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EXPERIMENT DATA OF ROSA-III INTEGRAL TEST, RUN 710 (FULL ECCS ACTUATION, WITHOUT HEAT GENERATION IN CHANNEL A)

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The report presents data of RUN 710 at ROSA-III test facility. RUN 710 simulates a 200% double-ended break at the inlest side of a recirculation pump of a BWR. All ECCS are activated and electric power to simulated fuel rods in one core channel among four is not supplied in RUN 710. The primary initial conditions are steam dome pressure 7.35 MPa, lower plenum subcooling 10.8 K, core inlet flow rate 31.3 kg/s and core heat generation 2.42 MW. Peak cladding temperature is 609 K at Position 3, 352.5 mm above the mid plane of the core. All heater rods are quenched after ECCS actuation and the effectiveness of ECCS is confirmed.

Keywords : BWR, LOCA, ECCS, Integral test, ROSA-III Facility, Blowdown

ROSA－Ⅲ実験データレポート ： RUN710
（全ECCS作動，1チャンネル発熱無し）

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本報はROSA－Ⅲ実験装置における実験RUN710の実験データレポートである。RUN710はBWRの再循環ポンプ吸込側配管の200％両端破断を模擬した実験である。実験は，すべてのECCSを作動させ，炉心4チャンネルのうち1チャンネルを発熱させないで行った。主な実験初期条件は系圧力7.35MPa，炉心入口サブクーリング10.8K，炉心入口流量31.3kg／s，炉心発熱量2.42MWである。最高被覆管温度は609Kで炉心中央面から352.5mm上，Position 3で得られた。すべての模擬燃料棒はECCS作動後クエンチし，ECCSの有効性を確認した。

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ABBREVIATIONS

Systemes

ROSA	Rig of Safety Assessment
BWR	Boiling Water Reactor
LBWR	Large Boiling Water Reactor
ECCS	Emergency Core Cooling System
HPCS	High Pressure Core Spray
LPCS	Low Pressure Core Spray
LPCI	Low Pressure Coolant Injection
ADS	Automatic Depressurization System

Vessels

PV	Pressure Vessel
PWT	Pure Water Tank
FWT	Feed Water Tank
AT	Air Tank
CWT	Cooling Water Tank
HPCST	High Pressure Core Spray Tank
LPCST	Low Pressure Core Spray Tank
LPCIT	Low Pressure Coolant Injection Tank
POOL	Pool

Pumps

JP	Jet Pump
MRP	Main Recirculation Pump
HPWP	High Pressure Water Pump
WSP	Water Supply Pump
FWP	Feed Water Pump
HPCSP	High Pressure Core Spray Pump
LPCSP	Low Pressure Core Spray Pump
LPCIP	Low Pressure Core Injection Pump

Piping

V	Valve
AV	Air actuation Valve
CV	Control Valve
CHV	Check Valve
QSV	Quick Shut-off Valve
OR	Orifice
RD	Rupture Disk
RCN	Rapid Condencer
(2)B	(2) inchs pipe of Schedule 80
DL(+100)	Elevation (+100 mm) from the bottom of PV

Measurements

P	Pressure
D	Differential Pressure
F	Flow Rate
T	Temperature
TS	Temperature of Solid
TF	Temperature of Fuel
L	Liquid Level
LB	Liquid Level in Channel Box
LL	Liquid Level in the Lower Plenum
S	Signal
W	Power
N	Rotation Speed
DF	Density of Fluid
M	Momentum Flux

Units

K	Kelvin
kg	Kilogram
ℓ	Liter
m	Meter
mm	Milimeter
MPa	Megapascal
rpm	Revolution per Minute
s	Second
W	Watt

Miscellaneous

ESF	Engineered Safety Features
LOCA	Loss-of-Coolant Accident
LOCE	Loss-of-Coolant Experiment
MLHR	Maximum Linear Heat Rate

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 (ECCS), and the quantitative magins 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 (LOCE) 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.

Run 710, conducted on August 1, 1979, is a blowdown test with full ECCS actuation, simulating a double-ended break on the inlet side of a recirculation pump. Heat generation in the core simulates decay-heat power, delayed neutron fission power and stored heat release of actual fuel rods after the break. Heater power is not supplied to Channel A to examine the effect of low power channel to the thermo-hydraulic phenomena during a LOCA.

The primary objectives of the test were to:

(1) Provide data to evaluate ROSA-III emergency core cooling system (ECCS) scaling techniques in the blowdown of a system.

(2) Provide integral system code assessment data on a double-ended break at the recirculation pump inlet side.

Run 710 was conducted from initial conditions of 7.35 Mpa and 553 K in the steam dome of the pressure vessel. The subcooling in the lower plenum was 10.8 K. The core inlet flow rate was 31.3 kg/s and the core outlet quality was 1.9 %. The steady state power for the core was 2.42 MW corresponding to 26.9 % of the BWR steady state power.

The purpose of this report is to present the data from Run 708 in an uninterpreted but readily usable form for use by the nuclear community in advance of datailed analysis and interpretation. Section II briefly describes the ROSA-III configuration, Section III discusses the ROSA-III instrumentation system and the methods of obtaining certain measurements, Section IV summarizes Run 710 initial conditions and test procedures, and Section V presents the data with supporting information for data interpretation. Section VI describes concluding remarks.

2. ROSA-III TEST FACILITY

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).

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 III. The ROSA-III major components and the pressure vessel internal structure are shown schematically in Figure 2.1 and 2.2, respectively. The ROSA-III piping system is shown in Figure 2.3, and the major characteristics of the ROSA-III facility are compared with those of a LBWR in Table 2.1.

The pressure vessel 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. The core is composed of four half-length simulated fuel assemblies and a control rod simulator. Each fuel assembly contains 63 fuel rods which are spaced and supported in a square (8 × 8) array by lower and upper tie plates. The simulated fuel rod is heated electrically with chopped-cosine axial power distribution. The effective heated length is 1880 mm, one half of the active length of a BWR fuel rod. The orifice plate assembly at core inlet simulates the flow resistance of the nuclear core.

The steam line and the feedwater line simulate those of a BWR. Steam is discharged into the atmosphere through the steam line connected to the steam dome. The steam line has three branches. The first branch has a control valve 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 first branch to the third one. The feedwater line is connected to the feedwater sparger located above the downcomer region. The feedwater is preheated in heat exchangers (EX1 and EX2) and supplied to the feedwater sparger.

The coolant recirculation system simulates the BWR recirculation loop. The system consists of two loops provided with a recirculation pump and two jet pumps in each loop. One 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 to simulate a double-ended shear break or a split break. Each break simulator is composed of 30 cm long nozzle which determines the break area, a rupture disk, and a spear to break the rupture disk. 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 nozzle diameter of 26.2 mm. The flow area of the nozzle corresponds to 1/424 of the recirculation loop piping flow area of a BWR/6.

The ECCS of ROSA-Ⅲ simulates that of the BWR, including HPCS, LPCS, LPCI and ADS. The spray systems, the HPCS and the LPCS, spray the emergency cooling water on the top of the core. The LPCI system supplies the emergency cooling water into the core-shroud directly. 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 pump flow rate.

Piping of recirculation line was changed a little after RUN 706 to reduce the flow resistance for better simulation of BWR piping.

3. INSTRUMENTATION

The instrumentation system of the ROSA-III was designed to obtain thermo-hydraulic data in a BWR LOCA to contribute to assess the analytical code. The channel configuration of the instrumentation differs following the renewal of the simulated fuel assembly or remodeling of the loop system. The measurement list for the present run is shown in Table 3.1. Most of the measurements are recorded on the main data acquisition system (DATAC-2000B) with a half-inch width magnetic tape and the rest are recorded on the supplemental recording system with a casset tape of 100 channel capacity (cf. Table 3.2). The list number corresponds to the fuel assembly number. In the case of list with two figures the first digit indicates the fuel assembly number and the second digit indicates the revised version number of the instrumentation system for the same assembly.

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 for the after power simulation and it is measured by fast response electric power meter.

Pump revolution speed is measured by counting the number of gear blades on the axis of a pump.

On-off signals such as valve position, pump revolution direction, rupture disk break 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.

Temperatures of fluid, structure materials and fuel rods are measured with thermocouples of 1.6 mmϕ or 1.0 mmϕ.

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 liquid water or steam at each level.

The void fraction of fluid is measured by a needle type electrical resistance probe or a correlation type electrical capacitance probe. The former detects passing bubble and the void fraction is obtained by integrating the void signal. The latter detects the average void distribution around the probe with the capacitance. The correlation between two sensors gives the velocity of the bubble.

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 Cs-137 and the detector is NaI scintillator which is cooled by water.

Flow direction in the core is measured from the canti-lever contact signal. The canti-lever is moved to the direction of the fluid flow and generates a contact signal.

Two-phase flow rate measurement is done by means of the combination of two signals from drag disk, turbine and gamma ray densitometer in a pipe.

Some of measurement methods described above are still under development and further improvements are expected in accuracy and reliability.

The measurement location of each instrumentation in the measurement list are shown in the figures of flow diagram, loop instrumentation, in-vessel instrumentation, or in-core instrumentation (Figs. 3.1 - 3.14).

Simulated fuel rods are named by one aplhabet and two numerals. Alphabet shows the fuel channel, the first and the second numerals show column and row in 8×8 fuel rod array, respectively, for the heater channel C. Fuel rods in other channels are named after rotating about the center of control rod simulator to the channel C. For example, C27 shows fuel rod in the second column and seventh row of fuel rod array in the fuel channel C. A17 shows fuel rod in the eighth column and second row of fuel rod array in the fuel channel A.

The data acquisition system utilizes two recording systems of major and minor importance. The data recorded on the magnetic tape of the main acquisition system are processed by the FACOM 203-75 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 tape is re-processed using the correct conversion factors determined from consistency examination. Data processing program developed for the ROSA-III test can compare the measured data in a figure not only with other channels of the same test but also with the data of other runs or with calculated results by LOCA analysis code such as RELAP or ALARM.

Instrumentation and data processing is described in reference [2].

4. TEST CONDITIONS

The test conditions of Run 710 are summarized in Table 4.1. Run 710 simulates a 200% double-ended break at the recirculation pump suction side. The pressure in the steam dome of the pressure vessel is 7.35 MPa and the temperature is its saturated value, 562K. The initial lower plenum subcooling is 10.8K. The core inlet flow rate is 31.3 kg/s and the core outlet quality is estimated to be 1.9 %. Initial recirculation flow rates of the broken loop and the intact loop are 0.0209 m^3/s and 0.0208 m^3/s, respectively. Steady state steam discharge flow rate was 1.1 kg/s.

The steady state power is 2.42 MW which corresponds to 26.9 % of the BWR steady state power, and the maximum linear heat rate (MLHR) was 9.56 kW/m. The transient power simulated decay heat power, delayed neutron fission power and stored heat release from BWR fuel rods. Measured transient power is shown in Fig. 5.39 and Fig. 5.40. In RUN 710 heat is not generated in Channel A.

The steam line and feedwater line are independent open loops for the present test. Each line has steady and transient lines as shown in the flow diagram Fig. 3.1 and the steady line is switched to the transient line at the time of break. Each line has a flow meter. The closure of the valves in the steam line and feedwater line takes a few seconds as shown in Fig. 5.42. The steady flow line of main steam were closed at 1.0 s and transient flow line began to open at 0.6 s and completely opened at 1 s. This line initiated closing at 3.5 s and closed completely at 5 s. The feedwater line initiated closing at 2 s and completely closed at 3 s. It takes 1.5 and 1.0 s for closing transient steam line and feedwater line, respectively. The valve characteristics are shown in Table 4.2.

5. DATA PRESENTATION

The sequence of major events are surmmarised in Table 5.1. Feedwater line and steam line were completely closed at 4.8 s and 8.6 s after initiation of break, respectively. The recirculation suction line outlet from downcomer uncovered at 17 s and high quality fluid flowed out from the vessel side of the break thereafter. Heater rod surfaces above Position 3 in Channel B, C, and D exposed to steam at 16 s and rewetted at 20.6 s due to the initiation of a lower plenum flashing at 17 s. The HPCS was initiated at 20.0 s after break. Heater rod surfaces above Position 4 in Channel B, C and D reexposed to steam at 60 s. The LPCS and LPCI were initiated at 67 s and 79.6 s, respectively. All heater rods were quenched at 98 s and the mixture level in the core recovered at 100 s. ADS valve was opened at 112 s and closed at 480 s approximately. Heater rod surface temperature in Channel A simply decreased with time because of no heat generation, however, some exposure to steam was observed above the midplane of the core.

Figure 5.1 through 5.7 show pressure transients in the vessel and loops. Figure 5.8 through Fig. 5.33 give differential pressure through the vessel and loops. In Fig. 5.12 CH 27 and CH 29 are over the scale due to inadequate settings of the measurement range.

Figure 5.34 through Fig. 5.38 show flowrate.

Figure 5.39 and Fig. 5.40 show power supplies for simulated fuel rods with the maximum capacities of 550 and 2100 kW. The 1800 kW power system was not used and heat was not generated in Channel A.

Pump rotations of recirculation pumps in the intact and broken loops are shown in Fig. 5.41. The rotation of broken loop pump reversed at 3.7 s.

Major operational signals of breaks and valves are shown in Fig. 5.42.

Figure 5.43 through Fig. 5.65 give the fluid temperatures. In the figures the fluid temperatures at the bottom of the lower plenum and upper plenum, CH 276 and CH 66 are presented as the basis for comparison, which are nearly equal to the saturation temperature in the system after the initiation of a lower plenum flashing at 17 s.

Structure wall temperatures are shown in Fig. 5.77 through Fig. 5.82. The data of CH 276 is also presented in the figures.

Conductivity signals in the core and the lower plenum are shown in Fig. 5.83 through Fig. 5.86. High value indicates a liquid phase and low value indicates a vapor phase.

Heater rod surface temperatures are shown in Fig. 5.87 through Fig. 5.121. In the figures the fluid temperature in the lower plenum, CH 276 is also shown as the basis for comparison. The heater rod surface temperatures are compared in the figures showing the axial distribution along the heater rod and the horizontal distribution in the core.

The mixture level variation in the lower plenum and the core obtained from the conductivity probe signals are shown in Fig. 5.122. In the figure heater rod surface conditions are also presented.

6. CONCLUDING REMARKS

The conduct of ROSA-III experiment Run 710 and the experimental data acquired concerning integral system phenomena associated with a loss of coolant are considered to have met the objectives as described in section I.

The ROSA-III facility and its instrumentation worked well, and the obtained experimental data are useful for assessing computer codes for BWR LOCA/ECCS analyses in the blowdown from a 200 % double-ended break at recirculation pump suction. Electric power for the core simulates decay-heat power, delayed neutron fission power and stored heat release of BWR fuel rods.

ACKNOWLEDGMENT

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Table 2.1 Primary Characteristics of BWR-6 and ROSA-III

	BWR-6	ROSA-III	BWR/ROSA
No. of Recirc. Loops	2	2	1
No. of Jet Pumps	24	4	6
No. of Separators	251	1	251
No. of Fuel Assemblies	848	4	212
Active Fuel Length (m)	3.76	1.88	2
Total Volume (m^3)	621	1.42	437
Power (MW)	3800	< 4.24	> 896
Pressure (MPa)	7.23	7.23	1
Core Flow (kg/s)	1.54×10^4	< 36.4	> 424
Recirculation Flow (l/s)	2970	7.01	424
Feedwater Flow (kg/s)	2060	4.86	424
Feedwater Temp (K)	489	489	1

Table 3.1 ROSA-III measurement list 21

CH. No.	Item	Symb.	Location	Descriptions	LOC. Fig. No.	Range & Output	Accu-racy	Data Fig. No.	Measurement comments
1	Press.	P- 1	Lower Plenum		3.2	0∿100kg/cm^2 0∿ 10 V	±1.08 %F.S.	5.1	Initial values are adjusted to precise pressure gauge data
2	"	P- 2	Mixing Plenum		"	"	"	"	
3	"	P- 3	Steam Dome		"	"	"	"	
4	"	F- 4	Downcomer Bottom		"	"	"	"	
5	"	P- 5	JP-3 Drive	broken loop	3.3	"	"	5.2	
6	"	P- 6	JP-4 Drive	"	"	"	"	"	
7	"	P- 7	JP-3 Suction	"	"	"	"	"	
8	"	P- 8	JP-4 Suction	"	"	"	"	"	
9	"	P- 9	MRP-1 Suction	intact loop	3.4	"	"	5.3	
10	"	P-10	MRP-2 Suction	broken loop	3.3	"	"	"	
11	"	P-11	MRP-2 Discharge	"	"	"	"	"	
12	"	P-12	Above Break A	pump side	"	"	"	5.4	
13	"	P-13	Below Break A	"	"	"	"	"	
14	"	P-14	Above Break B	vessel side	"	"	"	5.5	
15	"	P-15	Below Break B	"	"	"	"	"	
16	"	P-16	Steam Line	"	"	"	"	5.1	
17	Diff.P	D- 1	Lower Pl.-Mixing Pl.		3.2	-0.5∿3.5kg/cm^2 2∿ 10 V	±0.63 %F.S.	5.8	
18	"	D- 2	Mixing Pl.-Steam Dome		"	-0.1∿0.9kg/cm 2∿ 10 V	"	"	

CH. No.	Item	Symb.	Location	Description	LOC. Fig. No.	Range & Output	Accu-racy	Data Fig. No.	Measurement comments
19	Diff.P	D- 3	Lower Plenum Head		3.2	0∿1.5kg/cm^2 2∿ 10 V	±0.63 %F.S.		not measured
20	"	D- 4	Downcomer Head		"	0∿1.0kg/cm^2 2∿ 10 V	"	5.9	
21	"	D- 5	PV. Bottom-Top		"	-1.0∿9.0kg/cm^2 2∿ 10 V	"	5.10	
22	"	D- 6	JP-1 Discharge-Suction	intact loop	3.4	-1.0∿3.0kg/cm^2 2∿ 10 V	"	5.11	
23	"	D- 7	JP-1 Drive-Suction	"	"	0∿ 25kg/cm^2 2∿ 10 V	"	5.12	
24	"	D- 8	JP-2 Discharge-Suction	"	"	-1.0∿3.0kg/cm^2 2∿ 10 V	"	5.11	
25	"	D- 9	JP-2 Drive-Suction	"	"	0∿ 25kg/cm^2 2∿ 10 V	"	5.12	
26	"	D-10	JP-3 Discharge-Suction	broken loop	3.3	-1.0∿3.0kg/cm^2 2∿ 10 V	"	5.11	
27	"	D-11	JP-3 Drive-Suction	"	"	-5.0∿ 25kg/cm^2 2∿ 10 V	"	5.12	
28	"	D-12	JP-4 Discharge-Suction	"	"	-1.0∿3.0kg/cm^2 2∿ 10 V	"	5.11	
29	"	D-13	JP-4 Drive-Suction	"	"	-5.0∿ 25kg/cm^2 2∿ 10 V	"	5.12	
30	"	D-14	MRP-1 Discharge-Suction	intact loop	3.4	-1.0∿ 25kg/cm^2 2∿ 10	"	5.13	
31	"	D-15	MRP-2 Discharge-Suction	broken loop	3.3	-1.0∿ 25kg/cm^2 2∿ 10	"	"	

CH. No.	Item	Symb.	Location	Description	LOC. Fig. No.	Range & Output	Accu-racy	Data Fig. No.	Measurement comments
32	Flow	F- 1	Main Steam Line		3.6	0∿ 15kg/sec 2∿ 10 V	±0.92 %F.S.	5.34	
33	"	F- 2	ADS. Steam Line		"	0∿3.0kg/sec 2∿ 10 V	"	"	
34	"	F- 3	Condensed Water A		3.5	0∿250kg/sec 2∿ 10 V	±1.4% F.S.		not qualified
35	"	F- 4	Cooling Water A		"	"	"		"
36	"	F- 5	Condensed Water B		"	"	"		"
37	"	F- 6	Cooling Water B		"	"	"		"
38	"	F- 7	HPCS(Mixing Plenum)	not used	3.1	0∿150ℓ/min 2∿ 10 V	±0.79 %F.S.	5.35	
39	"	F- 8	HPCS(Lower Plenum)	"	"	"	"		not used
40	"	F- 9	LPCS(Mixing Plenum)	"	"	"	"	5.35	
41	"	F-10	LPCS(Lower Plenum)	"	"	"	"		not used
42	"	F-11	LPCI(Mixing Plenum)	"	"	0∿500ℓ/min 2∿ 10 V	"	5.35	
43	"	F-12	LPCI(Lower Plenum)	"	"	"	"		not used
44	"	F-13	LPCI MRP-2 Suction	"	"	0∿250ℓ/min 2∿ 10 V	"		"
45	"	F-14	LPCI MRP-1 Suction	"	"	"	"		"
46	"	F-15	Transient Feed Water		3.7	0∿600ℓ/min 2∿ 10 V	"	5.36	
47	"	F-16	Steady Feed Water		"	0∿250ℓ/min 2∿ 10 V	"	"	

CH. No.	Item	Symb.	Location	Description	LOC. Fig. No.	Range & Output	Accu-racy	Data Fig. No.	Measurement comments
48	Flow	F-17	JP-1 Discharge	intact loop	3.4	0∼1000ℓ/min 2∼ 10 V	±0.88 %F.S.	5.37	
49	"	F-18	JP-2 Discharge	"		"	"	"	
50	"	F-19	JP-3 Discharge +	broken loop	3.3	"	±0.92 %F.S.	"	
51	"	F-20	JP-3 Discharge −	reverse flow	"	0∼ 300ℓ/min 2∼ 10 V	"	5.38	
52	"	F-21	JP-4 Discharge +		"	0∼1000ℓ/min 2∼ 10 V	"	5.37	
53	"	F-22	JP-4 Discharge −	reverse flow	"	0∼ 300ℓ/min 2∼ 10 V	"	5.38	
54	Power	W- 1	550 KVA Power			0∼ 550 KVA 0∼ 10 V	±1.0% F.S.	5.39	
55	"	W- 2	1800 KVA Power			0∼1700 KVA 0∼ 10 V	"		not used
56	"	W- 3	2100 KVA Power			0∼2100 KVA 0∼ 10 V	"	5.40	
57	Rev.No.	N- 1	MRP-1	intact loop	3.4	0∼5000rpm 0∼ 10 V	±1.08 %F.S.	5.41	
58	"	N- 2	MRP-2	broken loop	3.3	"	"	"	
59	Signal	S- 1	Break Signal A		3.5	0 ∼ 5 V	-	5.42	cf. sequence of events
60	"	S- 2	Break Signal B		"	"	-	"	(Table 5.1)
61	"	S- 3	QSV Signal		"	close ∼ open 0 ∼ 5 V	-	"	
62	"	S- 9	Transient Feed Water		3.7	"	-	"	

CH. No.	Item	Symb.	Location	Description	LOC. Fig. No.	Range & Output	Accu-racy	Data Fig. No.	Measurement comments
63	Signal	S-10	Main Steam Isolation Valve		3.6	close ∿ open 0 ∿ 5 V	-	5.42	
64	"	S-11	Steam Line Valve		"	"	-	"	
65	Temp.	T- 1	Lower Plenum	Recirculation inlet fluid temp.	3.8	0 ∿ 400°C 0 ∿ 10 V	±0.64 %F.S.	5.43	
66	"	T- 2	Mixing Plenum	fluid temp.	3.2	"	"	"	
67	"	T- 3	Steam Dome	"	"	"	"	"	
68	"	T- 4	Upper Downcomer	"	"	"	"	"	
69	"	T- 5	Lower Downcomer	"	3.8	"	"	"	
70	"	T- 6	JP-1 Driving Water	"	3.4	"	"	5.44	
71	"	T- 7	JP-2 Driving Water	"	"	"	"	"	
72	"	T- 8	JP-3 Driving Water	"	3.3	"	"	5.45	
73	"	T- 9	JP-4 Driving Water	"	"	"	"	"	
74	"	T-10	JP-1 Discharge	"	3.4	"	"	5.44	
75	"	T-11	JP-2 Discharge	"	"	"	"	"	
76	"	T-12	JP-3 Discharge	"	3.3	"	"	5.45	
77	"	T-13	JP-4 Discharge	"	"	"	"	"	
78	"	T-14	MRP-1 Suction	"	3.4	"	"	5.44	
79	"	T-15	MRP-1 Discharge	"	"	"	"	"	
80	"	T-16	MRP-2 Suction	"	3.3	"	"	5.45	
81	"	T-17	MRP-2 Discharge	"	"	"	"	"	
82	"	T-18	Above Break A	"	3.5	"	"	5.46	

CH. No.	Item		Location	Description	LOC. Fig. No.	Range & Output	Accu-racy	Date Fig. No.	Measurement comments
83	Temp.	T-19	Above Break B	fluid temp	3.5	0∿400°C 0∿ 10 V	±0.64 %F.S.	5.46	
84	"	T-20	Condensed Water A	"	"	"	"		not qualified
85	"	T-21	Condensed Water B	"	"	"	"		"
86	"	T-22	Discharged Steam Above V.	"	3.6	"	"	5.48	
87	"	T-23	Discharged Steam Below V.	"	"	"	"	"	
88	"	TS-15	Dummy Block B Side 3	Slab surface temp.	3.11	"	"	5.77	
89	"	TS-18	Dummy Block B Side 6	"	"	"	"	"	
90	"	TS-21	Dummy Block O Side 9	"	"	"	"	"	
91	"	TS-24	Dummy Block O Side 12	"	"	"	"	"	
92	"	TS-25	JP-1 Diffuser Wall	Slab temp.	3.4	"	"	5.78	
93	"	TS-26	JP-2 Diffuser Wall	"	"	"	"	"	
94	"	TS-27	JP-3 Diffuser Wall	"	3.3	"	"	"	
95	"	TS-28	JP-4 Diffuser Wall	"	"	"	"	"	
96	"	TS-29	PV. Wall Inside 1-1	"	3.8	"	"	5.79	
97	"	TS-30	PV. Inner Surface 1-2	"	"	"	"	"	
98	"	TS-31	PV. Inner Surface 1-3	Slab surface temp.	"	"	"	"	
99	"	TS-32	PV. Wall Inside 2	"	"	"	"	"	
100	"	TS-33	PV. Wall Inside 3	Slab temp.	"	"	"	"	
101	"	TS-34	PV. Wall Inside 4	"	"	"	"	"	
102	"	TS-35	Lower Plenum Inner Surface	Surface temp.	"	"	"	5.80	
103	"	TS-36	Lower Plenum Wall Inside	Slab temp.	"	"	"	"	

CH. No.	Item	Symb.	Location	Description	LOC. Fig. No.	Range & Output	Accu-racy	Data Fig. No.	Measurement comments
104	Temp.	TF2-1	A-11 Fuel Rod Pos. 3	Surface temp.	3.12	0~1200°C 0~ 10 V	±0.64 %F.S.	5.87	
105	"	TF2-2	" 4	"	"	"	"	"	
106	"	TF2-3	" 5	"	"	"	"	"	
107	"	- 4	A-13 Fuel Rod Pos. 3	"	"	"	"	5.88	
108	"	- 5	" 4	"	"	"	"	"	
109	"	- 6	" 5	"	"	"	"	"	
110	"	- 7	A-15 Fuel Rod Pos. 3	"	"	"	"	5.89	
111	"	- 8	" 4	"	"	"	"	"	
112	"	- 9	" 5	"	"	"	"	"	
113	"	-10	A-17 Fuel Rod Pos. 3	"	"	"	"	5.90	
114	"	-11	" 4	"	"	"	"	"	
115	"	-12	" 5	"	"	"	"	"	
116	"	-13	A-31 Fuel Rod Pos. 3	"	"	"	"	5.91	
117	"	-14	" 4	"	"	"	"	"	
118	"	-15	" 5	"	"	"	"	"	
119	"	-16	A-33 Fuel Rod Pos. 1	"	"	"	"	5.92	
120	"	-17	" 2	"	"	"	"	"	
121	"	-18	" 3	"	"	"	"	"	
122	"	-19	" 4	"	"	"	"	"	
123	"	-20	" 5	"	"	"	"	"	
124	"	-21	" 6	"	"	"	"	"	

CH. No.	Item	Symb.	Location	Description	LOC. Fig. No.	Range & Output	Accu-racy	Data Fig. No.	Measurement comments
125	Temp.	TF2-22	A-33 Fuel Rod Pos. 7	Surface temp.	3.12	0∿1200°C 0∿ 10 V	±0.64 %F.S.	5.92	
126	"	-23	A-35 Fuel Rod Pos. 3	"	"	"	"	5.93	
127	"	-24	" 4	"	"	"	"	"	
128	"	-25	" 5	"	"	"	"	"	
129	"	-26	A-37 Fuel Rod Pos. 3	"	"	"	"	5.94	
130	"	-27	" 4	"	"	"	"	"	
131	"	-28	" 5	"	"	"	"	"	
132	"	-29	A-51 Fuel Rod Pos. 3	"	"	"	"	5.95	
133	"	-30	" 4	"	"	"	"	"	
134	"	-31	" 5	"	"	"	"	"	
135	"	-32	A-53 Fuel Rod Pos. 3	"	"	"	"	5.96	
136	"	-33	" 4	"	"	"	"	"	
137	"	-34	" 5	"	"	"	"	"	
138	"	-35	A-57 Fuel Rod Pos. 3	"	"	"	"	5.97	
139	"	-36	" 4	"	"	0∿1220°C 0∿ 10 V	"	"	
140	"	-37	" 5	"	"	"	"	"	
141	"	-38	A-71 Fuel Rod Pos. 3	"	"	"	"	5.98	
142	"	-39	" 4	"	"	"	"	"	
143	"	-40	" 5	"	"	"	"	"	
144	"	-41	A-73 Fuel Rod Pos. 3	"	"	"	"	5.99	

CH. No.	Item	Symb.	Location	Descriptions	LOC. Fig. No.	Range & Output	Accu-racy	Data Fig. No.	Measurement comments
145	Temp.	TF2-42	A-73 Fuel Rod Pos. 4	Surface temp.	3.12	0∿1220°C 0∿ 10 V	±0.64 %F.S.	5.99	
146	"	-43	" 5	"	"	"	"	"	
147	"	-44	A-75 Fuel Rod Pos. 3	"	"	"	"	5.100	
148	"	-45	" 4	"	"	"	"	"	
149	"	-46	" 5	"	"	"	"	"	
150	"	-47	A-77 Fuel Rod Pos. 1	"	"	"	"	5.101	
151	"	-48	" 2	"	"	"	"	"	
152	"	-49	" 3	"	"	"	"	"	
153	"	-50	" 4	"	"	"	"	"	
154	"	-51	" 5	"	"	"	"	"	
155	"	-52	" 6	"	"	"	"	"	
156	"	-53	" 7	"	"	"	"	"	
157	"	-54	B-15 Fuel Rod Pos. 1	"	"	"	"	5.102	
158	"	-55	" 2	"	"	"	"	"	
159	"	-56	" 3	"	"	"	"	"	
160	"	-57	" 4	"	"	"	"	"	
161	"	-58	" 5	"	"	"	"	"	
162	"	-59	" 6	"	"	"	"	"	
163	"	-60	" 7	"	"	"	"	"	
164	"	-61	B-85 Fuel Rod Pos. 1	"	"	"	"	5.103	
165	"	-62	" 2	"	"	"	"	"	

CH. No.	Item	Symb.	Location	Descriptions	LOC. Fig. No.	Range & Output	Accuracy	Data Fig. No.	Measurement comments
166	Temp.	TF2-63	B-85 Fuel Rod Pos. 3	Surface temp.	3.12	0∼1220°C 0∼ 10 V	±0.64 %F.S.	5.103	
167	"	-64	" 4	"	"	"	"	"	
168	"	-65	" 5	"	"	"	"	"	
169	"	-66	" 6	"	"	"	"	"	
170	"	-67	" 7	"	"	0∼ 976°C 0∼ 10 V	"	"	
171	"	-68	C-11 Fuel Rod Pos. 3	"	"	"	"	5.104	
172	"	-69	" 4	"	"	"	"	"	
173	"	-70	" 5	"	"	"	"	"	
174	"	-71	C-13 Fuel Rod Pos. 3	"	"	"	"	5.105	
175	"	-72	" 4	"	"	"	"	"	
176	"	-73	" 5	"	"	"	"	"	
177	"	-74	C-15 Fuel Rod Pos. 3	"	"	"	"	5.106	
178	"	-75	" 4	"	"	"	"	"	
179	"	-76	" 5	"	"	"	"	"	
180	"	-77	C-31 Fuel Rod Pos. 3	"	"	"	"	5.107	
181	"	-78	" 4	"	"	"	"	"	
182	"	-79	" 5	"	"	"	"	"	
183	"	-80	C-33 Fuel Rod Pos. 1	"	"	"	"	5.108	
184	"	-81	" 2	"	"	"	"	"	
185	"	-82	" 3	"	"	"	"	"	

CH. No.	Item	Symb.	Location	Descriptions	LOC. Fig. No.	Range & Output	Accu-racy	Data Fig. No.	Measurement comments
186	Temp.	TF2-83	C-33 Fuel Rod Pos. 4	surface temp.	3.12	0~ 976°C 0~ 10 V	±0.64 %F.S.	5.108	
187	"	-84	" 5	"	"	"	"	"	
188	"	-85	" 6	"	"	"	"	"	
189	"	-86	" 7	"	"	"	"	"	
190	"	-87	C-35 Fuel Rod Pos. 3	"	"	"	"	5.109	
191	"	-88	" 4	"	"	"	"	"	
192	"	-89	" 5	"	"	"	"	"	
193	"	-90	C-51 Fuel Rod Pos. 3	"	"	"	"	5.110	
194	"	-91	" 4	"	"	"	"	"	
195	"	-92	" 5	"	"	"	"	"	
196	"	-93	C-53 Fuel Rod Pos. 3	"	"	"	"	5.111	
197	"	-94	" 4	"	"	"	"	"	
198	"	-95	" 5	"	"	"	"	"	
199	"	-96	C-77 Fuel Rod Pos. 1	"	"	"	"	5.112	
200	"	-97	" 2	"	"	"	"	"	
201	"	-98	" 3	"	"	"	"	"	
202	"	-99	" 4	"	"	"	"	"	
203	"	-100	" 5	"	"	"	"	"	
204	"	-101	" 6	"	"	"	"	"	
205	"	-102	" 7	"	"	"	"	"	
206	"	-103	D-27 Fuel Rod Pos. 1	"	"	"	"	5.113	

CH. No.	Item	Symb.	Location	Descriptions	LOC. Fig. No.	Range & Output	Accuracy	Data Fig. No.	Measurement comments
207	Temp.	TF2-104	D-27 Fuel Rod Pos. 2	surface temp.	3.12	0∿976°C 0∿ 10 V	±0.64 %F.S.	5.113	
208	"	-105	" 3	"	"	"	"	"	
209	"	-106	" 4	"	"	"	"	"	
210	"	-107	" 5	"	"	"	"	"	
211	"	-108	" 6	"	"	"	"	"	
212	"	-109	" 7	"	"	"	"	"	
213	"	-110	D-88 Fuel Rod Pos. 1	"	"	"	"	5.114	
214	"	-111	" 2	"	"	"	"	"	
215	"	-112	" 3	"	"	"	"	"	
216	"	-113	" 4	"	"	"	"	"	
217	"	-114	" 5	"	"	"	"	"	
218	"	-115	" 6	"	"	"	"	"	
219	"	-116	" 7	"	"	"	"	"	
220	"	-117	A-55 Tie Rod Pos. 1	fluid temp	"	"	"	5.66	
221	"	-118	" 2	"	"	"	"	"	
222	"	-119	" 3	"	"	"	"	"	
223	"	-120	" 4	"	"	"	"	"	
224	"	-121	" 5	"	"	"	"	"	
225	"	-122	" 6	"	"	"	"	"	
226	"	-123	" 7	"	"	"	"	"	
227	"	-124	B-55 Tie Rod Pos. 1	"	"	"	"	5.67	

CH. No.	Item	Symb.	Location	Descriptions	LOC. Fig. No.	Range & Output	Accuracy	Data Fig. No.	Measurement comments
228	Temp.	TF2-125	B-55 Tie Rod Pos. 2	fluid temp.	3.12	0∿976°C 0∿ 10 V	±0.64 %F.S.	5.67	
229	"	-126	" 3	"	"	"	"	"	
230	"	-127	" 4	"	"	"	"	"	
231	"	-128	" 5	"	"	"	"	"	
232	"	-129	" 6	"	"	"	"	"	
233	"	-130	" 7	"	"	"	"	"	
234	"	-131	C-55 Tie Rod Pos. 1	"	"	"	"	5.68	
235	"	-132	" 2	"	"	"	"	"	
236	"	-133	" 3	"	"	"	"	"	
237	"	-134	" 4	"	"	"	"	"	
238	"	-135	" 5	"	"	"	"	"	
239	"	-136	" 6	"	"	"	"	"	
240	"	-137	" 7	"	"	"	"	"	
241	"	-138	D-55 Tie Rod Pos. 1	"	"	"	"	5.69	
242	"	-139	" 2	"	"	"	"	"	
243	"	-140	" 3	"	"	"	"	"	
244	"	-141	" 4	"	"	"	"	"	
245	"	-142	" 5	"	"	"	"	"	
246	"	-143	" 6	"	"	"	"	"	
247	"	-144	" 7	"	"	"	"	"	
248	"	TC - 1	Channel Box A Outlet	"	"	"	"	5.49	

CH. No.	Item	Symb.	Location	Descriptions	LOC. Fig. No.	Range & Outlet	Accu-racy	Data Fig. No.	Measurement comments
249	Temp.	TC- 2	Channel Box A Inlet	fluid temp.	3.12	0∿970°C 0∿ 10 V	±0.64 %F.S.	5.50	
250	"	- 3	" B Outlet	"	"	"	"	5.49	
251	"	- 4	" B Inlet	"	"	"	"	5.50	
252	"	- 5	" C Outlet	"	"	"	"	5.49	
253	"	- 6	" C Inlet	"	"	"	"	5.50	
254	"	- 7	" D Outlet	"	"	"	"	5.49	
255	"	- 8	" D Inlet	"	"	"	"	5.50	
256	"	TB - 1	C.B.Inner Surface Pos.A-1	surface temp.	"	"	"	5.81	
257	"	- 2	" A-2	"	"	"	"	"	
258	"	- 3	" A-3	"	"	"	"	"	
259	"	- 4	" A-4	"	"	"	"	"	
260	"	- 5	" A-5	"	"	"	"	"	
261	"	- 6	" A-6	"	"	"	"	"	
262	"	- 7	" A-7	"	"	"	"	"	
263	"	- 8	" A-8	"	"	"	"	5.82	
264	"	- 9	" A-9	"	"	"	"	"	
265	"	-10	" A-10	"	"	"	"	"	
266	"	-11	" A-11	"	"	"	"	"	
267	"	-12	" A-12	"	"	"	"	"	
268	"	-13	" A-13	"	"	"	"	"	
269	"	-14	" A-14	"	"	"	"	"	

CH. No.	Item	Symb.	Location	Descriptions	LOC. Fig. No.	Range & Output	Accu-racy	Data Fig. No.	Measurement comments
270	Temp.	TP- 1	Lower PL. 0° High	surface temp.	3.10	0~976°C 0~ 10 V	±0.64 %F.S.	5.51	
271	"	- 2	" Middle	"	"	"	"	"	
272	"	- 3	" Low	"	"	"	"	"	
273	"	- 4	Lower PL. 180° High	"	"	"	"	"	
274	"	- 5	" Middle	"	"	"	"	"	
275	"	- 6	" Low	"	"	"	"	"	
276	"	- 7	Lower PL. Center Low	fluid temp.	"	"	"	"	
277	"	- 8	" Bottom	"	"	"	"	"	
278	"	- 9	Lower PL. Guide Tube	"	"	"	"	5.52	
279	"	-10	Lower PL. Outer Bottom	"	"	"	"	"	
280	"	TG2- 1	Upper Tieplate A Up. 1	"	3.12	"	"	5.53	
281	"	- 2	"	"	"	"	"	5.54	
282	"	- 3	"	"	"	"	"	5.55	
283	"	- 4	"	"	"	"	"	5.56	
284	"	- 5	"	"	"	"	"	5.57	
285	"	- 6	"	"	"	"	"	5.58	
286	"	- 7	"	"	"	"	"	5.59	
287	"	- 8	"	"	"	"	"	5.60	
288	"	- 9	"	"	"	"	"	5.61	
289	"	-10	"	"	"	"	"	5.62	
290	"	-11	Upper Tieplate A Low. 11	"	"	"	"	5.53	

CH. No.	Item	Symb.	Location	Descriptions	LOC. Fig. No.	Range & Output	Accu-racy	Data Fig. No.	Measurement comments
291	Temp.	TG2-12	Upper Tieplate A Low. 12	fluid temp.	3.12	0∿976°C 0∿ 10 V	±0.64 %F.S.	5.54	
292	"	-13	" 13	"	"	"	"	5.55	
293	"	-14	" 14	"	"	"	"	5.56	
294	"	-15	" 15	"	"	"	"	5.57	
295	"	-16	" 16	"	"	"	"	5.58	
296	"	-17	" 17	"	"	"	"	5.59	
297	"	-18	" 18	"	"	"	"	5.60	
298	"	-19	" 19	"	"	"	"	5.61	
299	"	-20	" 20	"	"	"	"	5.62	
300	Water Level	LB- 1	C.B. Water Level Pos. 1-1		"	ON-OFF 0∿ 10 V		5.83	
301	"	- 2	" 1-2		"	ON-OFF		"	
302	"	- 3	" 1-3		"	"		"	
303	"	- 4	" 1-4		"	"		"	
304	"	- 5	" 1-5		"	"		"	
305	"	- 6	" 1-6		"	"		"	
306	"	- 7	" 1-7		"	"		"	
307	"	- 8	C.B. Water Level Pos. 2-1		"	"		5.84	
308	"	- 9	" 2-2		"	"		"	
309	"	-10	" 2-3		"	"		"	
310	"	-11	" 2-4		"	"		"	

CH. No.	Item	Symb.	Location	Descriptions	LOC. Fig. No.	Range & Output	Accu-racy	Data Fig. No.	Measurement comments
311	Water Level	LB-12	C.B. Water Level Pos. 2-5		3.12	ON-OFF		5.84	
312	"	-13	" 2-6		"	"		"	
313	"	-14	" 2-7		"	"		"	
314	"	-15	C.B. Water Level Pos. 3-1		"	"		5.85	
315	"	-16	" 3-2		"	"		"	
316	"	-17	" 3-3		"	"		"	
317	"	-18	" 3-4		"	"		"	
318	"	-19	" 3-5		"	"		"	
319	"	-20	" 3-6		"	"		"	
320	"	-21	" 3-7		"	"		"	
321	"	LL- 1	Lower PL. Center High		3.10	"		5.86	
322	"	- 2	" Middle 1		"	"		"	
323	"	- 3	" Middle 2		"	"		"	
324	"	- 4	" Low		"	"		"	
325	"	- 5	Lower Pℓ. 0° Low		"	"		"	
326	"	- 6	" Bottom		"	"		"	
327	"	- 7	Lower Pℓ. 180° Low		"	"		"	
328	"	- 8	" Bottom		"	"		"	
329	Void	VE- 1	Lower Pℓ. Void 0°		3.12	0 ∿ 1.0 0∿ 10 V			not measured
330	"	- 2	" Center		"	"			"
331	"	- 3	" 180°		"	"			"

CH. No.	Item	Symb.	Location	Descriptions	LOC. Fig. No.	Range & Output	Accu-racy	Data Fig. No.	Measurement comments
332	Void	VE- 4	Outlet of Channel A		3.12	0 ~ 1.0 0 ~ 10 V			not measured
333	"	- 5	"		"	"			"
334	"	- 6	"		"	"			"
335	"	- 7	Outlet of Channel B		"	"			"
336	"	- 8	"		"	"			"
337	"	- 9	"		"	"			"
338	"	-10	Outlet of Channel C		"	"			"
339	"	-11	"		"	"			"
340	"	-12	"		"	"			"
341	"	-13	Outlet of Channel D		"	"			"
342	"	-14	"		"	"			"
343	"	-15	"		"	"			"
344	"	VP- 1	Lower Pℓ. Void 1-1		"	"			"
345	"	- 2	" 1-2		"	"			"
346	"	- 3	" 2-1		"	"			"
347	"	- 4	" 2-2		"	"			"
348	Flow	FE- 1	Channel A Outlet			0~3.0m/sec 0~ 10 V			" "
349	"	- 2	" B "			"			"
350	"	- 3	" C "			"			"
351	"	- 4	" D "			"			"

CH. No.	Item	Symb.	Location	Descritptions	LOC. Fig. No.	Range & Output	Accu-racy	Data Fig. No.	Measurement comments
352	Direc.	FD- 1	Channel A Outlet			Pos. - Neg. +10 ∿ -10 V			undefined data
353	"	- 2	" B "			"			"
354	"	- 3	" C "			"			"
355	"	- 5	" D "			"			"
356	Dens.	DF- 1	JP-1.2 Outlet Beam 1			0 ∿ 1000kg/m^3 0 ∿ 10 V log			not measured
357	"	- 2	" 2			"			"
358	"	- 3	" 3			"			"
359	"	- 4	JP-3.4 Outlet Beam 1			"			"
360	"	- 5	" 2			"			"
361	"	- 6	" 3			"			"
362	"	- 7	Break A Beam 1			"			"
363	"	- 8	Break A Beam 2			"			"
364	Mome.F	M - 1	JP-1.2 Outlet			0∿1.5×10^{5}kg/ms^2 0∿10 V			"
365	"	- 2	JP-3.4 Outlet			"			"
366	"	- 3	Break A			"			"
367	Flow	F- 23	JP-1.2 Outlet			0∿30ℓ/sec 0∿10 V			"
368	"	- 24	JP-3.4 Outlet			"			"
369	"	- 25	Break A			0∿30kg/sec 0∿10 V			"

CH. No.	Item	Symb.	Location	Descriptions	LOC. Fig. No.	Range & Output	Accu-racy	Data Fig. No.	Measurement comments
370	Press.	P-17	JP-1.2 Outlet			0∿100kg/cm^2 0∿10 V			not measured
371	"	-18	JP-3.4 "			"			"
372	"	-19	Break A			"			"
373	Temp.	T-24	JP-1.2 Outlet			0∿400°C 0∿10 V			"
374	"	-25	JP-3.4 "			"			"
375	"	-26	Break A			"			"
376	Press.	P-20	Break Nozzle A Pos. 1			0∿100kg/cm^2 0∿10 V		5.6	
377	"	P-21	" 2			"		"	
378	"	P-22	" 3			"		"	
379	"	P-23	" 4			"		"	
380	"	P-24	" 5			"		"	
381	"	P-25	Break Nozzle B Pos. 1			"		5.7	
382	"	P-26	" 2			"		"	
383	"	P-27	" 3			"		"	
384	"	P-28	" 4			"		"	
385	"	P-29	" 5			"		"	
386	Diff.P	D-16	DC Bottom-MRP-1 Suction			-0.5∿0.5kg/cm^2 2∿10 V		5.14	
387	"	D-17	MRP-1 Discharge-JP-1 Drive			0∿2.5kg/cm^2 2∿10 V		5.15	

CH. No.	Item	Symb.	Location	Descriptions	LOC. Fig. No.	Range & Output	Accu-racy	Data Fig. No.	Measurement comments
388	Diff.P	D-18	MRP-1 Discharge-JP-2 Drive			0∿2.5kg/cm^2 2∿10 V		5.16	
389	"	D-19	DC Middle-JP-1 Suction			0∿2.5kg/cm^2 2∿10 V		5.17	
390	"	D-20	" -JP-2 "			"		5.18	
391	"	D-21	JP-1 Discharge-Lower PL.			-1.0∿1.0kg/cm^2 2∿10 V		5.19	
392	"	D-22	JP-2 "			"		5.20	
393	"	D-23	DC Bottom-Break PV Side			0∿20.0kg/cm^2 2∿10 V		5.21	
394	"	D-24	Break PV.Side-Break Pump Side			0∿1.0kg/cm^2 2∿10 V		5.22	
395	"	D-25	Break Pump Side-MRP-2 Suction			-5.0∿1.0kg/cm^2 2∿10 V		5.23	
396	"	D-26	MRP-2 Discharge-JP-3 Drive			-5.0∿5.0kg/cm^2		5.24	
397	"	D-27	" JP-4 "			"		5.25	
398	"	D-28	DC Middle-JP-3 Suction			-2.5∿2.5kg/cm^2 2∿10 V		5.26	
399	"	D-29	" JP-4 "			"		5.27	
400	"	D-30	JP-3 Discharge-Below Y			-1.0∿1.0kg/cm^2 2∿10 V		5.28	
401	"	D-31	JP-4 " "			"		5.29	
402	"	D-32	Below Y-Lower PL.			-0.5∿0.5kg/cm^2 2∿10 V		5.30	

CH. No.	Item	Symb.	Descriptions		LOC. Fig. No.	Range & Output	Accu-racy	Data Fig. No.	Measurement comments
403	Diff.P	D-33	Lower PL.-DC Middle			-2.5∿2.5kg/cm^2 2∿10 V		5.31	
404	"	D-34	Lower PL.-DC Bottom			"		5.32	
405	"	D-35	DC Bottom-DC Middle			-0.5∿0.5kg/cm^2 2∿10 V		5.33	
406	"	D-36	DC Middle-Steam Dome			"		"	
407	"	D-37	LP Middle-Upper PL.			0∿2.5kg/cm^2 2∿10 V			not measured
408	"	D-38	Lower PL. Bottom-Middle			0∿0.5kg/cm^2 2∿10 V			"
409	"	D-39	Upper PL. Head			0∿0.2kg/cm^2 2∿10 V			not measured
410	"	D-40	Channel Orifice A			0∿1.0kg/cm^2 2∿10 V			"
411	"	D-41	" B			"			"
412	"	D-42	" C			"			"
413	"	D-43	" D			"			"
414	"	D-44	Bypass Hole			0∿2 kg/cm^2 2∿10 V			"
415	Temp.	T-27	Break Nozzle A Pos. 1			0∿400°C 0∿10 V			"
416	"	T-28	" 2			"			"
417	"	T-29	" 3			"			"
418	"	T-30	" 4			"			"

CH. No.	Item	Symb.	Location	Descriptions	LOC. Fig. No.	Range & Output	Accu-racy	Data. Fig. No.	Measurement comments
419	Temp.	T-31	Break Nozzle A Pos. 5			0∿400°C 0∿10 V		5.63	
420	"	T-32	Break Nozzle B Pos. 1			"			not measured
421	"	T-33	" 2			"			"
422	"	T-34	" 3			"			"
423	"	T-35	" 4			"			"
424	"	T-36	" 5			"		5.64	
425	"	T-37	Feed Water		3.12	"		5.65	
451		LP-1	550 KVA Power		-				not calculated
452		LP-2	1800 KVA Power		-				"
453		LP-3	2100 KVA Power		-				"
454		MF-1	Dis. Flow A		5.11				
455		MF-2	Dis. Flow B		5.12				
456		MF-3	JP-1,2 Outlet	not used					
457		MF-4	JP-3,4 Outlet	"					
458		MF-5	Break A	"					
459		MF-7	JP-1,2 Outlet	"					
460		MF-8	JP-3,4 Outlet	"					
461		MF-9	Break A	"					
462		X- 1	Break A		5.24				
463		X- 2	Break B		5.25				
464		X- 3	JP-1,2 Outlet	not used					

CH. No.	Item	Symb.	Location	Descriptions	LOC. Fig. No.	Range & Output	Accu-racy	Data Fig. No.	Measurement comments
465		X- 4	JP-3,4 Outlet	not used					
466		X- 5	Break A	"					
467		DF-10	JP-1,2 Outlet	"					
468		DF-11	JP-3,4 Outlet	"					
469		DF-12	Break A	"					
470		DF-14	JP-1,2 Out Av.	"					
471		DF-15	JP-3,4 Out Av.	"					
472		DF-16	Break A Av.	"					
473		FG-1	JP-1,2 Outlet	"					
474		FG-2	JP-3,4 Outlet	"					
475		FG-3	Break A	"					

Table 3.2 List of instrumentation for supplemental recording system

CH. No.	Item	Symb.	Location	Descriptions	LOC. Fig. No.	Range	Data Fig. No.	Measurement comments
539	Slab temp.	TS- 1	Core barrel A 1			0 ∿ 400°C		undefined data
540		TS- 2	A 2					"
541		TS- 3	A 3					"
542		TS- 4	A 4					"
543		TS- 5	A 5					"
544		TS- 6	A 6					"
545		TS- 7	C 7					"
546		TS- 8	C 8					"
547		TS- 9	C 9					"
548		TS-10	C 10					"
549		TS-11	C 11					"
550		TS-12	C 12					"
551		TS-13	Dummy block, B side 1					"
552		TS-14	B side 2					"
553		TS-16	B side 4					"
554		TS-17	B side 5					"
555		TS-19	O side 7					"
556		TS-20	O side 8					"
557		TS-22	O side 10					"

CH. No.	Item	Symb.	Location	Descriptions	LOC. Fig. No.	Range	Data Fig. No.	Measurement comments
558	Slab temp.	TS-23	Dummy block, 0 side 11			0 ∿ 400°C		undefined data
559	Direction of rev.	RD- 1	Main recirc, pump 1			pos. ∿ neg.		"
560	‖	RD- 2	‖ 2			‖		"
561	Signal	S - 4	Cooling water valve A			open∿close		"
562	‖	S - 5	‖ B			‖		"
563	‖	S - 6	HPCS valve			‖		"
564	‖	S - 7	LPCS valve			‖		"
565	‖	S - 8	LPCI valve			‖		"
566	‖	S -12	ADS valve			‖		"
567	‖	S -13	MRP-1 power			ON ∿ OFF		"
568	‖	S -14	MRP-2 power			‖		"
569								
570								
571								
572								
573								
574								
575								
576								
577								
578								

CH. No.	Item	Symb.	Location	Descriptions	LOC. Fig. No.	Range	Data Fig. No.	Measurement comments
579								
580								
581								
582								
583								
584								
585								
586								
587								
588								
589								
590								
591	Liquid level	L - 1	Lower plenum			ON ∼ OFF		undefined data
592	‖	L - 2	‖			‖		"
593	‖	L - 3	‖			‖		"
594	‖	L - 4	‖			‖		"
595	‖	L - 5	‖			‖		"
596	‖	L - 6	Mixing plenum			‖		"
597	‖	L - 7	Downcomer			‖		"
598	‖	L - 8	‖			‖		"
599	‖	L - 9	‖			‖		"
600	‖	L -10	‖			‖		"

Table 4.1 Test Conditions of the ROSA-III RUN 710

Parameter	Specified Value	Measured Value
Break Conditions		
Location	Recirculation pump suction line	Recirculation pump suction line
Type	Double-ended	Double-ended
Break Orifice Diameter (mm)	26.2	26.2
Initial System Conditions		
Steam Dome Pressure (MPa)	7.35	7.35
Lower Plenum Temperature (K)	----	553
Lower Plenum Subcooling (K)	----	10.8
Core Inlet Flow Rate (kg/s)	36.4	31.3
Broken Loop Flow Rate (m^3/s)	----	2.09×10^{-2}
Intact Loop Flow Rate (m^3/s)	----	2.08×10^{-2}
Core Outlet Quality (-)	----	0.019 (Estimated)
Power Level (kW)	3231 (500+808+1923)	2423 (500+0+1923)
Maximum Linear Heat Rate		
of Region 1 [39 rods] (kW/m)	9.56	9.56
Region 2 [63 rods] (kW/m)	9.56	0
Region 3 [150 rods] (kW/m)	9.56	9.56
Power Curve	Fig. 2.5	Fig. 5.39 and Fig. 5.40
Water Level in PV (m)	4.62	4.62
Feedwater Conditions		
Steady State Line		
Temperature (K)	----	345
Flow Rate (m^3/s)	----	Fig. 5.36

Table 4.1 (Continued)

Parameter		Spesified Value	Measured Value
Feedwater Conditions (Continued)			
Transient Line			
Temperature	(K)	343	345
Flow Rate	(m^3/s)	Keep Steady State Value	Fig. 5.36
Termination Time	(s)	2.0	3.1 (Completely Closed at 4.8 s)
Steam Discharge Conditions			
Steady State Line			
Flow Rate	(kg/s)	----	1.1
Transient Line			
Flow Rate	(kg/s)	----	Fig 5.36
Orifice Diameter	(mm)	20.0	20.0
Termination Time	(s)	3.0	3.2 (Completely Closed at 8.6 s)
ECCS Conditions			
HPCS			
Injection Location		Upper plerum	Upper plenum
Initiation Time	(s)	27.0	20.0
at Pressure in PV	(MPa)	----	6.3
Water Level in PV	(m)	----	----
Coolant Temperature	(k)	313	313
Injection Flow Rate	(m^3/s)	2.28×10^{-4} at 8.0 MPa 9.67×10^{-4} at0.95 MPa	Fig. 5.35

Table 4.1 (Continued)

Parameter		Specified Value	Measured Value
ECCS Conditions (Continued)			
LPCS			
Injection Location		Upper plenum	Upper plenum
Initiation Time	(s)	----	67.0
at Pressure in PV	(MPa)	2.16	2.22
Water Level in PV	(m)	----	----
Coolant Temperature	(K)	313	313
Injection Flow Rate	(m^3/s)	9.67×10^{-4}	Fig. 5.35
LPCI			
Injection Location		in-shroud	in-shroud
Initiation Time	(s)	13 s after LPCS activation	79.6
at Pressure in PV	(MPa)	----	1.68
Coolant Temperature	(K)	313	313
Injection Flow Rate	(m^3/s)	3.83×10^{-3}	Fig. 5.35
ADS Conditions			
Valve Opening Time	(s)	120	112
Valve Closed Time	(s)	480	480 (Approx.)
Flow Rate	(m^3/s)	----	Not Measured
Orifice Diameter	(mm)	6.0	6.0

Table 4.2 Valve Caracteristics of Steam Discharge Line

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

Orifice	Diamater (mm)	Area (mm^2)
OR3	Not Used	-
OR4	6.0	28.27
OR5	20.0	314.16

Table 5.1 Sequence of Events in RUN 710

Time After Break (s)	Events
0.0	Break Initiation of core power control (1) Terminate intact loop recirculation pump power Terminate broken loop recirculation pump power
3.1	Initiation of feed water valve closure
3.2	Initiation of steam discharge line valve closure
4.8	Closure of feed water line
8.6	Closure of steam discharge line
12	Jet pump suction nozzle uncovery
13.3	Initiation of core power reduction
16	Exposure of rod above Pos.3
17	Recirculation pump suction nozzle uncovery
17	Lower plenum flashing initiation
20.0	HPCS injection initiation
20.6	Rewetting above Pos.3
60	Reexposure above Pos.4
67.0	LPCS injection initiation
79.6	LPCI injection initiation
83	Quench at Pos.4
92	Quench at Pos.3
96	Quench at Pos.2
98	Quench at Pos.1
100	Recovery of Mixture Level in Channel C
112	ADS valve opening
(480)*	ADS valve closure End of data acquisition

Notes : (1) See Fig. 5.39 and Fig. 5.40

* Approximate value

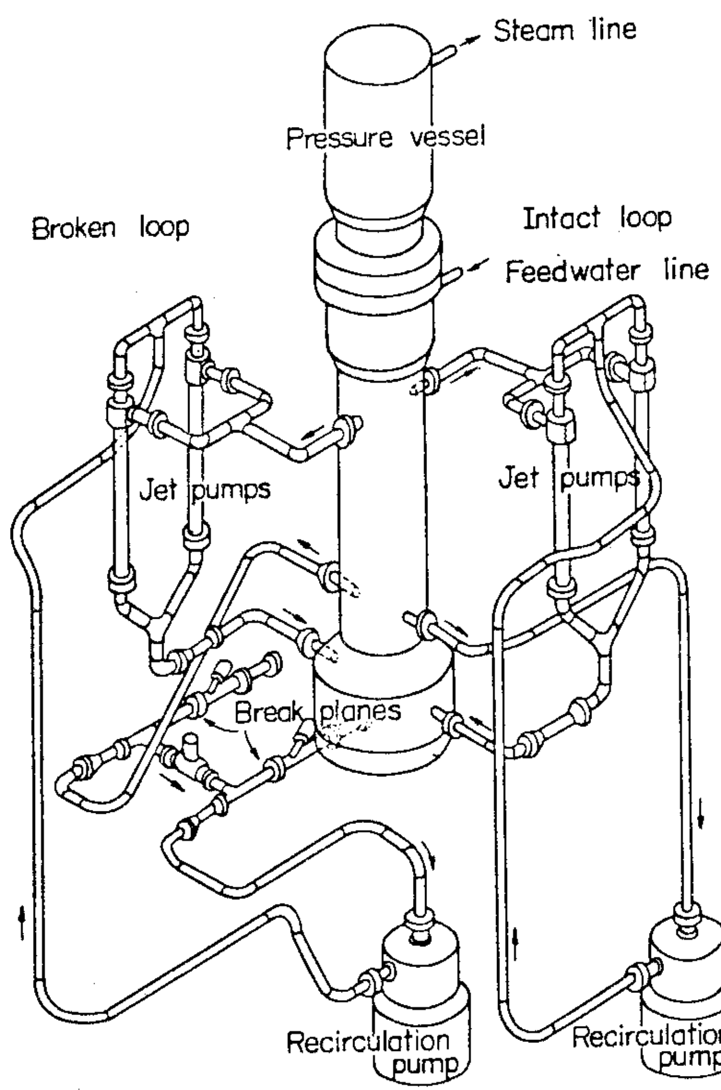


Fig. 2.1 Schematic diagram of ROSA-III test facility

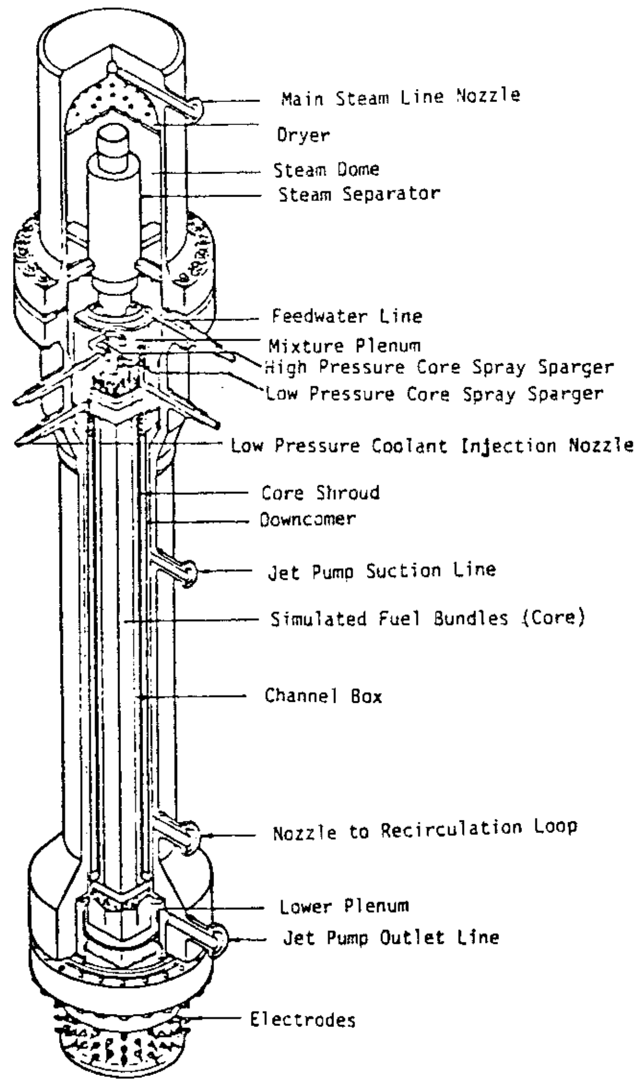


Fig. 2.2 Internal structure of pressure vessel of ROSA-III

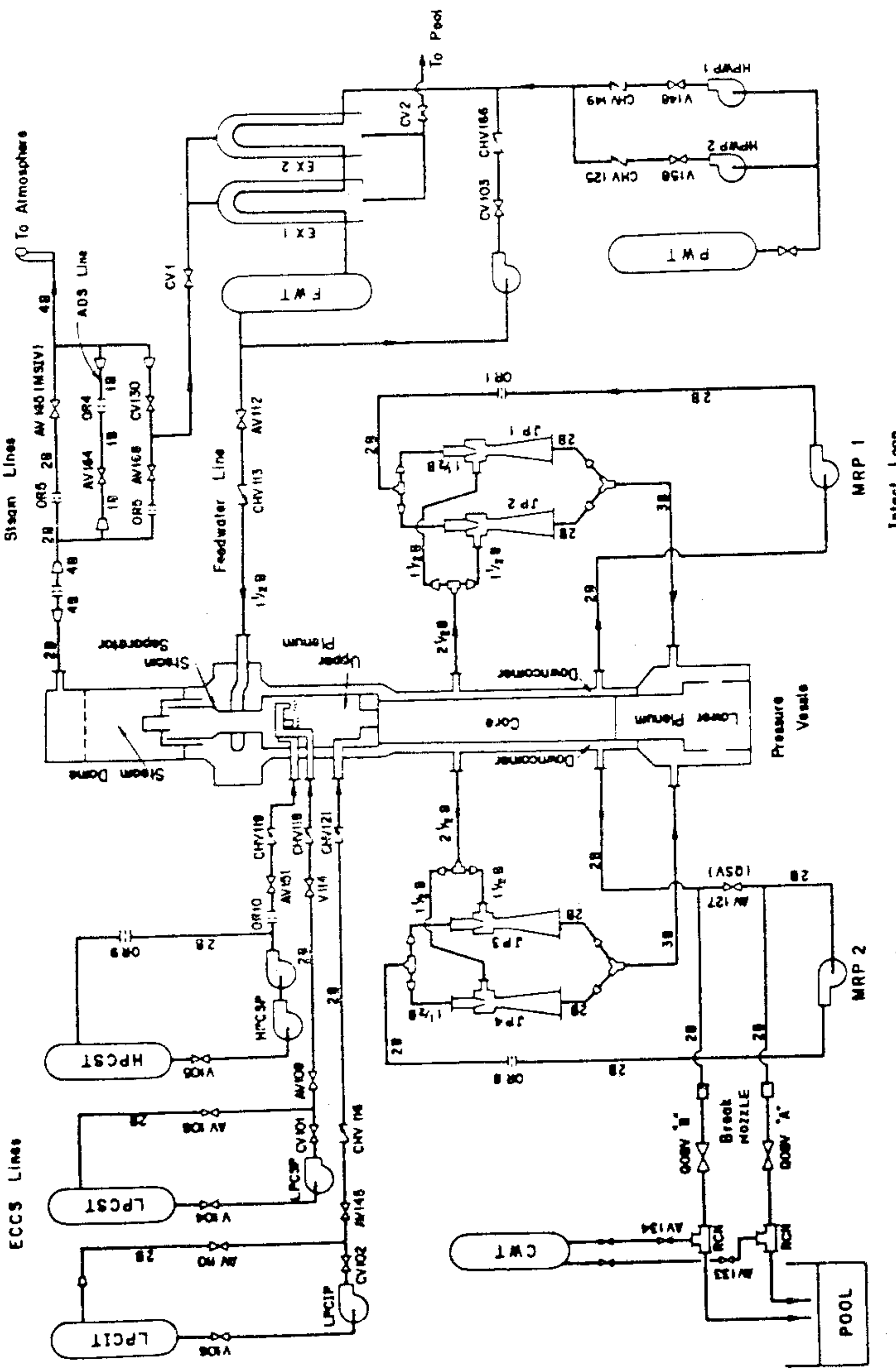
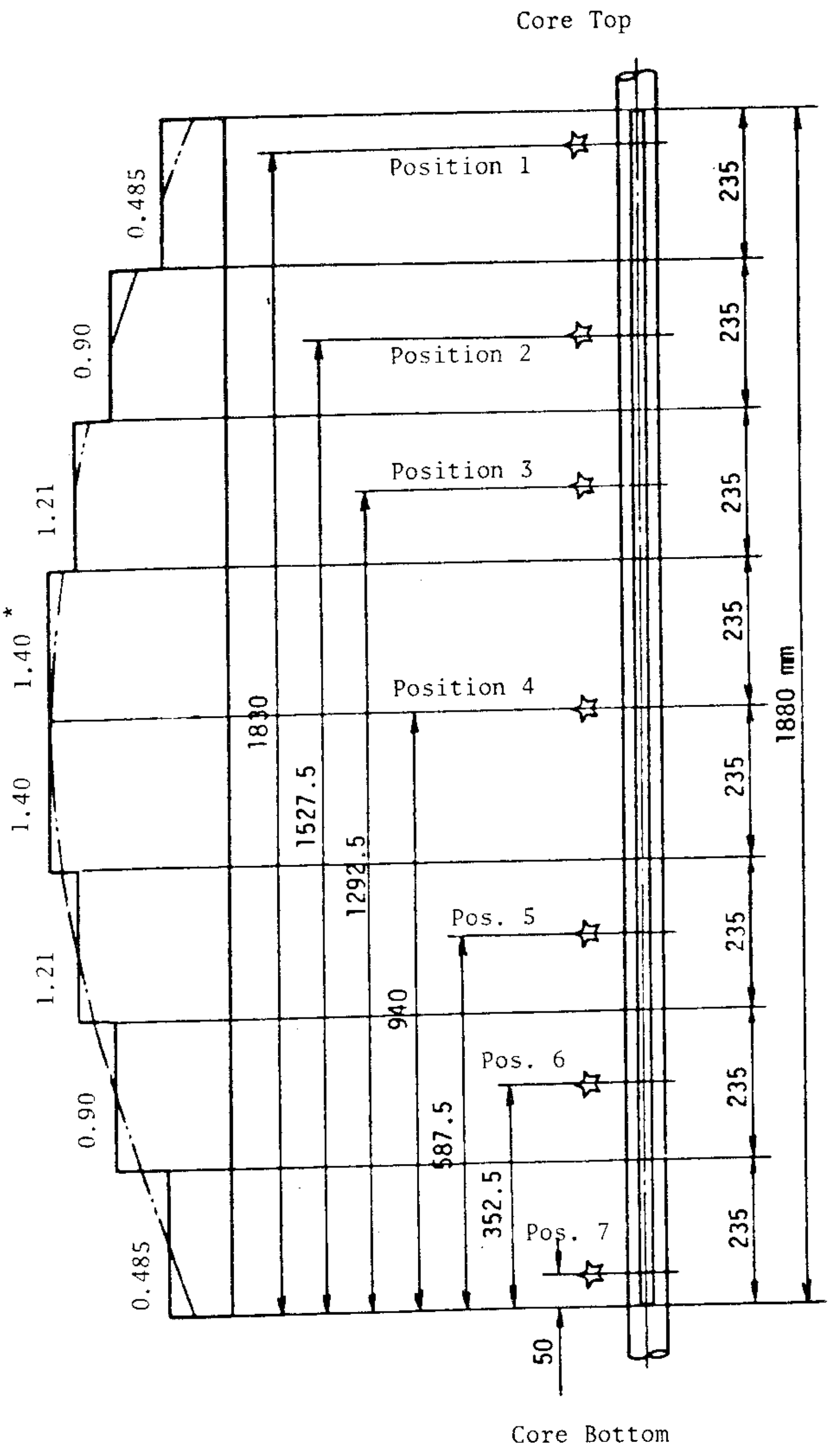


Fig. 2.3 ROSA-III piping schematic



☆ indicates position of thermocouple. * Axial Peaking Factor

Fig. 2.4 Axial power distribution of heater rod.

