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RELAP5/MOD.2 Post Test Analysis and Accuracy Quantification of Lobi Test BL-34

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ABSTRACT

The present document deals with the Relap5/Mod3.2 analysis of the small break LOCA experiment BL-34 performed in LOBI/MOD2 facility.

LOBI/MOD2 was a PWR simulator (Integral Test Facility) installed at JRC (Joint Research Center) in Ispra Establishment (I). Volume scaling and core power scaling factors are 1/712, with respect to the KWU Siemens 1300 MWe (3900 MWt) standard reactor.

The experiment is originated by a small break in the cold leg (2" equivalent break area in the plant) without the actuation of the high pressure injection system. Low pressure injection system actuation occurs after core dry-out and accumulators intervention is foreseen when primary pressure falls below 4 MPa.

The Relap5 code has been extensively used at University of Pisa; the nodalization of LOBI facility has been qualified through the application of the version Relap5/Mod2 to the same experiment and another test performed in the same facility.

Sensitivity analyses have been addressed to the influence of several parameters (like discharge break coefficient, time of accumulators start etc.) upon the predicted transient evolution.

Qualitative and quantitative code calculation accuracy evaluation has been performed.

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1. INTRODUCTION

The performance assessment and validation of large thermalhydraulic codes and the accuracy evaluation when calculating the safety margins of Light Water Reactors are among the objectives of international research programs, such those organized by the committee on the Safety of Nuclear Installations (CSNI) and the Code Application and Maintenance Program (CAMP).

Solution of these problems would ensure the effectiveness of engineered safety features and, eventually, lead to cost reductions through better design. This activities could also contribute to the determination of a uniform basis on which to assess the consequences of reactor system failures in Nuclear Power Plants, refs. [1] and [2].

The execution of the experiments in Integral Test Facilities simulating the behavior of a nuclear plant, plays an important role in this connection, both considering the system code assessment and the possibilities to identify and characterize the relevant phenomena during off-normal conditions.

A special kind of experiments are the so called counterpart tests. These are similar experiments performed in differently scaled facilities. It is well clear that transient scenarios measured in the experimental rigs can not be directly extrapolated to the plant conditions. Nevertheless one of the objectives of a counterpart test is to evaluate the influence of the geometric dimension of the loop upon the evolution of a given accident.

Counterpart tests have been performed in four PWR simulators: LOBI, SPES, BETHSY and LSTF, ref. [3], respectively available at the European Community Joint Research Center of Ispra (I), at SIET in Piacenza (I), at CENG in Grenoble (F) and at JAERI in Tokai-Mura (J). The selected experiment is a small break LOCA originated by a rupture in the cold leg, without actuation of high pressure injection system and with accumulators availability, in particular, starting from low power conditions (about 10% of the nominal period). Both tests have been performed in the smallest facilities, SPES and LOBI, starting from full power conditions, all other conditions being the same.

The activity documented in this report is a part of a multipurpose research aiming at the overall evaluation and exploitation of the counterpart test database. On one hand the Relap5 system code (Mod2 and, presently, Mod3.2) has been applied to the post test analysis of the four experiments and to the evaluation of plant scenario during the same transient; on the other hand the experimental data base have been evaluated to demonstrate the similarity in the behavior of the facilities, ref. [3]. The two parts of the research have been merged and conclusions have been drawn in relation to the scaling of phenomena and of the accuracy of thermalhydraulic code calculations.

Previous reports dealt with the evaluation of the experimental data base constituted by the four counterpart experiments (ref. [4]) and with the qualification of Relap5/Mod2 nodalization used for the post test analyses, ref. [5], as well as with a complete evaluation of the data base leading to the evaluation of uncertainties (e.g. ref. [6]).

The present document deals with the post test analysis performed by Relap5/Mod3.2 of the small break LOCA counterpart test carried out in LOBI/MOD2 facility (BL-34), ref. [7].

The purpose of this report is to evaluate the performance of the Relap5/Mod3.2 in comparison with the previous application with the version Mod2. In order to achieve this, a systematic qualitative and quantitative accuracy evaluation has been performed. The quantitative analysis has been performed adopting a method (ref. [8],) developed at DCMN, which has capabilities in quantifying the errors in code predictions related to the measured experimental signal; the Fast Fourier Transform (FFT) is used aiming to have an integral representation of the code calculation discrepancies (i.e. error between measured and calculated time trends) in the frequency domain.

2. DESCRIPTION OF THE EXPERIMENT

2.1 LOBI facility

The LOBI-MOD2 facility is a high pressure integral system test facility simulating the geometrical and operating configuration of a four-loops 1300 MWe PWR. More in particular, it reproduces the KWU PWR plant installed at Biblis (Germany).

This facility was designed, released and operated at the Joint Research Centre (JRC) of Ispra Establishment, and it was one of the largest high pressure integral systems of this kind operating in Europe.

A sketch of the primary circuit of the facility is reported in Fig. 1. It essentially consists of the following parts (refs. [9] and [10]):

- a pressure vessel containing the heated bundle consisting of 64 directly heated rods arranged in 8x8 square matrix. A cosine shaped axial power profile is obtained trough seven different thickness of the hollow cylinder simulating the rods. Nominal heating power is 5.3 MW. Four bypass flow paths are realized in the vessel region: three between upper plenum and downcomer and one between lower plenum and upper plenum. The ones between upper plenum and downcomer are obtained via gap in the connection hot leg-vessel, via "ad hoc" holes in the barrel and via the upper head, respectively;
- a small vessel simulating the upper head of the PWR vessel;
- two loops, respectively called "INTACT" loop and "BROKEN" loop, the former representing the three unbroken loops of the four-loops reference PWR plant, the latter simulating "broken" loop in which pipe ruptures of various sizes can be mounted at different locations. The two loops are equipped with equal recirculation pumps which, during steady-state, run at different velocities to achieve rightly scaled flow rates. In each loop a steam generator is containing components such as inverted U-tubes, an annular downcomer and coarse and fine steam separators modeling the geometry of the reference plant. The exchanged power in the two steam generators, at the nominal operating conditions, is of 1.32 MW (8 U-tubes) and of 3.96 MW (24 U-tubes) for the BROKEN and the INTACT loop, respectively;
- an active secondary loop system, shown in Fig. 2, containing two condensers simulating the reactor turbines, the feed water pump and the auxiliary feedwater system;
- a pressurizer and surge line connectable to either the intact or broken loop;
- emergency core cooling system equipped with active High Pressure Injection System with up to 4 HPIS injection pumps, Low Pressure Injection System and a Passive Accumulator System, with two accumulators, one in each loop.

The scaling criteria utilized in the LOBI-MOD2 facility led to the following characteristics:

- volume, primary circuit coolant mass flow and power input are scaled down from the referred reactor values, by a factor of 712;
- in order to preserve the gravitational head the absolute heights and relative elevations of the individual system components have been kept at reactor values with the exception of the pressurizer, which is shorter in order to preserve the scaling ratio and maintain, at the same time, an acceptable flow area.

The LOBI test facility was initially designed to simulate the thermalhydraulic scenario in a Pressurized Water Reactor during Large Break Loss-of Coolant Accident (LBLOCA). Subsequent modifications to the original LOBI/MOD1 facility, like a more accurate design of the secondary side of steam generators, a new reactor pressure vessel and a greater number of thermocouples installed, made LOBI/MOD2 well faced for simulation of a wide variety of Small Break LOCA (SBLOCA) and special transients experiments.

The instrumentation system of the facility allowed the measurements of the main thermalhydraulic parameters performed at the boundaries of the principal loop components and at the principal sections of the pressure vessel and the steam generators.

The main measurement locations in the facility can be classified as follows:

- Loop pipes: performed within "measurement inserts" which contain the complete instrumentation for each location. The "insert" can be "simple" or "complete". In the simple insert the measurement of fluid and wall temperatures and absolute and differential pressure are performed. The complete inserts also contain flow and density measurement devices. A distinction, in the instrumentation available in the inserts, is made between vertical and horizontal pipes: the inserts for horizontal flow are supplied with double instrumentation for temperature and flow measurement in order to show eventual stratification phenomena in the pipe section.
- Reactor pressure vessel simulator: with absolute pressure taken in the upper plenum. Differential pressure measurements are provided over all the main sections along the flow path of the pressure vessel. Mass flow information is provided by flow and density measurements in the core inlet box. A second density measurement indicates voiding of the lower plenum. Fluid and wall temperatures are measured in the more representative locations in the vessel.
- Heater rod bundle: each heater rod is supplied with three thermocouples in the tube wall.
- Steam generators: measurements are provided of fluid temperatures, U-tubes wall temperatures and differential pressure on the primary and secondary side.
- Pressurizer: fluid temperatures and pressure are measured and the surge line flow is obtained by a full flow turbine. Differential pressure is measured over the surge line and over the height of the pressurizer to monitor the filling level.

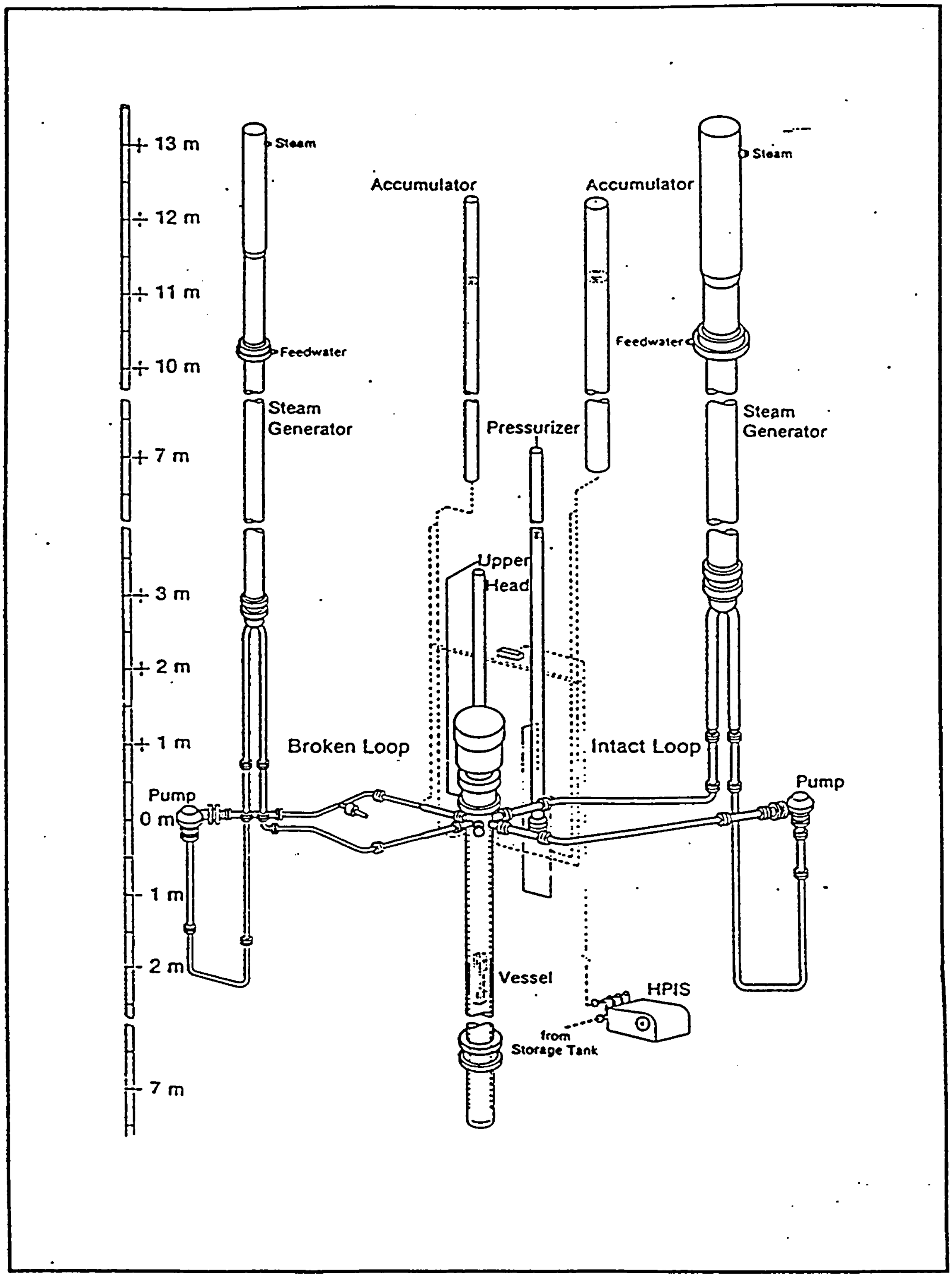

Fig. 1: LOBI/MOD2 facility - primary circuit

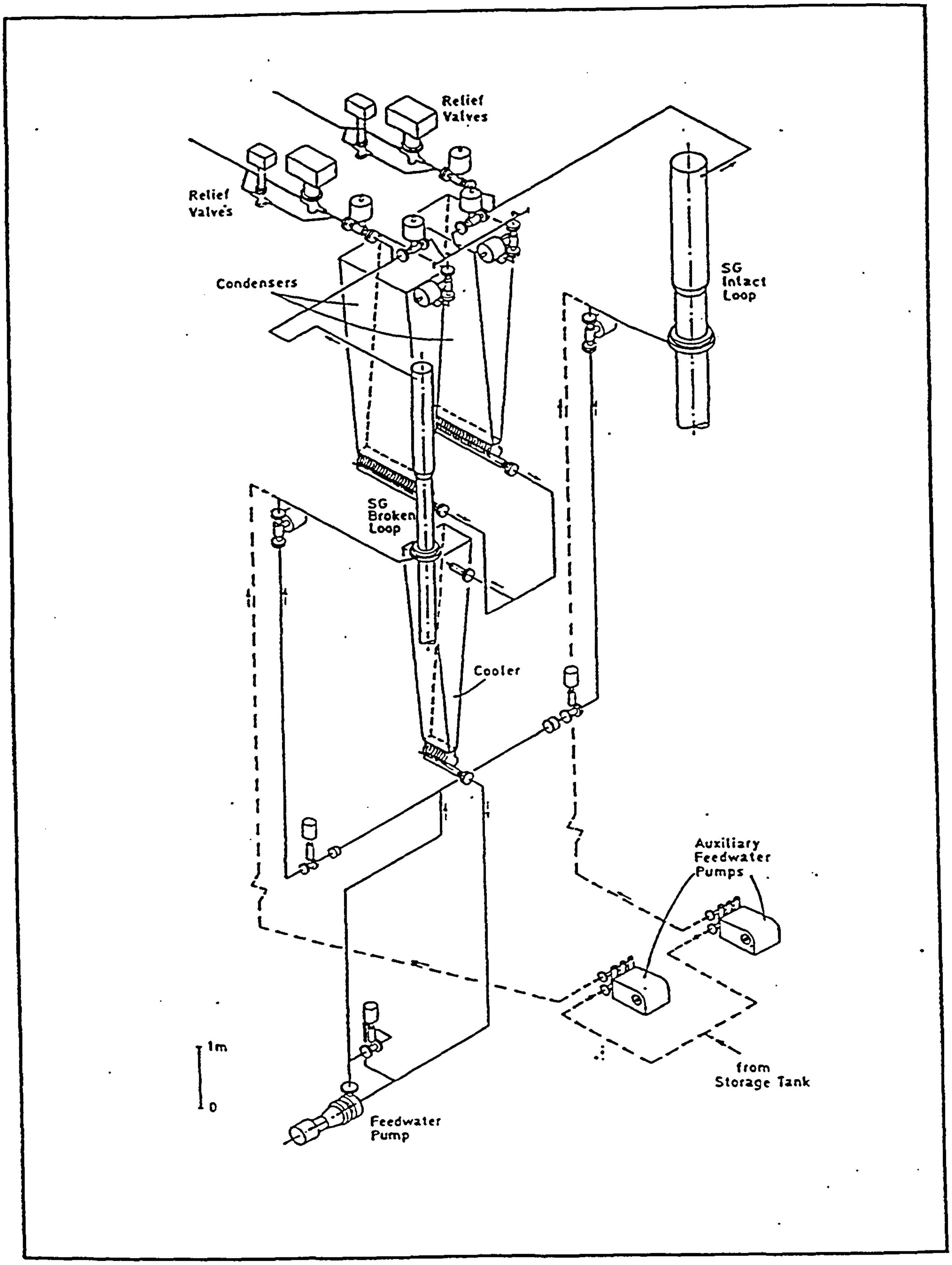

Fig. 2: LOBI/MOD2 facility - secondary circuit

2.2 Test BL-34

The experiment BL-34 is a Small Break LOCA originated by a rupture in the cold leg, without high pressure injection system but with accumulators active and low pressure injection system intervention. It is a low power test, about 12 % of the nominal power.

Few relevant initial conditions, in comparison with the high power test BL-44 and with the other counterpart tests, are reported in Tab. 1. The transient setpoints imposed and the resulting sequence of events for LOBI BL-34 test are reported in Tabs. 2 and 3. The transient scenario can be derived from Figs. 3 and 4.

The accident can be subdivided into four main periods from a phenomenological point of view:

a) subcooled blowdown and first core dryout rewet (time from 0 to 180 s);
b) saturated blowdown and primary to secondary side pressure decoupling (from 180 s up to accumulators emptying);
c) mass depletion in the primary loop (from accumulators emptying to the final core dryout);
d) intervention of low pressure injection system that quenches the core.

Phase a). Following the break the primary system pressure is subject to an initial fast decrease (0.1 MPa/s) up to the achievement of saturation conditions upstream the break; this occurs at about 80 s into the transient. The sharp initial pressure decrease lead to scram, main coolant pump trip and isolation of steam generators in the first 10 s of the transient. Pressurizer emptying occurs in about 20 seconds. During the phase a), U-tubes draining occurs in primary side (at about 90 s)for the loss of natural circulation between core and downcomer through the steam generators: at this time the saturation temperature in the primary loop is still few degrees higher than saturation temperature in the secondary side.

The stop in natural circulation, essentially due to voiding and mass depletion in the upper zones of the loop, causes manometer type situation in the primary loop piping: the steam produced in the core partly flows directly in the break through the bypass and partly pushes down the level in the core, to balance the liquid level present in loop seals. In this situation core dryout occurs at about 135 s. The rod temperature excursion ends when loop seals clearing starts (at about 160 s in the broken loop). Quench does not occur simultaneously to the broken loop seal clearing at level 10 in the axial position of the bundle, while at level 11 and 12 occurs simultaneously to the intact loop seal clearing.

It could be underlined that, when the loop seals occur, the following situation is present:

a) being some tubes still in two phase circulation or slowly emptying, they can still have water in both sides;
b) some tubes must have just steam because, if all of them had been in two phase flow, there would not have been level decrease in the descending side and thus loop seal clearing;
c) the outlet plenum is empty;
d) the loop seal (SG side) is voided at least up to the upper part of the horizontal loop seal pipe, to allow steam passing through the pump side loop seal.

After the loop seal clearing of both loops occurs, sufficient liquid mass is present in the core to cool the rods. Following the above events (especially broken loop seal clearing) a large amount of steam is present upstream the break and an important break flow rate decrease takes place.

Phase b). Continuous core boil off and primary-to-secondary side pressure decoupling characterize the first part of phase b). The core boil off (produced steam flows almost entirely to the break) causes a second dryout at about 360 s at a pressure higher than the accumulators pressure (4 MPa); liquid level hold up in the broken loop seal occurs, starting from about 200 s, somewhat limiting steam flow to the break. Probably the reverse speed of the pump (at -28 rpm during the whole transient) contributes to the formation of liquid hold up in the broken loop seal, pump side. In this period the heat transfer from secondary side to primary side is quite small compared with core power, because the high void fraction in the U-tubes. The accumulators intervention at 420 s causes the recovery of liquid level in the core and a second rewet that is completed at about 550 s. The isolation of accumulators occurs at about 950 s: in the period from 420 to 950 s the primary system mass increases, because the liquid flow rate delivered by accumulators is larger than the break flow rate.

Phase c). The stop of accumulators injection (t = 953 s) causes another mass depletion period, leading to the third dryout at about 1700 s into the transient, when the primary pressure was around 1 MPa. No other significant event occurs in this period, excluding the core level depression. When the rods surface temperature reaches 773 K, the low pressure injection system is actuated (2100 s) in the intact loop cold leg.

Phase d).The LPIS flow rate (0.4 kg/s) is quite effective in causing the third core quench and in recovering the facility. The quench front velocity is larger than 0.02 m/s and, at about 2200 s, the core is completely recovered. Core refill occurs in this period. The test was terminated at 2400 s, with pressure around 0.4 MPa.

	unit	Lobi BL-34	Lobi BL-44	Spes SP-SB-03	Spes SP-SB-04	Bethsy 6.2TC	Lstf SB-CL-21
core power	kW	630	5280	768	5600	2863	7930
pressurizer pressure	MPa	15.47	15.46	15.06	15.16	15.38	15.4
hot leg temperature	K	589	589	586	589	587	590
average core ΔT	K	27.5	35	28.6	31	31	31
core inlet mass flow rate	kg/s	3.6	28	4.21	31.8	19.5	48.4
bypass DC-UH mass flowrate / core mass flowrate	%	0.83	0.11	0.81	0.97	0.72	0.52
steam generator secondary side pressure	MPa	il 6.94 bl 6.91	il 5.12 bl 5.11	6.94 6.87 6.88	6.7	6.86 6.84 6.84	7
steam generator downcomer level	m	il 8.14 bl 4.48	il 8.14 bl 4.48	11.5	11.5	11.2 11.1 11.1	11.24 11.23
pressurizer level	m	5	5.1	3.23	3.77	7.45	1.7
feedwater mass flow rate	kg/s	il 0.19 bl 0.06	il 1.95 bl 0.75	0.095 0.093 0.0965	3.4	0.561	2.2 2.3
feed water temperature	K	il 415 bl 409	-	473.6 437.8 440.1	523	523	523

Tab. 1: Relevant initial and boundary conditions for Lobi test BL-34 in comparison with the other counterpart tests.

EVENT	TIME AND/OR SET POINT VALUES
Break opening	0. s
SCRAM signal	PRZ pressure < 13 MPa
Pumps coastdown initiation	PRZ pressure < 13 MPa
Feed water closure	PRZ pressure < 13 MPa
Accumulators start	PRZ pressure < 4.0 MPa
Accumulators stop	0.09 m^3 (low water volume signal)
LPIS intervention	max. rod temperature > 773 K
End of transient	PRZ pressure < 0.7 MPa or ad hoc signal

Tab. 2: Imposed sequence of trips for LOBI test BL-34 (specified).

	LOBI BL-34
Break opening	0
Scram power curve enabled	0.5
Start of main coolant pumps coast down	IL 1.1 BL 1.1
Main steam line valve closure	-
Feedwater valve closure	IL 2.7 BL 2.4
Upper plenum in saturation condition	7
Pressurizer emptied	23
Break two phase flow	120
First dryout	135
Loop seal clearing	IL 180 BL 160
Occurrence of minimum primary side mass	420 2100
Primary-secondary pressure reversal	164
Second dryout	362
Rewetting due to accumulators	550
Accumulators injection start	420
Accumulators injection stop	953
Final dryout	1705
LPIS start	2100
Final rewetting	2150
End of test	2400

Tab. 3 - LOBI BL-34 experiment: resulting sequence of main events.

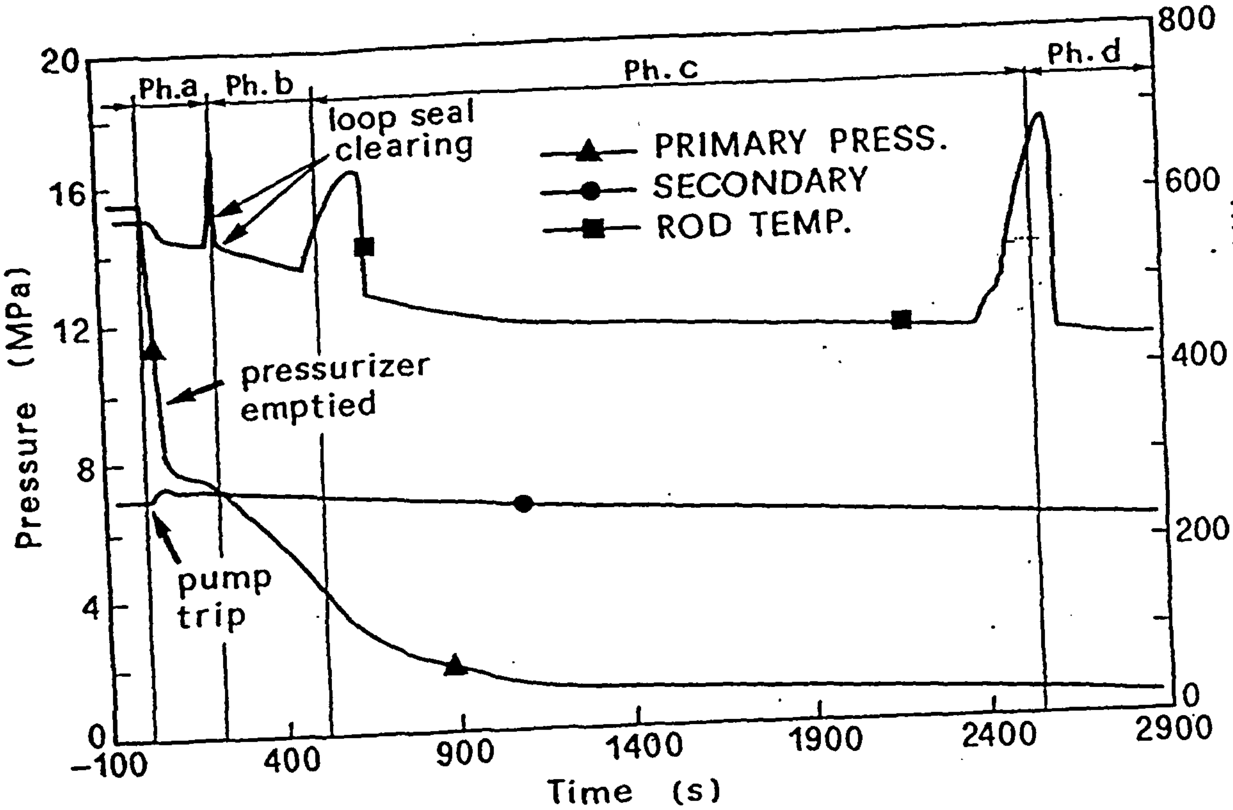

Fig. 3: BL-34 test - measured trends of primary pressure, secondary pressure and rod surface temperature

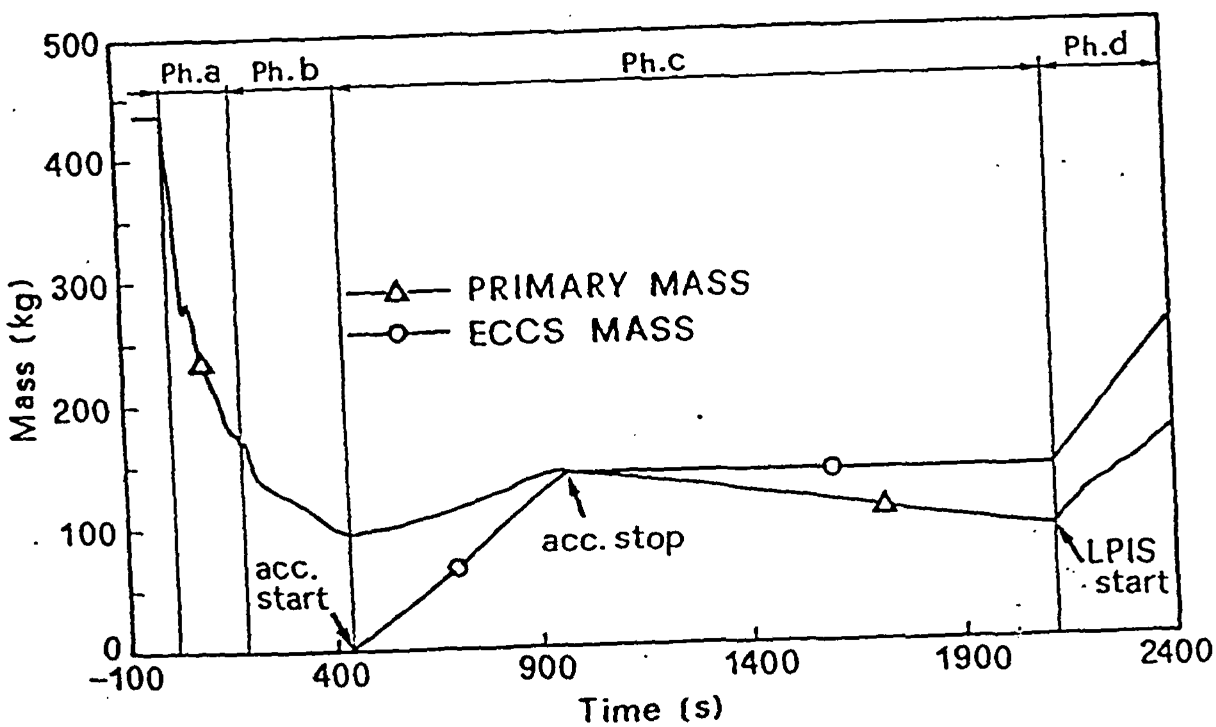

Fig. 4 : BL-34 test - measured trends of primary mass and of ECC delivered mass

3. ADOPTED CODE AND NODALIZATION

3.1 Relap5/Mod3.2 code

The light water reactor transient analysis code, RELAP5, was developed at the Idaho National Engineering Laboratory (INEL) for the U.S. Nuclear Regulatory Commission (NRC). Specific applications of the code have included simulations of transients in LWR system such as loss of coolant, anticipated transients without Scram (ATWS) and operational transients, such as loss of feed water, loss of offsite power, station blackout and turbine trip.

The Mod3 version of RELAP5 has been still developed by the INEL, but a consortium consisted of several countries and domestic Organizations that were members of the International Code Assessment and Application Program (ICAP) and its successor organization, Code Application and Maintenance Program (CAMP), contributed to the development and the validation process.

RELAP5/Mod3.2 code, refs. [11] and [12], is based on a non-homogeneous, non-equilibrium set of six partial derivative balance equations for the steam and the liquid phase. A non-condensable component in the steam phase and a non-volatile component (boron) in the liquid phase can be treated by the code. A fast, partially implicit numeric scheme is used to solve the equations inside control volumes connected by junctions.

In particular, the control volume has a direction associated with it that is positive from the inlet to the outlet. The fluid scalar properties, such as pressure, energy, density and void fraction, are represented by the average fluid condition and are viewed as being located at the control volume center. The fluid vector properties, i.e. velocities, are located at the junctions and are associated with mass and energy flow between control volumes. Control volumes are connected in series using junctions to represents flow paths.

Heat flow paths are also modeled in a one-dimensional sense, using a staggered mesh to calculate temperatures and heat flux vectors. The heat structure is thermally connected to the hydrodynamic control volumes through heat flux that is calculated using a boiling heat transfer formulation. The heat structures are used to simulate pipe walls, heater elements, nuclear fuel pills and heat exchanger surfaces.

Several new models, improvements to existing models and user conveniences have been added. The new models include:

- the Bankoff counter-current flow limiting correlation;
- the ECCMIX component for modeling of the mixing of the subcooled emergency core cooling system liquid and resulting interfacial condensation;
- a zirconium-water reaction model to model the exothermic energy production on the surface of zirconium cladding material at high temperature;
- a surface to surface radiation heat transfer model with multiple radiation enclosures defined through user input;
- a thermal stratification model.

3.2 General criteria adopted for the code models

A detailed nodalization reproducing each geometrical zone of the loop has been developed: in principle it is suitable for different types of transients.

The general methodology followed is described in refs. [12] and [13]. Being used, in this case, the Relap5/Mod3 code, great care is given to the information contained in the specific user manual.

Nevertheless, it should be noted that this information alone is generally not exhaustive for the development of an adequate set of input data. So, few supplementary criteria, to those reported in the manual, have been fixed, as result of experience, in the attempt to set up a "homogeneous" nodalization, that is to avoid imbalance in the distribution of hydraulic and thermal meshes. Of course, the achievement of this objective, requires a good user knowledge of the reference facility characteristics. Moreover, the prevision of the phenomena to be simulated in the calculation can also have a role in this context. Compromises apply in the choice of number of nodes: on the one hand there is the need to develop a model adherent to the geometric and material particularities of the physical system, on the other hand computer capabilities (essentially CPU time) limit the maximum number of nodes.

Two limits have been fixed for the linear dimension of nodes: all the volumes should have their flow lengths comprised between 0.5 and 1.0 m (with the exception of core stack, much more detailed, of the descending zone of the SG U-tubes and of the pressurizer and accumulator surge lines, nodalized by 2.0 m length nodes). With regard to conduction heat transfer, the distance between neighboring mesh points inside structures must be less than 5 mm in each case, up to the lower limit of few tenths of mm used for heated rods and steam generator U-tubes. In the subdivision of volumes and slabs the position of instrumentation has been considered.

