%FS	Fig. 6 and Fig. 10
24A386	Outer surface temperature 3 of core side shielding block	0-500°C	±0.75%FS	Fig. 6 and Fig. 10
24A387	Outer surface temperature 4 of core side shielding block	0-500°C	±0.75%FS	Fig. 7 and Fig. 10
24A388	Outer surface temperature 5 of core side shielding block	0-500°C	±0.75%FS	Fig. 7 and Fig. 10
24A389	Outer surface temperature 6 of core side shielding block	0-500°C	±0.75%FS	Fig. 7 and Fig. 10
24A390	Outer surface temperature 7 of core side shielding block	0-500°C	±0.75%FS	Fig. 9 and Fig. 10
24A391	Outer surface temperature 8 of core side shielding block	0-500°C	±0.75%FS	Fig. 9 and Fig. 10
24A392	Outer surface temperature 9 of core side shielding block	0-500°C	±0.75%FS	Fig. 9 and Fig. 10
24A393	Inner surface temperature 1 of core side shielding block	0-600°C	±0.75%FS	Fig. 6 and Fig. 10
24A394	Inner surface temperature 2 of core side shielding block	0-600°C	±0.75%FS	Fig. 7 and Fig. 10
24A395	Inner surface temperature 3 of core side shielding block	0-600°C	±0.75%FS	Fig. 9 and Fig. 10
24A396	Outer surface temperature 1 of permanent reflector block	0-600°C	±0.75%FS	Fig. 6 and Fig. 10
24A397	Outer surface temperature 2 of permanent reflector block	0-600°C	±0.75%FS	Fig. 6 and Fig. 10
24A398	Outer surface temperature 3 of permanent reflector block	0-600°C	±0.75%FS	Fig. 6 and Fig. 10
24A399	Outer surface temperature 4 of permanent reflector block	0-600°C	±0.75%FS	Fig. 7 and Fig. 10
24A400	Outer surface temperature 5 of permanent reflector block	0-600°C	±0.75%FS	Fig. 7 and Fig. 10
24A401	Outer surface temperature 6 of permanent reflector block	0-600°C	±0.75%FS	Fig. 7 and Fig. 10
24A402	Outer surface temperature 7 of permanent reflector block	0-600°C	±0.75%FS	Fig. 9 and Fig. 10
24A403	Outer surface temperature 8 of permanent reflector block	0-600°C	±0.75%FS	Fig. 9 and Fig. 10
24A404	Outer surface temperature 9 of permanent reflector block	0-600°C	±0.75%FS	Fig. 9 and Fig. 10
24A405	Inner surface temperature 1 of permanent reflector block	0-700°C	±0.75%FS	Fig. 6 and Fig. 10
24A406	Inner surface temperature 2 of permanent reflector block	0-700°C	±0.75%FS	Fig. 6 and Fig. 10

PID No.	Measurement parameter	Measurement range	Accuracy	Location of Measurement element
24A407	Inner surface temperature 3 of permanent reflector block	0-700°C	±0.75%FS	Fig. 6 and Fig. 10
24A408	Inner surface temperature 4 of permanent reflector block	0-700°C	±0.75%FS	Fig. 7 and Fig. 10
24A409	Inner surface temperature 5 of permanent reflector block	0-700°C	±0.75%FS	Fig. 7 and Fig. 10
24A410	Inner surface temperature 6 of permanent reflector block	0-700°C	±0.75%FS	Fig. 7 and Fig. 10
24A411	Inner surface temperature 7 of permanent reflector block	0-700°C	±0.75%FS	Fig. 9 and Fig. 10
24A412	Inner surface temperature 8 of permanent reflector block	0-700°C	±0.75%FS	Fig. 9 and Fig. 10
24A413	Inner surface temperature 9 of permanent reflector block	0-700°C	±0.75%FS	Fig. 9 and Fig. 10
24A414	Bottom surface temperature 1 of core outlet plenum side block	0-1000°C		Fig. 9 and Fig. 10
24A415	Bottom surface temperature 2 of core outlet plenum side block	0-1000°C		Fig. 9 and Fig. 10
24A416	Bottom surface temperature 3 of core outlet plenum side block	0-1000°C		Fig. 9 and Fig. 10
24A417	Upper surface temperature 1 of core bottom block	0-1000°C		Fig. 11
24A418	Upper surface temperature 2 of core bottom block	0-1000°C		Fig. 11
24A419	Upper surface temperature 3 of core bottom block	0-1000°C		Fig. 11
24A420	Upper surface temperature 1 of core support plate	0-500°C	±0.75%FS	Fig. 12
24A421	Upper surface temperature 2 of core support plate	0-500°C	±0.75%FS	Fig. 12
24A422	Upper surface temperature 3 of core support plate	0-500°C	±0.75%FS	Fig. 12
24A423	Upper surface temperature 4 of core support plate	0-500°C	±0.75%FS	Fig. 12
24A424	Upper surface temperature 5 of core support plate	0-500°C	±0.75%FS	Fig. 12
24A425	Upper surface temperature 6 of core support plate	0-500°C	±0.75%FS	Fig. 12
24A426	Upper surface temperature 7 of core support plate	0-500°C	±0.75%FS	Fig. 12
24A427	Temperature 1 of core support grid	0-600°C	±0.75%FS	Fig. 1
24A428	Temperature 2 of core support grid	0-600°C	±0.75%FS	Fig. 1
24A429	Temperature 3 of core support grid	0-600°C	±0.75%FS	Fig. 1
24A430	Temperature 4 of core support grid	0-600°C	±0.75%FS	Fig. 1
24A431	Upper surface temperature 1 of seal plate	0-500°C	±0.75%FS	Fig. 13
24A432	Upper surface temperature 2 of seal plate	0-500°C	±0.75%FS	Fig. 13
24A433	Upper surface temperature 3 of seal plate	0-500°C	±0.75%FS	Fig. 13
24A434	Temperature 1 of core outlet plenum block	0-1100°C		Fig. 5 and Fig. 10
24A435	Temperature 2 of core outlet plenum block	0-1100°C		Fig. 5 and Fig. 10
24A436	Temperature 3 of core outlet plenum block	0-1100°C		
24A440	Coolant (helium) temperature 1 in RPV top cover	0-500°C	±0.75%FS	Fig. 14
24A441	Coolant (helium) temperature 2 in RPV top cover	0-500°C	±0.75%FS	Fig. 14

PID No.	Measurement parameter	Measurement range	Accuracy	Location of Measurement element
24A442	Coolant (helium) temperature 3 in RPV top cover	0-500°C	±0.75%FS	Fig. 14
24A443	Coolant (helium) temperature 4 in RPV top cover	0-500°C	±0.75%FS	Fig. 14
24A444	Coolant (helium) temperature 5 in RPV top cover	0-500°C	±0.75%FS	Fig. 14
24A445	Coolant (helium) temperature 6 in RPV top cover	0-500°C	±0.75%FS	Fig. 14
24A446	Coolant (helium) temperature 7 in RPV top cover	0-500°C	±0.75%FS	Fig. 14
24A447	Coolant (helium) temperature 8 in RPV top cover	0-500°C	±0.75%FS	Fig. 14
24A448	Coolant (helium) temperature 9 in RPV top cover	0-500°C	±0.75%FS	Fig. 14
24A449	Coolant (helium) temperature 10 in RPV top cover	0-500°C	±0.75%FS	Fig. 14
24A450	Coolant (helium) temperature 11 in RPV top cover	0-500°C	±0.75%FS	Fig. 14
24A451	Coolant (helium) temperature 12 in RPV top cover	0-500°C	±0.75%FS	Fig. 14
24A452	Coolant (helium) temperature 13 in RPV top cover	0-500°C	±0.75%FS	Fig. 14
24A453	Coolant (helium) temperature 14 in RPV top cover	0-500°C	±0.75%FS	Fig. 14
24A454	Coolant (helium) temperature 15 in RPV top cover	0-500°C	±0.75%FS	Fig. 14
24A455	Coolant (helium) temperature 16 in RPV top cover	0-500°C	±0.75%FS	Fig. 14
24A456	Coolant (helium) temperature 17 in RPV top cover	0-500°C	±0.75%FS	Fig. 14
24A457	Coolant (helium) temperature 18 in RPV top cover	0-500°C	±0.75%FS	Fig. 14
24A458	Coolant (helium) temperature 19 in RPV top cover	0-500°C	±0.75%FS	Fig. 14
24A459	Coolant (helium) temperature 20 in RPV top cover	0-500°C	±0.75%FS	Fig. 14
24A460	Coolant (helium) temperature 21 in RPV top cover	0-500°C	±0.75%FS	Fig. 14