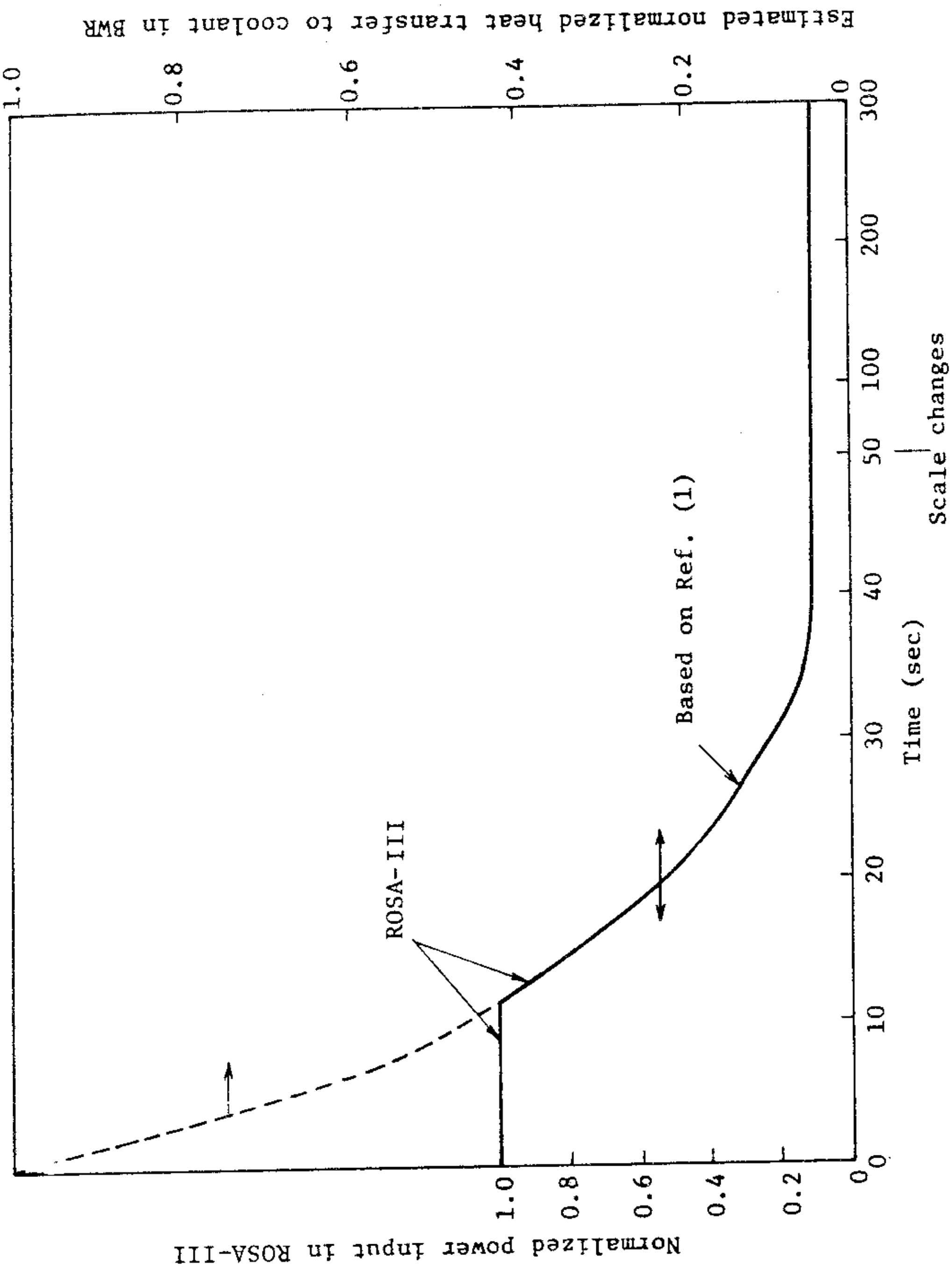


Fig. 2.5 Power transient

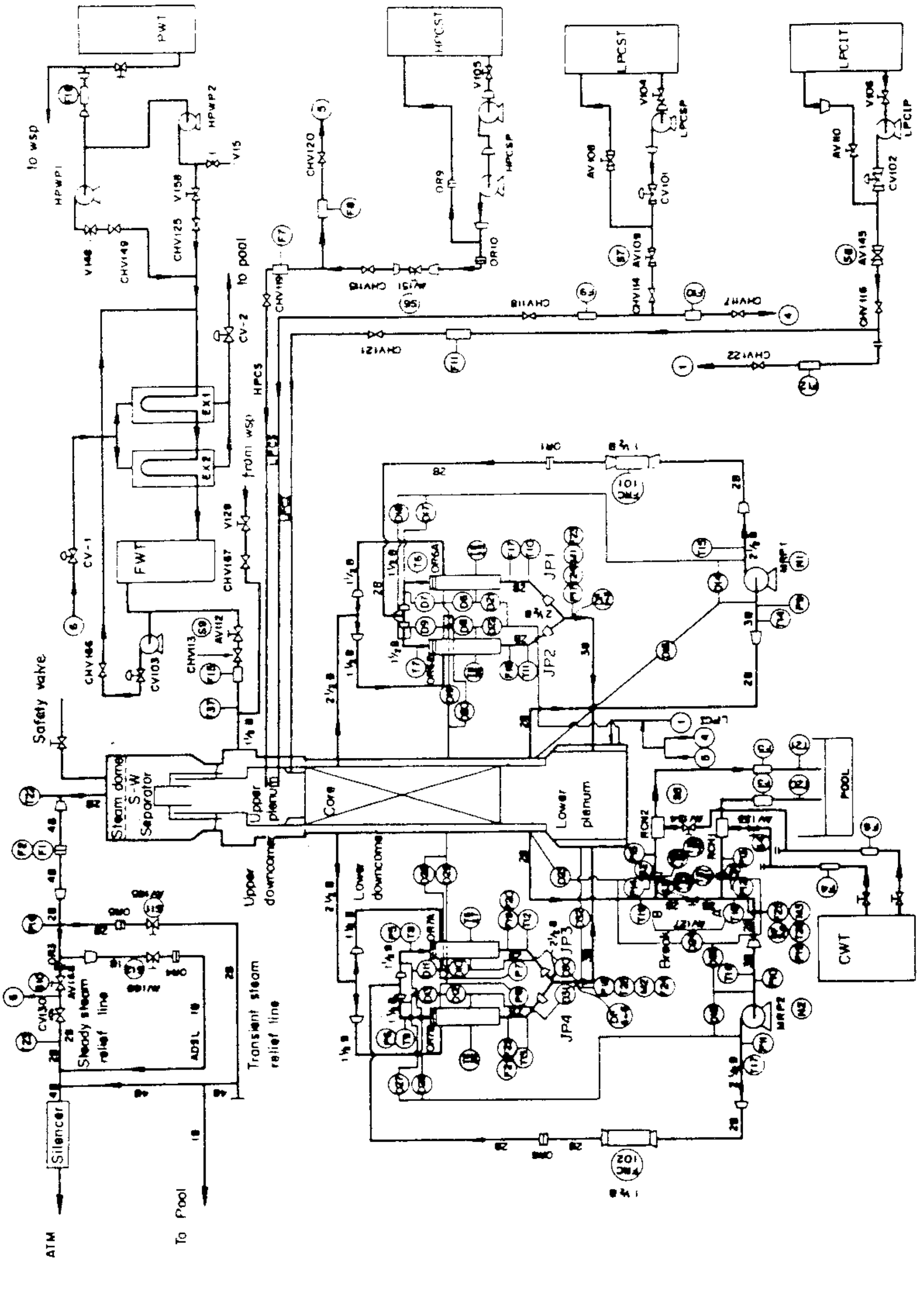


Fig. 3.1 Flow diagram and instrumentation location of ROSA-III facility

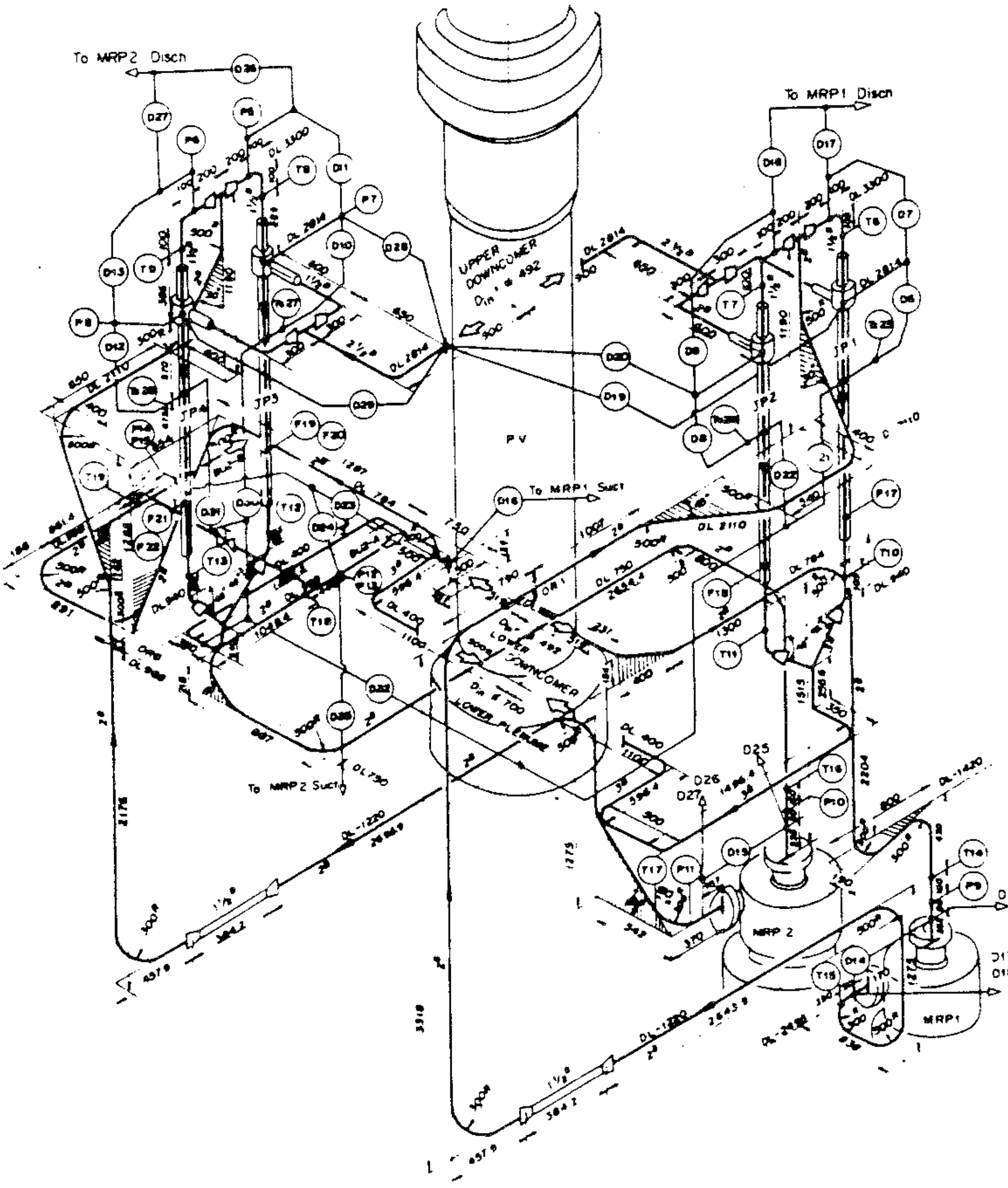


Fig. 3.2 ROSA-III circulation loops with instrumentation

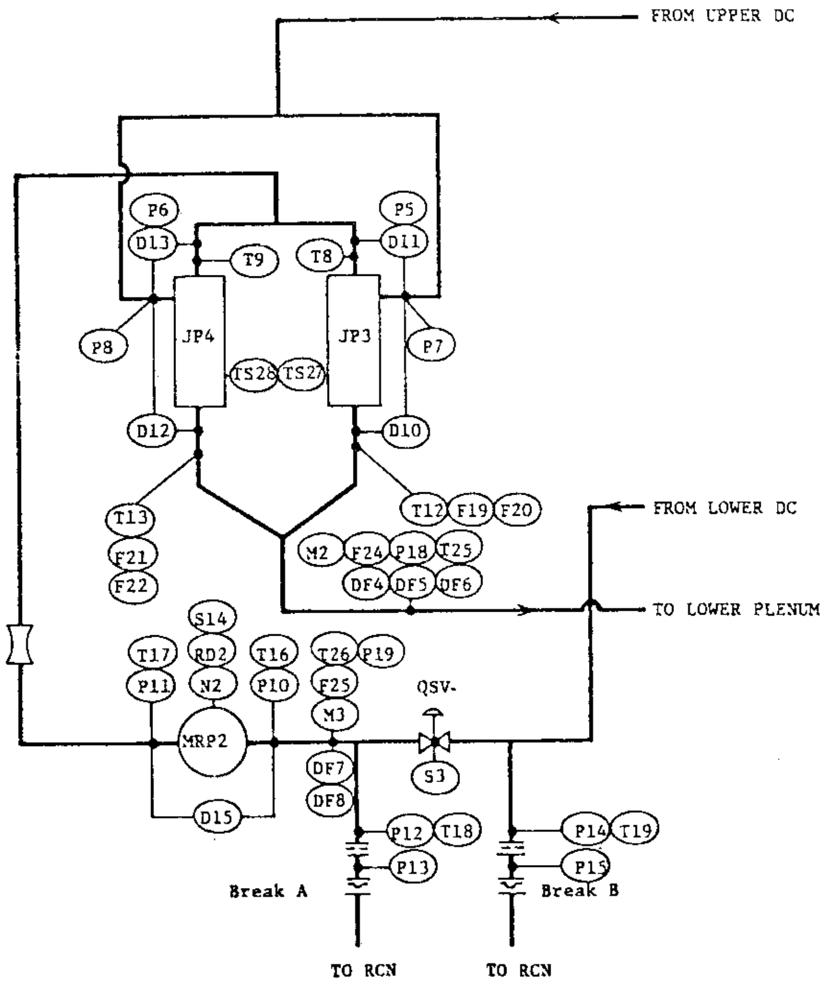


Fig. 3.3 Instrumentation arround the broken loop jet pumps and recirculation pump

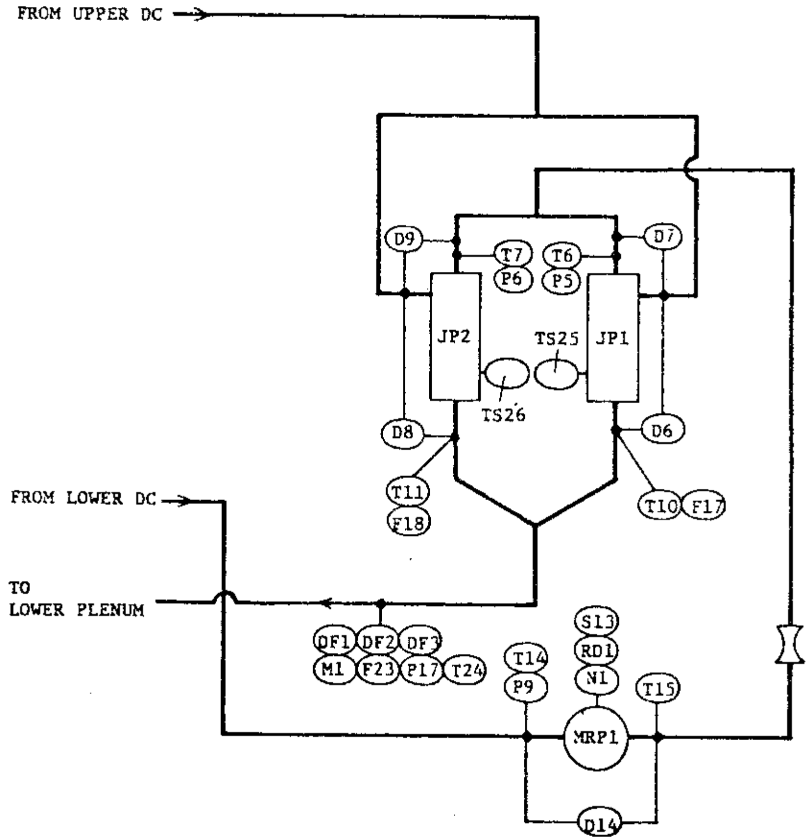


Fig. 3.4 Instrumentation arround the intact loop jet pumps and recirculation pump

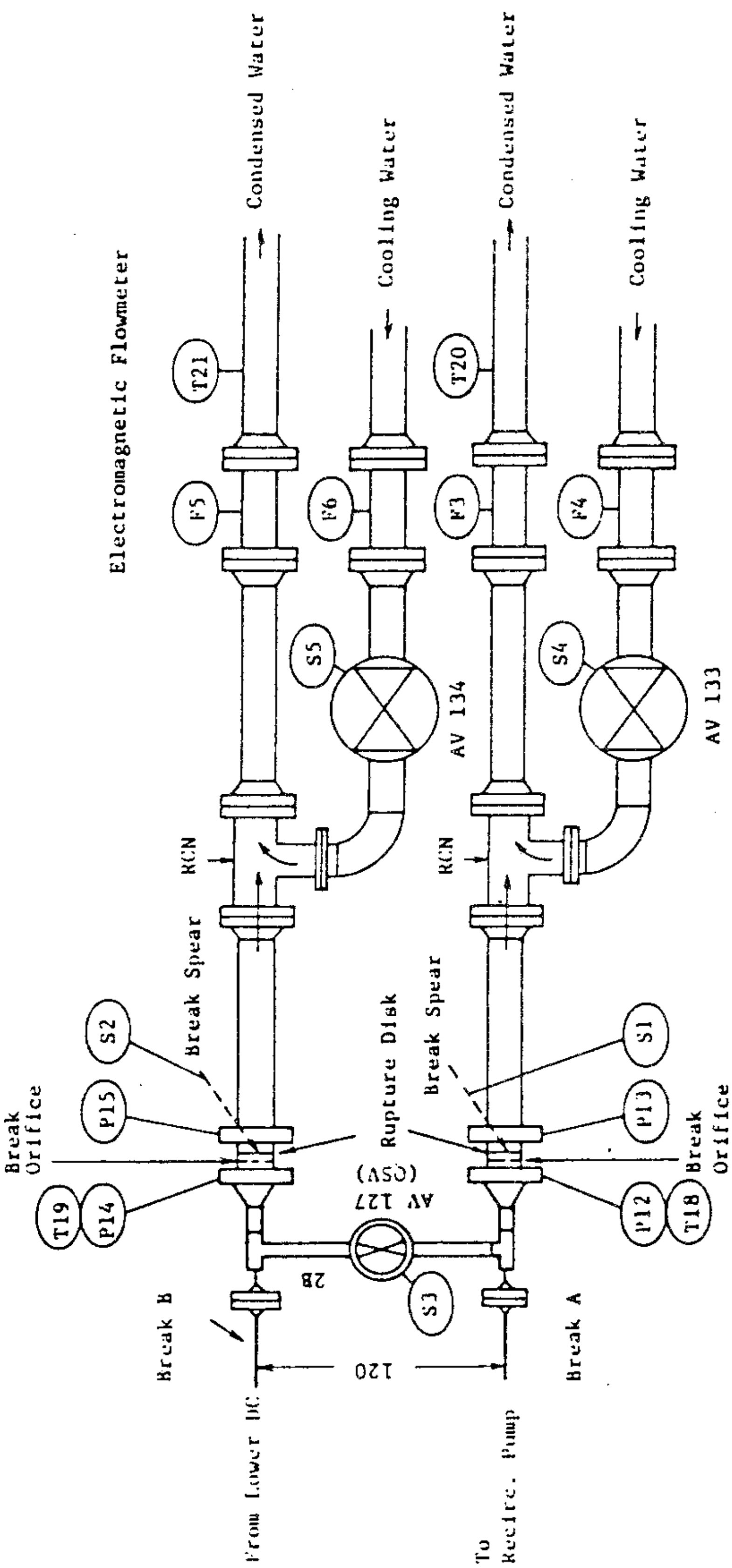


Fig. 3.5 Instrumentation in the break unit

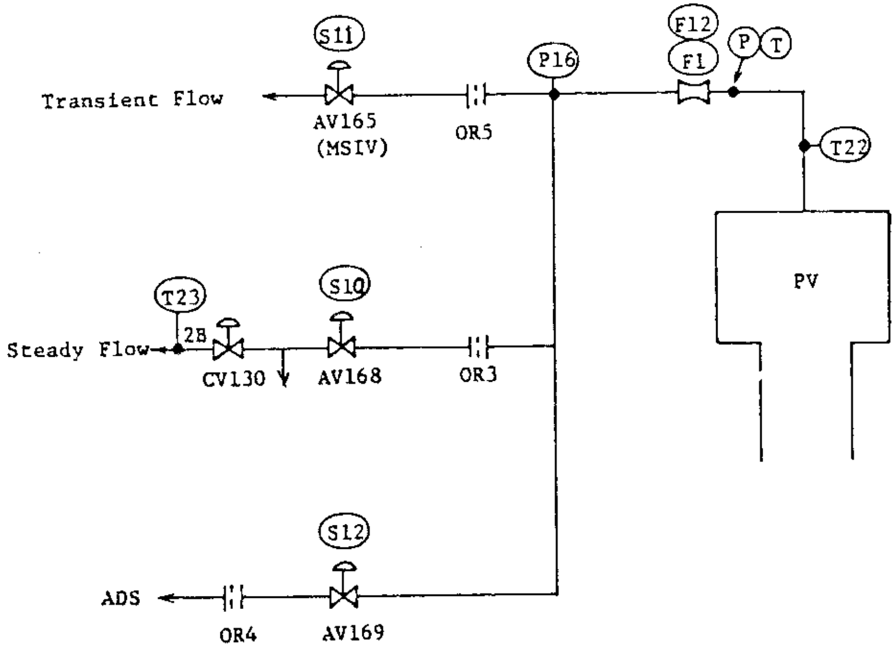


Fig. 3.6 Instrumentation in the steam line

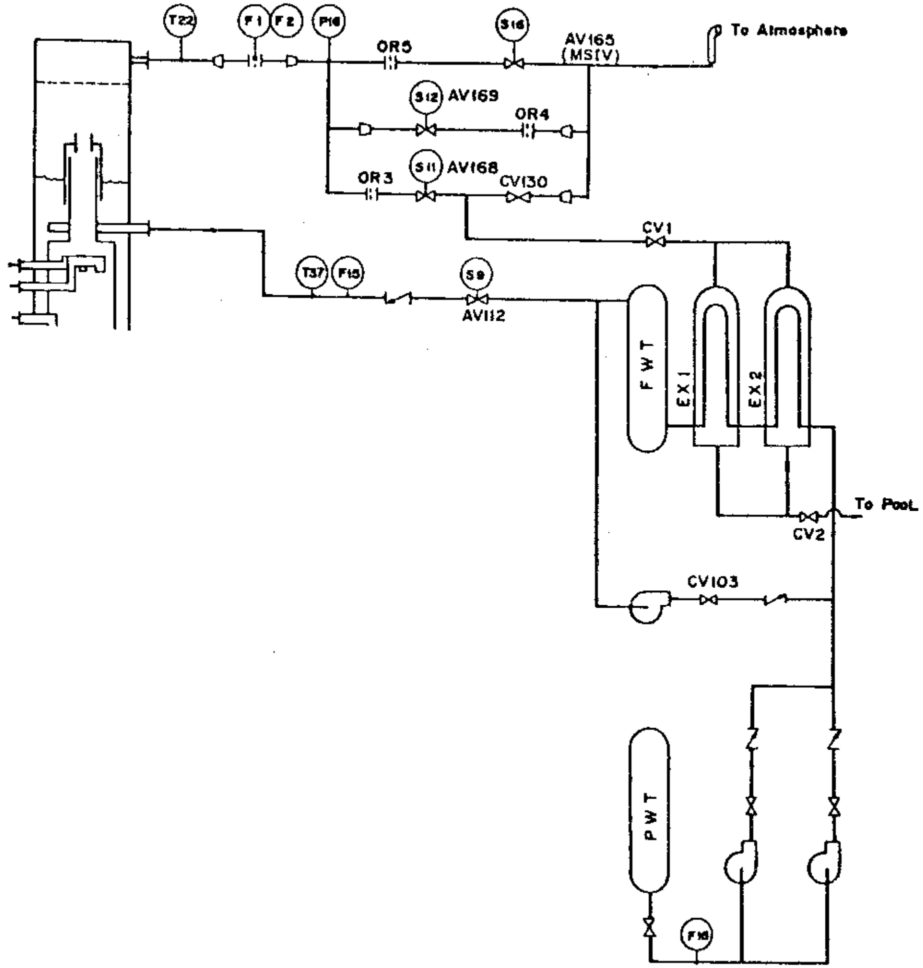


Fig. 3.7 Instrumentation in the feedwater line

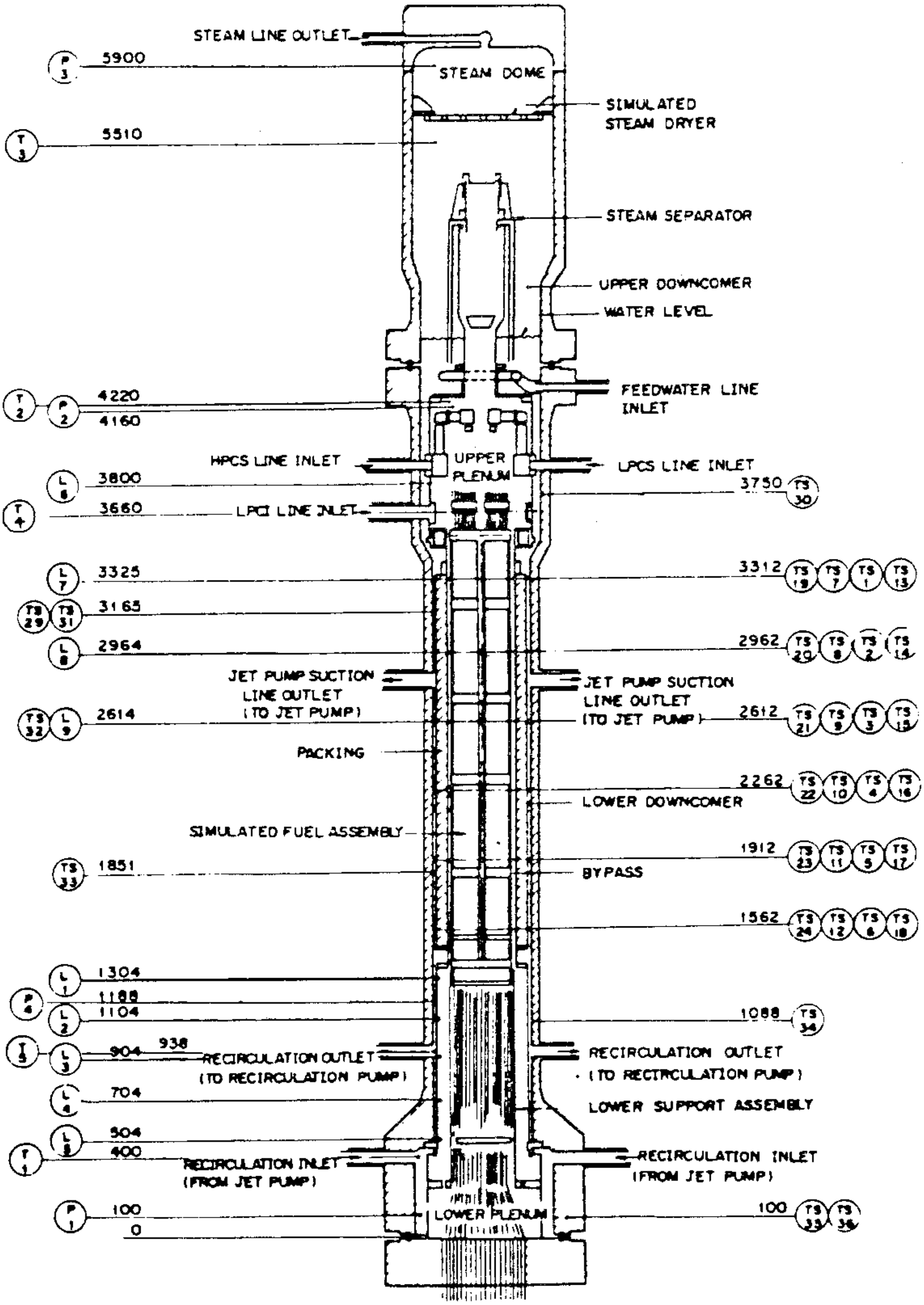


Fig. 3.8 ROSA-III pressure vessel with instrumentation

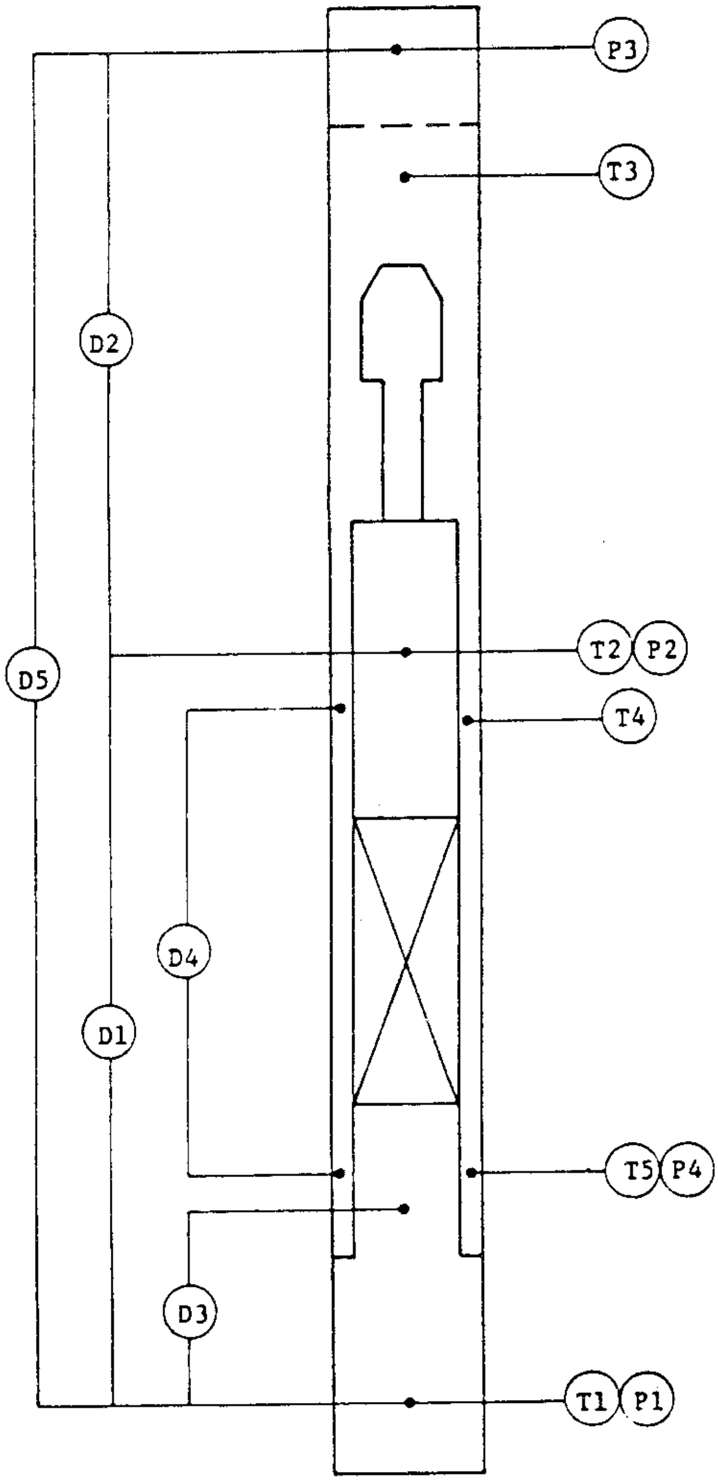


Fig. 3.9 Instrumentation in the pressure vessel

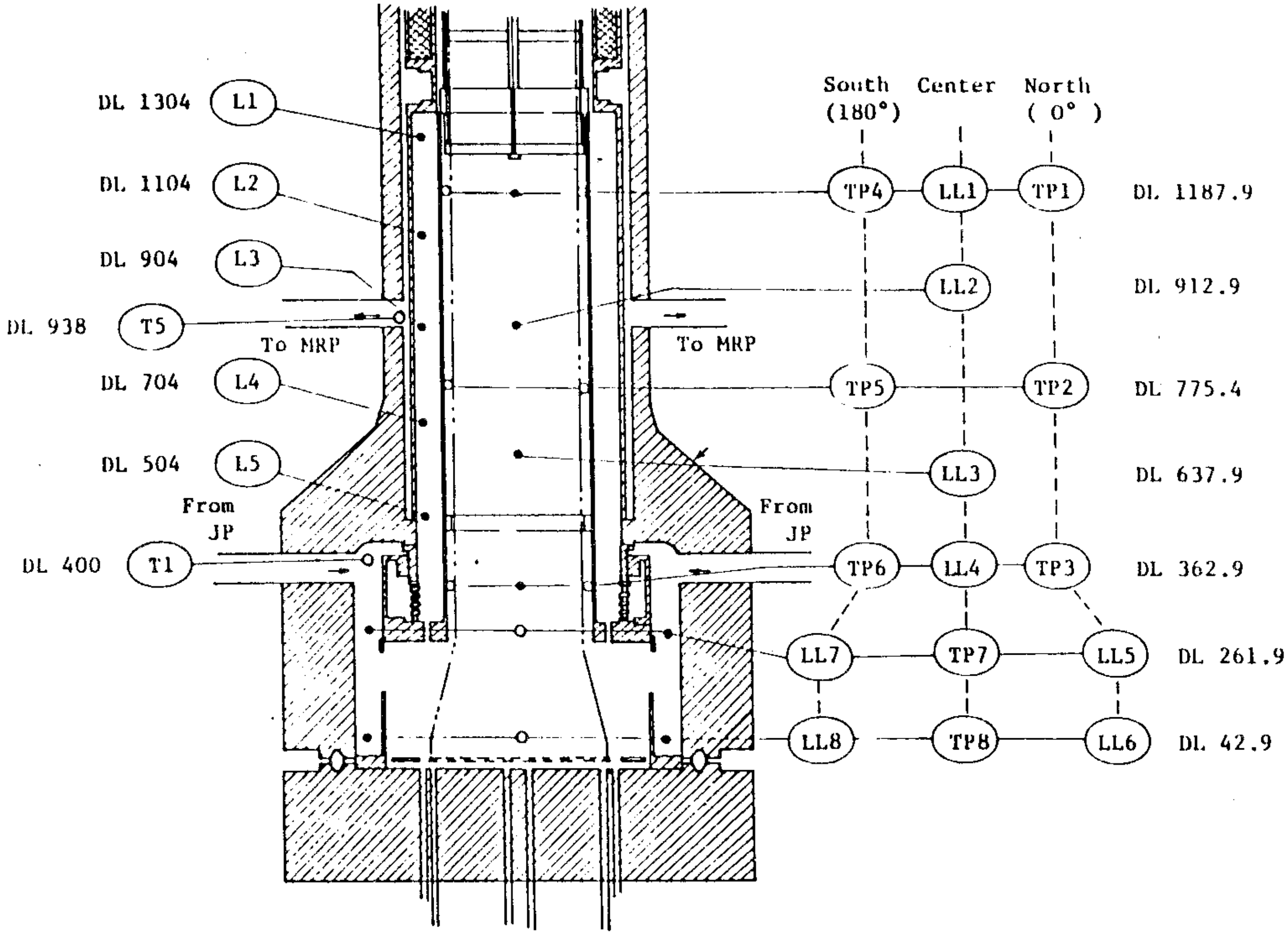


Fig. 3.10 Instrumentation location in lower plenum

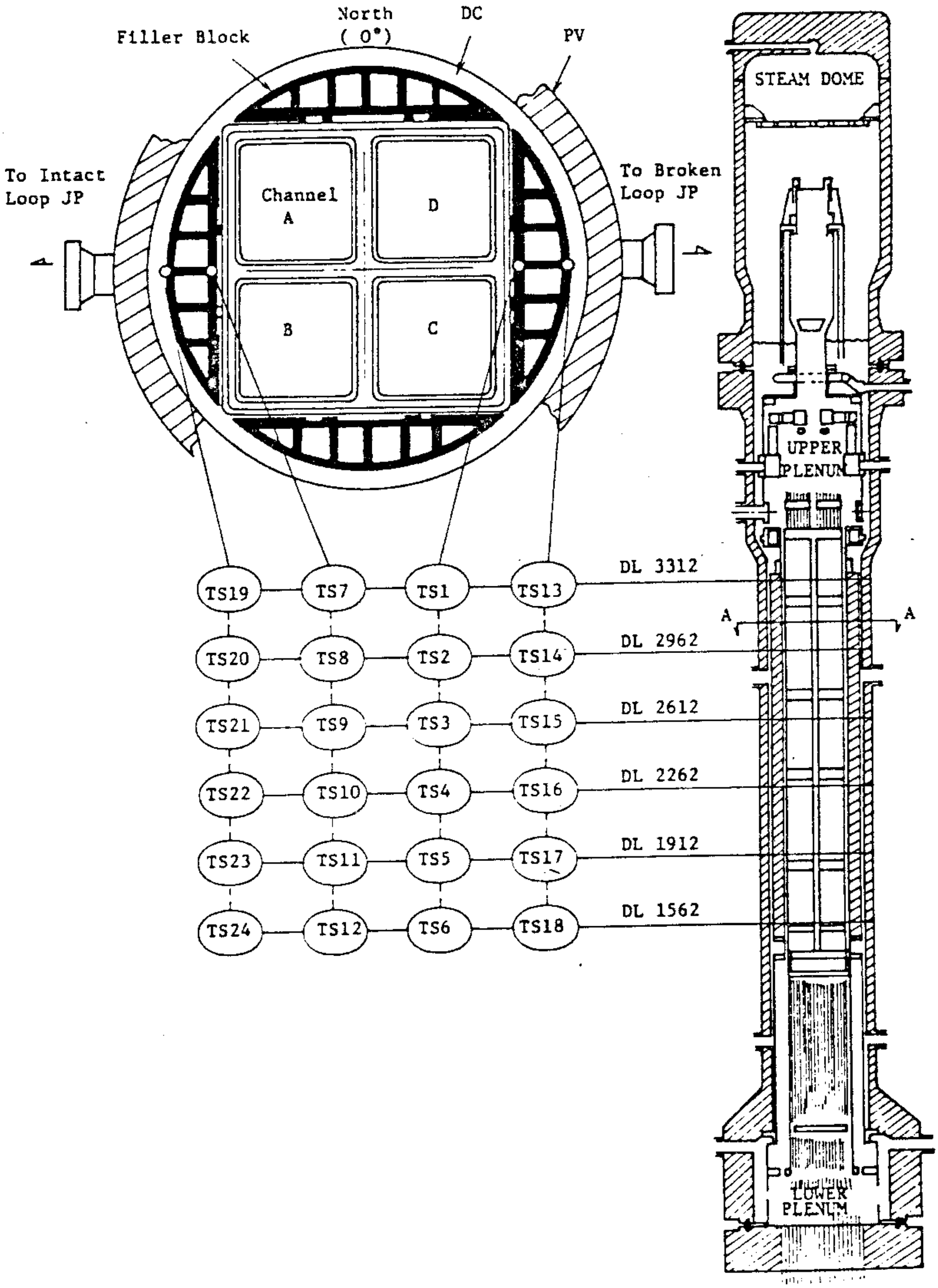


Fig. 3.11 Location of thermocouple in filler blocks

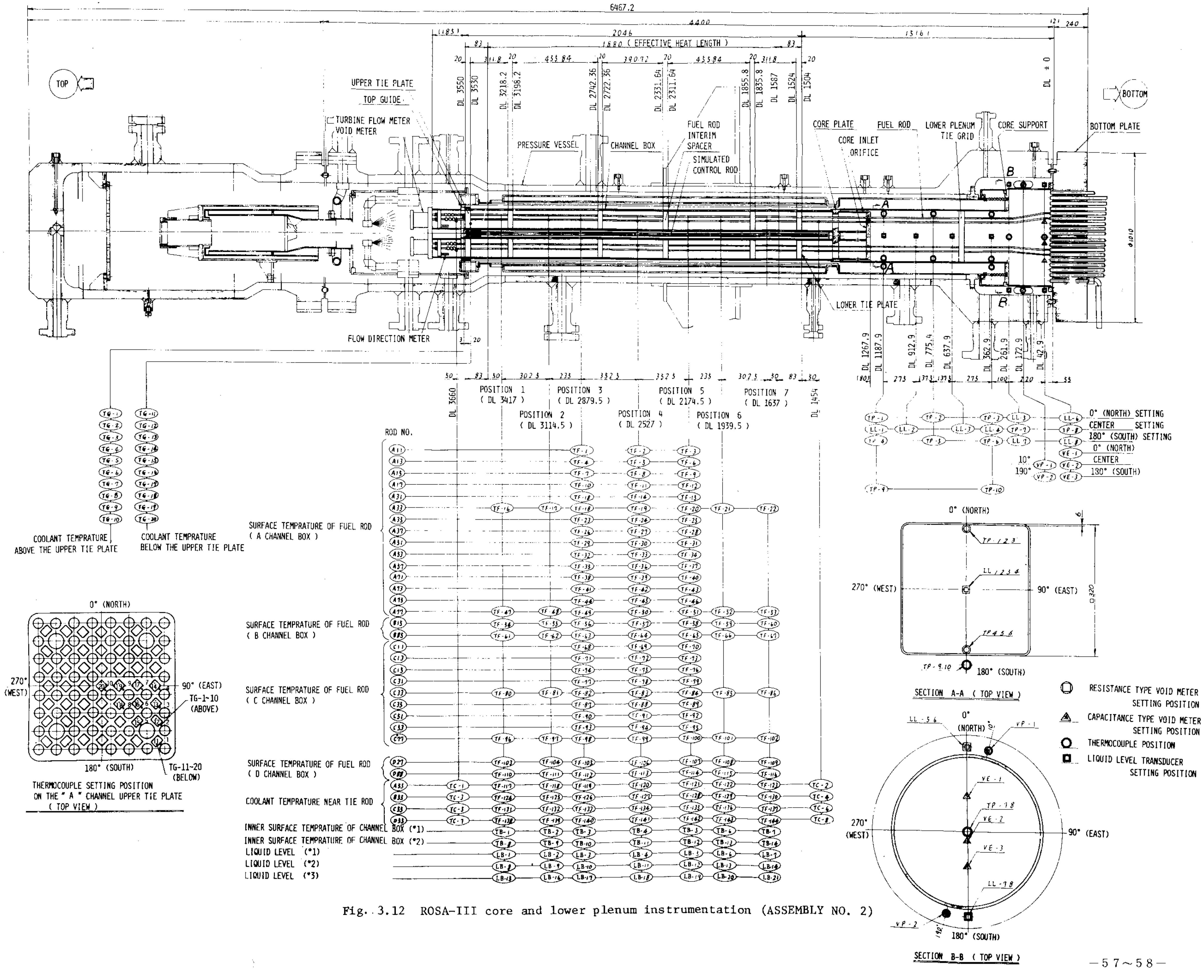
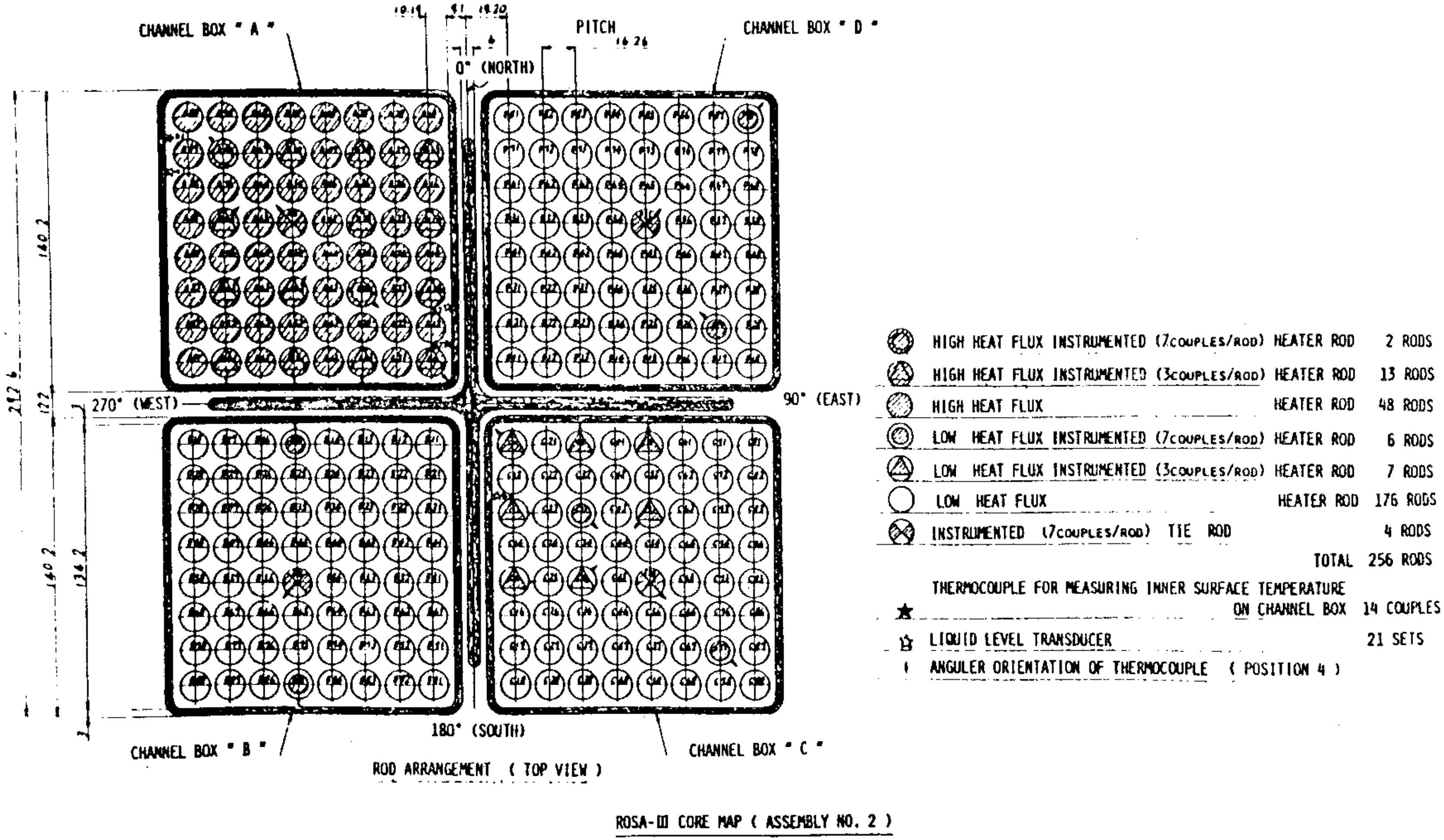


Fig. 3.12 ROSA-III core and lower plenum instrumentation (ASSEMBLY NO. 2)



ROSA-III CORE MAP (ASSEMBLY NO. 2)