The following choices have been made with regard to code options:

- thermodynamic non-equilibrium is allowed in all control volumes;
- the smooth area change for all the junctions where it is allowed (i.e. excluding the motor valves);
- the stratification option is used in the junctions of the hot legs and cold legs horizontal parts.

3.3 LOBI/MOD2 nodalization description

The LOBI/MOD2 nodalization is shown in Fig. 5. The correspondence between the zones of the facility and the nodes of the code model are exposed in Tab. 4. In this table the facility is divided in general zones, composed by single components, reported in the table according to flow paths in nominal conditions. The number and the type of the hydraulic nodes, corresponding at each single component of the facility, are indicated in the table itself.

Hereafter some significant aspects of the nodalization development are summarized.

Primary system model

The vessel model consists of 29 hydraulic components which are connected through 48 junctions.

The heat structures utilized in the RPV model are made up of 47 heat slabs, distinguished in:

- 13 active structures for the heaters;
- 30 heat slabs for the vessel wall;
- 4 internal non-active structures.

In the vessel model all the bypass flow paths, reported in the facility description, have been modeled:

- bypass from downcomer top to upper plenum via holes simulated by junctions 430-02 (bypass flow rate equal to 0.35 kg/s);
- bypass from downcomer top to upper plenum via gap in the connections with the hot legs simulated by junctions 500-03 and 700-03 (bypass area strictly dependent by thermal expansion of the structures, thus the bypass flow rate valuable, with a large uncertainty band, roughly equal to 1 kg/s):
- bypass from downcomer top to upper head simulated by node 440-01 with bypass flow rate roughly equating to 0.3 kg/s.

Both the broken and the intact loop represent with geometrical fidelity the real hydraulic configuration of the experimental facility. Notwithstanding this, the degree of detail is properly increased in the BL, where are localized, in transient conditions, the most important thermalhydraulic phenomena.

Intact and broken loop are so simulated:

- 53 nodes and 54 junctions for the IL;
- 55 nodes and 57 junctions for the BL.

The accumulators are schematized in both loops and are connected to the respective cold legs.

The localized pressure drops, due to the "locked rotor resistance simulator" is introduced in the loop by the *motor valve* 747 component.

The *time dependent volumes* 742, 603 and 602, connected with the primary system through the *time dependent junctions* 744, 601 and 604 respectively, simulate the pump cooling system. Each system is realized with cold water injection in the pump and consequent water draining from the lower plenum.

Two additional systems can be noted in the pressurizer nodalization:

- a *time dependent volume* and related valve (components 541 and 542);
- a *time dependent junction* and related *time dependent volume (*components 531 and 534).

Both are control systems. The former system allows the primary side pressure to remain constant in a steady-state period. The latter system maintains at an assigned value the liquid level inside the pressurizer. The temperature of the fluid possibly injected by this system corresponds to the saturation conditions inside the pressurizer. A check has been made to verify that the flow rates and the energy exchanged between this system and the primary circuit are well below the reference flow rate and energy values of the primary side. Finally the black structures inside the pressurizer model represents the internal heaters.

Secondary system

The secondary side nodalizations of the two steam generators are very similar, both concerning the hardware of the facility and the control systems (23 nodes, 23 junctions and 45 heat slabs).

Four zones can be recognized in each steam generator:

1) the downcomer, consisting of a single stack of nodes that simulates a multitubular geometry;
2) the riser zone, essentially including the U-tubes;
3) the top of the vessel, including the separator, the dryer and the steam dome regions;
4) the steam line downstream the dome of each SG is simulated with a *time dependent volume* (829 for IL and 929 for BL) connected to the dome by a *time dependent junction* (828 for IL and 928 for BL).

The degree of detail of the nodalization is commensurate to what considered in the primary loop. In particular, the heights of the riser volumes are the same as the minimum between the heights of the rising and the descending corresponding nodes of the primary side U-tubes.

The components 815-01 for IL and 915 for BL simulates the separators in the secondary sides that are necessary in the code model in order to achieve quality equal to 1 in the steam domes.

A relatively large number of control volumes are connected with the steam generators; the following functions are accomplished:

- feed water injection: *time dependent volumes* 832 (IL) and 932 (BL); *time dependent junctions* 833 (IL) and 933 (BL);
- AFW injection: *time dependent volumes* 836 (IL) and 936 (BL); *time dependent junctions* 837 (IL) and 937 (BL);
- safety system: *time dependent volumes* 826 (IL) and 926 (BL), simulating the safety tanks; *trip valves* 825 (IL) and 925 (BL), simulating the safety valves;
- components 824-01 and 823, for IL, and 924-01 and 923, for BL, simulate the control system that assures constant pressure during a steady state period.

The geometrical features of the piping and system connected with SGs are not simulated (e.g. feed water lines, pre-heaters, steam lines - including condenser - etc.), because this is not relevant for the prediction of the transients of interest.

The utilized code resources for the LOBI/MOD2 nodalization are summarized in Tab. 5. In particular, the number of hydraulic components and of the heat structures are here reported.

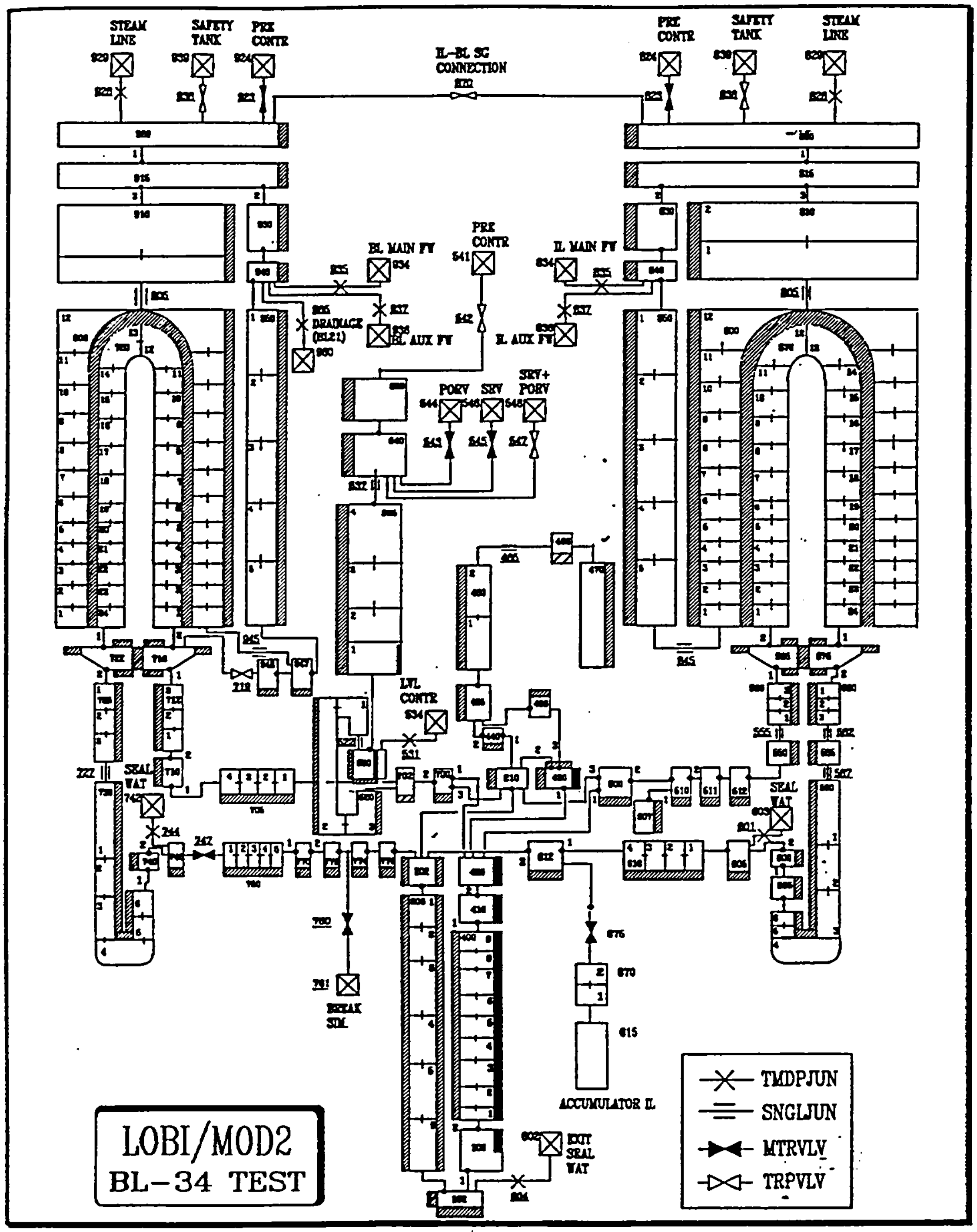

Fig. 5: Relap5/Mod3 nodalization of LOBI/MOD2 facility

GENERAL ZONE	NAME	NUMBER	TYPE
PRESSURE VESSEL	DOWNCOMER REGION	200	PIPE
		202	BRANCH
		210	BRANCH
	LOWER PLENUM	102	BRANCH
	CORE REGION	106	PIPE
		400	BRANCH
		410	BRANCH
		420	BRANCH
		430	BRANCH
	UPPER HEAD	440	BRANCH
		450	BRANCH
		455	BRANCH
		460	PIPE
		465	SNGLJUN
		466	BRANCH
		470	SNGLVOL
INTACT LOOP	VESSEL NOZZLE	500	BRANCH
	HOT LEG	507	BRANCH
		510	BRANCH
		511	BRANCH
		512	BRANCH
		550	SNGLVOL
		555	SNGLJUN
		560	PIPE
	SG INLET PLENUM	565	BRANCH
	U-TUBES	570	PIPE
	SG OUTLET PLENUM	575	BRANCH
	LOOP SEAL	580	PIPE
		582	SNGLJUN
		585	SNGLVOL
		587	SNGLJUN
		590	PIPE
		595	BRANCH
	PUMP	600	PUMP
	COLD LEG VESSEL NOZZLE	605	BRANCH
		610	PIPE
		612	BRANCH
BROKEN LOOP	VESSEL NOZZLE	700	BRANCH
	HOT LEG	702	BRANCH
		705	PIPE
		710	BRANCH
		712	PIPE
	SG INLET PLENUM	718	BRANCH
	U-TUBES	720	PIPE
	SG OUTLET PLENUM	722	BRANCH

Tab. 4 (part 1): Relap5/Mod3.2 nodalization - correspondence between code nodes and hydraulic zones

GENERAL ZONE	NAME	NUMBER	TYPE
	LOOP SEAL	725	PIPE
		727	SNGLJUN
		730	PIPE
	PUMP	740	PUMP
	COLD LEG	745	BRANCH
		747	MTRVLV
		750	PIPE
		770	BRANCH
		772	BRANCH
		774	BRANCH
		776	BRANCH
PRESSURIZER	SURGE LINE	520	PIPE
		532	SNGLJUN
	PRESSURIZER VESSEL	530	BRANCH
		535	PIPE
		537	SNGLJUN
		539	BRANCH
		540	BRANCH
	PORV VALVE	543	TRPVLV
	PORV TANK	544	TMDPVOL
	PORV AD VALVE	545	TRPVLV
	PORV TANK	546	TMDPVOL
SECONDARY SIDE INTACT LOOP	FEEDWATER TANK	832	TMDPVOL
	FEEDWATER JUNCTION	833	TMDPJUN
	AUX. FW. TANK	836	TMDPVOL
	AUX. FW. JUNCTION	837	TMDPJUN
	DOWNCOMER	830	BRANCH
		840	BRANCH
		850	PIPE
		845	SNGLJUN
	RISER	800	ANNULUS
		805	SNGLJUN
		810	PIPE
	SEPARATORS	815	SEPARATOR
	STEAM DOME	820	BRANCH
	STEAM LINE JUN.	828	TMDPJUN
	STEAM LINE TANK	829	TMDPVOL
	SG DIS TANK	826	TMDPVOL
	SG DIS JUNCTION	825	TMDPJUN
SECONDARY SIDE BROKEN LOOP	FEEDWATER TANK	932	TMDPVOL
	FEEDWATER JUNCTION	933	TMDPJUN
	AUX. FW. TANK	936	TMDPVOL
	AUX. FW. JUNCTION	937	TMDPJUN
	DOWNCOMER	930	BRANCH
		940	BRANCH

Tab. 4 (part 2): Relap5/Mod3.2 nodalization - correspondence between code nodes and hydraulic zones

GENERAL ZONE	NAME	NUMBER	TYPE
SECONDARY SIDE BROKEN LOOP		950	PIPE
		945	SNGLJUN
	RISER	900	ANNULUS
		905	SNGLJUN
		910	PIPE
	SEPARATORS	915	SEPARATOR
	STEAM DOME	920	BRANCH
	STEAM LINE JUN.	928	TMDPJUN
	STEAM LINE TANK	929	TMDPVOL
	SG DIS TANK	926	TMDPVOL
	SG DIS JUNCTION	925	TMDPJUN
ACCUMULATOR	INTACT LOOP ACC.	615	ACCUM
	ACC. SURGE LINE	670	PIPE
	CONNECTION VALVE	675	MTRVLV
CONTROL COMPONENTS	PRZ CONTROL PRESSURE	541	TMDPVOL
		542	TRPVLV
	PRZ CONTROL LEVEL	534	TMDPVOL
		531	TMDPJUN
	SG BL CONTROL PRESSURE	924	TMDPVOL
		923	MTRVLV
	SG IL CONTROL PRESSURE	824	TMDPVOL
		823	MTRVLV
	SG BL CONTROL LEVEL	934	TMDPVOL
		935	TMDPJUN
	SG IL CONTROL LEVEL	834	TMDPVOL
		835	TMDPJUN
BREAK	BREAK VOLUME	761	TMDPVOL
	BREAK VALVE	760	MTRVLV
LPIS	LPIS TANK	630	TMDPVOL
	LPIS JUNCTION	625	TMDPJUN
PUMP SEAL WATER	EXIT SEAL WATER	602	TMDPVOL
		604	TMDPJUN
	IL PUMP SEAL WATER	603	TMDPVOL
		601	TMDPJUN
	BL PUMP SEAL WATER	742	TMDPVOL
		744	TMDPJUN
IL-BL SF CONNECTION		870	TRPVLV

Tab. 4 (part 3): Relap5/Mod3.2 nodalization - correspondence between code nodes and hydraulic zones

PARAMETER	VALUE
1. NUMBER OF NODES	
– primary side	158
– secondary side	58
– total	216
2. NUMBER OF JUNCTIONS	
– primary side	162
– secondary side	59
– total	221
3. NUMBER OF SLABS	
– primary side	171
– secondary side	76
– total	247
4. OVERALL NUMBER OF MESH POINTS	1841
5. NUMBER OF CORE ACTIVE STRUCTURES	13
6. HEAT TRANSFER AREA (m^2)	
– core region	14.495
– steam generator U-tubes	32.344
7. NUMBER OF MESH POINTS	
– core slabs	205
– stem generator slabs	336
8. BYPASS FLOW PATHS	
LOWER PLENUM - UPPER PLENUM	
– area (m^2)	$4.266 \cdot 10^{-3}$
– total energy loss coefficient [ΣK_i (forward)/ΣK_i (reverse)]	$6.19 \cdot 10^3/6.19 \cdot 10^3$
DOWNCOMER - UPPER HEAD	
– area (m^2)	$3.14 \cdot 10^{-4}$
– total energy loss coefficient [ΣK_i (forward)/ΣK_i (reverse)]	100/100
9. OVERALL VOLUME (m^3)	$6.445 \cdot 10^{-2}$

Tab. 5: Relap5/Mod3.2 LOBI nodalization - overview of code resources

3.4 Nodalization qualification

A nodalization representing an actual system (Integral Test Facility or plant) can be considered qualified when:

- it has a geometrical fidelity with the involved system;
- it reproduces the measured nominal steady state condition of the system;
- it shows a satisfactory behavior in time dependent conditions.

Taking into account these statements, a standard procedure to obtain a "qualified nodalization" has been defined, ref. [14].

The qualification process consists of two main phases:

1) **steady state level:** the nodalization is qualified against data available from nominal stationary conditions measured in the simulated system. To this aim:
   a) relevant geometrical parameters of the facility (e.g. volume, heat transfer area, elevations, pressure drops distribution etc.) are compared with the input data and the differences among them must be acceptably small. The adopted acceptability criteria are reported in the first part of Tab. 6 (see also Fig. 6);
   b) the nominal steady state conditions are simulated with a code running (a hundred seconds time interval is considered acceptable to reach correct steady state values); significant parameters are selected and compared with the measured results. A parameter is considered as significant when it is of major relevance in determining the plant behavior and can be reliably measured. The adopted acceptability criteria for this step are reported in the second part of Tab. 6 (see also Fig. 7).
2) **transient level**: the nodalization is tested in time-dependent conditions reproducing the available experimental transients. This phase also includes the procedure for the qualitative and the quantitative (through the application of the FFT based method) evaluation of the code accuracy, necessary to demonstrate the acceptability of the code transient performance. The demonstration of the quality of the nodalization at the transient level, before application to the reference calculation (BL-34 in this case), involves at least one among the following steps:
   a) perform a "K_v scaled" calculation aiming at the comparison between the nodalization performance and experimental data in another facility (proper scaling factors must be adopted to fix initial and boundary conditions);
   b) compare results of the nodalization with experimental data different than those object of the reference calculations (these can be operational transient data in the case of a Nuclear Power Plant);
   c) compare the results of the nodalization with calculations data coming from a previously qualified nodalization.

The idea of the "Kv-scaled calculation" (item a) comes from the objective to comparing calculated data with experimental data before adopting any nodalizations (i.e. including NPP nodalization) for any kind of calculation (code assessment, licensing, etc.). In this frame, adopting proper scaling criteria (time preventing, volume/power scaling)a comparison can be made between predicted and experimental data in the area of PWR and BWR. This must be used to detect nodalizations and user choice inadequacies. Correction of errors or deficiencies leads to a "on transient" qualified nodalization ready to be used for other purposes.

The acceptability constraints for the FFT (i. e. 0.4 for Average Accuracy and 0.1 for the primary pressure) must be fulfilled in any case.

The qualification process, summarized above, has been applied to the nodalization of Lobi facility.

As concerns the first phase (steady state level), the steady state acceptability criteria previously defined (reported in Tab. 6) have been verified; in particular, the comparison between the calculated and the measured volume vs. height curve and the distribution of pressure drops along the length are reported in Figs. 6 and 7, respectively.

The second part of the qualification process (transient level) has been conducted through the step b) and c) described above: in the first case the International Standard Problem 18, ref. [15], has been considered, while in the second case the previous simulation with the version Relap5/Mod2, ref. [5], has been utilized (see also below).

It is to be mentioned that the application of the FFT based methodology has been exhaustively performed in the Relap5/Mod2 simulation of BL-34 [16] and it was not repeated in a systematic way for the Relap5/Mod3.2 simulation. No important differences related to any of the finding of the Relap5/Mod2 analyses are expected.

	QUANTITY	ACCEPTABLE ERROR (°)
1	Primary circuit volume	1 %
2	Secondary circuit volume	2 %
3	Non-active structures heat transfer area (overall)	10 %
4	Active structures heat transfer area (overall)	0.1 %
5	Non-active structures heat transfer volume (overall)	14 %
6	Active structures heat transfer volume (overall)	0.2 %
7	Volume vs. height curve (i.e. "local" primary and secondary circuit volume)	10 %
8	Component relative elevation	0.01 m
9	Axial and radial power distribution (°°)	1 %
10	Flow area of components like valves, pumps orifices	1 %
11	Generic flow area	10 %
(*)		
12	Primary circuit power balance	2 %
13	Secondary circuit power balance	2 %
14	Absolute pressure (PRZ, SG, ACC)	0.1 %
15	Fluid temperature	0.5 % (**)
16	Rod surface temperature	10 K
17	Pump velocity	1 %
18	Heat losses	10 %
19	Local pressure drops	10 % (^)
20	Mass inventory in primary circuit	2 % (^^)
21	Mass inventory in secondary circuit	5 % (^^)
22	Flow rates (primary and secondary circuit)	2 %
23	Bypass mass flow rates	10 %
24	Pressurizer level (collapsed)	0.05 m
25	Secondary side or downcomer level	0.1 m (^^)

(°) The % error is defined as the ratio $\frac{|\text{reference or measured value - calculated value}|}{|\text{reference or measured value}|}$.

The "dimensional error" is the numerator of the above expression

(°°) Additional consideration needed

(*) With reference to each of the quantities below, following a one hundred s "transient-steady-state" calculation, the solution must be stable with an inherent drift < 1% / 100 s.

(**) And consistent with power error

(^) Of the difference between maximum and minimum pressure in the loop.

(^^) And consistent with other errors.

Tab. 6 - Criteria for nodalization qualification at the steady-state level.

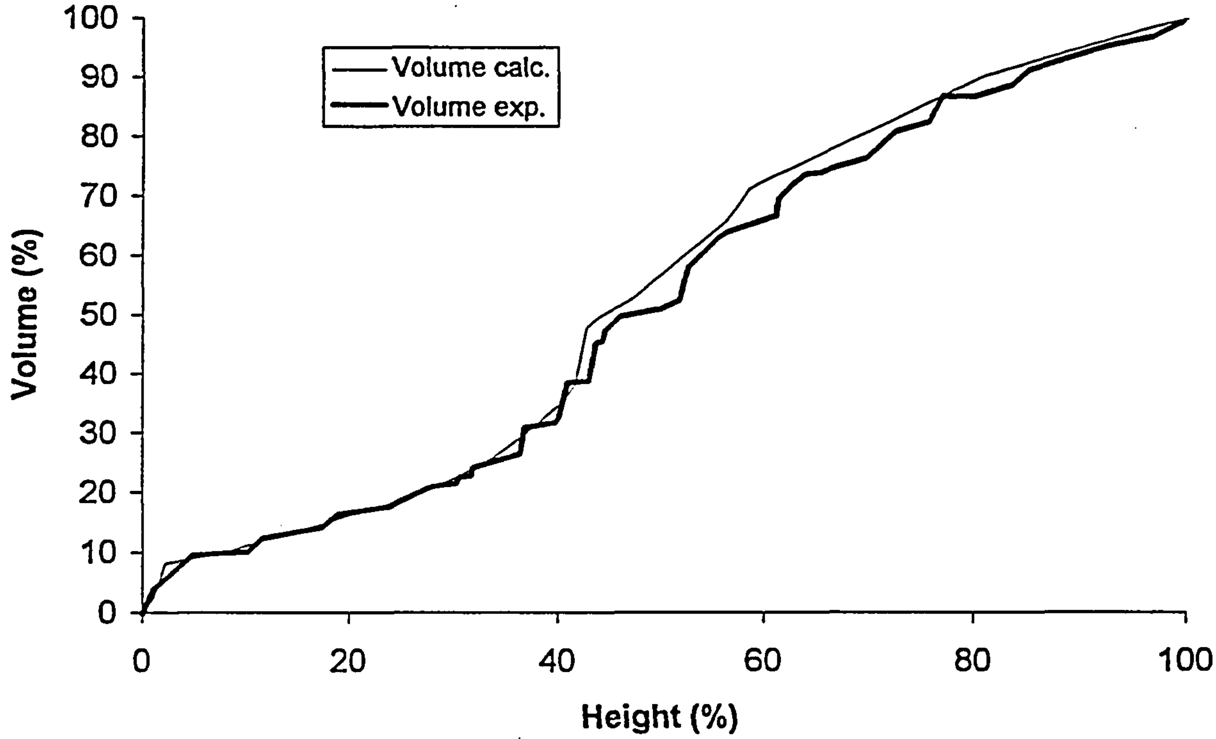

Fig. 6: Comparison between measured and calculated volume vs. height curve

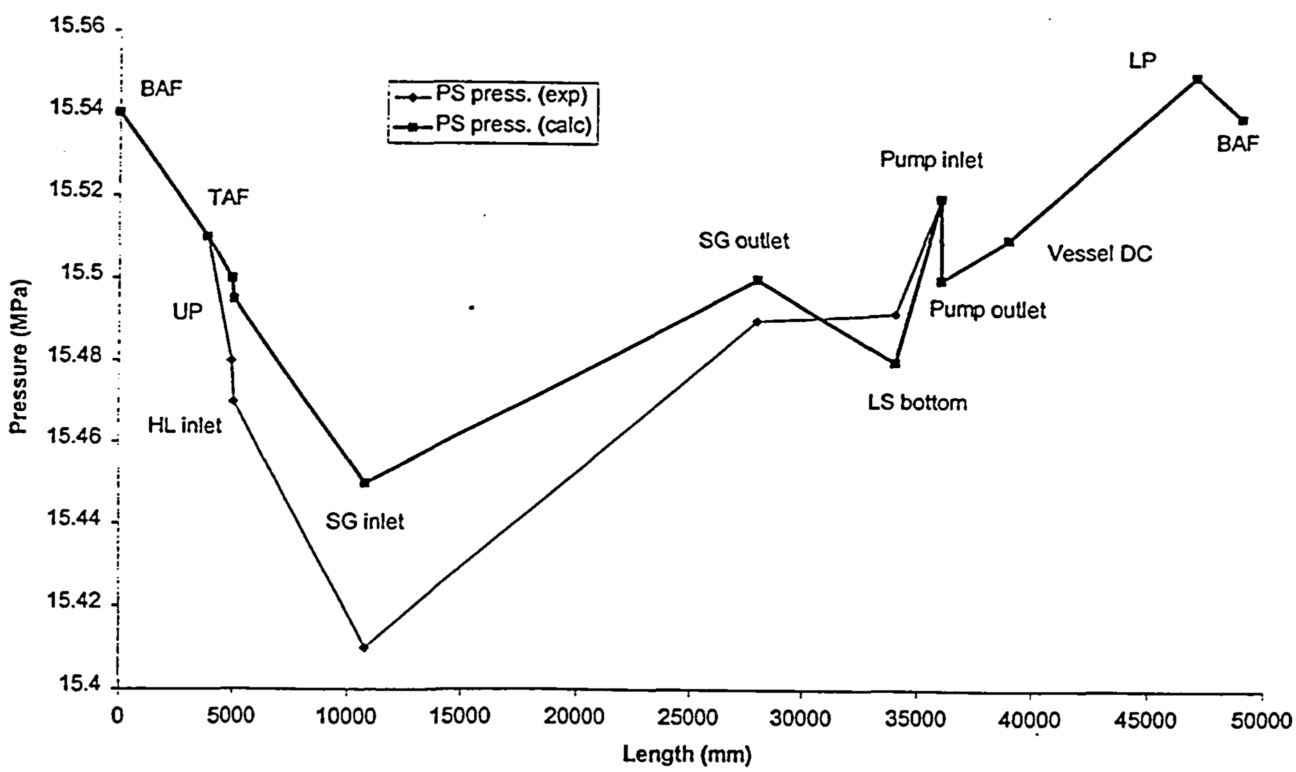

Fig. 7: Comparison between measured and calculated DP vs. length curve

4. ANALYSIS OF POST-TEST CALCULATION RESULTS

Three main calculation types can be distinguished in a meaningful code assessment process:

a) 100 s steady state;

b) reference calculation results;

c) results from sensitivity studies.

It may be noted that item a) may constitute a part of the nodalization qualification process, described in the previous chapter; however, the fulfillment of criteria reported in Tab. 6 is necessary each time a new experiment is considered and before starting transient calculations by using the previously qualified nodalization.

The reference calculation results, item b), must outcome from the qualified nodalization and satisfy qualitative and quantitative accuracy related criteria. The reference calculation is not "the best" calculation achievable by the code. In order to get the reference calculation, boundary and initial conditions of the considered experiment (i.e. input data for the reference calculation) may be changed within their uncertainty ranges; if a user choice is introduced (e.g. changes in noding detail), its validity and acceptability must be checked by repeating the nodalization qualification process.

Sensitivity analyses, item c), must be carried out to demonstrate the robustness of the calculation, to characterize the reasons for possible discrepancies between measured and calculated trends that appear in the reference calculation, to optimize code results and user option choices, to improve the knowledge of the code by the user.

The attention is focused hereafter toward the analysis of the reference calculation results, item b), considering that steady state calculation, item a), is part of the nodalization qualification process and sensitivity analyses, item c), can be designed following the analyses at the previous step. Typical results are provided in relation to the three steps.

When calculating the quantitative accuracy, twenty-one time trends have been selected in relation to which experimental data exist: these are assumed to be the minimum number of measured quantities that fully describe the experimental scenario. The related list is given in the first column of Tabs. 11, 13 and 14.

When calculating qualitative accuracy, including the comparison between time trends, reference is made to the same list (e.g. Apps. 1 and 2) of Tab. 13; the following quantities have been added to the comparison: pressure drop across DC-UH bypass, pressure drop in the U-tubes ascending leg (also a measure of liquid hold-up in the U-tubes), core inlet flow rate, pressure drop in cold leg, mass flow rate in SG downcomer, hot leg mass flow rate. Fig. 29 has been added to give an overall view of the system performance (primary and secondary pressure together).

4.1 Steady State calculations

A steady state calculation, by running the code with the 'TRANSNT' (transient) option for 100 s has been completed. This constitutes the final step of the nodalization qualification process at steady state level.

The related results are shown in Tab. 7 and in App. 1. In both cases, resulting values are compared with experimental data. In the case of Tab. 7, for completeness, the data calculated by Relap5/mod2 are included as taken from ref. [5].

It may be noted that the data in Tab. 7 deal with most of the parameters imposed for the nodalization qualification process (Tab. 6): the values in the table have been taken from the code output at 100. s. The time trends above identified are part of the App. 1, numbering of figures is different owing to the obvious lack of time trends dealing with ECC and break flow rates.

The analysis of data brings to the following conclusions:

- the criteria for nodalization qualification are fulfilled, though the complete comparison between data in Tab. 7 and in App. 1 with acceptability criteria has not been done owing to the lack of experimental data; in addition, some of the criteria can be matched by considering sums or combinations of values from Tab. 7 (e.g. the primary circuit power balance can be obtained by considering data at items 1, 4, 14, 16 and 17); still, the error on bypass flow rate, can be better seen by considering the errors in fluid temperatures owing to the fact that the direct experimental information about bypass flow rate is uncertain (measurement error not available);
- the calculated values are stable as it results from Figs. 1 to 26;
- differences between Relap5/mod2 and Relap5/mod3.2 codes results are negligible;
- discrepancies between measured and calculated values of heater rod temperatures, come from the position of thermocouples and from generic experimental error (the calculation result refer to the surface, the experimental data are taken slightly inside the surface, the error almost disappears at low linear rod power, during the transient);
- discrepancies in the case of primary side mass and vessel riser level, are within the acceptability criteria, considering the experimental uncertainties (about ± 3 % for primary mass);
- the discrepancy in the cases of pressure drops is attributed to the experimental error and to the position of the measurement pressure taps not accounted for by the calculated results;
- the discrepancy related to the recirculation mass flow rate in the steam generator, can also be originated by a measurement error; however, in this case tuning or adjustments of steady state code results was considered unnecessary owing to the low influence that this parameter has in the selected transient (early main coolant pump and feedwater trips occur).

4.2 Reference calculation results

The post-test calculation was performed starting from the input deck suitable for Relap5/Mod2. A 'blind' post test was performed by Relap5/Mod3.2 constituting the reference calculation for this study (label B34D); the related time trends and significant single valued parameters are reported, together with experimental data, in App. 2 and in Tab. 8, respectively.

A comprehensive comparison between measured and calculated trends or values was performed, including the following steps:

a) comparison between experimental and calculated time trends on the basis of the 29 variables introduced above (App. 2);
b) comparison between values of quantities characterizing the sequence of resulting events, Tab. 8;
c) qualitative evaluation of calculation accuracy on the basis of the phenomena included in the CSNI matrix, ref. [17], as given in Tab. 9;
d) qualitative evaluation of calculation accuracy on the basis of the Relevant Thermalhydraulic Aspects (RTA, also used for code uncertainty derivation, e.g. ref. [6]), as given in Tab. 10;
e) quantitative evaluation of calculation accuracy, utilizing the FFT based method (FFTBM), described in refs. [8] and [16], see also App. 1 in ref.[20], as given in Tab. 11.

Comments related to items a) and b) are given below, distinguishing groups of homogeneous variables, while the discussion about items c), d) and e) is given in sect. 4.2.1.

<u>Absolute Pressures</u>

The primary system pressure is quite well predicted by the code and the phenomenological phases (e.g. subcooled blowdown, saturated blowdown and steam flow from the break) can be easily recognized from the calculated time trend (Fig. 8 below and Fig. 1 in App. 2). During the saturated blowdown (from about 50 s up to 500 s) the calculated pressure is higher than the experimental one. This discrepancy is connected with the overestimation of the secondary side pressure (Fig. 2 of App. 2): heat losses to the environment appear to have a substantial role in this case.

The accumulator generally follows the primary pressure; time of accumulator actuation is reasonably well predicted, together with the time accumulator stop.

Fluid temperatures

Measured and calculated fluid temperatures are compared in Figs. 4, 5, 6, and 8 of App. 2, the last one related to the steam generator and the other ones related to the primary circuit.