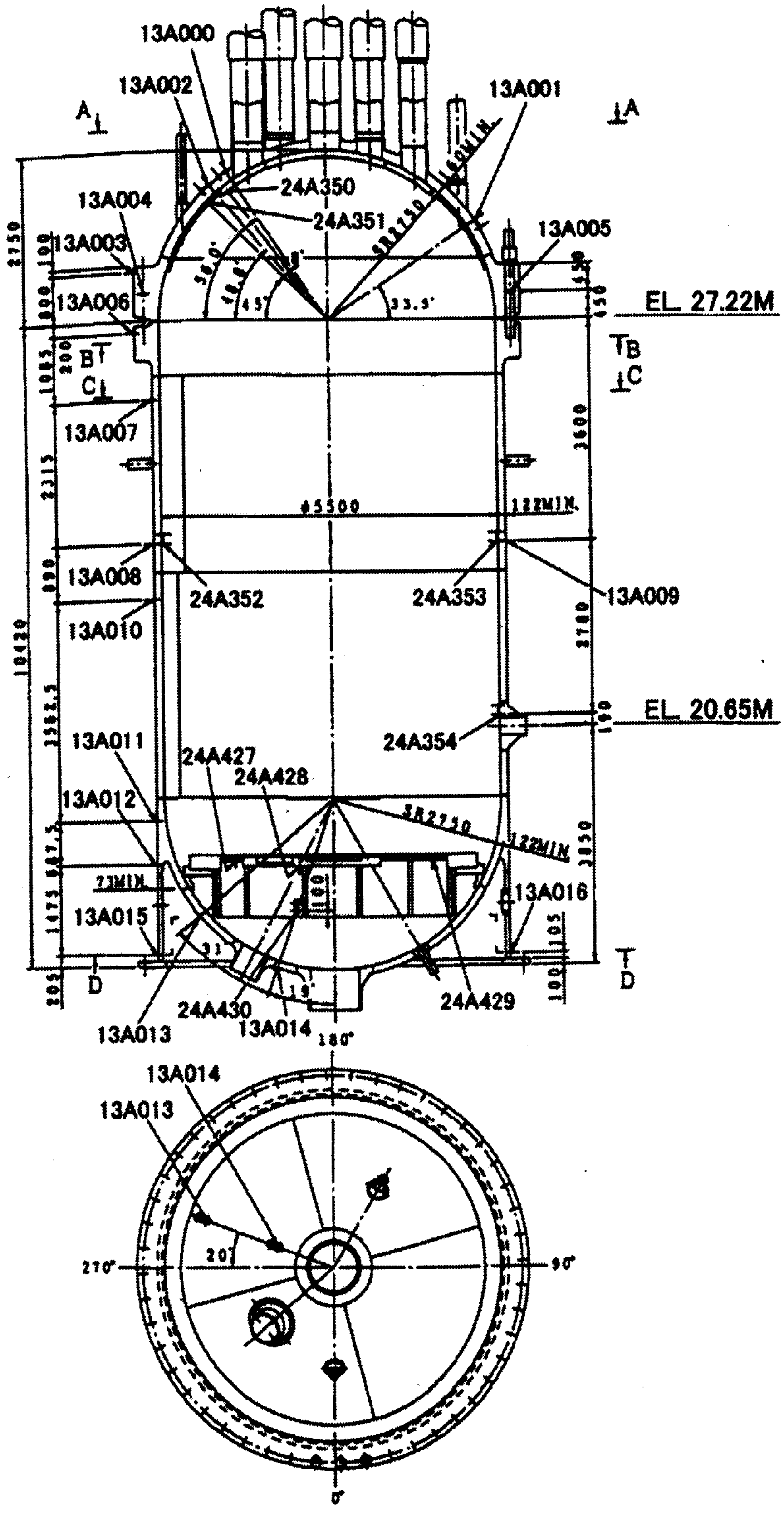


Fig. 1(1) Measuring position around RPV (Vertical cross-sectional view)

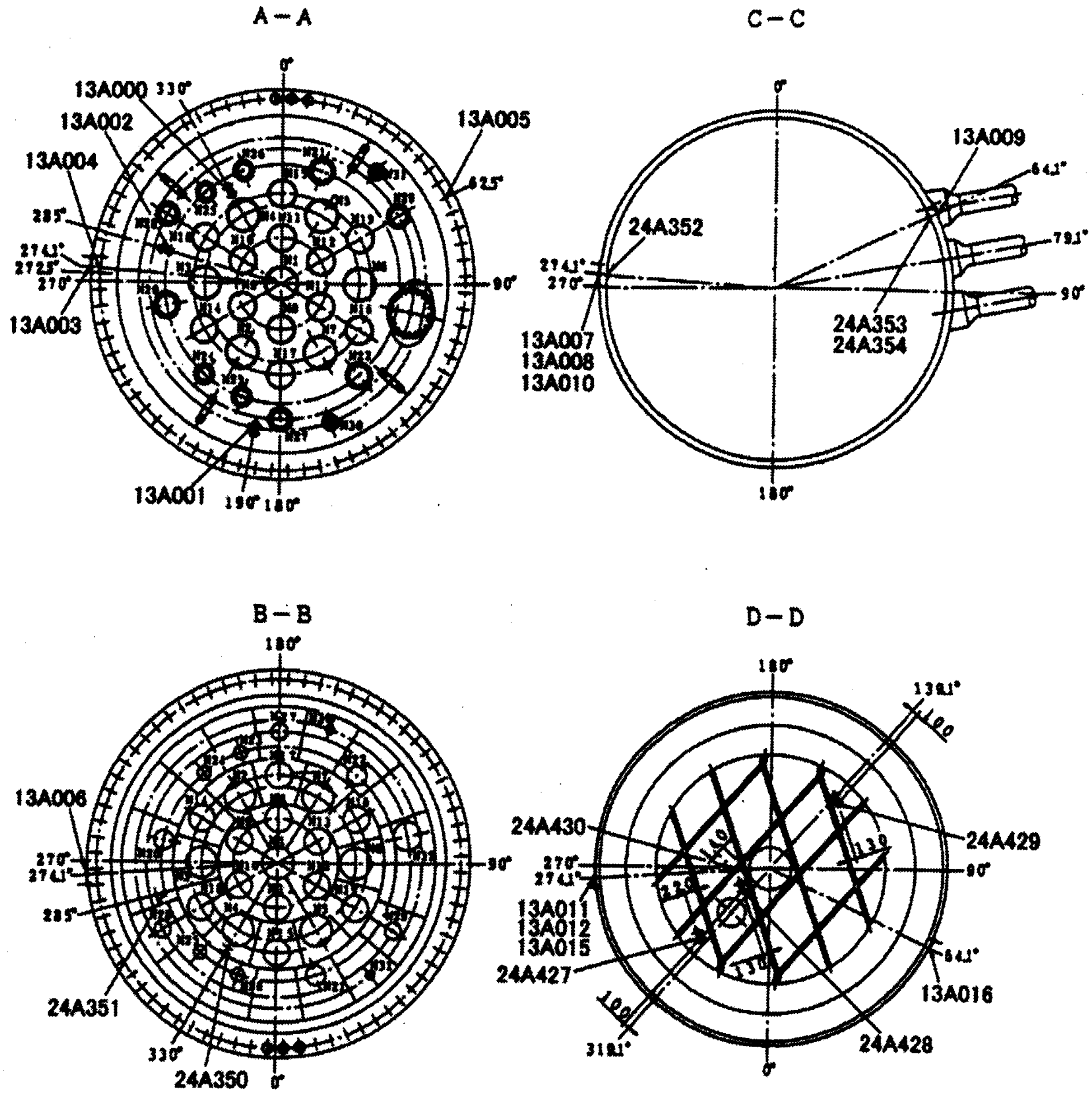


Fig. 1(2)　Measuring position around RPV (Horizontal cross-sectional view)