Fig. 3.13 ROSA-III core map

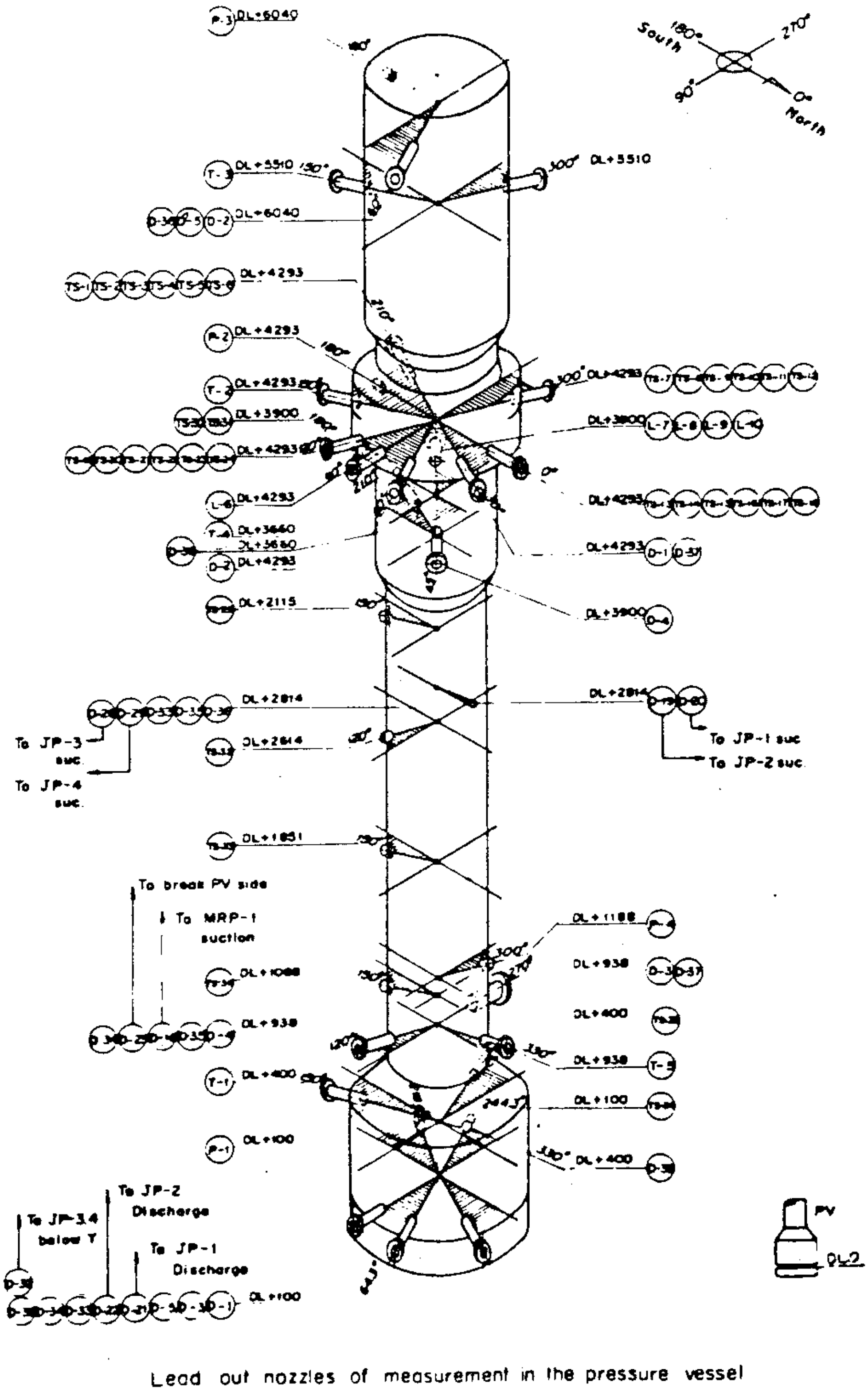


Fig. 3.14 Lead out nozzles of measurement in the pressure vessel

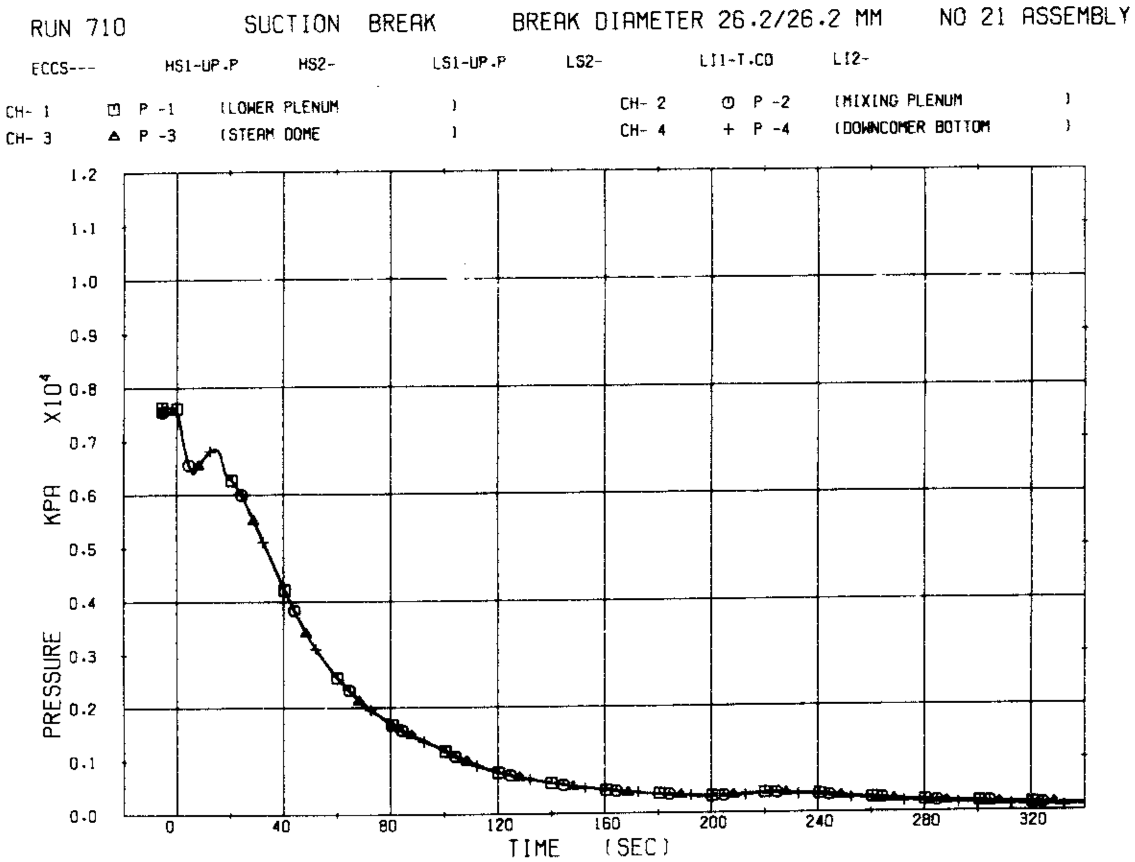


Fig. 5.1 Pressures in pressure vessel

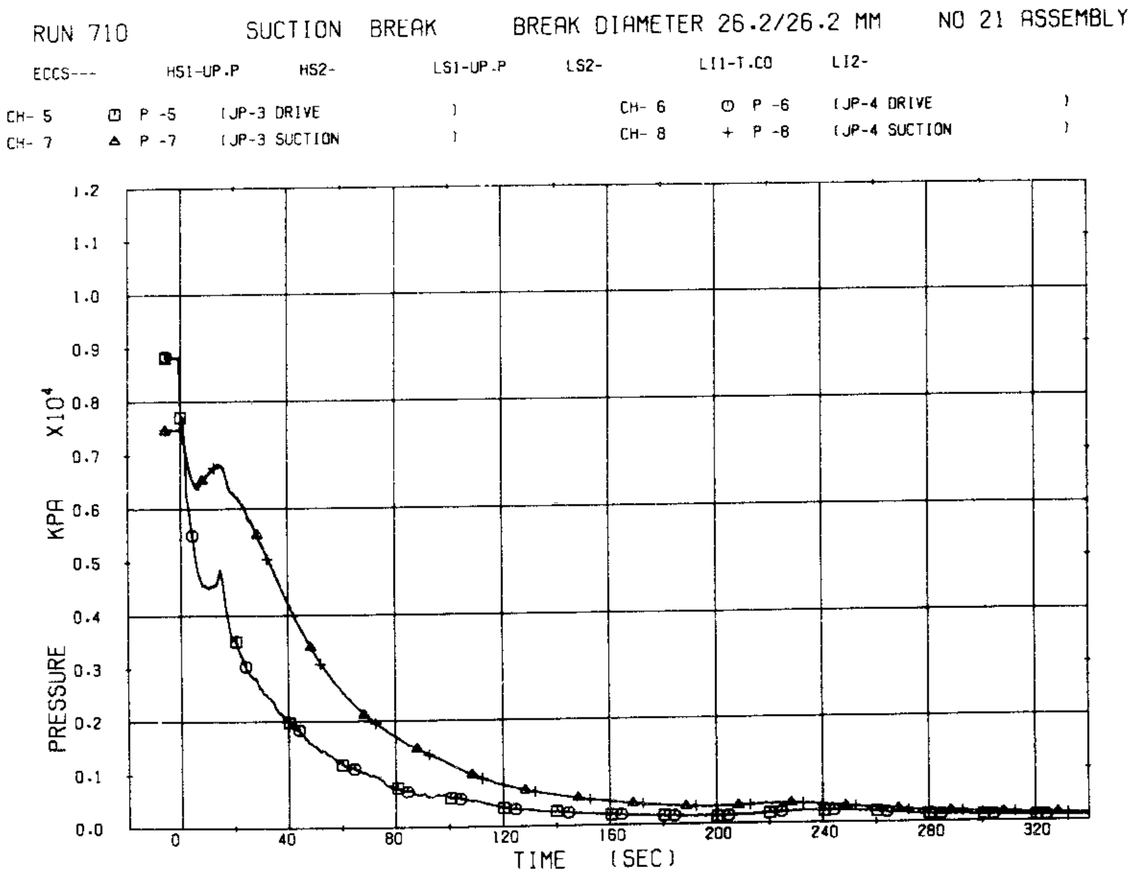


Fig. 5.2 Pressures in jet pumps

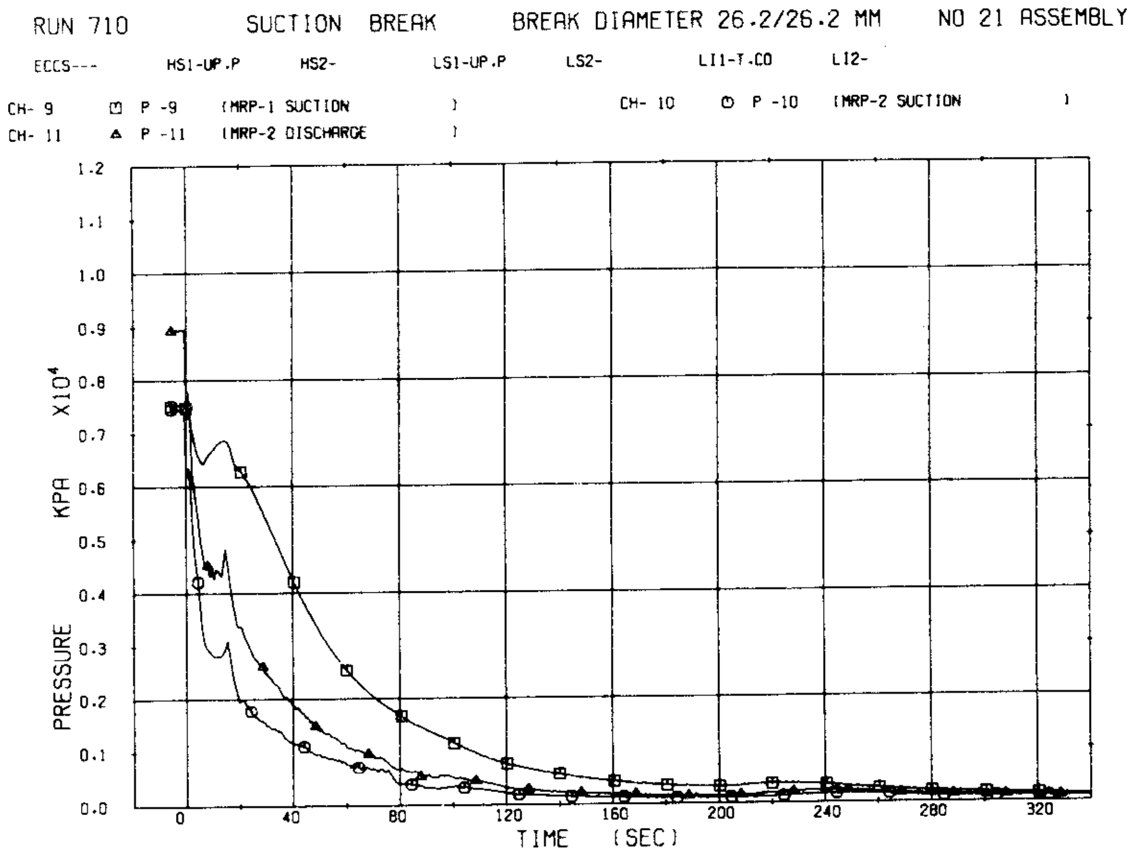


Fig. 5.3 Pressures at recirculation pump

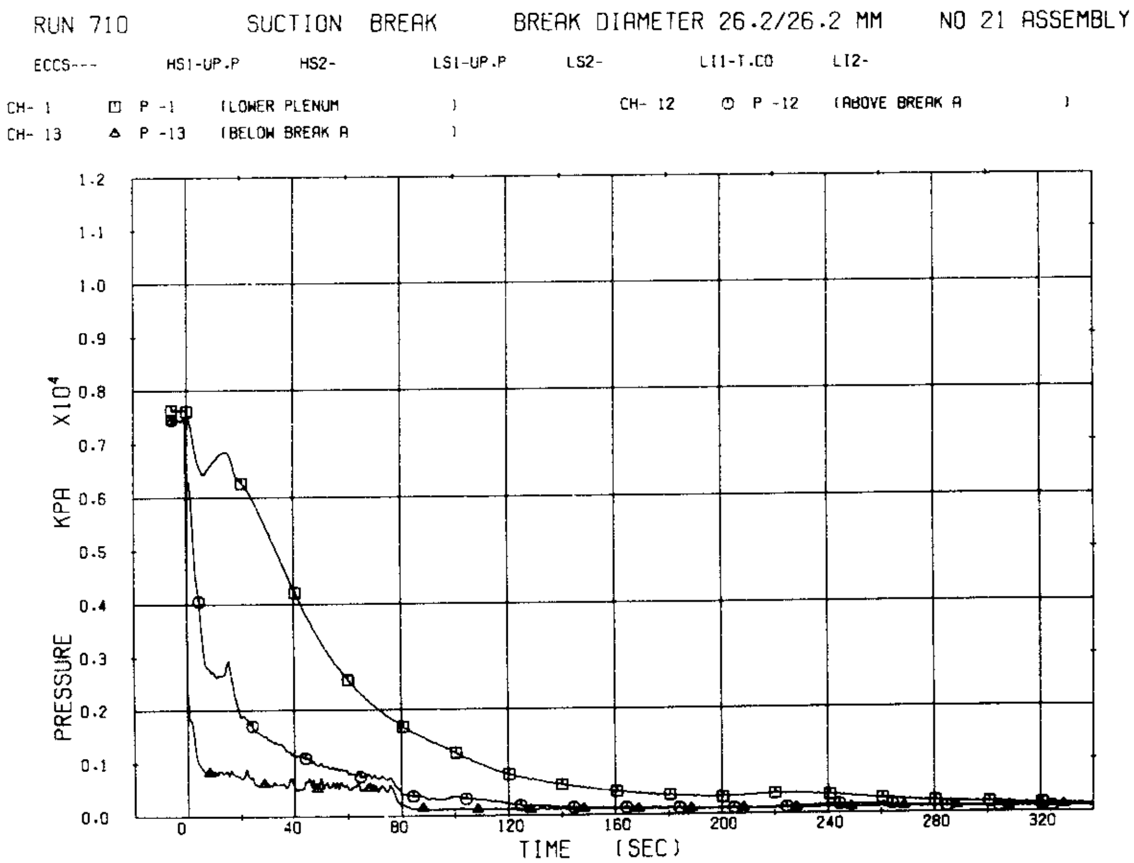


Fig. 5.4 Pressures at immediate above and below break A

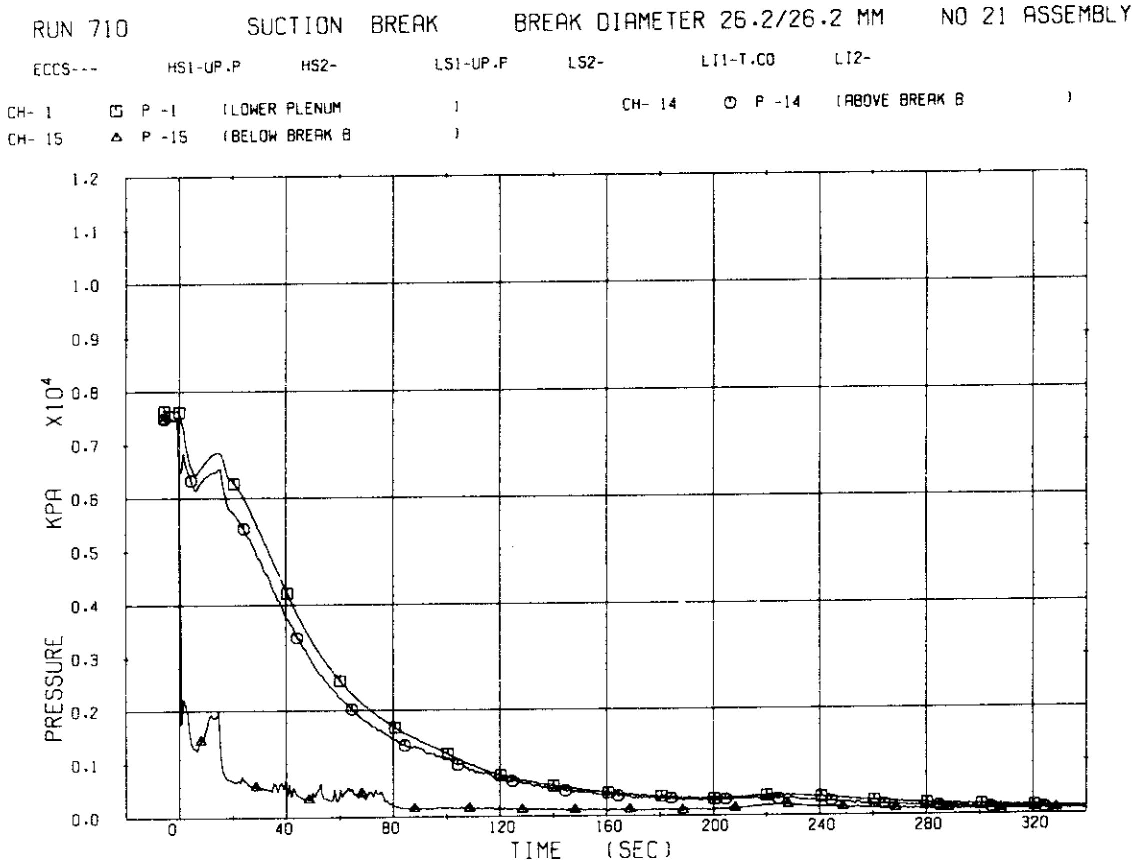


Fig. 5.5 Pressures at immediate above and below break B

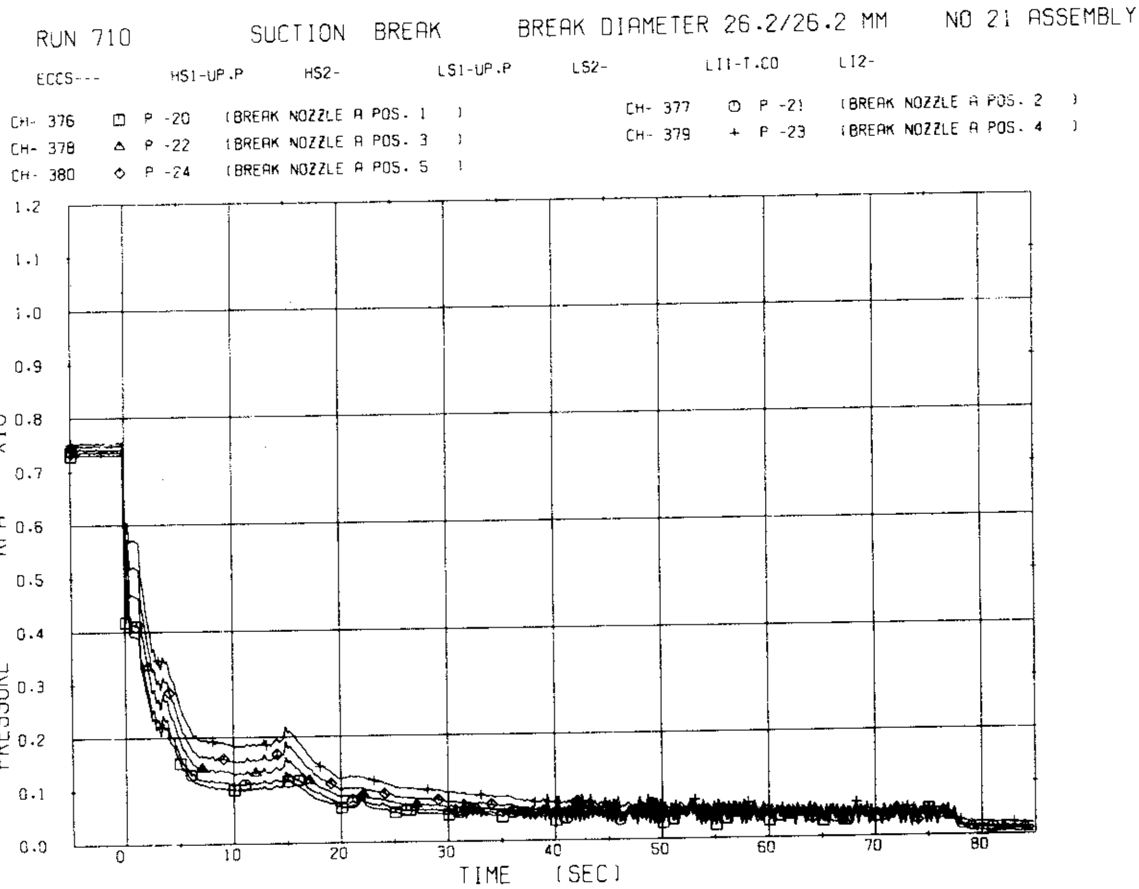


Fig. 5.6 Pressures in break nozzle A

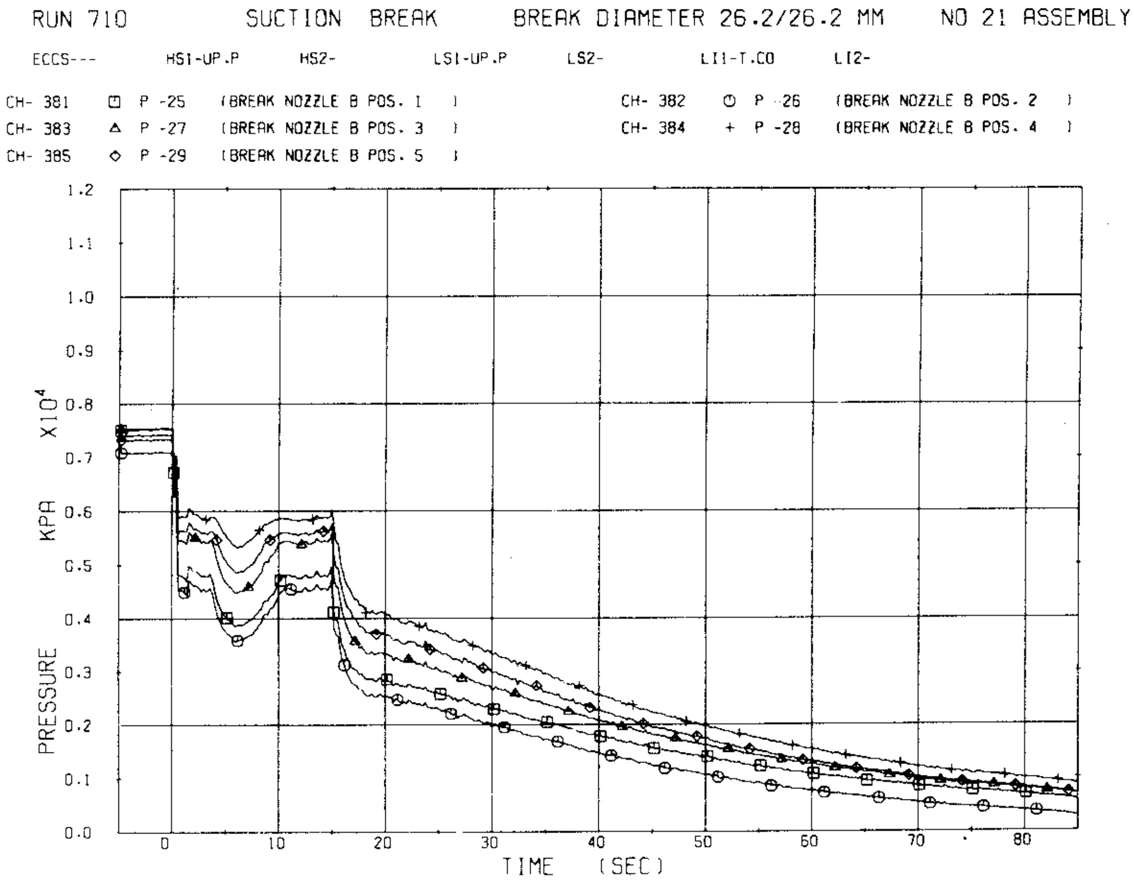


Fig. 5.7 Pressures in break nozzle B

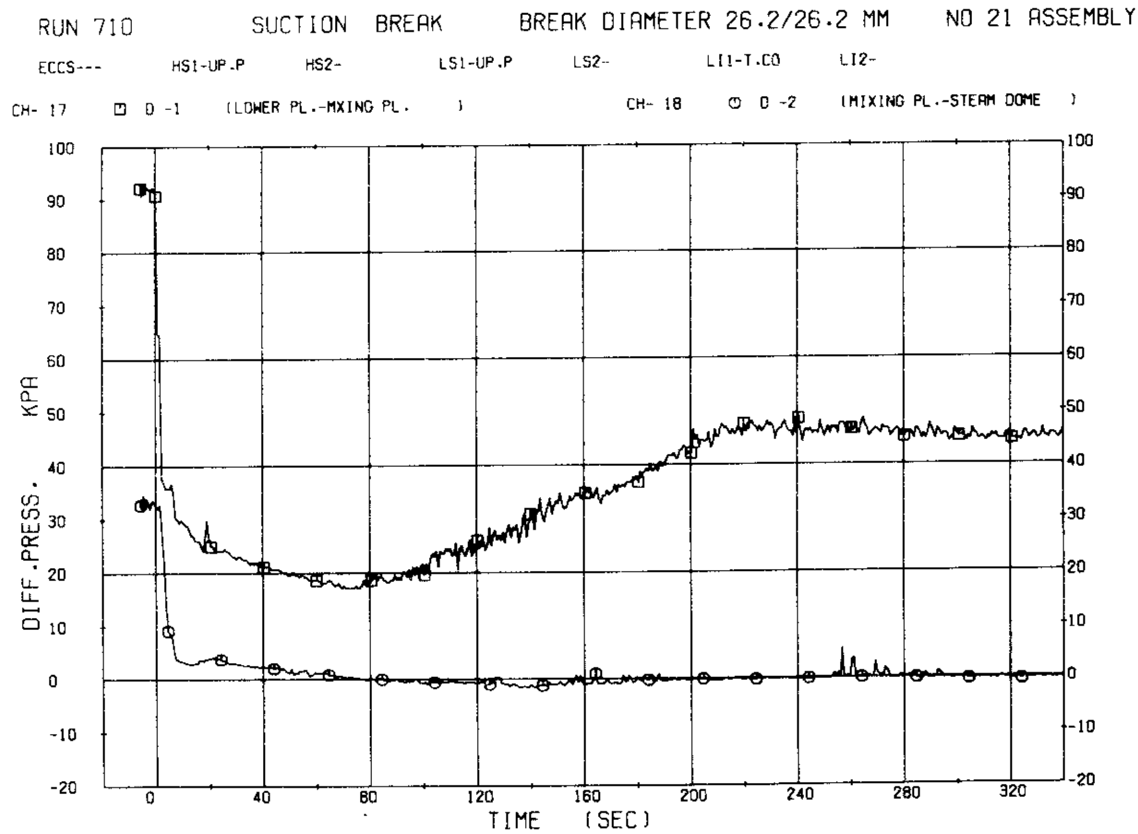


Fig. 5.8 Differential pressures between lower plenum and upper plenum, and upper plenum and steam dome.

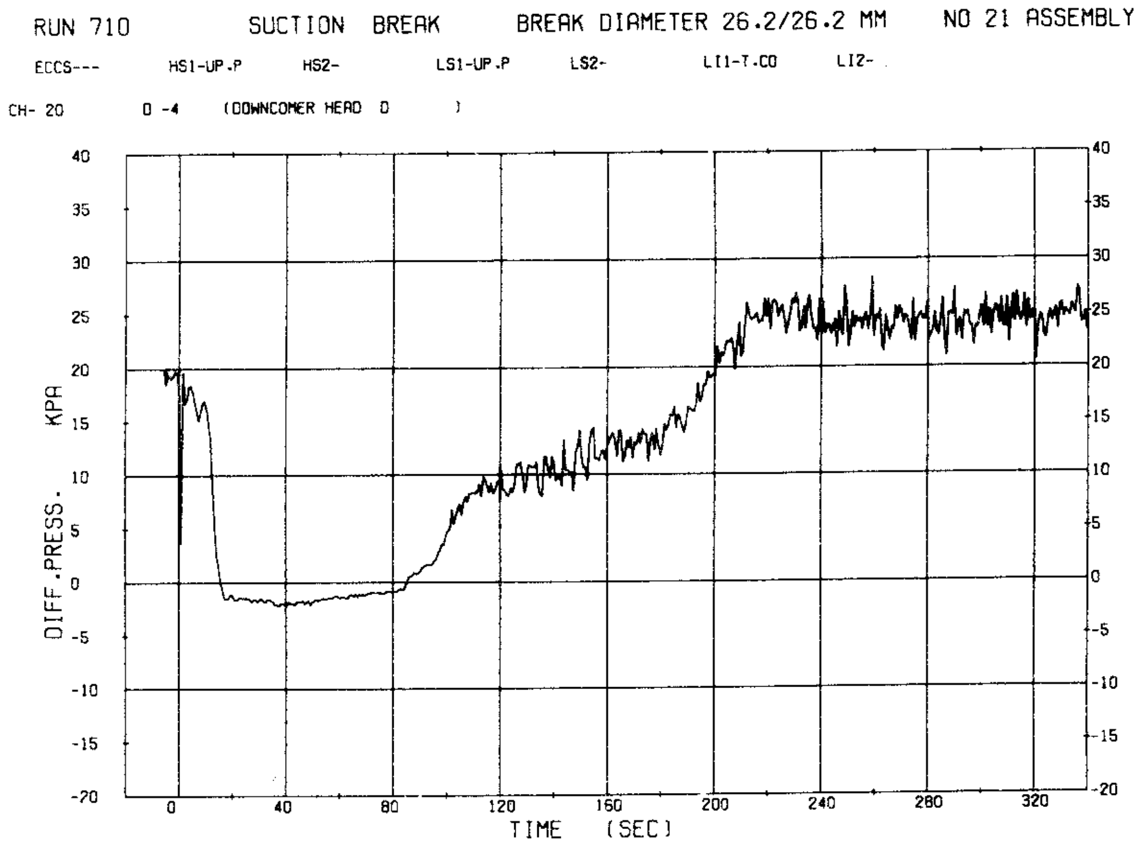


Fig. 5.9 Downcomer head

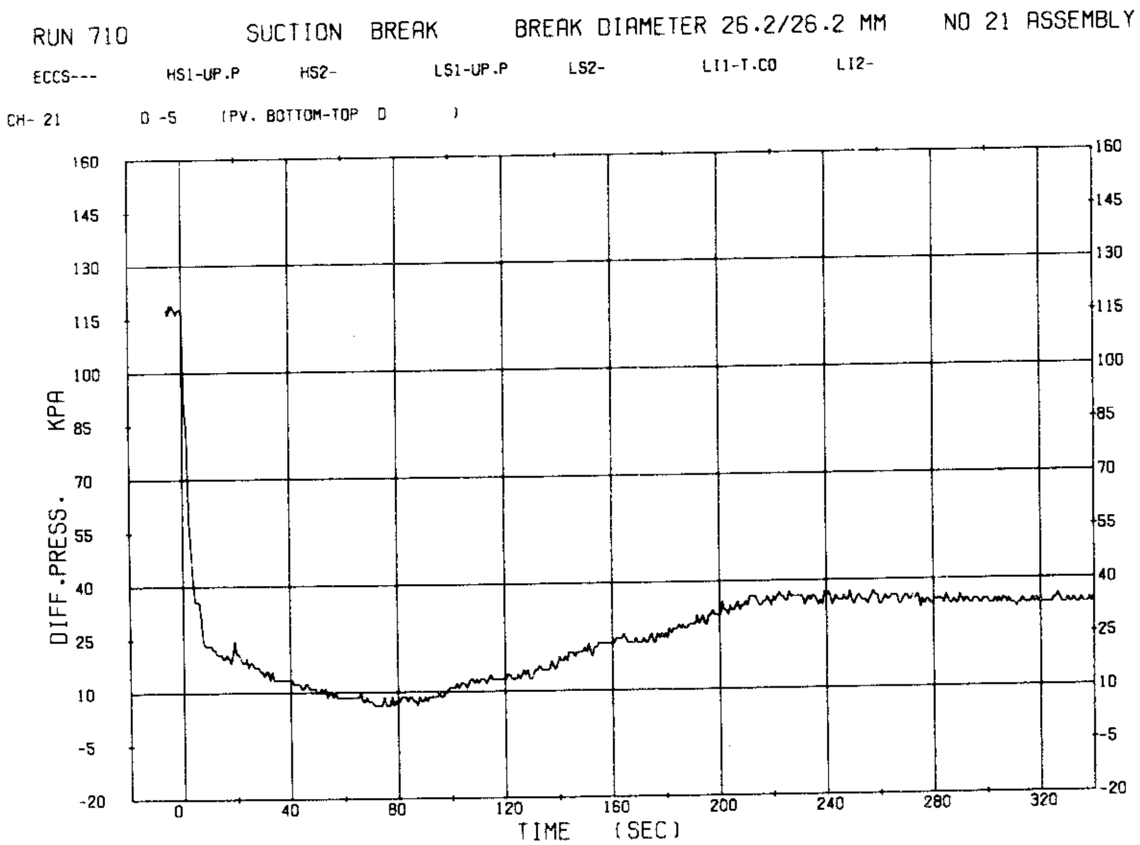


Fig. 5.10 Differential pressures between discharge and suction, and between drive and suction of intact loop jet pumps

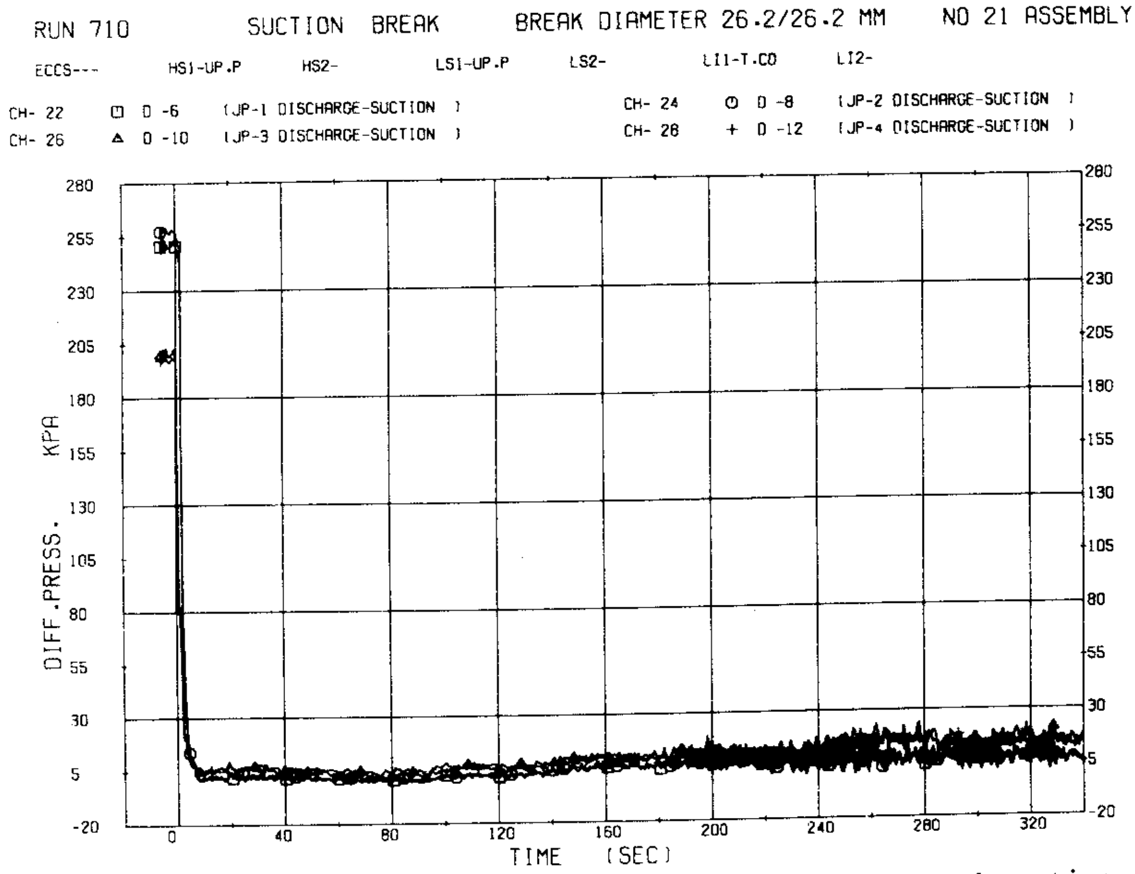


Fig. 5.11 Differential pressures between discharge and suction

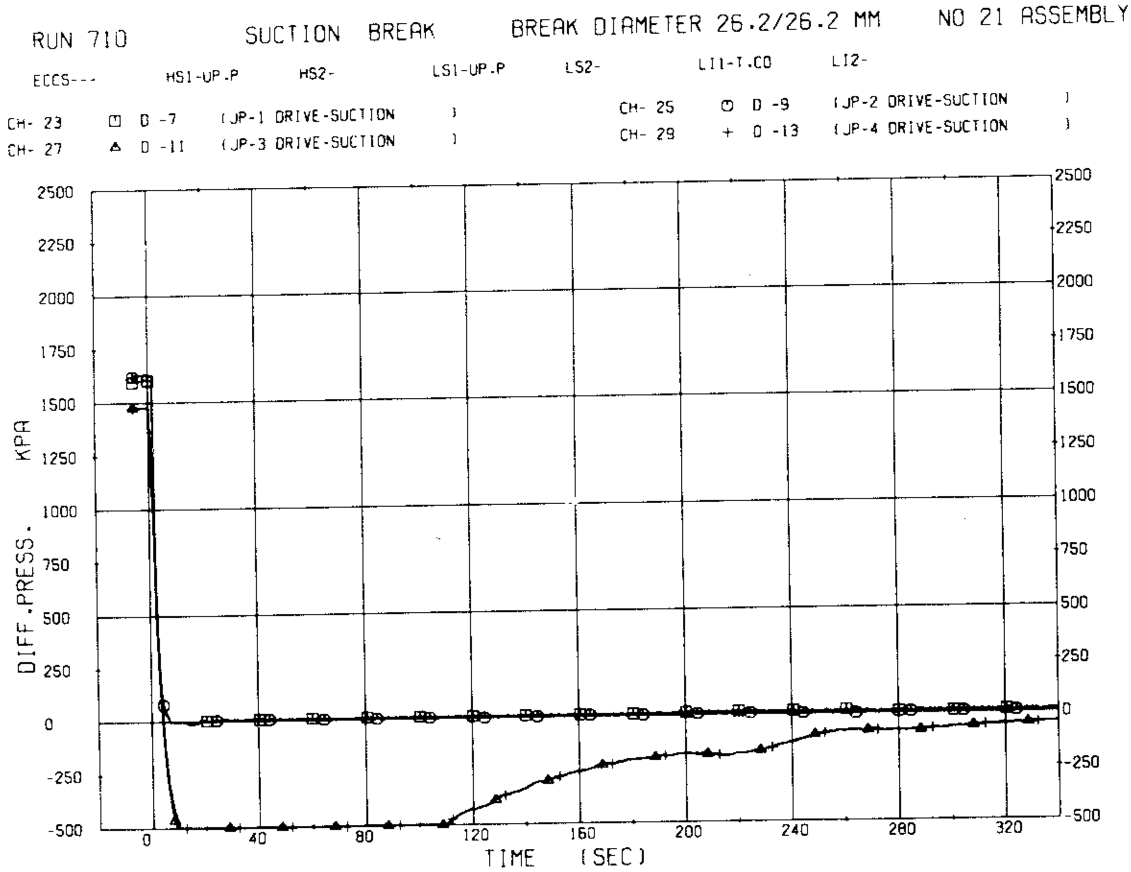


Fig. 5.12 Differential pressures between drive and suction

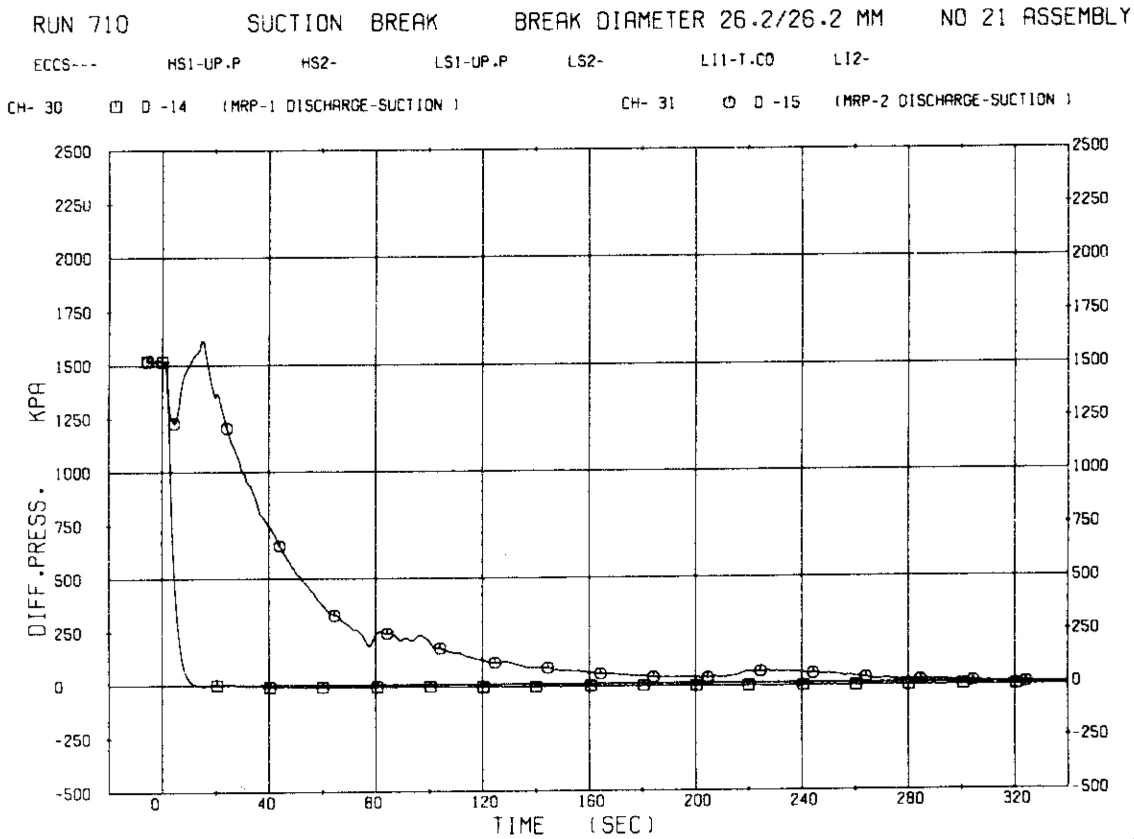


Fig. 5.13 Differential pressures between delivery and suction of recirculation pump