Core inlet and outlet fluid temperatures are qualitatively well predicted (Figs. 4 and 5). The predicted core outlet fluid temperature presents two peaks in correspondence to the two core level depressions. The superheating is larger than in the experiment and the position of the thermocouple strongly affects this time trend. This is specifically true for the upper head fluid temperature where a very high superheating is measured; in this case, it seems evident that the thermocouple gives a measure of the structural mass temperature starting from about 400 s into the transient, i.e. following the emptying of the upper head.

Mass flow rates and residual mass

The measured values of break flow rate (Fig. 9 below and Figs. 7 and 9 in App. 2), the ECCS flow rate (Fig. 10 below and Fig. 10 in App. 2), core inlet (Fig. 25 in App. 2), hot leg mass flow rate (Fig. 28 in App. 2) and the steam generator downcomer flow rate (Fig. 27 in App. 2) are compared with the respective calculated trends.

Break flow rate is well predicted; up to 500 s into the transient it is slightly underpredicted, but the related error can be considered within the uncertainty bands.

The calculated ECCS flow rate is in a good agreement with the calculated trend; it can be noted the overprediction of the flow rate delivered by accumulators and the slight delay of the LPIS intervention.

The residual mass in primary side is well predicted (Fig. 14 of App. 2); the calculated value is higher than the experimental one for all the transient, but the difference can be considered within the experimental uncertainty band.

Pressure drops

Pressure drops between different points of the primary circuit are considered in the comparison, e.g. Figs. 17, 19, 20, 22, 23, 24 and 26 in App. 2. All of the comparisons, with different extent, suffer of the limitation already explained in sect. 4.1 (pressure taps not coincident with the center of the volumes of the nodalization).

Pressure drops in loop seals are reasonably well predicted by the code; in the case of steam generator inlet plenum to U-tubes top and downcomer to upper head bypass, the calculated pressure drops trends are in a very good agreement with the experimental one.

Levels

The pressurizer level (Fig. 11 below and Fig. 21 in App. 2) is well predicted in the calculation, testifying the good prediction of the subcooled blowdown flow rate.

Core collapsed level constitutes a critical quantity during this experiment, as the level variations are directly connected with the occurrence of core dryout. The trend of this variable is strongly affected by the distribution of pressure drops along the loop that also influence the occurrence of threshold phenomena like loop seal clearing.

The calculated core level is in a quite good agreement with the experimental trend (Fig. 12 below and Fig. 15 in App. 2). The first core level depression is not predicted by the code: this discrepancy is connected with the bypass flow paths inside the vessel, that can facilitate the steam discharge form the upper plenum and limit the steam binding effect on the core level. Pumps operation and, in particular, uncertainties in the rotation speed as a function of time and in the head as a function of the rotation speed (homologous curves) can also have a role in this connection.

Rod Surface Temperatures

When analyzing the rod surface temperature trends, the three-dimensional situation in the core must be considered, as described into detail in ref. [4].

Representative experimental data at three core levels have been selected for the present comparison, distinguishing in the axial sense, the core bottom, the core middle and the core top regions (Figs. 11 to 13, respectively in App. 2, and Fig. 13 below related to the top region).

Calculated rod surface temperatures follow well the measured values. The first dryout is not predicted by the code and the reason is connected with the bypass flow paths into the vessel (see above). The second dryout situation is well predicted by the code: this is evident at the core high level, whereas, in the middle region, the code predicts the dryout occurrence in the nodes near to that one reported on figures, where there is an apparent discrepancy with the measured trend. The occurrence of the final dryout is reasonably well predicted.

QUANTITY	UNIT	EXP	CALC R5/M2	CALC R5/M3.2
1) Core power	kW	650	630	630
2) Pressurizer pressure	MPa	15.4	15.47	15.47
3) Pressurizer level	m	4.7	5.0	4.95
4) Core mass flow rate	kg/s	3.58	3.40	3.51
5) Core bypass mass flow rate	kg/s	0	0.0057	-
6) DC-UH bypass mass flow rate	kg/s	0.03	0.0023	0.015
7) Primary pumps speed	rad/s	il 7.11 bl 4.78	il 42.8 bl 18.1	il 42.7 bl 18.1
8) Core inlet temperature	K	558	561	559
9) Core outlet temperature	K	589	589	588
10) Core ΔT	K	31	27.5	29
11) Upper head temperature	K	565	607	562
12) Primary mass	kg	436	450	452
13) Acc. liquid temperature	K	303	303	300
14) Secondary pressure SG	MPa	il 6.9 bl 6.9	il 6.94 bl 6.91	il 6.94 bl 6.94
15) SG downcomer level	m	il 8.0 bl 8.4	il 8.14 bl 8.48	il 7.2 bl 7.9
16) Feedwater temperature	K	il 415 bl 409	il 415 bl 409	il 489 bl 489
17) Feedwater flow rate	kg/s	il 0.182 bl 0.061	il 0.19 bl 0.06	il 0.28 bl 0.11
18) Total primary side heat losses	kW	85.2	85.2	53.2
19) Secondary side heat losses	kW	15	15	23.5

Tab. 7: Comparison between measured and calculated (Relap5/Mod2 and Relap5/Mod3.2) relevant initial and boundary conditions

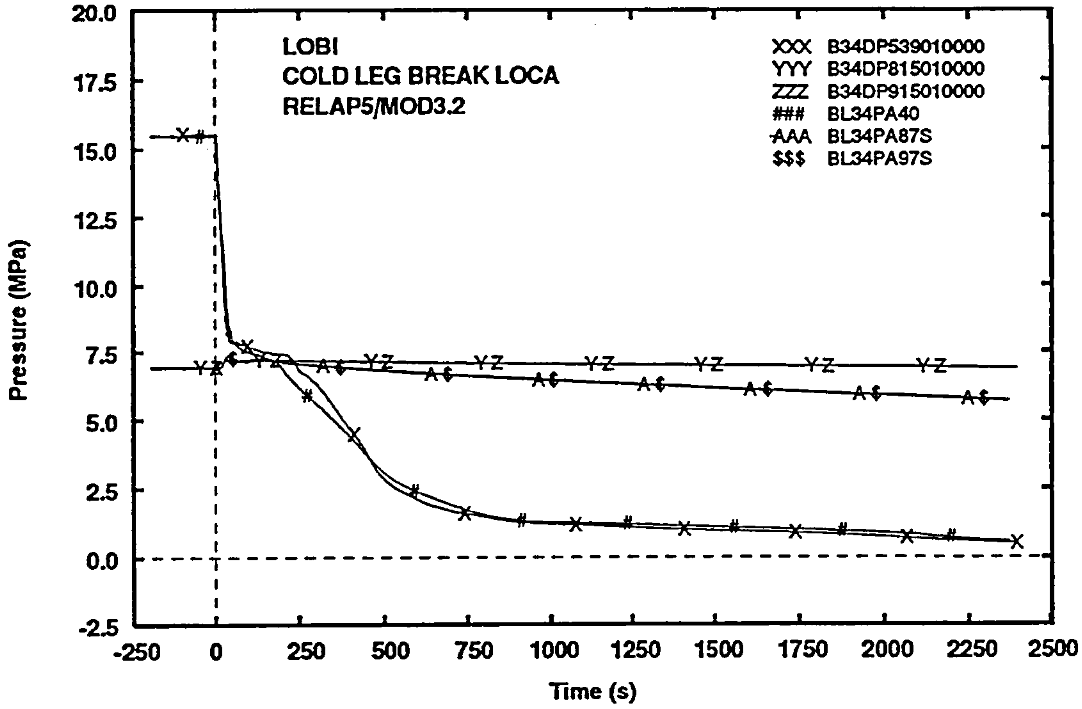

Fig. 8: LOBI post test BL-34 (reference calc.) - primary and secondary pressure

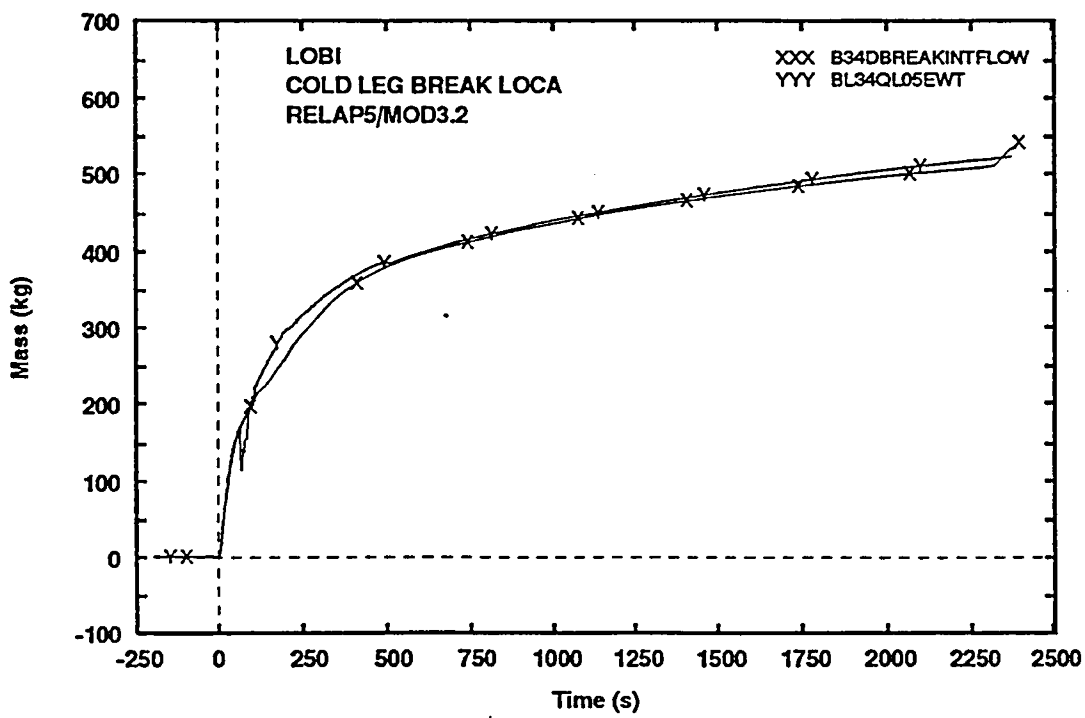

Fig. 9: LOBI post test BL-34 (reference calc.) - integral break flow rate

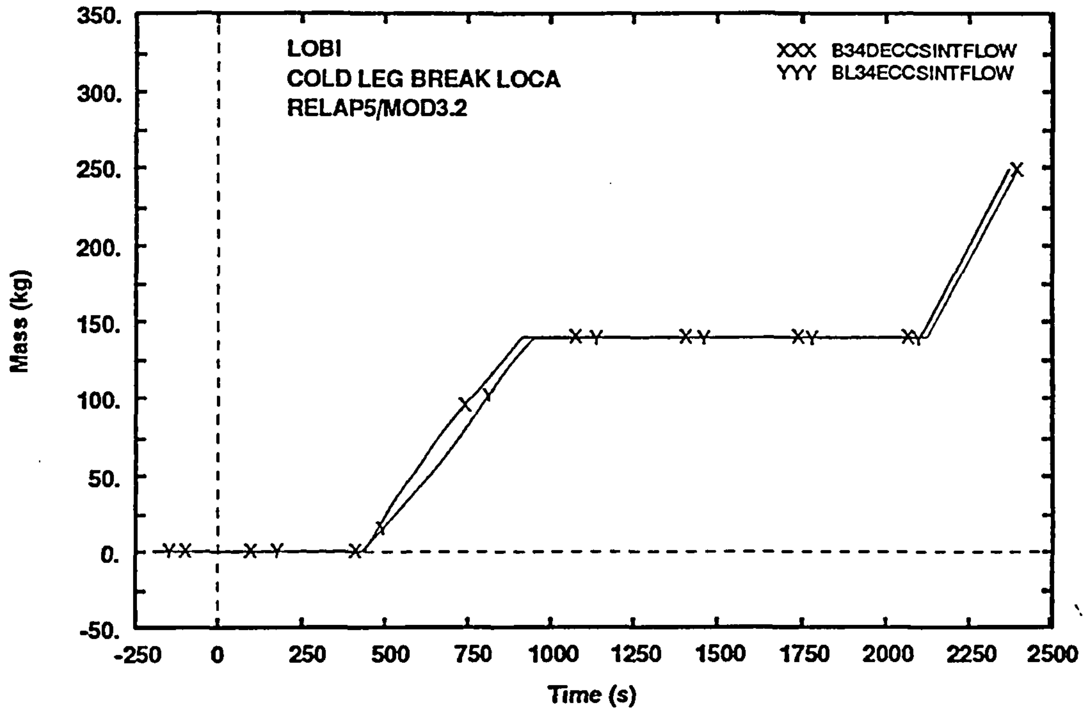

Fig. 10: LOBI post test BL-34 (reference calc.) - ECCS integral flow rate

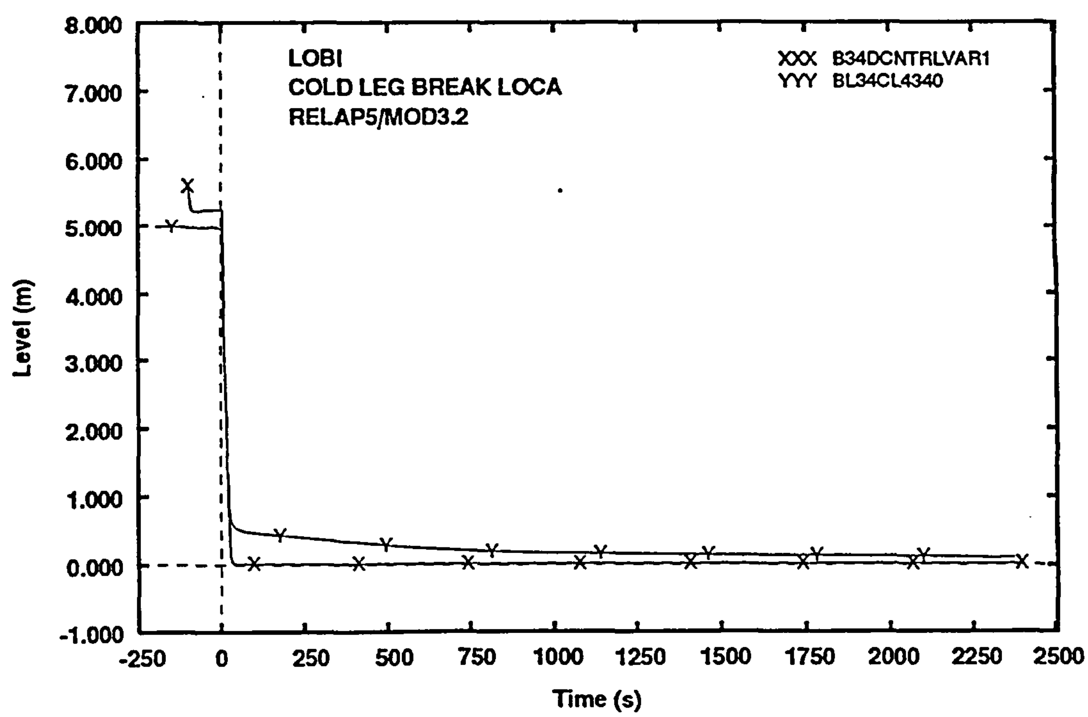

Fig. 11: LOBI post test BL-34 (reference calc.) - pressurizer level

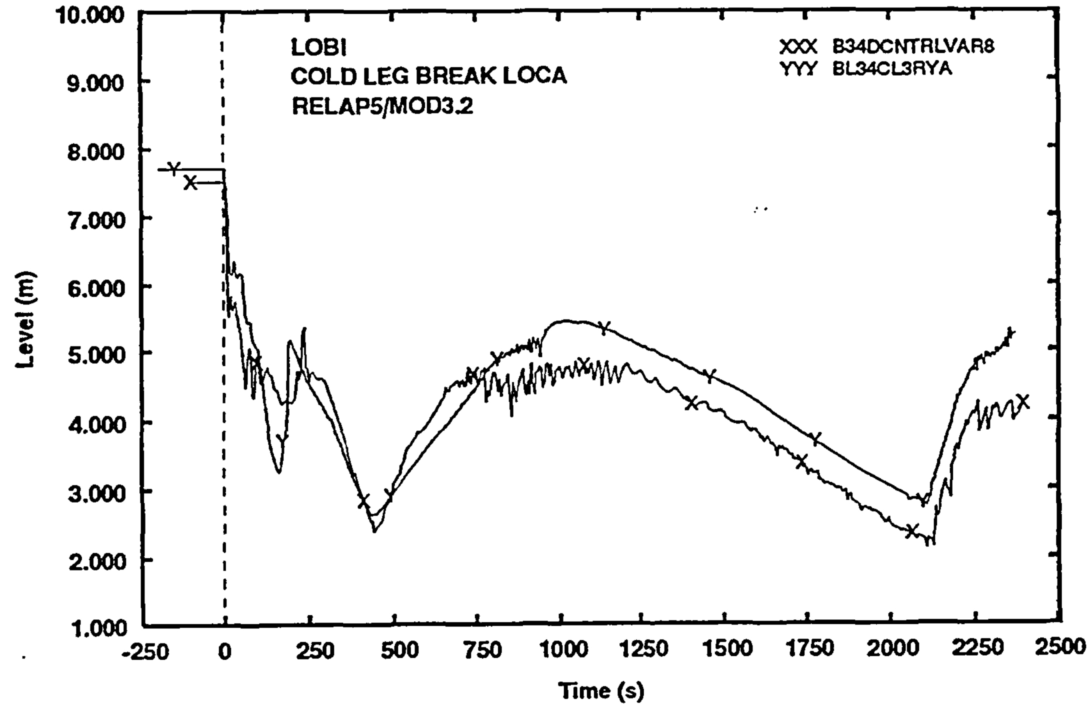

Fig. 12: LOBI post test BL-34 (reference calc.) - core level

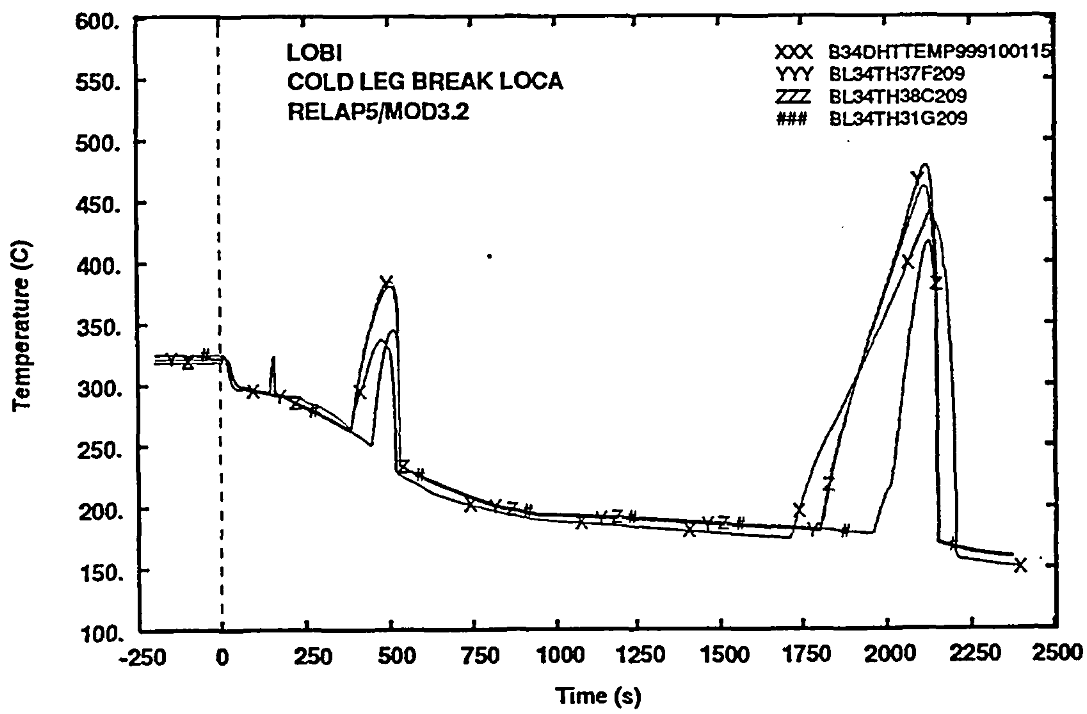

Fig. 13: LOBI post test BL-34 (reference calc.) - rod surface temperature (high level)

	EXP	B34D	B341	B342	B343	B334	B335	B336
Break opening	0	0	0	0	0	0	0	0
Scram power curve enabled	0.5	59	59	59	58	58	59	59
Start of main coolant pumps coast down	1.1	16	15	17	16	16	16	16
Main steam line valve closure	-	18	16	20	18	17	17	18
Feedwater valve closure	-	0	0	0	0	0	0	0
Upper plenum in saturation condition	7	12	10	11	11	10	11	12
Pressurizer emptied	23	25	223	26	24	24	24	24
Break two phase flow	120	60	50	75	58	54	57	58
First dryout	135	-	-	-	-	-	-	-
Loop seal clearing	il 180 bl 160	il - bl 157	-	-	-	-	il - bl 171	-
Occurrence of minimum primary side mass	420 2100	438	356	595	462	444	445	465
Primary-secondary pressure reversal	164	230	175	327	262	247	247	268
Second dryout	363	378	321	503	425	404	404	424
Rewetting due to accumulators	550	519	410	745	520	504	504	525
Accumulators injection start	420	433	354	593	458	444	444	466
Accumulators injection stop	953	919	755	1248	950	933	935	940
Final dryout	1705	1712	1531	1839	1711	1751	1747	1711
LPIS start	2100	2199	1919	2254	2134	2174	2174	2129
Final rewetting	2150	2206	2026	2317	2226	2271	2275	2219
End of test	2400	2500	2500	2500	2500	2500	2500	2500

Tab. 8: Resulting sequence of events, comparison among experimental test and calculated results

4.2.1 Qualitative and quantitative accuracy evaluation

Qualitative accuracy

The qualitative accuracy evaluation here discussed is based upon a systematic procedure consisting in the identification of phenomena (CSNI list) and of RTA. In both cases five levels of judgment are introduced (E, R, M, U, and -) whose meaning is detailed in the notes of Tab. 9 and in App. 1 of ref. [20]. The related results are reported in Tabs. 9 and 10, where for completeness the information related to Relap5/mod2 results are given.

A positive overall qualitative judgment is achieved if 'U' is not present; in addition, the parameters characterizing the RTA (i.e., SVP = Single Valued Parameter, TSE = parameter belonging to the Time Sequence of Events, IPA= Integral Parameter and NDP = Non Dimensional Parameter) give an idea of the amount of the discrepancy.

In the present case the following conclusions could be reached:

a) no 'U' mark is present;
b) all RTA of the experiment are present in the calculated data
c) the accuracy evaluation by adopting RTA and Key Phenomena, supports the conclusion that the calculation is qualitatively correct.

Quantitative Accuracy

The positive conclusion of the qualitative accuracy evaluation, makes it possible addressing the quantitative accuracy evaluation. To this aim a special methodology, developed at University of Pisa, and widely used has been adopted.

The methodology is based upon the use of the Fast Fourier Transform (e.g. ref. [19]); its main features are detailed in App. 1 of ref. [20].

The results of the application of the method are given in Tab. 11, where again the information related to Relap5/mod2 calculation is given too. The conclusions from the quantitative accuracy evaluation analysis are as follows:

a) the achieved results are well below the acceptability threshold both in relation to the overall accuracy (AA = 0.24 compared with the acceptability limit of 0.4) and the primary system pressure accuracy (AA = 0.061 compared with the acceptability limit of 0.1);
b) the achieved results appear slightly better than those obtained by Relap5/mod2.

Definitely, the documented reference calculation is acceptable from the code assessment point of view; i.e. the code is positively assessed in relation to its capabilities to predict this kind of transient.

Design of sensitivity calculations

Following the performed qualitative and quantitative accuracy evaluation, there is no need to perform additional calculations. Therefore, the planned sensitivity analyses are carried out with the main purpose of understanding the code behavior, rather than following needs for the accuracy evaluation.

The following objective for the studies were established:

1) influence of the break discharge coefficients;
2) prediction of the secondary side behavior;
3) prediction of the rods cladding temperature.

PHENOMENA	FACILITY	EXPERIMENT	JUDGEMENT OF CALC.	JUDGEMENT OF CALC.
	LOBI	BL-34	RELAP5/M2	RELAP5/M3.2
Natural circulation in one-phase flow	o	+	R	R
Natural circulation in two-phase flow	o	+	R	R
Reflux condenser mode and CCFL	+	-	M	M
Asymmetric loop behavior	+	+	M	M
Leak flow	o	o	E	E
Phase separation without mixture level formation	o	-	-	-
Mixture level and entrainment in SG secondary side	+	-	-	-
Mixture level and entrainment in the core	+	+	R	R
Stratification in horizontal pipes	+	+	M	M
Emergency core cooling mixing and condensation	+	+	R	R
Loop seal clearing	o	o	E	E
Pool formation in upper plenum - CCFL	-	-	-	-
Core wide void and flow distribution	-	-	-	-
Heat transfer in covered core	o	o	R	R
Heat transfer in partially uncovered core	+	o	R	R
Heat transfer in SG primary side	o	o	R	R
Heat transfer in SG secondary side	o	-	R	R
Pressurizer thermal hydraulics	+	+	E	E
Surge line hydraulics (CCFL choking)	+	-	-	-
One and two phase pump behavior	o	-	-	-
Structural heat and heat losses	+	+	E	E
Non condensable gas effect on leak flow	o	-	-	-
Phase separation in T-junctions	+	+	M	M
Separator behavior	-	-	-	-
Thermalhydraulic nuclear feedback	-	-	-	-
Boron mixing and transport	-	-	-	-

For the test facility vs. phenomenon:
- o suitable for code assessment
- \+ limited suitability
- \- not suitable

For phenomenon vs. test:
- o experimentally well defined
- \+ occurring but not well characterized
- \- not occurring or not measured

For phenomenon vs. calculation:
E = Excellent
R = Reasonable
M = Minimal
U = Unqualified
\- = Not applicable

Tab. 9: Judgment of code calculation performance on the basis of phenomena included in the CSNI matrix

		UNIT	EXP	CALC (R5/M2)	CALC (R5/M3.2)	Judgment M2/M3.2
	RTA: Pressurizer emptying					
TSE	emptying time*	s	23	23	25	E/E
	scram time	s	0.5	0.5	59	E/M
IPA	integrated flow from SL (from 0 up to emptying)	kg	-	-	-	-
	RTA: Steam generators secondary side behavior					
TSE	main steam line valve closure	s	-	-	18	-
	difference between PS and SS pressure at 100 s	MPa	0.2	n.a.	0.5	- / R
SVP	SG level • at the end of subcooled blowdown • when PS pressure equals SS pressure • when ACC starts • when LPIS starts	m	7.8 –7.7 7.9 – 7.7 7.6 – 7.8 7.8 – 7.5	n.a.	7.5 –7.9 7.5 – 7.6 7.5 – 7.6 7.41 – 7.45	- / E - / E - / E - / E
SVP	SG pressure • at the end of subcooled blowdown • when PS pressure equals SS pressure • when ACC starts • when LPIS starts	MPa	7.2 7.2 6.9 5.8	n.a.	7.2 7.18 7.13 6.9	- / E - / E - / R - / R
	RTA: Subcooled blowdown					
TSE	upper plenum in sat. conditions	s	7	50	12	R/R
	break two phase flow	s	120	100	60	R/R
IPA	break flow up to 30 s	kg	111	n.a.	118	- /E
	RTA: First dryout occurrence					
TSE	time of dry out	s	135	-	-	M/M
	range of dry out occurrence at various core levels	s	135-156	-	-	M/M
	peak cladding temperature	K	625	-	-	M/M
SVP	average linear power	kW/m	1.46	1.45	n.a.	E / -
	maximum linear power	kW/m	1.91	1.88	n.a.	E / -
	core power / primary mass	kW/kg	1.56	1.27	n.a.	R / -
IPA	integral of dry out at 2/3 of core height	°C s	10600	-	-	-
NDP	primary mass / initial mass	%	43.5	37	-	R / -
	RTA: Rewet by loop seal clearing					
	time of loop seal clearing	s	il 180 bl 160	il 200 bl 160	il - bl 157	R/M E/E
TSE	range of rewet occurrence	s	160-182	-	-	-
	time when rewet is completed	s	178	-	-	-
	RTA: Saturated blowdown					
TSE	PS pressure equal to SS pressure	s	164	167	230	E/R
SVP	break flow at 200 s break flow at 1000 s	kg/s	0.39 0.09	n.a.	0.61 0.08	/R - / E
IPA	integrated flow from 200 to 1000 s	kg	145	n.a.	173	- / R

Tab. 10 (part 1): Judgment of code calculation on the basis of relevant thermalhydraulic aspects

		UNIT	EXP	CALC (R5/M2)	CALC (R5/M3.2)	Judgment M2/M3.2
RTA: Mass distribution in primary side						
TSE	time of minimum mass occurrence	s	420 2100	419 1542	438 2123	E/R R/E
SVP	minimum primary side mass	kg	91.5 88.5	76 71	85 90	R/E R/E
	av. linear power at min. mass	kW/m	0.51	0.41	0.44	R/R
	minimum mass/ITF volume	kg/m^3	141.2 136.5	117.2 109.5	131.1 138.8	R/R R/E
RTA: Second dryout occurrence						
TSE	time of dry out	s	363	-	378	- / R
	range of dry out occurrence at various core levels	s	363-443	-	264 - 400	- /R
	peak cladding temperature	K	671	-	609	- / R
SVP	average linear power	kW/m	0.79	0.79	0.60	E/R
	core power / primary mass	kW/kg	1.02	-	1.09	- / E
IPA	integral of dry out at 2/3 of core height		48580	-	24948	- / R
NDP	primary mass / initial mass	%	24.4	-	30.3	- / R
RTA: Accumulators behavior						
TSE	accumulators injection starts	s	420	420	433	E/R
	accumulators injection stops	s	953	953	919	E/R
IPA	total mass delivered by accumulators	kg	-	-	139.1	-
NDP	minimum mass/initial mass	%	21	16.8	18.8	R/E
	primary mass/initial mass	%	32.4	30.2	19.2	E/R
RTA: Final dryout occurrence						
TSE	time of dry out	s	1705	1393	1712	R/E
	range of dry out occurrence at various core levels	s	1680-2020	n.a.	1712 – 2023	- /E
	peak cladding temperature	K	783	752	713	R/R
SVP	average linear power	kW/m	0.36	0.28	0.36	R/E
	rate of rod temperature increase	K/s	1.37	0.55	0.61	R/R
	core power / primary mass	kW/kg	0.32	0.45	0.85	R/R
IPA	integral of dry out at 2/3 of core height	°C s	40333	n.a.	32225	- / R
NDP	primary mass / initial mass	%	27	23	23.8	R/R
RTA: LPIS intervention						
TSE	LPIS start	s	2100	-	2119	- / E
	range of rewet occurrence		2114-2188	-	2149 – 2259	- / R
	final rewetting	s	2150	-	2206	- / R
IPA	integrated flow from start to end of rewet	kg	21	-	34	- / R
NDP	primary m-ass/initial mass	%	20.3	-	19.9	- / E

Tab. 10 (part 2) : Judgment of code calculation on the basis of relevant thermalhydraulic aspects

PARAMETER	R5/M2		R5/M3	
	AA	WF	AA	WF
1 - PRZ pressure	0.03	0.05	0.061	0.032
2 - SG pressure - secondary side	0.21	0.05	0.356	0.044
3 - ACC pressure	0.09	0.02	0.061	0.022
4 - Core inlet fluid temperature	0.04	0.05	0.065	0.036
5 - Core outlet fluid temperature	0.14	0.05	0.063	0.048
6 - Upper head fluid temperature	0.31	0.03	0.324	0.026
7 - Integral break flow rate	0.04	0.05	0.076	0.042
8 - SG DC bottom fluid temperature	0.12	0.04	0.098	0.042
9 - Break flow rate	0.6	0.13	0.595	0.114
10 - ECCS integral flow rate	0.27	0.06	0.065	0.034
11 - Heater rod temp. (bottom level)	0.05	0.06	0.076	0.043
12 - Heater rod temp. (middle level)	0.92	0.06	0.530	0.025
13 - Heater rod temp. (high level)	0.78	0.06	0.501	0.032
14 - Primary side total mass	0.34	0.07	0.145	0.049
15 - Core level	0.95	0.07	0.385	0.036
16 - SG DC level	0.14	0.06	0.119	0.054
17 - DP inlet-outlet SG (IL)	0.92	0.05	1.207	0.046
18 - Core power	0.61	0.06	1.150	0.071
19 - DP loop seal BL - ascending side	0.60	0.014	0.398	0.045
20 - DP loop seal BL - descending side	0.53	0.08	0.799	0.042
21 - PRZ level	0.37	0.06	0.226	0.055
TOTAL	**0.33**	**0.05**	**0.24**	**0.038**

Tab. 11: Summary of results obtained by application of FFT method to the selected parameters for the reference calculation

4.3 Sensitivity calculations

Considering the reference calculation, a series of sensitivity analyses have been carried out, addressing the items 1), 2) and 3), reported in section 4.2.1, and additional input parameters; these are essentially user's choices that may have some effect in solving discrepancies leading to the same items.