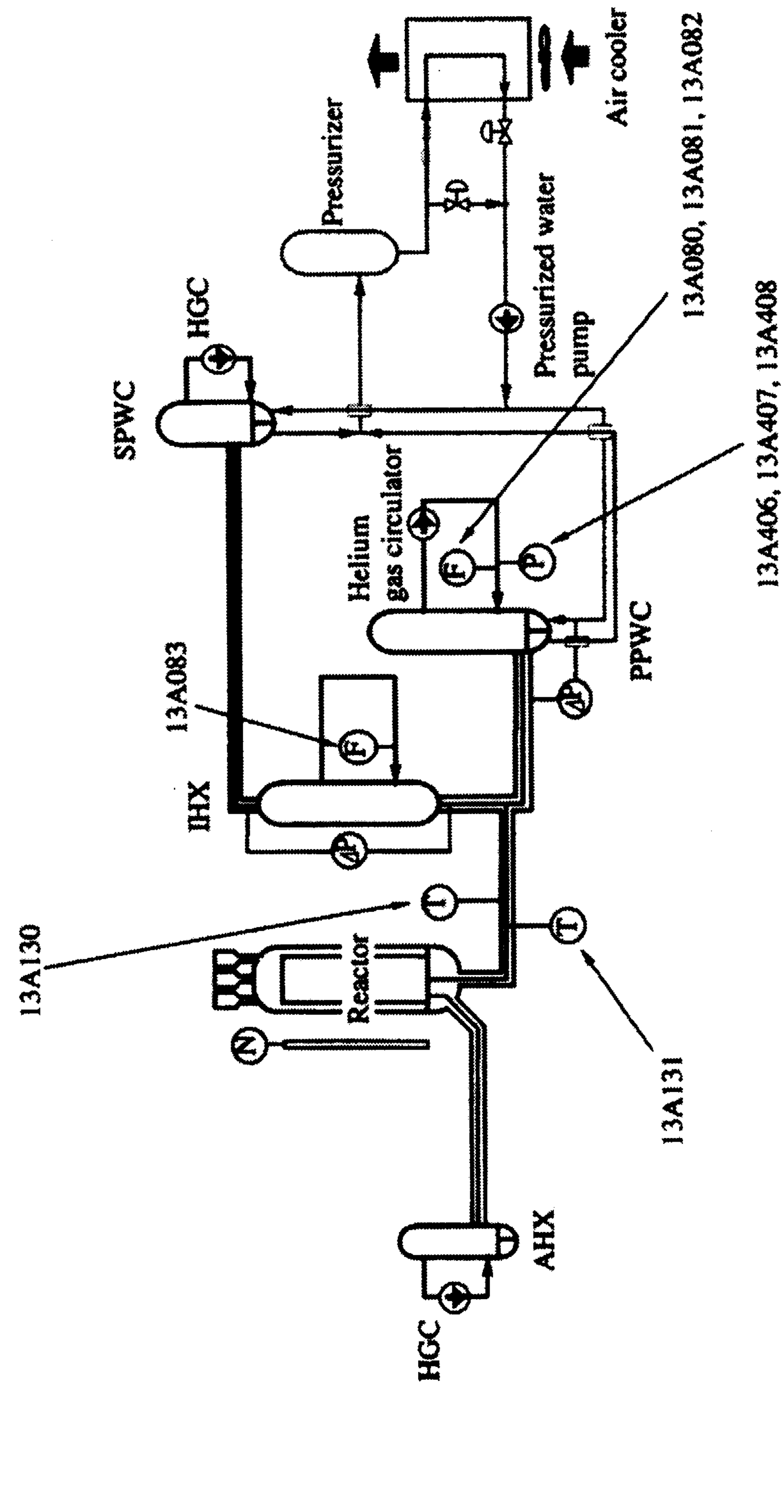


Fig. 2 Measuring position for coolant temperature, flow rate and pressure

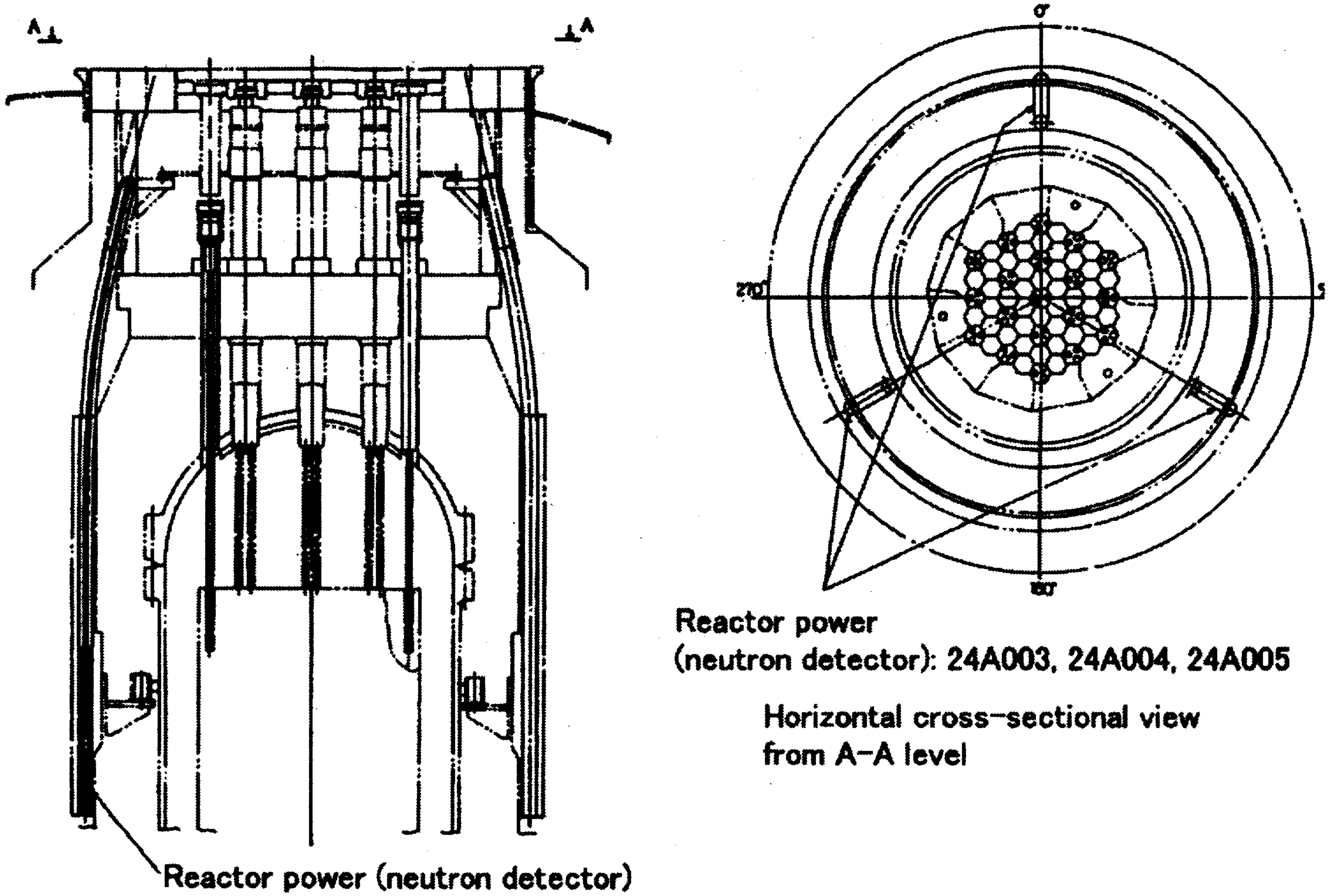


Fig. 3 Measuring position for reactor power

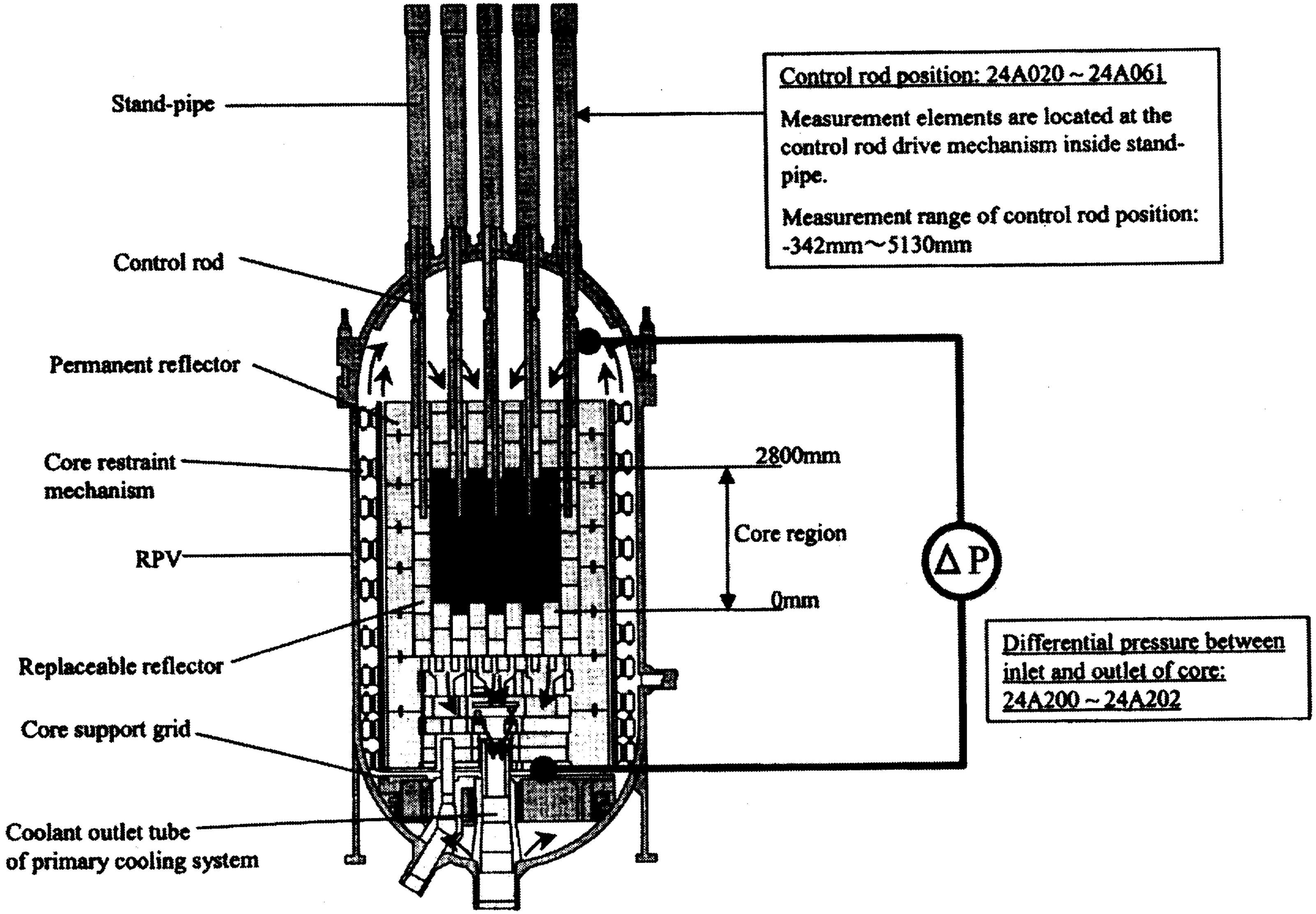