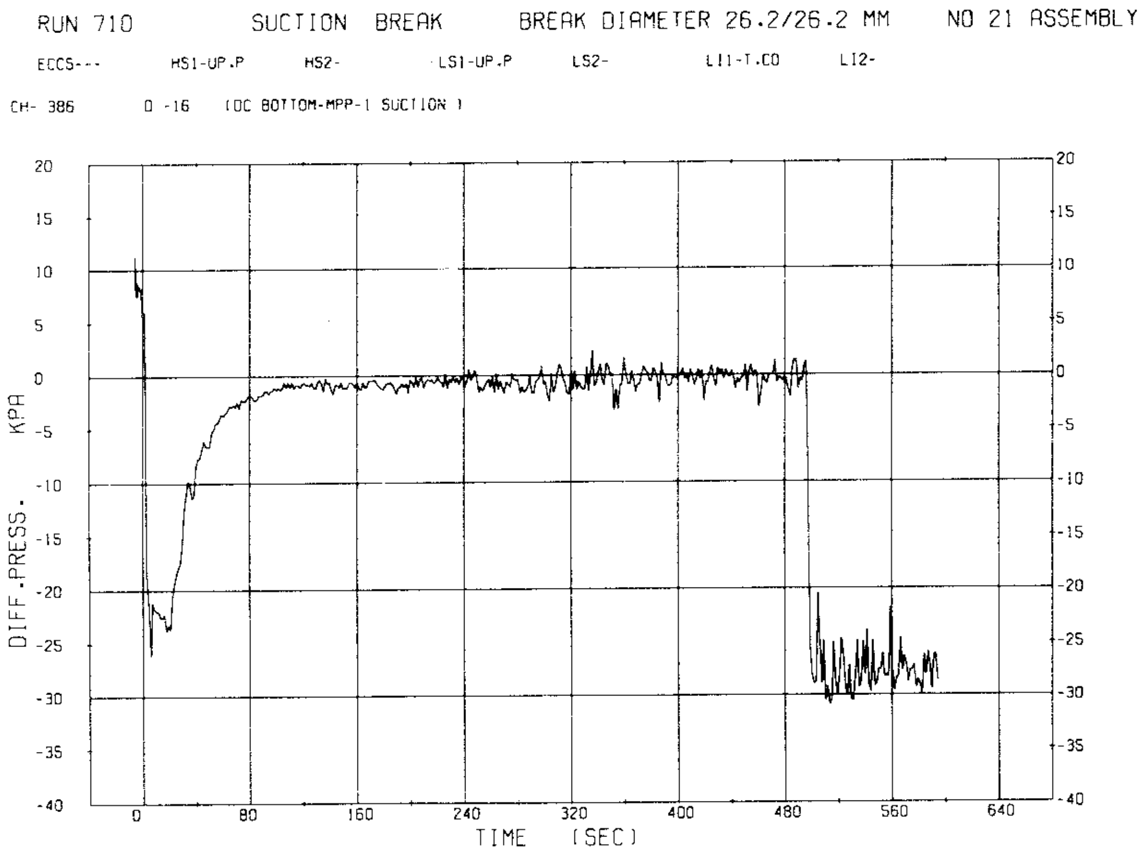


Fig. 5.14 Differential pressure between downcomer bottom and MRP1 suction

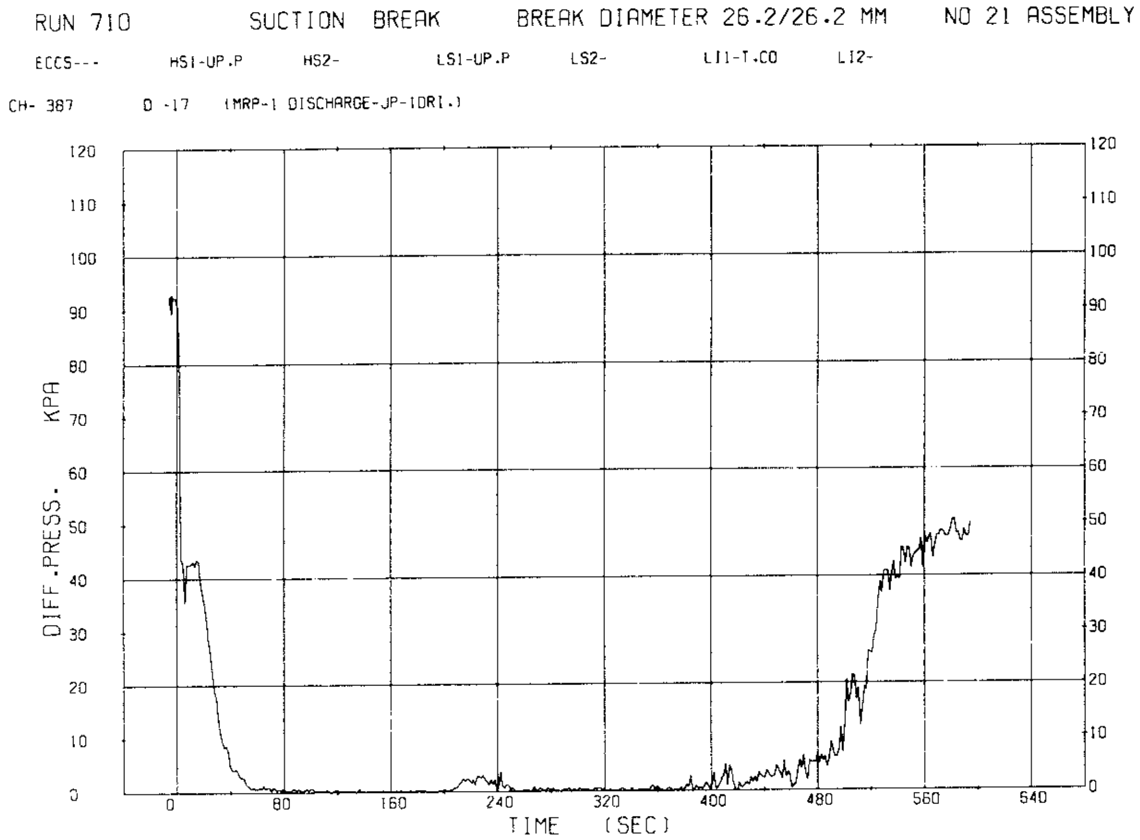


Fig. 5.15 Differential pressure between MRP1 discharge and JP1 drive

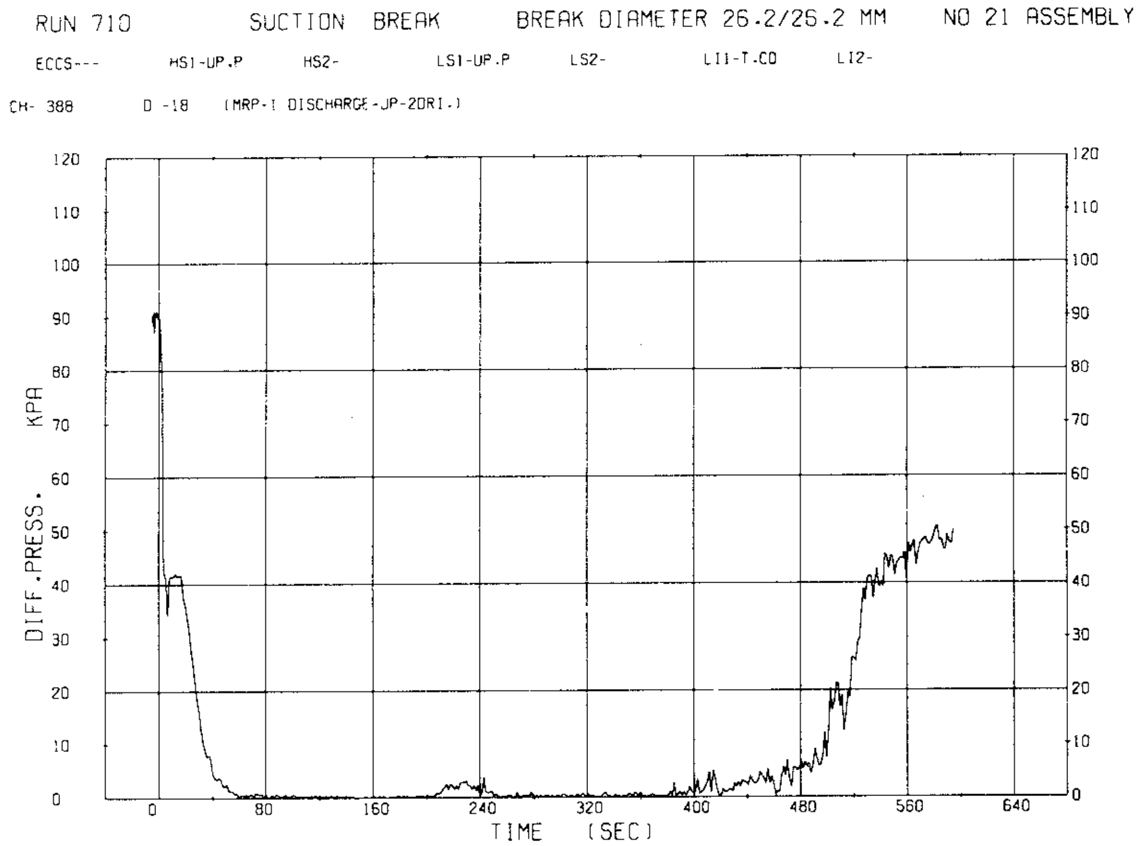


Fig. 5.16 Differential pressure between MRP1 discharge and JP2 drive

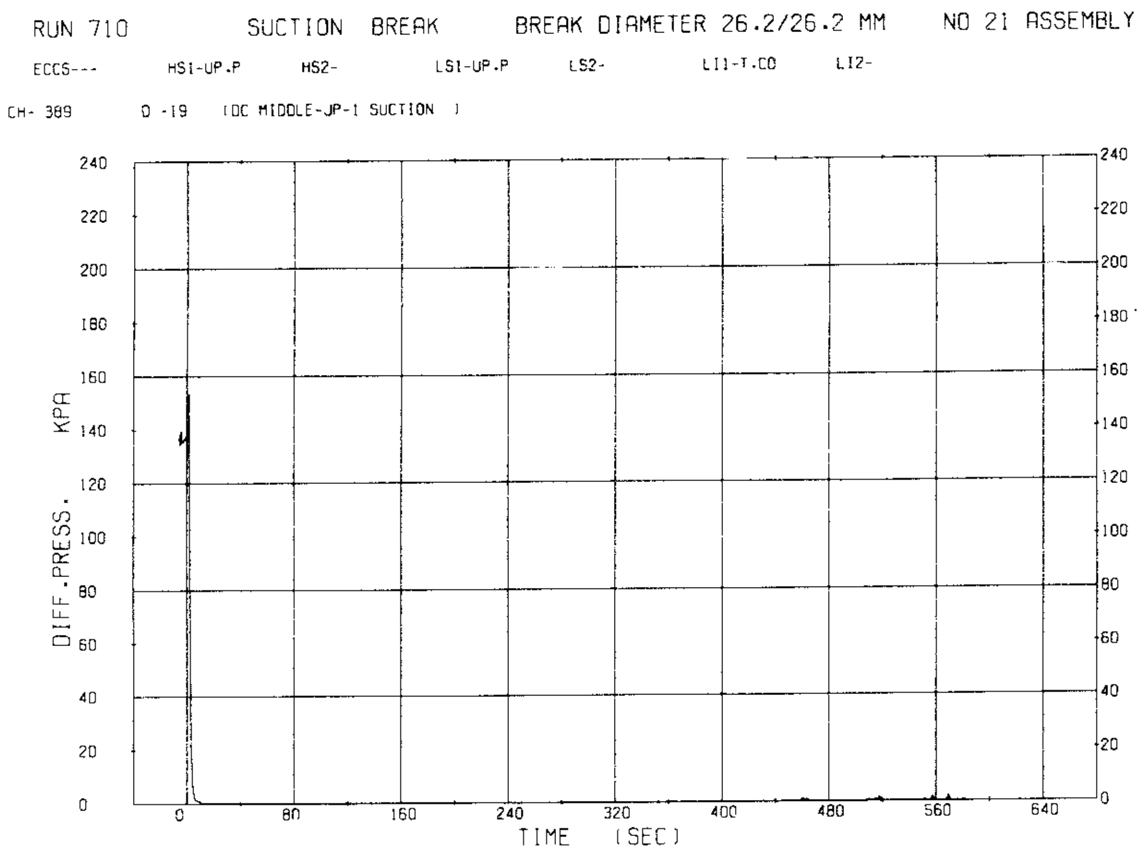


Fig. 5.17 Differential pressure between downcomer middle and JP1 suction

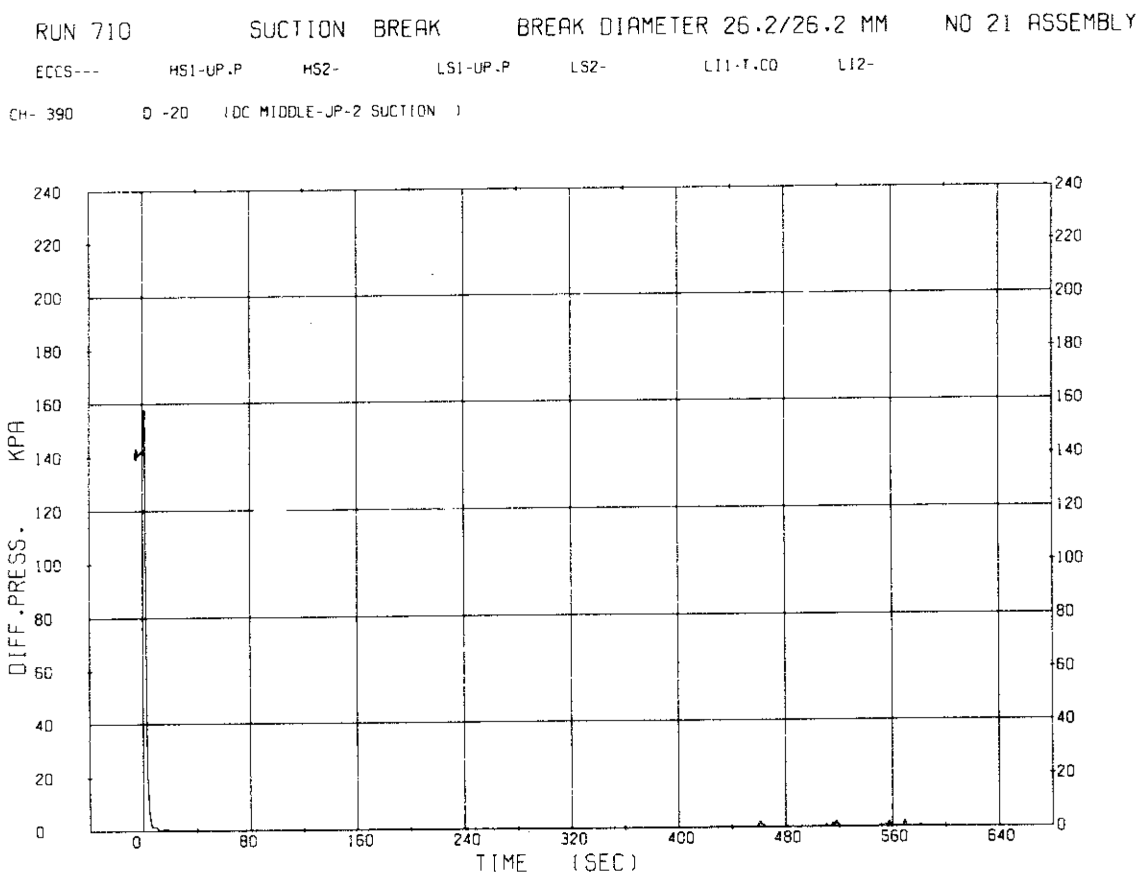


Fig. 5.18 Differential pressure between downcomer middle and JP2 suction

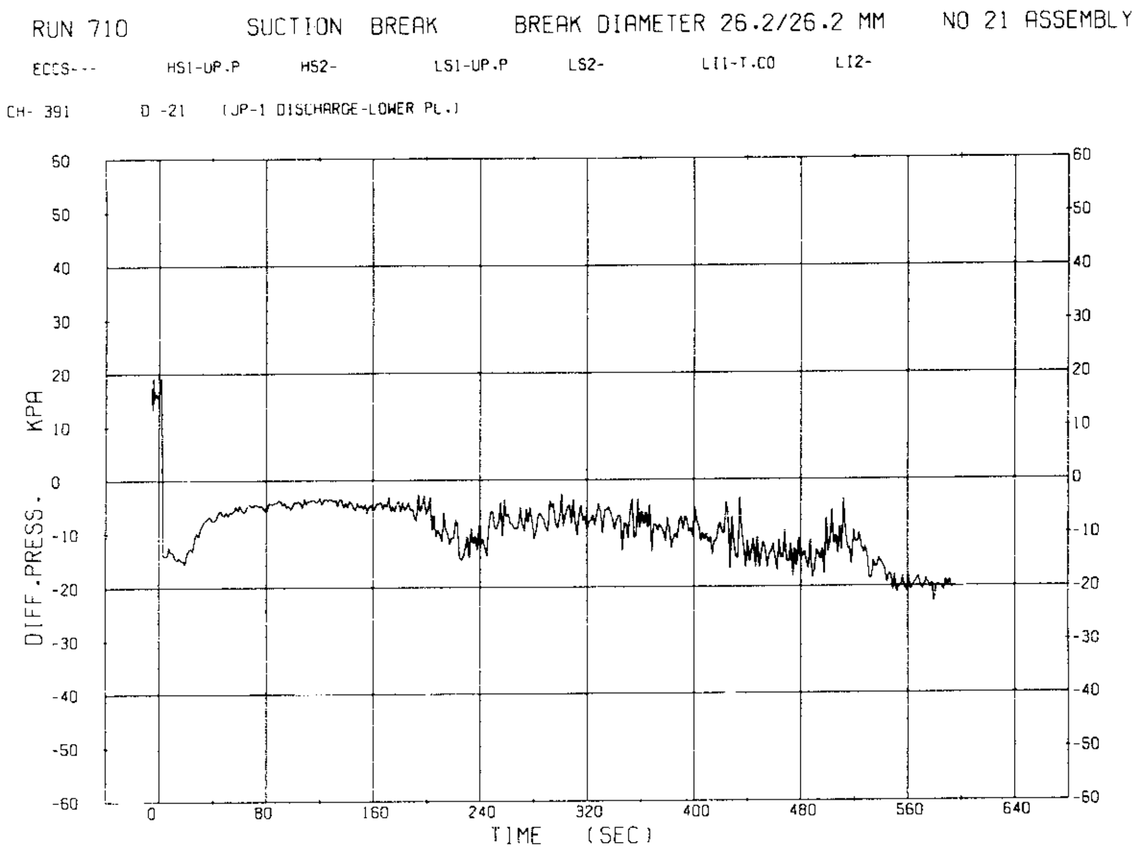


Fig. 5.19 Differential pressure between JP1 discharge and lower plenum

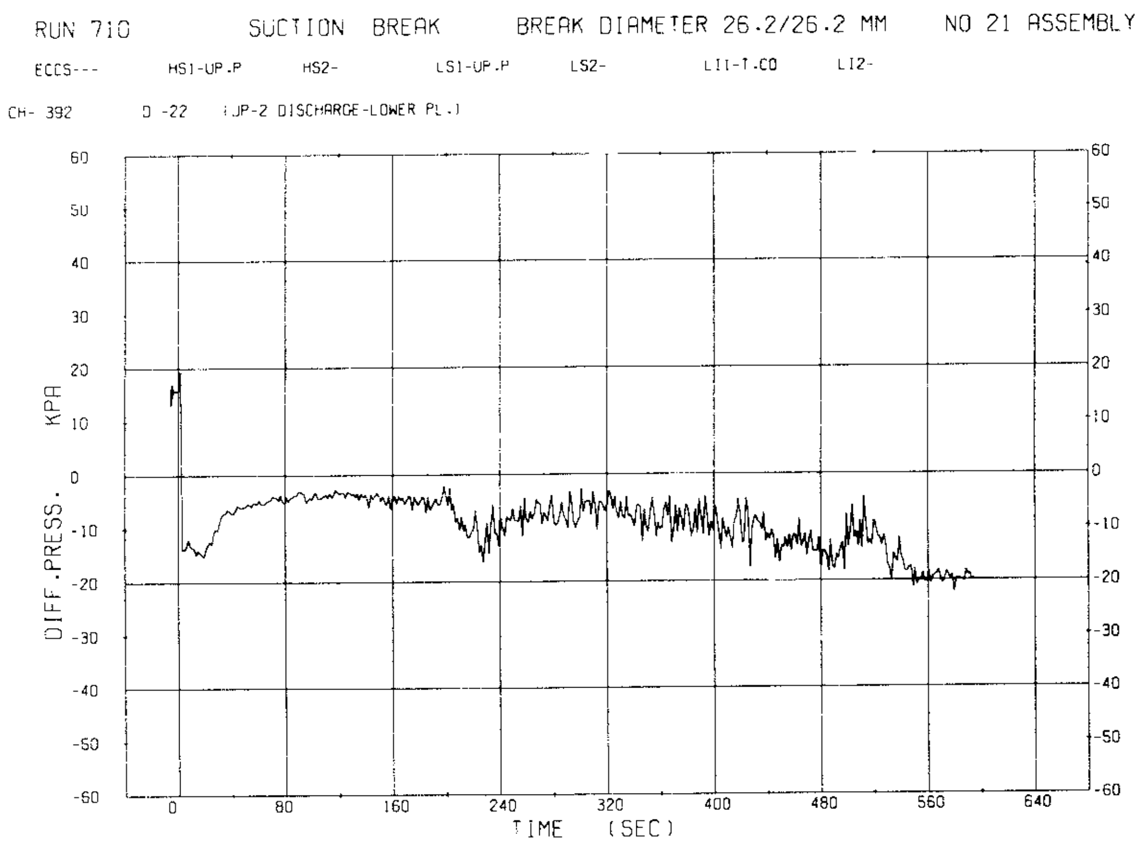


Fig. 5.20 Differential pressure between JP2 discharge and lower plenum

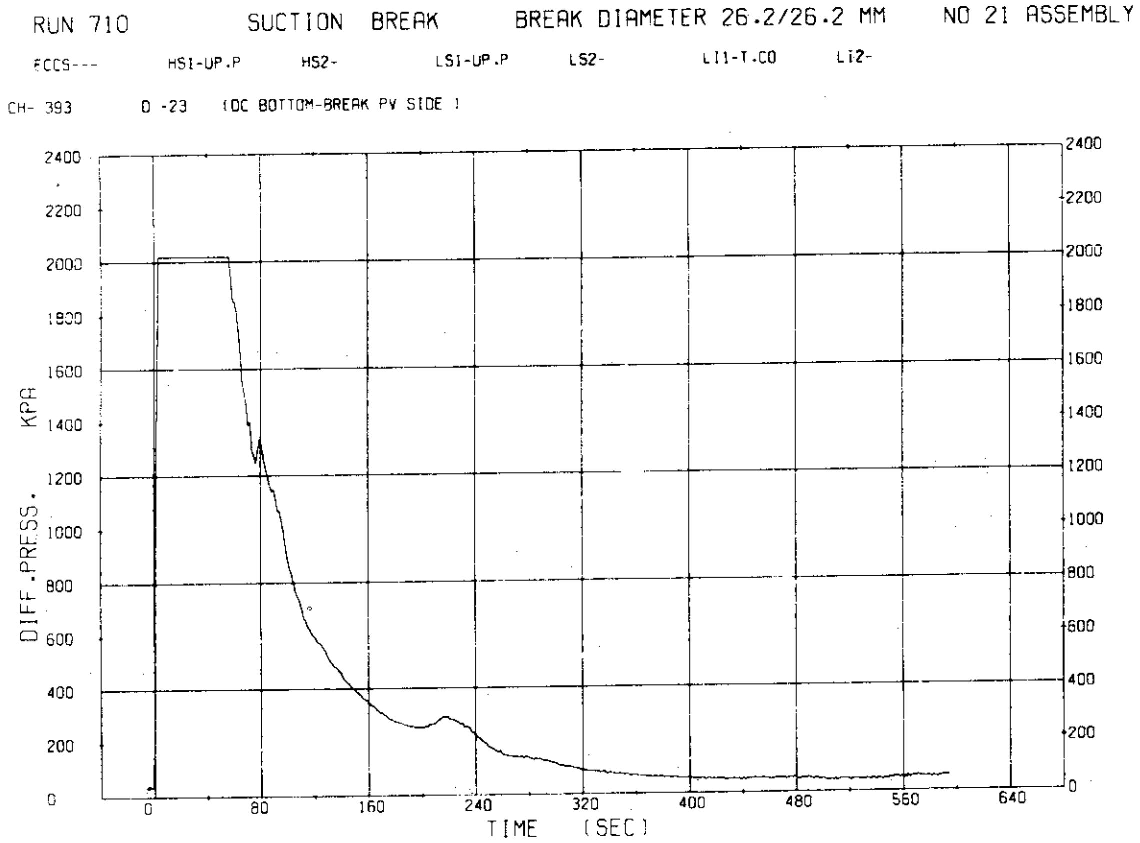


Fig. 5.21 Differential pressure between downcomer bottom and bleak B

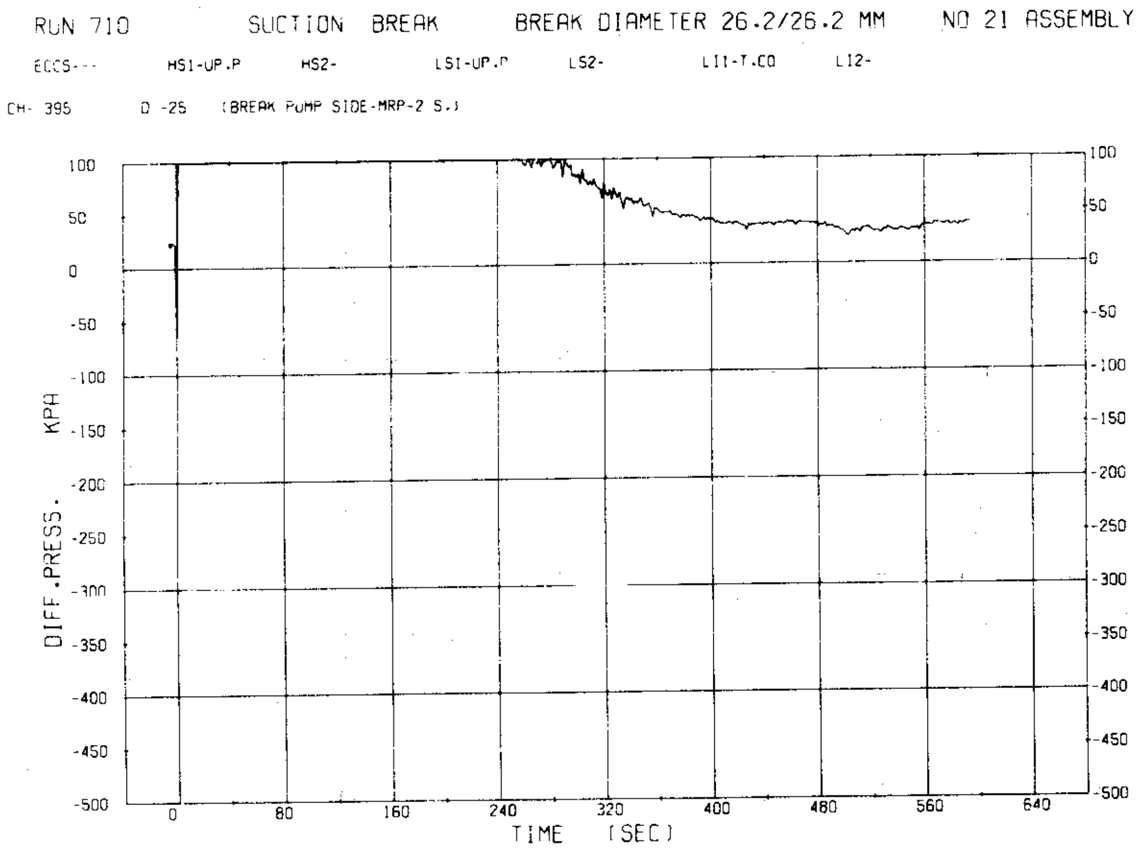


Fig. 5.22 Differential pressure between break B and break A

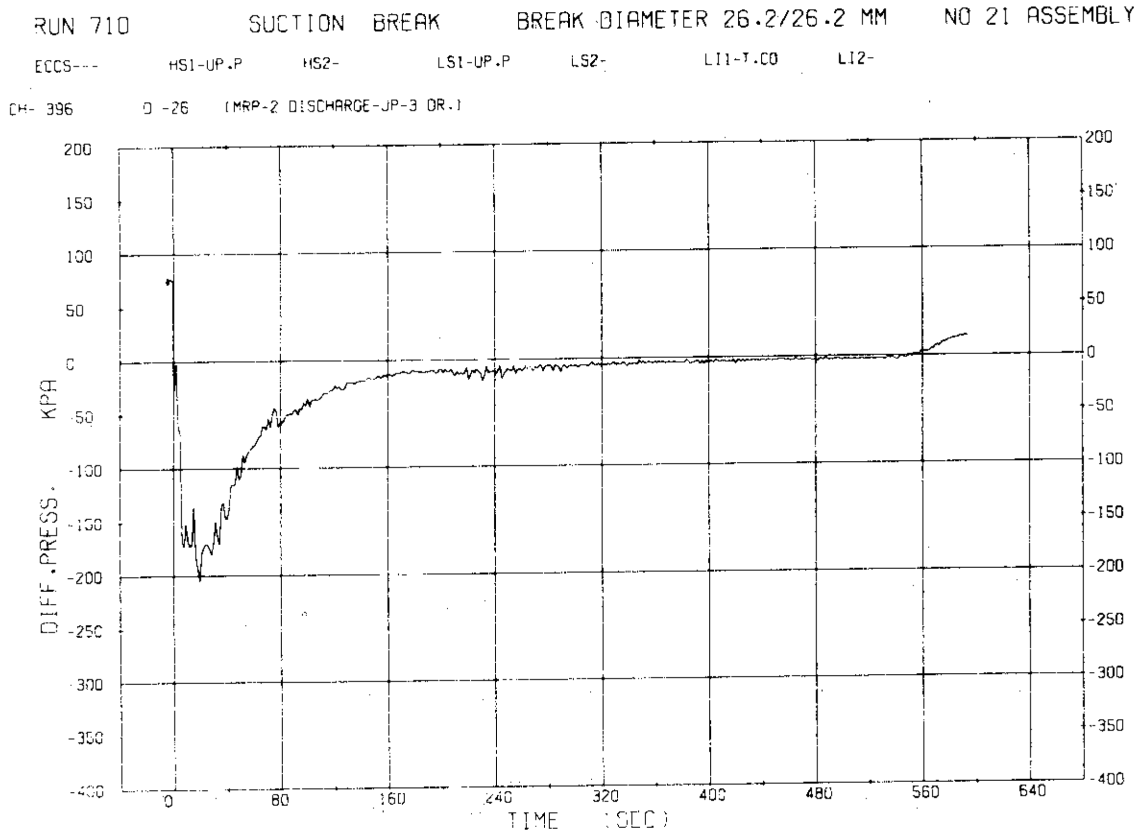


Fig. 5.23 Differential pressure between break A and MRP2 suction

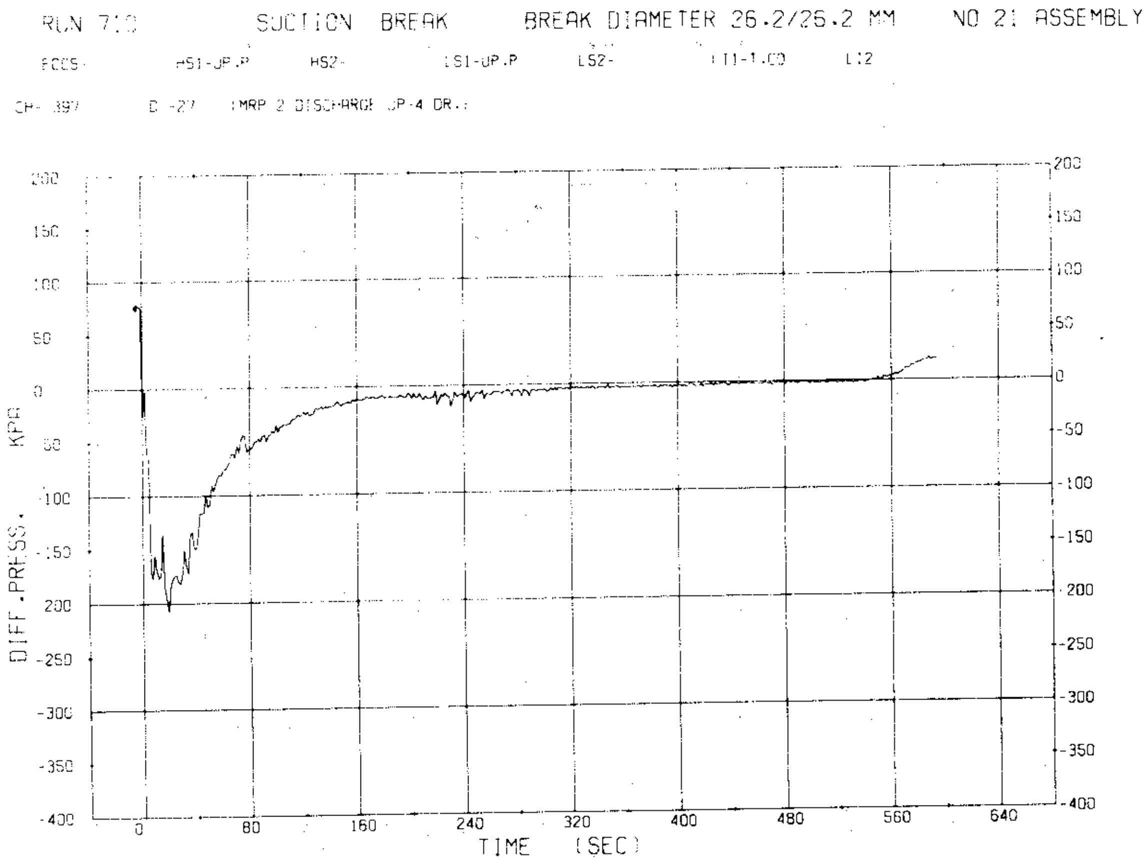


Fig. 5.24 Differential pressure between MRP2 discharge and JP3 drive

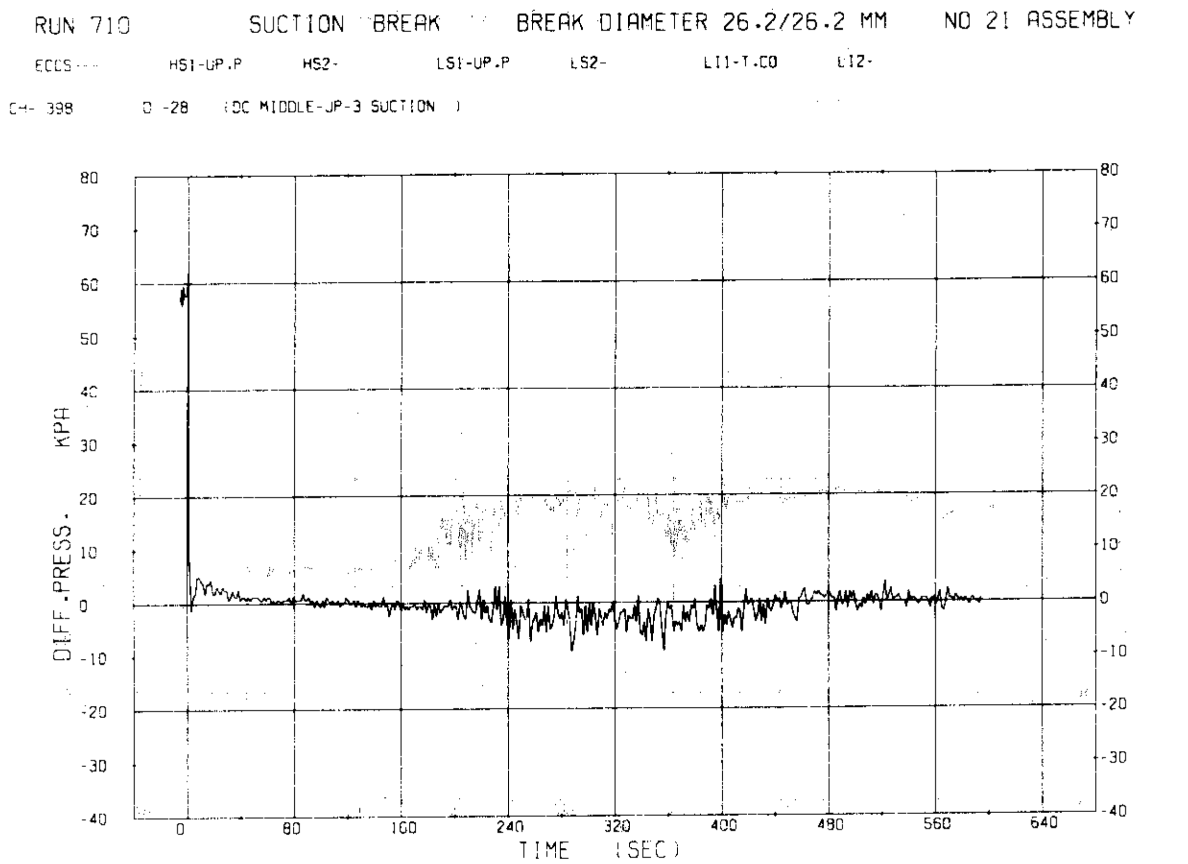


Fig. 5.25 Differential pressure between MRP2 discharge and JP4 drive

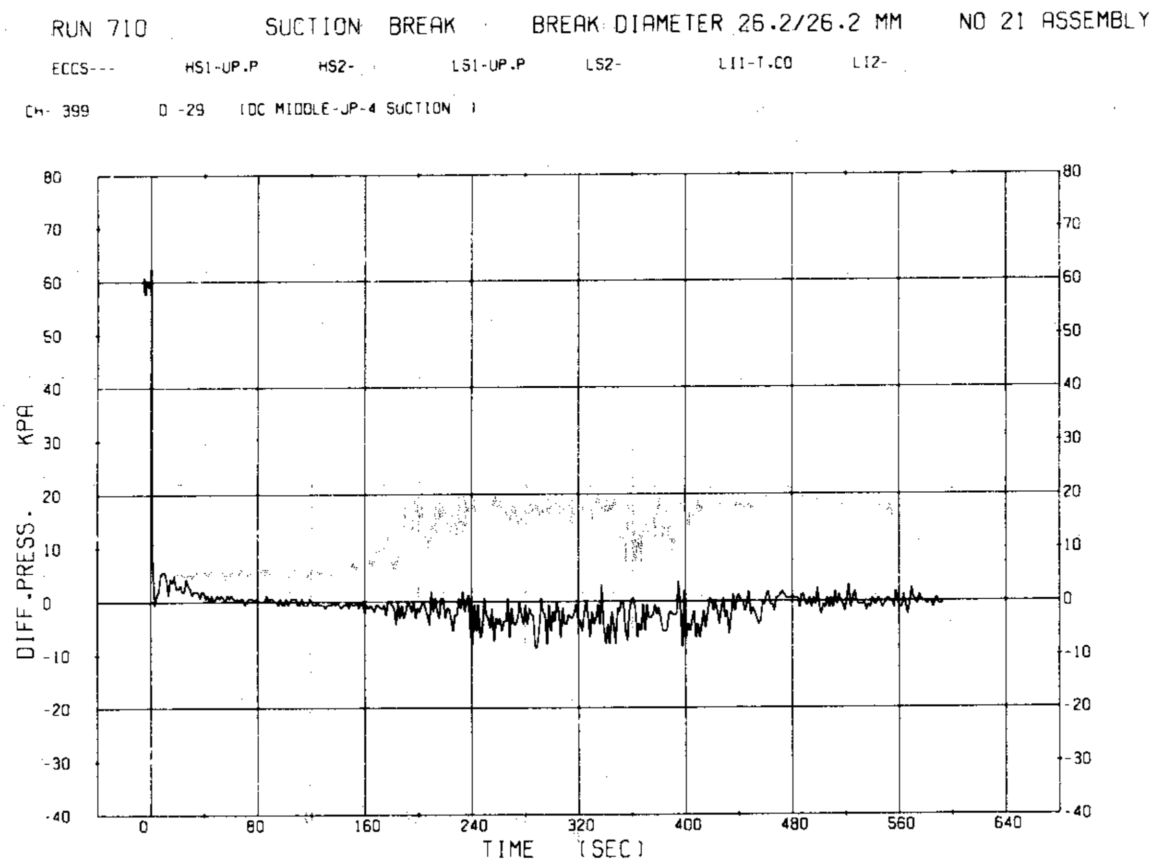


Fig. 5.26 Differential pressure between downcomer middle and JP3 suction

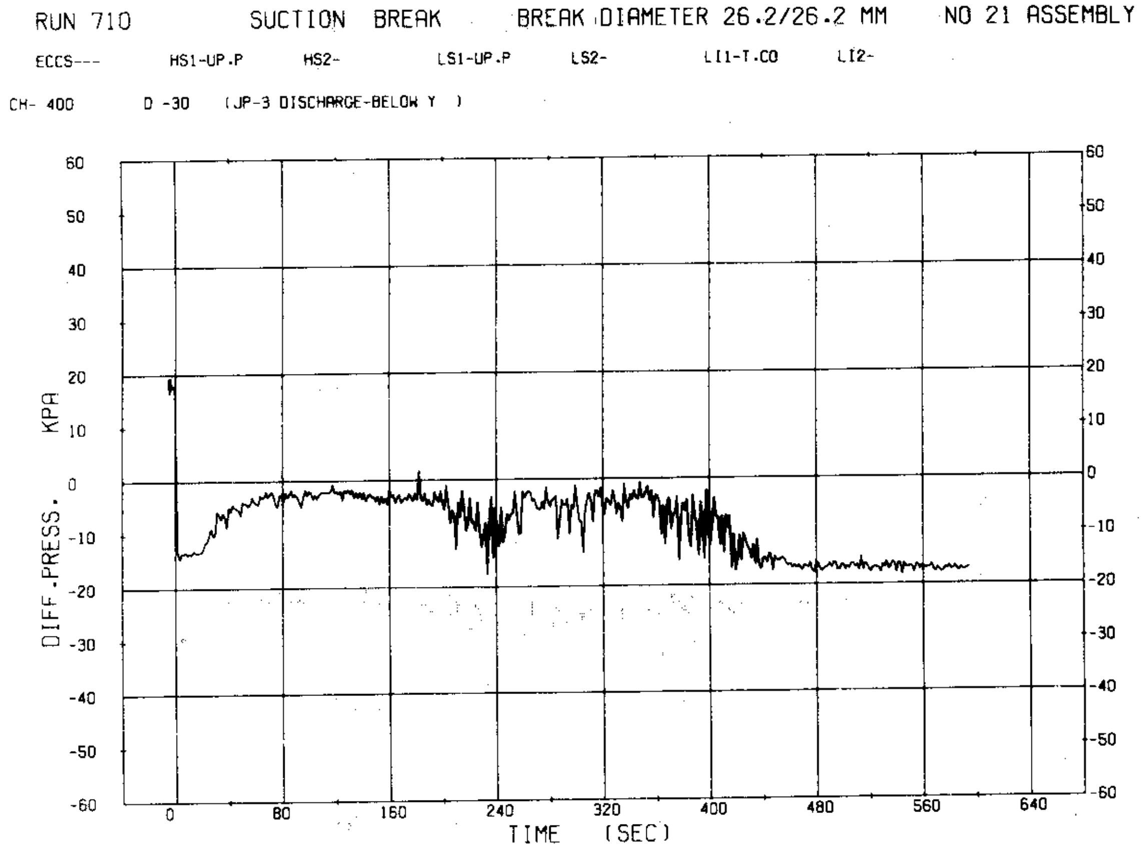


Fig. 5.27 Differential pressure between downcomer middle and JP4 suction

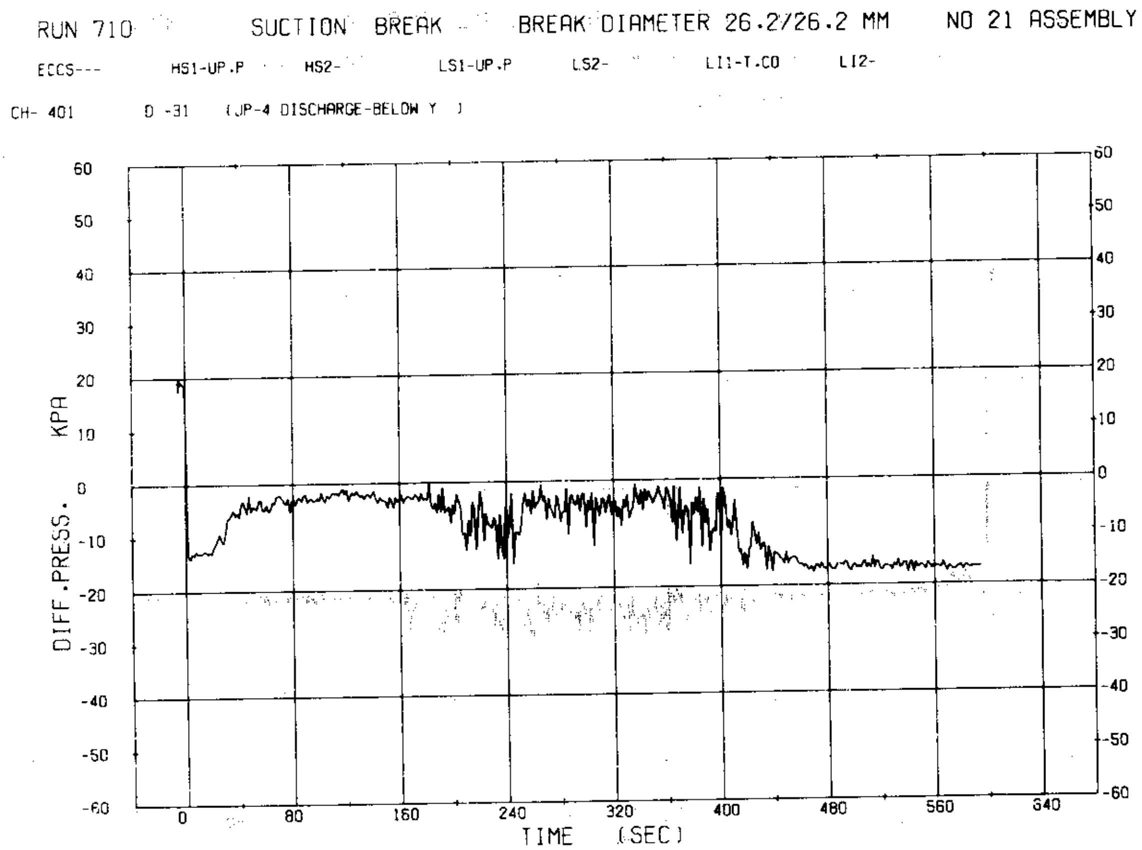


Fig. 5.28 Differential pressure between JP3 discharge and below Y

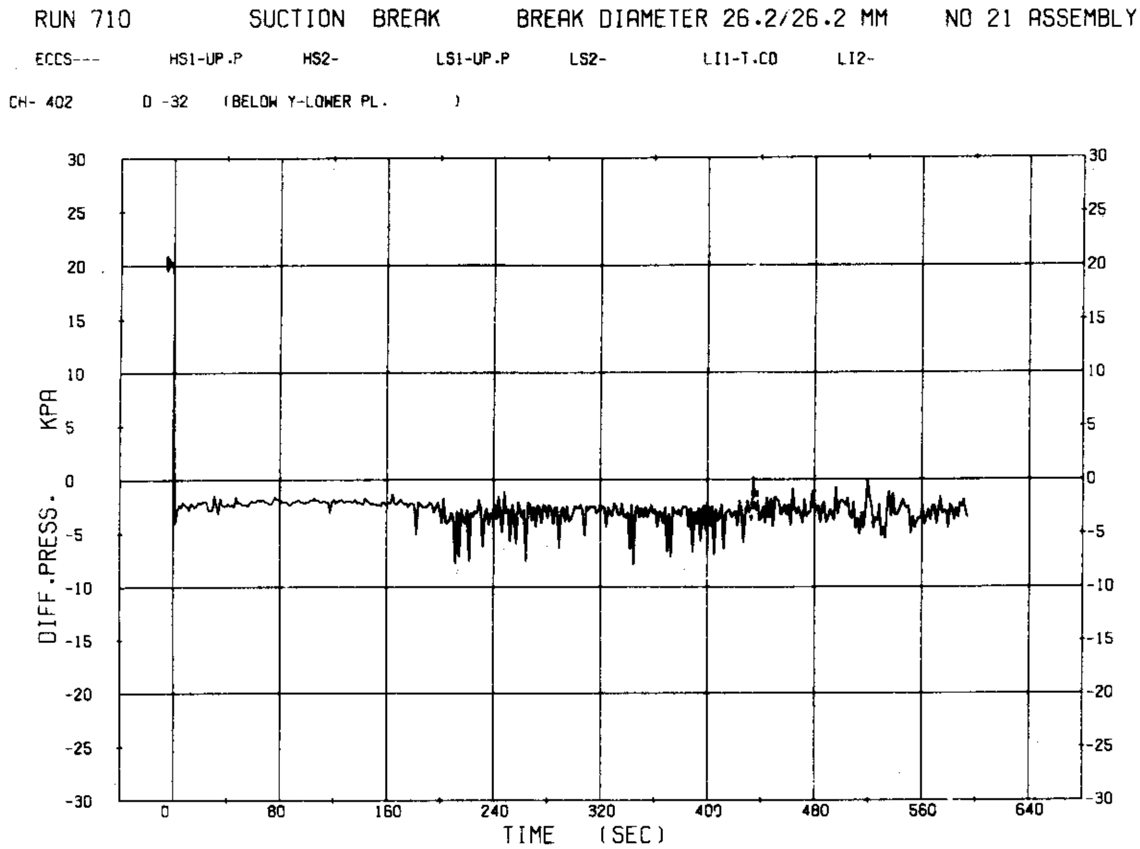


Fig. 5.29 Differential pressure between JP4 discharge and below Y

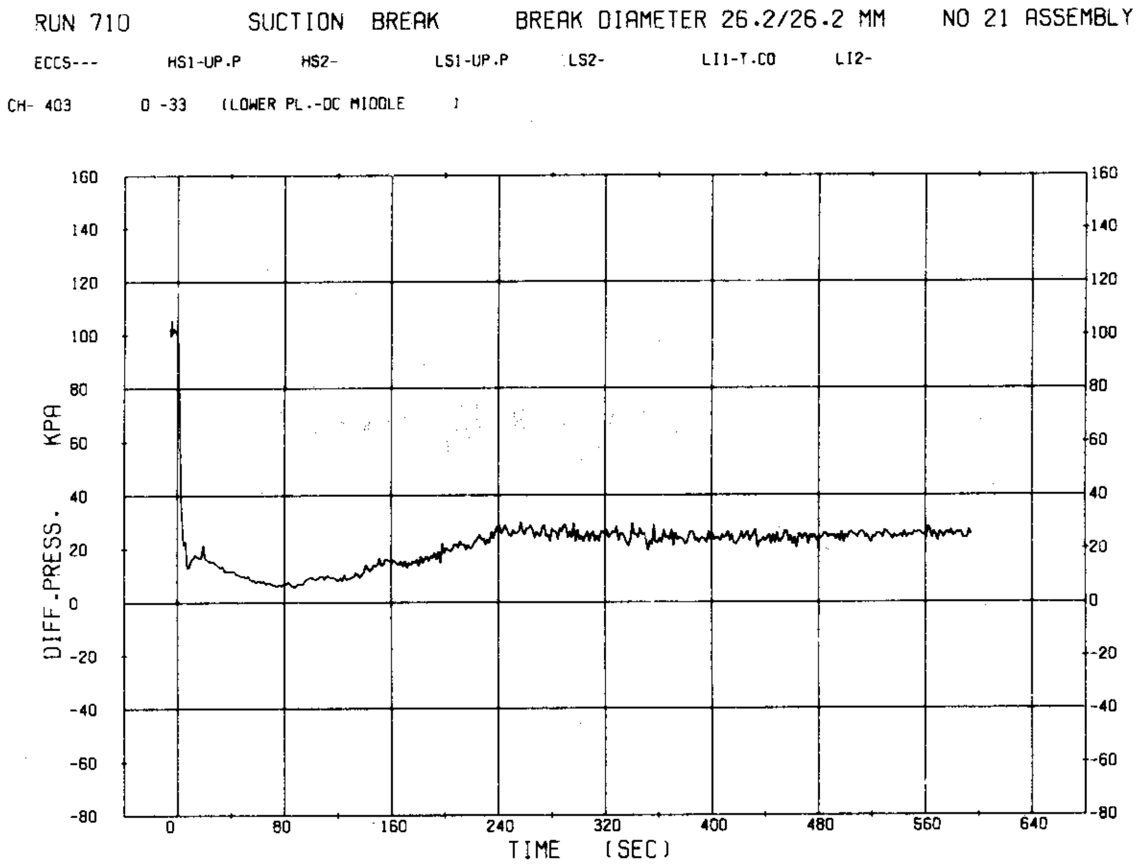


Fig. 5.30 Differential pressure between blow Y and lower plenum

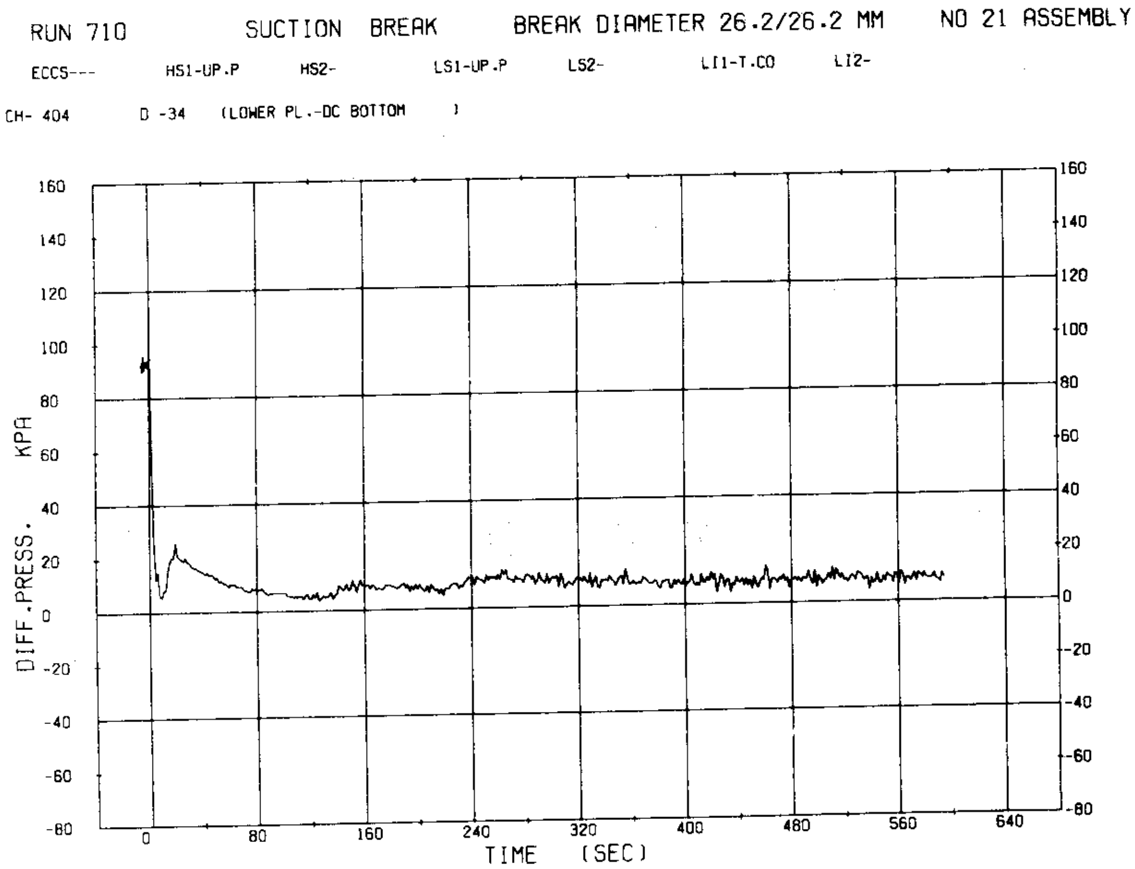


Fig. 5.31 Differential pressure between lower plenum and downcomer bottom

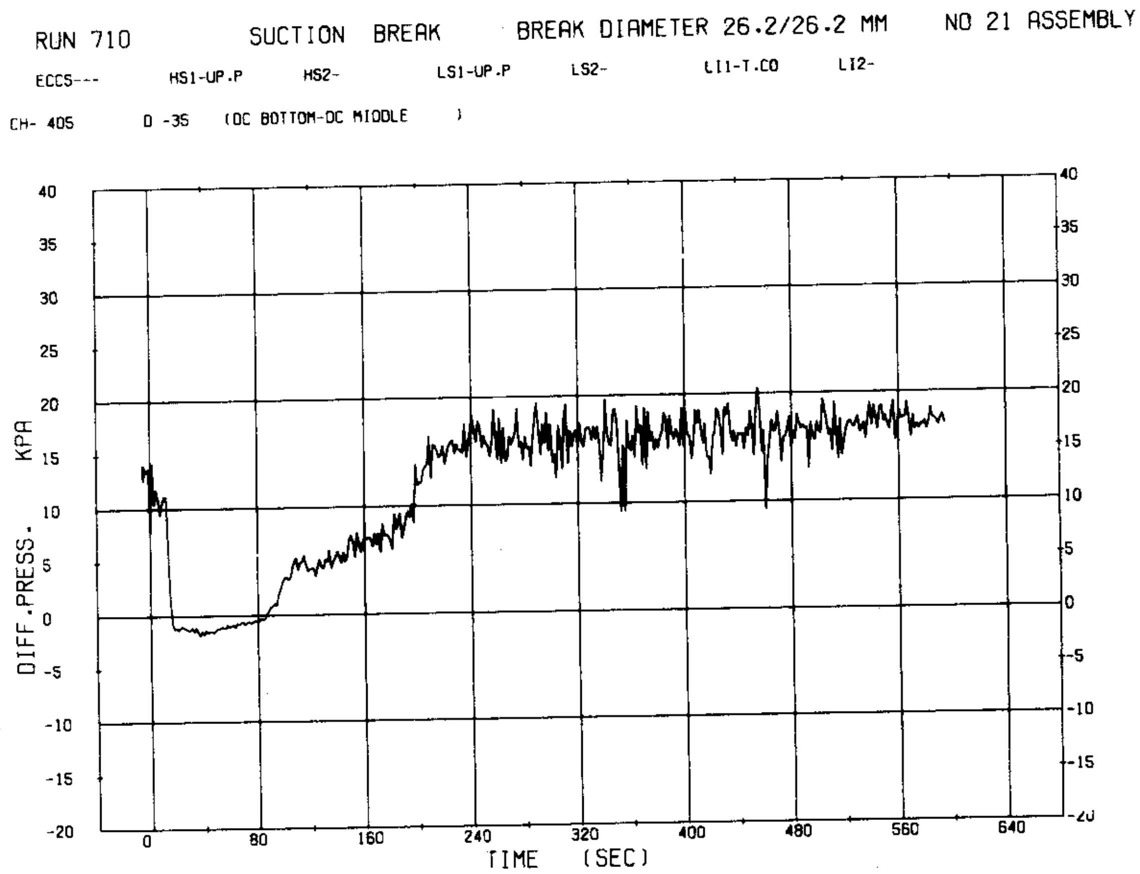


Fig. 5.32 Differential pressure between lower plenum and downcomer bottom

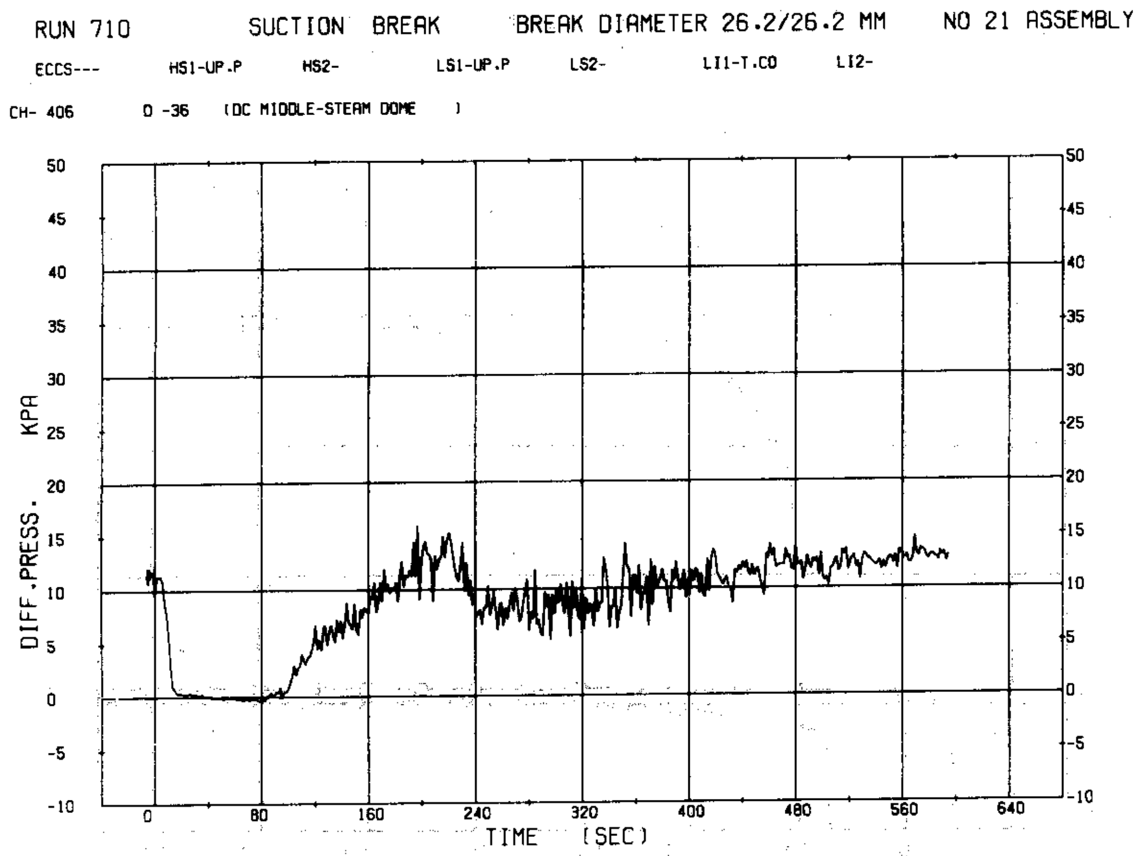


Fig. 5.33 Differential pressure between downcomer bottom and downcomer middle

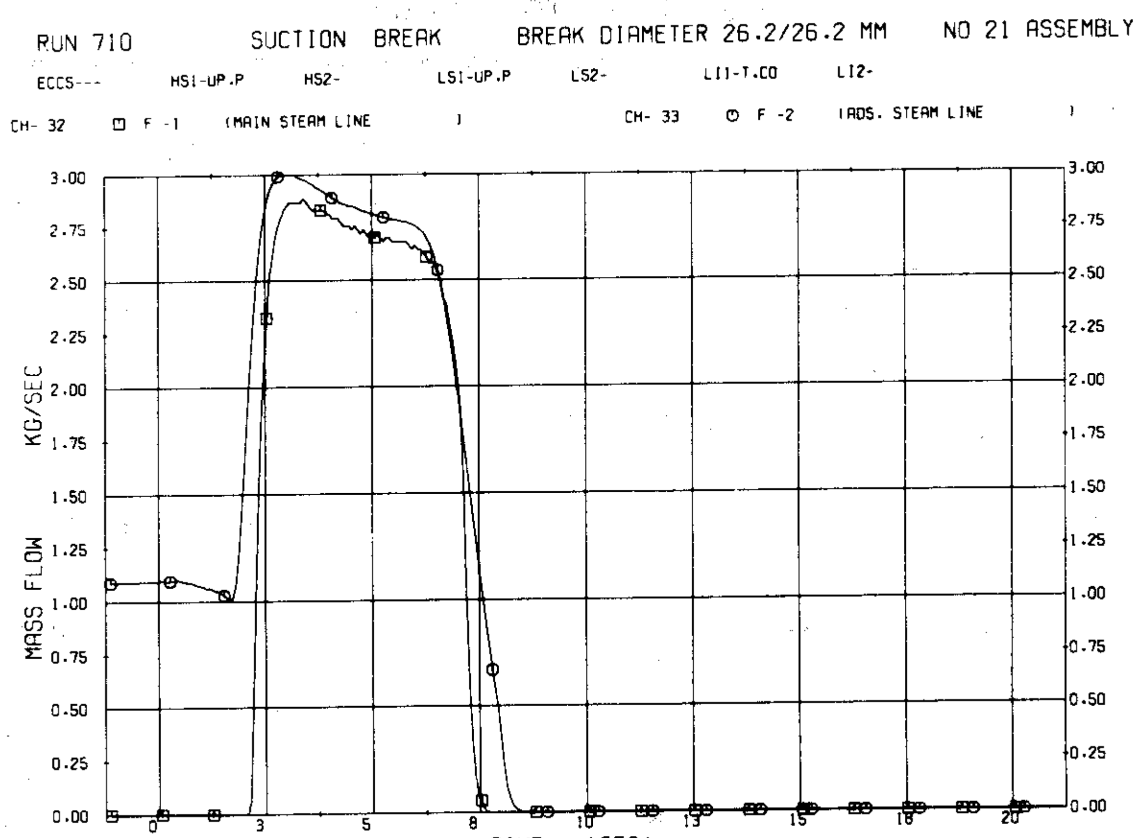


Fig. 5.34 Flowrate of main steam line

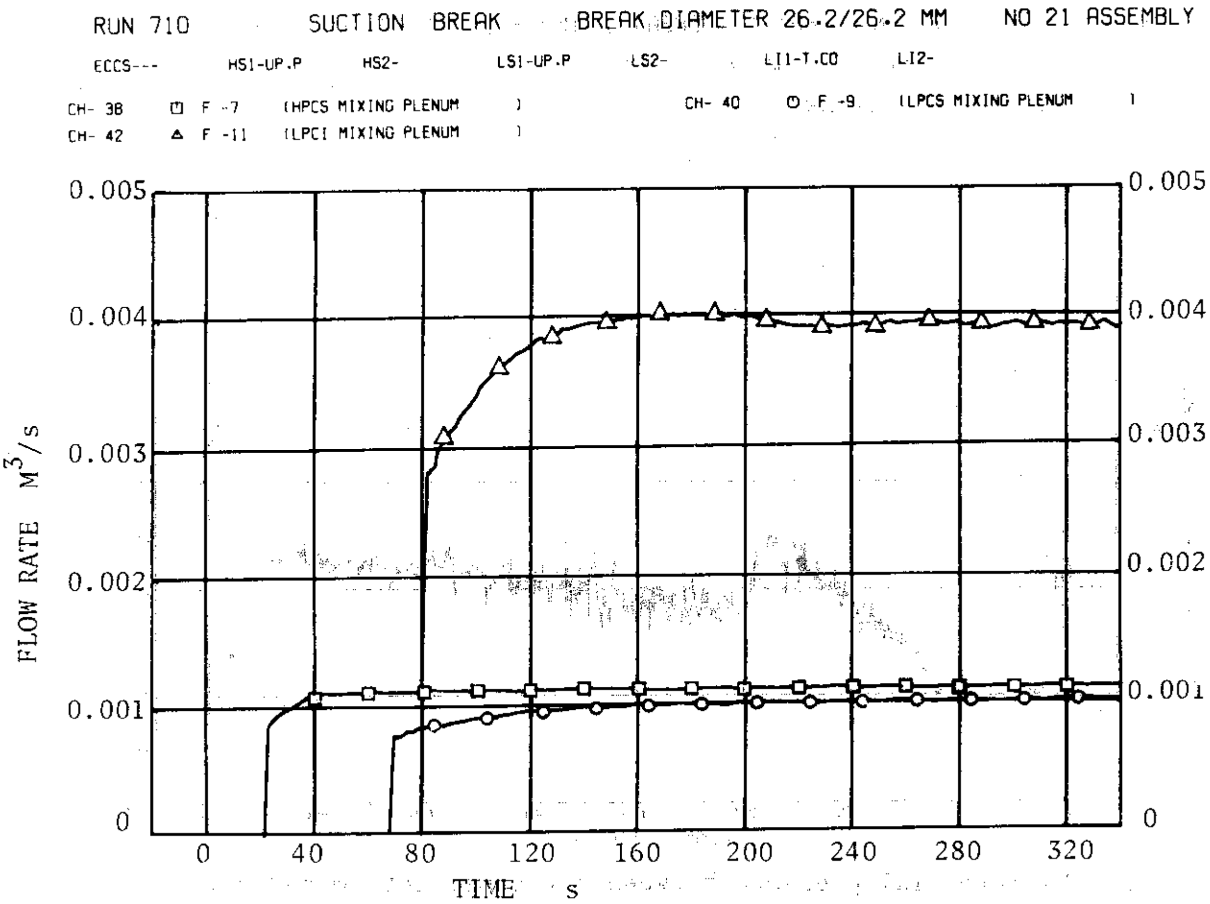


Fig. 5.35 ECCS flowrate

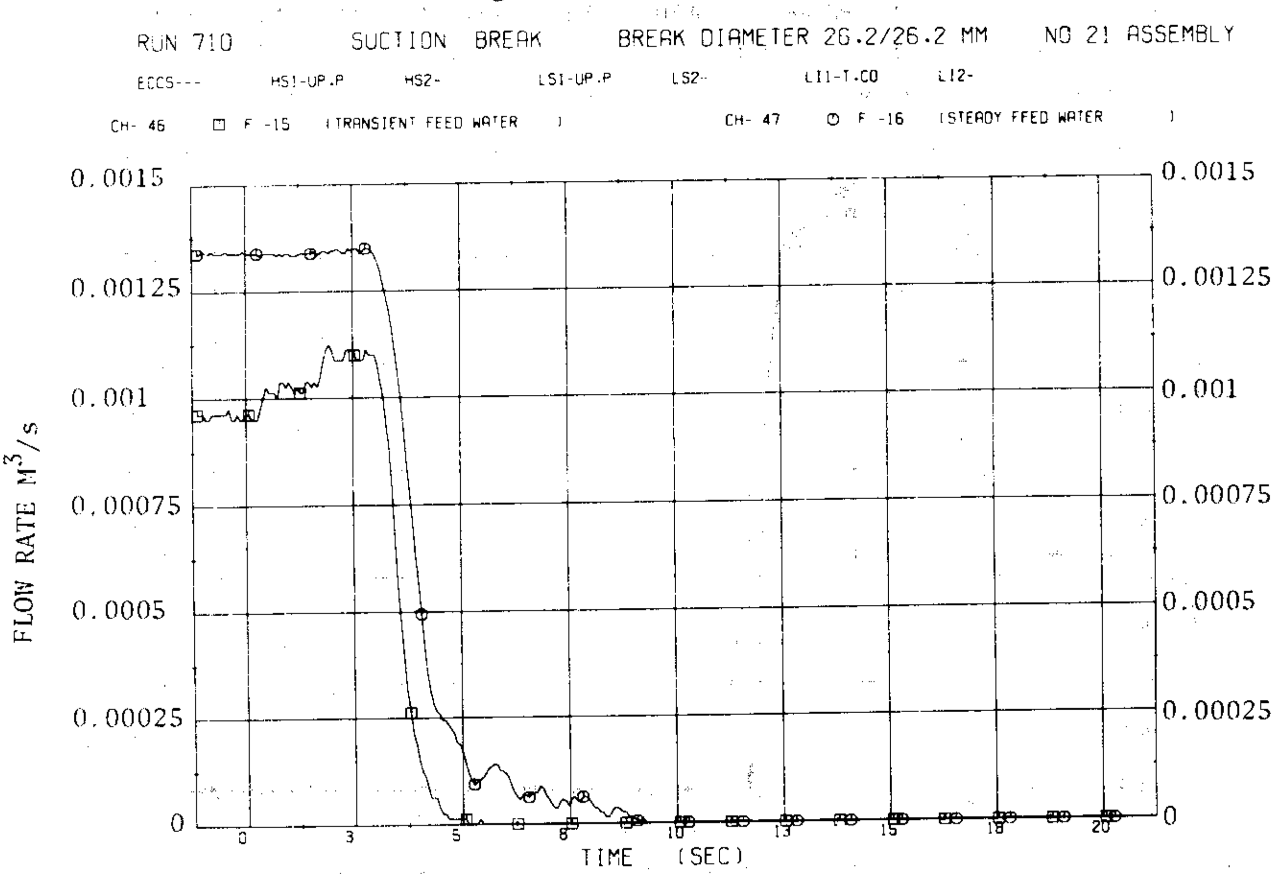


Fig. 5.36 Feedwater flowrate

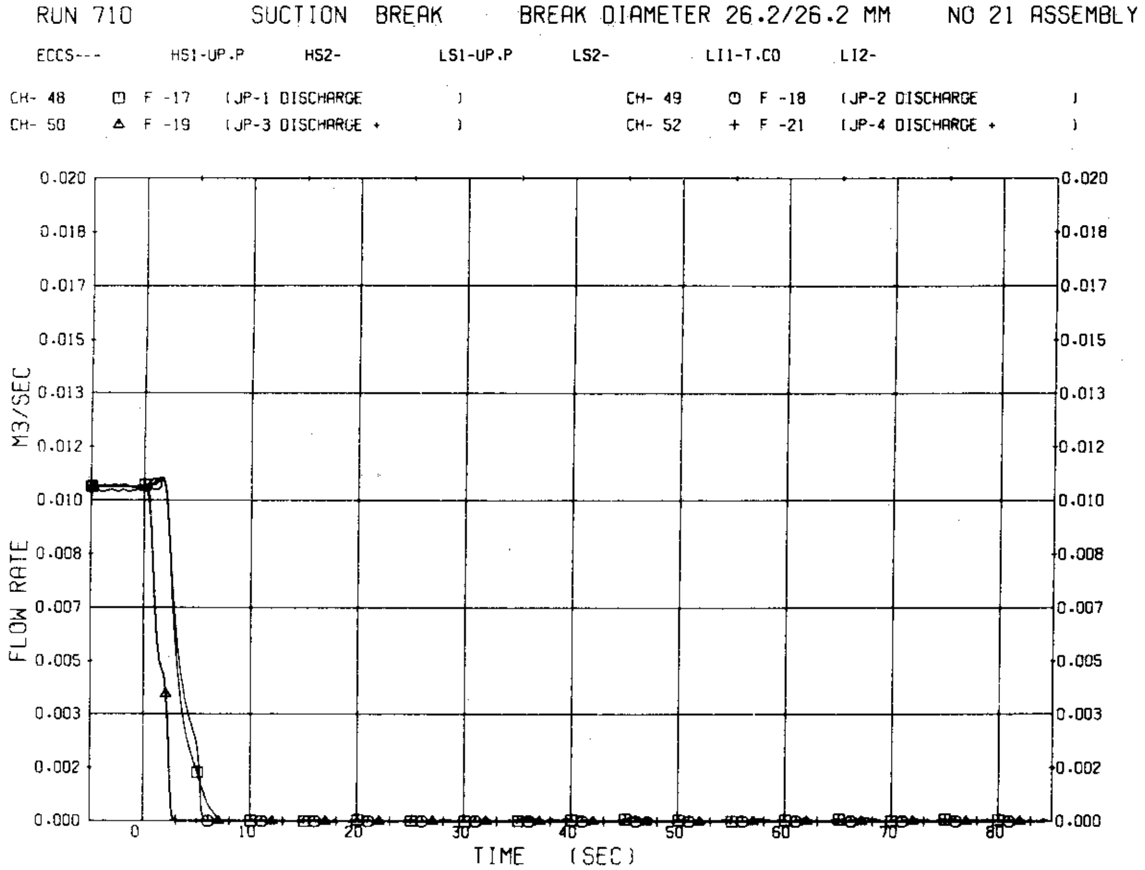


Fig. 5.37 Discharge flowrate of JPs, positive