The characteristics of the performed calculations can be drawn from Tab. 12, together with the results of the FFT methodology application (overall calculation and primary pressure). The summary of the FFT results related to all the parameters for all the performed sensitivity calculations are given in Tabs. 13 and 14.

The comparison between calculated and measured trends for each sensitivity analysis is reported in Appendix 3. In Figs. 14 to 25 the comparison of the sensitive analyses with the reference calculation is shown for some parameters of interest (primary pressure, break flow rate, heater rods temperature); more details are given hereafter .

1) Influence of the break discharge coefficients

Two calculations have been performed: in the first one (run B341) the break discharge coefficients (subcooled and two phase) have been increased of 0.2, while in the second analysis (run B342) the discharge coefficients have been decreased of the same quantity. In both cases, there are no improvements of the predicted trends, with respect to the reference calculation, as can be deducted from the global accuracy evaluation (see Tab. 13).

In particular, the increase of the discharge coefficients results in a better prediction of the integral break flow rate (and, consequently, of the primary pressure and the fluid temperatures) up to about 300 s; afterwards, the break flow rate is overestimated, causing a faster depressurization of the primary side, with the consequent anticipation of the accumulators intervention and the early prediction of the dry out occurrence.

The decrease of the discharge coefficients causes the underprediction of the break flow rate: this discrepancy corresponds to the overprediction of the primary pressures (as can be noted from Tab. 13 the related AA value is the worst of all the calculations) and to the delay of the main phenomena, like the dryout occurrence.

2) Prediction of the secondary side behavior

Aiming to improve the prediction of the secondary side parameters, the heat transfer coefficient has been multiplied by 1.5, so to increase the heat losses from the secondary side to the environment. The effect on the calculated results is negligible.

3) Prediction of the rods cladding temperature

In order to obtain a better prediction of the rods cladding temperature, three analyses, adopting different options on the active structure of core, have been performed: in the first one (run B346) the core grids have been introduced (expanded format on card 901); in the other two (runs B344 and B345) the convective boundary conditions for the geometry types vertical boundary without crossflow (option 110 on card 601) and vertical bundle with crossflow (option 111 on card 601) have been activated. In all cases the calculated trends appear unaffected by the adopted changes; in particular the activation of option 110 or 111 give exactly the same results, as can be noted from Tab.13.

ID Calculation	Variations from reference case	FFT application results (AA_{tot} / WF / AA_P)	Notes
B341	CD Break increased of 0.2	0.3 / 0.036 / 0.027	To evaluate the influence of the break discharge coefficients
B342	CD Break decreased of 0.2	0.29 / 0.032 / 0.011	To evaluate the influence of the break discharge coefficients
B343	Secondary side heat losses increased	0.25 / 0.037 / 0.028	To improve the secondary side behavior
B346	Introduction of core grids	0.24 / 0.037 / 0.027	To improve the prediction of rods temperature
B344	Like B346; option 101 on card 601 (active structures of core)	0.26 / 0.039 / 0.03	To improve the prediction of rods temperature
B345	Like B346; option 111 on card 601 (active structures of core)	0.26 / 0.039 / 0.03	To improve the prediction of rods temperature

Tab. 12: Sensitivity calculation matrix: varied input parameters and FFT results

Calculation ID	B34D	B341	B342	B343	B344	B345	B346
1) Primary side pressure	0.061	0.092	0.110	0.071	0.064	0.064	0.073
2) Secondary side pressure	0.356	0.356	0.355	0.328	0.359	0.359	0.360
3) Accumulator 1 pressure	0.061	0.185	0.210	0.079	0.066	0.066	0.083
4) Fluid core inlet temperature	0.065	0.125	0.087	0.065	0.069	0.069	0.068
5) Fluid core outlet temperature	0.063	0.107	0.097	0.065	0.063	0.063	0.068
6) Upper plenum fluid temperature	0.324	0.370	0.272	0.324	0.325	0.325	0.326
7) Integral break mass flowrate	0.076	0.079	0.108	0.085	0.078	0.078	0.082
8) SG bottom downcomer fluid temperature	0.098	0.126	0.086	0.180	0.109	0.109	0.107
9) Break mass flowrate	0.595	0.723	0.495	0.690	0.600	0.600	0.604
10) ECCS integral mass flowrate	0.065	0.364	0.269	0.076	0.140	0.140	0.072
11) Rods clad. temperature (bottom level)	0.076	0.124	0.089	0.077	0.075	0.075	0.081
12) Rods clad. temperature (middle level)	0.530	0.705	0.731	0.647	0.694	0.694	0.609
13) Rods clad. temperature (high level)	0.501	0.783	0.834	0.561	0.782	0.782	0.531
14) Primary side mass inventory	0.145	0.185	0.268	0.164	0.189	0.189	0.161
15) Core level	0.385	0.498	0.580	0.415	0.474	0.474	0.432
16) SG downcomer level	0.119	0.109	0.123	0.127	0.116	0.116	0.112
17) Pressure drop SG inlet-outlet	1.207	1.177	1.123	1.184	1.150	1.150	1.218
18) Core power	1.150	0.930	0.369	0.399	0.257	0.257	0.435
19) Pressure drop loop seal (ascending side)	0.398	0.260	0.522	0.426	0.407	0.407	0.424
20) Pressure drop loop seal (decending side)	0.799	0.418	0.963	0.843	0.835	0.835	0.802
21) Pressurizer level	0.226	0.226	0.231	0.226	0.226	0.226	0.226
Calculation result	**0.24**	**0.30**	**0.29**	**0.25**	**0.26**	**0.26**	**0.24**

Tab. 13: Summary of results obtained by application of FFT method to the selected parameters for the sensitivity calculations (AA values)

Calculation ID	B34D	B341	B342	B343	B344	B345	B346
1) Primary side pressure	0.032	0.027	0.011	0.028	0.03	0.03	0.027
2) Secondary side pressure	0.044	0.044	0.043	0.043	0.044	0.044	0.044
3) Accumulator 1 pressure	0.022	0.008	0.007	0.017	0.02	0.02	0.017
4) Fluid core inlet temperature	0.036	0.036	0.017	0.033	0.036	0.036	0.032
5) Fluid core outlet temperature	0.048	0.045	0.023	0.045	0.048	0.048	0.044
6) Upper plenum fluid temperature	0.026	0.029	0.018	0.026	0.026	0.026	0.026
7) Integral break mass flowrate	0.042	0.054	0.034	0.038	0.04	0.04	0.037
8) SG bottom downcomer fluid temperature	0.042	0.043	0.042	0.043	0.042	0.042	0.043
9) Break mass flowrate	0.114	0.104	0.122	0.106	0.113	0.113	0.113
10) ECCS integral mass flow rate	0.034	0.046	0.048	0.05	0.055	0.055	0.049
11) Rods clad. temperature (bottom level)	0.043	0.042	0.017	0.04	0.038	0.038	0.04
12) Rods clad. temperature (middle level)	0.025	0.02	0.037	0.022	0.02	0.02	0.023
13) Rods clad. temperature (high level)	0.032	0.021	0.05	0.028	0.052	0.052	0.029
14) Primary side mass inventory	0.049	0.025	0.047	0.049	0.055	0.055	0.048
15) Core level	0.036	0.023	0.047	0.036	0.043	0.043	0.038
16) SG downcomer level	0.054	0.055	0.053	0.053	0.054	0.054	0.055
17) Pressure drop SG inlet-outlet	0.046	0.039	0.042	0.044	0.037	0.037	0.047
18) Core power	0.071	0.067	0.095	0.097	0.06	0.06	0.091
19) Pressure drop loop seal (ascending side)	0.045	0.044	0.031	0.041	0.029	0.029	0.041
20) Pressure drop loop seal (decending side)	0.042	0.047	0.035	0.038	0.032	0.032	0.038
21) Pressurizer level	0.055	0.055	0.055	0.056	0.056	0.056	0.055
Calculation result	**0.038**	**0.036**	**0.032**	**0.037**	**0.039**	**0.039**	**0.037**

Tab. 14: Summary of results obtained by application of FFT method to the selected parameters for the sensitivity calculations (WF values)

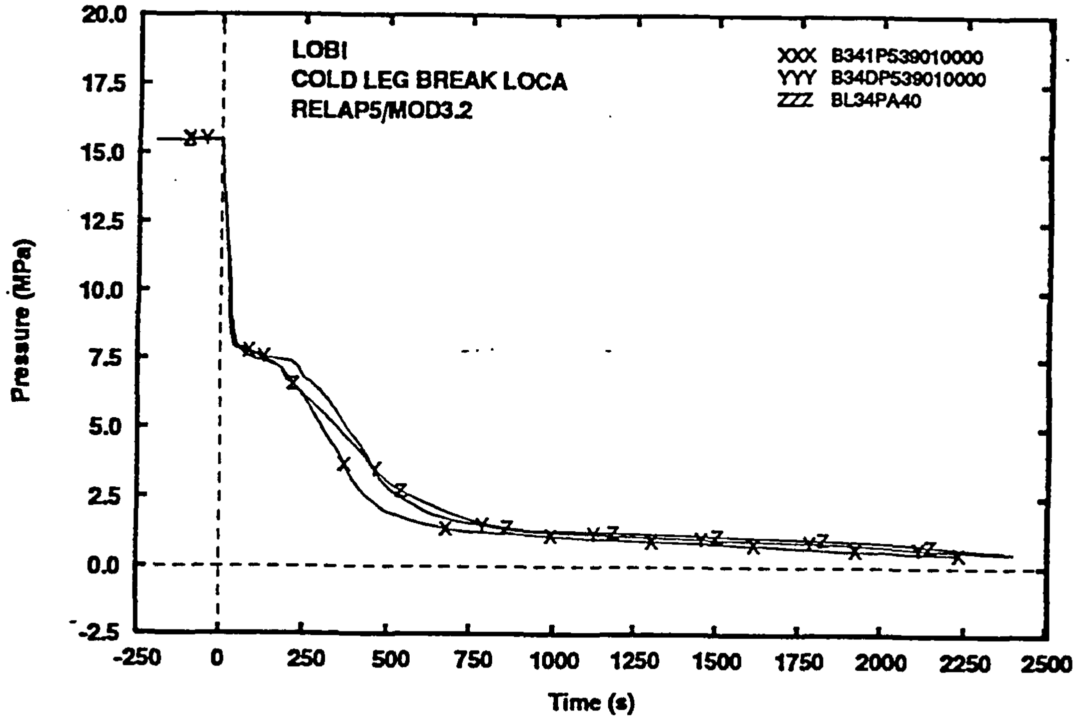

Fig. 14: LOBI post test BL-34 (run B341) - PRZ pressure

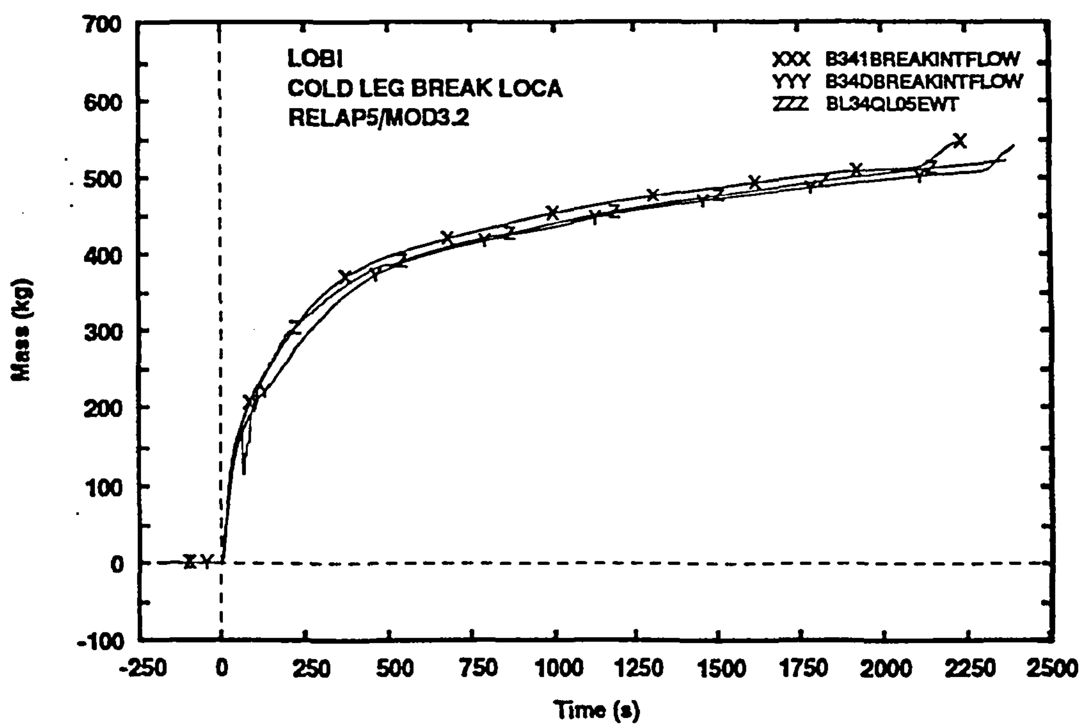

Fig. 15: LOBI post test BL-34 (run B341) - break integral flow rate

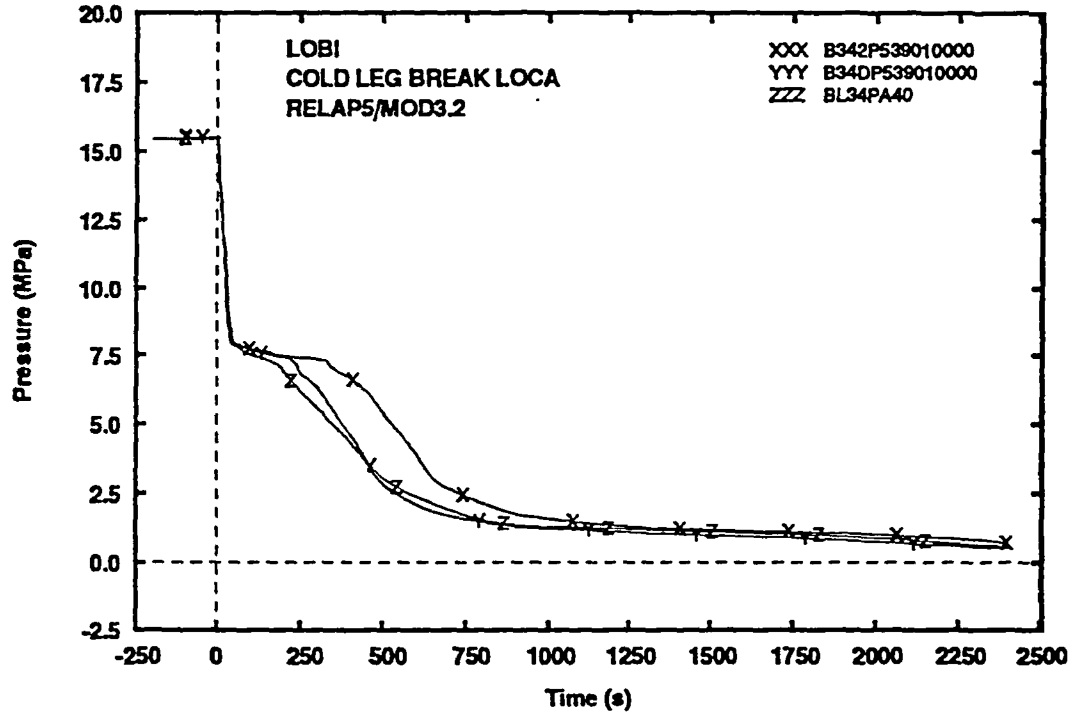

Fig. 16: LOBI post test BL-34 (run B342) - PRZ pressure

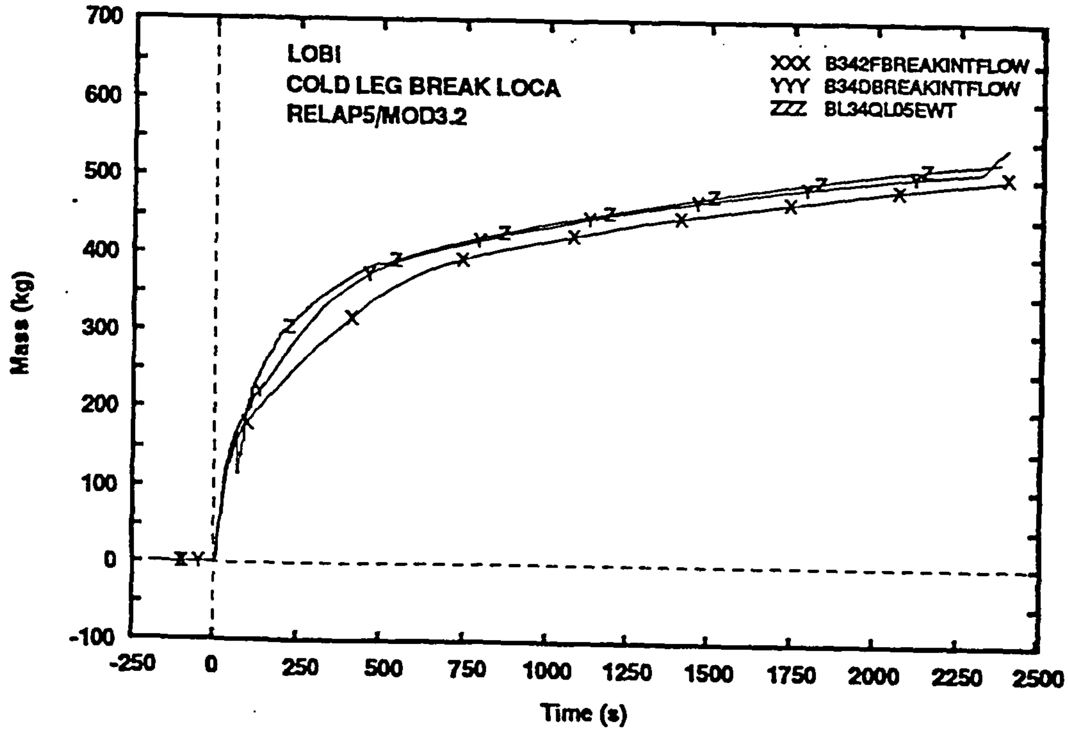

Fig. 17: LOBI post test BL-34 (run B342) - break integral flow rate

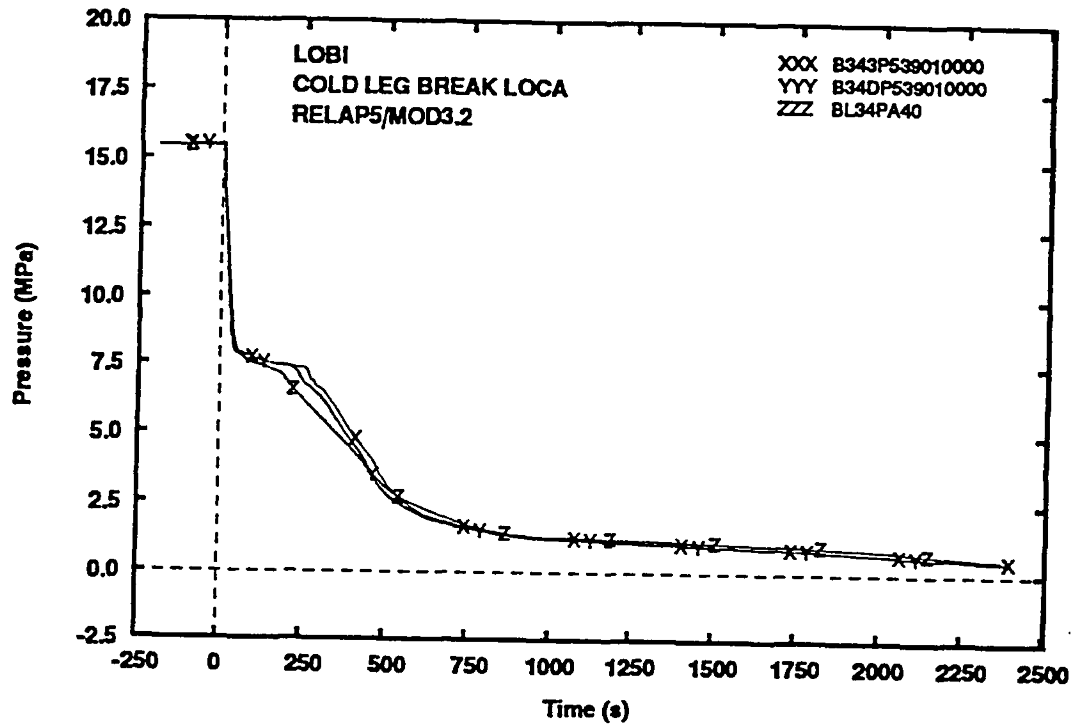

Fig. 18: LOBI post test BL-34 (run B343) - PRZ pressure

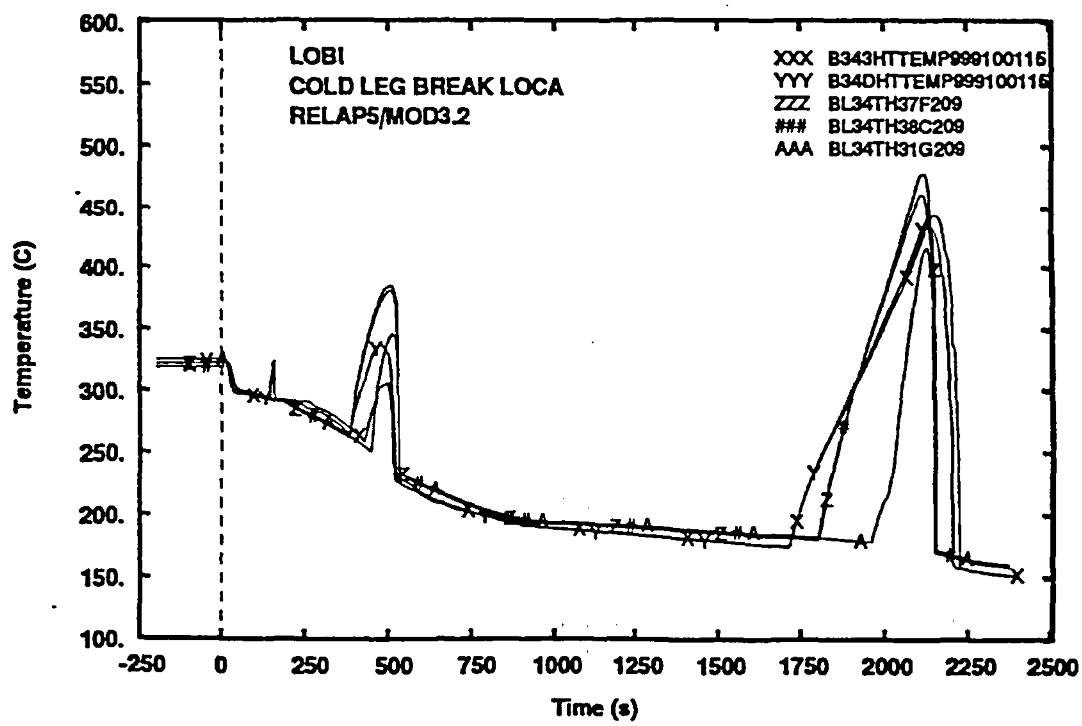

Fig. 19: LOBI post test BL-34 (run B343) - heater rod temperature (high level)

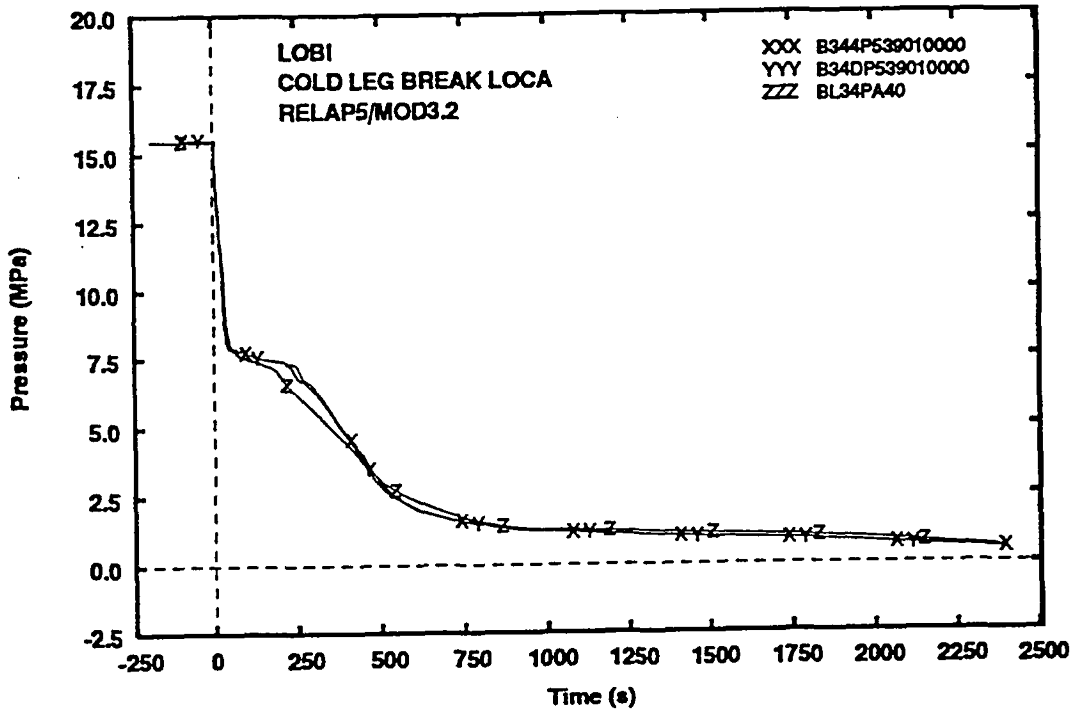

Fig. 20: LOBI post test BL-34 (run B344) - PRZ pressure

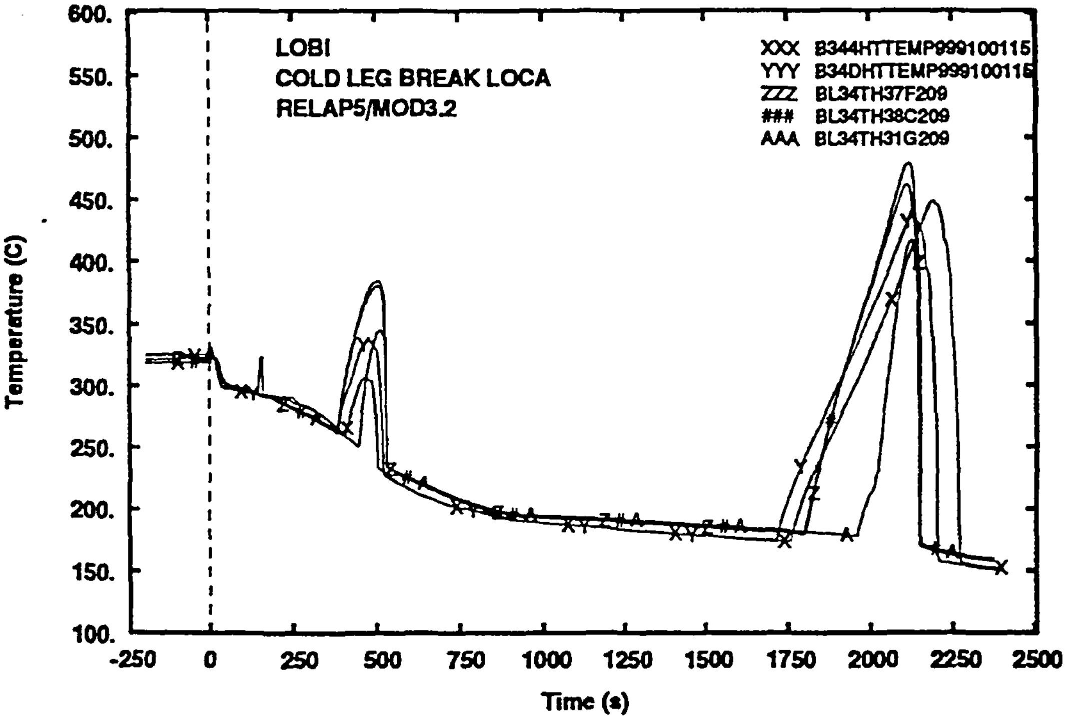

Fig. 21: LOBI post test BL-34 (run B344) - heater rod temperature (high level)

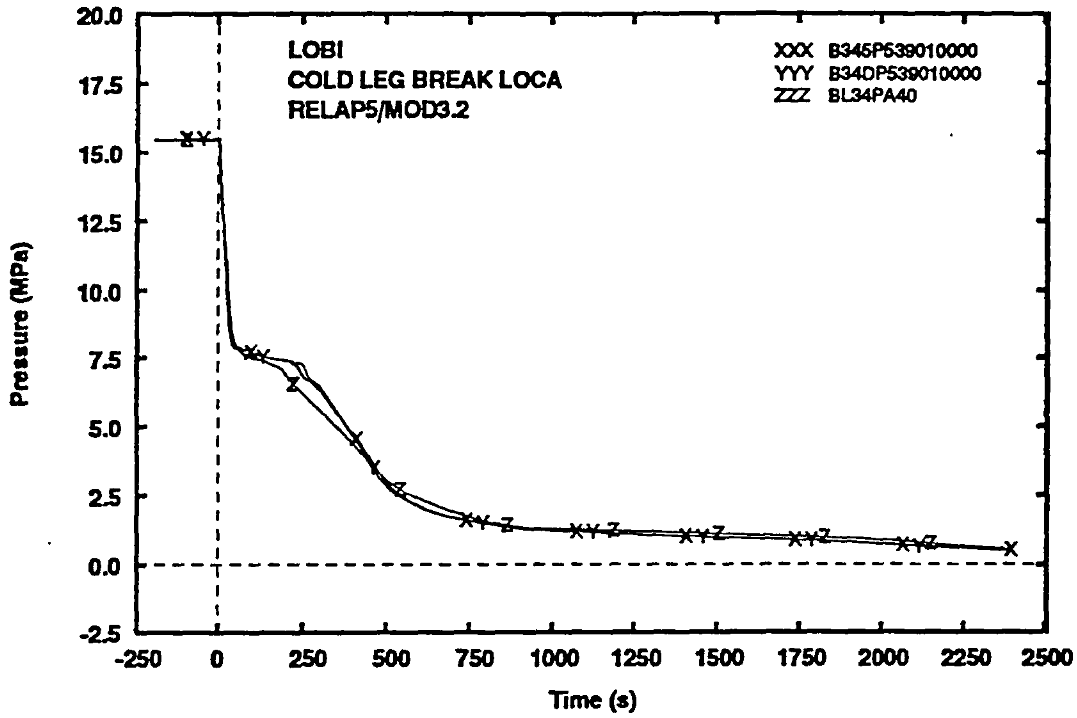

Fig. 22: LOBI post test BL-34 (run B345) - PRZ pressure

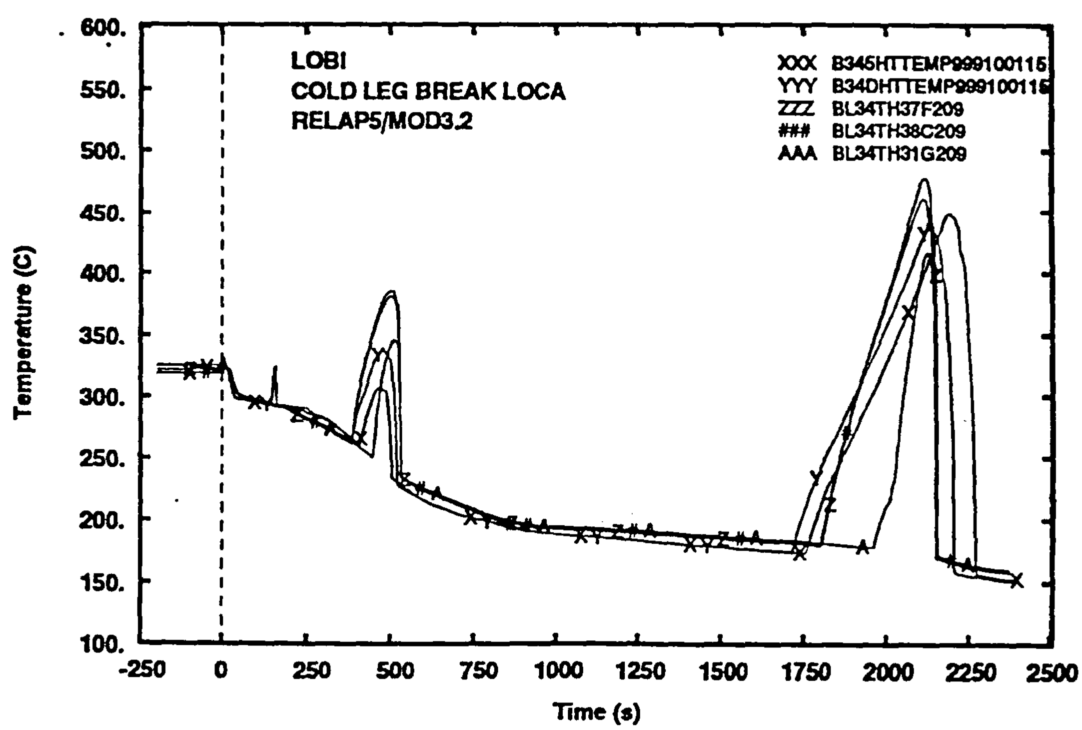

Fig. 23: LOBI post test BL-34 (run B345) - heater rod temperature (high level)