Fig. 4 Measuring position for control rod position and differential pressure of core

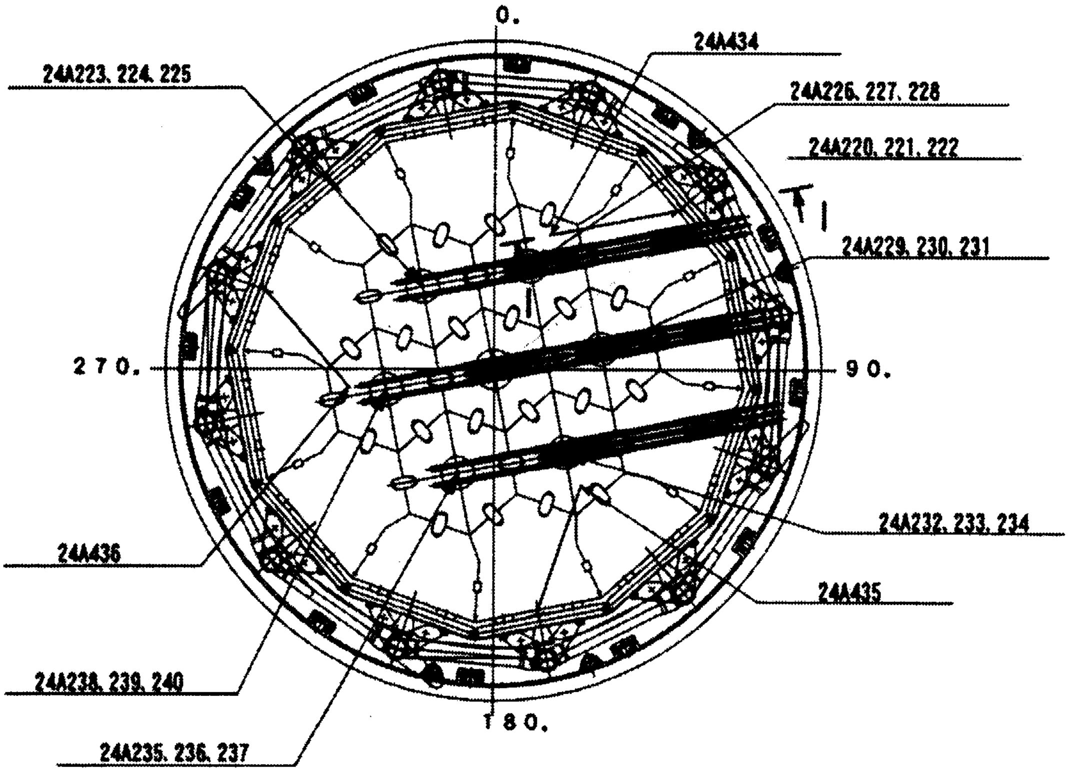


Fig. 5 Measuring position of C-C cross section (See Fig. 10)

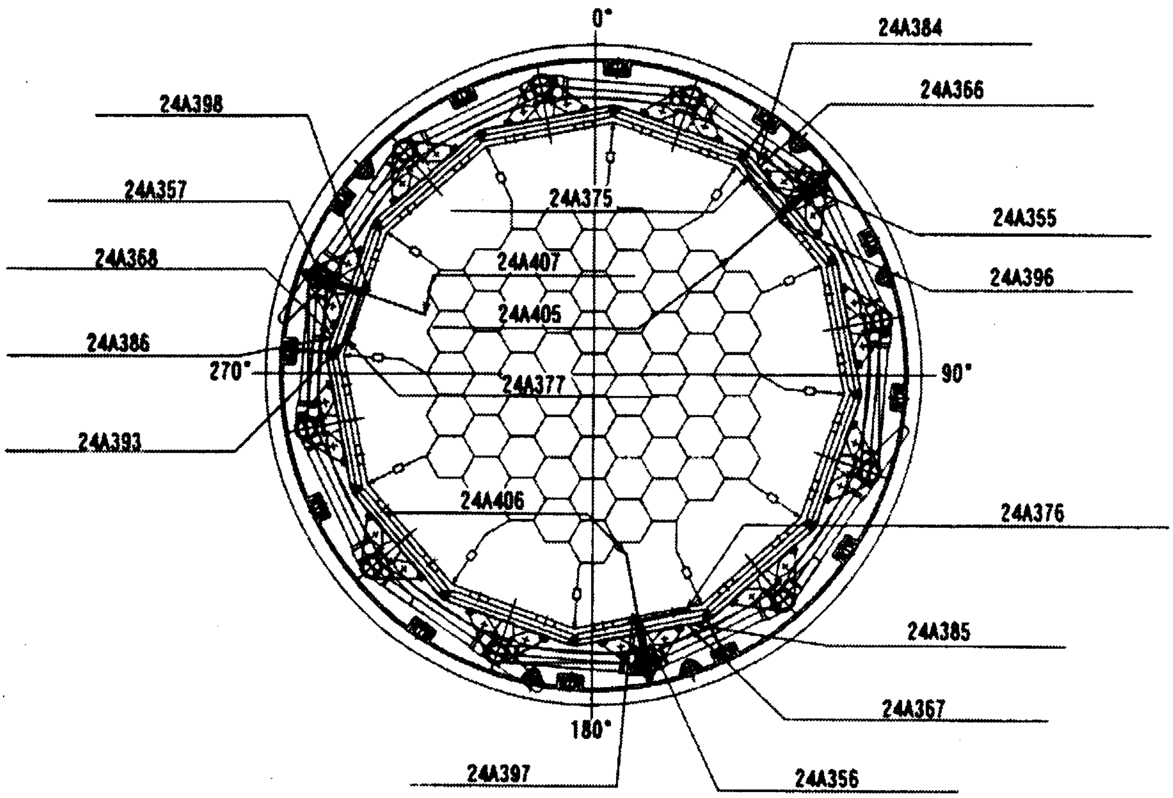


Fig. 6 Measuring position of E-E cross section (See Fig. 10)