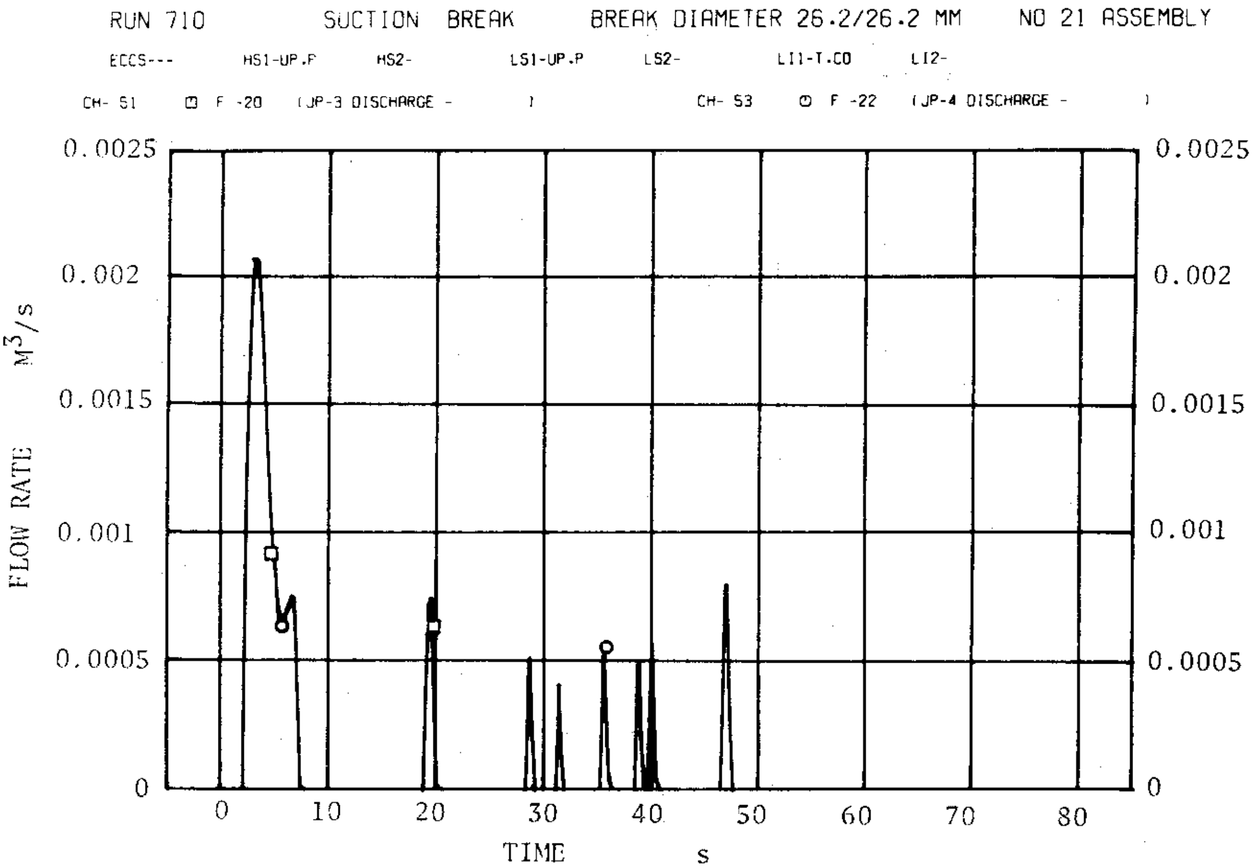


Fig. 5.38 Discharge flowrate of broken loop JPs, negative

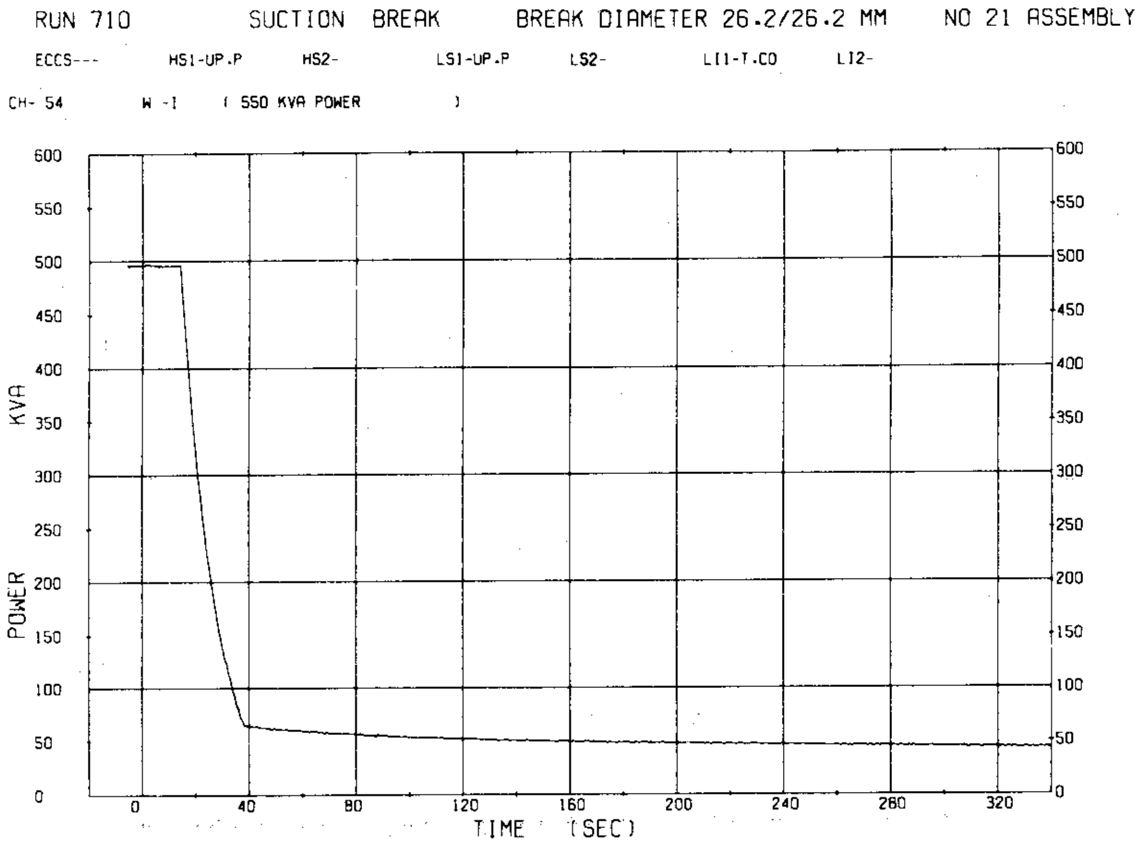


Fig. 5.39 Power transient, 550 kw system

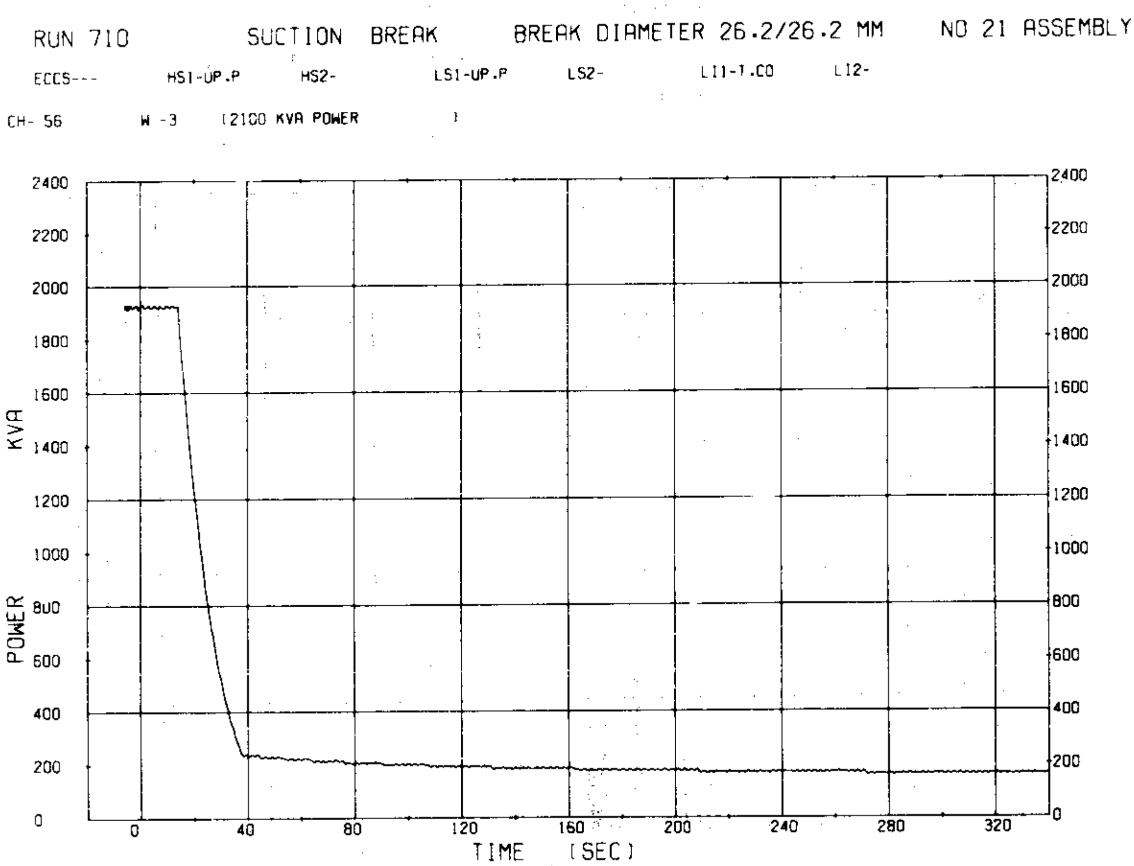


Fig. 5.40 Power transient, 2100 kw system

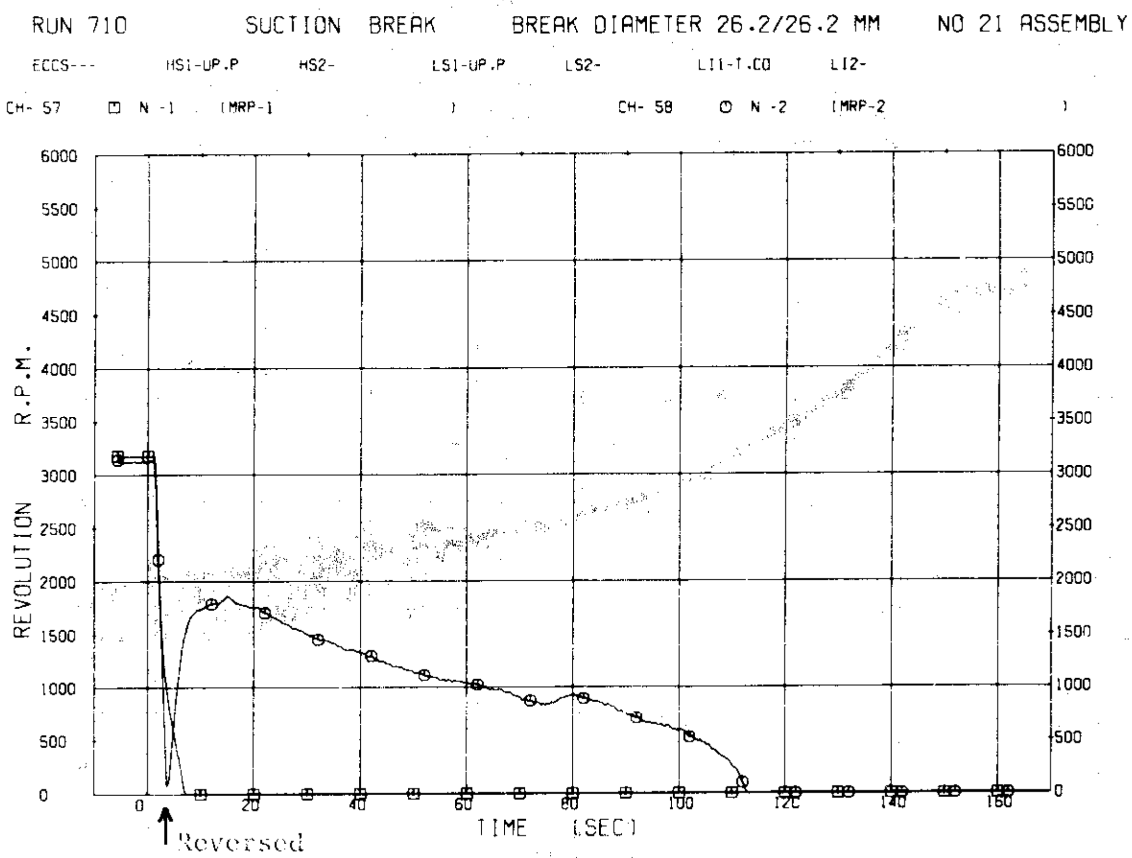


Fig. 5.41 Pump rotations of MRPs

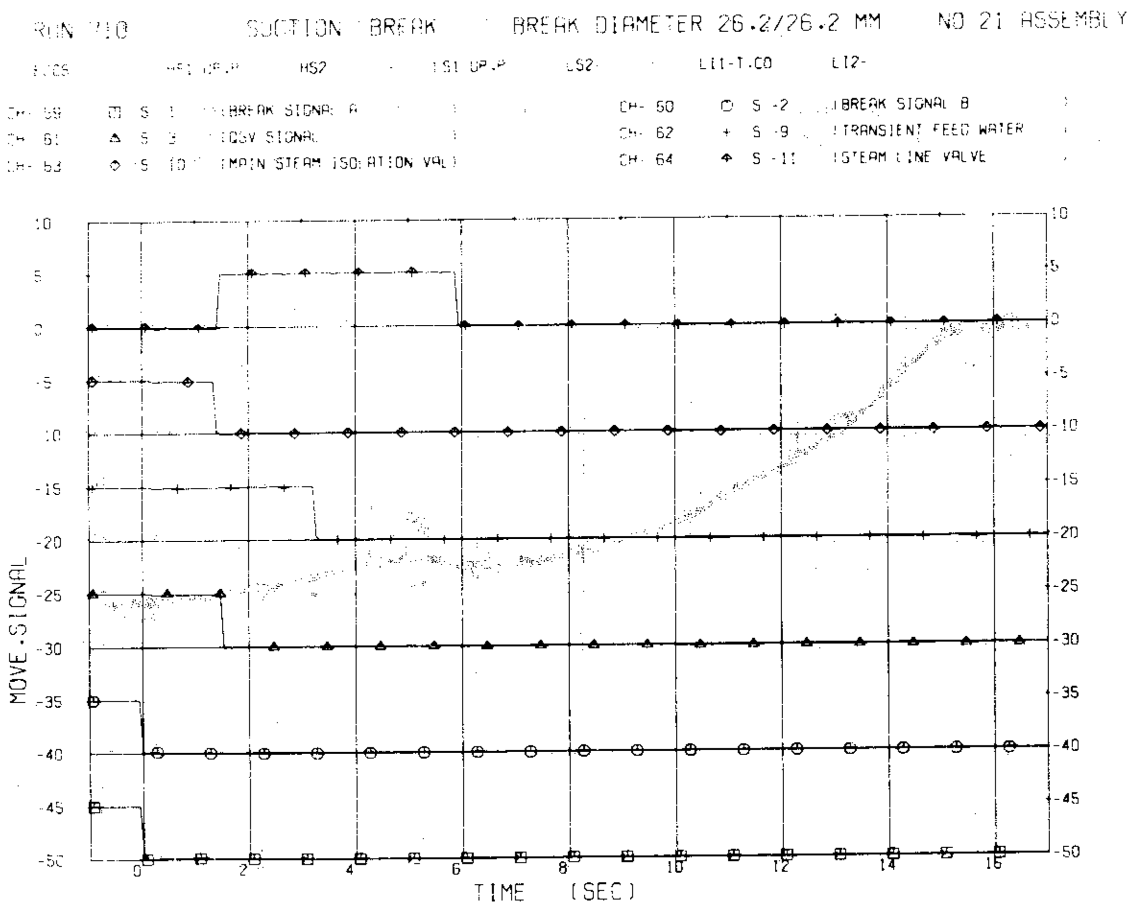


Fig. 5.42 Operation signals of breaks and valves

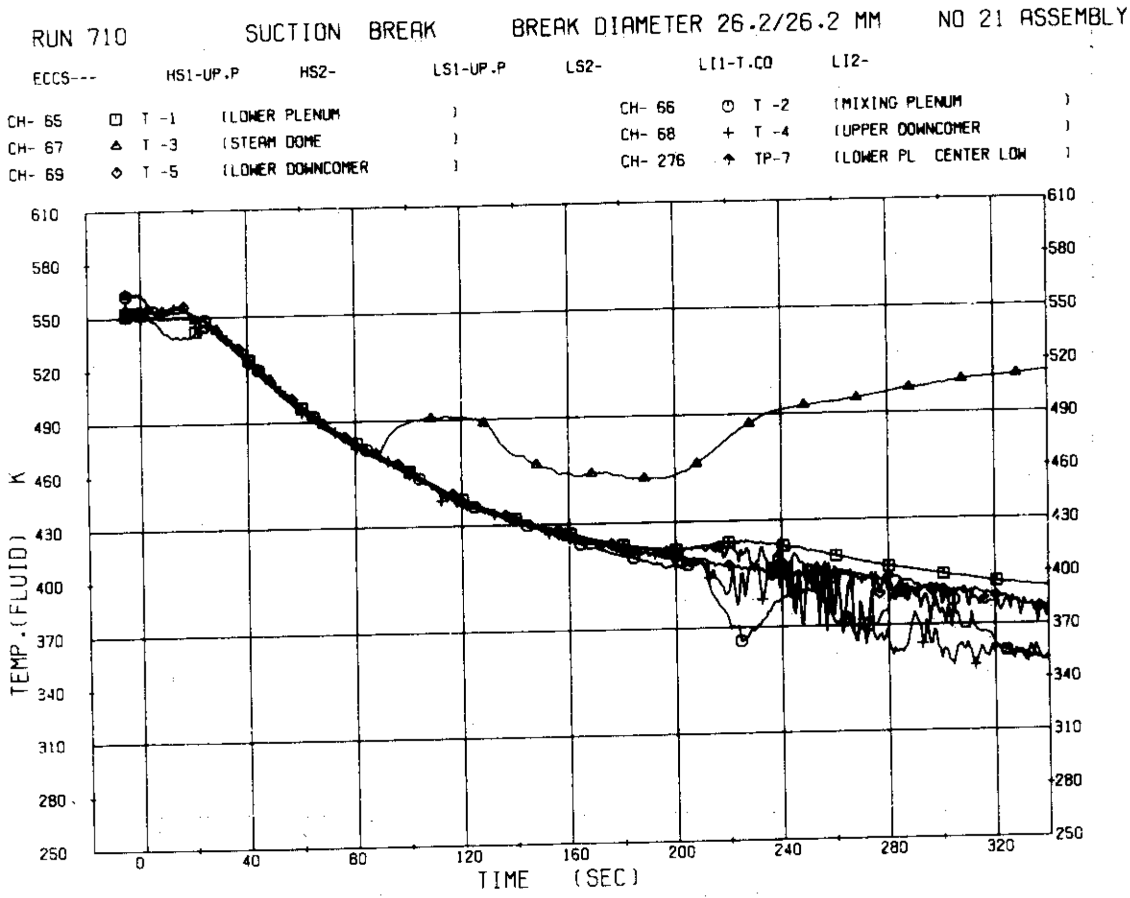


Fig. 5.43 Fluid temperature in PV

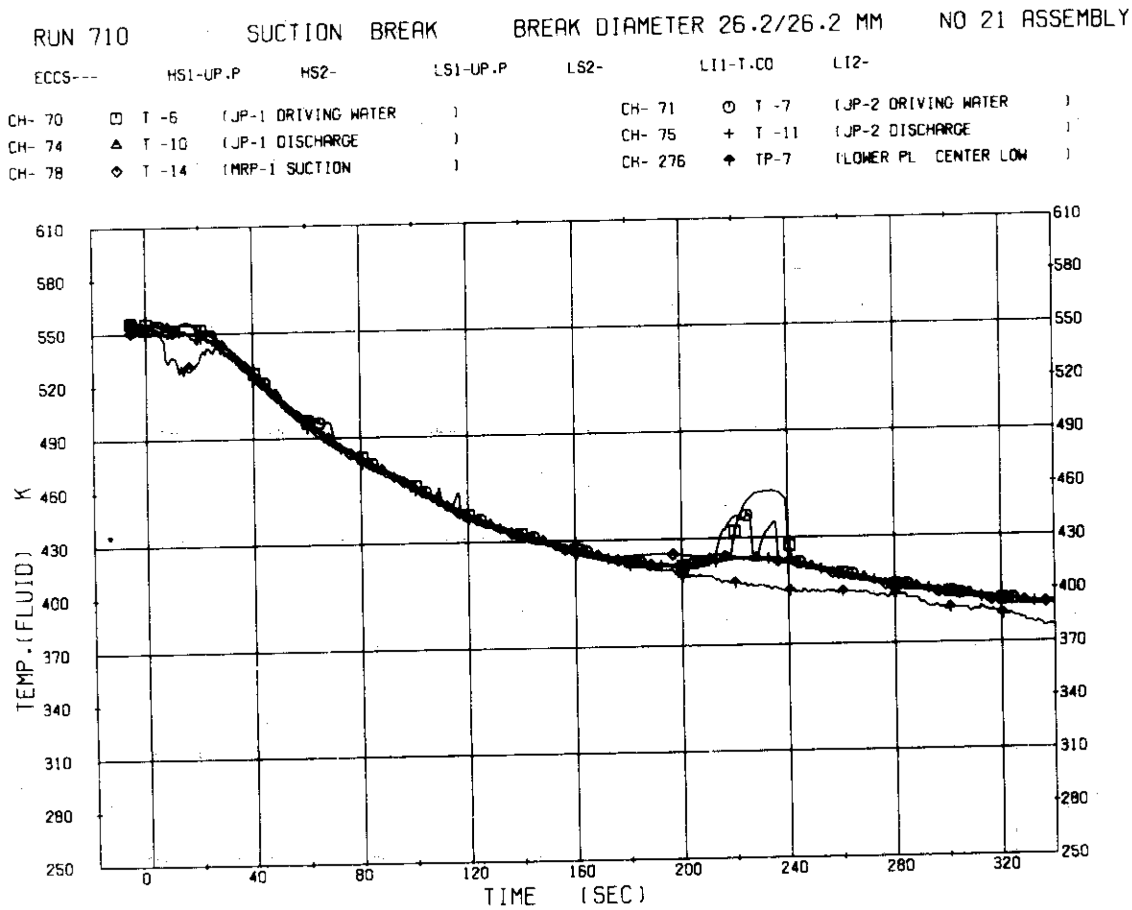


Fig. 5.44 Fluid temperature in intact loop

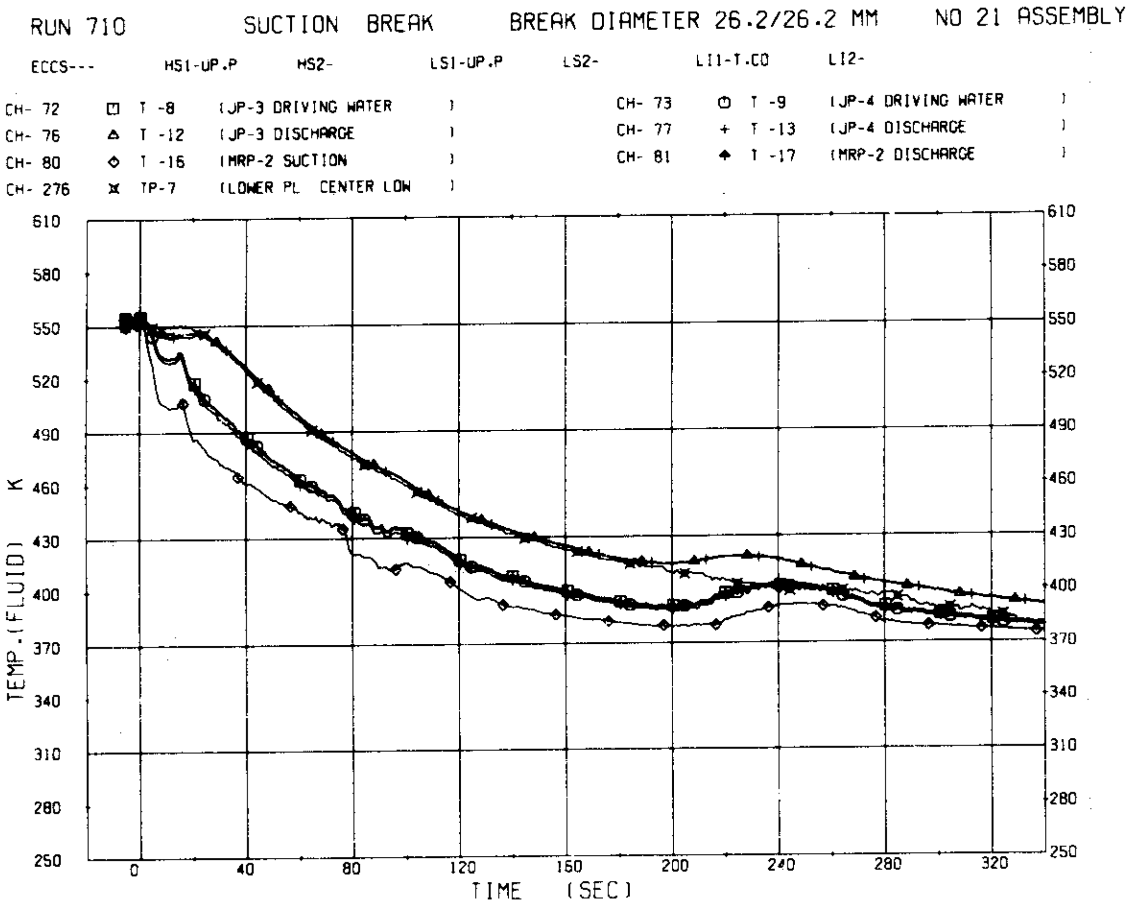


Fig. 5.45 Fluid temperature in broken loop

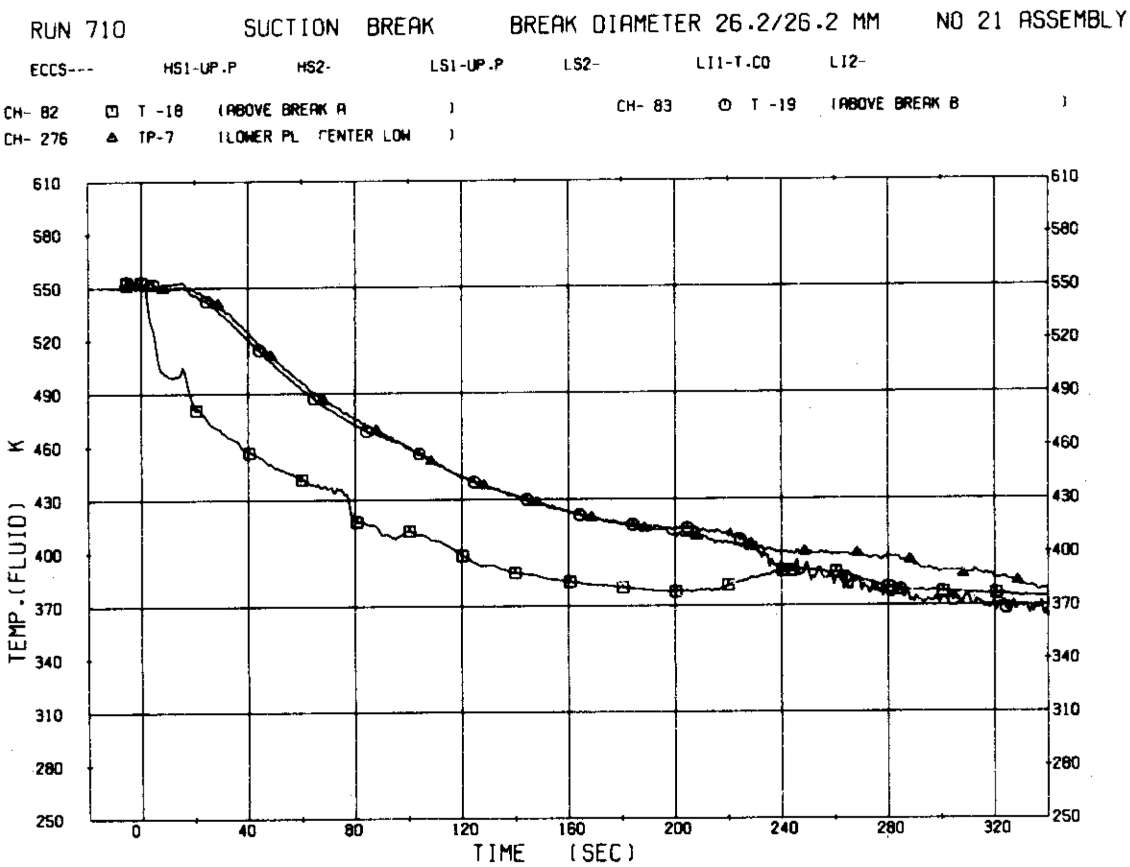


Fig. 5.46 Fluid temperature above break A

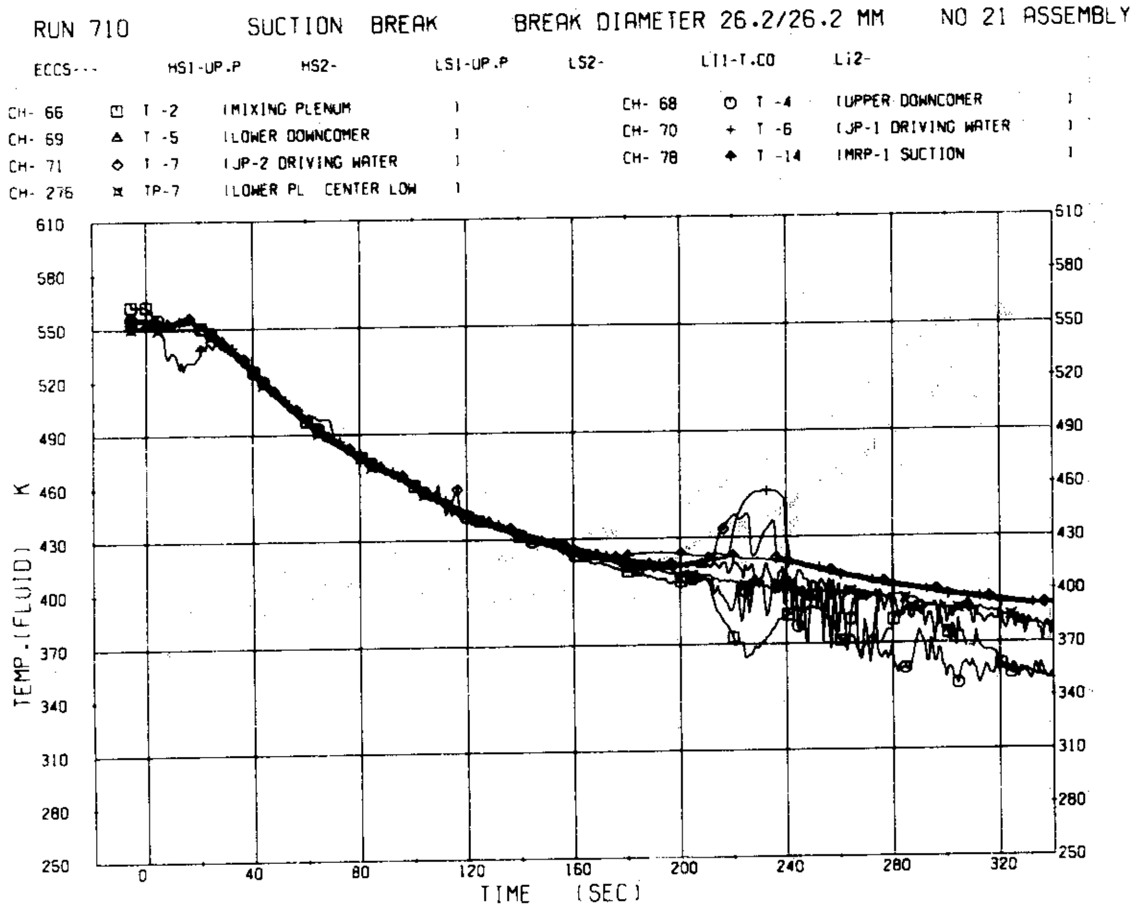


Fig. 5.47 Fluid temperature combarison in PV and intact loop

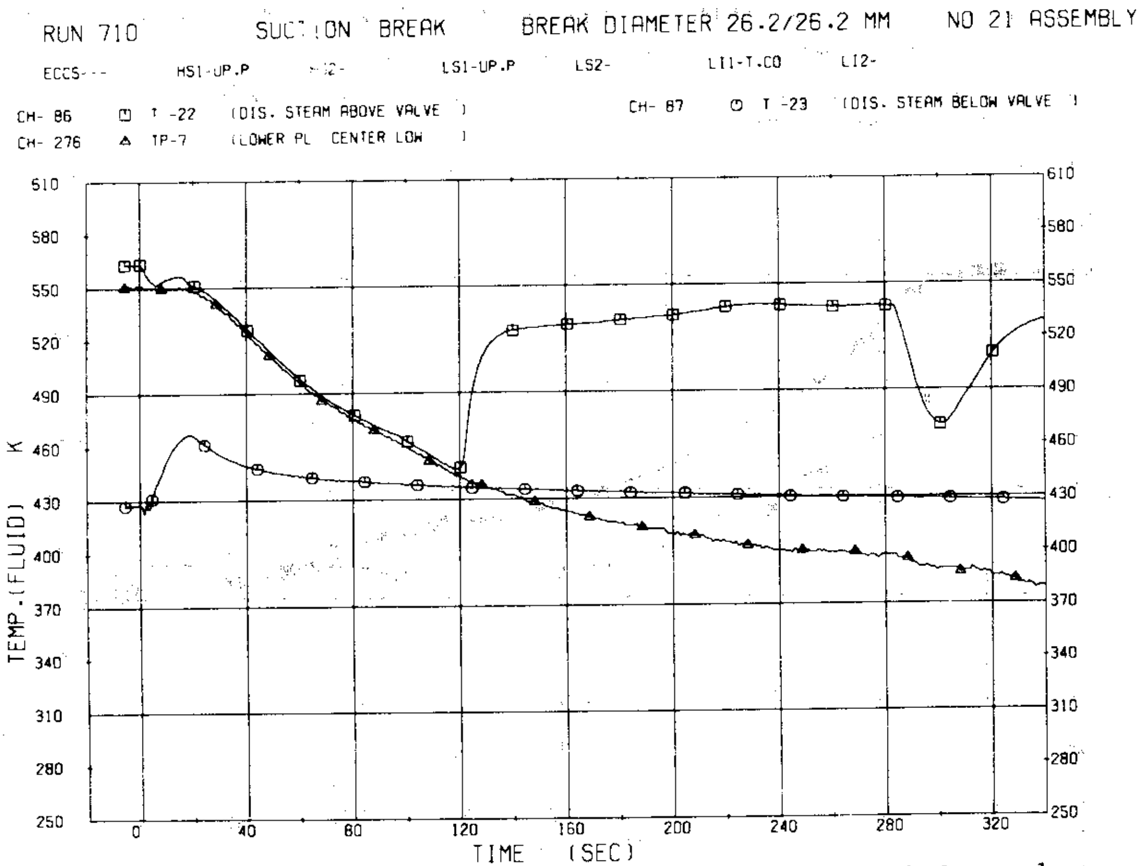


Fig. 5.48 Discharged steam temperatures above and below valve

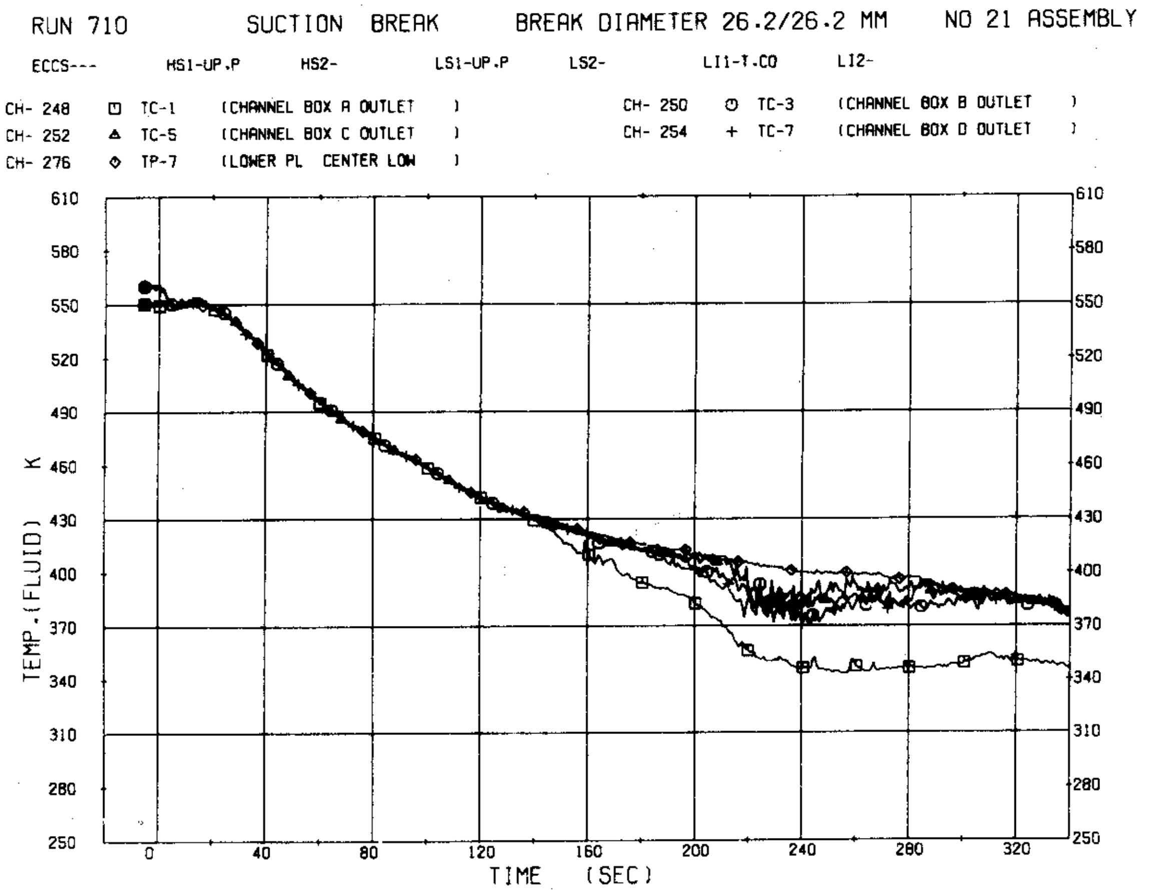


Fig. 5.49 Fluid temperatures at channel box outlets

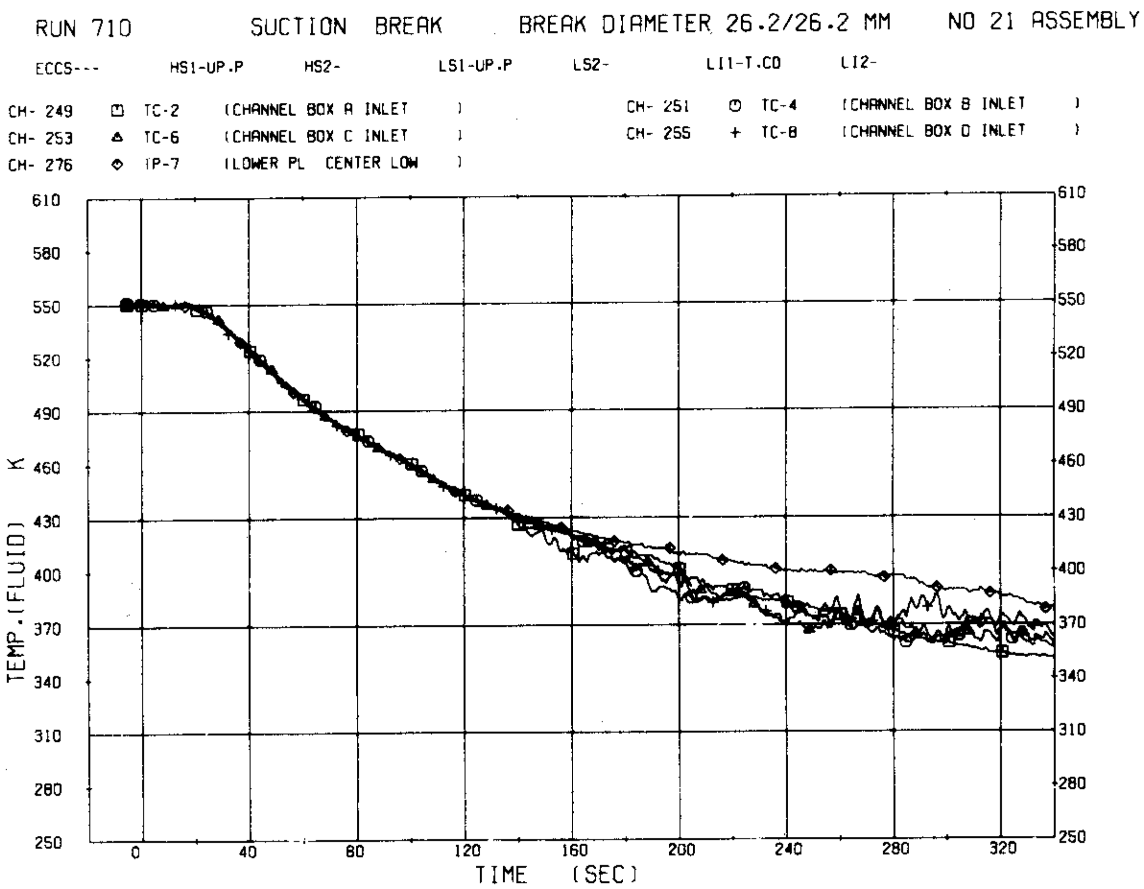


Fig. 5.50 Fluid temperatures at channel box inlets

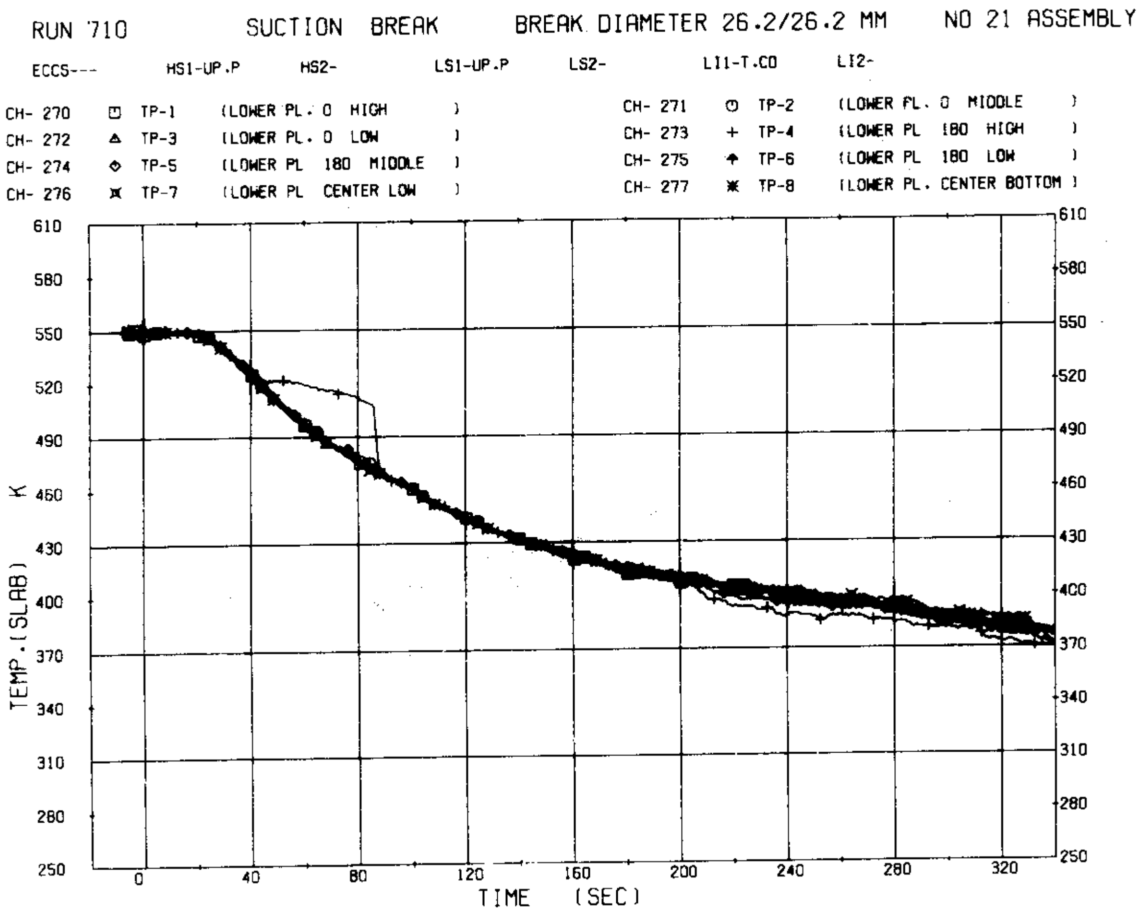


Fig. 5.51 Fluid temperatures in lower plenum

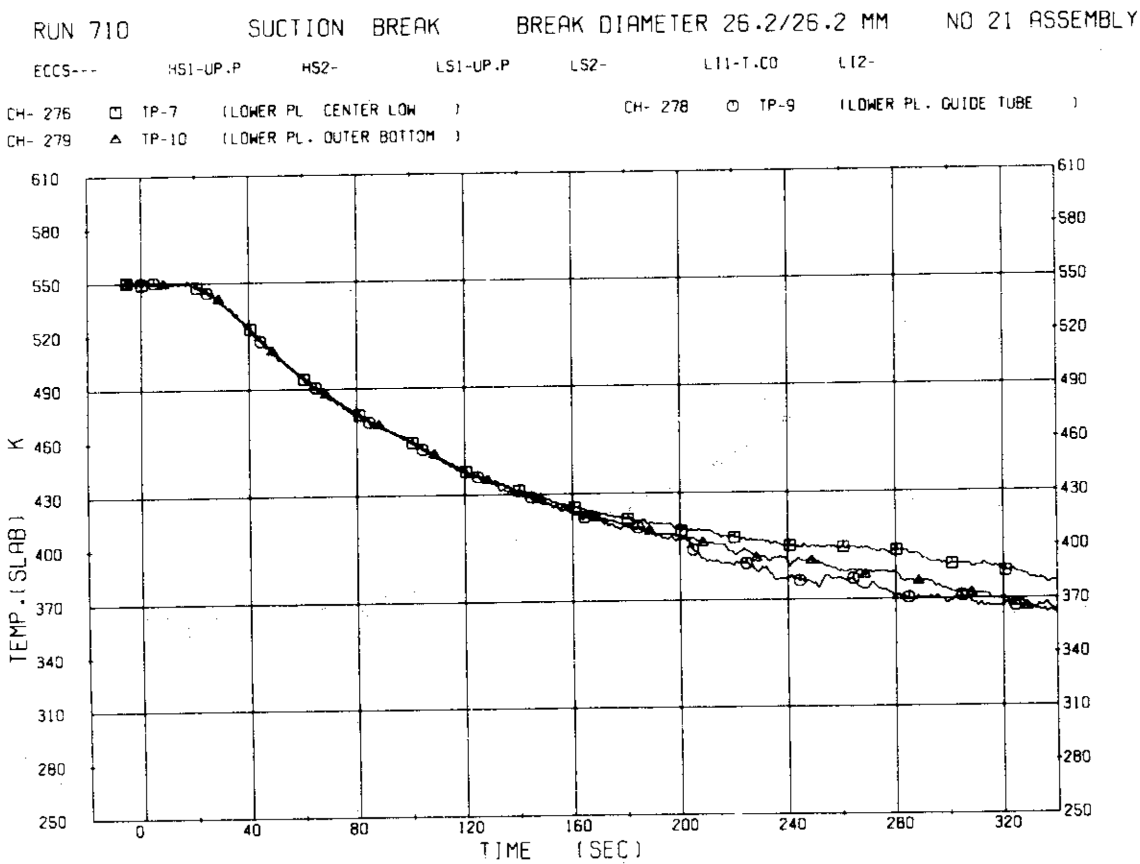


Fig. 5.52 Fluid temperatures in guide tube

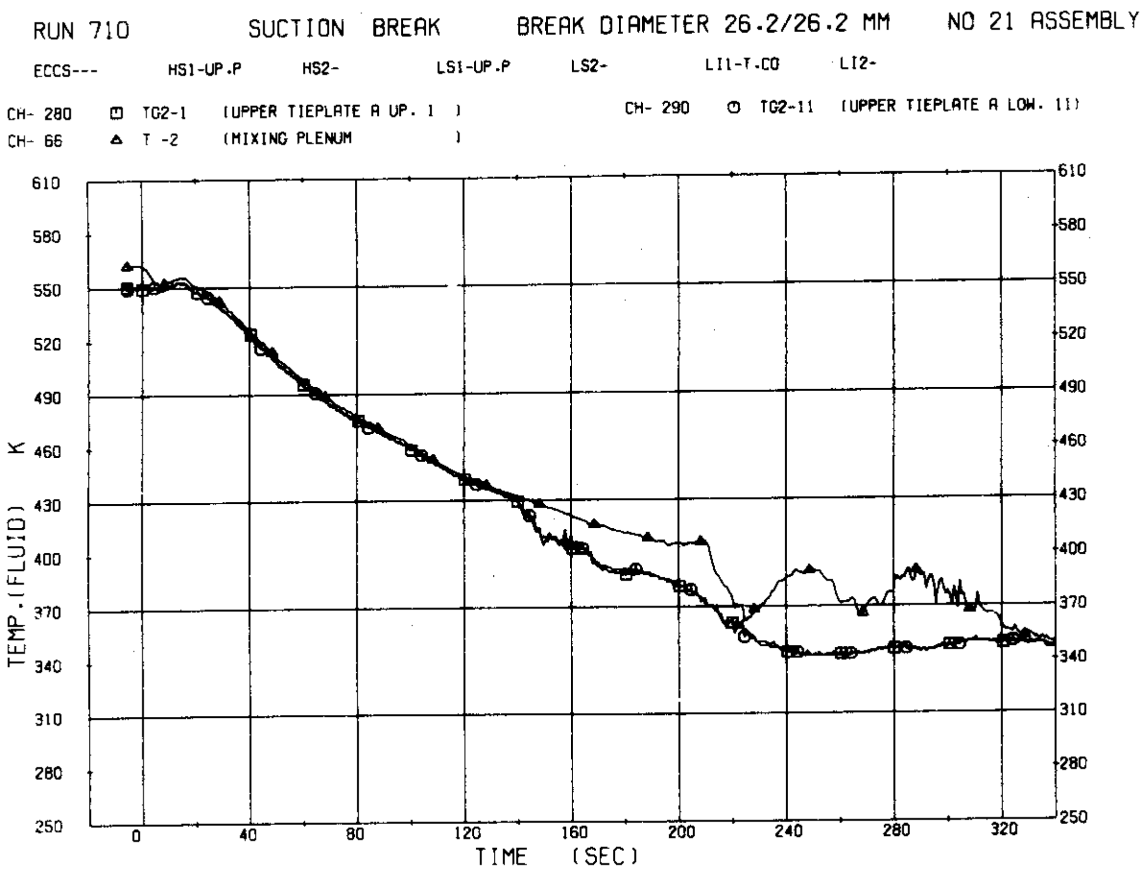


Fig. 5.53 Fluid temperatures above and below tie plate A

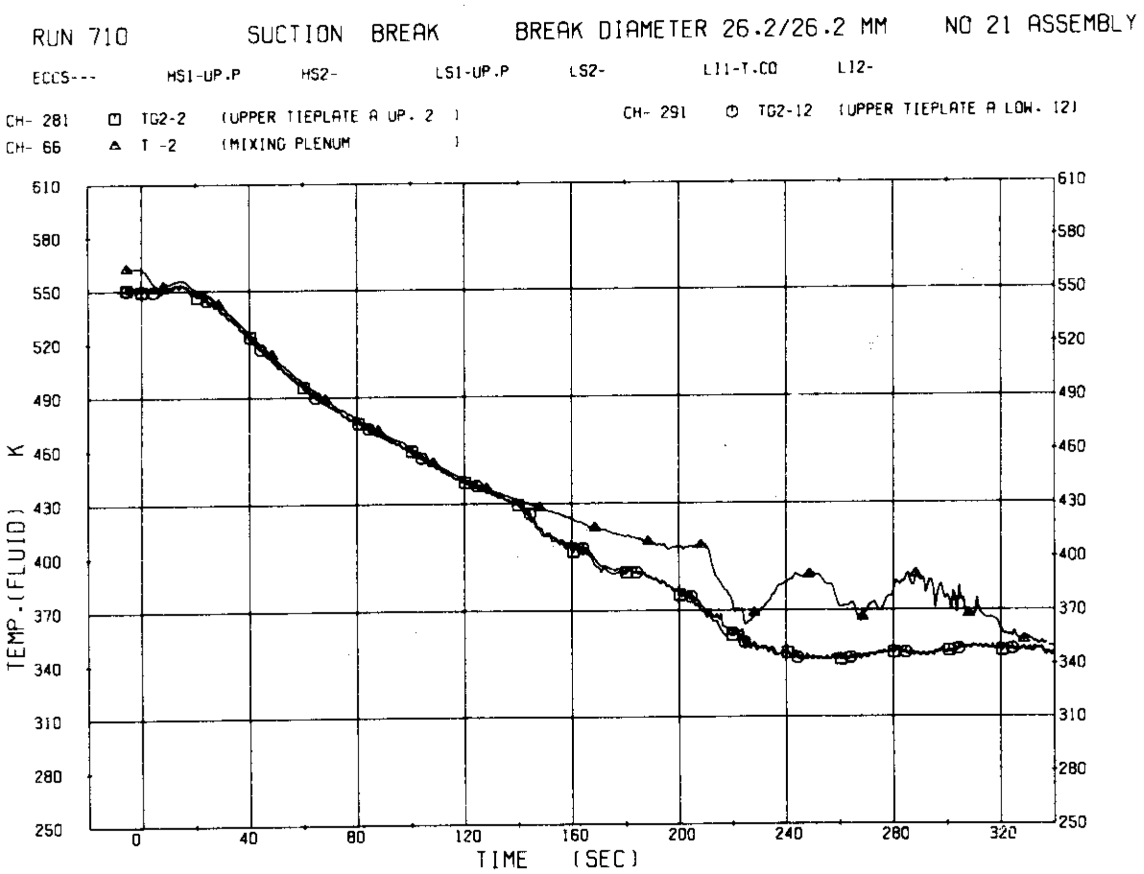


Fig. 5.54 Fluid temperatures above and below tie plate A

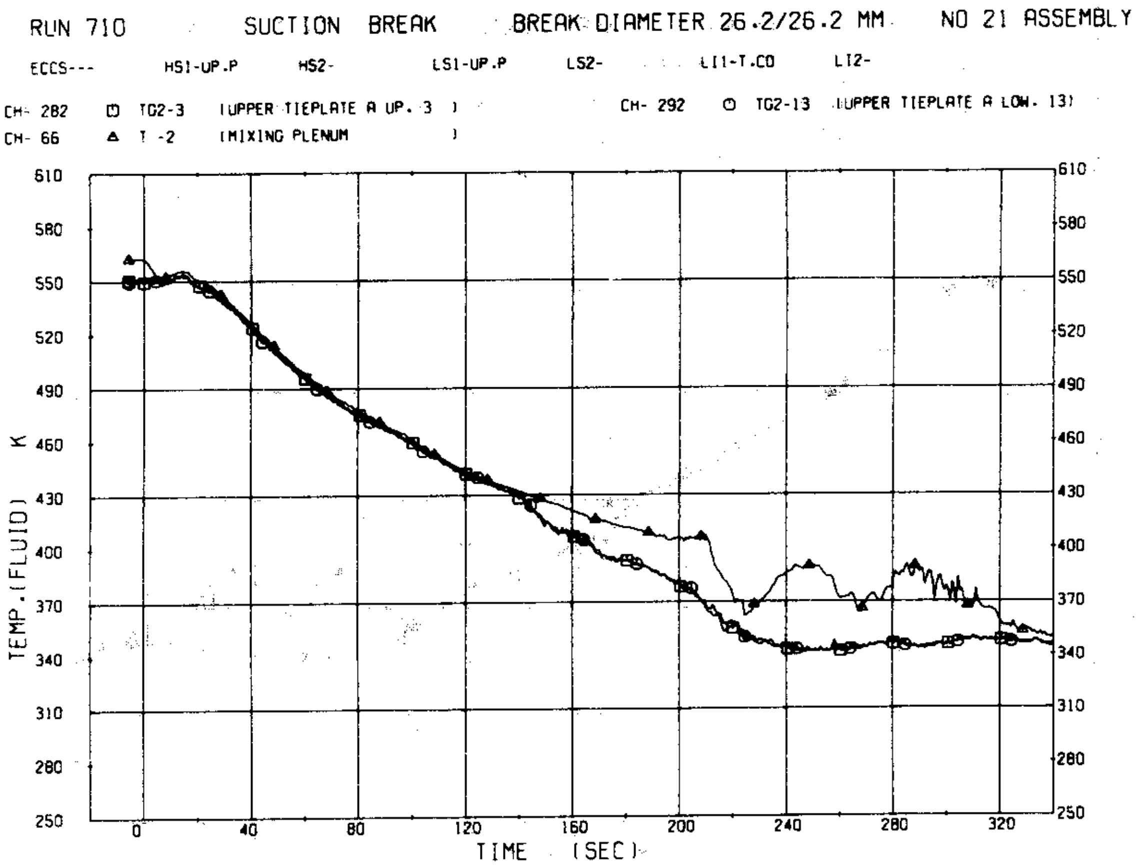


Fig. 5.55 Fluid temperatures above and below tie plate A

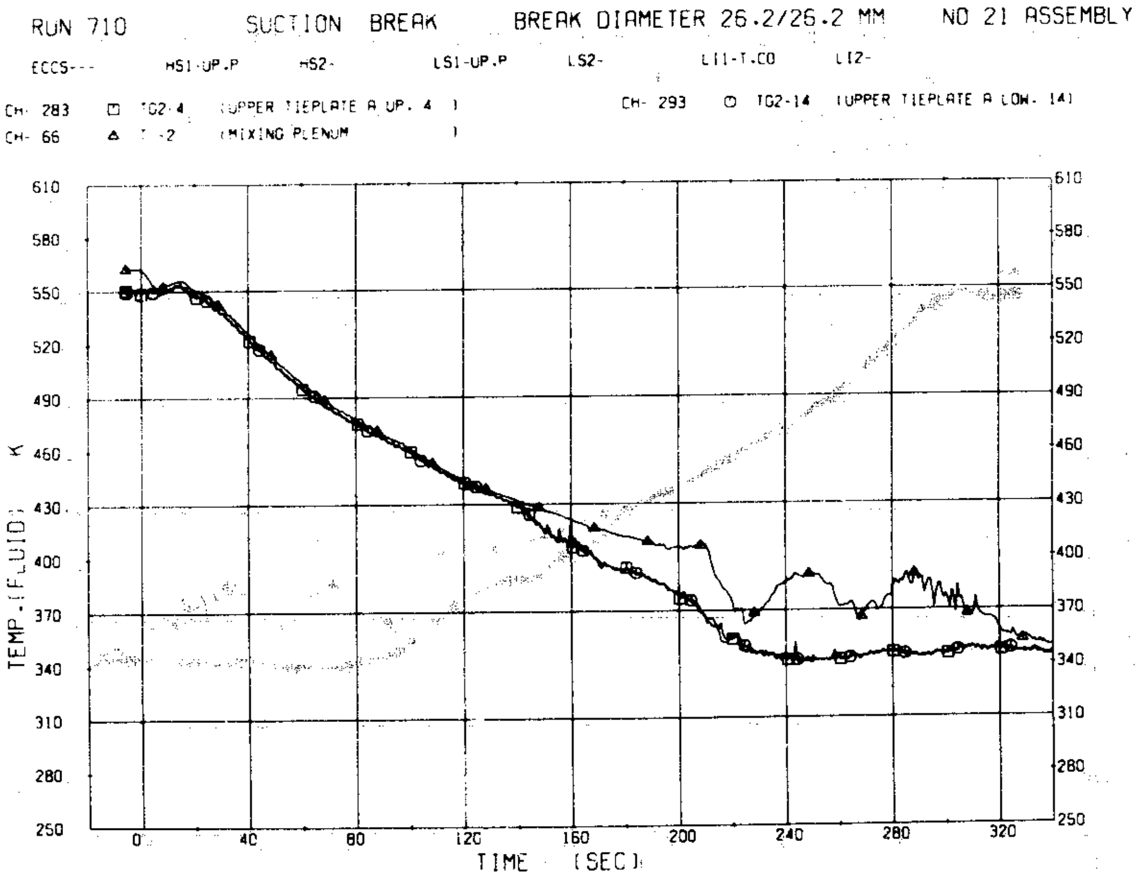


Fig. 5.56 Fluid temperatures above and below tie plate A

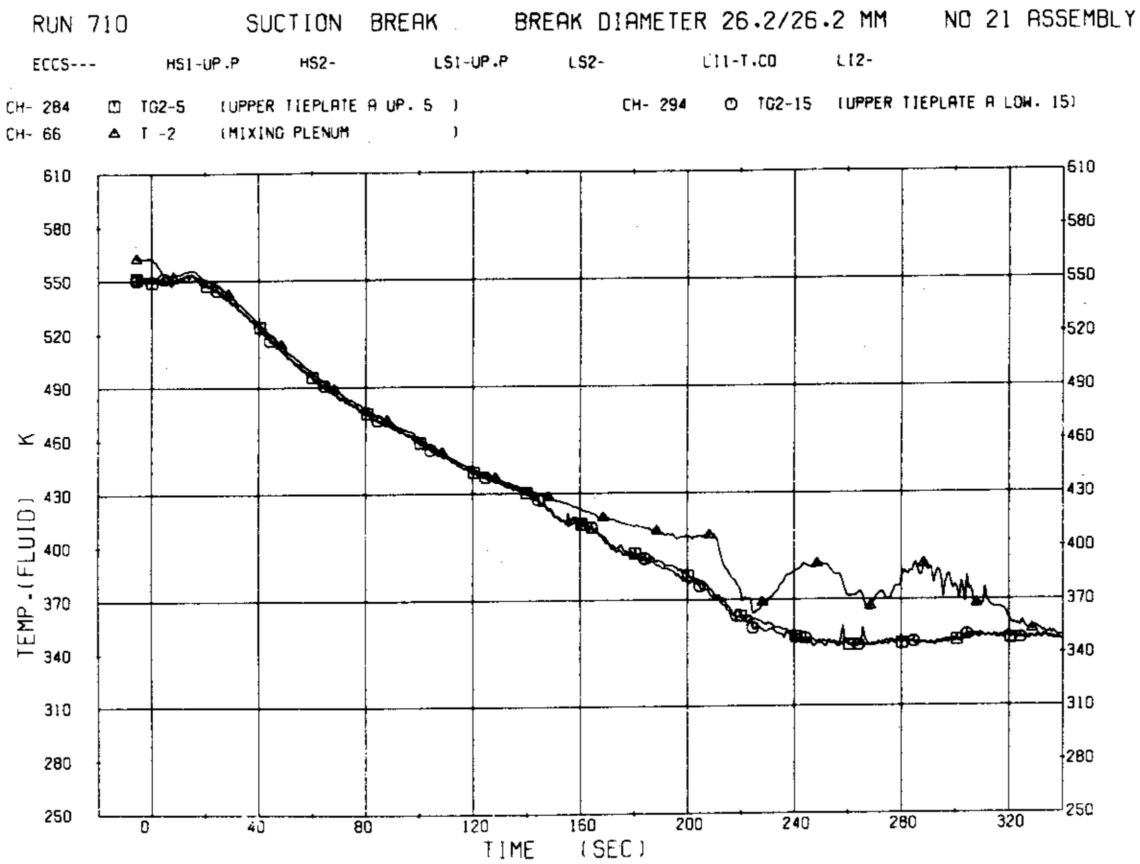


Fig. 5.57 Fluid temperatures above and below tie plate

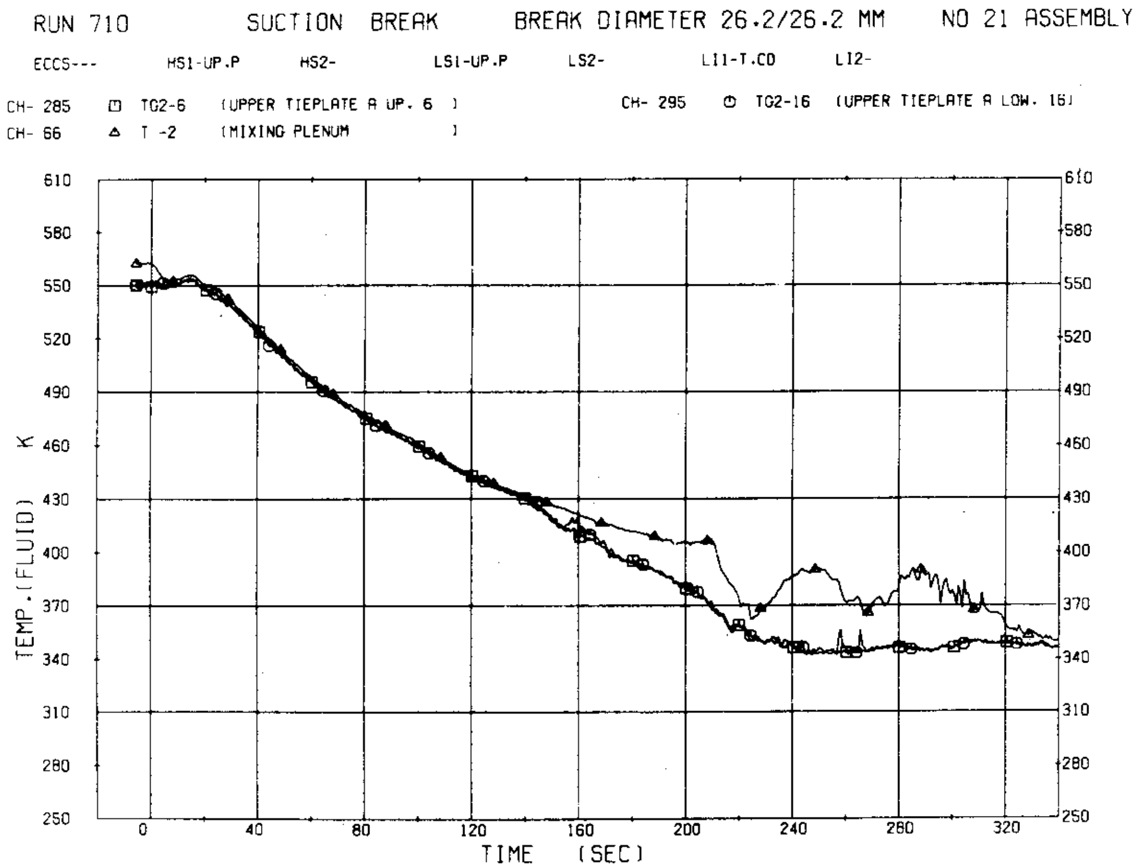


Fig. 5.58 Fluid temperatures above and below tie plate

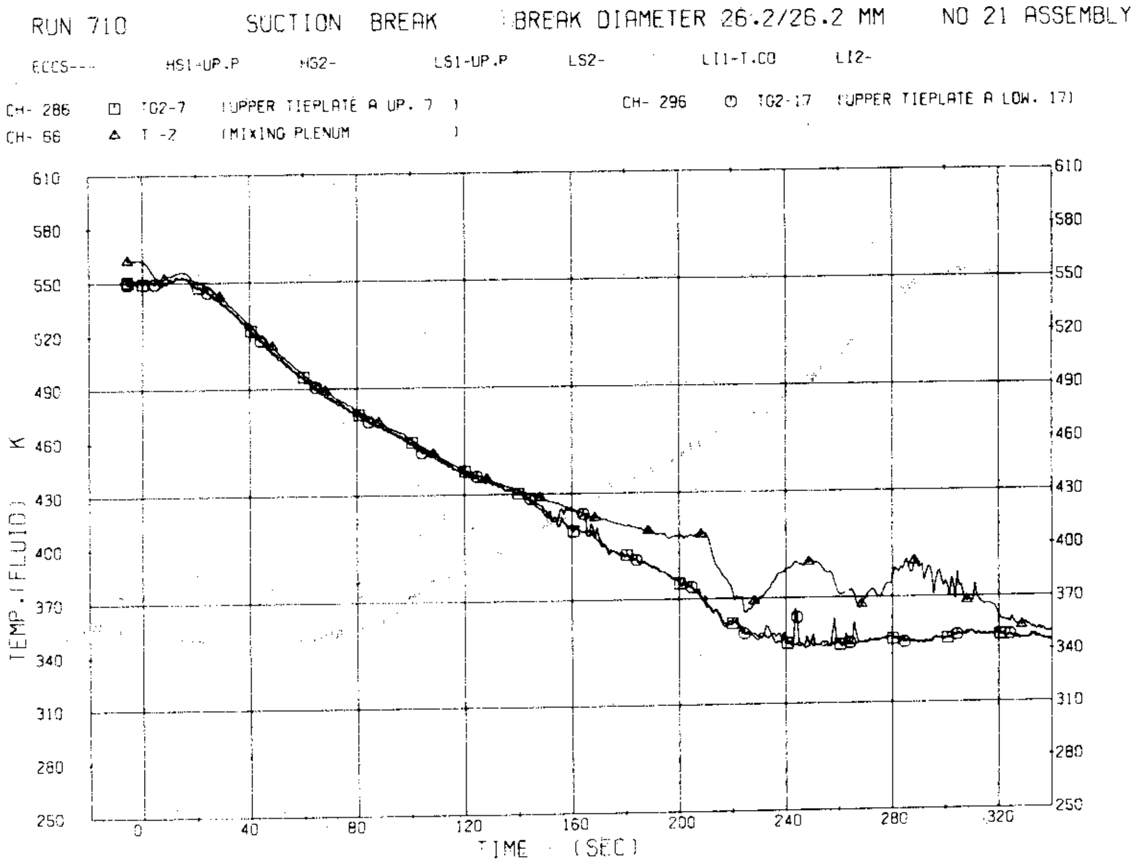


Fig. 5.59 Fluid temperatures above and below tie plate

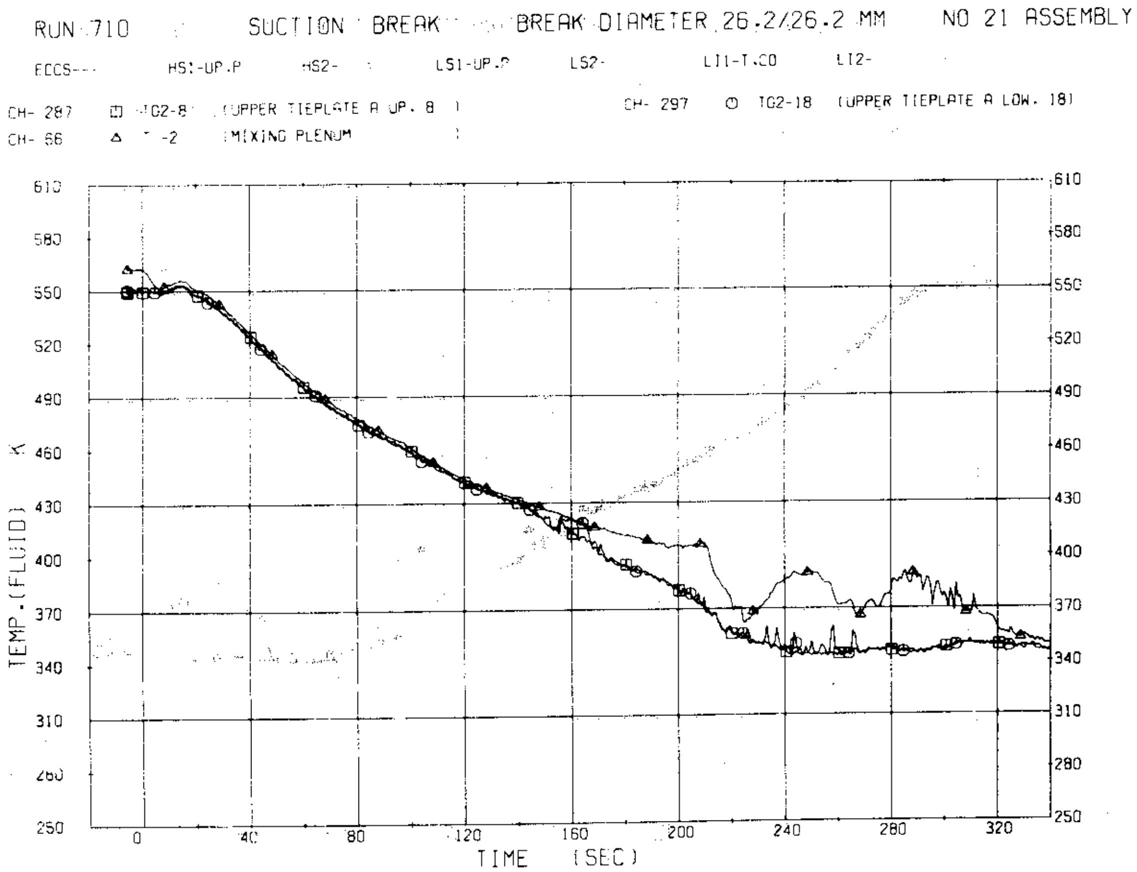


Fig. 5.60 Fluid temperatures above and below tie plate

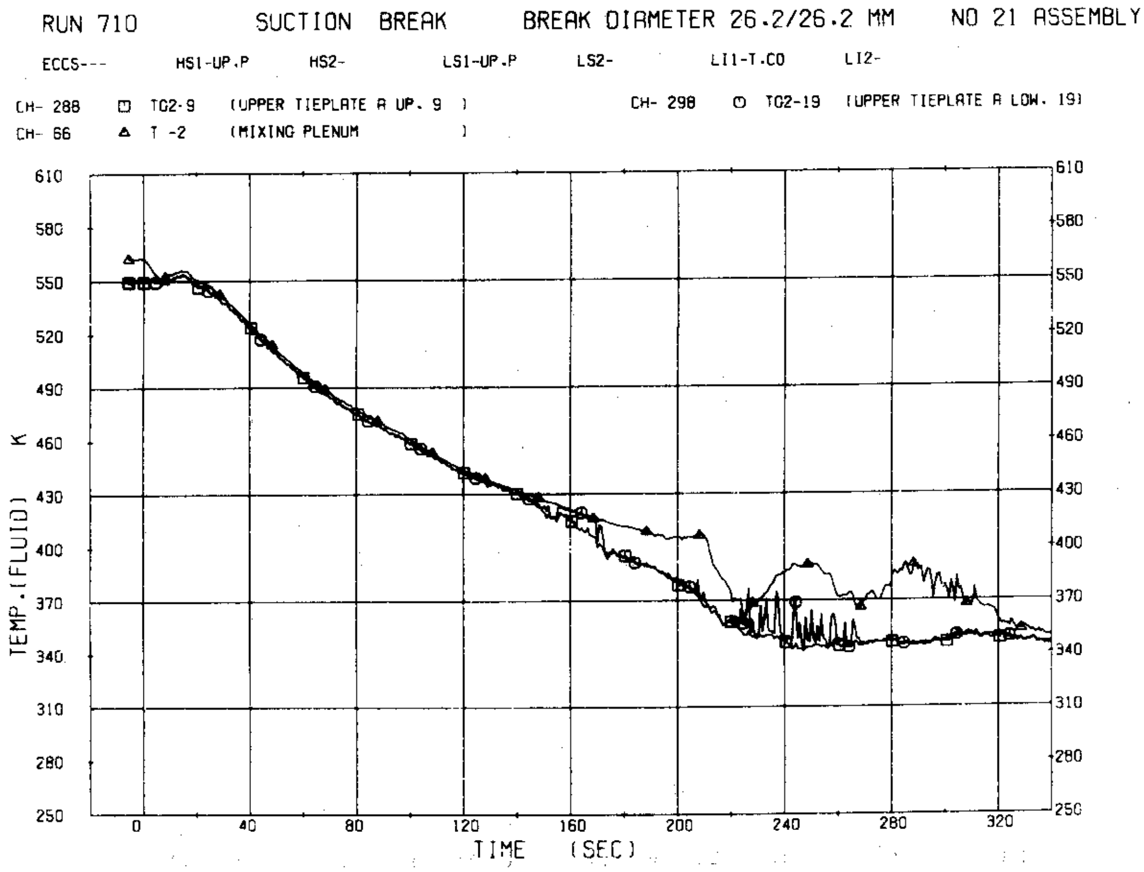


Fig. 5.61 Fluid temperatures above and below tie plate

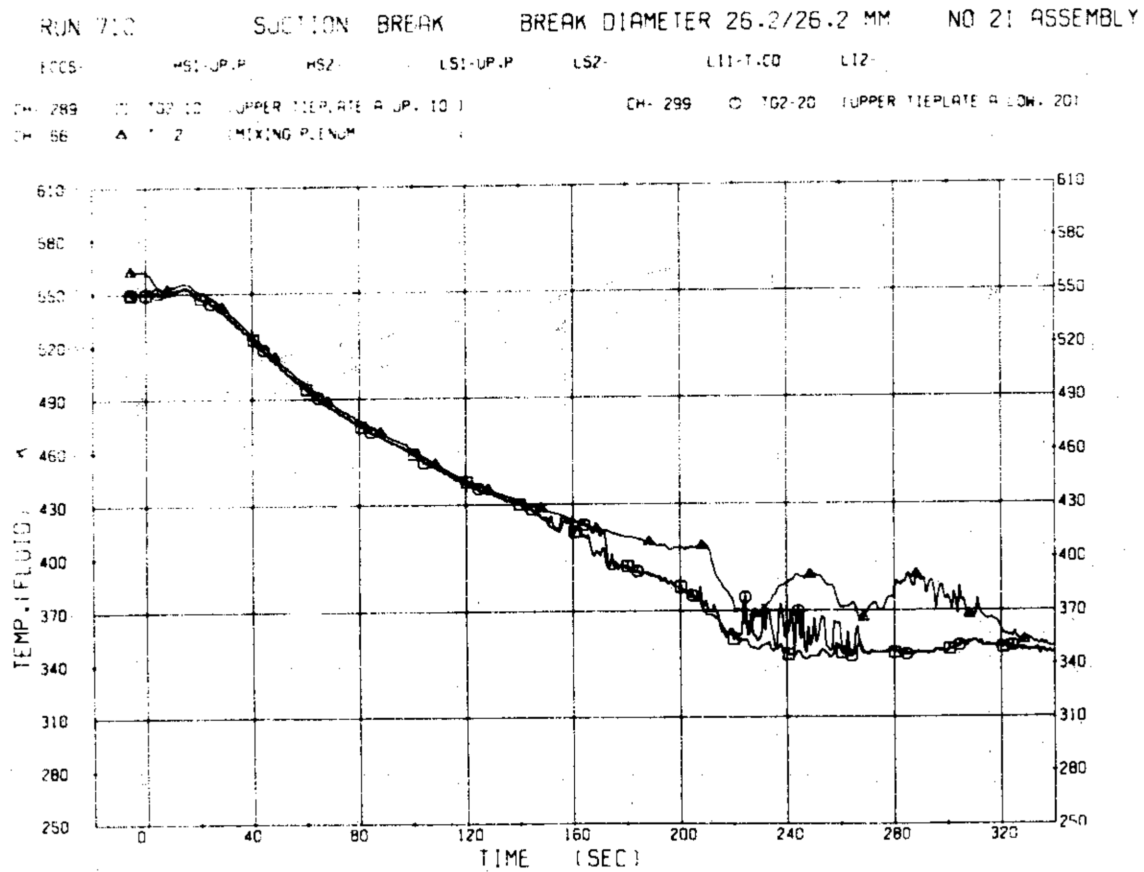


Fig. 5.62 Fluid temperatures above and below tie plate

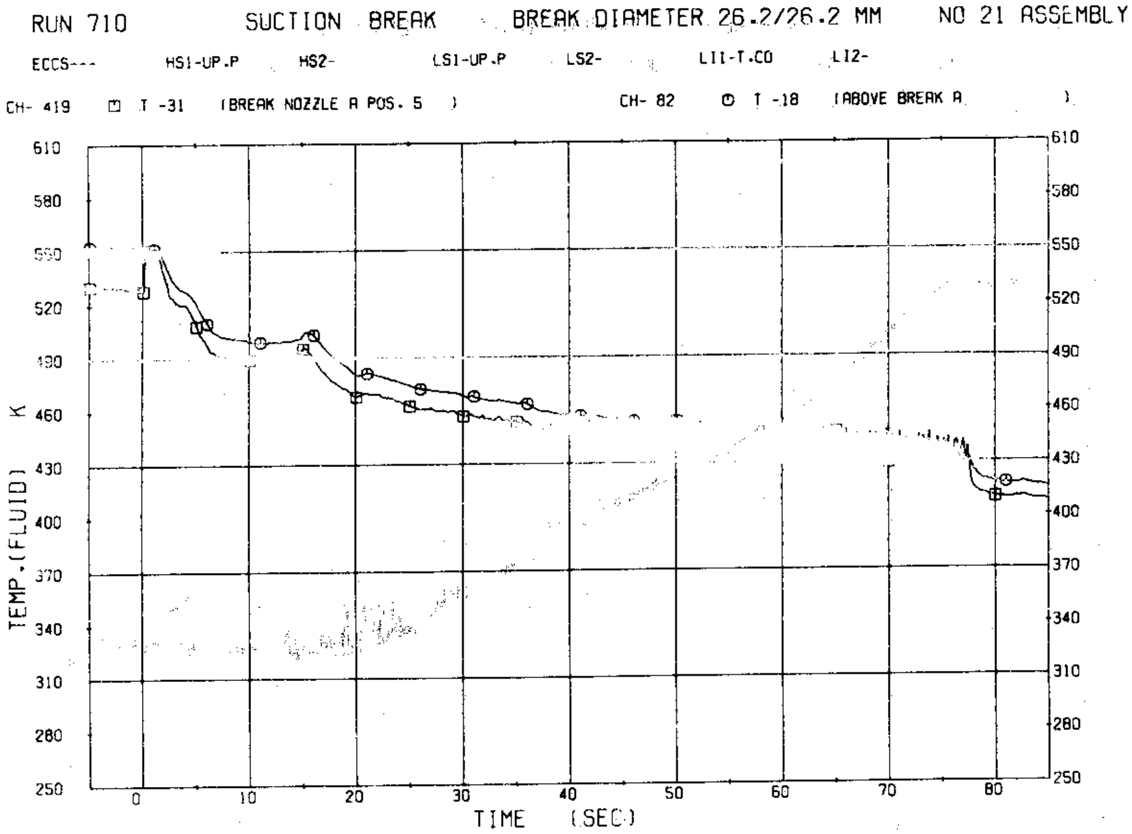


Fig. 5.63 Fluid temperature at break nozzle A position 5

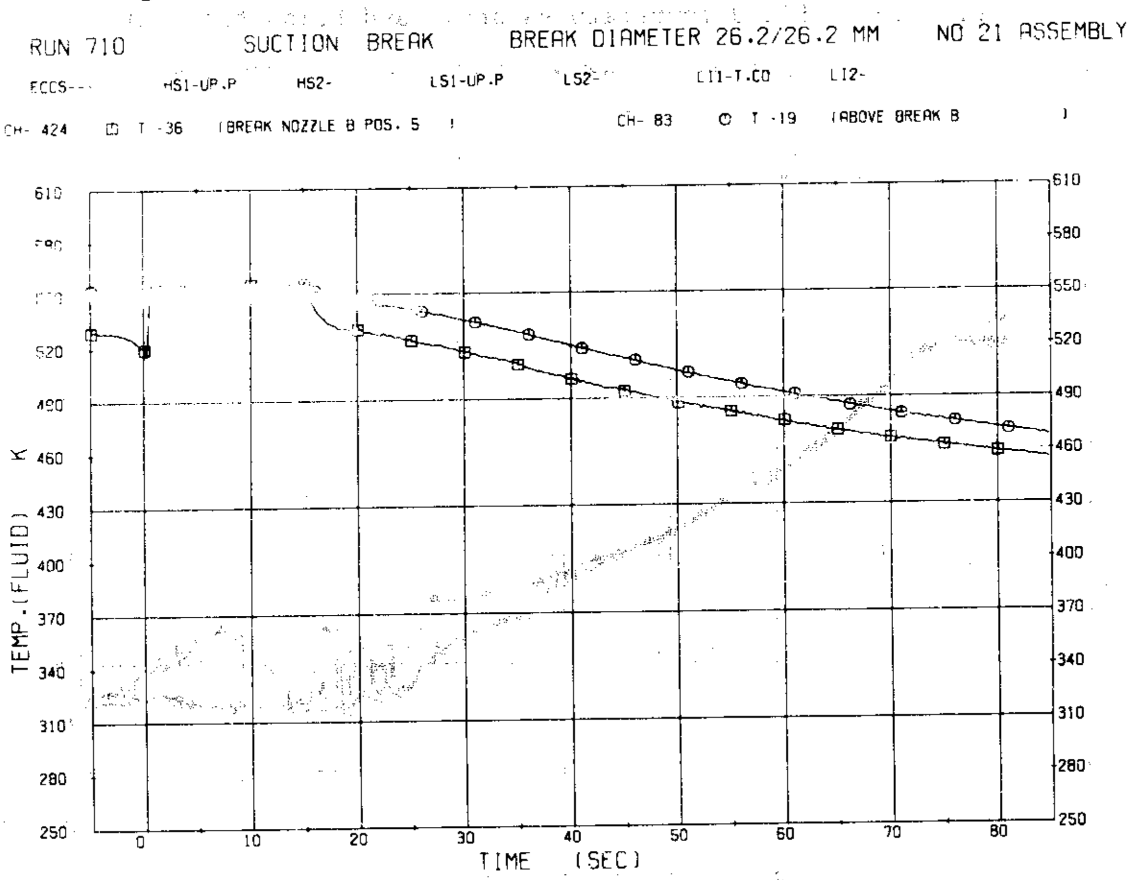


Fig. 5.64 Fluid temperature at breat nozzle B position 5