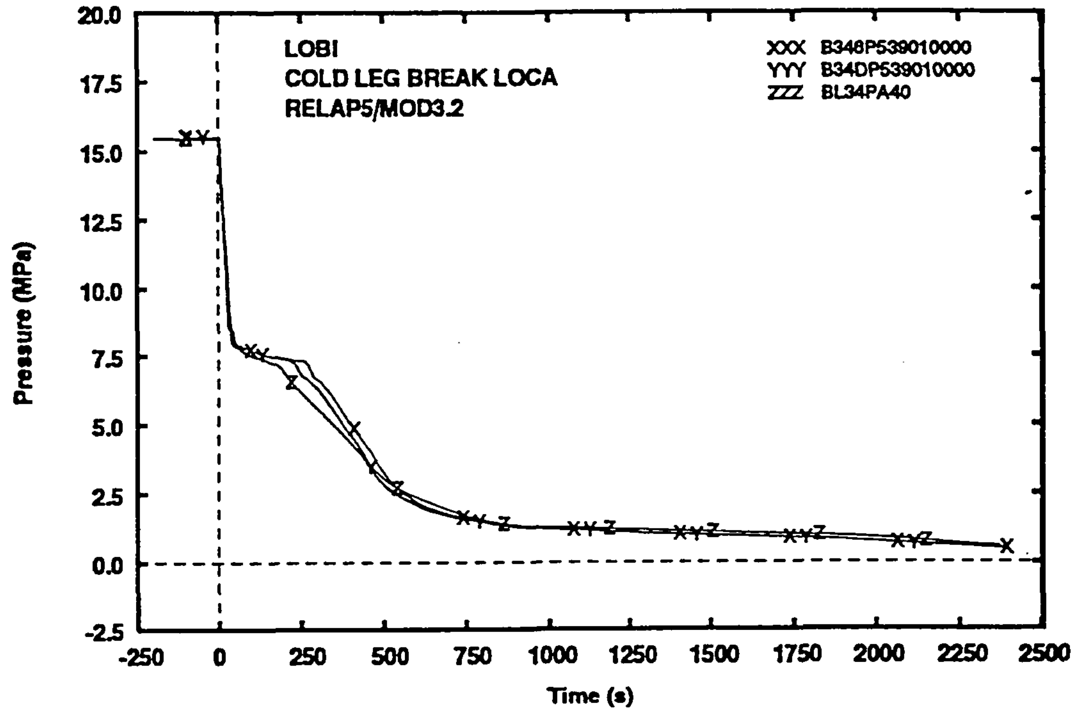

Fig. 24: LOBI post test BL-34 (run B346) - PRZ pressure

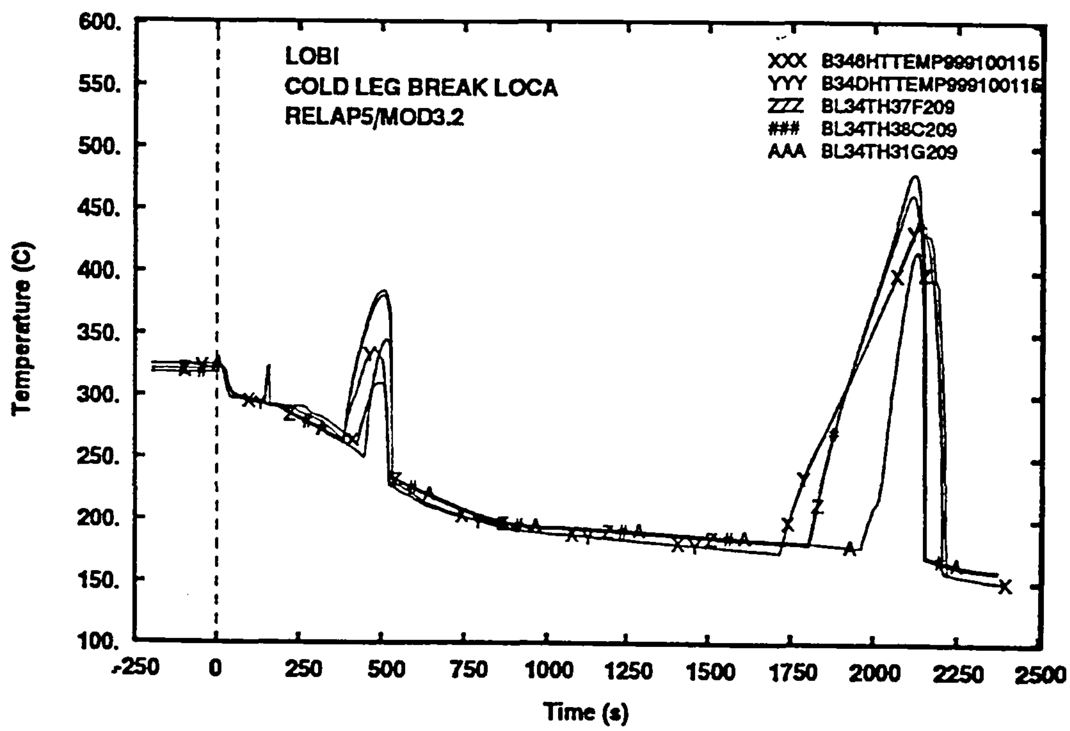

Fig. 25: LOBI post test BL-34 (run B346) - heater rod temperature (high level)

5. CONCLUSIONS

The analyzed transient (BL-34) is a small break LOCA experiment originated by a rupture in the cold leg of the broken loop of the LOBI/MOD2 facility. No high injection system is provided during the test; three dryout situations occur: the first one is quenched by an intrinsic mechanism like loop seal clearing; the second one is quenched by the intervention of the accumulators and the third one is recovered by the actuation of the low pressure injection system.

A qualified Relap5/Mod3.2 nodalization has been used for the analysis. The comparison between the code prediction and the experimental data leads to the conclusion that the code is able to predict all the significant aspects of the transient, with the exception of the first dryout phenomenon.

The present one constitutes the fourth analysis related to Small Break LOCA having similar characteristics (counterpart tests), e.g. refs. [20], [21] and [22].

Basically, the main conclusions achieved in previous analyses are confirmed by the present one:

- the Relap5/Mod3.2 has full capability in predicting the Relevant Thermalhydraulic Aspects that characterize the transient;
- the above conclusion has been reached following a detailed procedure, including qualitative and quantitative evaluation of accuracy;
- a limited set of sensitivity calculations has been carried out in the present case, considering the reasonable agreement reached in the reference calculation and the results of sensitivity analyses performed and documented in the above mentioned studies: the here considered sensitivity studies do not bring important advances in understanding code capabilities;
- minor discrepancies between measured and calculated trends, judged to be reasonable and acceptable, have been discussed in the text.

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LIST OF ABBREVIATIONS

AA	Average Amplitude
ACC	Accumulator
ATWS	Anticipated Transient Without Scram
BL	Broken Loop
CAMP	Code Assessment and Maintenance Program
CCFL	Counter Current Flow Limitation
CSNI	Committee on the Safety of Nuclear Installations
DC	Downcomer
DCMN	Dipartimento Costruzioni Meccaniche e Nucleari
DP	Differential Pressure
ECCS	Emergency Core Cooling Systems
FFT	Fast Fourier Transform
HPIS	High Pressure Injection System
ICAP	International Code Assessment and Application Program
IL	Intact Loop
INEL	Idaho National Engineering Laboratories
IPA	Integral parameter
ISP	International Standard Problem
ITF	Integral Test Facility
$K_{reverse}$	Reverse form loss coefficient
LOCA	Loss Of Coolant Accident
LPIS	Low Pressure Injection System
MFWIV	Main Feed Water Injection Valve
NA	Not Available
NPP	Nuclear Power Plant
NRC	Nuclear Regulatory Commission
PORV	Pressurizer Operated Relief Valve
PRZ	Pressurizer
SG	Steam Generator
SVP	Single Valued Parameter
TSE	Time Sequence of Events
UH	Upper Head
WF	Weighted Frequency

SUBSCRIPTS

A_R	break area
c	core
G_C	overall core inlet flow rate
P_R	break position
RL	recirculation loop
V	fluid volume
W	core power
WI	total energy supplied by the heater rods

Appendix 1

Steady state calculation

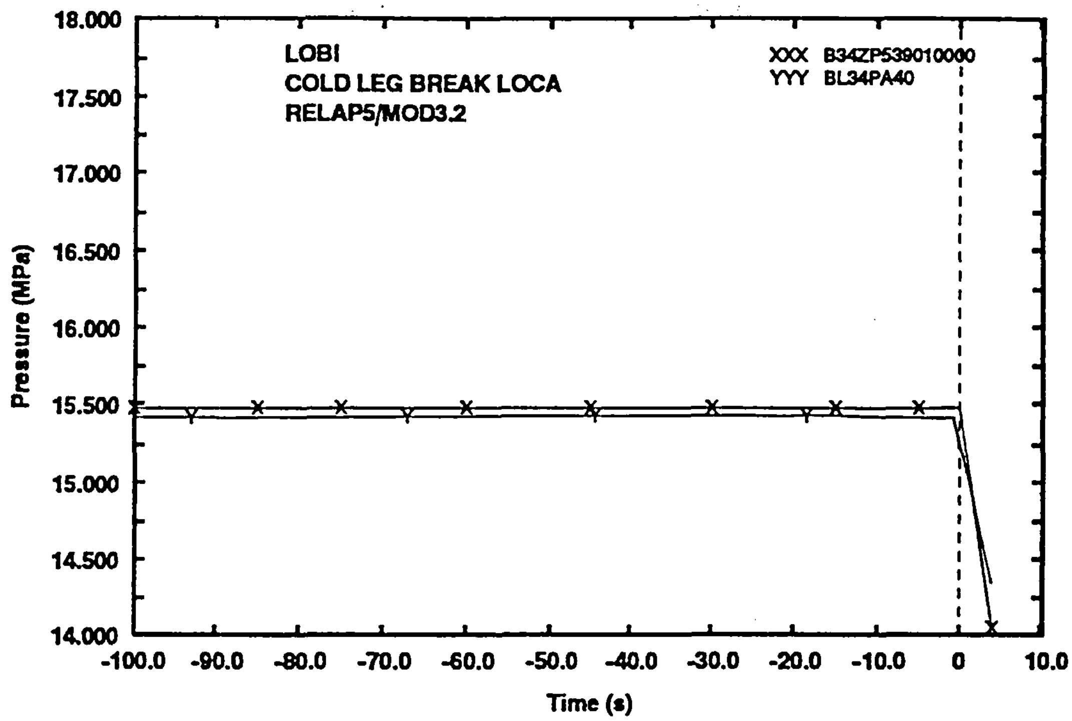

Fig. 1- PRZ pressure

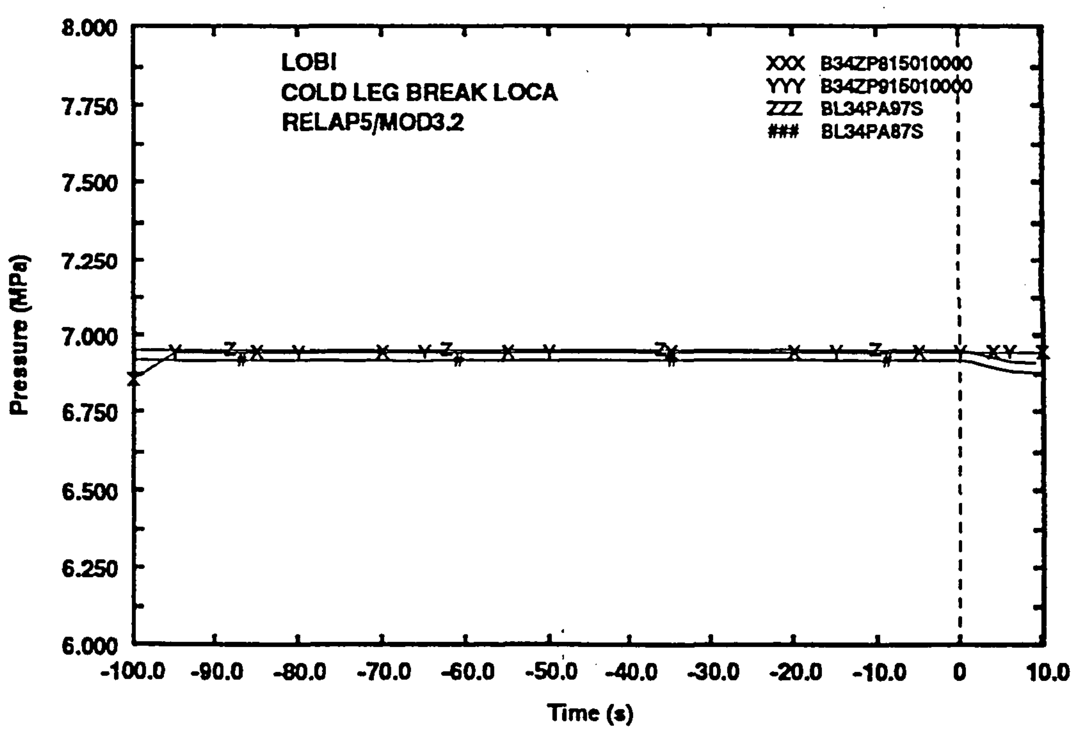

Fig. 2- SGs secondary side pressure

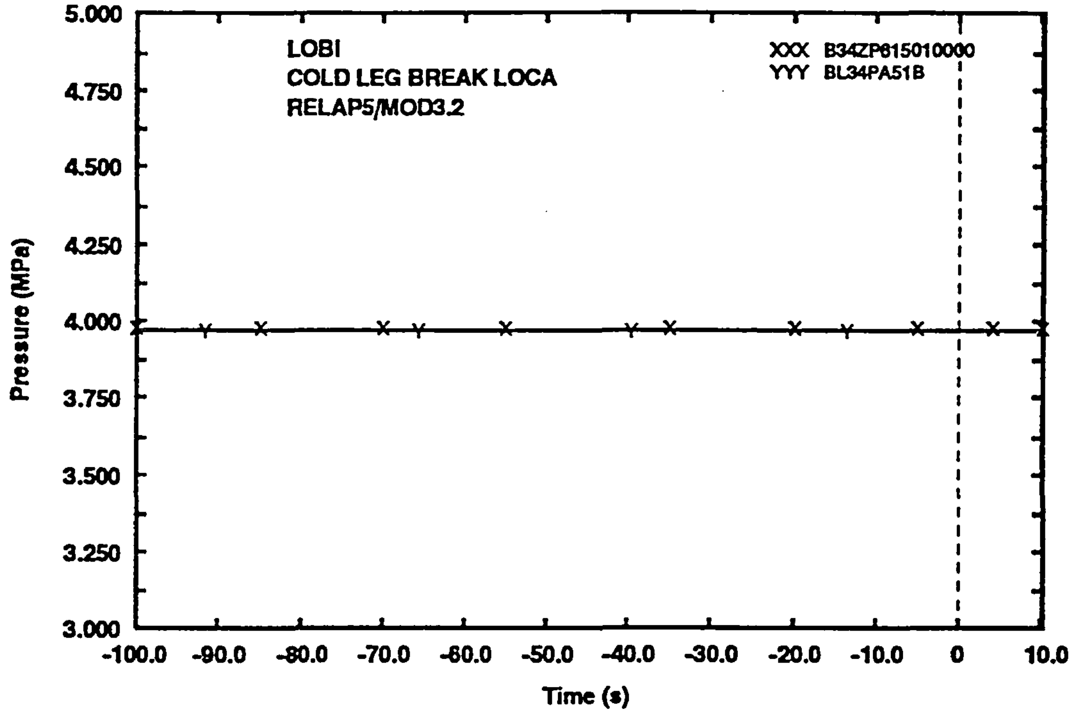

Fig. 3- Accumulator pressure

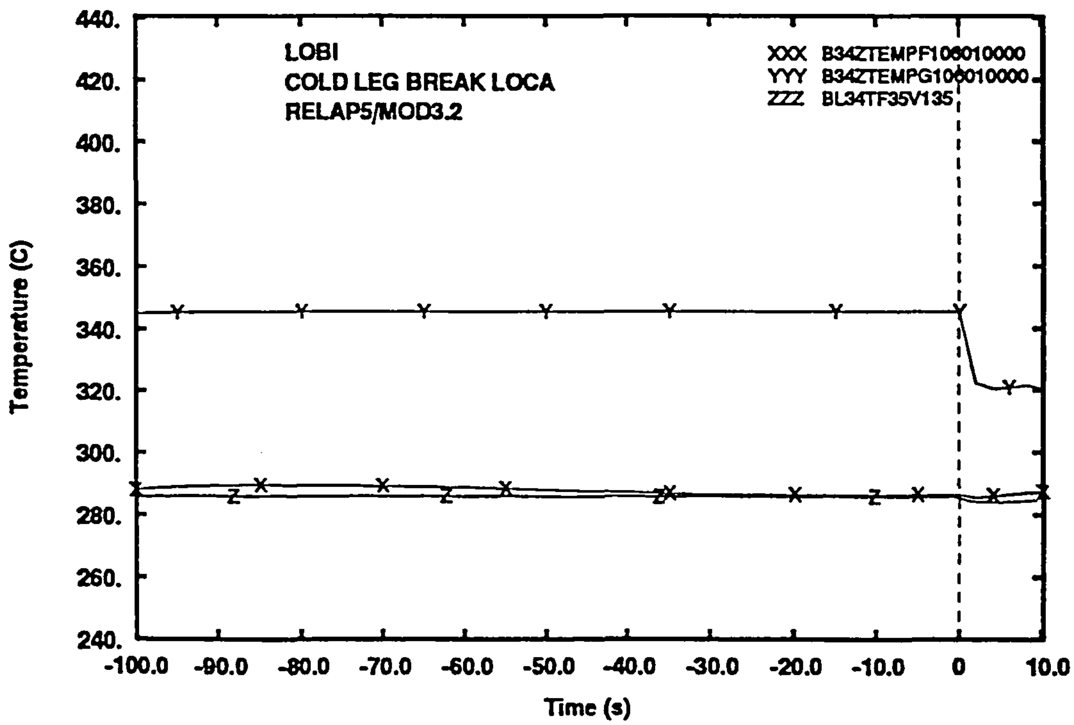

Fig. 4- Core inlet fluid temperature

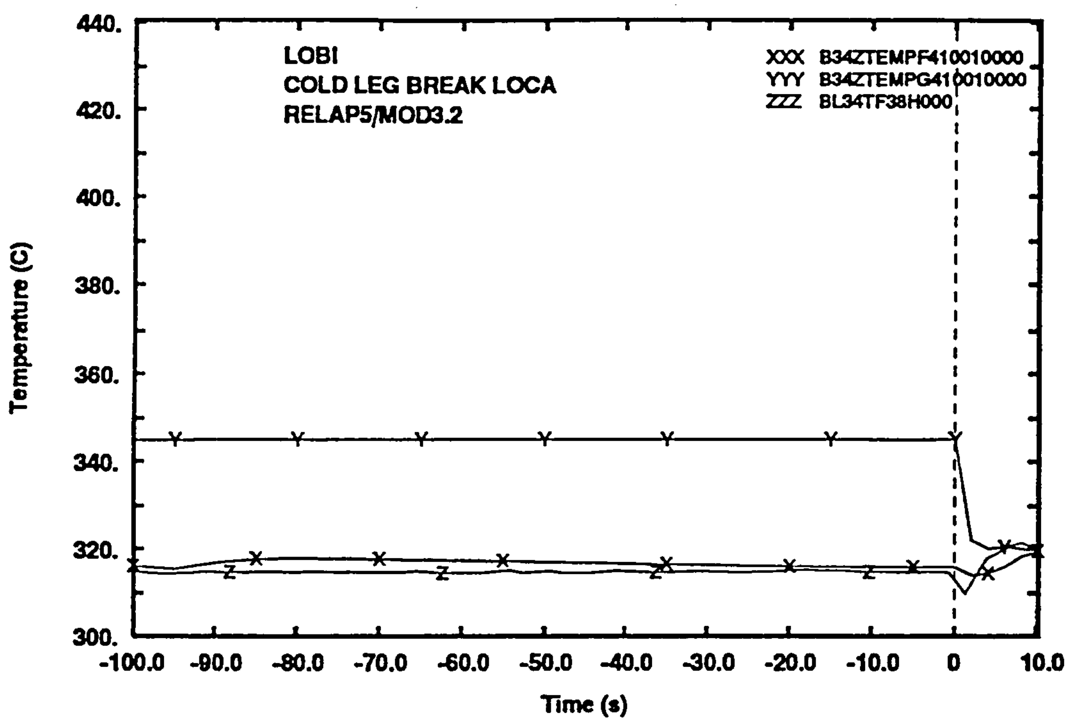

Fig. 5- Core outlet fluid temperature

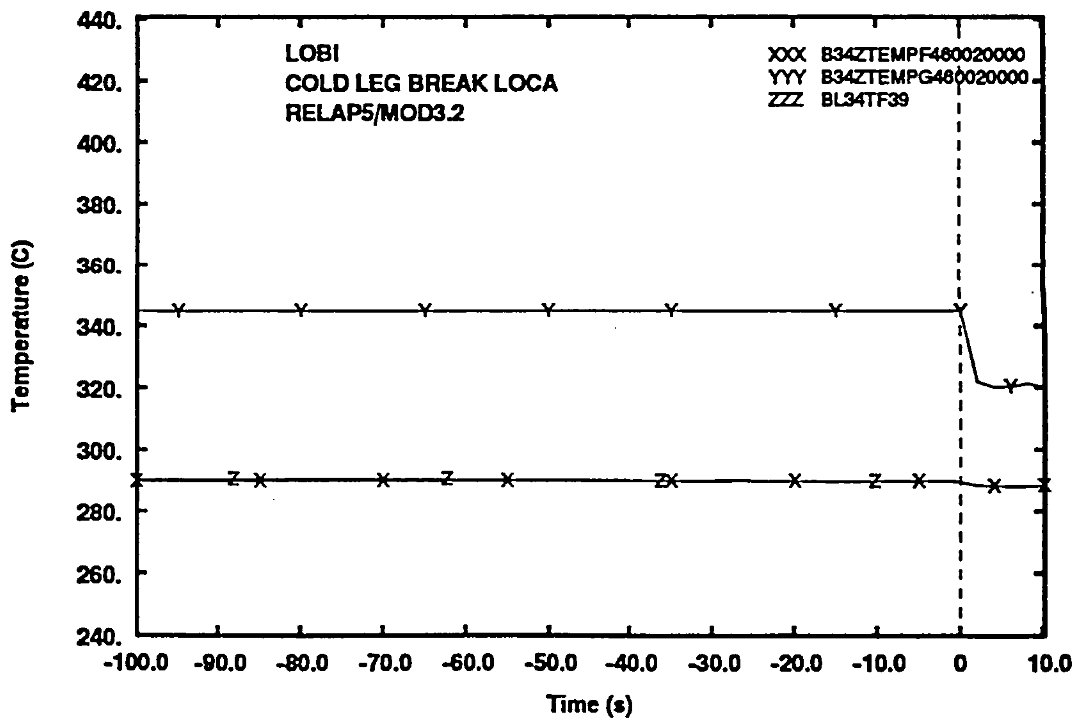

Fig. 6- Upper Head coolant temperature

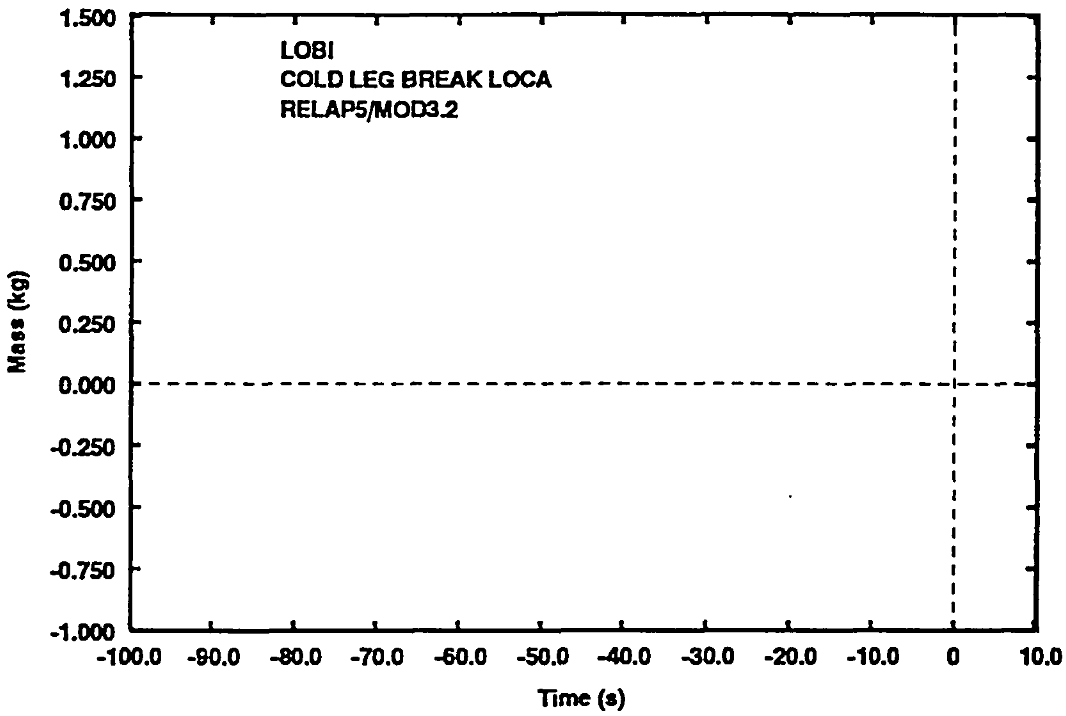

Fig. 7- Integral break flowrate (not relevant for steady state)

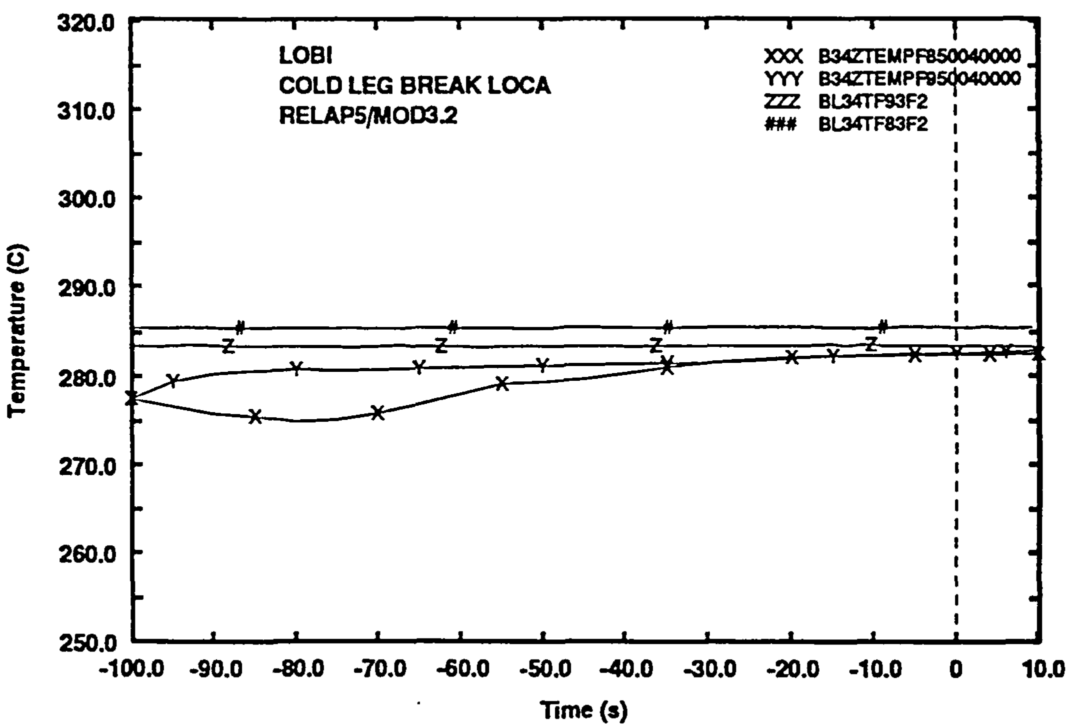

Fig. 8- SG bottom DC fluid temperature

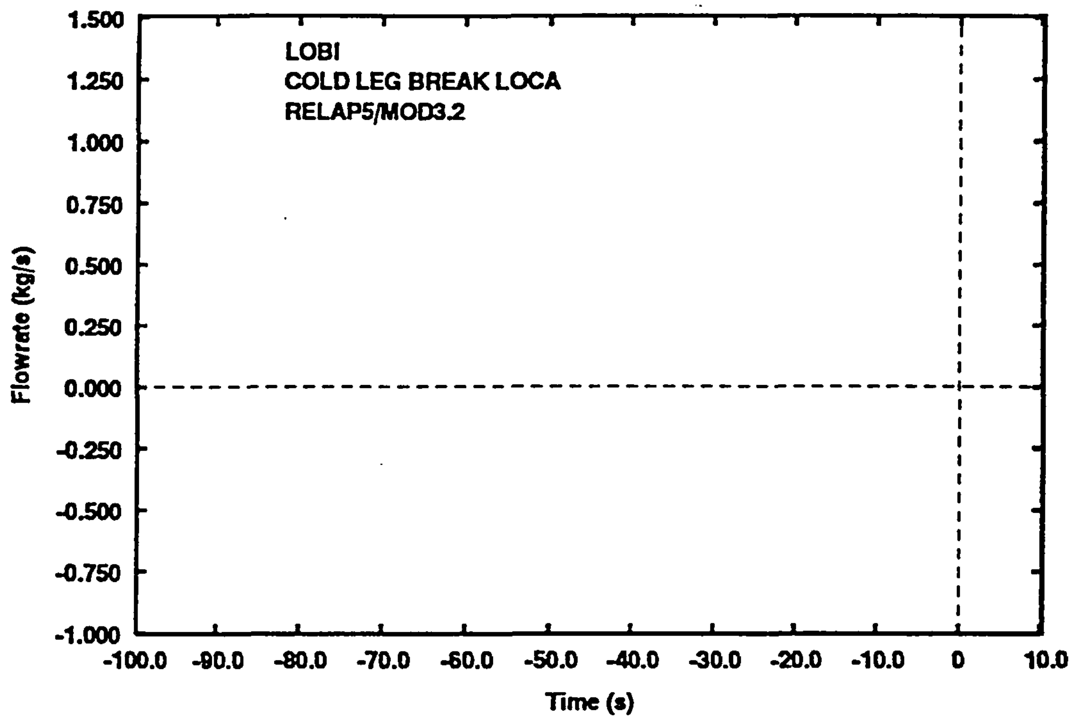

Fig. 9- Break flowrate (not relevant for steady state)

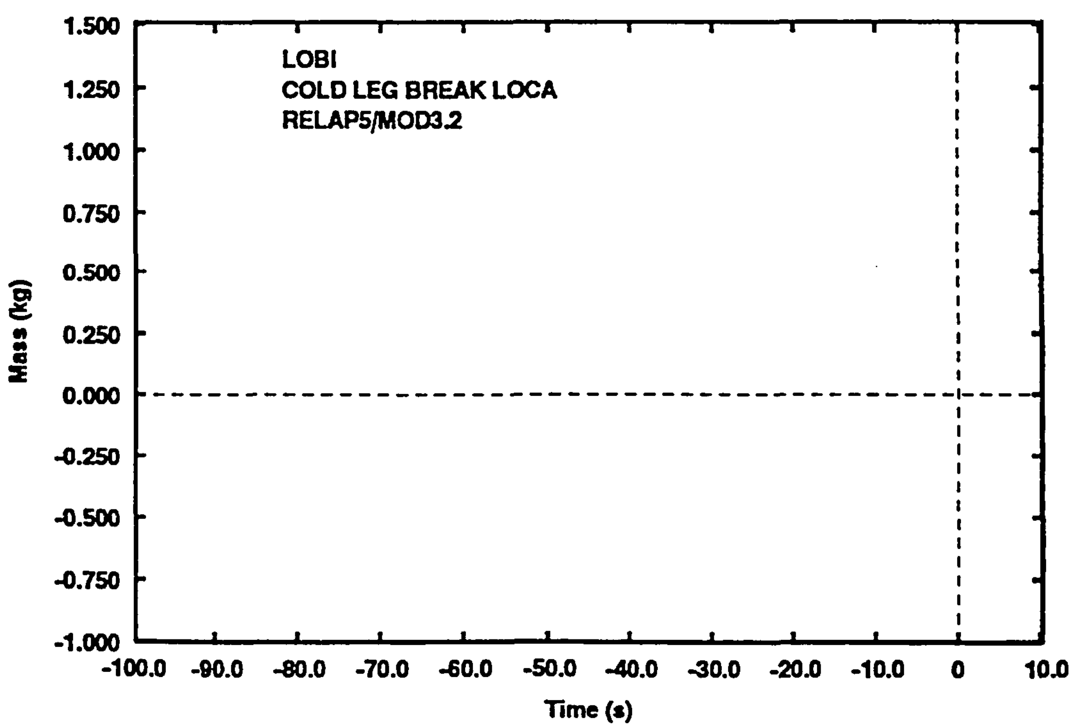

Fig. 10- ECCS integral flowrate (not relevant for steady state)