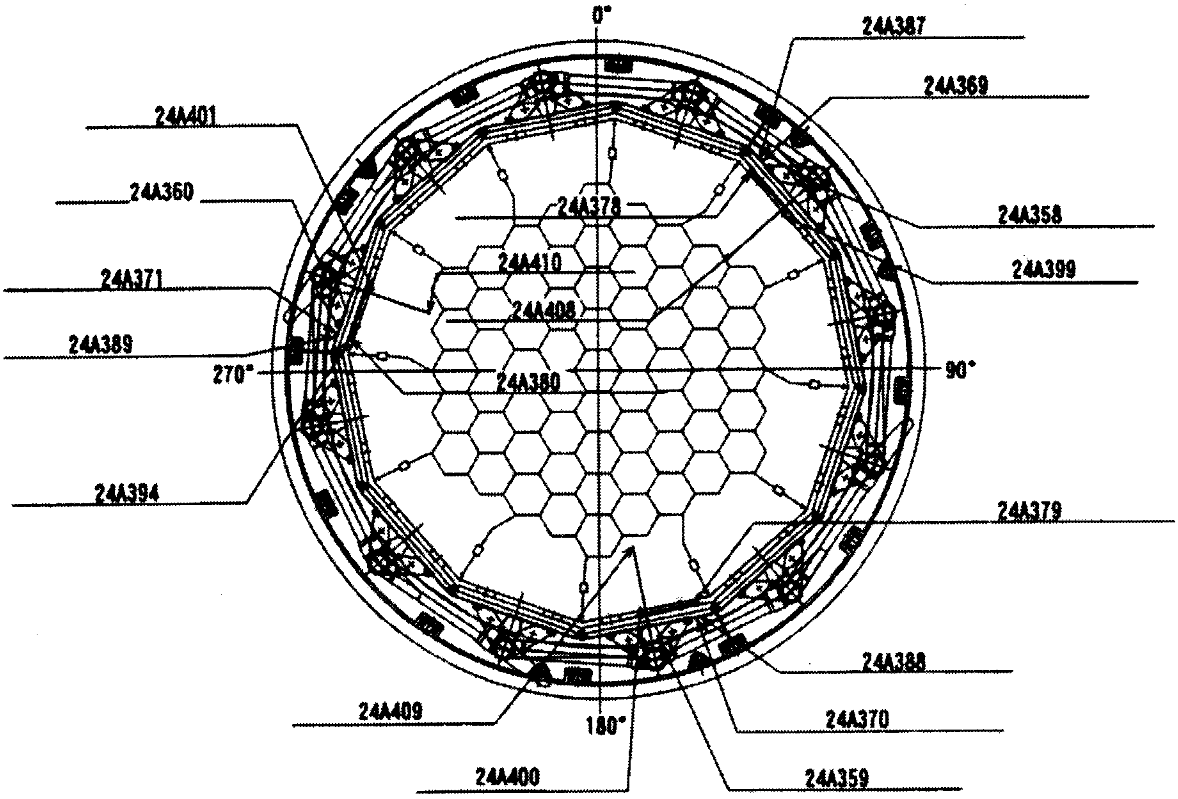


Fig. 7 Measuring position of D-D cross section (See Fig. 10)

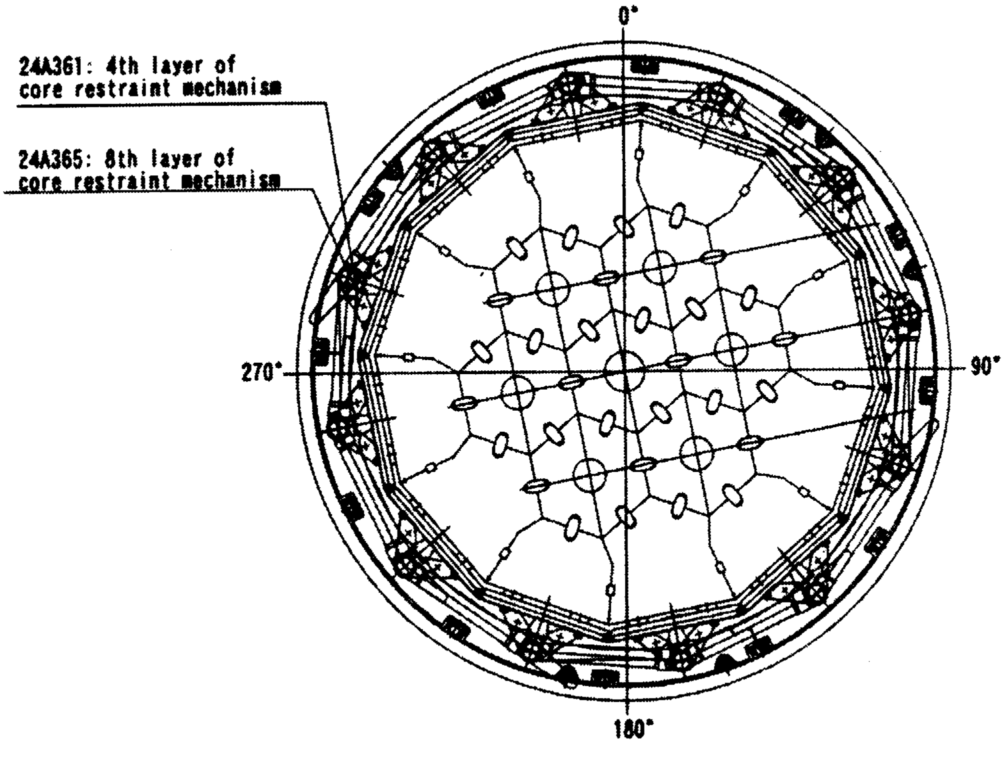


Fig. 8 Measuring position of B-B cross section (See Fig. 10)

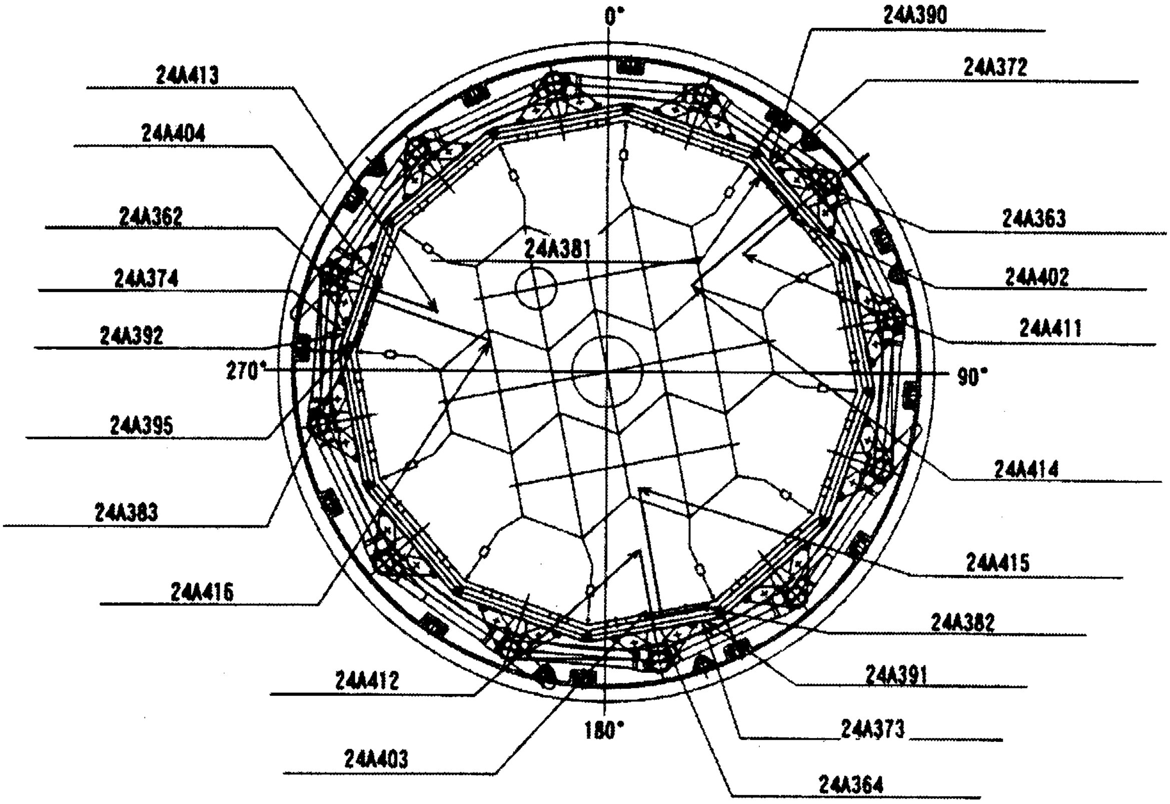


Fig. 9 Measuring position of A-A cross section (See Fig. 10)