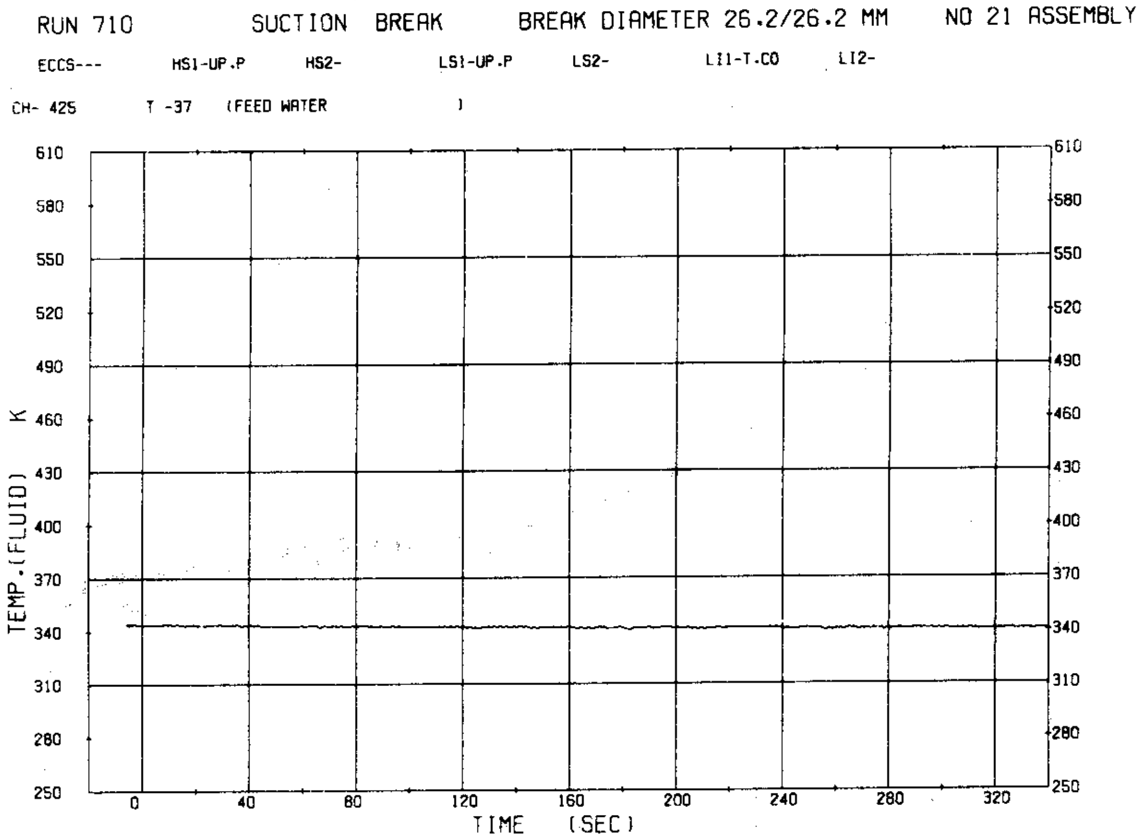


Fig. 5.65 Feedwater temperature

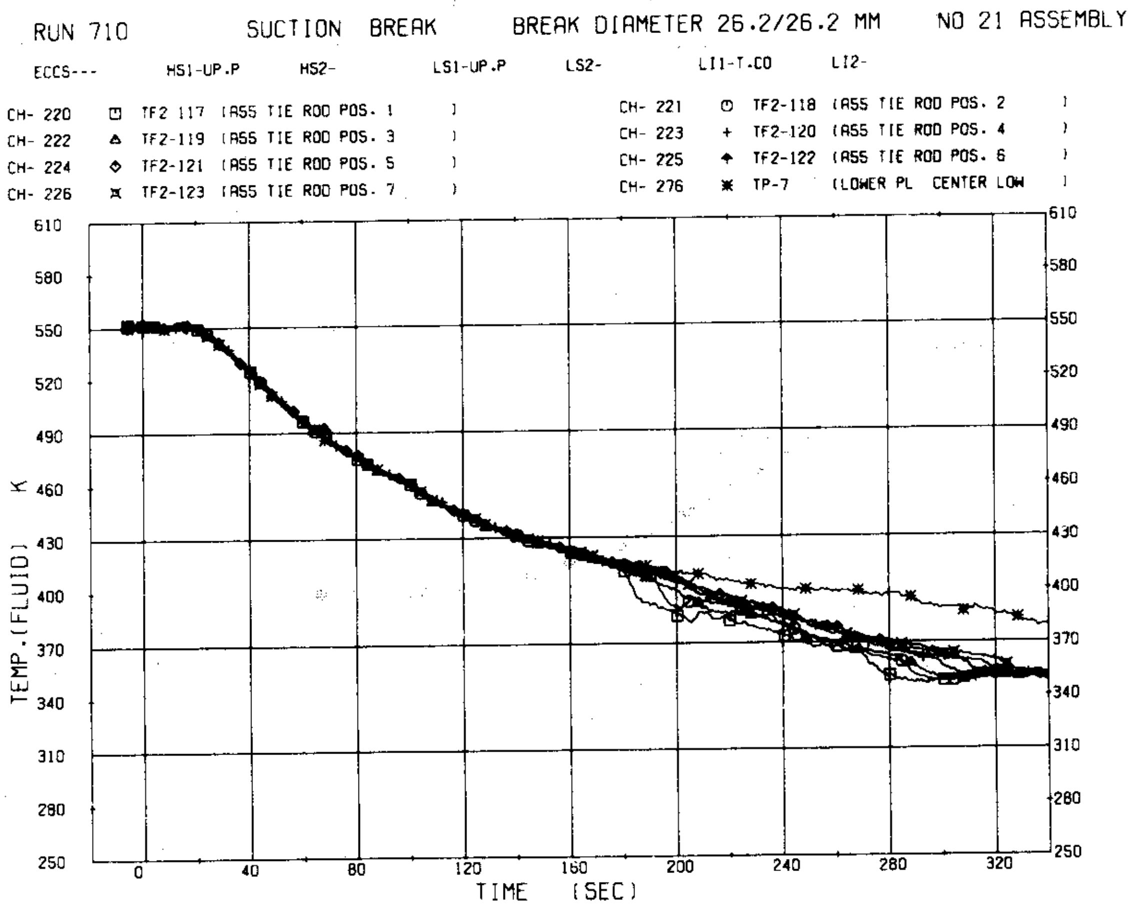


Fig. 5.66 Fluid temperatures arround tie rod A55

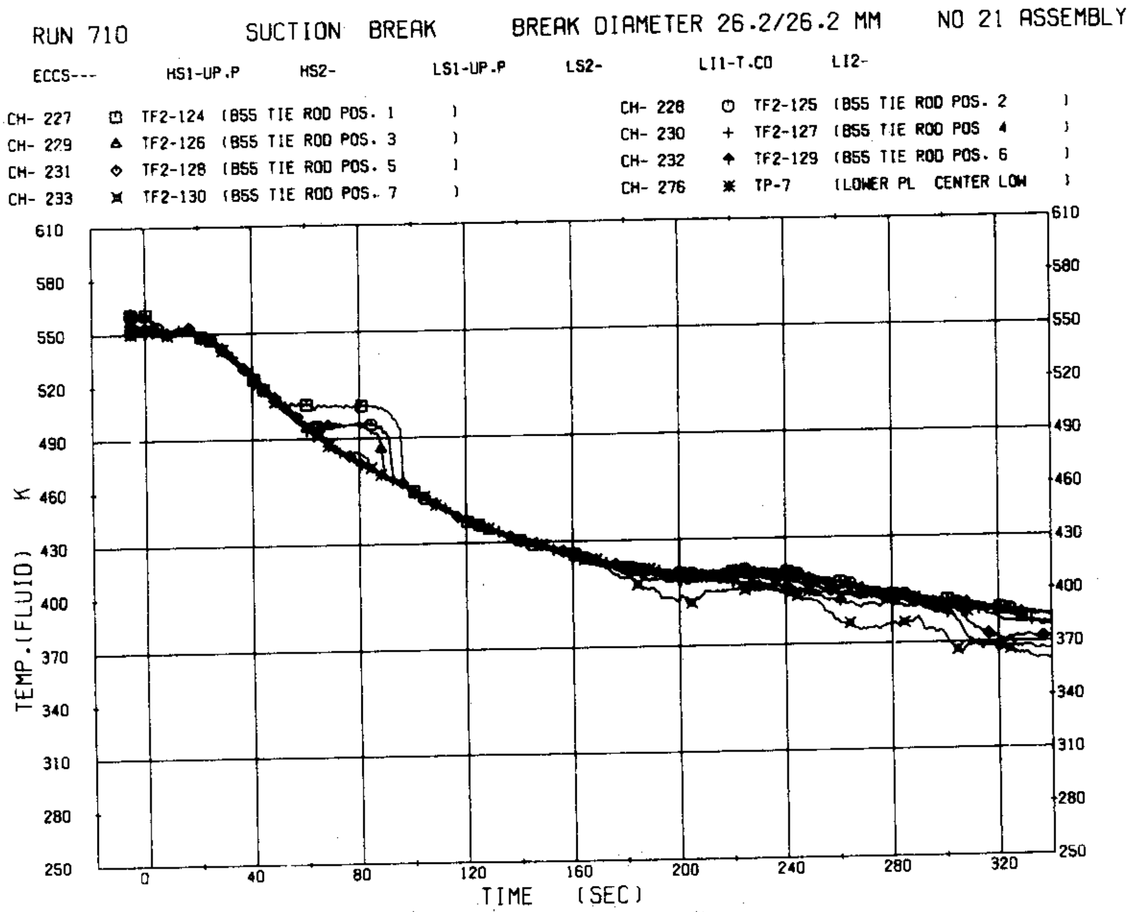


Fig. 5.67 Fluid temperatures arround tie rod B55

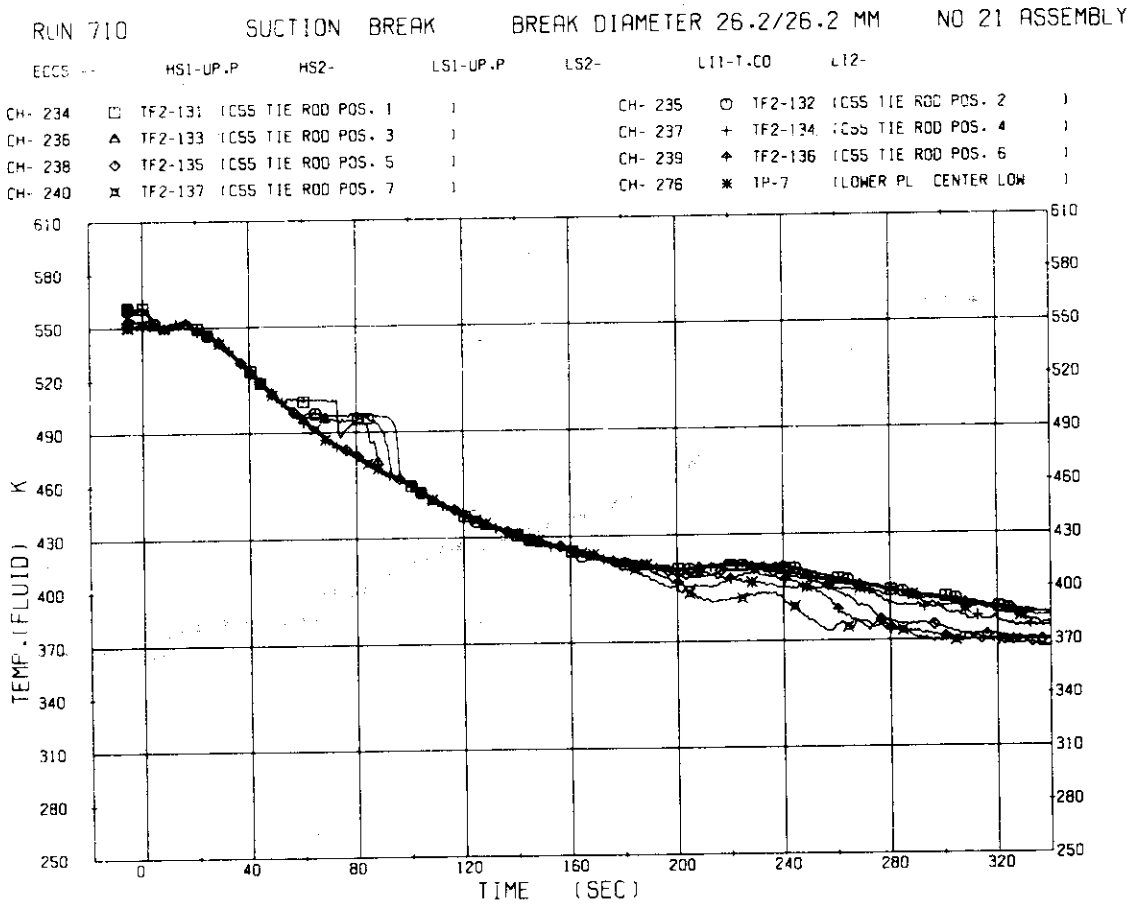


Fig. 5.68 Fluid temperatures arround tie rod C55

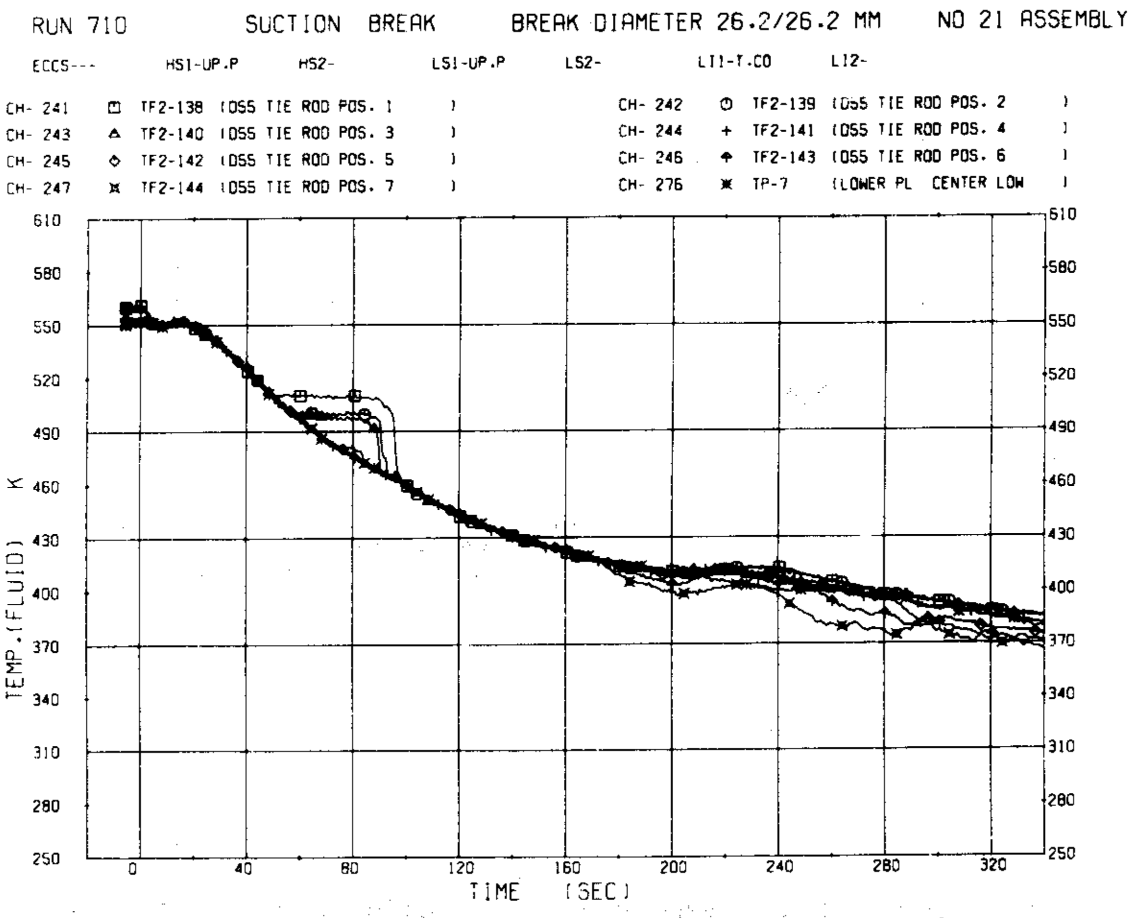


Fig. 5.69 Fluid temperatures arround tie rod D55

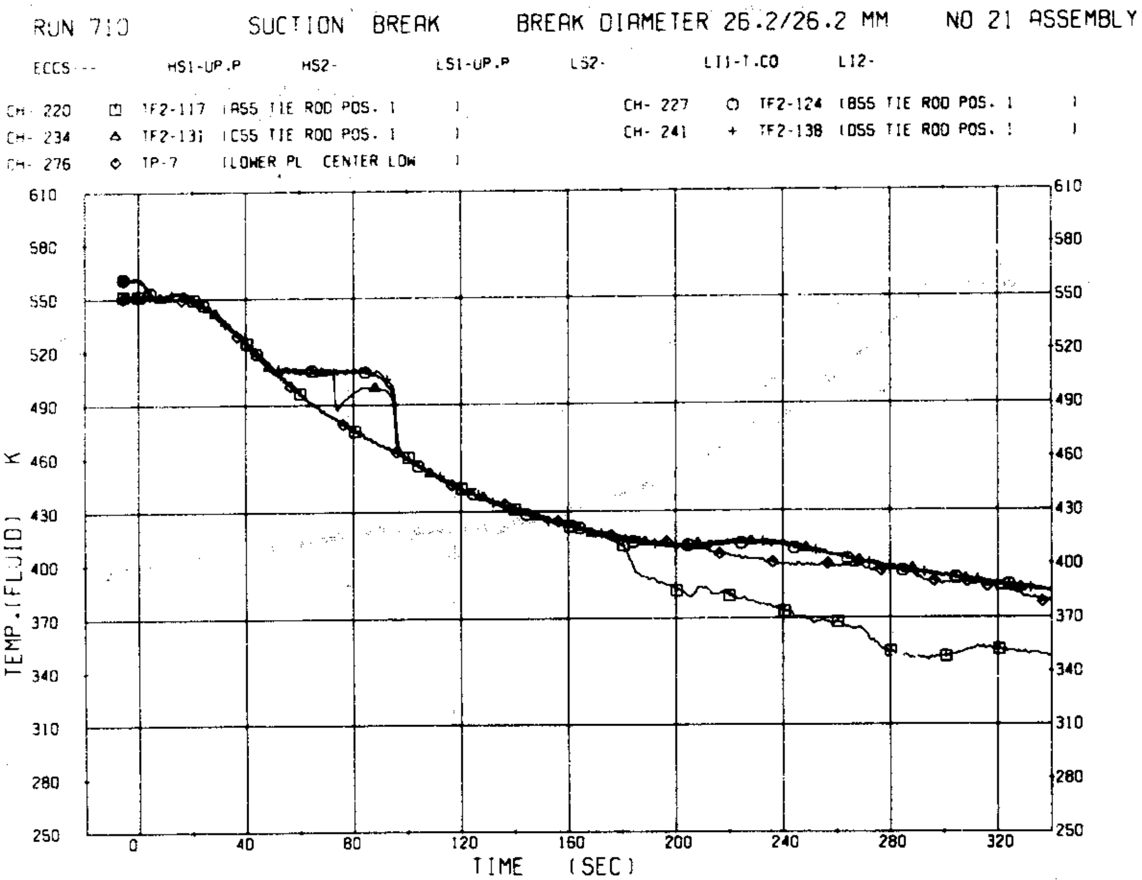


Fig. 5.70 Fluid temperatures at position 1 arround tie rod

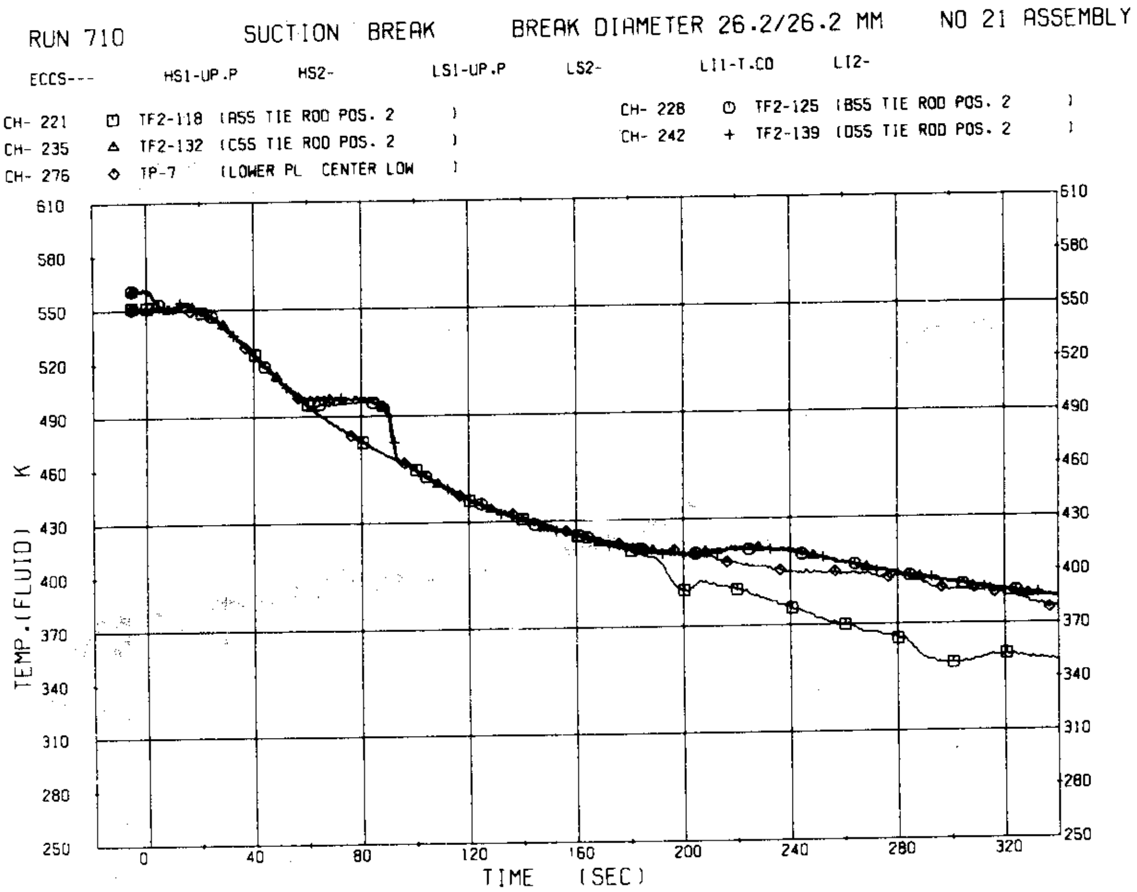


Fig. 5.71 Fluid temperatures at position 2 arround tie rod

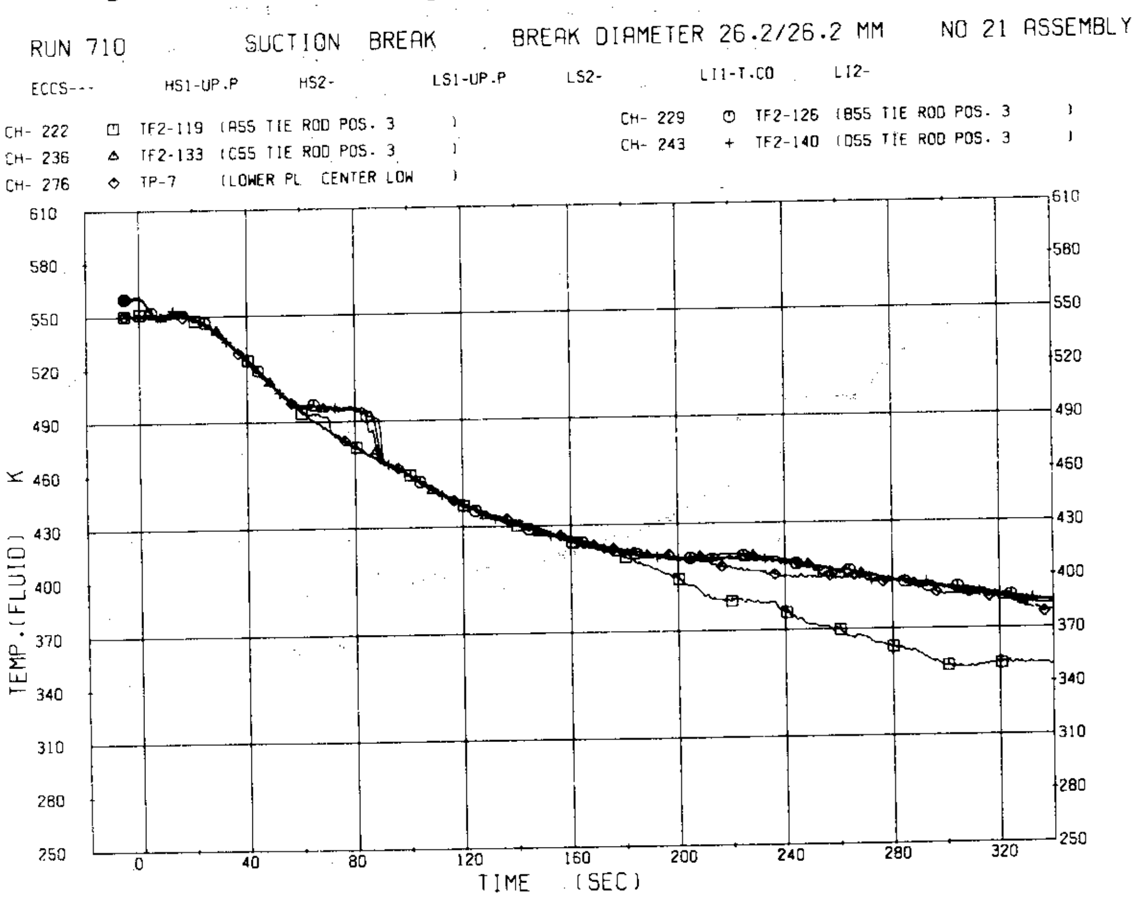


Fig. 5.72 Fluid temperatures at position 3 arround tie rod

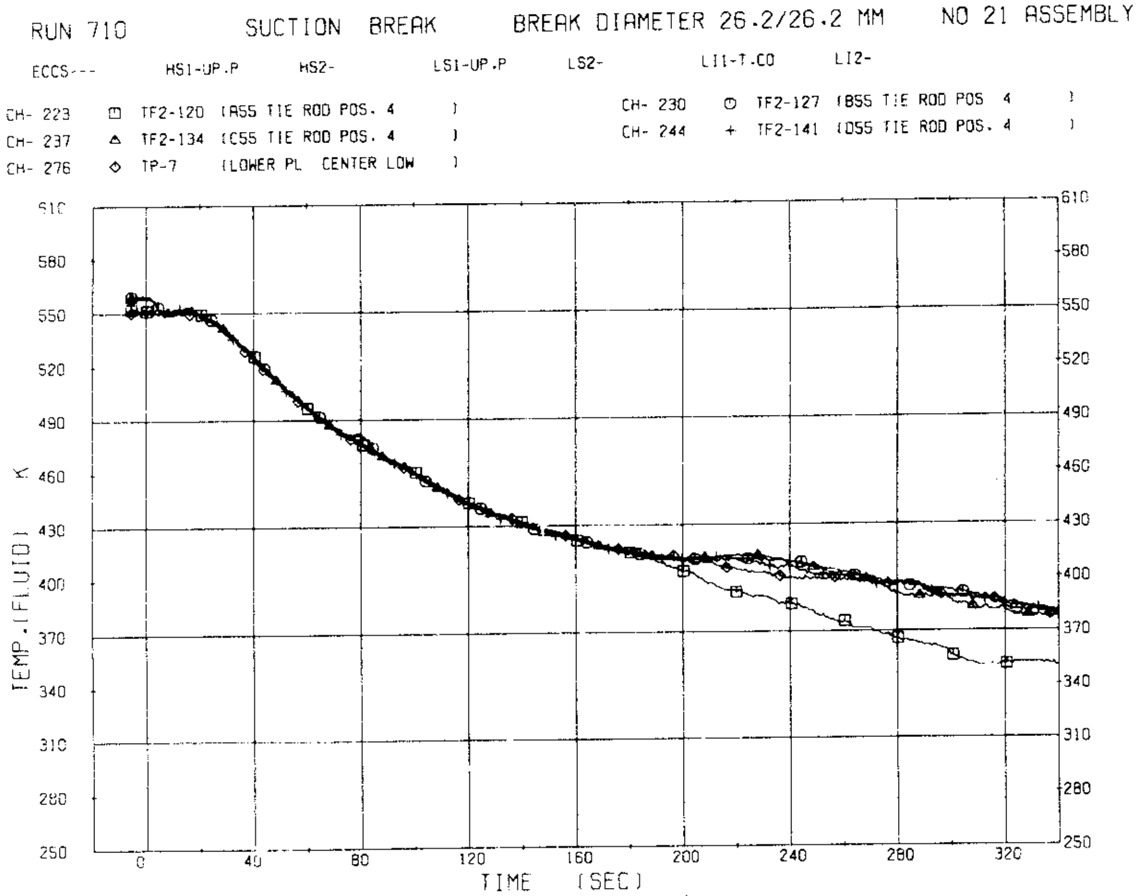


Fig. 5.73 Fluid temperatures at pesition 4 arround tie rod

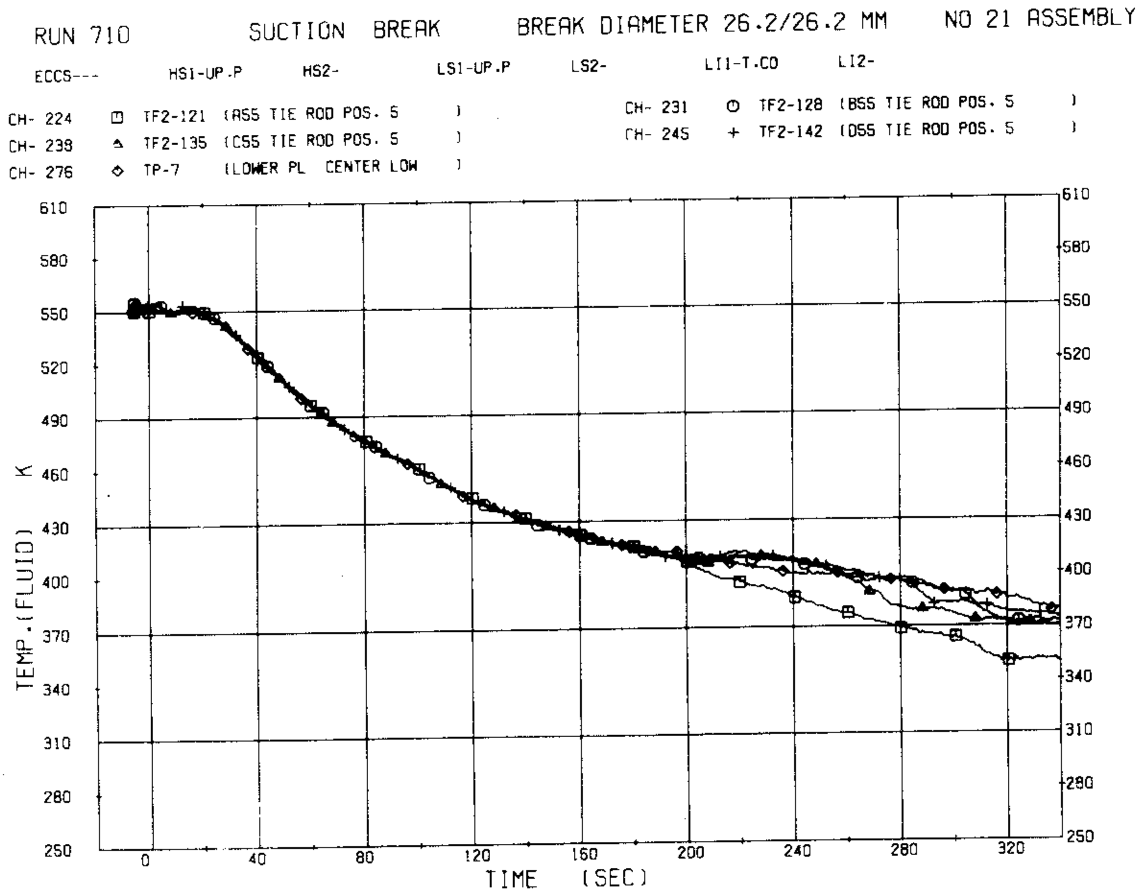


Fig. 5.74 Fluid temperatures at position 5 arround tie rod

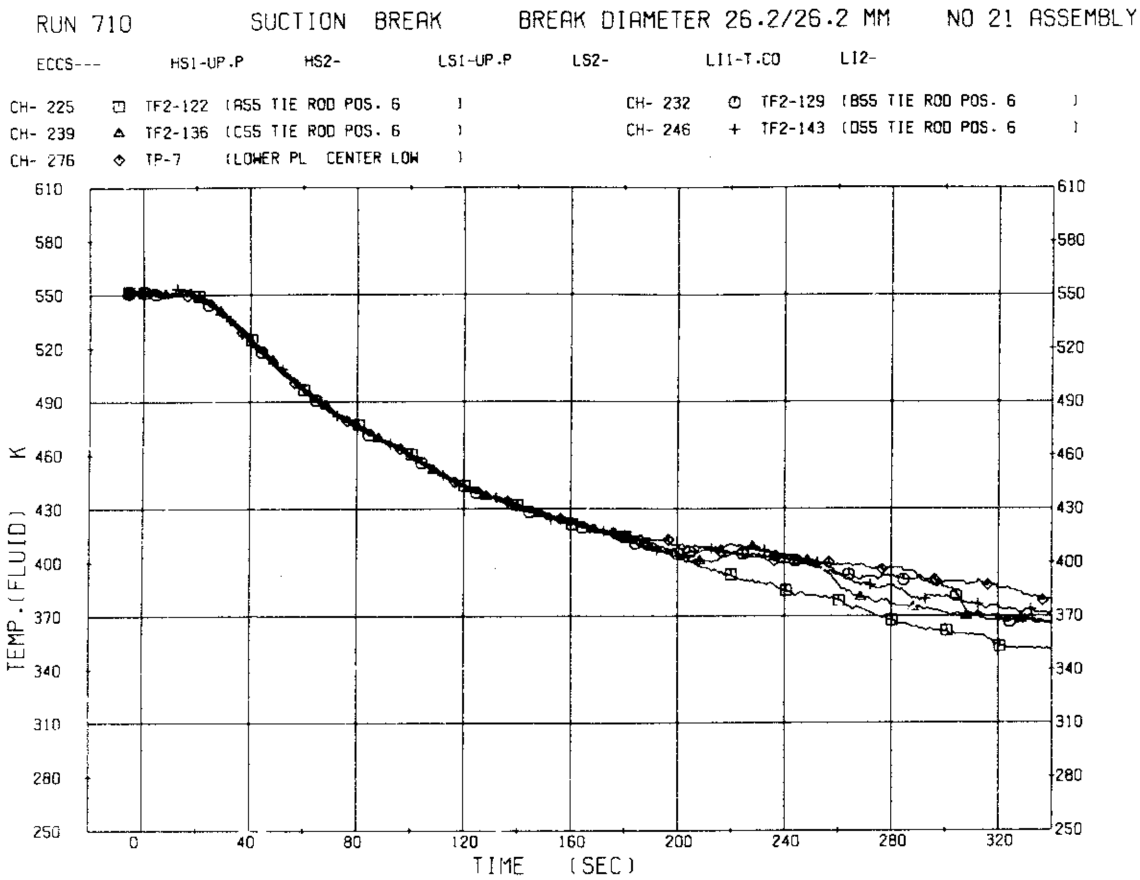


Fig. 5.75 Fluid temperatures at position 6 arround tie rod

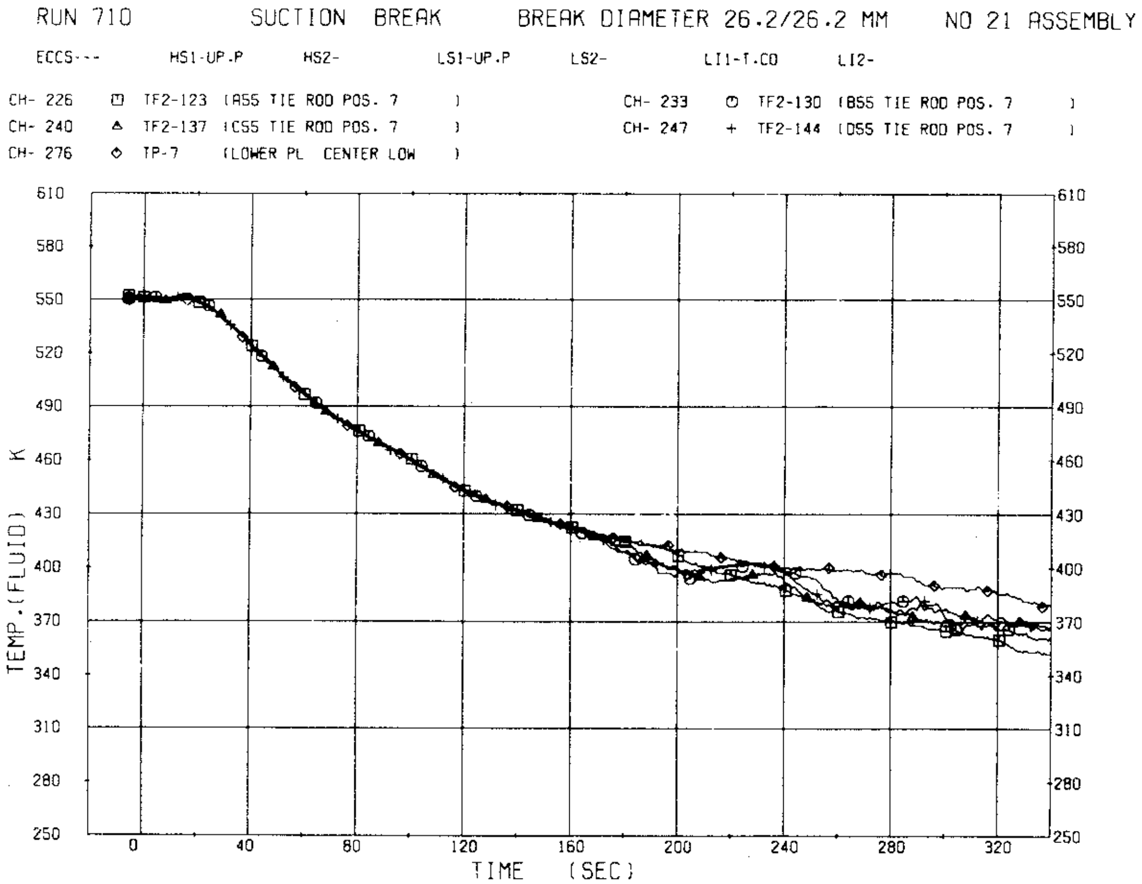


Fig. 5.76 Fluid temperatures at position 7 arround tie rod

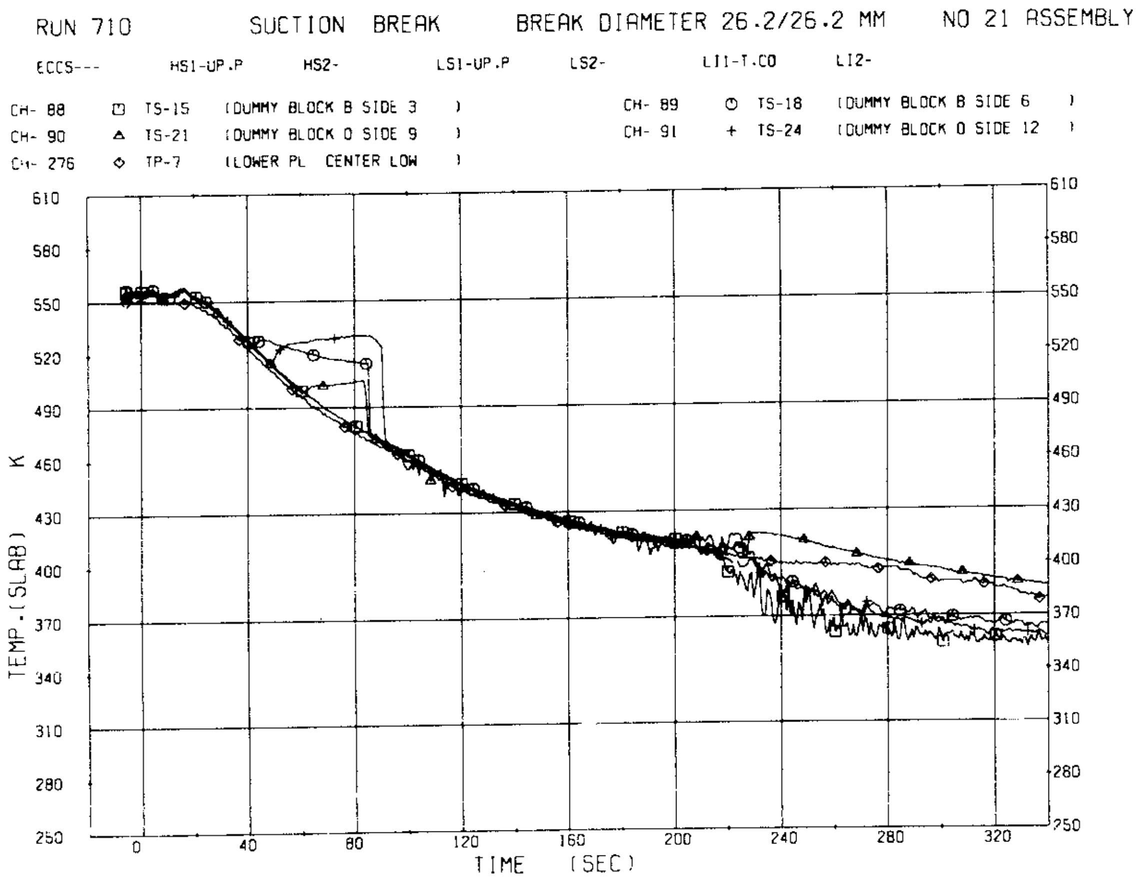


Fig. 5.77 Surface temperature of filler blocks

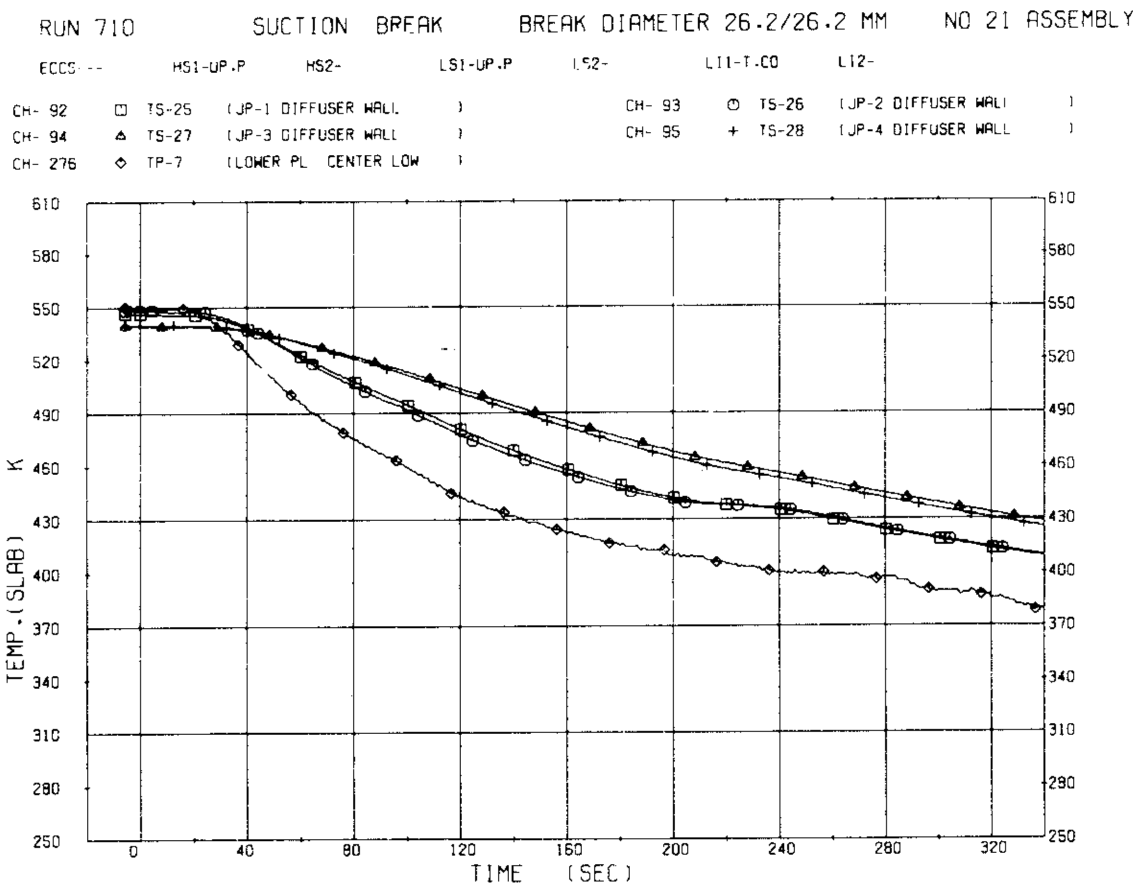


Fig. 5.78 Slab temperatures of jet pump diffuser

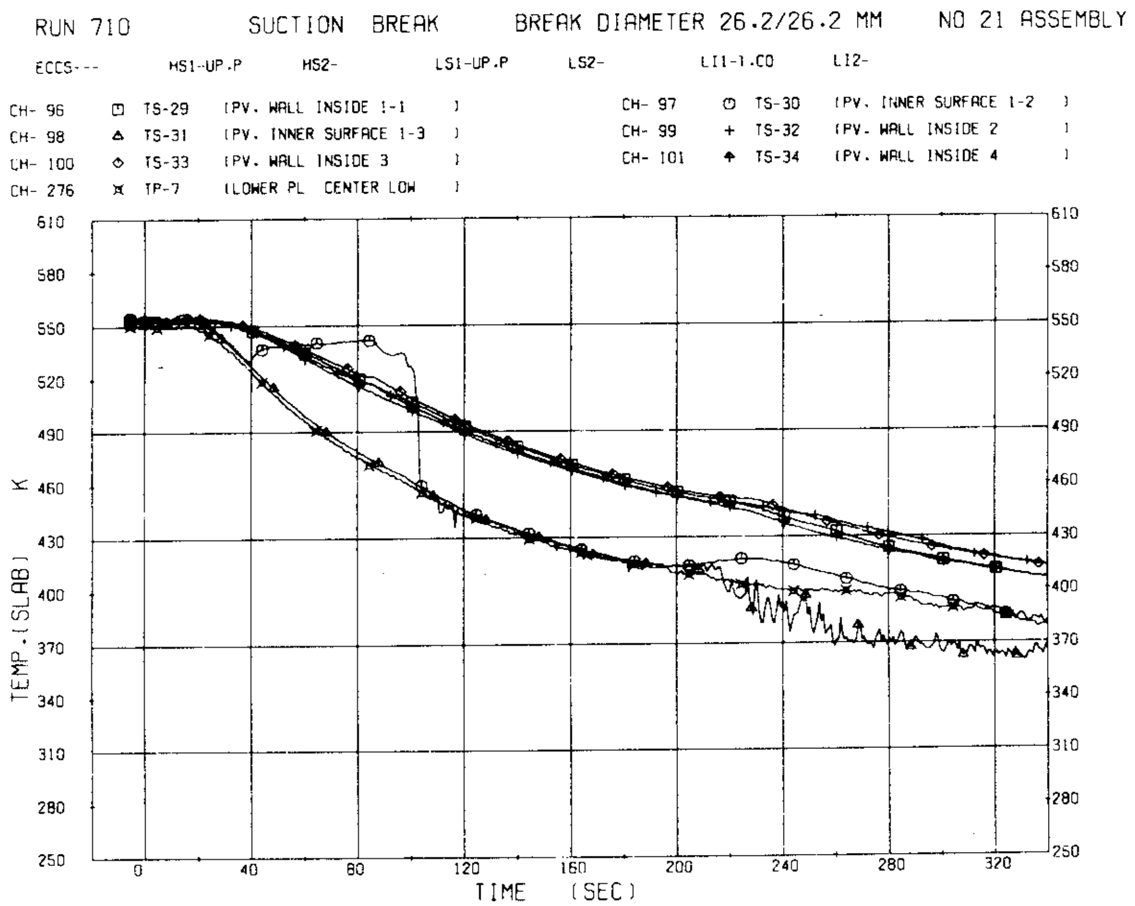


Fig. 5.79 Inner surface temperatures of pressure vessel wall

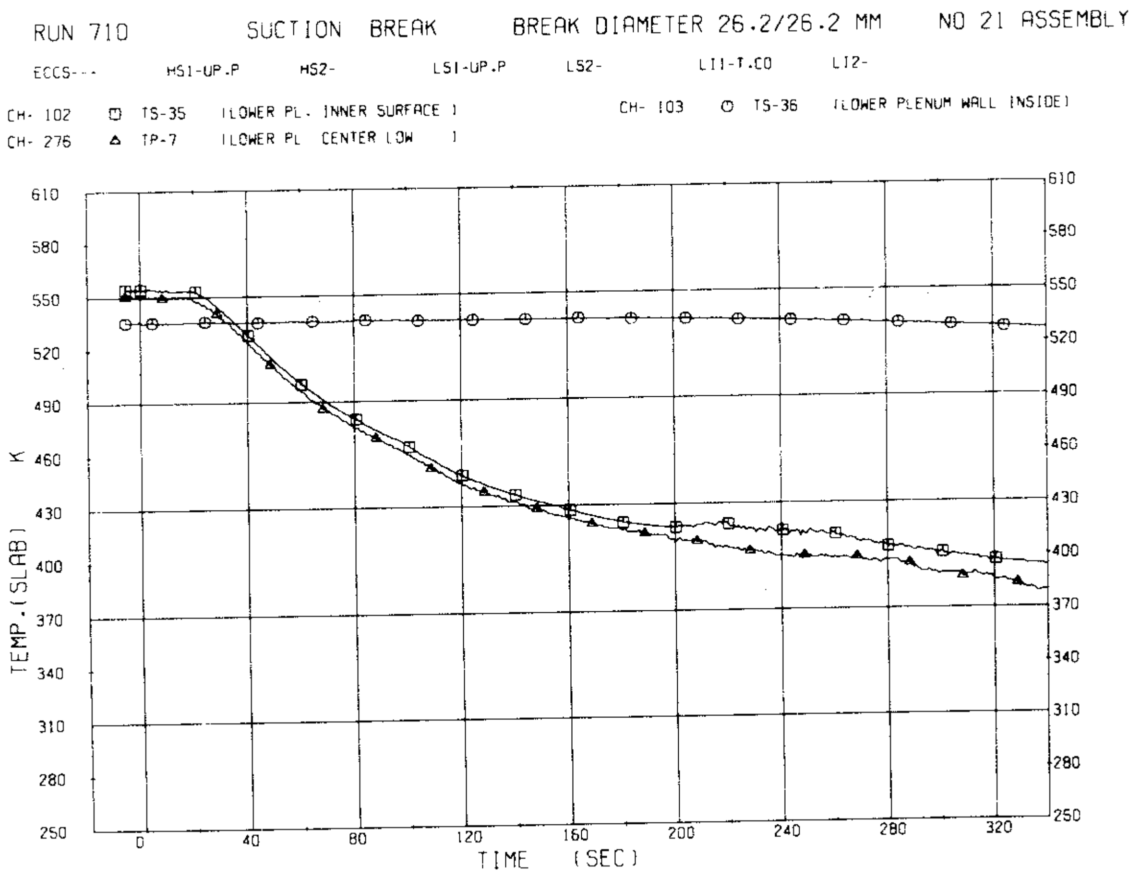


Fig. 5.80 Inner surface temperatures of pressure vessel lower plenum wall

RUN 710 SUCTION BREAK BREAK DIAMETER 26.2/26.2 MM NO 21 ASSEMBLY

ECCS--- HS1-UP.P HS2- LS1-UP.P LS2- LI1-T.CO LI2-

CH- 256 □ TB-1 (C.B.INNER SURF. POS.A-1) CH- 257 ○ TB-2 (C.B.INNER SURF. POS.A-2)
CH- 258 △ TB-3 (C.B.INNER SURF. POS.A-3) CH- 259 + TB-4 (C.B.INNER SURF. POS.A-4)
CH- 260 ◇ TB-5 (C.B.INNER SURF. POS.A-5) CH- 261 ↑ TB-6 (C.B.INNER SURF. POS.A-6)
CH- 262 ¤ TB-7 (C.B.INNER SURF. POS.A-7) CH- 276 * TP-7 (LOWER PL CENTER LOW)

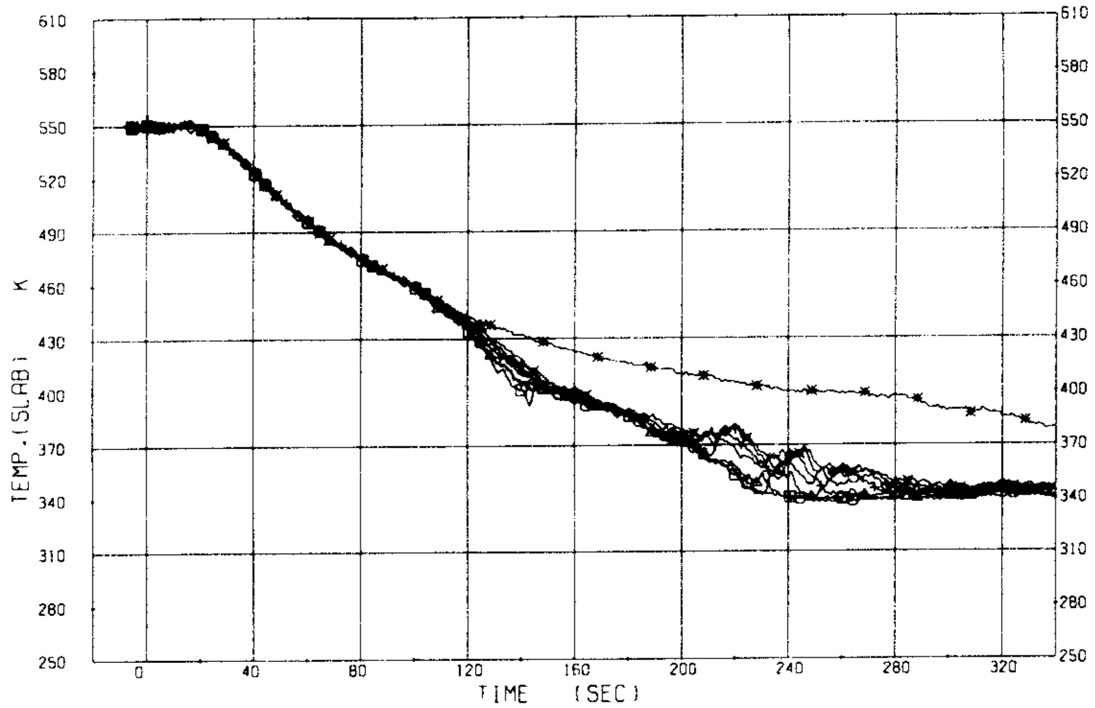


Fig. 5.81 Inner surface temperatures of channel box A

RUN 710 SUCTION BREAK BREAK DIAMETER 26.2/26.2 MM NO 21 ASSEMBLY

ECCS--- HS1-UP.P HS2- LS1-UP.P LS2- LI1-T.CO LI2-

CH- 263 □ TB-8 (C.B.INNER SURF. POS.A-8) CH- 264 ○ TB-9 (C.B.INNER SURF. POS.A-9)
CH- 265 △ TB-10 (C.B.INNER SURF. POS.A-10) CH- 266 + TB-11 (C.B.INNER SURF. POS.A-11)
CH- 267 ◇ TB-12 (C.B.INNER SURF. POS.A-12) CH- 268 ↑ TB-13 (C.B.INNER SURF. POS.A-13)
CH- 269 ¤ TB-14 (C.B.INNER SURF. POS.A-14) CH- 276 * TP-7 (LOWER PL CENTER LOW)