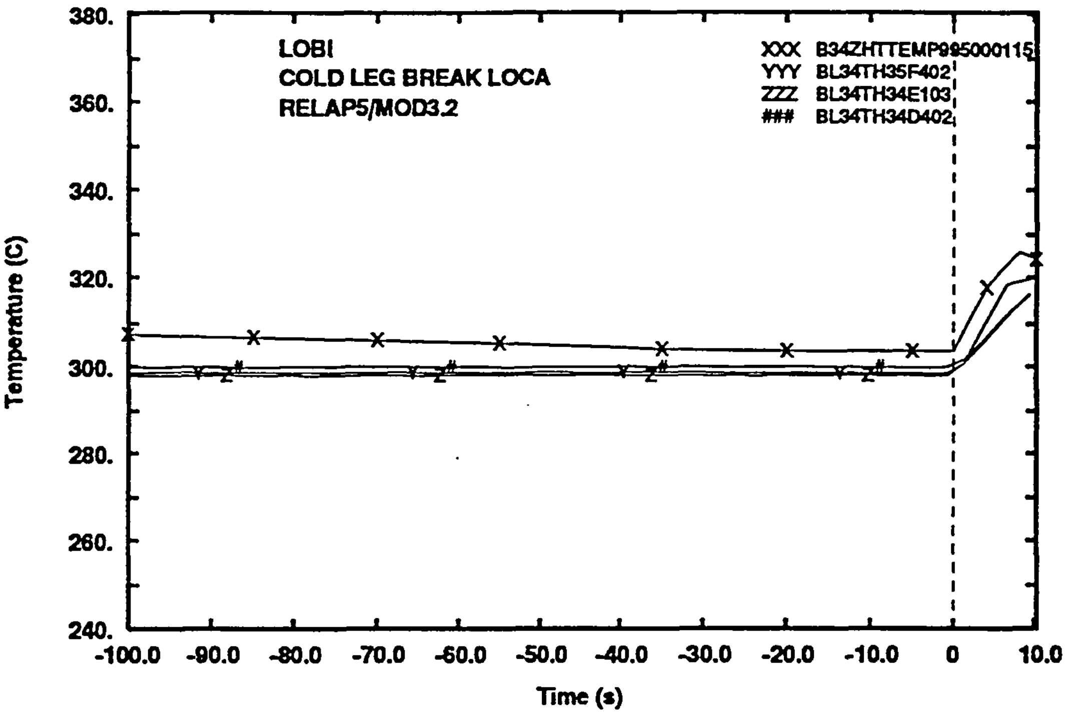

Fig. 11- Heater rod temperature (bottom level)

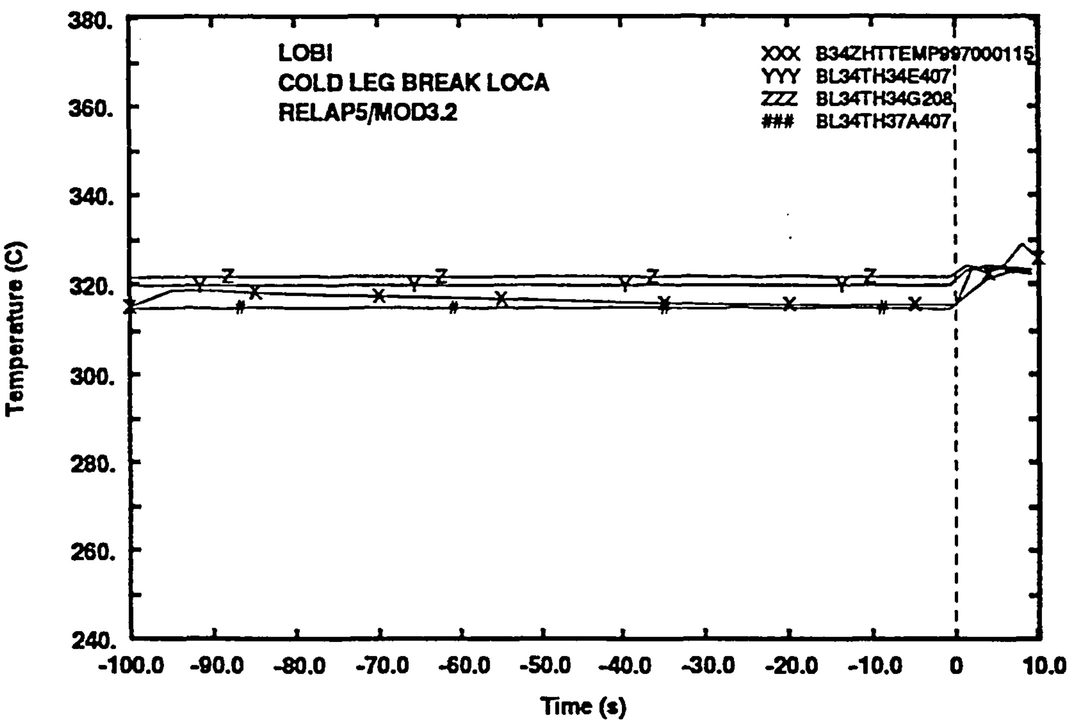

Fig. 12- Heater rod temperature (middle level)

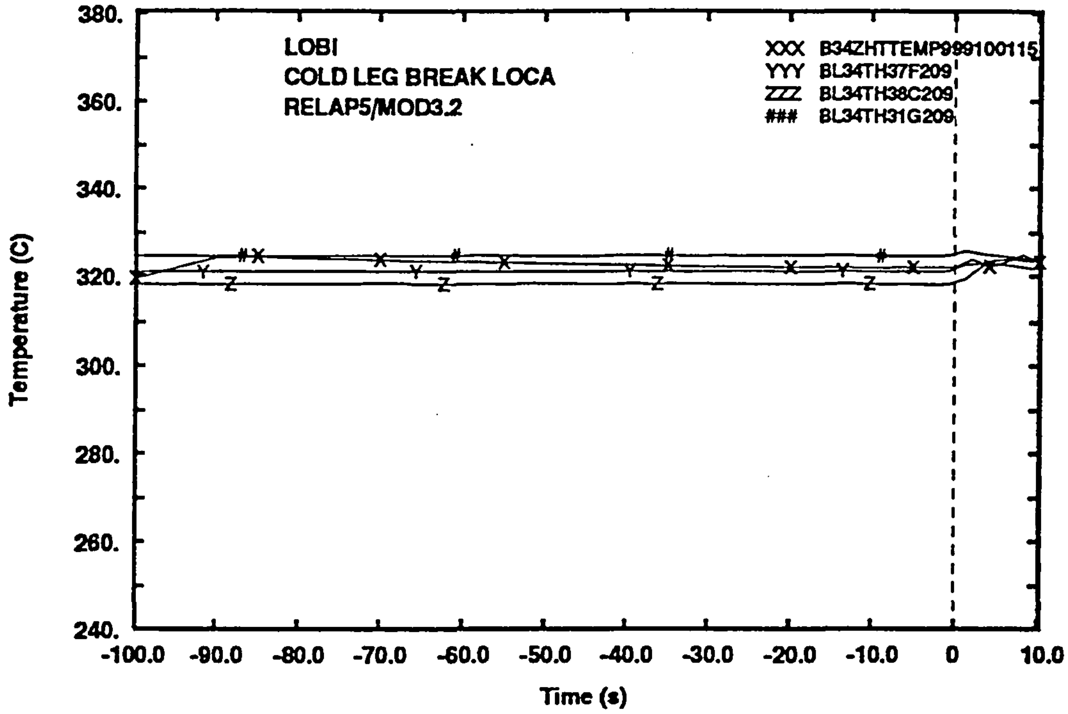

Fig. 13- Heater rod temperature (high level)

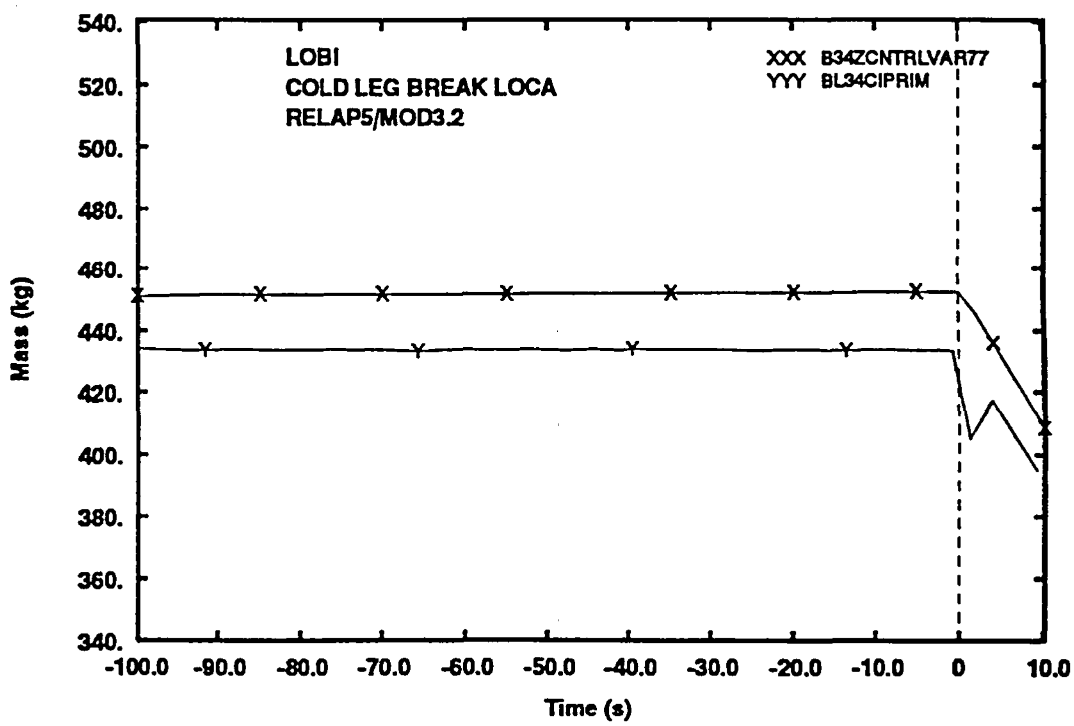

Fig. 14- Primary side total mass

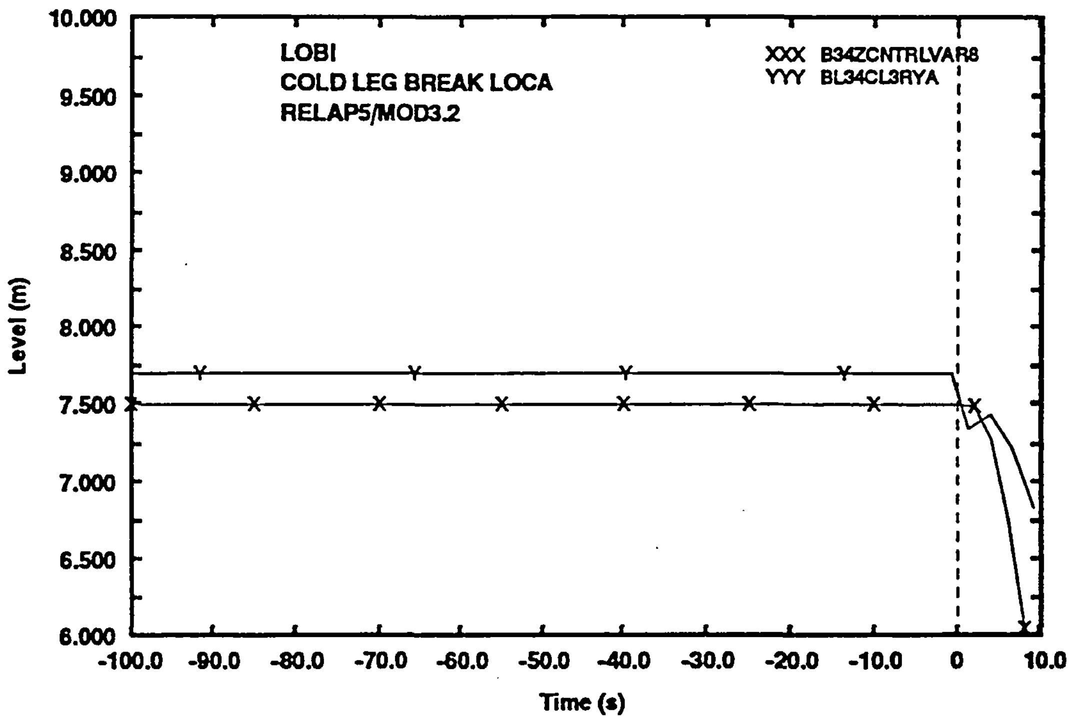

Fig. 15- Vessel riser level

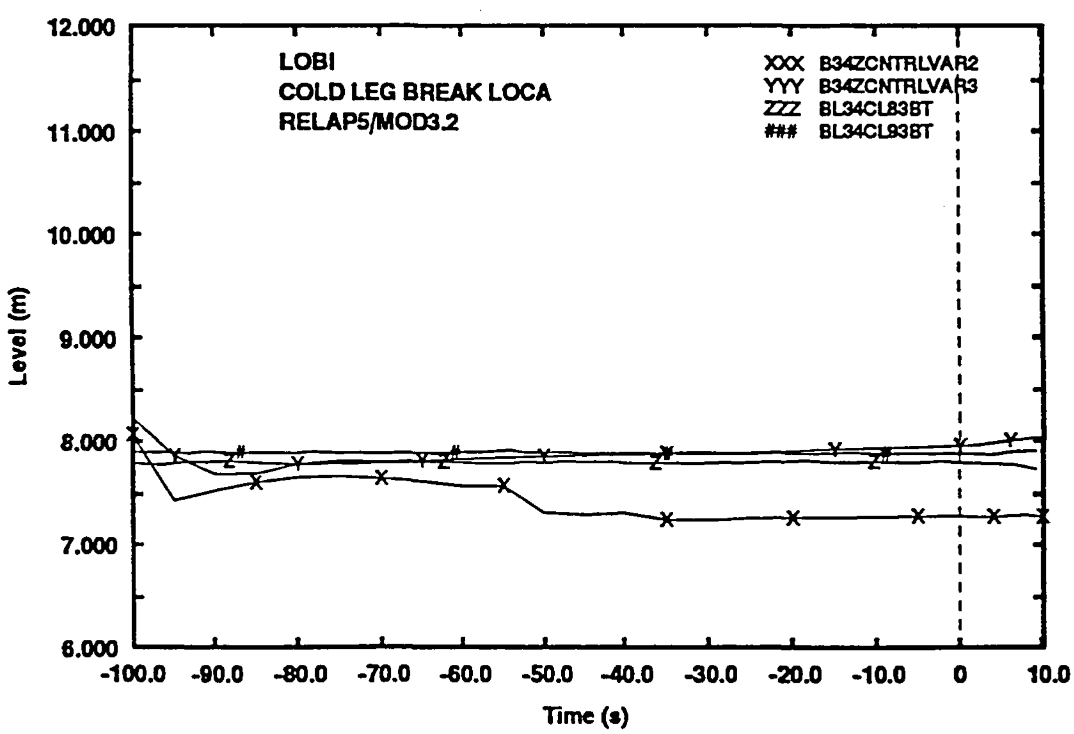

Fig. 16- SG DC level

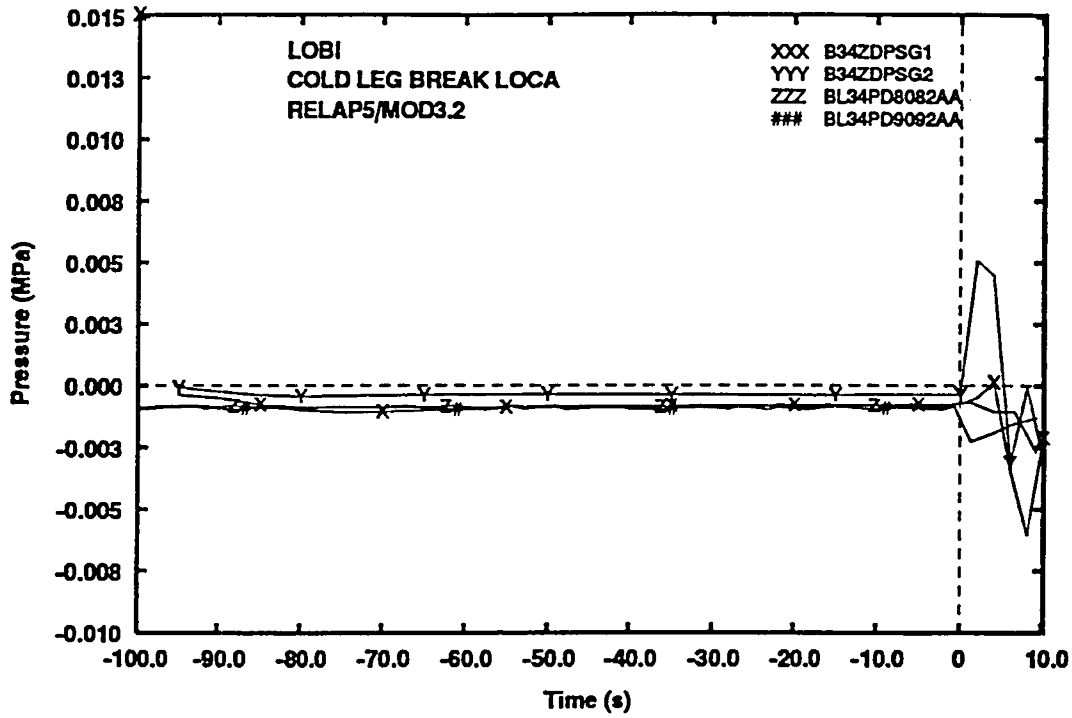

Fig. 17- Pressure drop across inlet-outlet SG

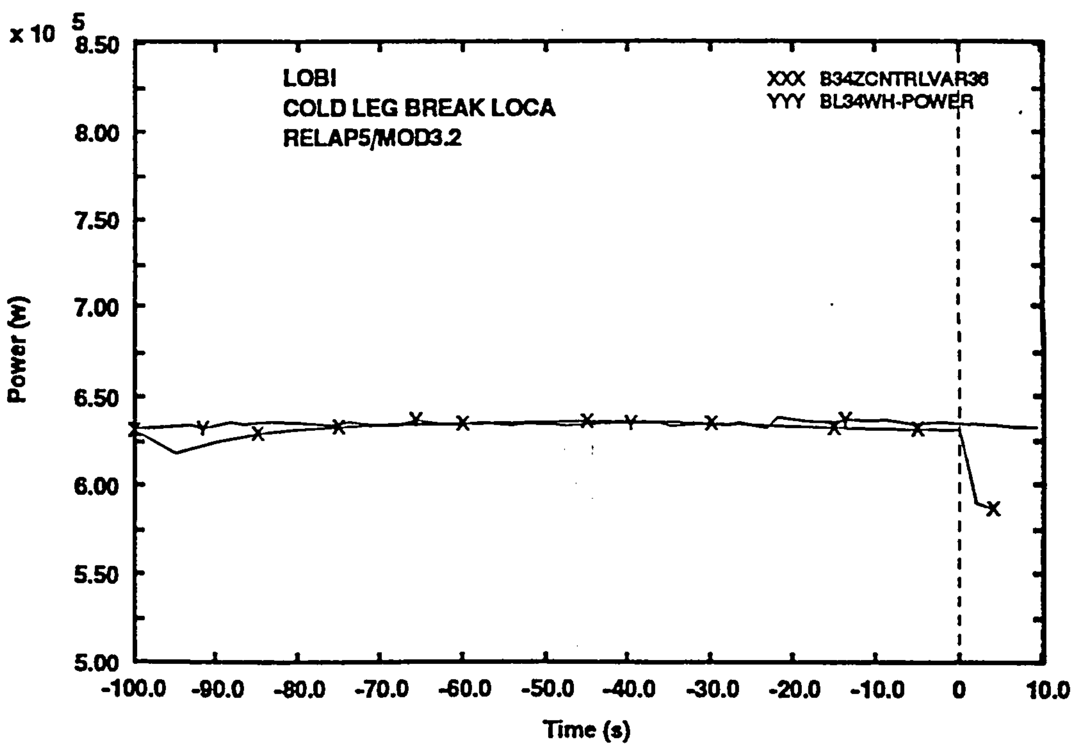

Fig. 18- Core power (exp.) and exchanged power (calc.)

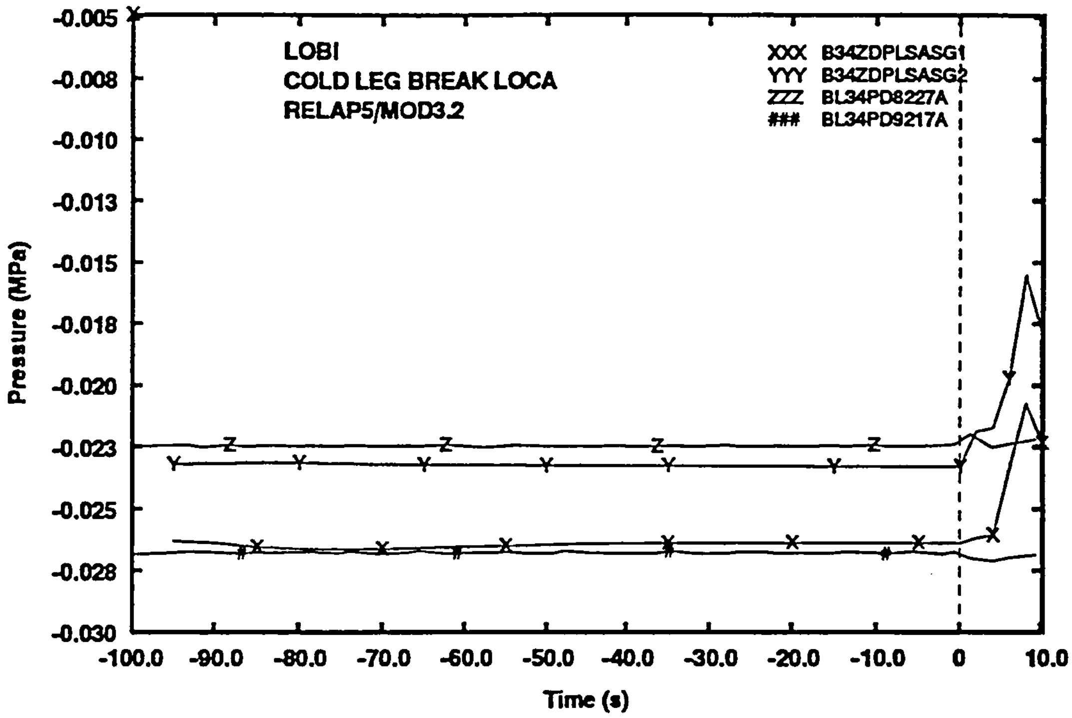

Fig. 19- Pressure drop across loop seal (ascendig side)

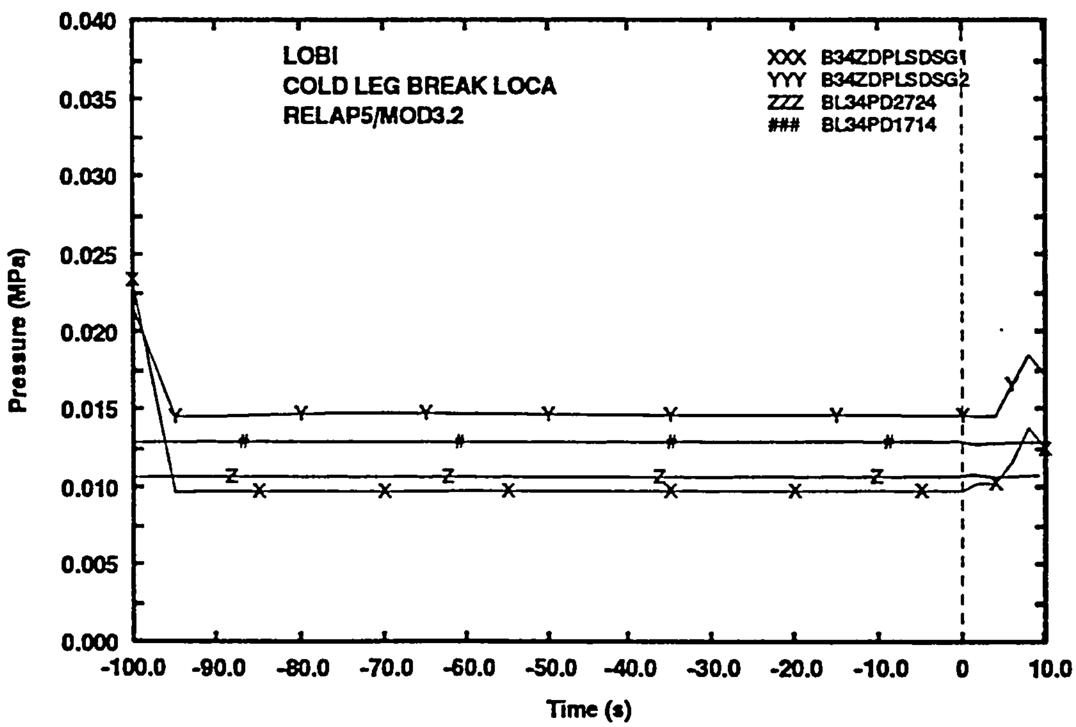

Fig. 20- Pressure drop across loop seal (descendig side)

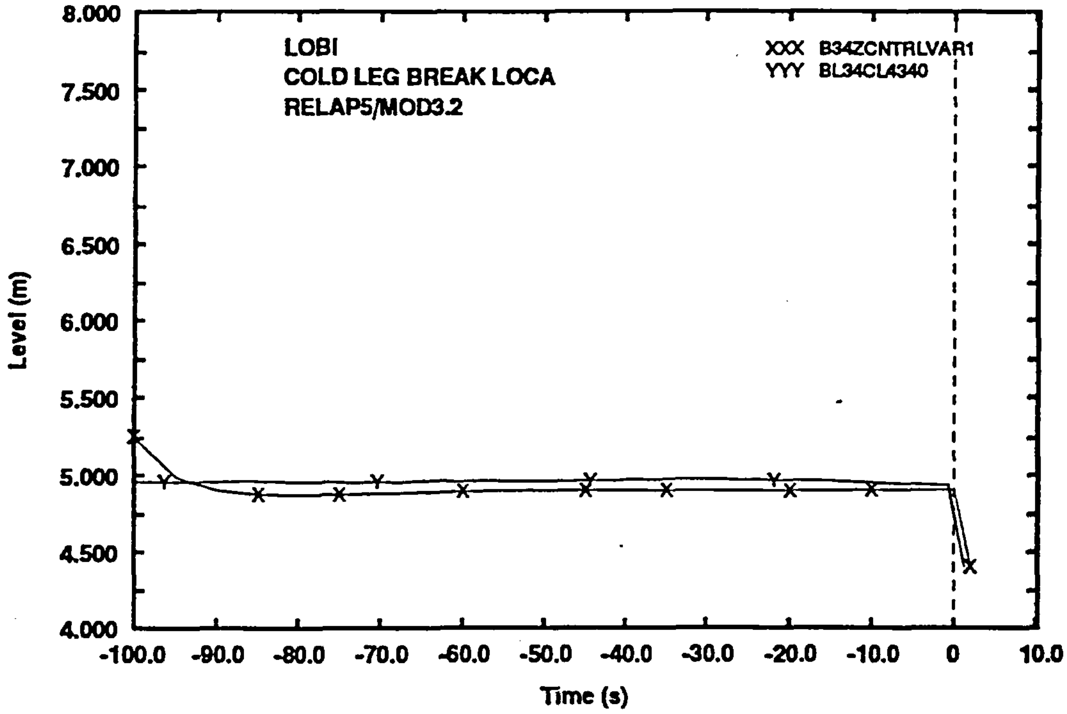

Fig. 21- PRZ level

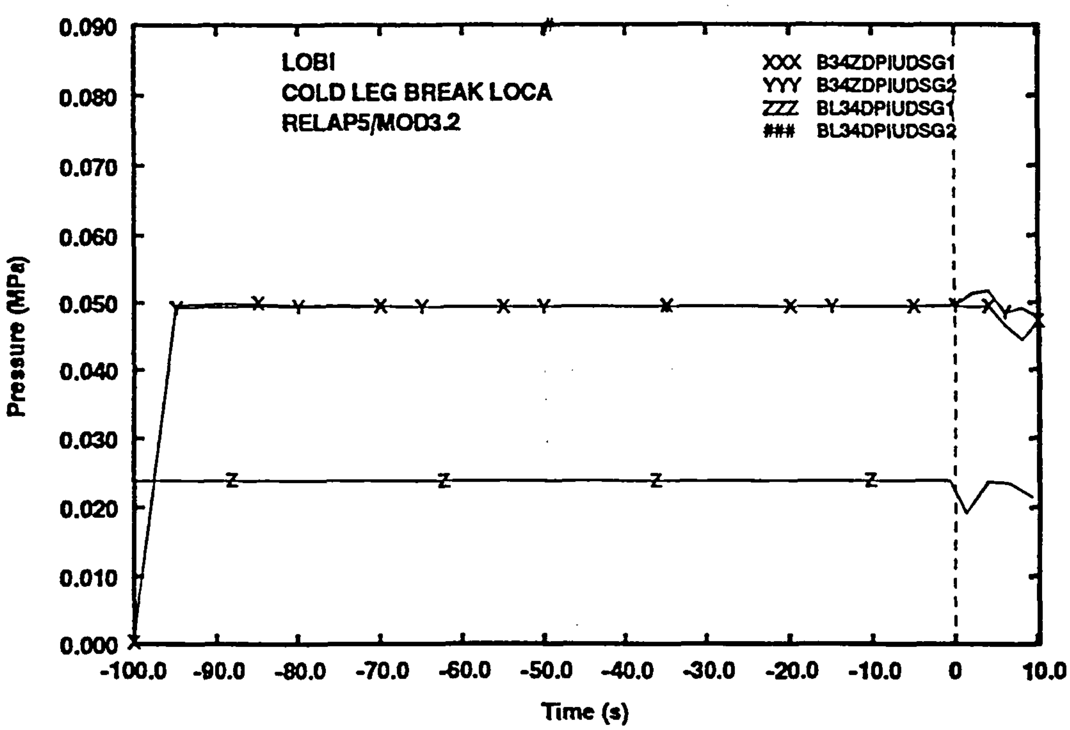

Fig. 22- Pressure drop between SG inlet plenum and Utubes top

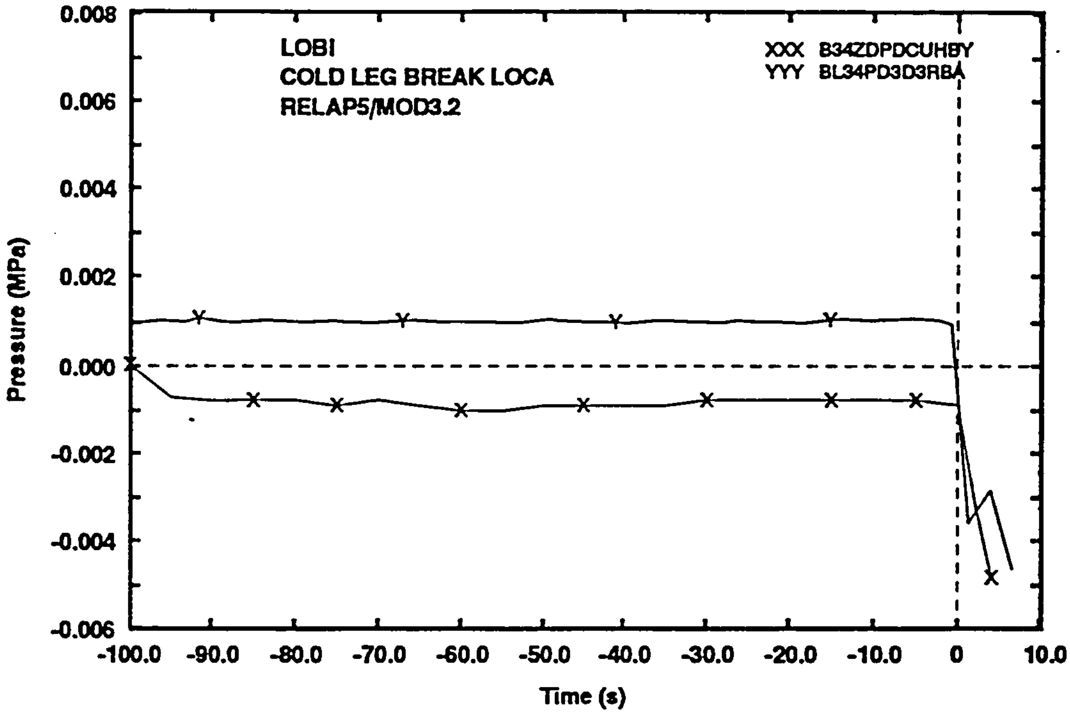

Fig. 23- Pressure drop across DC-UH bypass

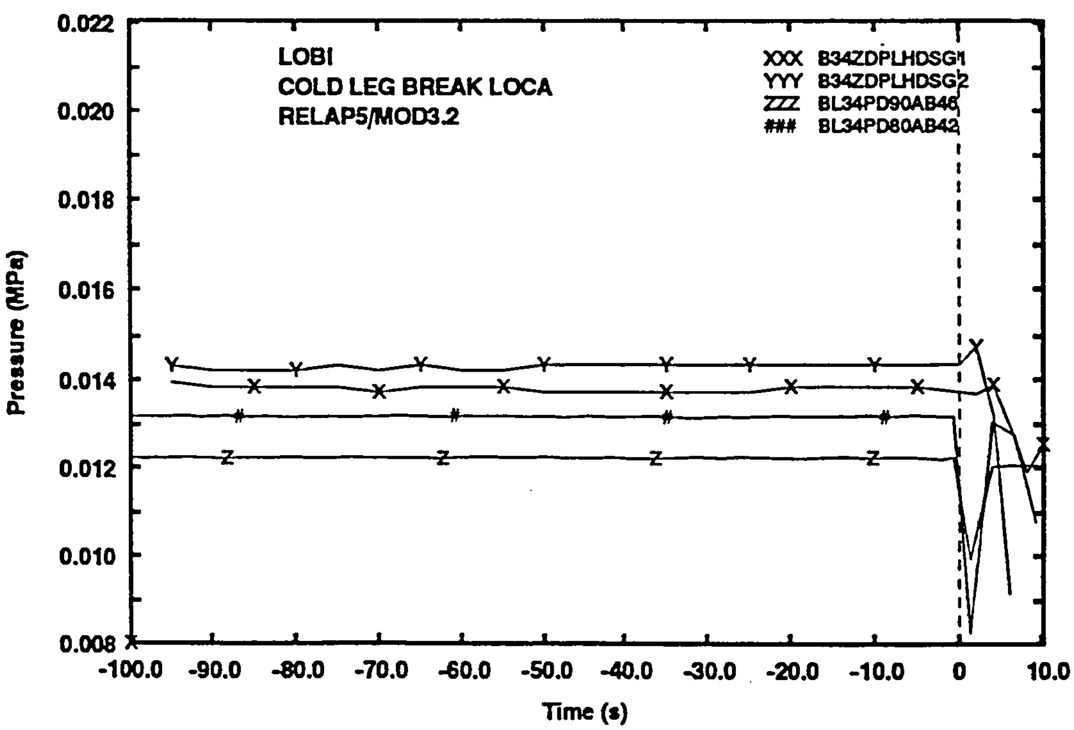

Fig. 24- Liquid hold up in SG (primary side)