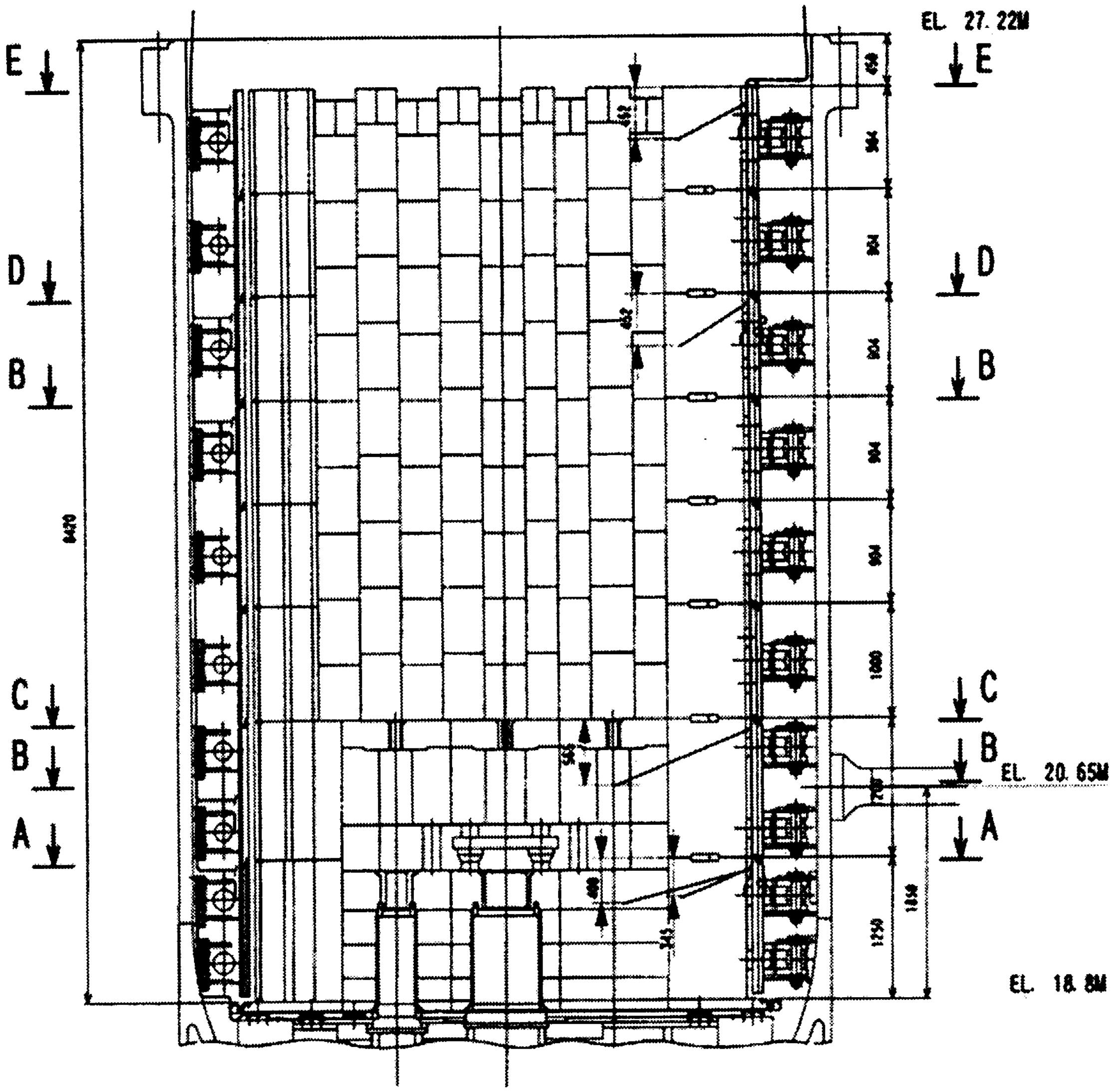


Fig. 10 Vertical cross-section view of RPV

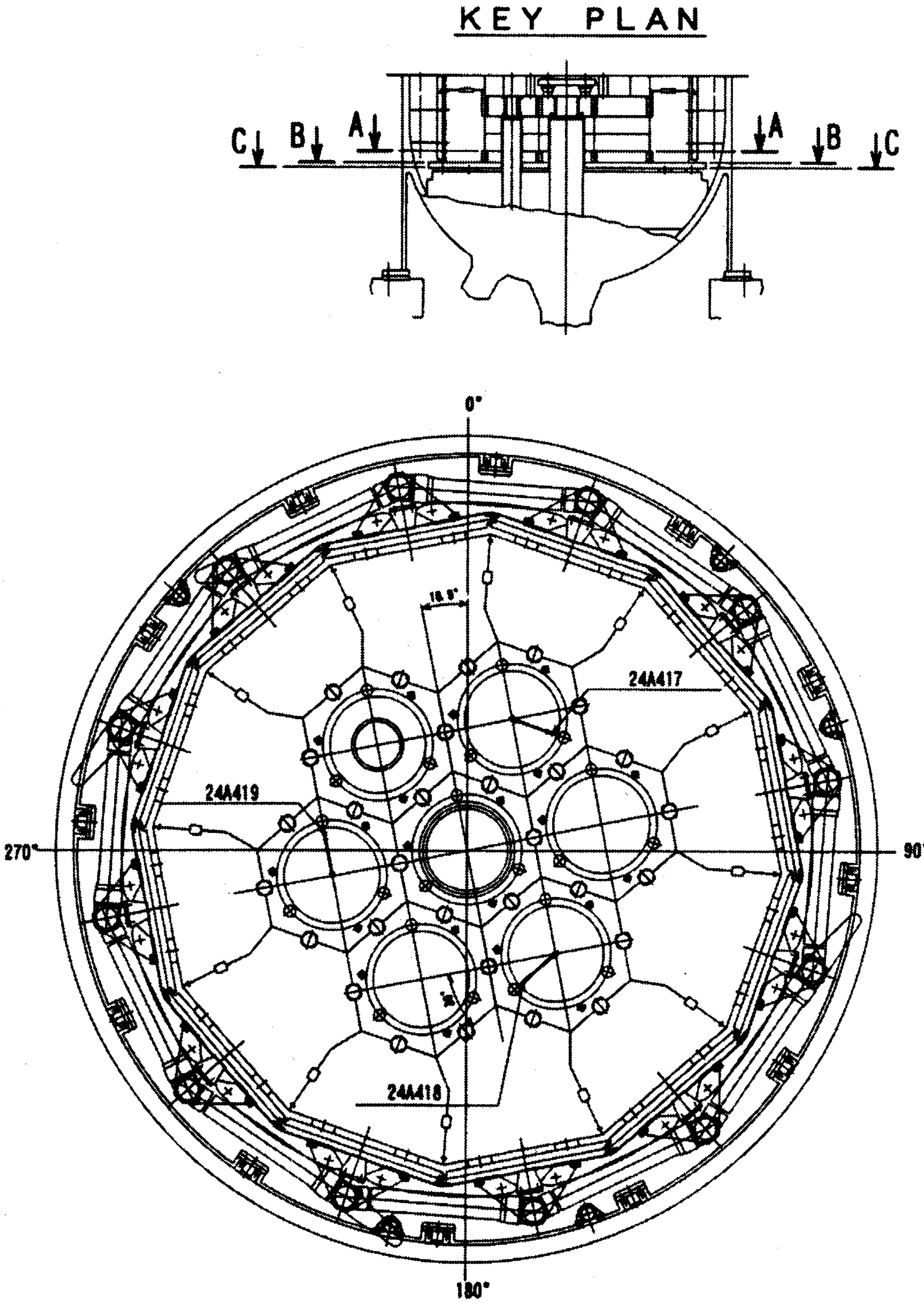


Fig. 11 Measuring position of A-A cross section