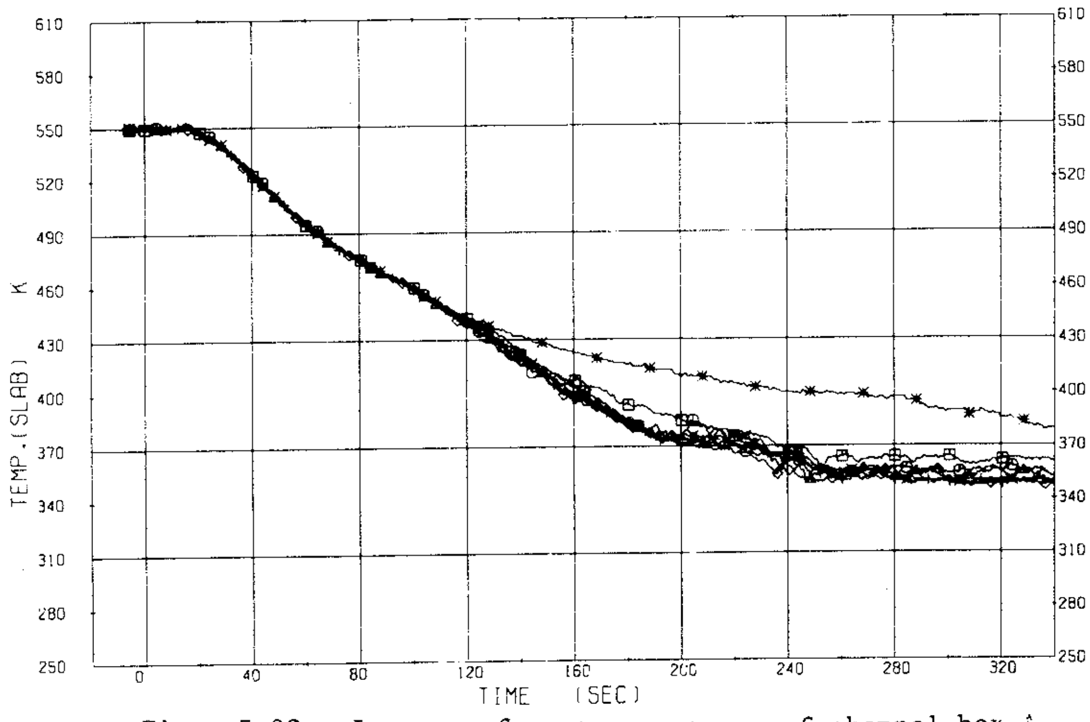


Fig. 5.82 Inner surface temperatures of channel box A

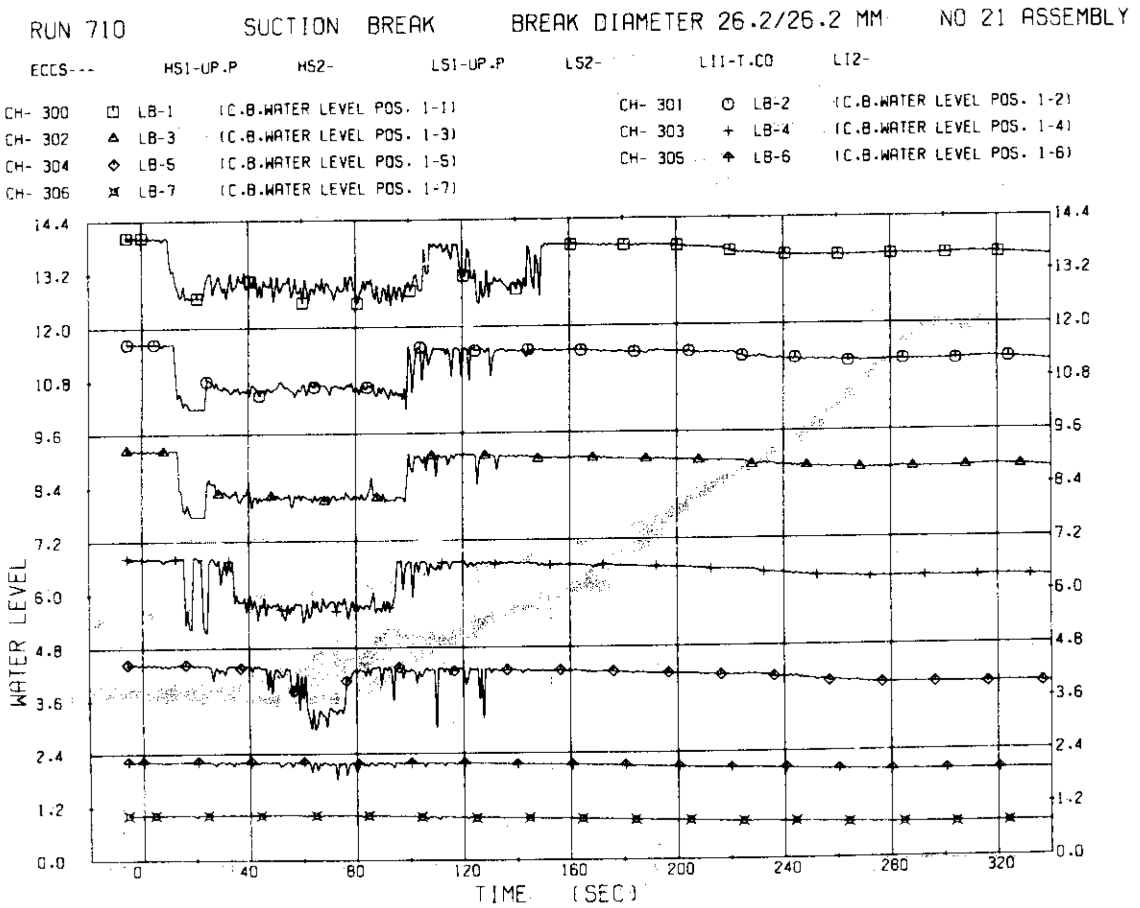


Fig. 5.83 Conductivity probe signals in Channel A

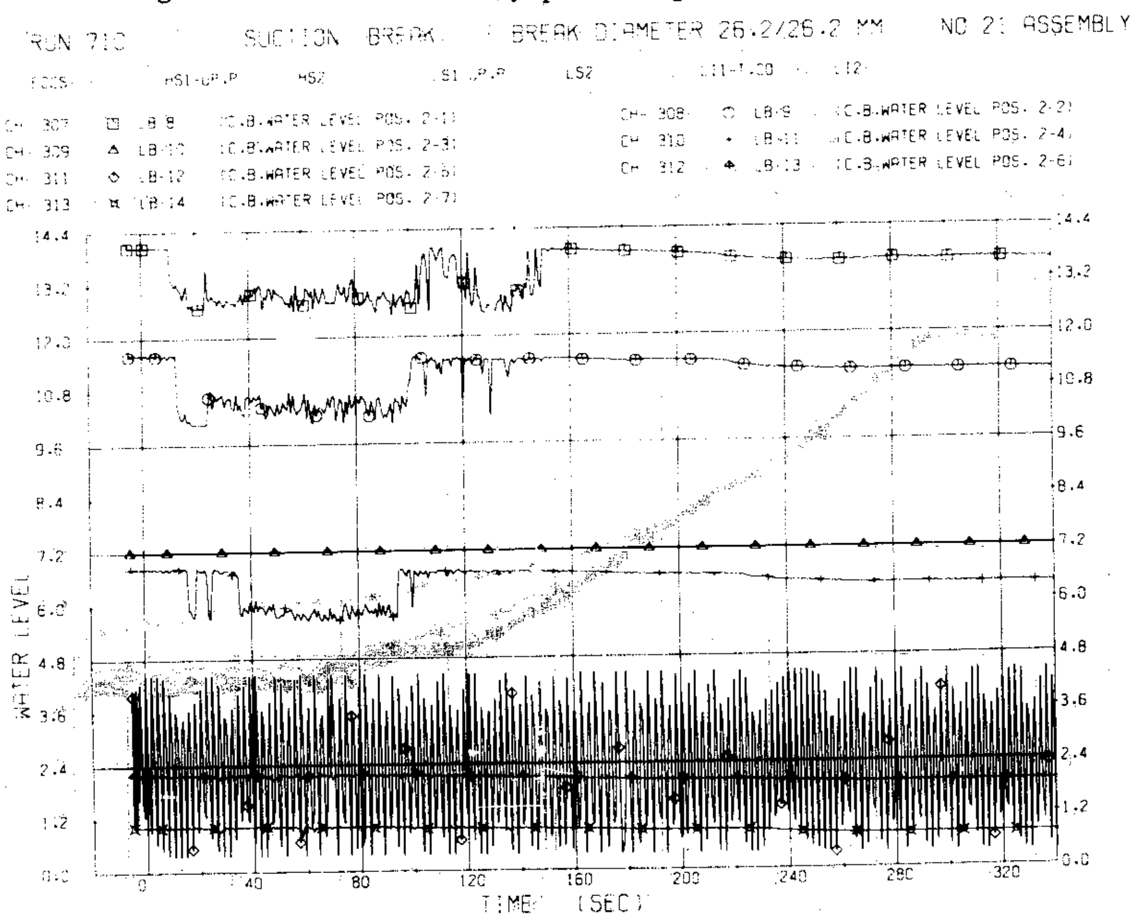


Fig. 5.84 Conductivity probe signals in Channel A

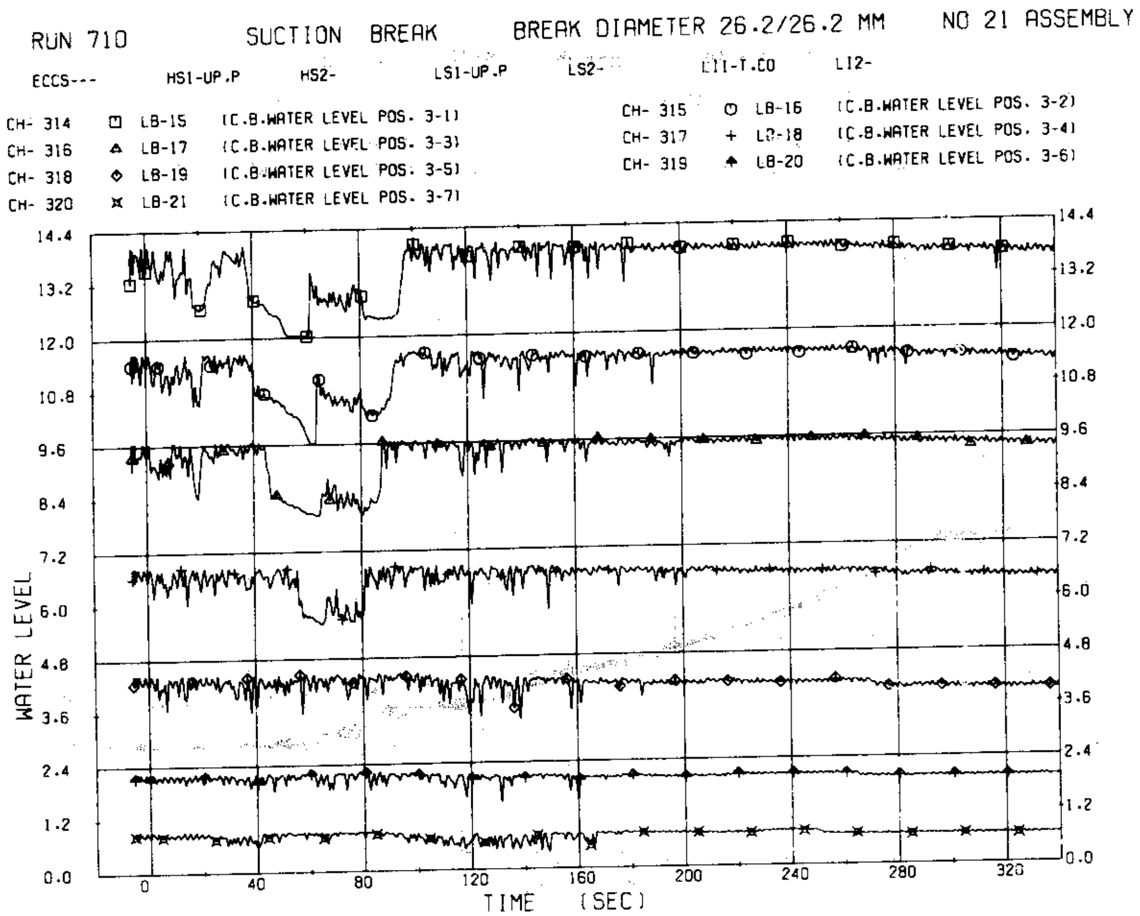


Fig. 5.85 Conductivity probe signals in Channel C

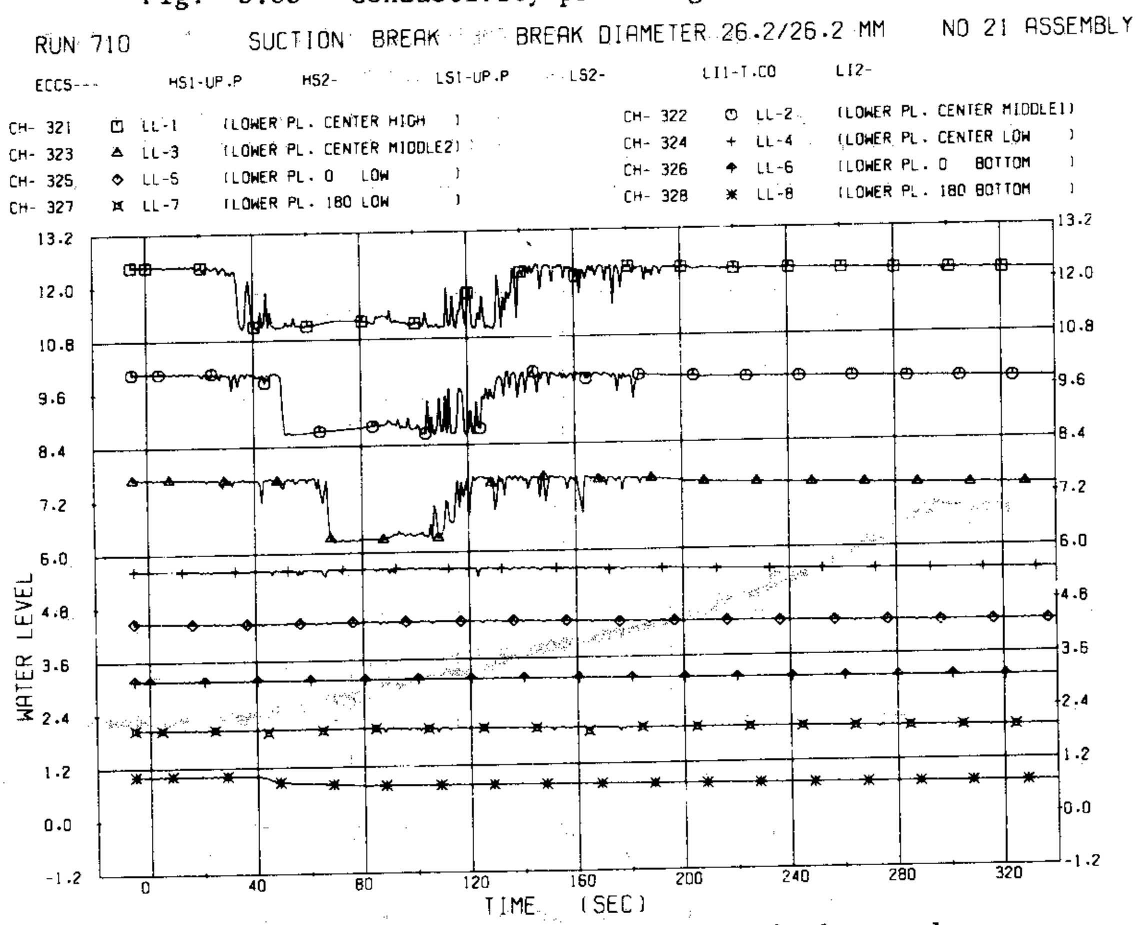


Fig. 5.86 Conductivity probe signals in lower plenum

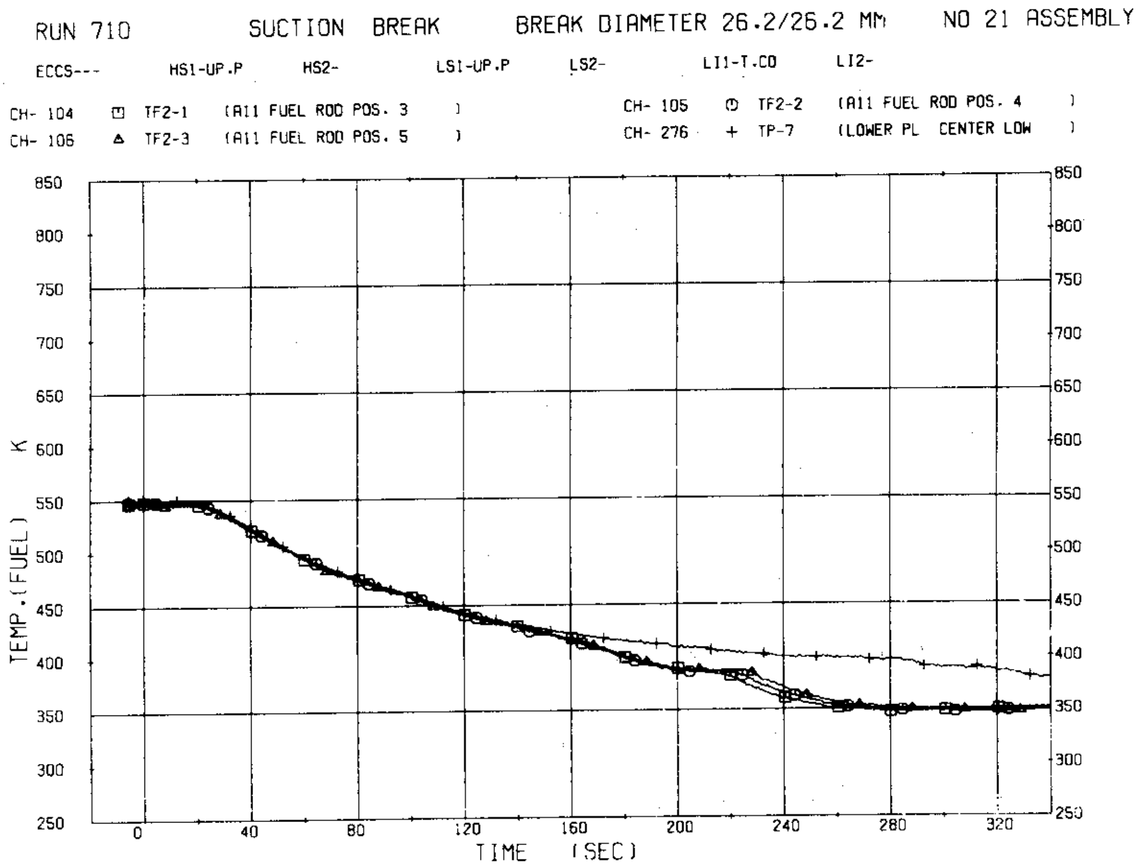


Fig. 5.87 Fuel rod surface temperatures, A11

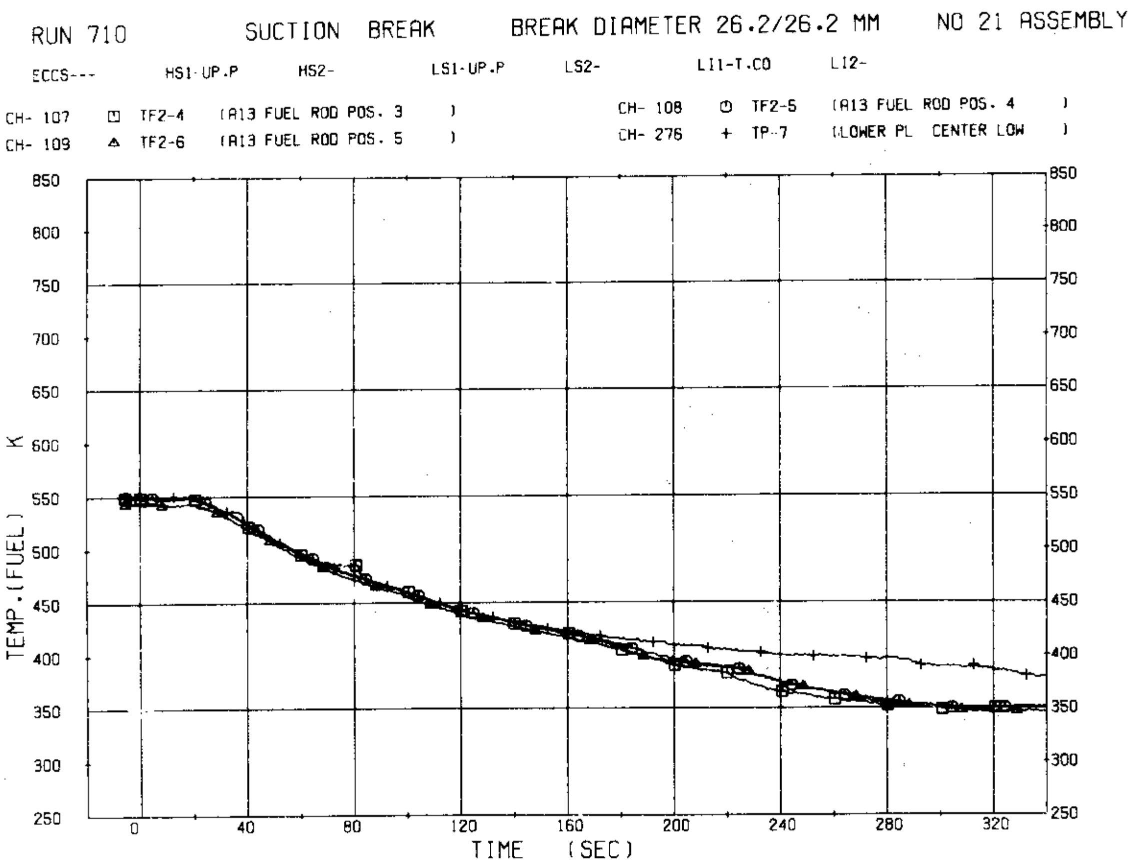


Fig. 5.88 Fuel rod surface temperatures, A13

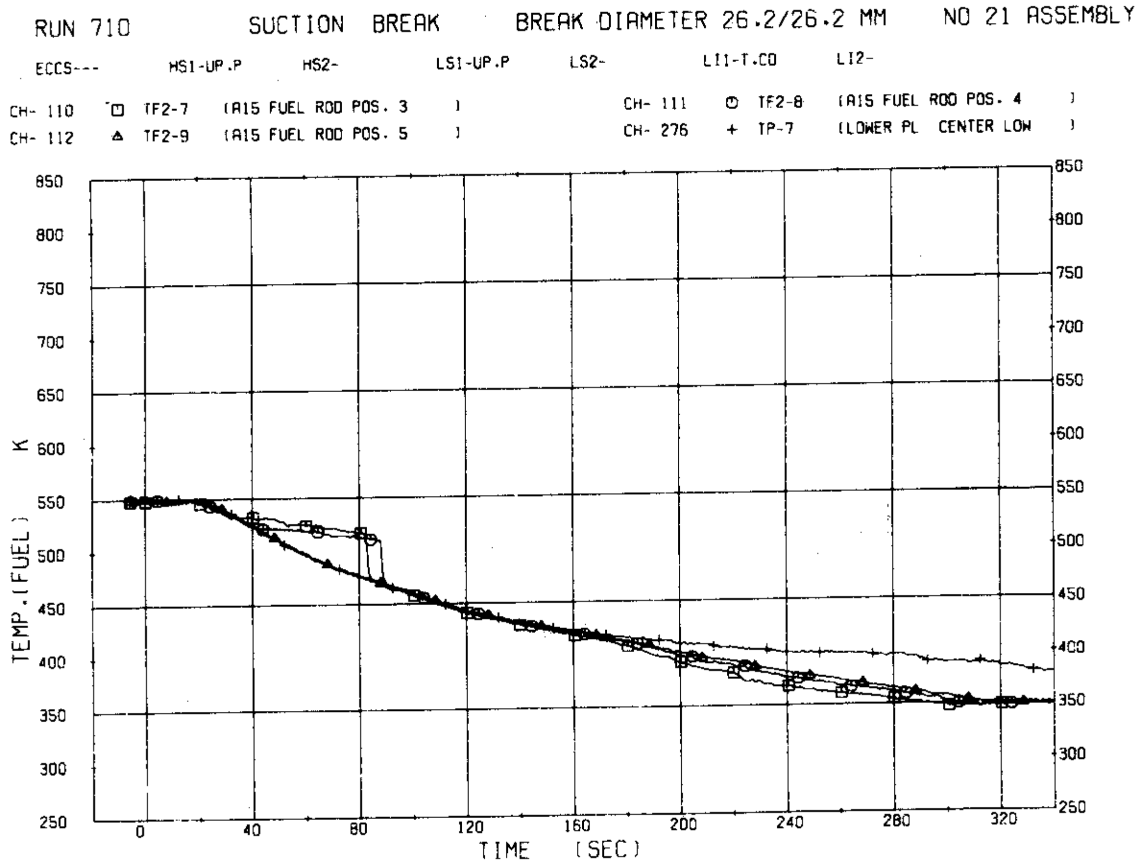


Fig. 5.89 Fuel rod surface temperatures, A15

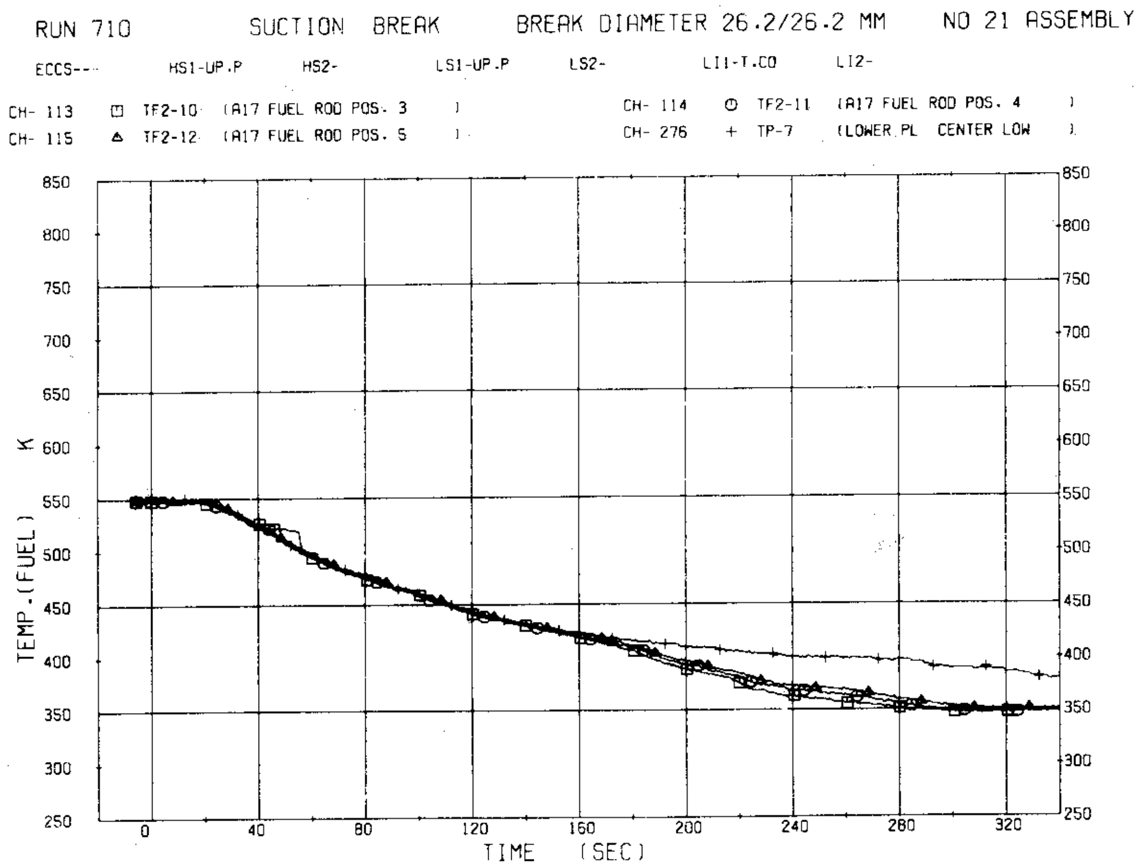


Fig. 5.90 Fuel rod surface temperatures, A17

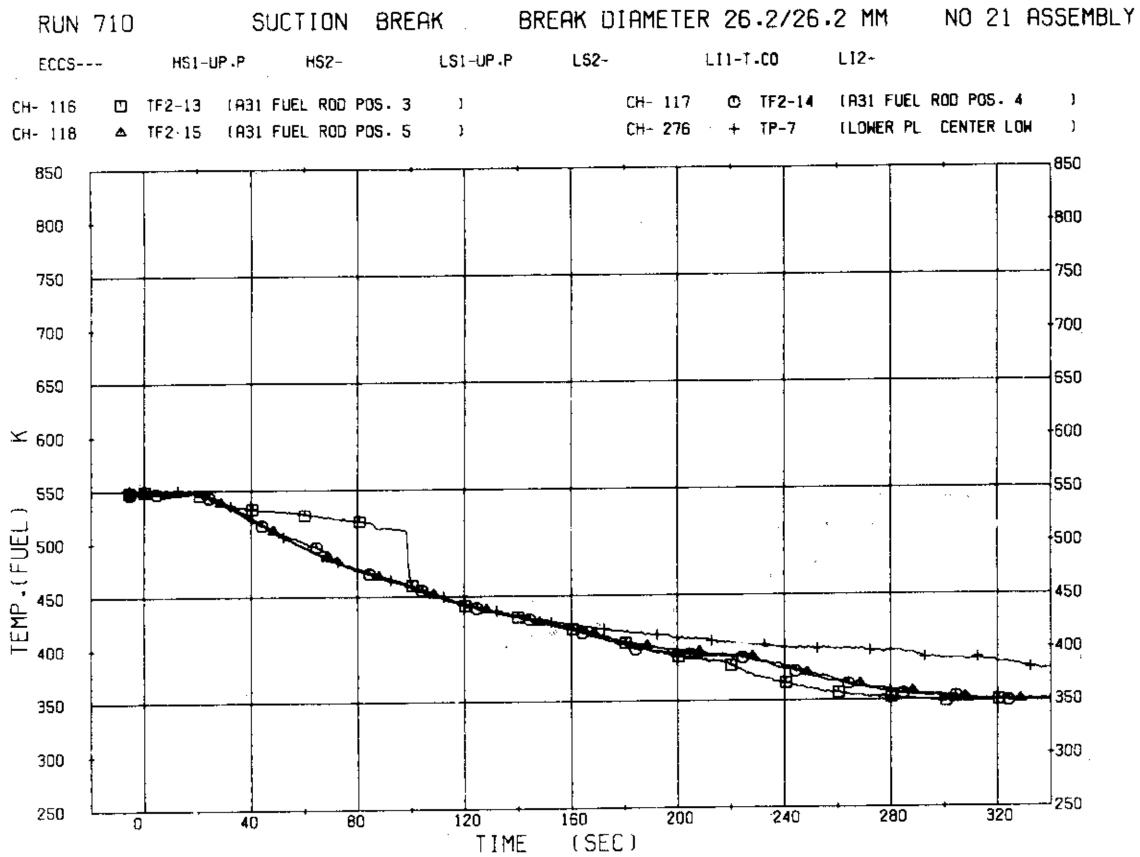


Fig. 5.91 Fuel rod surface temperatures, A31

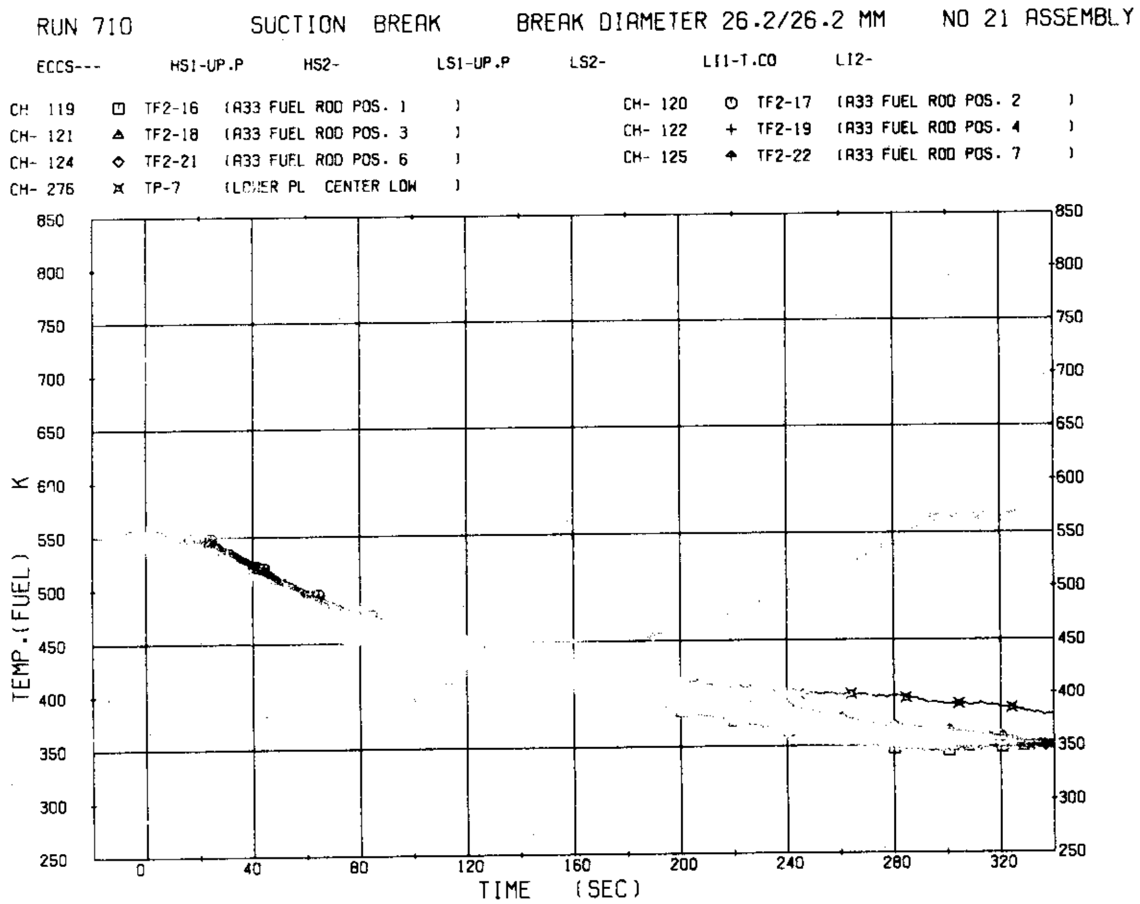


Fig. 5.92 Fuel rod surface temperatures, A33

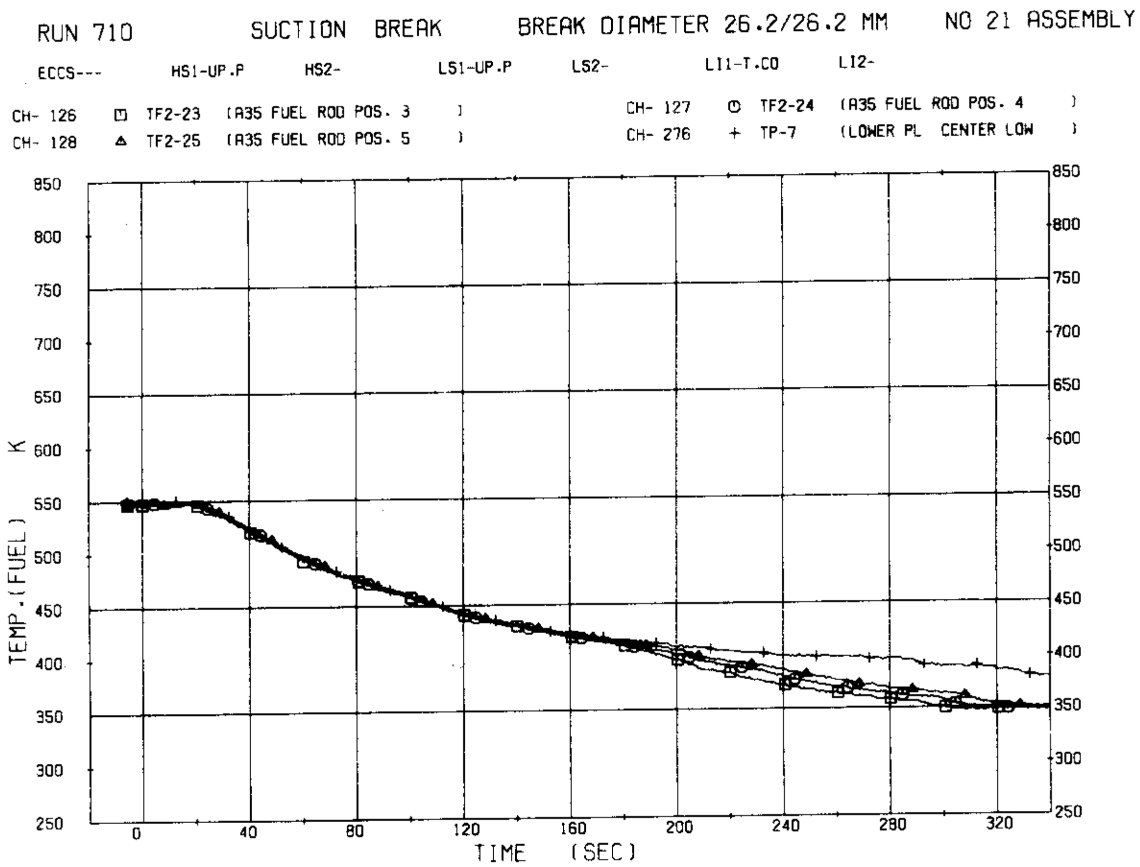


Fig. 5.93 Fuel rod surface temperatures, A35

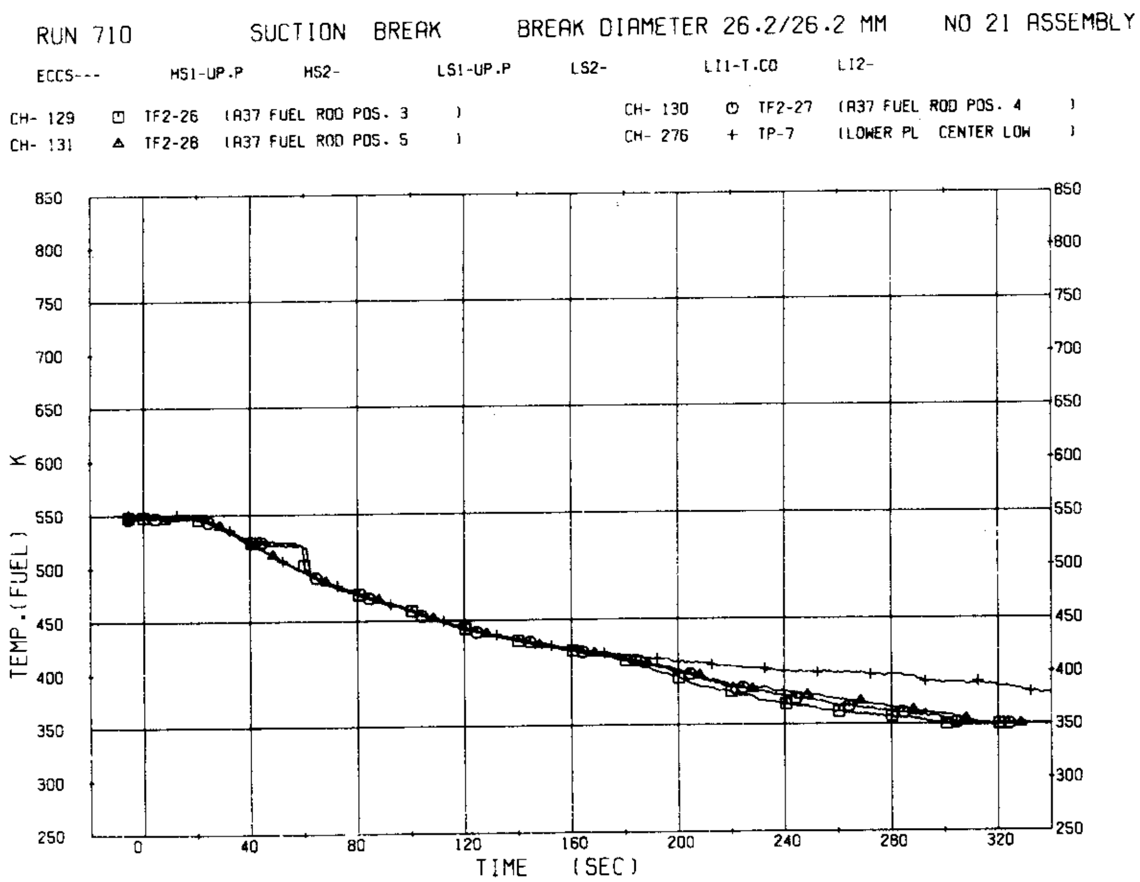


Fig. 5.94 Fuel rod surface temperatures, A37

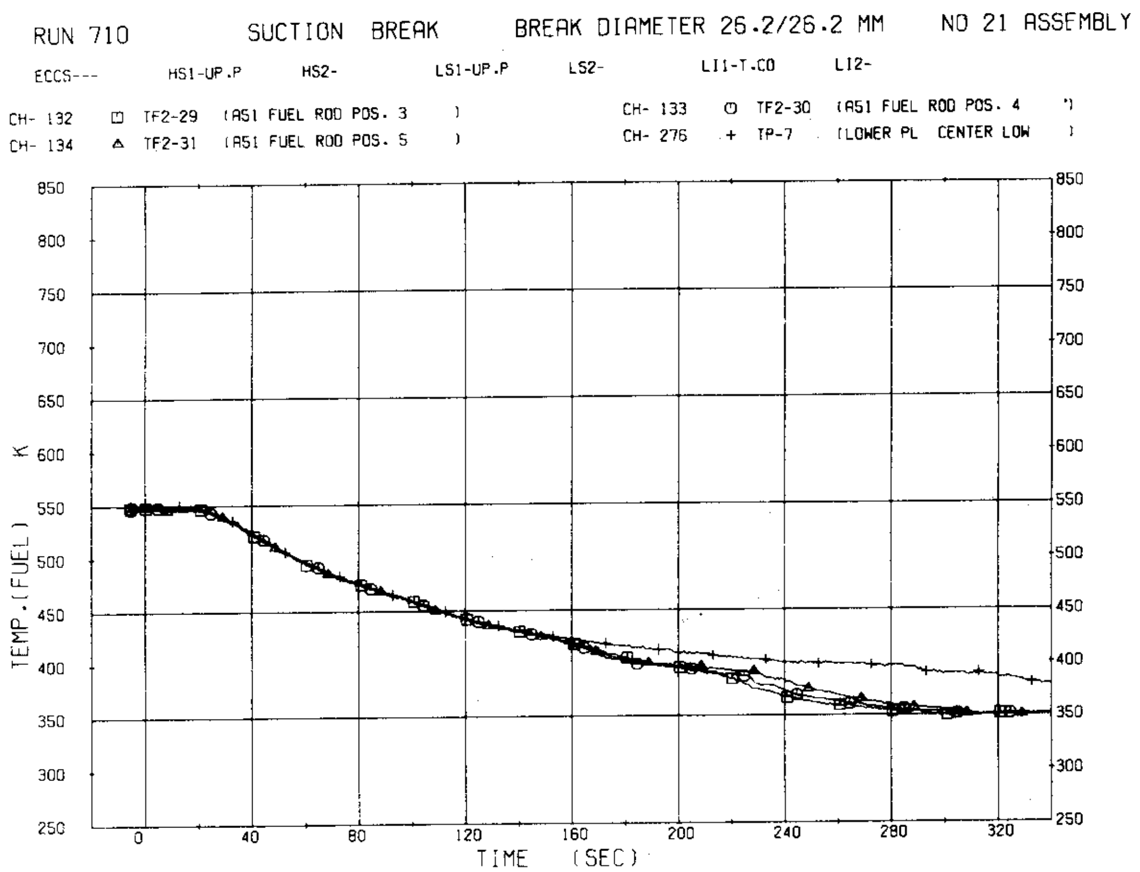


Fig. 5.95 Fuel rod surface temperatures, A51

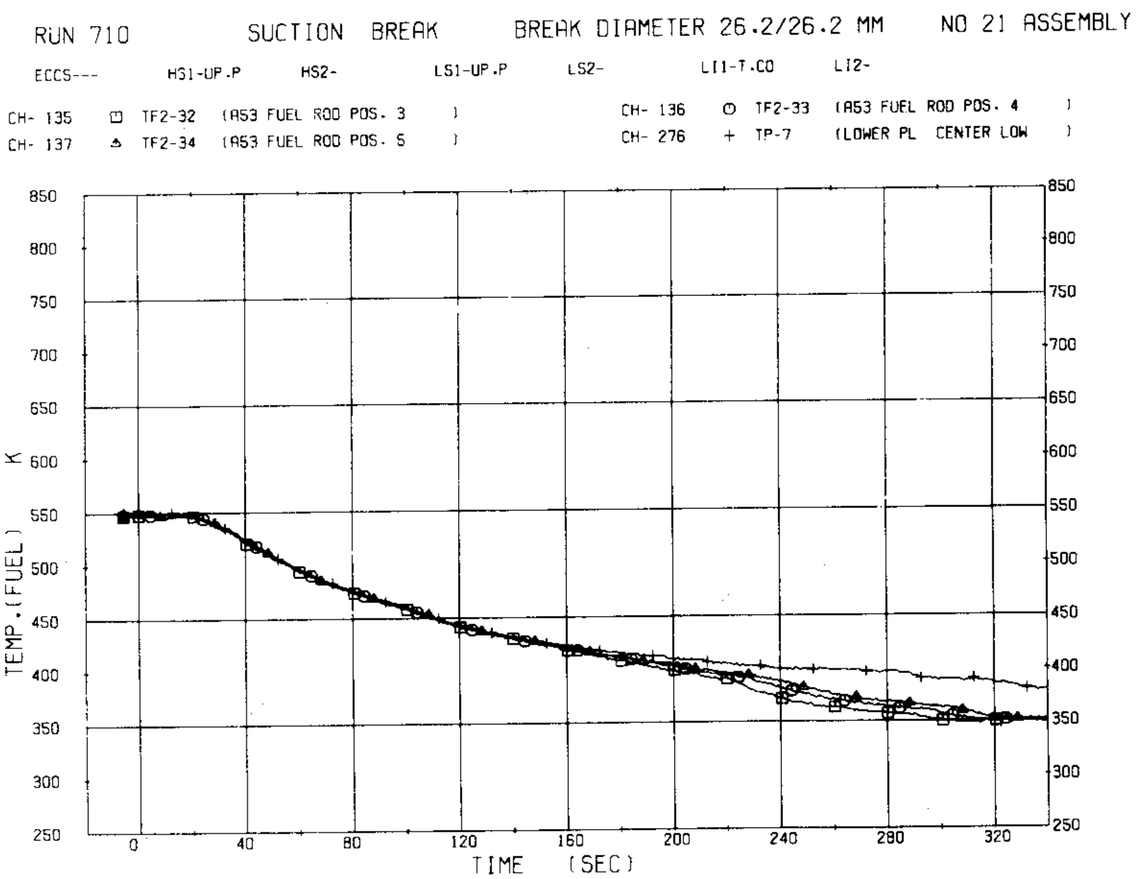


Fig. 5.96 Fuel rod surface temperatures, A53

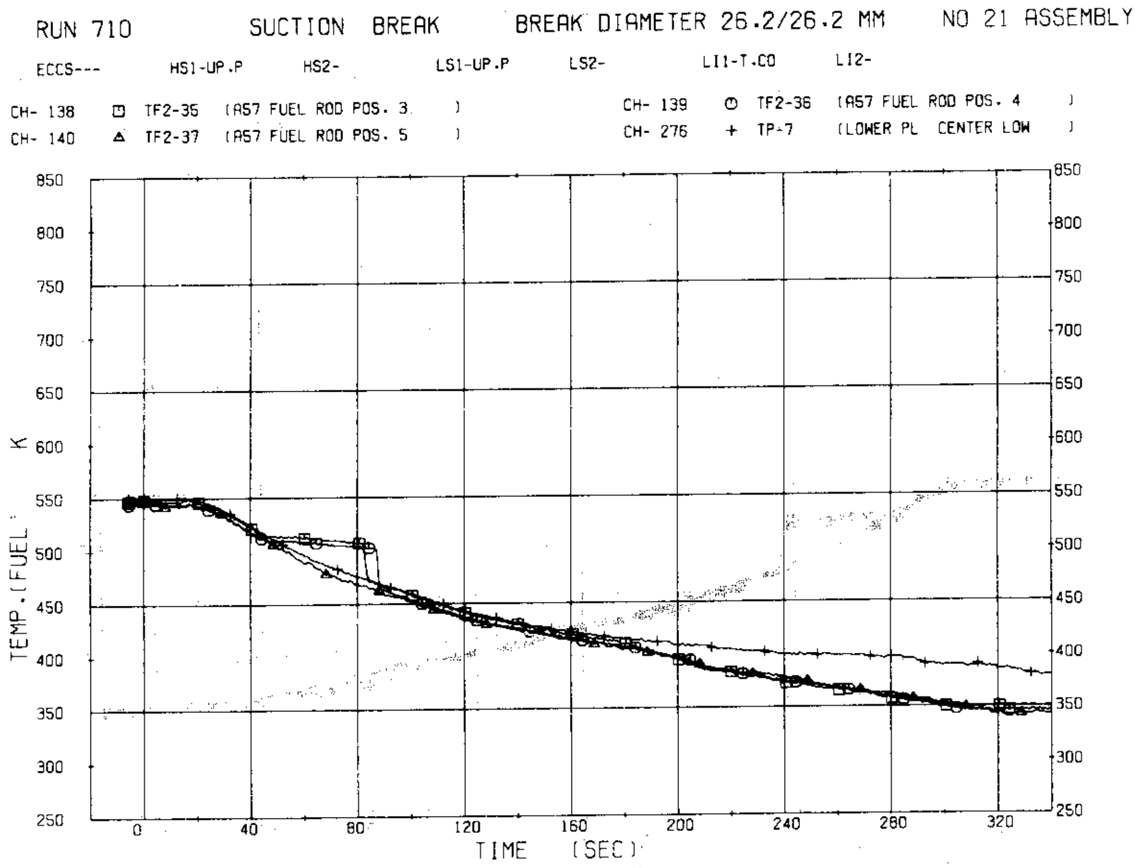


Fig. 5.97 Fuel rod surface temperatures, A57

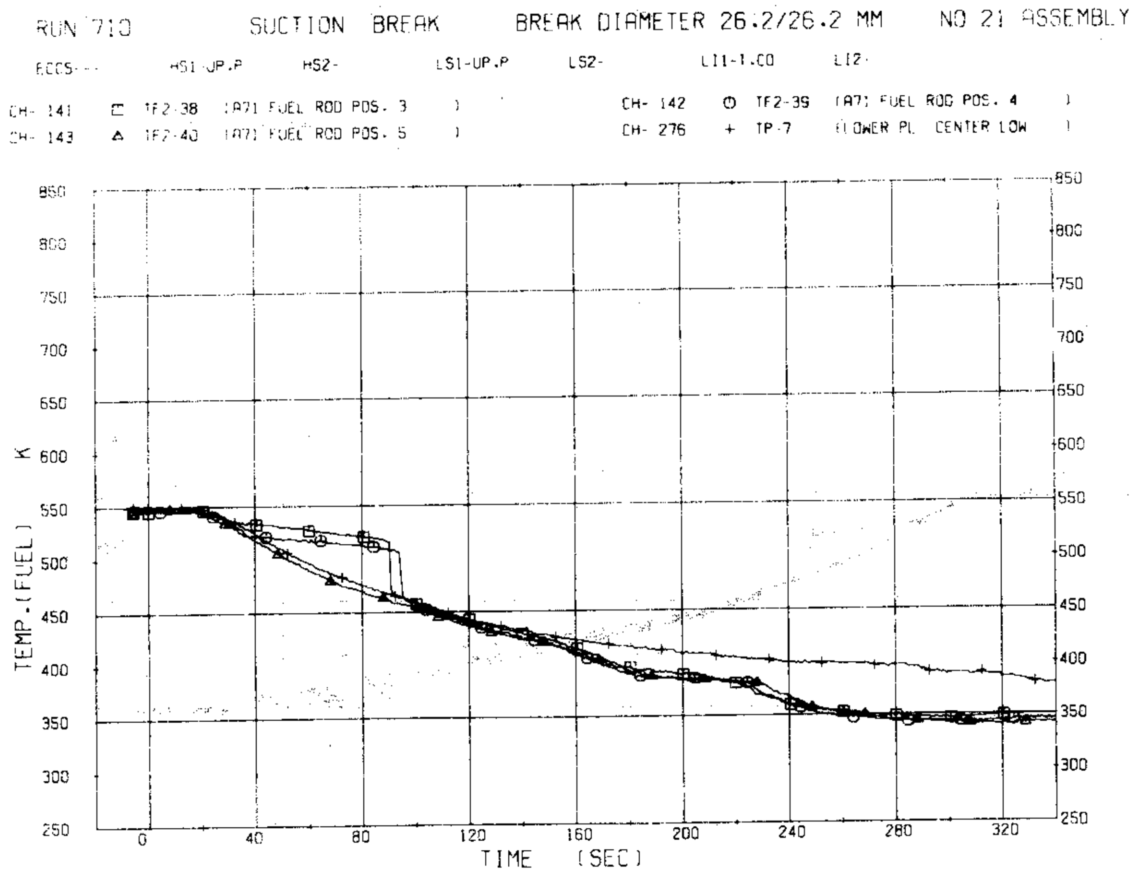


Fig. 5.98 Fuel rod surface temperatures, A71

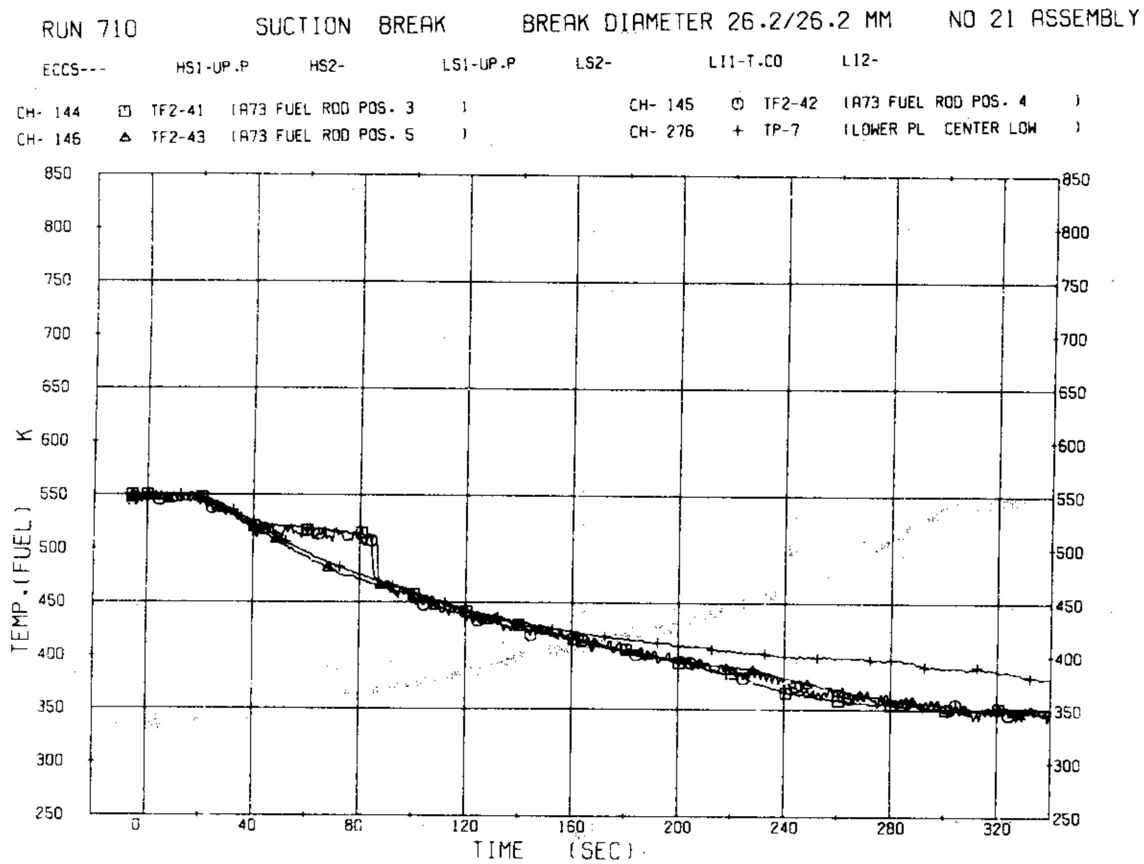


Fig. 5.99 Fuel rod surface temperatures, A73

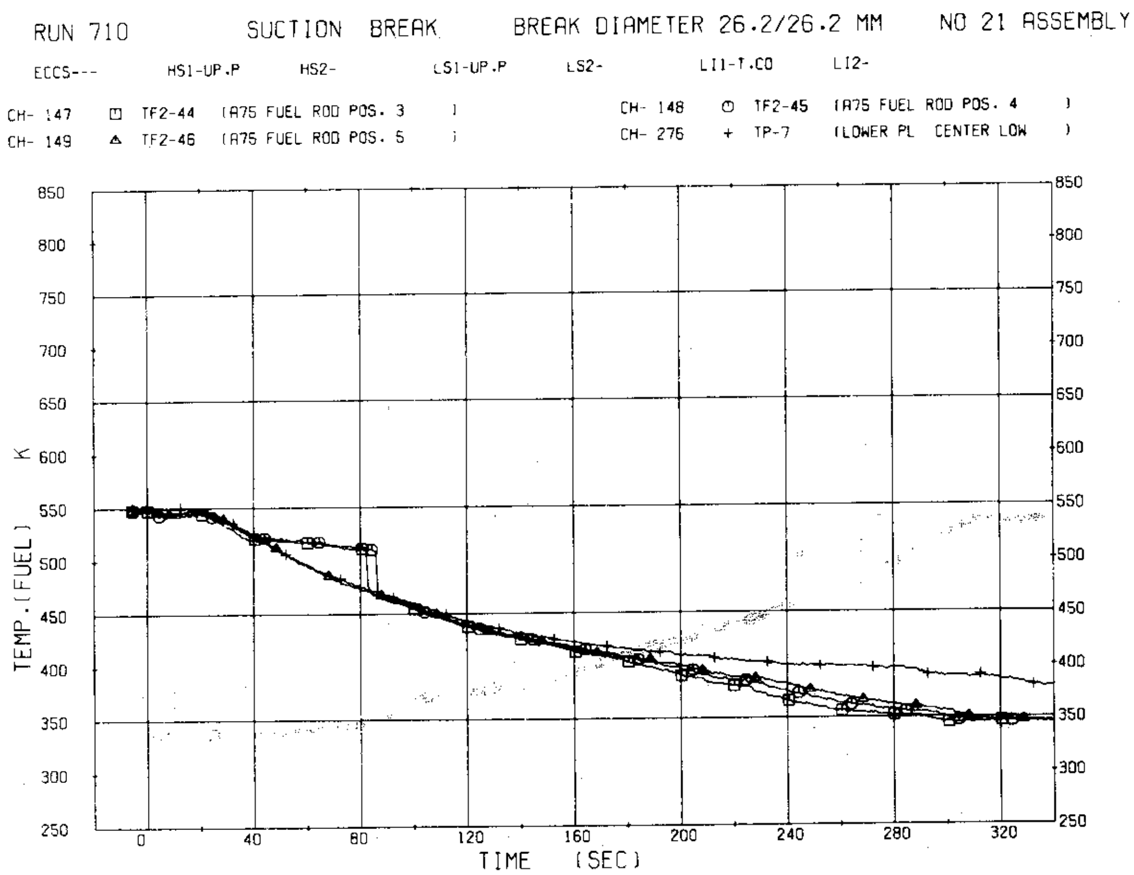


Fig. 5.100 Fuel rod surface temperatures, A75

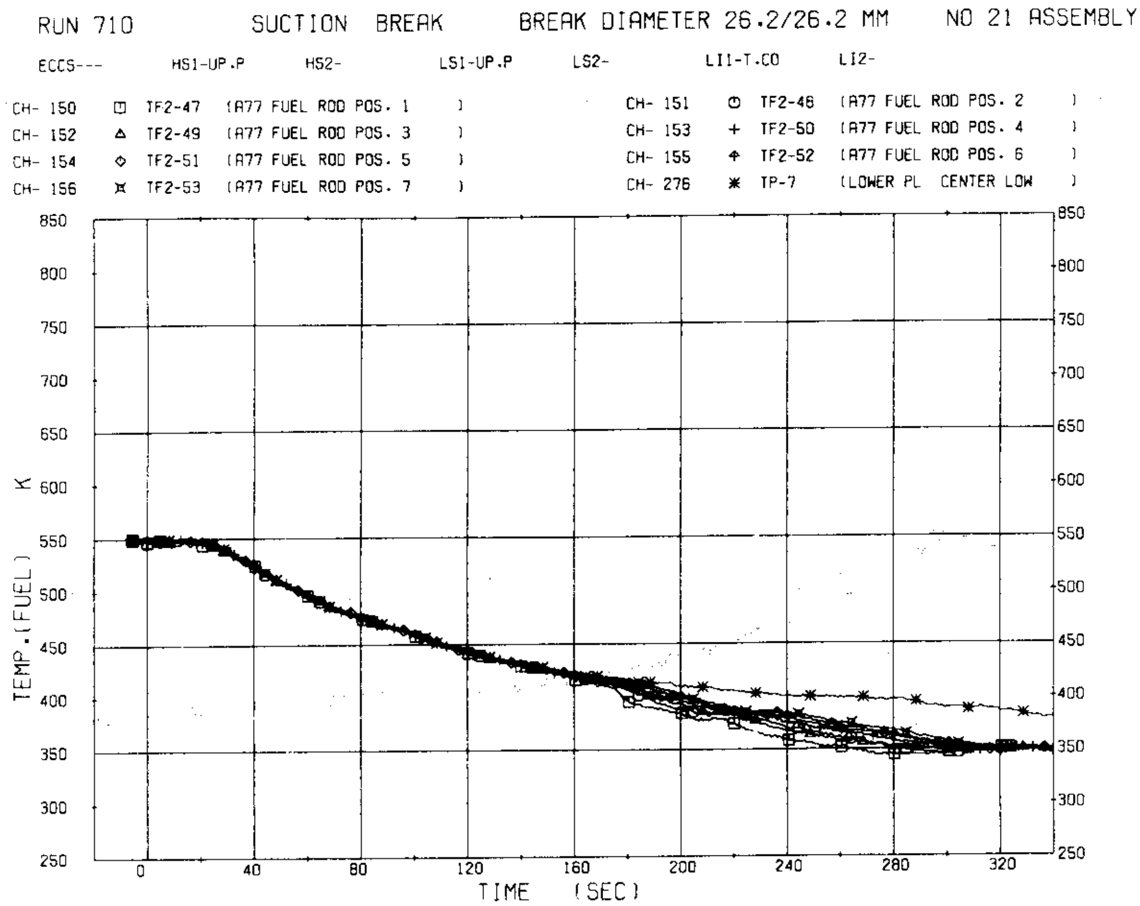


Fig. 5.101 Fuel rod surface temperatures, A77

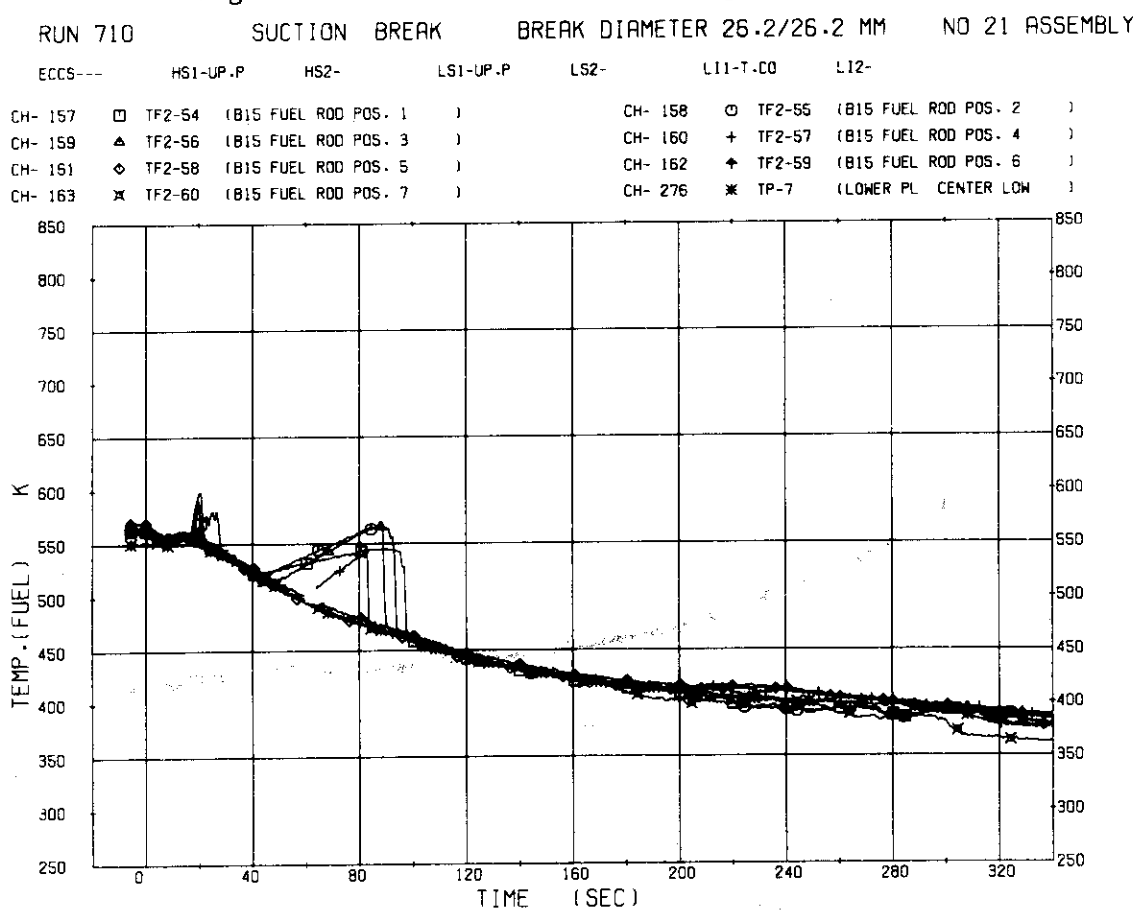


Fig. 5.102 Fuel rod surface temperatures, B15

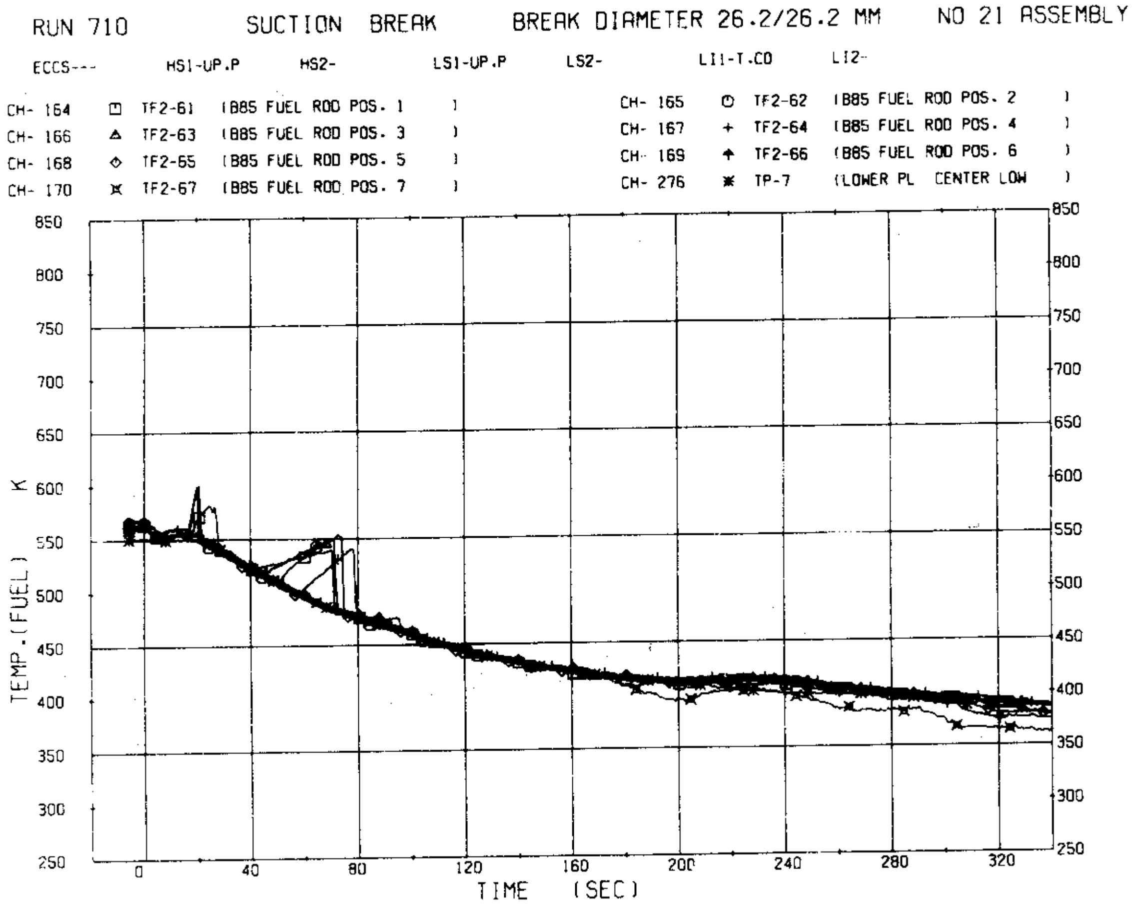


Fig. 5.103 Fuel rod surface temperatures, B85