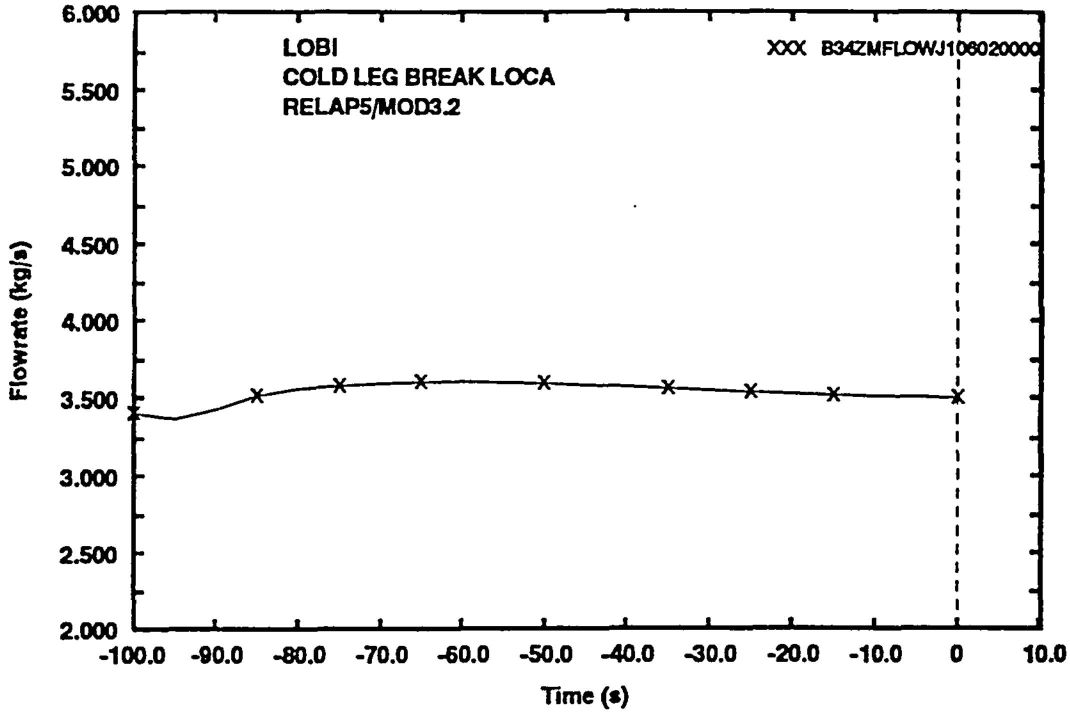

Fig. 25- Core inlet flow rate

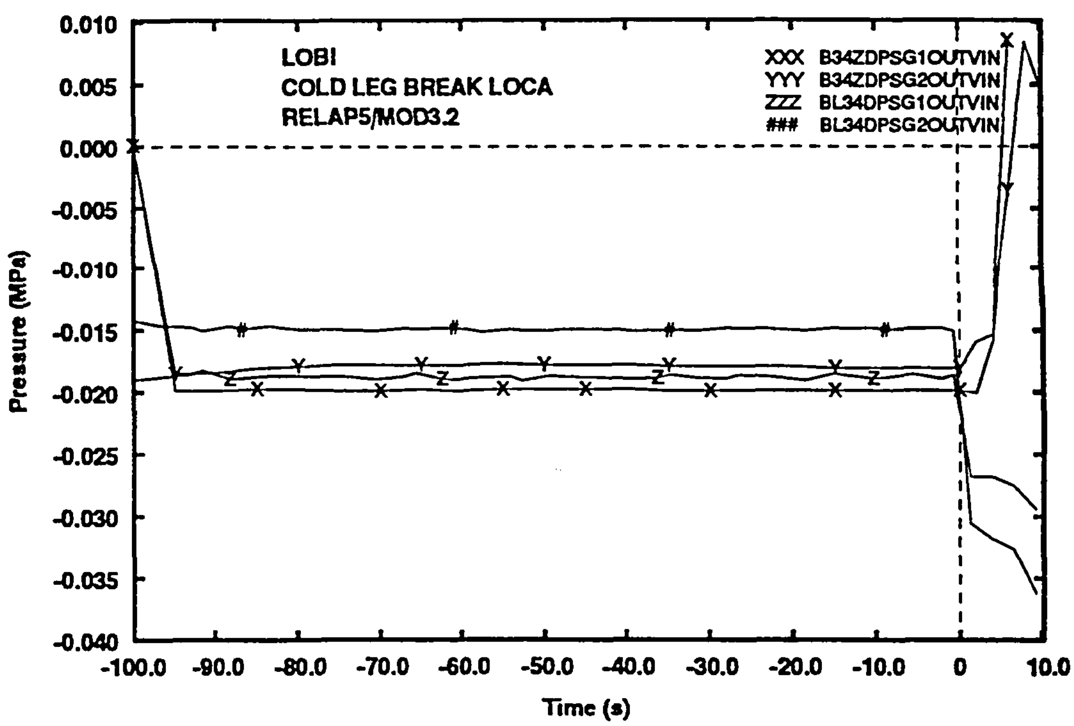

Fig. 26- pressure drop across SG outlet and vessel nozzle.

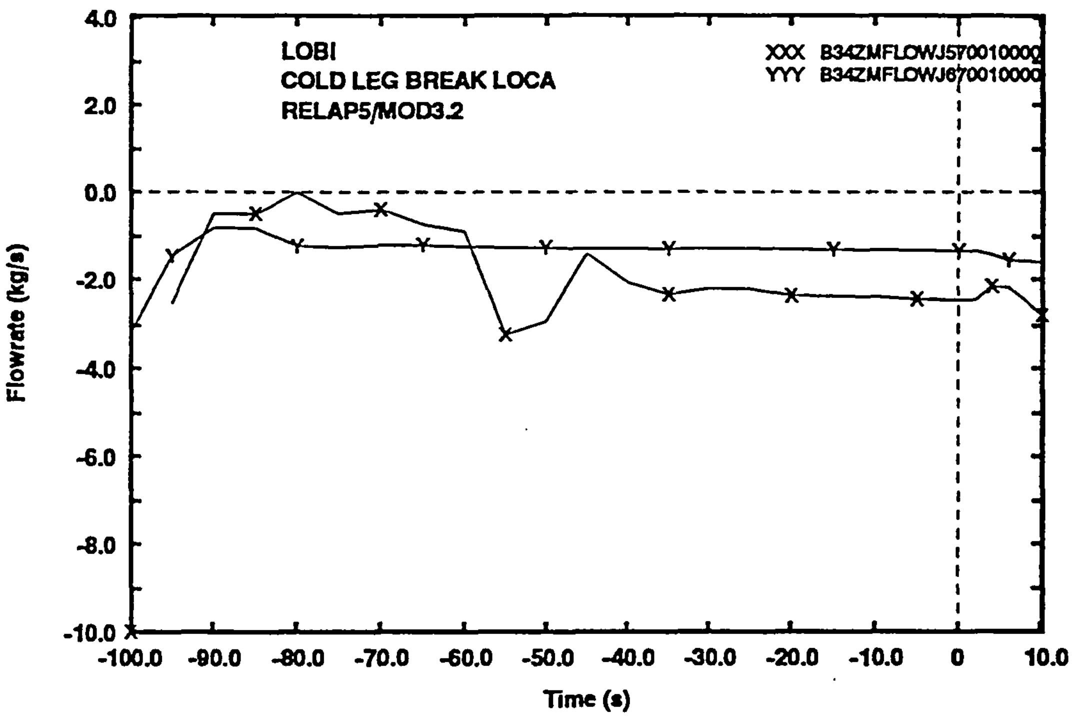

Fig. 27- SG DC flowrate

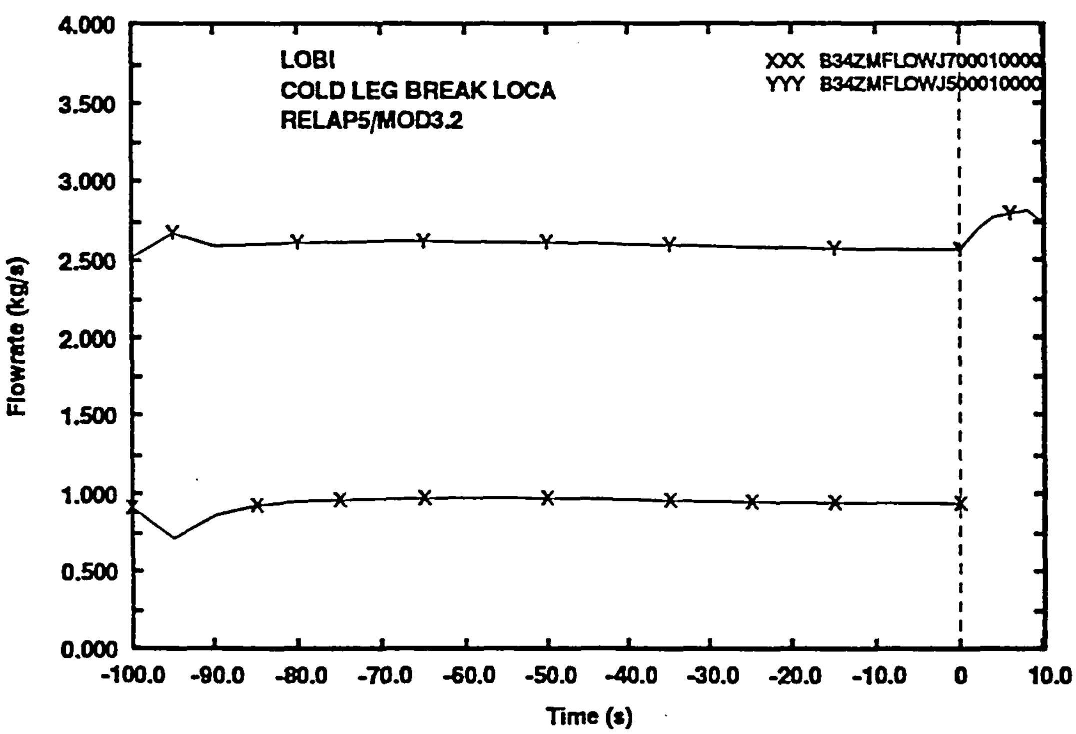

Fig. 28- Hot leg mass flowrate

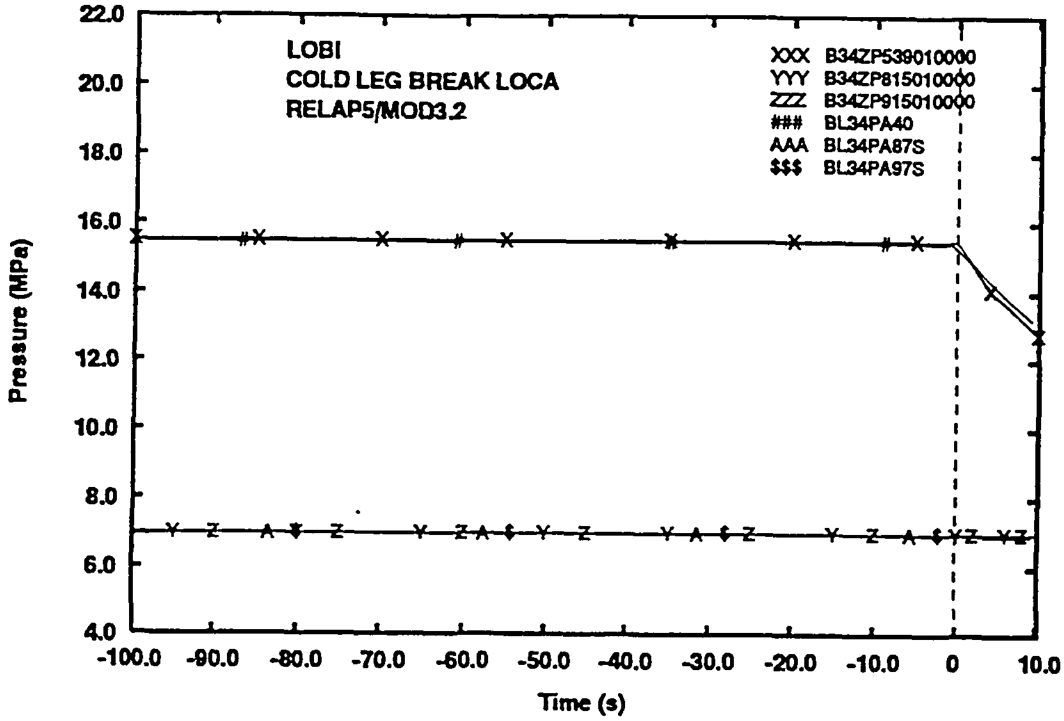

Fig. 29- Primary and secondary pressure

Appendix 2

Results of the reference calculation (run B24D)