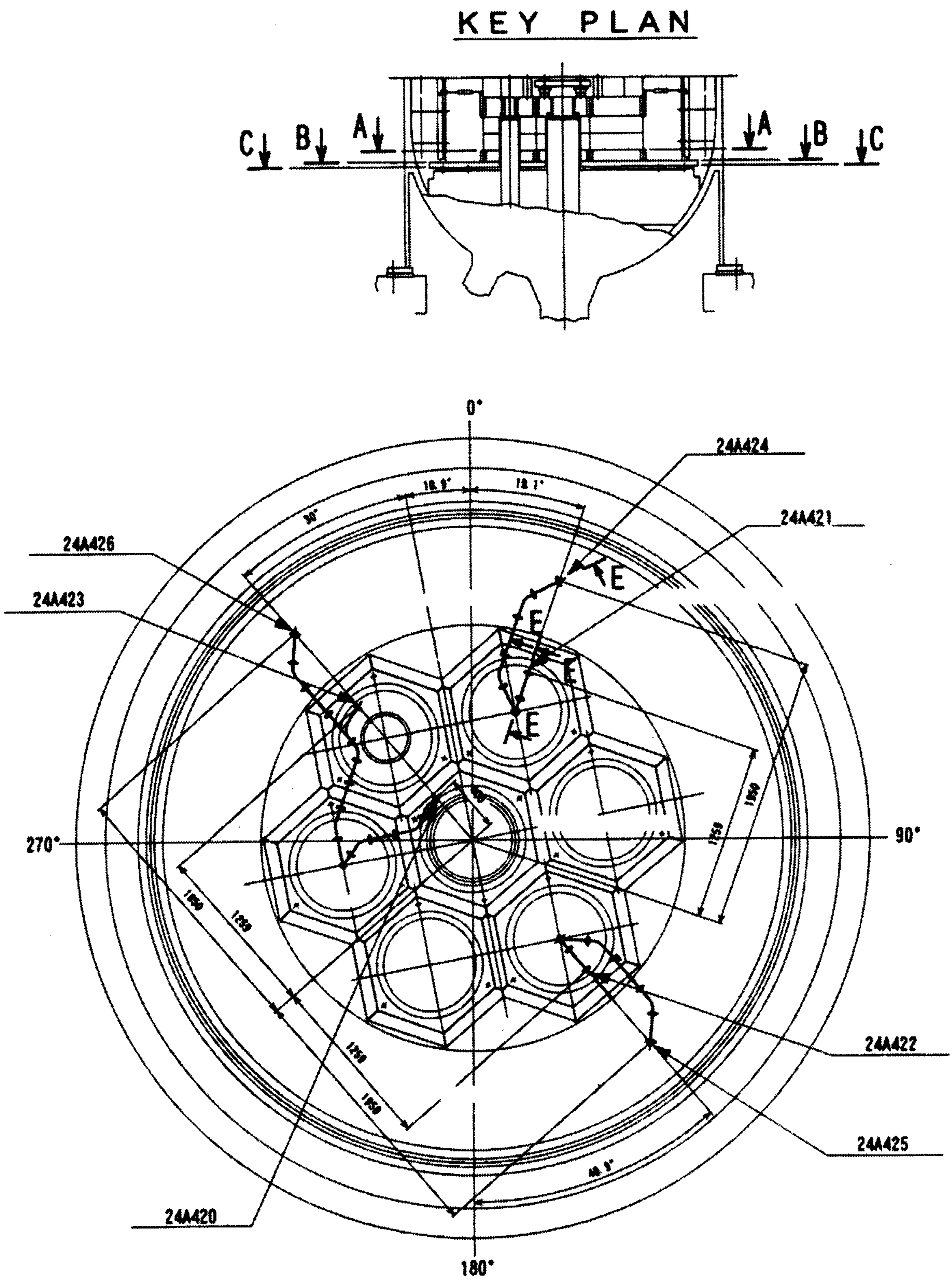
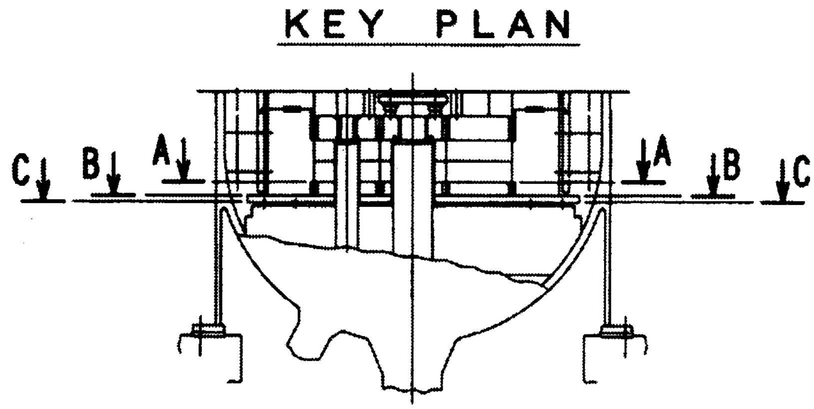


Fig. 12 Measuring position of B-B cross section



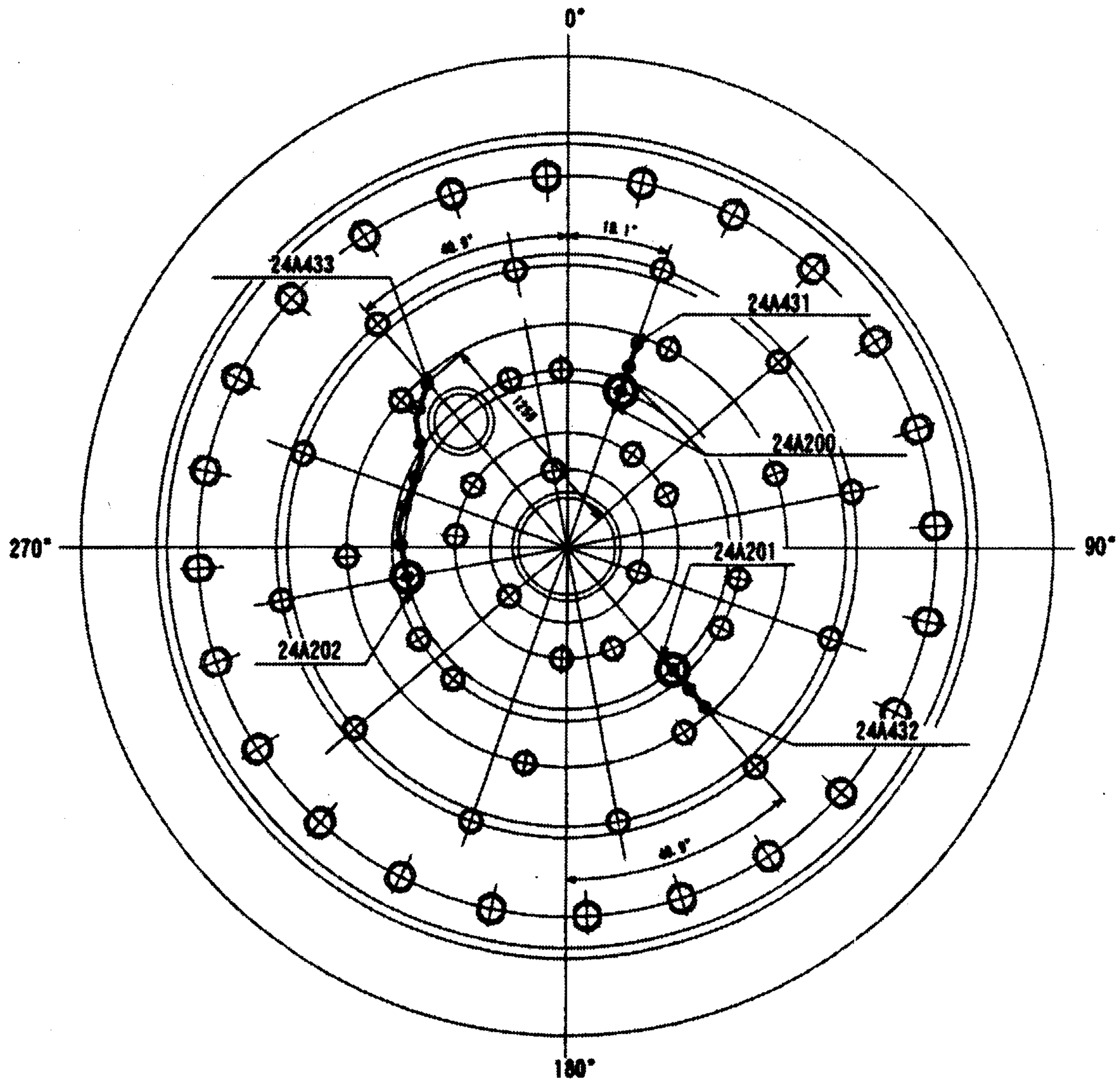
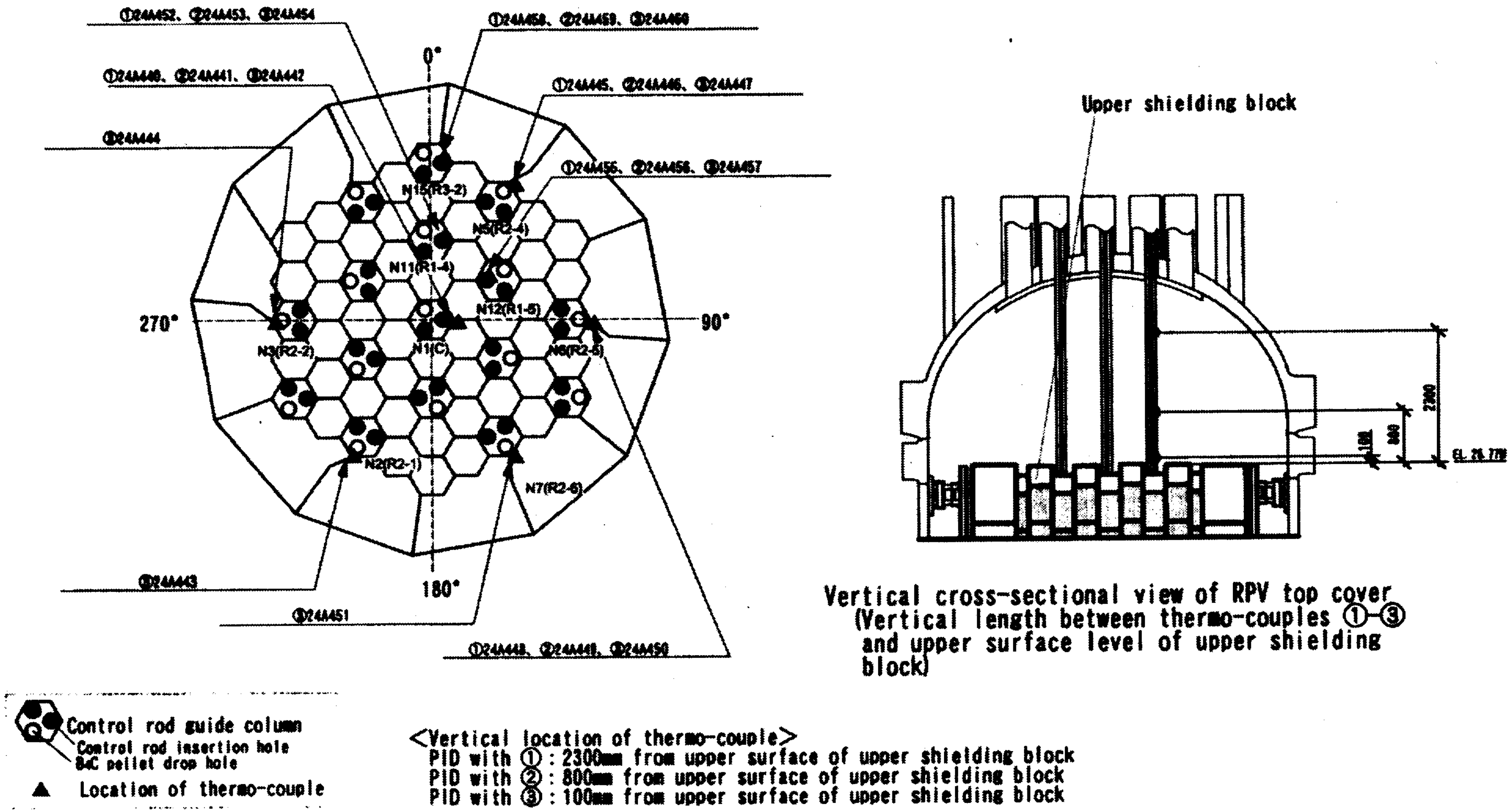