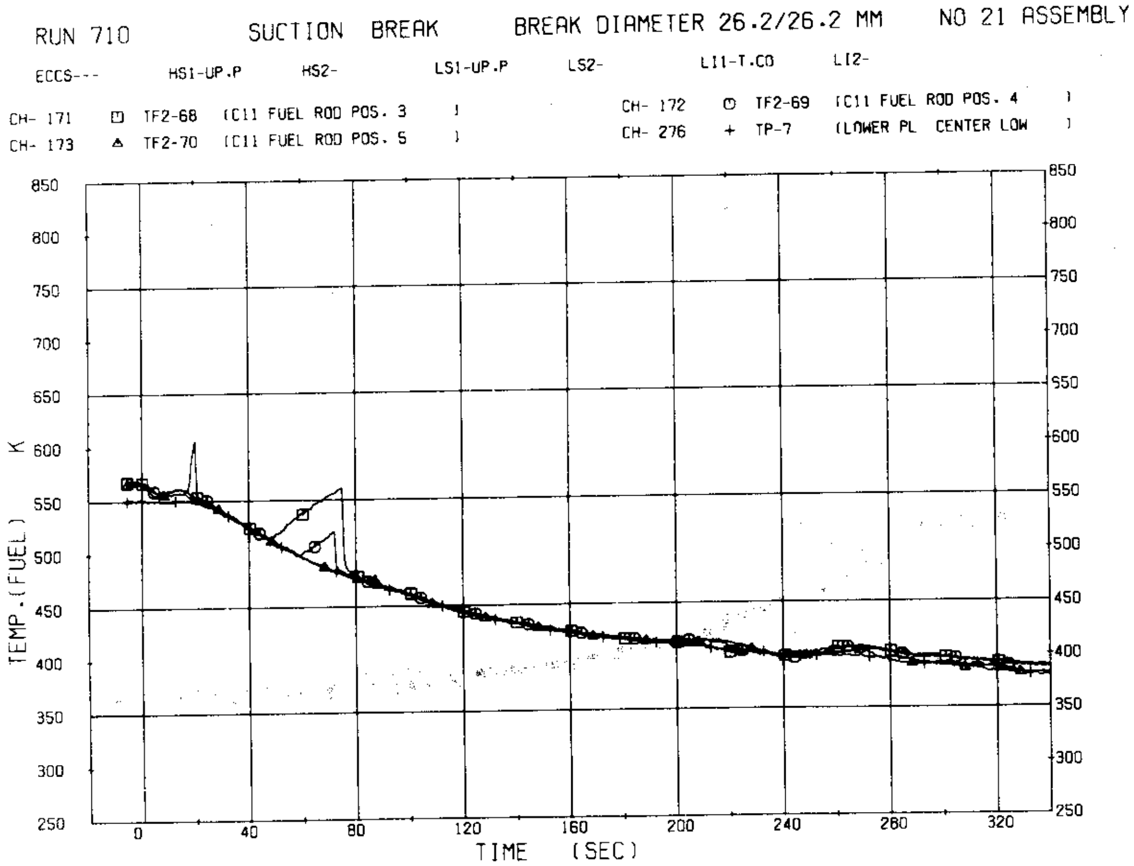


Fig. 5.104 Fuel rod surface temperatures, C11

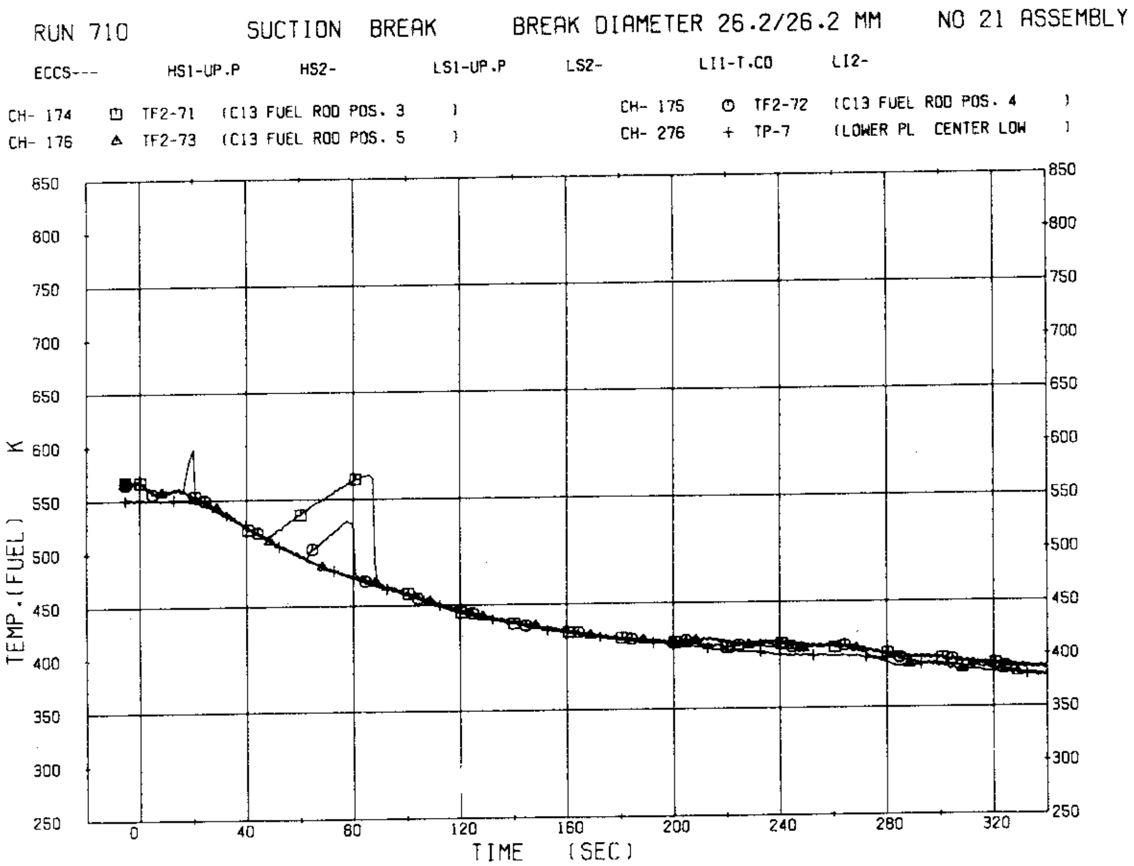


Fig. 5.105 Fuel rod surface temperatures, C13

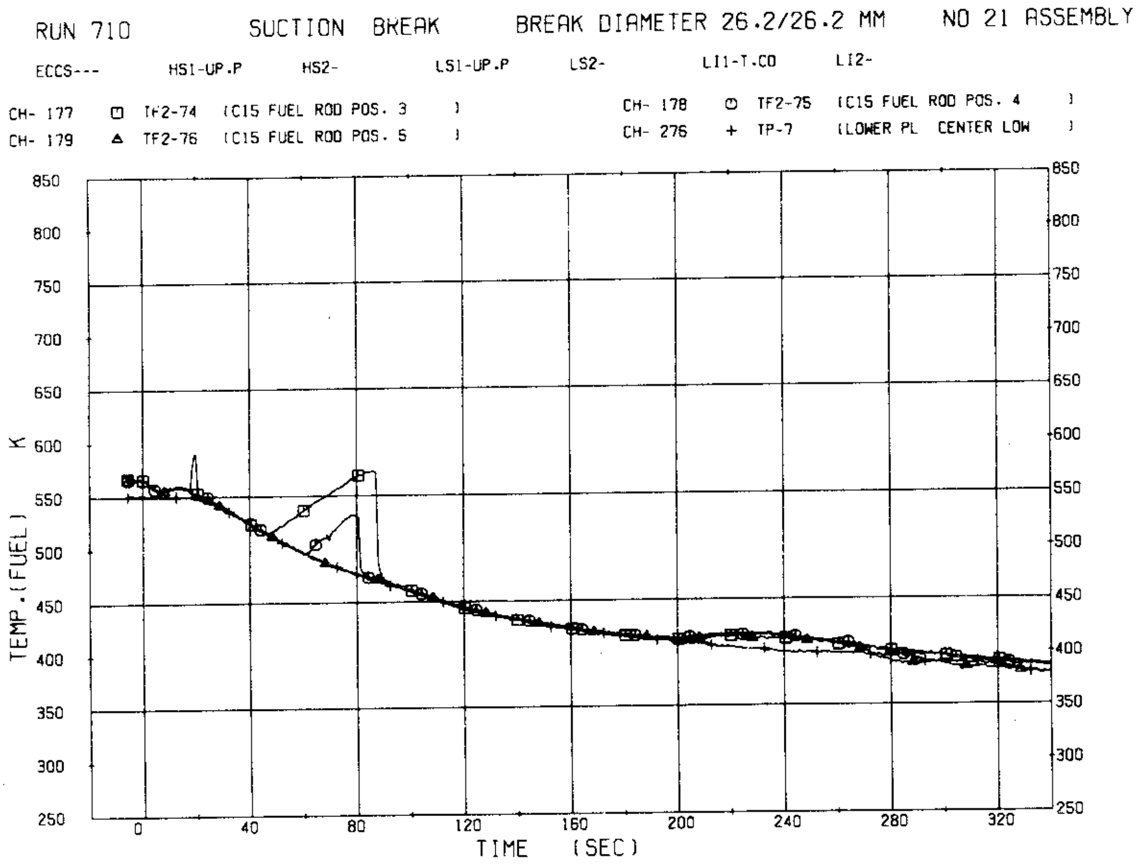


Fig. 5.106 Fuel rod surface temperatures, C15

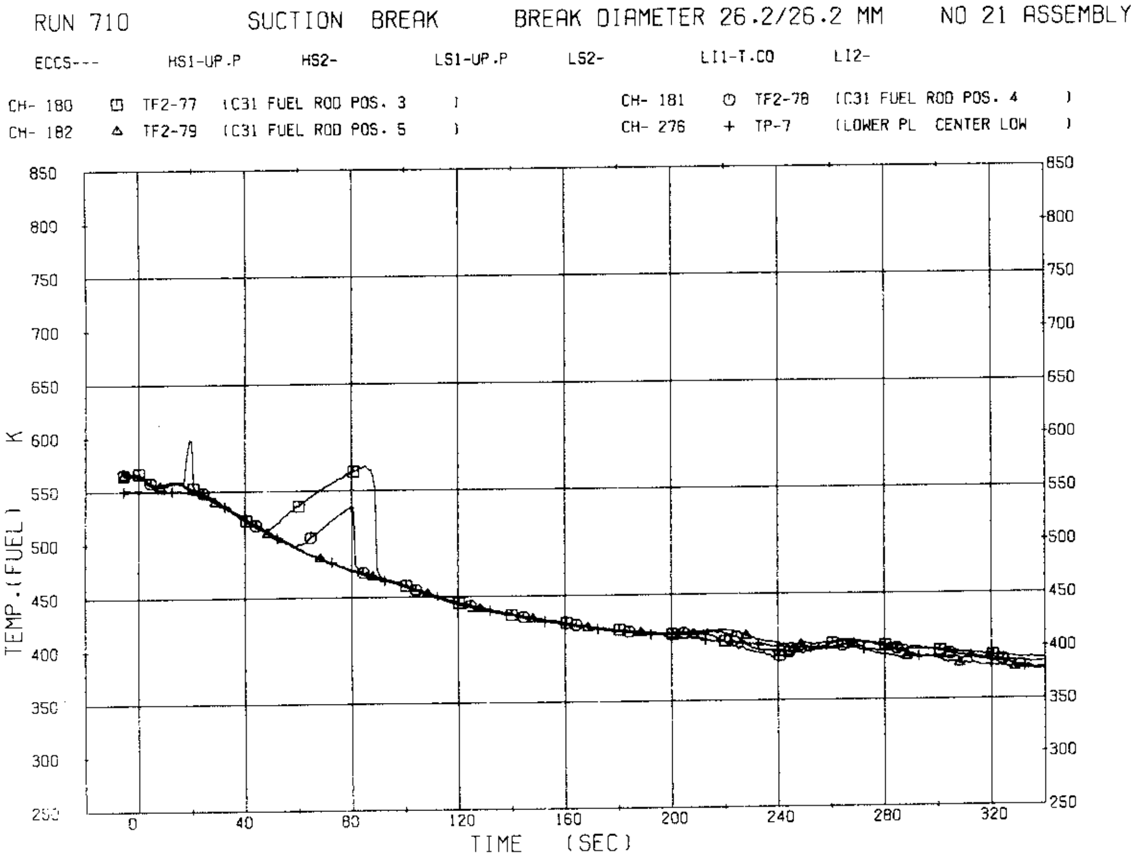


Fig. 5.107 Fuel rod surface temperatures, C31

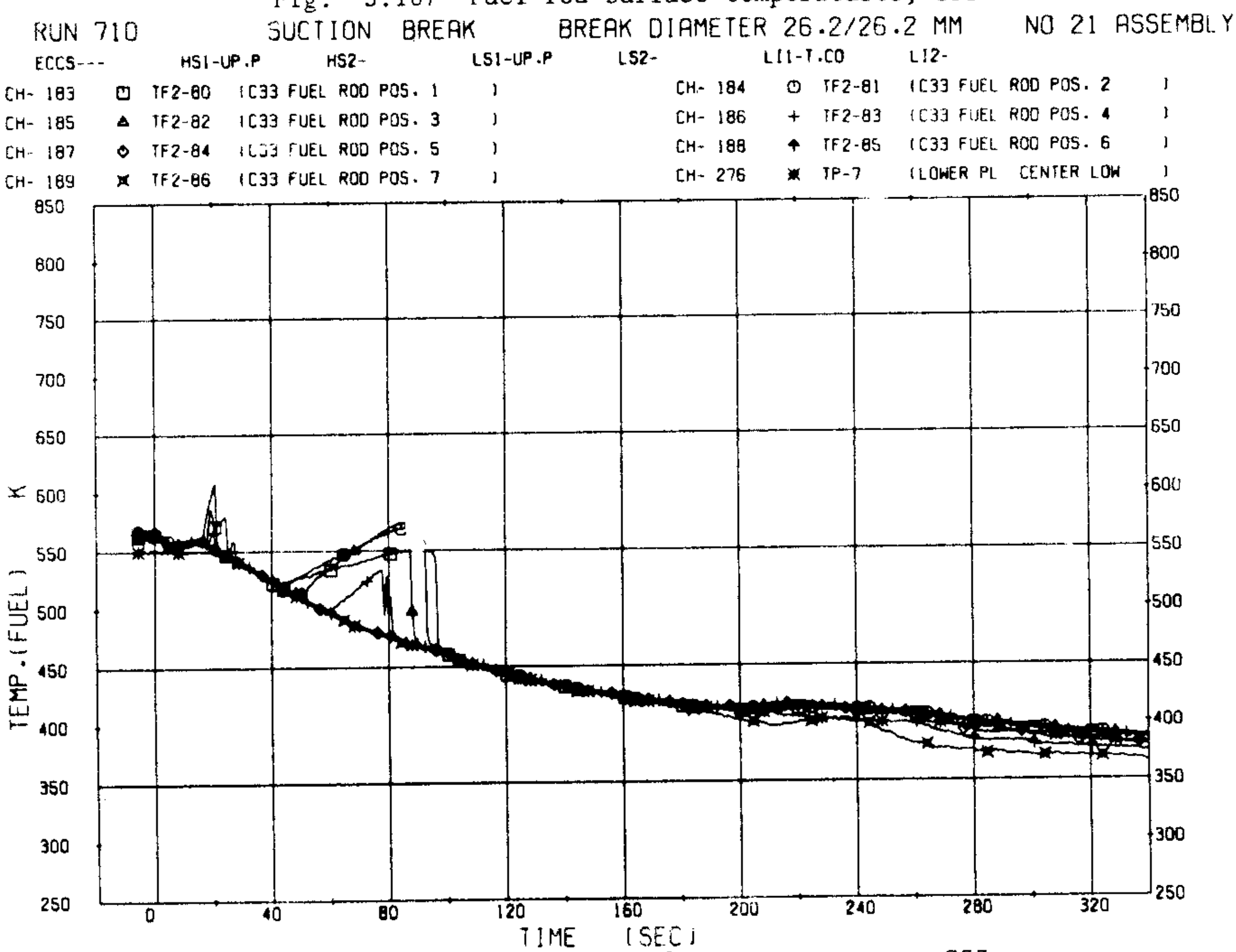


Fig. 5.108 Fuel rod surface temperatures, C33

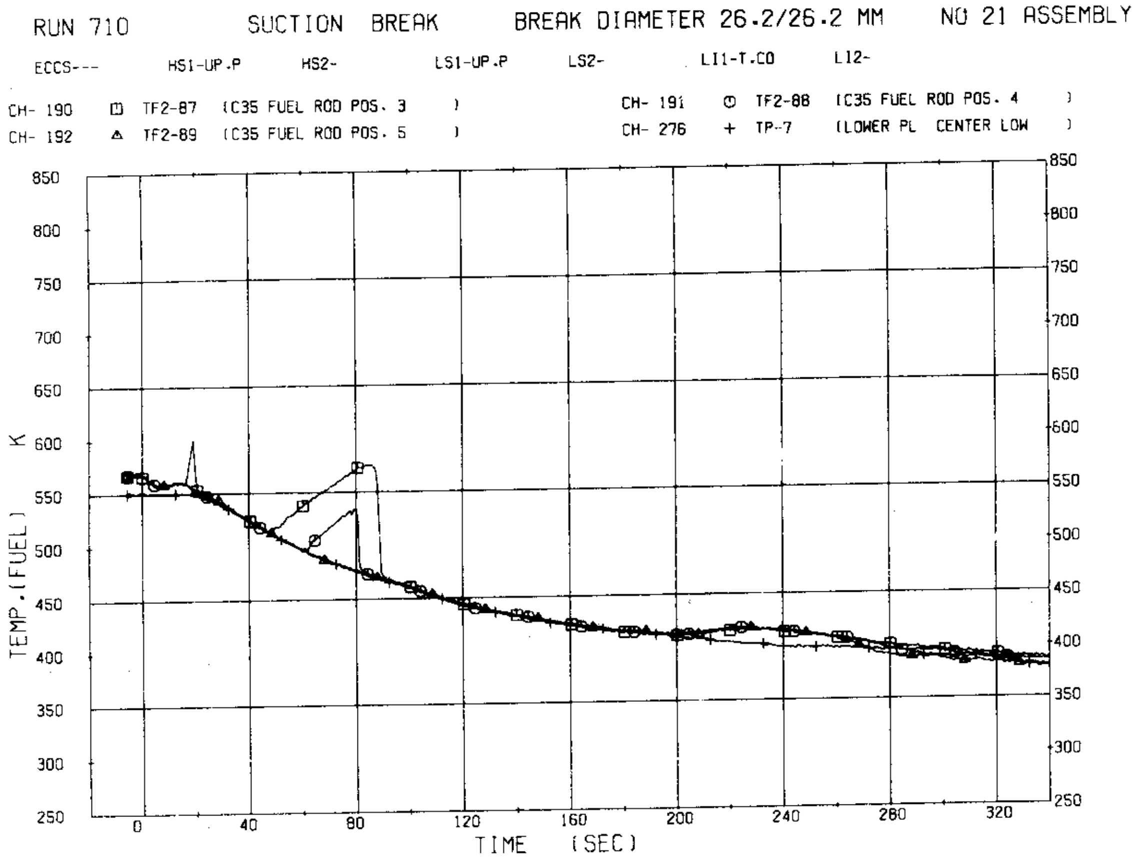


Fig. 5.109 Fuel rod surface temperatures, C35

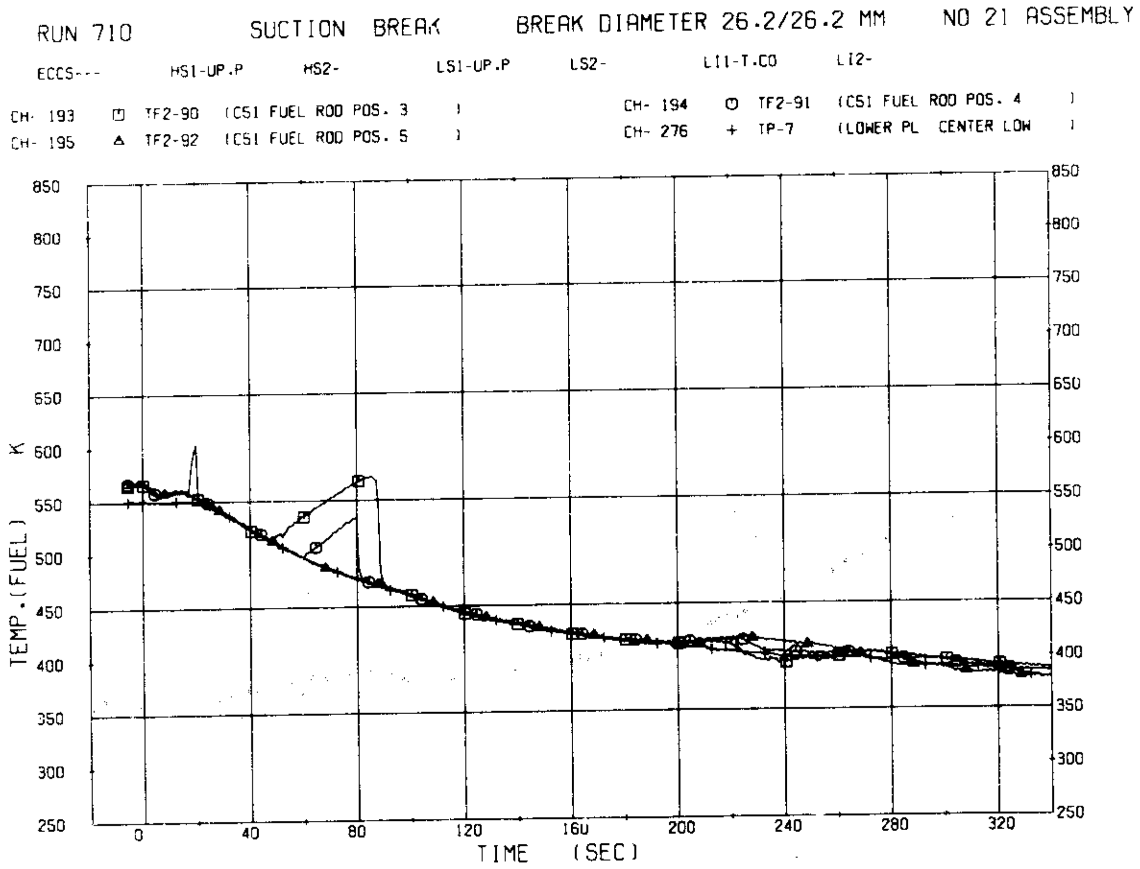


Fig. 5.110 Fuel rod surface temperatures, C51

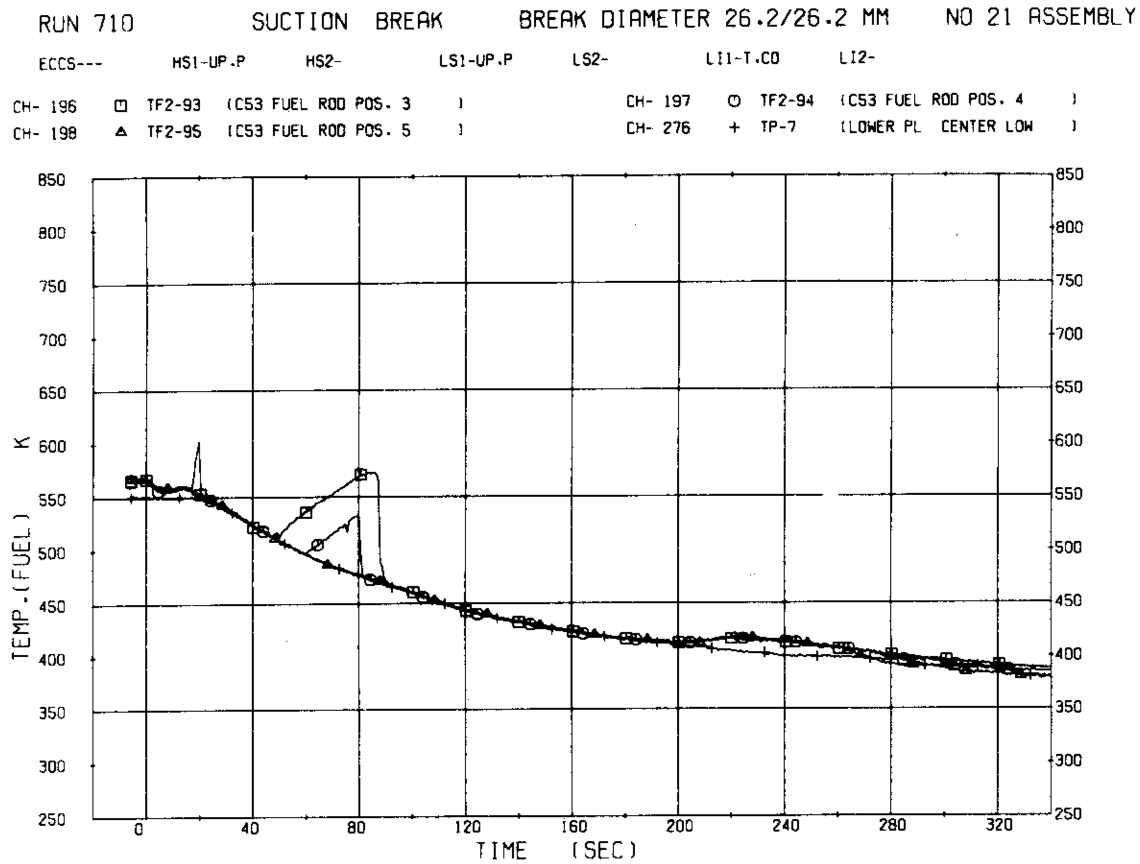


Fig. 5.111 Fuel rod surface temperatures, C53

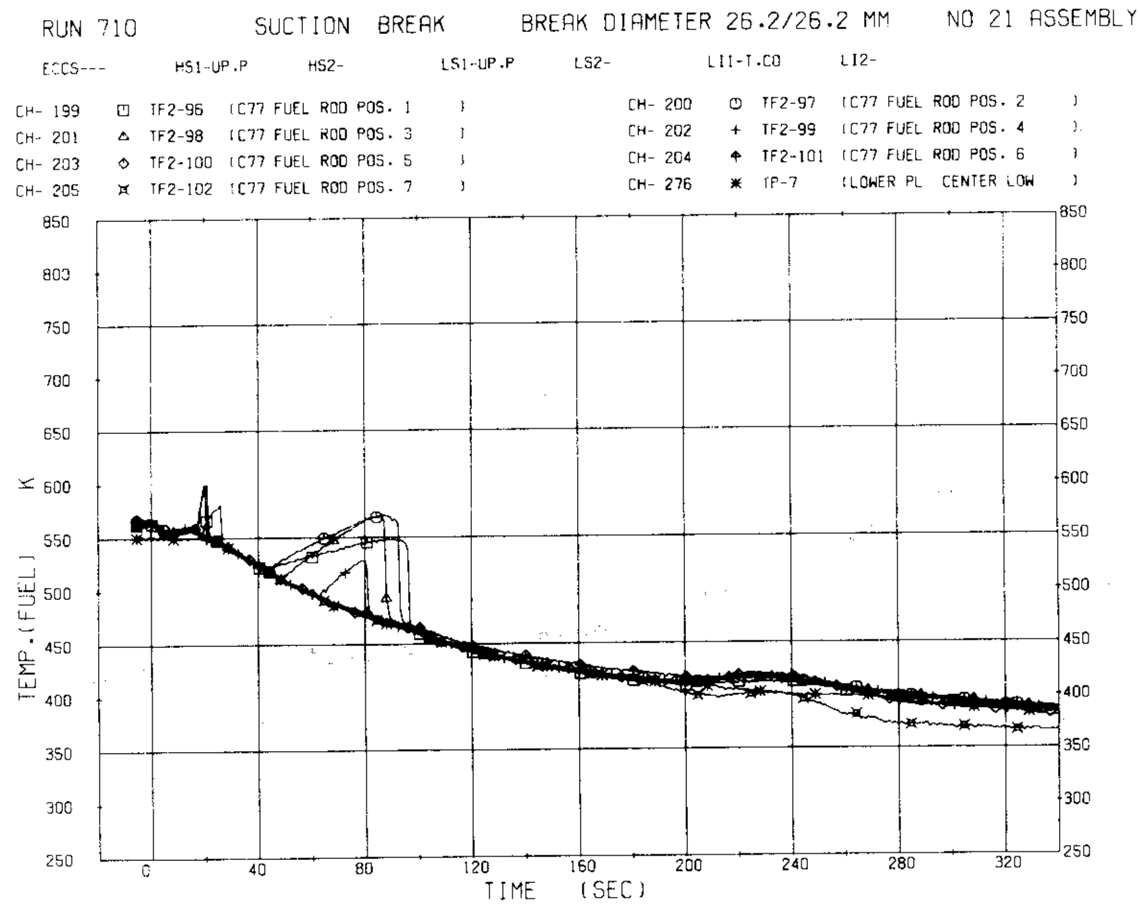


Fig. 5.112 Fuel rod surface temperatures, C77

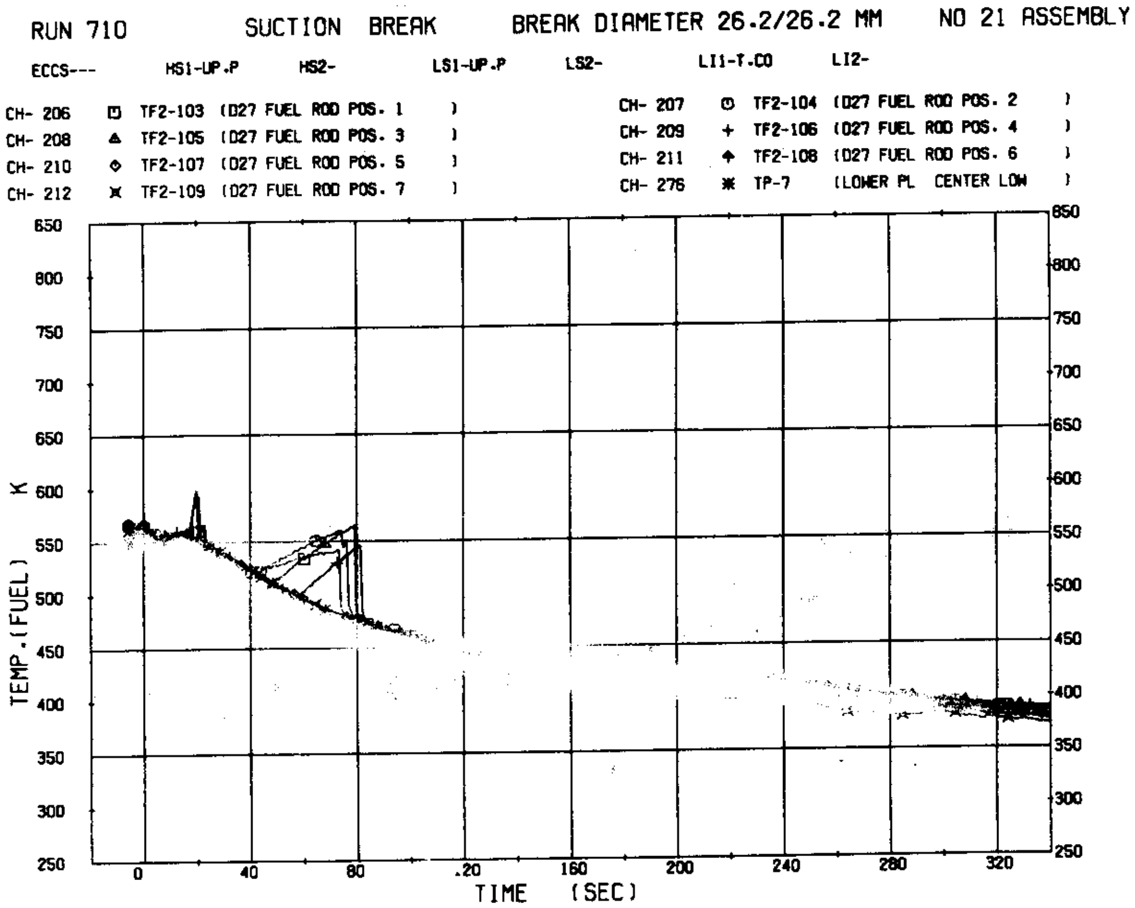


Fig. 5.113 Fuel rod surface temperatures, D27

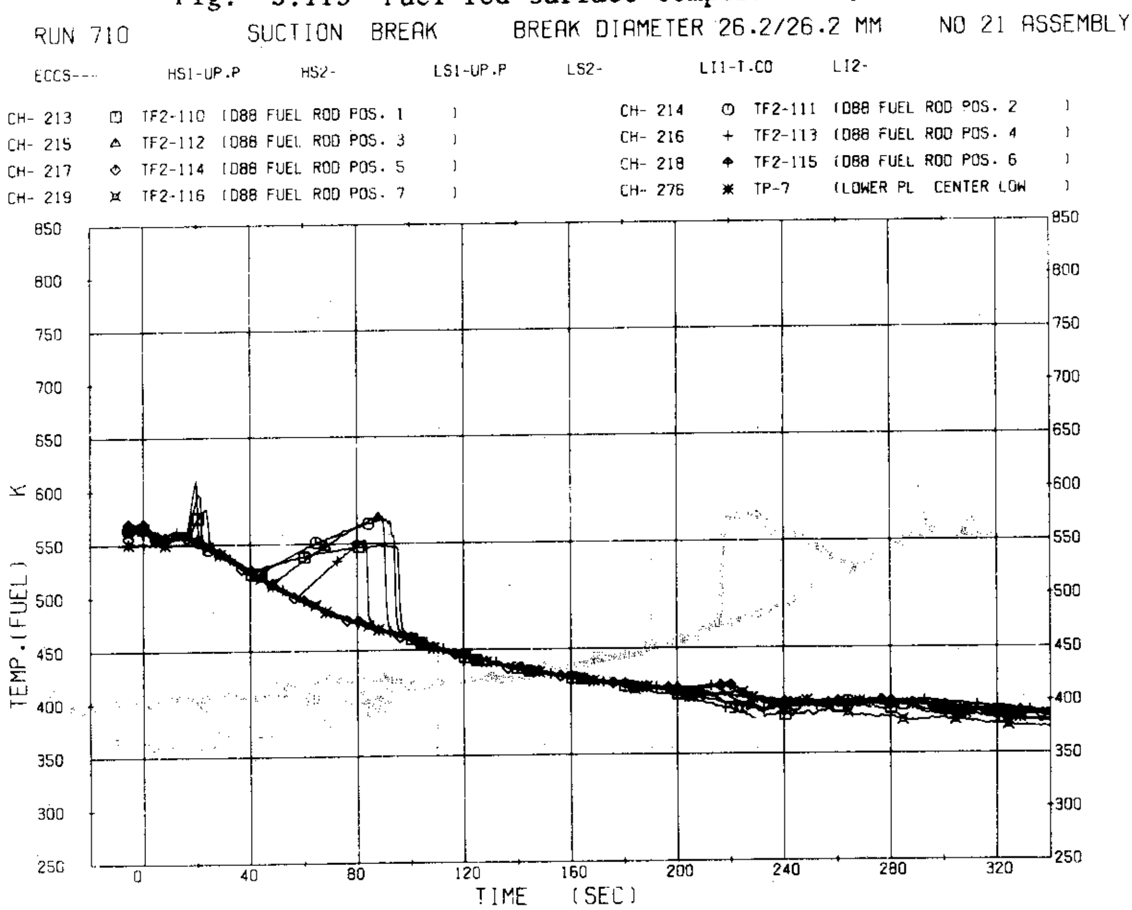


Fig. 5.114 Fuel rod surface temperatures, D88

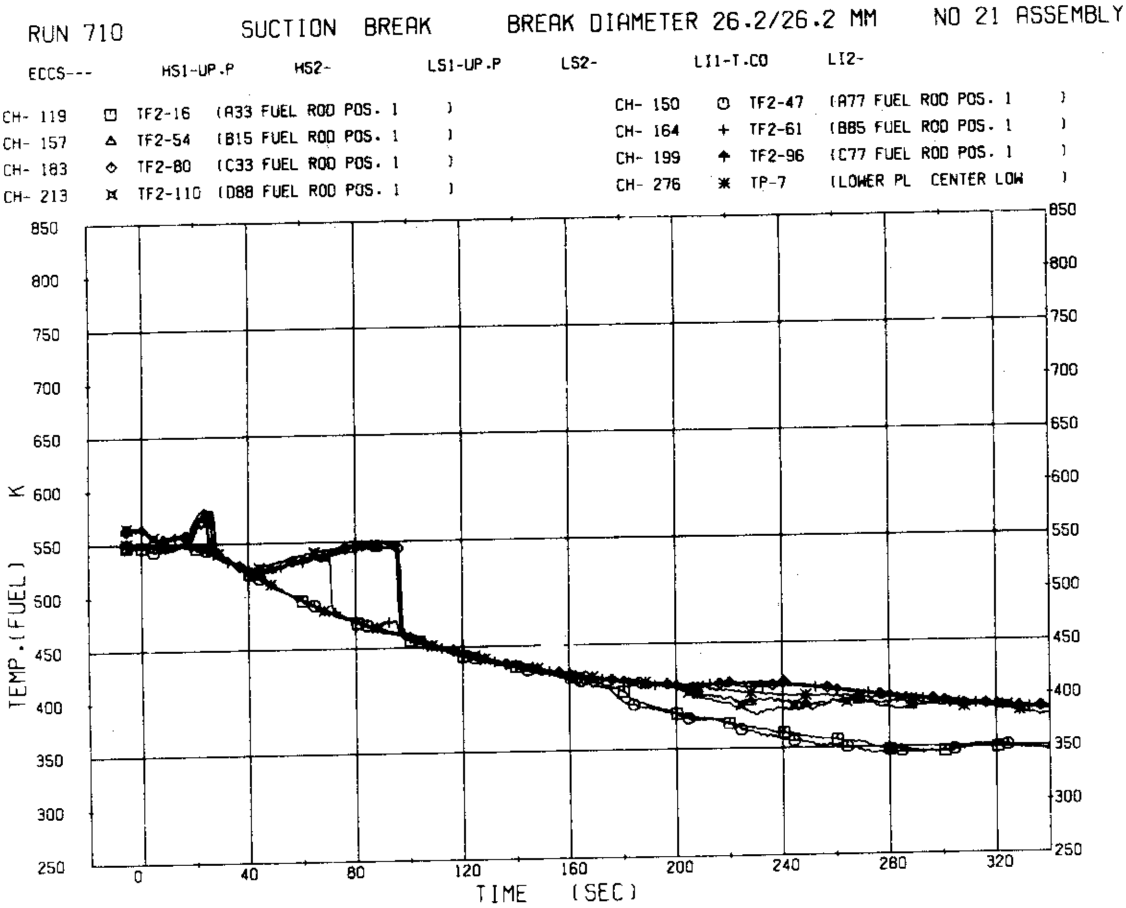


Fig. 5.115 Fuel rod surface temperatures at position 1 in Channel A, B, C and D

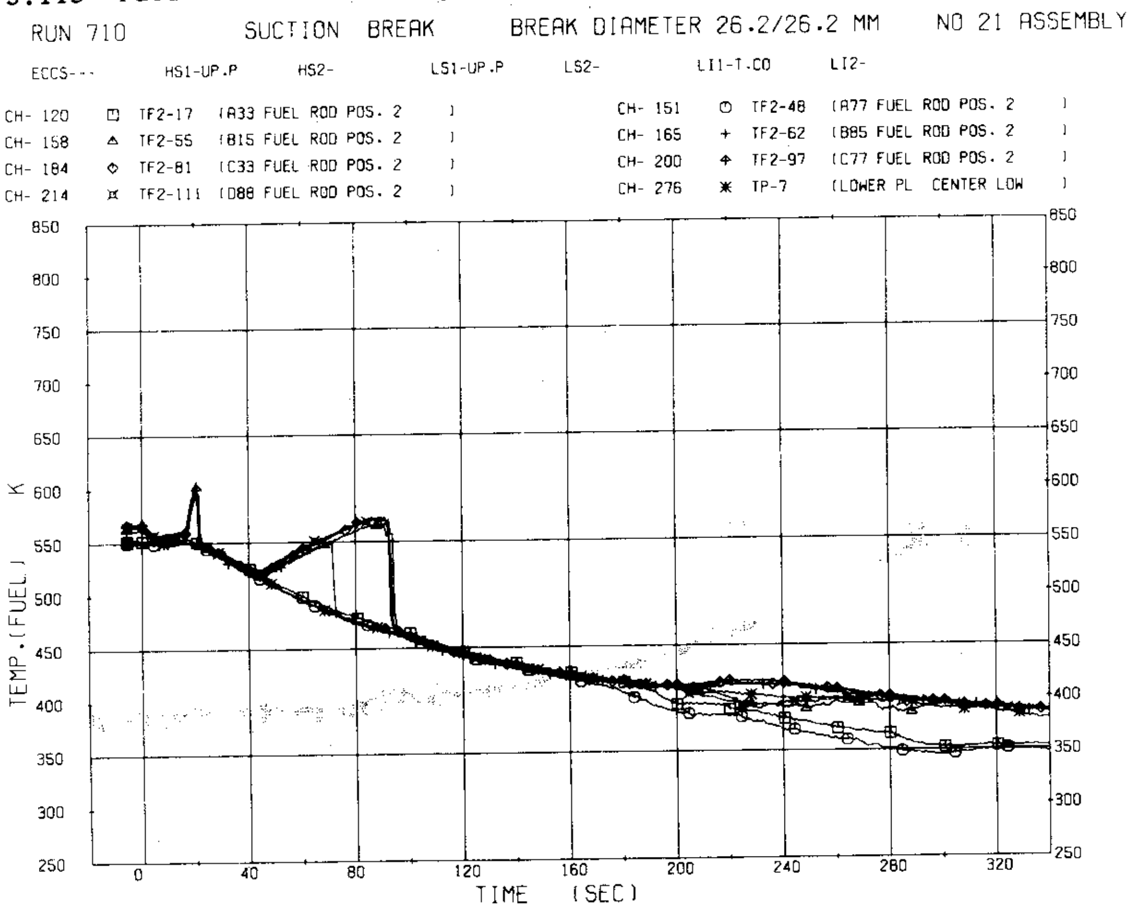


Fig. 5.116 Fuel rod surface temperatures at position 2 in Channel A, B, C and D

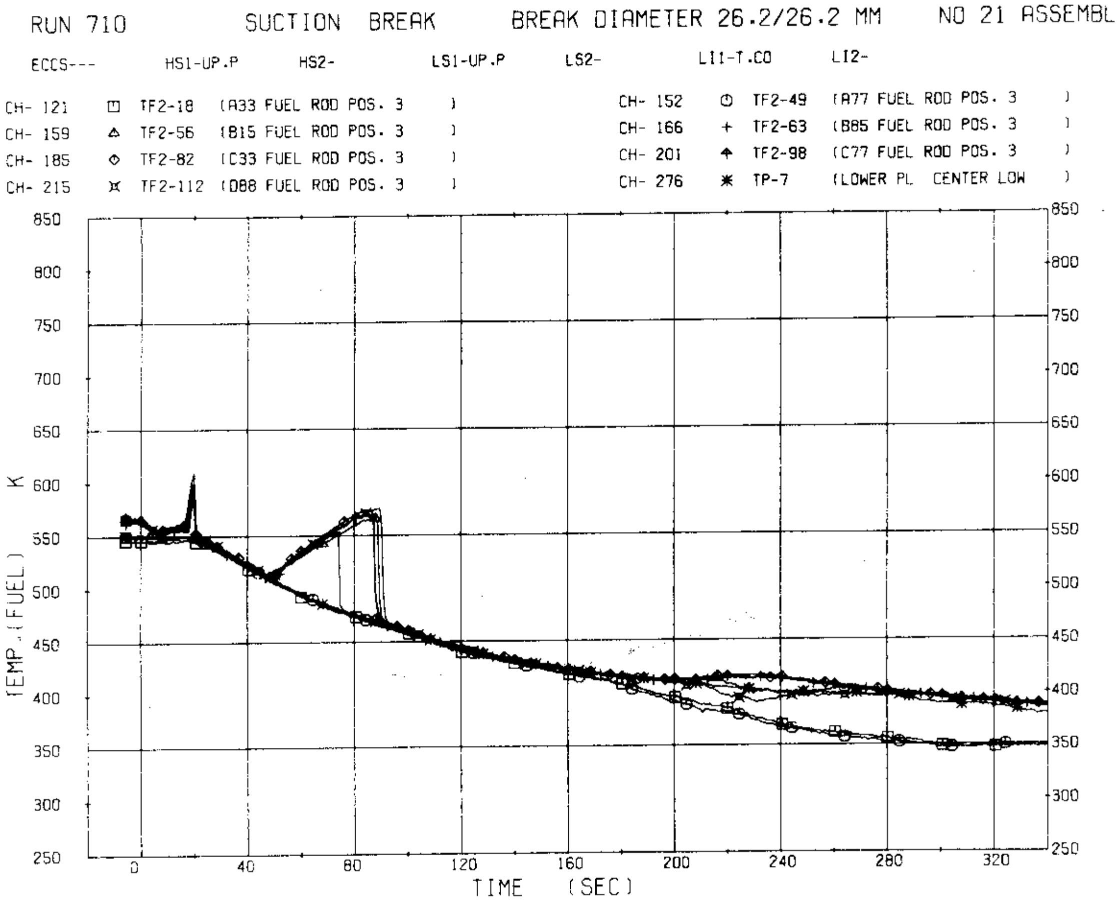


Fig. 5.117 Fuel rod surface temperatures at position 3 in Channel A, B, C and D

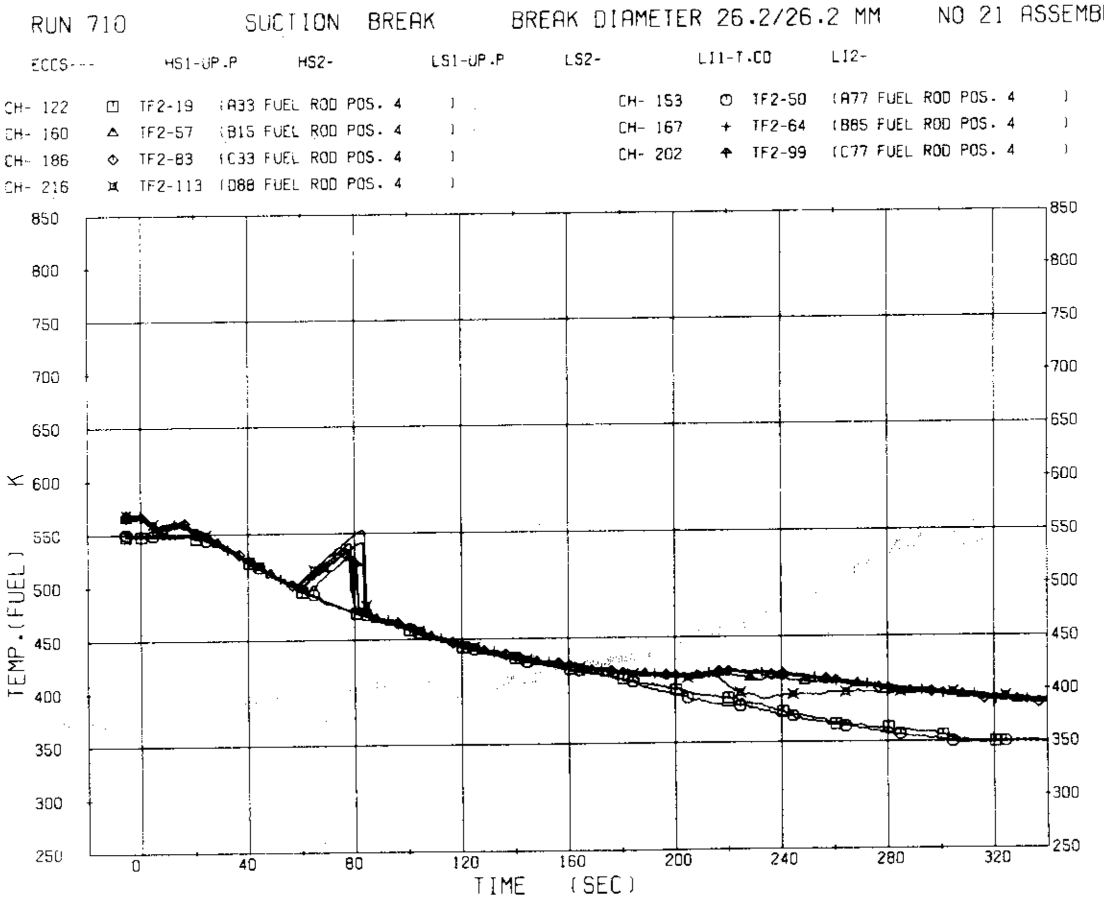


Fig. 5.118 Fuel rod surface temperatures at position 4 in Channel A, B, C and D

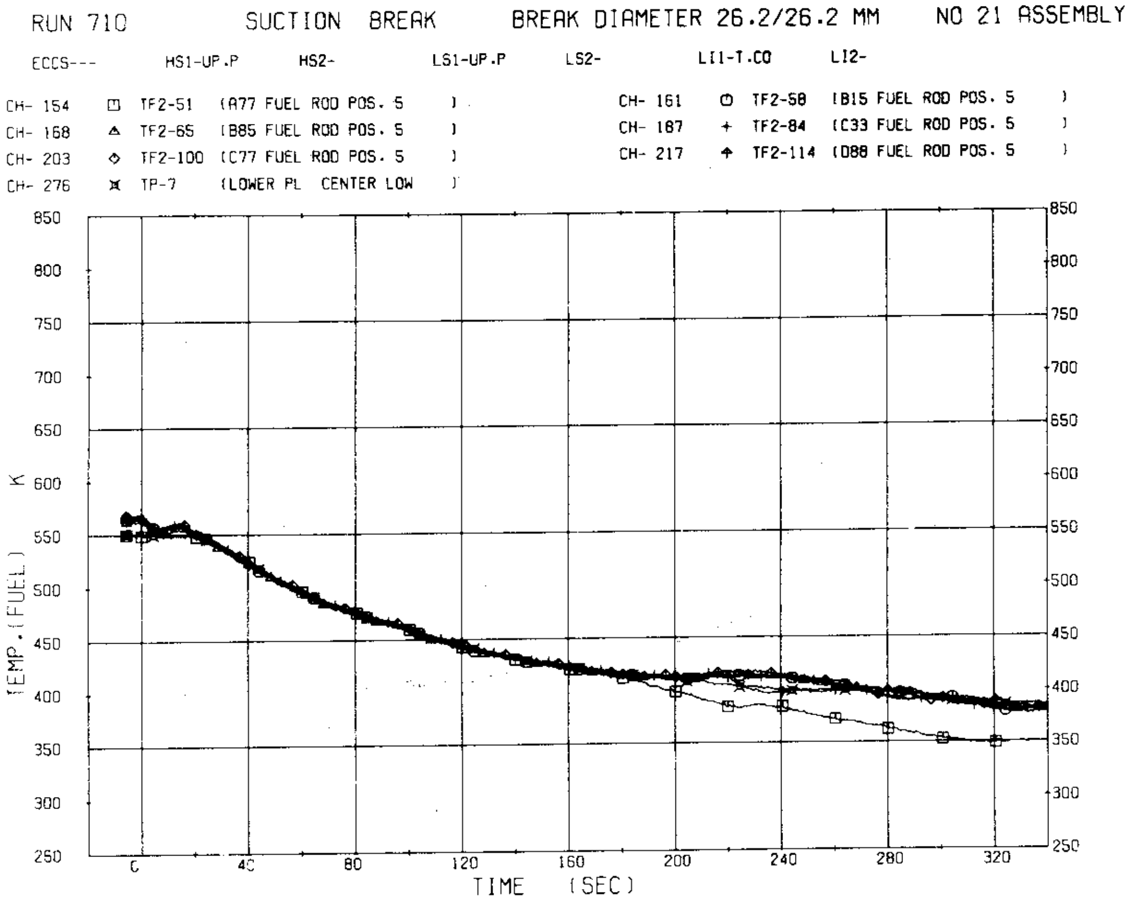


Fig. 5.119 Fuel rod surface temperatures at position 5 in Channel A, B, C and D

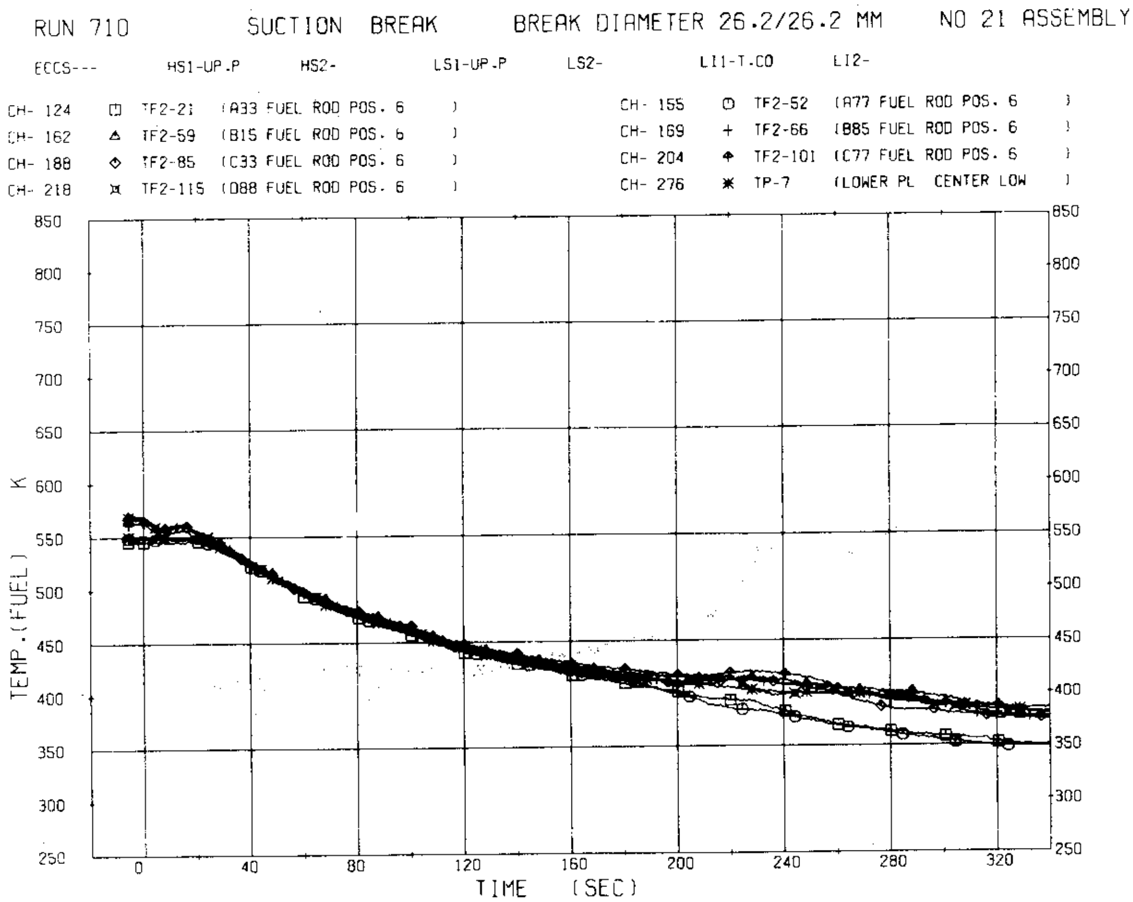


Fig. 5.120 Fuel rod surface temperatures at position 6 in Channel A, B, C and D

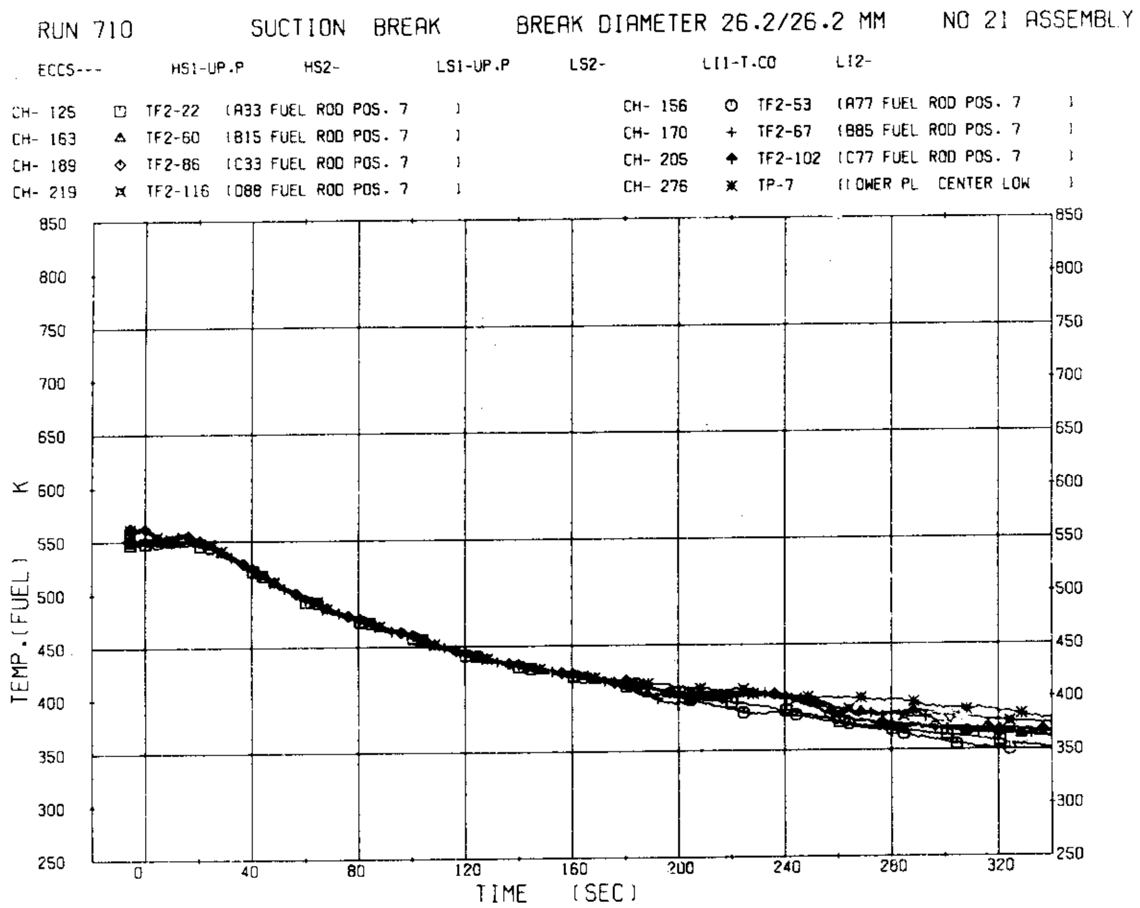


Fig. 5.121 Fuel rod surface temperatures at position 7 in Channel A, B, C and D

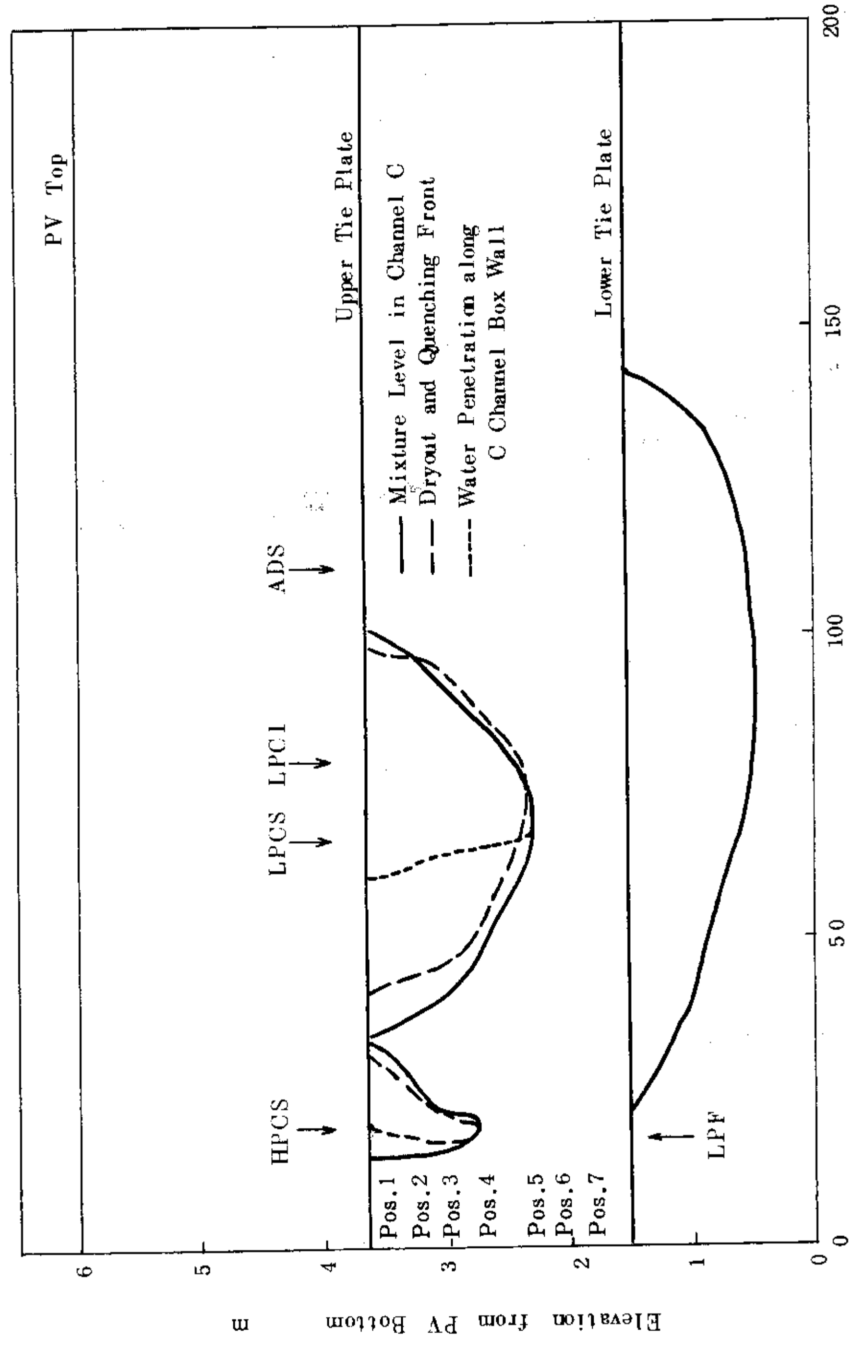


Fig. 5.122 Mixture Level in Core and Lower Plenum and Heater Rod Surface Codition