Fig. 13 Measuring position of C-C cross section



Horizontal cross-sectional view of core
(Upper surface level of upper shielding block)

Fig. 14 Measuring position for core inlet coolant temperature

国際単位系 (SI) と換算表

表1 SI基本単位および補助単位

量	名 称	記 号
長さ	メートル	m
質量	キログラム	kg
時間	秒	s
電流	アンペア	A
熱力学温度	ケルビン	K
物質量	モル	mol
光度	カンデラ	cd
平面角	ラジアン	rad
立体角	ステラジアン	sr

表2 SIと併用される単位

名 称	記 号
分，時，日	min，h，d
度，分，秒	°，′，″
リットル	l，L
トン	t
電子ボルト	eV
原子質量単位	u

$1\ \mathrm{eV}=1.60218\times10^{-19}\ \mathrm{J}$

$1\ \mathrm{u}=1.66054\times10^{-27}\ \mathrm{kg}$

表3 固有の名称をもつSI組立単位

量	名 称	記号	他のSI単位による表現
周波数	ヘルツ	Hz	s^{-1}
力	ニュートン	N	$m\cdot kg/s^2$
圧力，応力	パスカル	Pa	N/m^2
エネルギー，仕事，熱量	ジュール	J	N·m
工率，放射束	ワット	W	J/s
電気量，電荷	クーロン	C	A·s
電位，電圧，起電力	ボルト	V	W/A
静電容量	ファラド	F	C/V
電気抵抗	オーム	Ω	V/A
コンダクタンス	ジーメンス	S	A/V
磁束	ウェーバ	Wb	V·s
磁束密度	テスラ	T	Wb/m^2
インダクタンス	ヘンリー	H	Wb/A
セルシウス温度	セルシウス度	℃	
光束	ルーメン	lm	cd·sr
照度	ルクス	lx	lm/m^2
放射能	ベクレル	Bq	s^{-1}
吸収線量	グレイ	Gy	J/kg
線量当量	シーベルト	Sv	J/kg

表4 SIと共に暫定的に維持される単位

名 称	記 号
オングストローム	Å
バーン	b
バール	bar
ガル	Gal
キュリー	Ci
レントゲン	R
ラド	rad
レム	rem

$1\ \text{Å}=0.1\ \mathrm{nm}=10^{-10}\ \mathrm{m}$

$1\ \mathrm{b}=100\ \mathrm{fm}^2=10^{-28}\ \mathrm{m}^2$

$1\ \mathrm{bar}=0.1\ \mathrm{MPa}=10^5\ \mathrm{Pa}$

$1\ \mathrm{Gal}=1\ \mathrm{cm/s^2}=10^{-2}\ \mathrm{m/s^2}$

$1\ \mathrm{Ci}=3.7\times10^{10}\ \mathrm{Bq}$

$1\ \mathrm{R}=2.58\times10^{-4}\ \mathrm{C/kg}$

$1\ \mathrm{rad}=1\ \mathrm{cGy}=10^{-2}\ \mathrm{Gy}$

$1\ \mathrm{rem}=1\ \mathrm{cSv}=10^{-2}\ \mathrm{Sv}$

表5 SI接頭語

倍数	接頭語	記 号
10^{18}	エクサ	E
10^{15}	ペタ	P
10^{12}	テラ	T
10^{9}	ギガ	G
10^{6}	メガ	M
10^{3}	キロ	k
10^{2}	ヘクト	h
10^{1}	デカ	da
10^{-1}	デシ	d
10^{-2}	センチ	c
10^{-3}	ミリ	m
10^{-6}	マイクロ	μ
10^{-9}	ナノ	n
10^{-12}	ピコ	p
10^{-15}	フェムト	f
10^{-18}	アト	a

(注)

1. 表1－5は「国際単位系」第5版，国際度量衡局 1985年刊行による。ただし，1 eV および1 uの値はCODATAの1986年推奨値によった。
2. 表4には海里，ノット，アール，ヘクタールも含まれているが日常の単位なのでここでは省略した。
3. barは，JISでは流体の圧力を表わす場合に限り表2のカテゴリーに分類されている。
4. EC閣僚理事会指令ではbar，barnおよび「血圧の単位」mmHgを表2のカテゴリーに入れている。

換　算　表

力	N($=10^5$dyn)	kgf	lbf
	1	0.101972	0.224809
	9.80665	1	2.20462
	4.44822	0.453592	1

粘　度　$1\ \mathrm{Pa\cdot s(N\cdot s/m^2)}=10\ \mathrm{P}$(ポアズ)(g/(cm·s))

動粘度　$1\ \mathrm{m^2/s}=10^4\mathrm{St}$(ストークス)($\mathrm{cm^2/s}$)

圧力	MPa(=10 bar)	kgf/cm^2	atm	mmHg(Torr)	lbf/in^2(psi)
	1	10.1972	9.86923	7.50062×10^3	145.038
	0.0980665	1	0.967841	735.559	14.2233
	0.101325	1.03323	1	760	14.6959
	1.33322×10^{-4}	1.35951×10^{-3}	1.31579×10^{-3}	1	1.93368×10^{-2}
	6.89476×10^{-3}	7.03070×10^{-2}	6.80460×10^{-2}	51.7149	1

エネルギー・仕事・熱量	J($=10^7$erg)	kgf·m	kW·h	cal(計量法)	Btu	ft·lbf	eV
	1	0.101972	2.77778×10^{-7}	0.238889	9.47813×10^{-4}	0.737562	6.24150×10^{18}
	9.80665	1	2.72407×10^{-6}	2.34270	9.29487×10^{-3}	7.23301	6.12082×10^{19}
	3.6×10^{6}	3.67098×10^{5}	1	8.59999×10^{5}	3412.13	2.65522×10^{6}	2.24694×10^{25}
	4.18605	0.426858	1.16279×10^{-6}	1	3.96759×10^{-3}	3.08747	2.61272×10^{19}
	1055.06	107.586	2.93072×10^{-4}	252.042	1	778.172	6.58515×10^{21}
	1.35582	0.138255	3.76616×10^{-7}	0.323890	1.28506×10^{-3}	1	8.46233×10^{18}
	1.60218×10^{-19}	1.63377×10^{-20}	4.45050×10^{-26}	3.82743×10^{-20}	1.51857×10^{-22}	1.18171×10^{-19}	1

1 cal = 4.18605 J (計量法)
　= 4.184 J　(熱化学)
　= 4.1855 J　(15 °C)
　= 4.1868 J (国際蒸気表)

仕事率　1 PS (仏馬力)
　= 75 kgf·m/s
　= 735.499 W

放射能	Bq	Ci
	1	2.70270×10^{-11}
	3.7×10^{10}	1

吸収線量	Gy	rad
	1	100
	0.01	1

照射線量	C/kg	R
	1	3876
	2.58×10^{-4}	1

線量当量	Sv	rem
	1	100
	0.01	1

(86年12月26日現在)

Safety Demonstration Test (S1C-2/S2C-1) Plan using the HTTR (Contract Research)