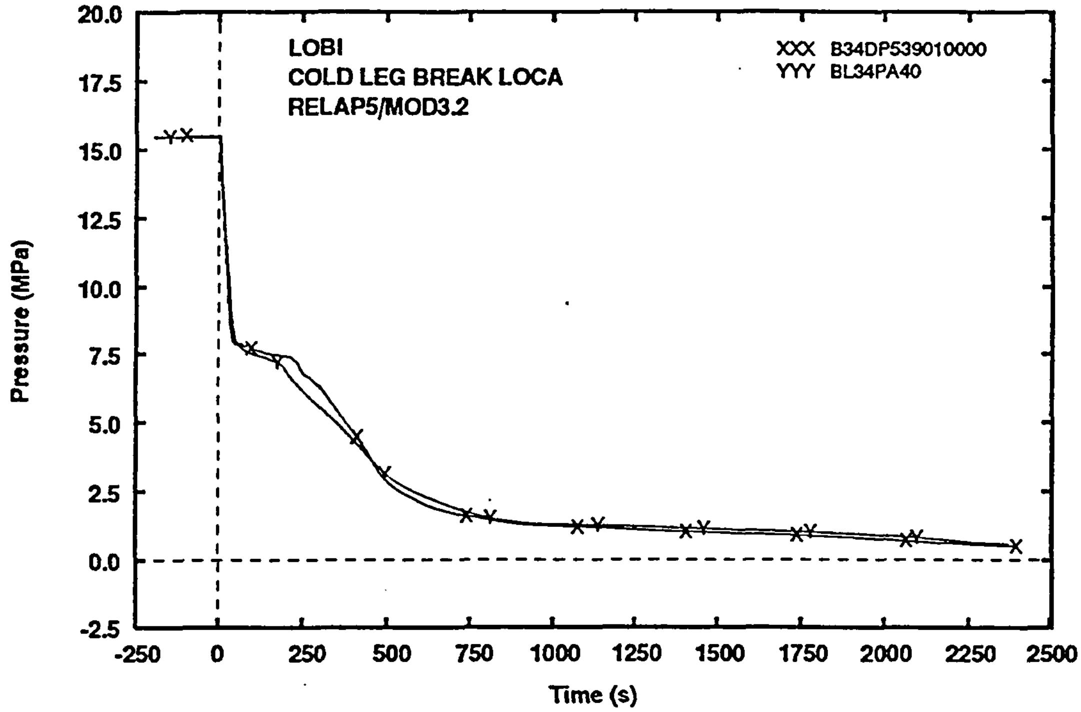

Fig. 1- PRZ pressure

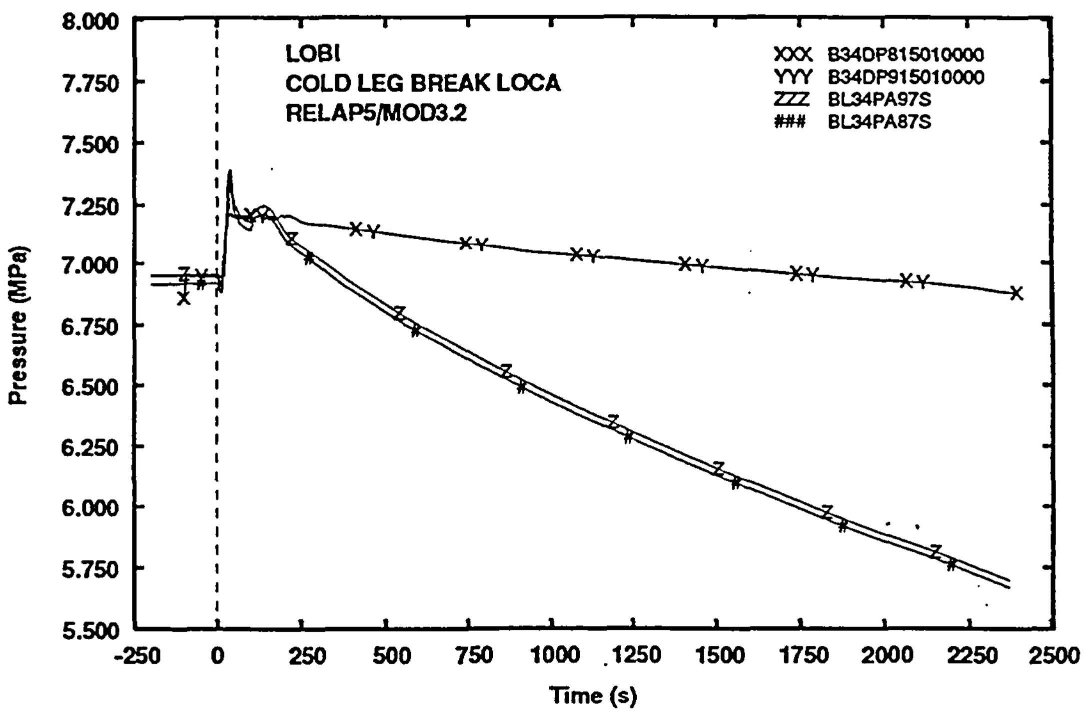

Fig. 2- SGs secondary side pressure

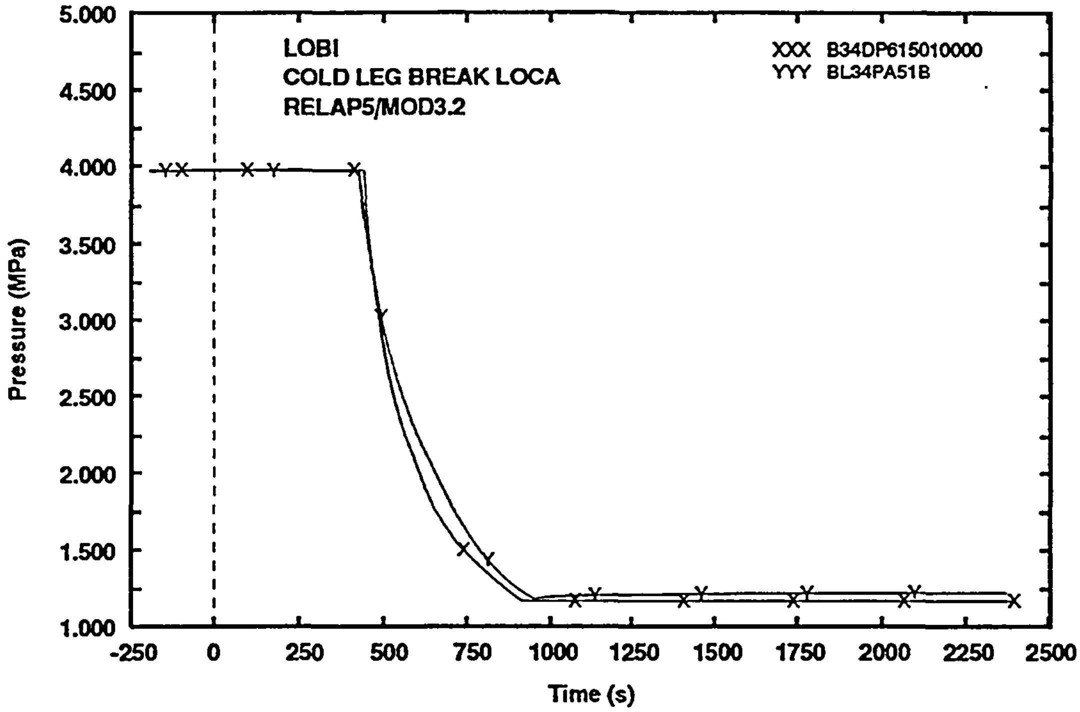

Fig. 3- Accumulator pressure

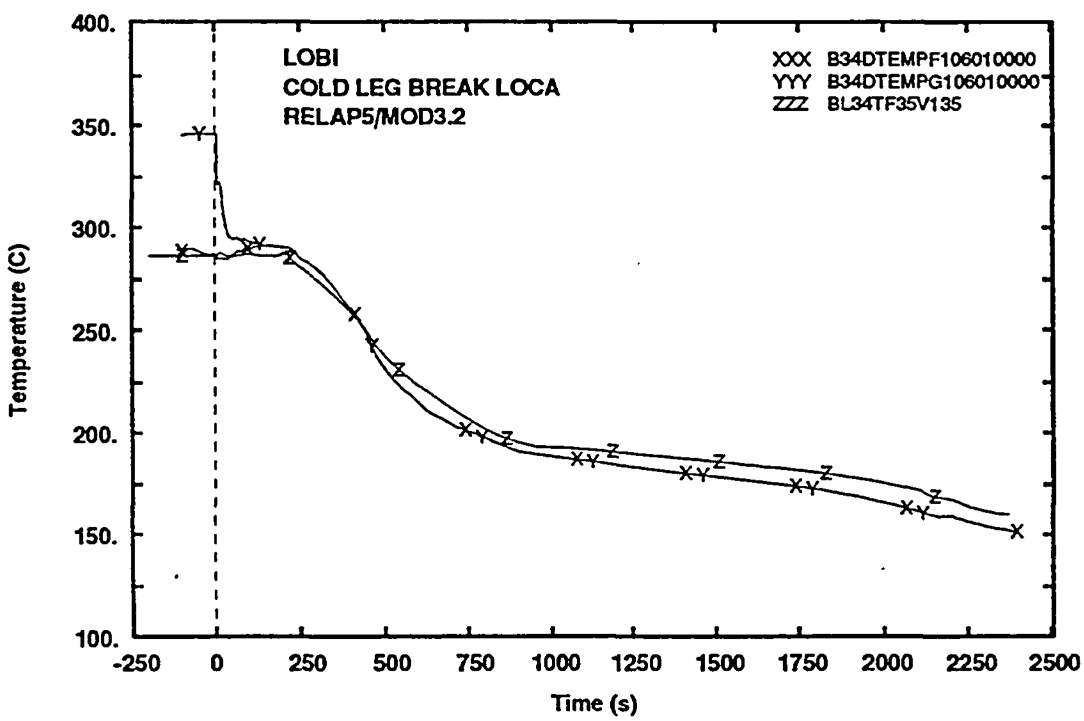

Fig. 4- Core inlet fluid temperature

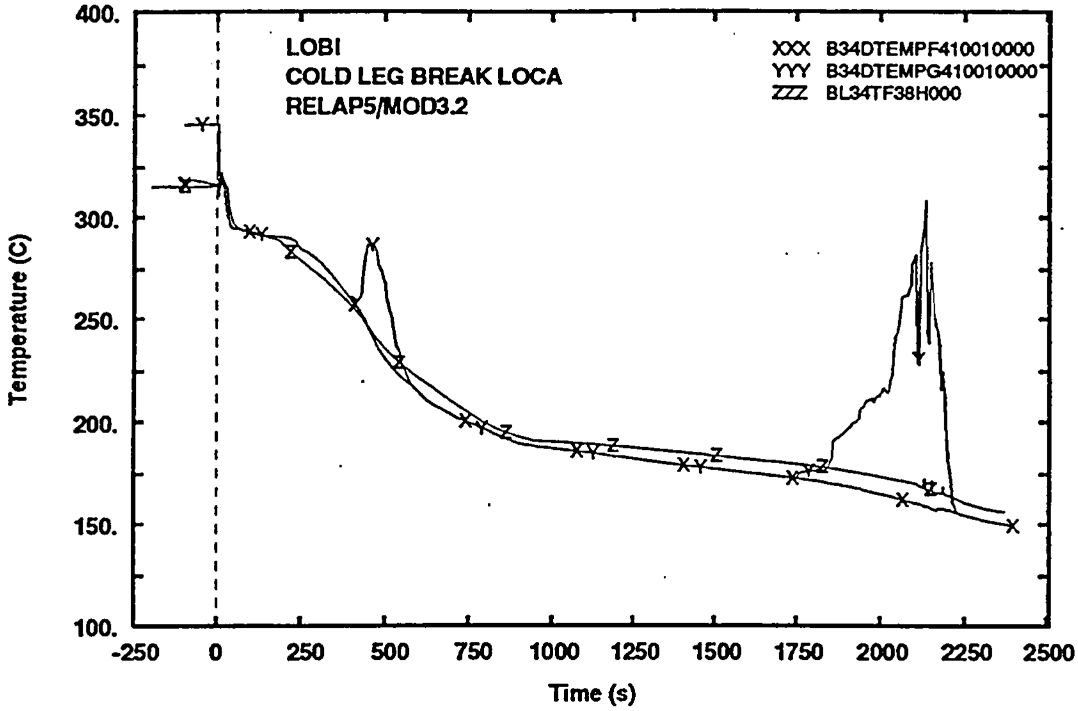

Fig. 5- Core outlet fluid temperature

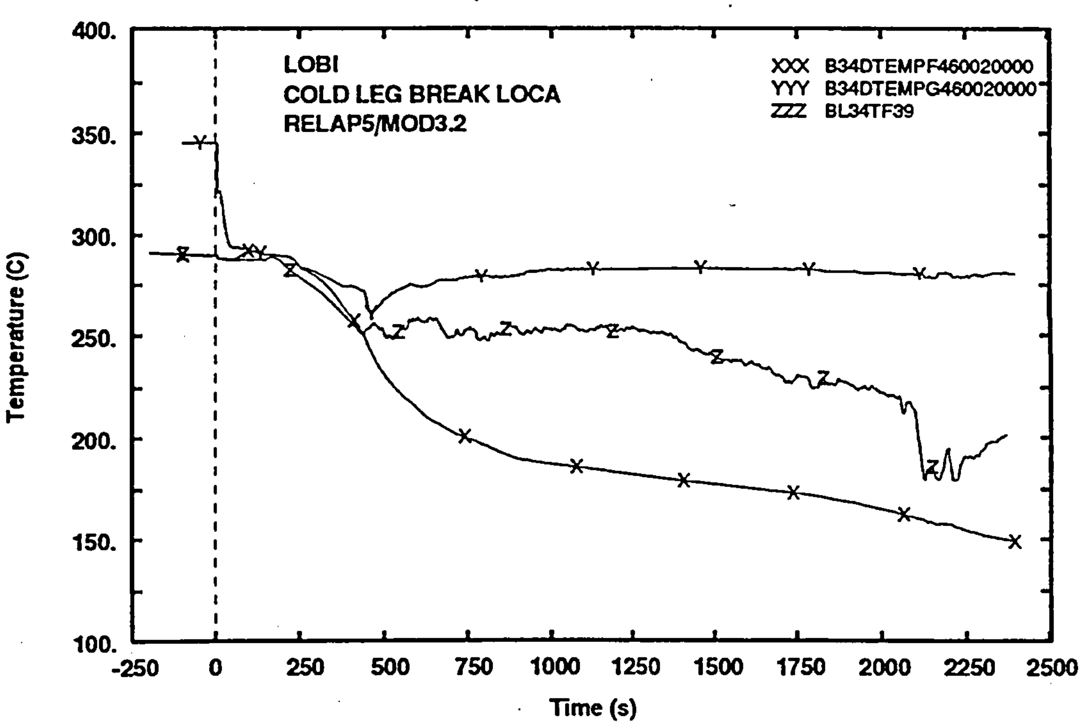

Fig. 6- Upper Head coolant temperature

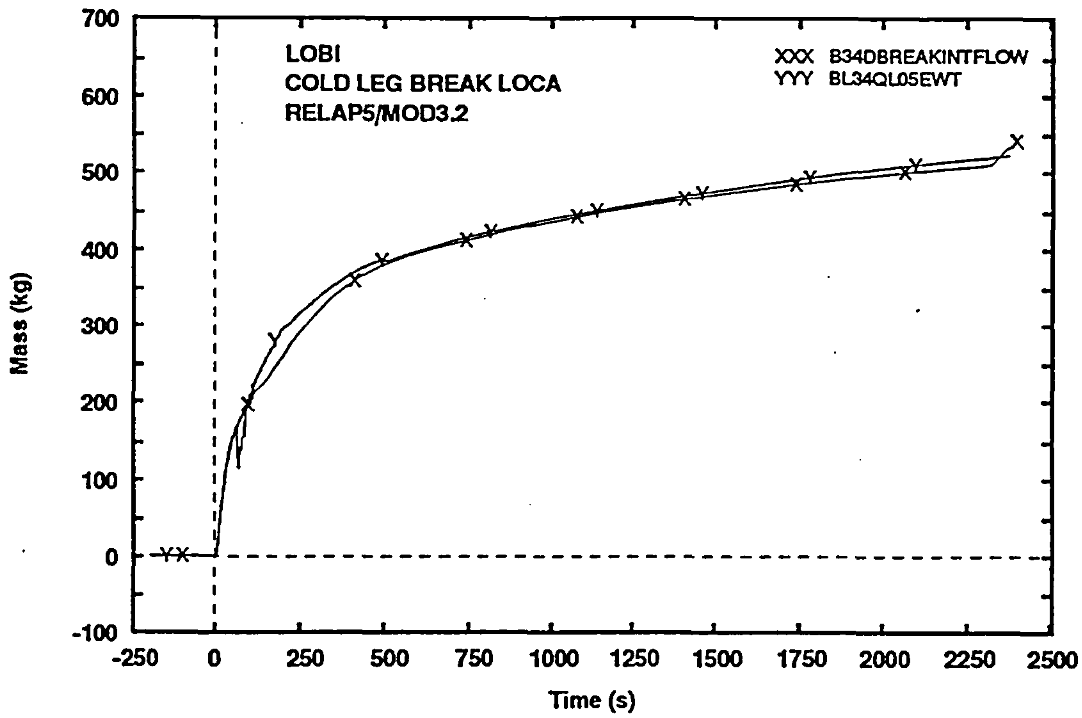

Fig. 7- Integral break flowrate

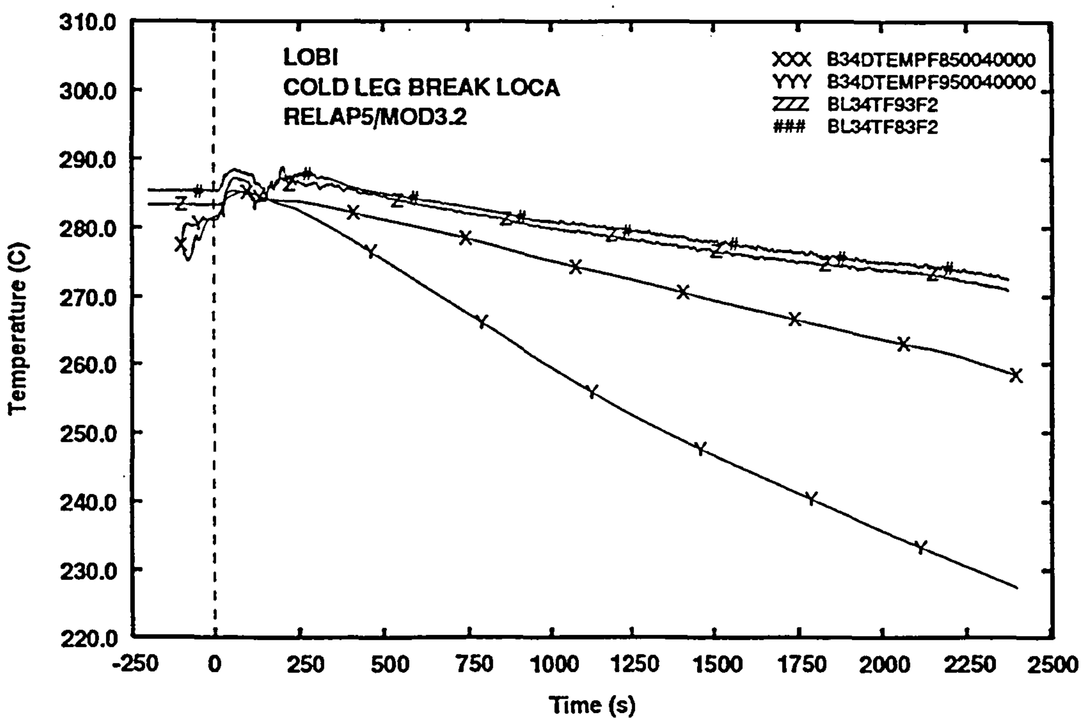

Fig. 8- SG bottom DC fluid temperature

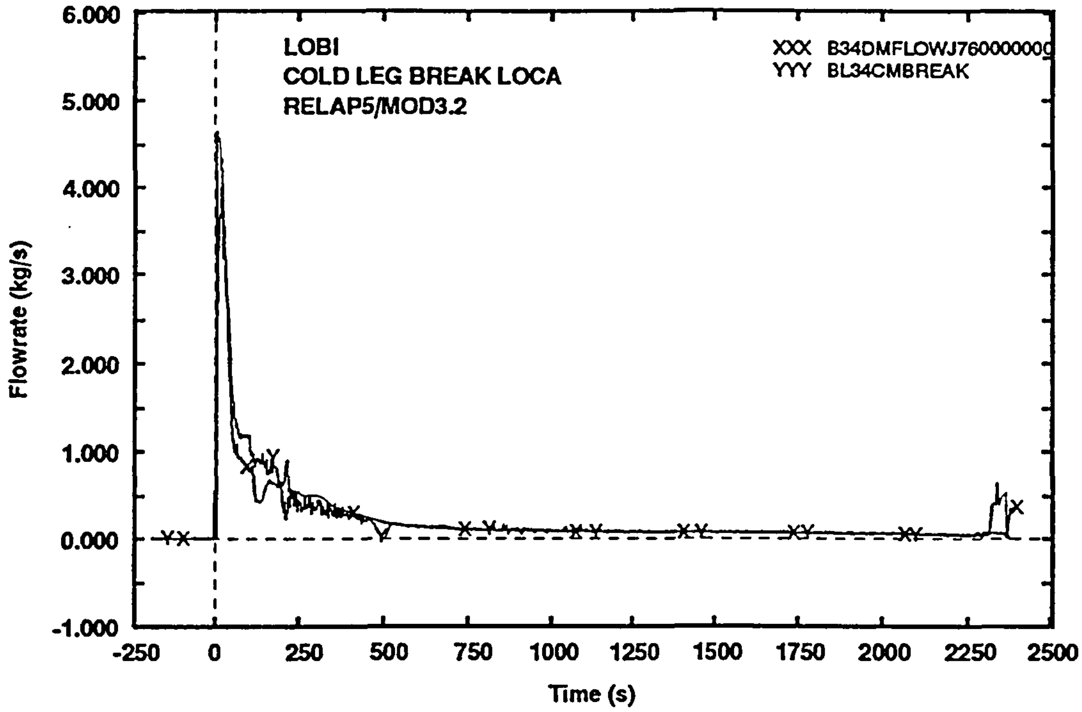

Fig. 9- Break flowrate

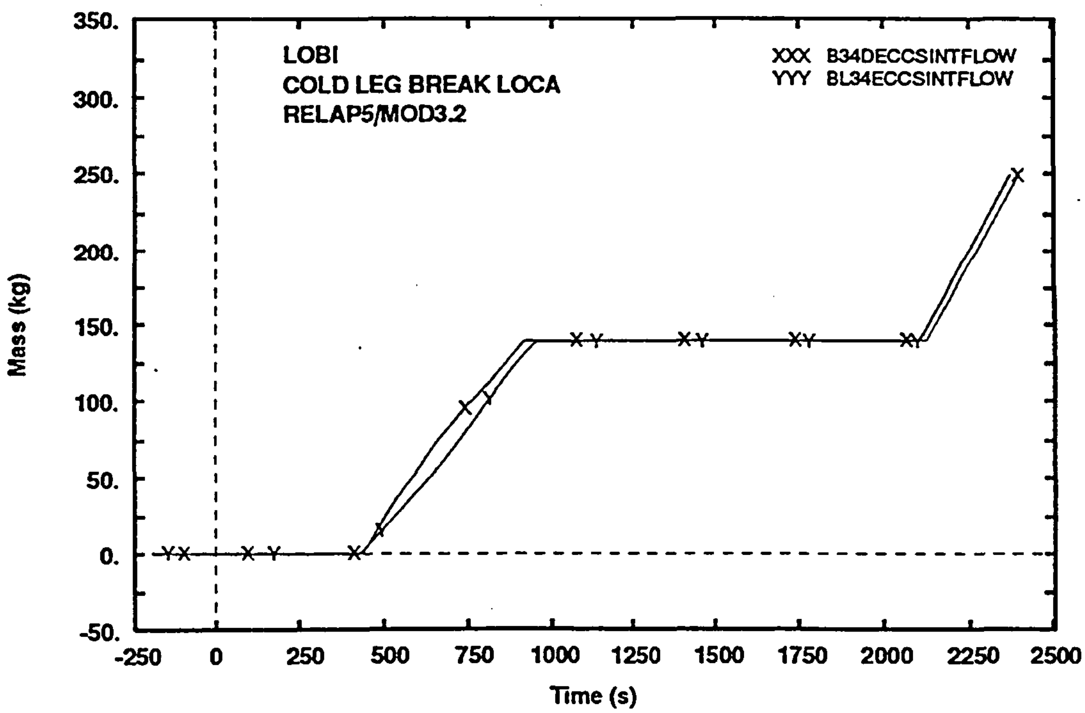

Fig. 10- ECCS integral flowrate

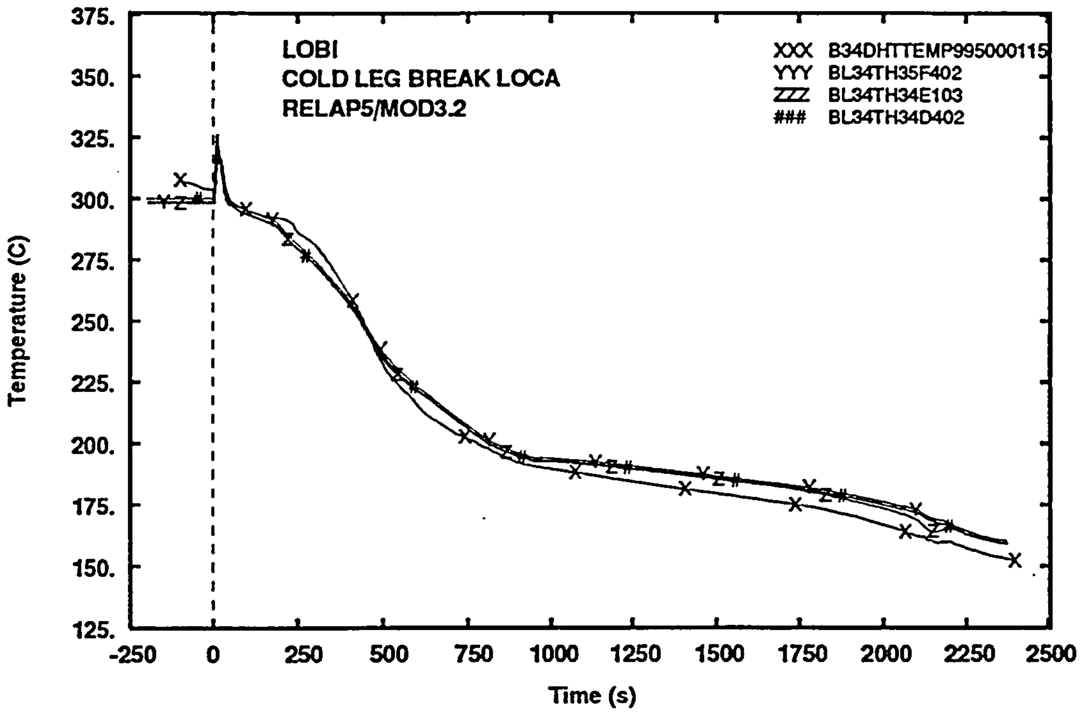

Fig. 11- Heater rod temperature (bottom level)

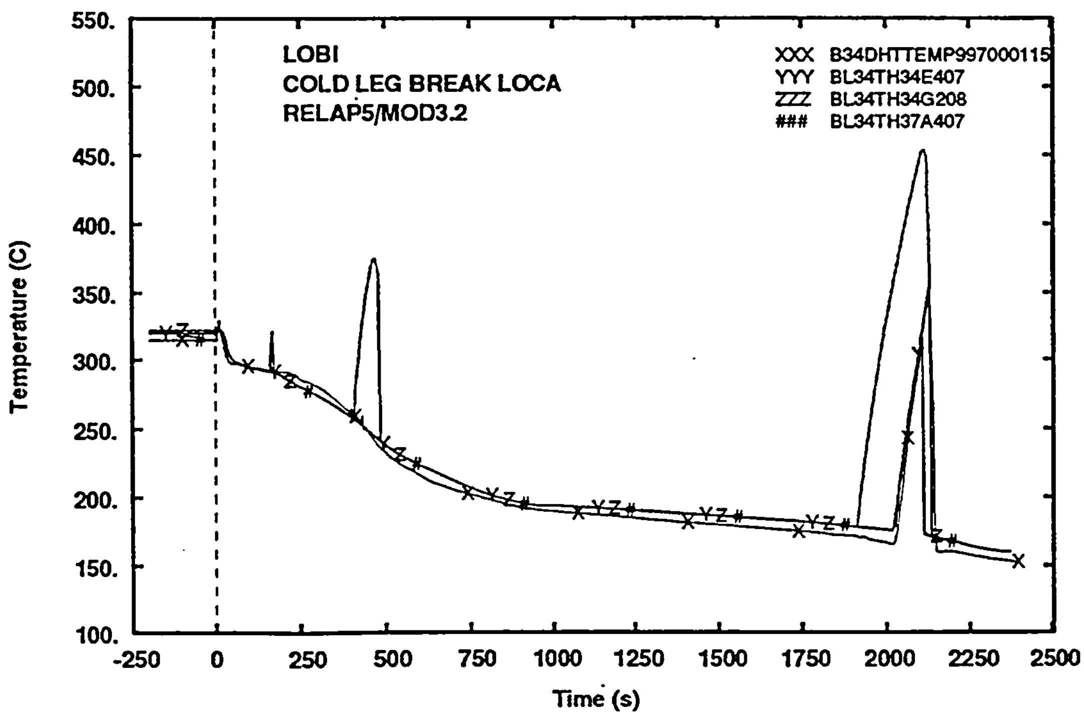

Fig. 12- Heater rod temperature (middle level)

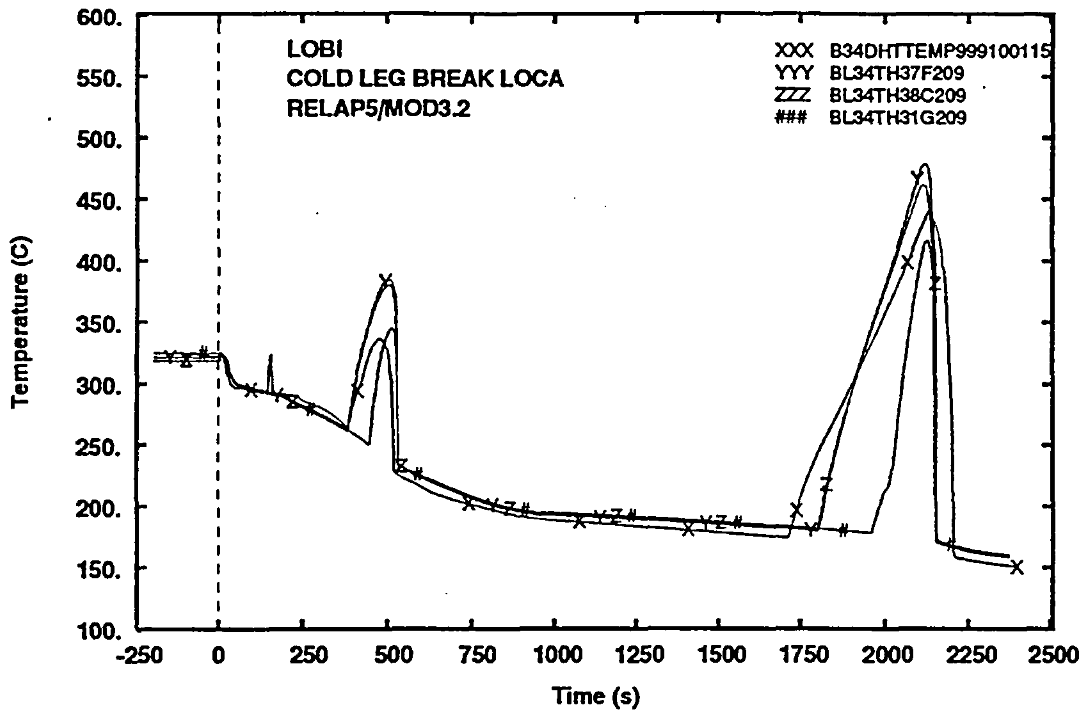

Fig. 13- Heater rod temperature (high level)

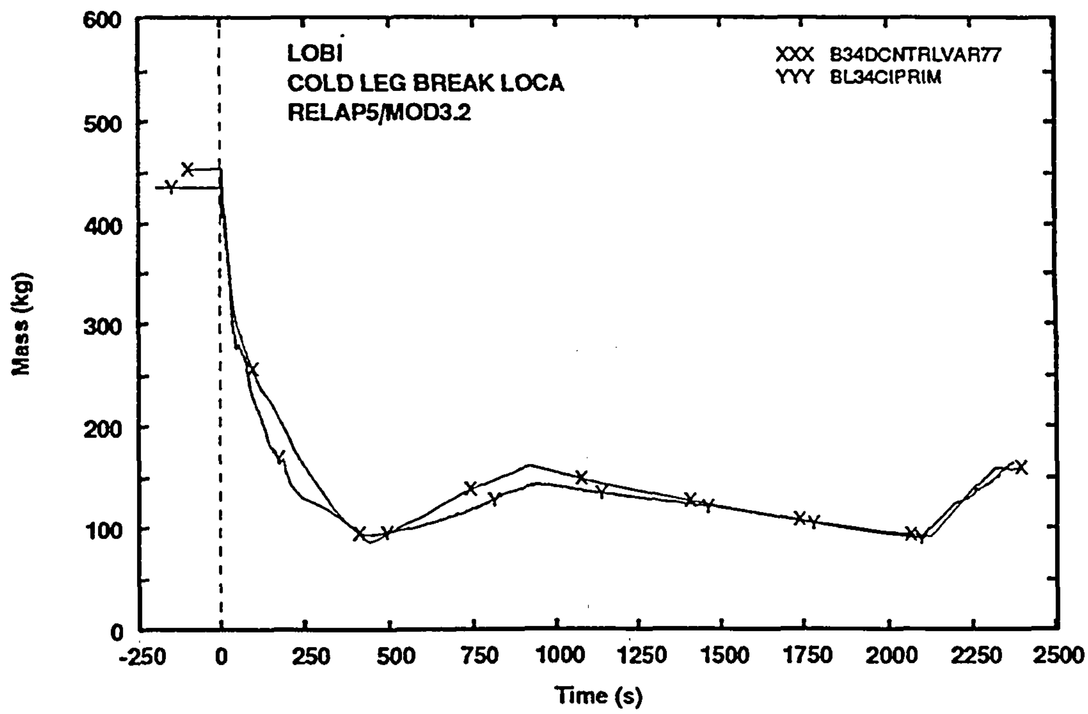

Fig. 14- Primary side total mass

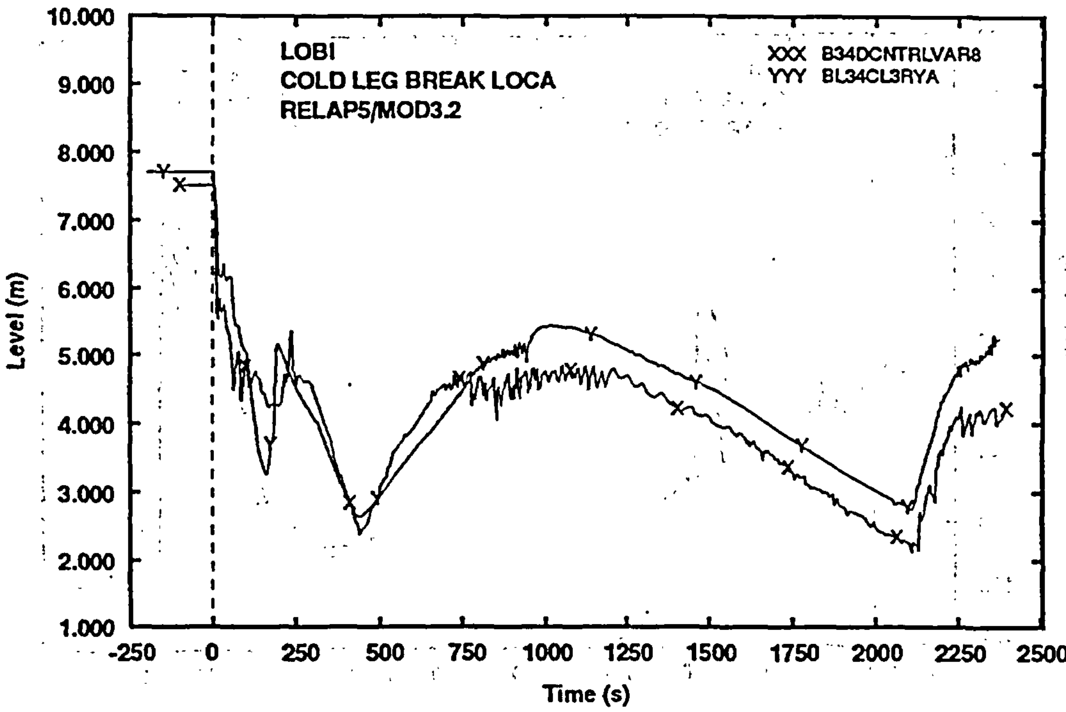

Fig. 15- Vessel riser level

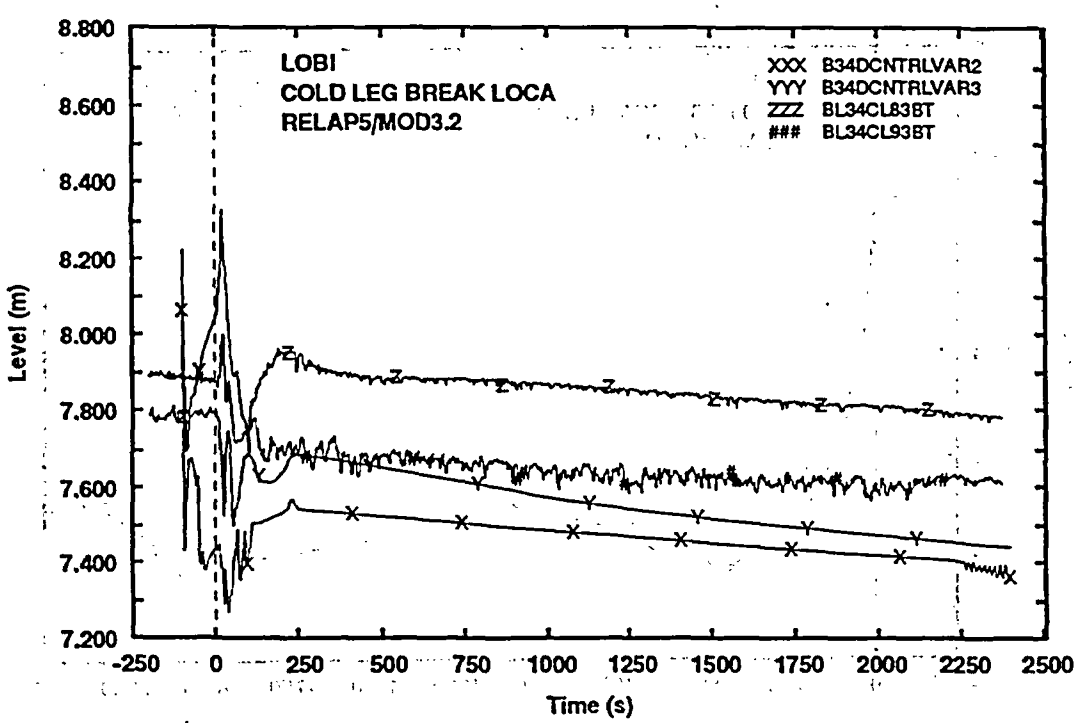

Fig. 16- SG DC level

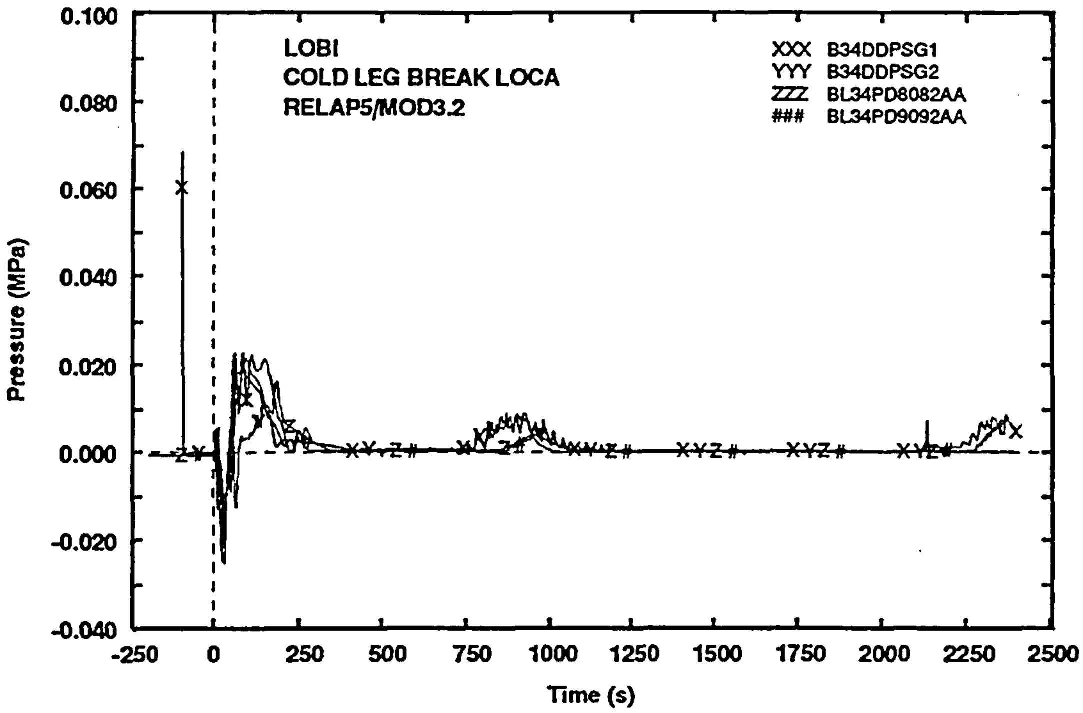

Fig. 17- Pressure drop across inlet-outlet SG

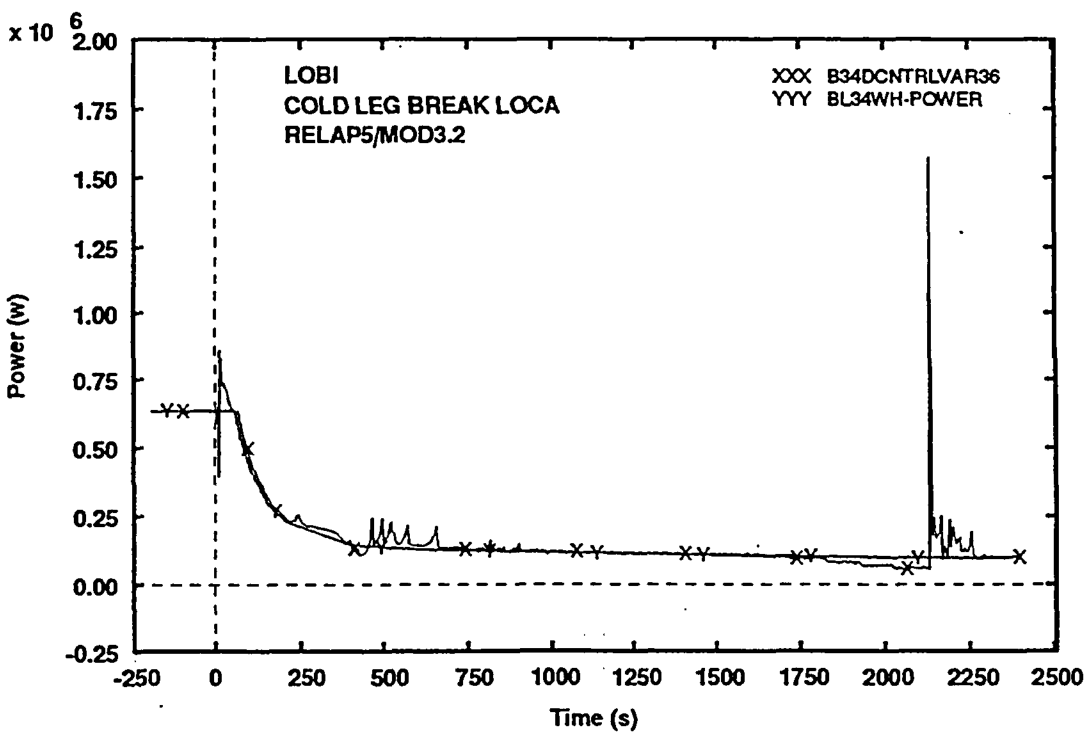

Fig. 18- Core power (exp.) and exchanged power (calc.)

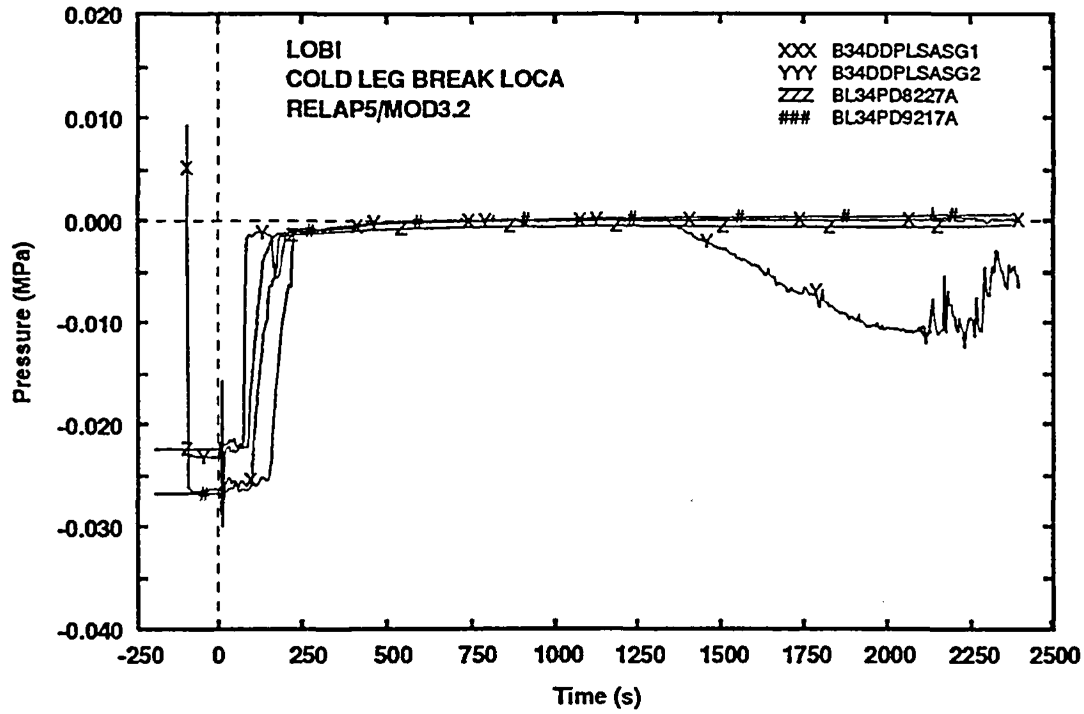

Fig. 19- Pressure drop across loop seal (ascendig side)

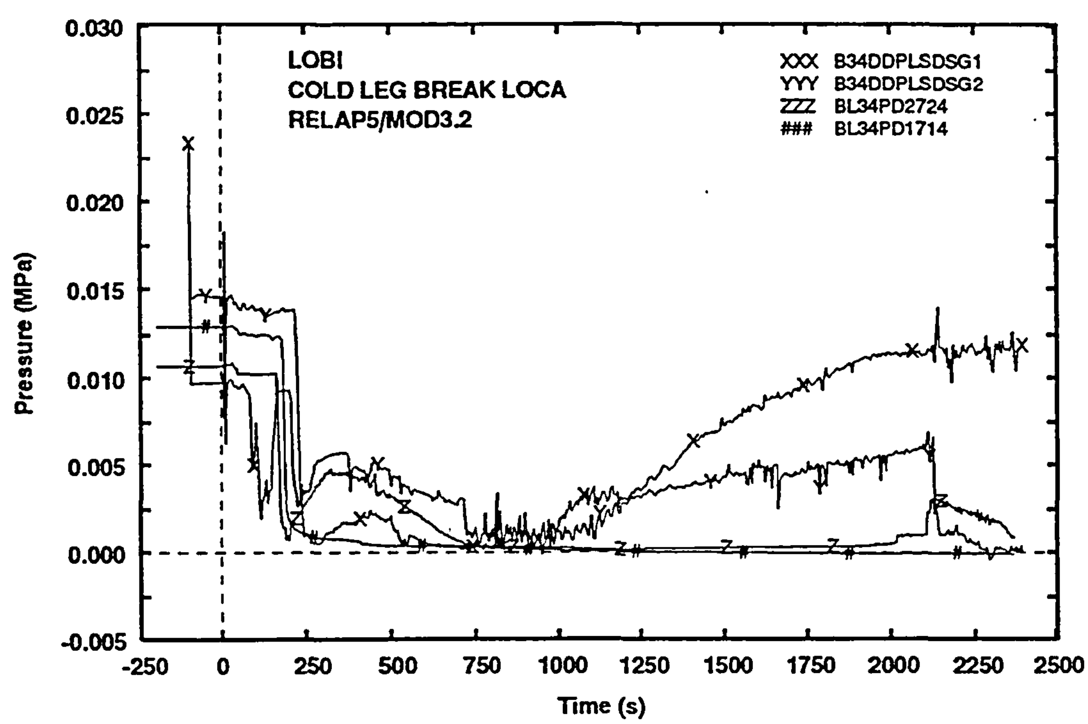

Fig. 20- Pressure drop across loop seal (descendig side)

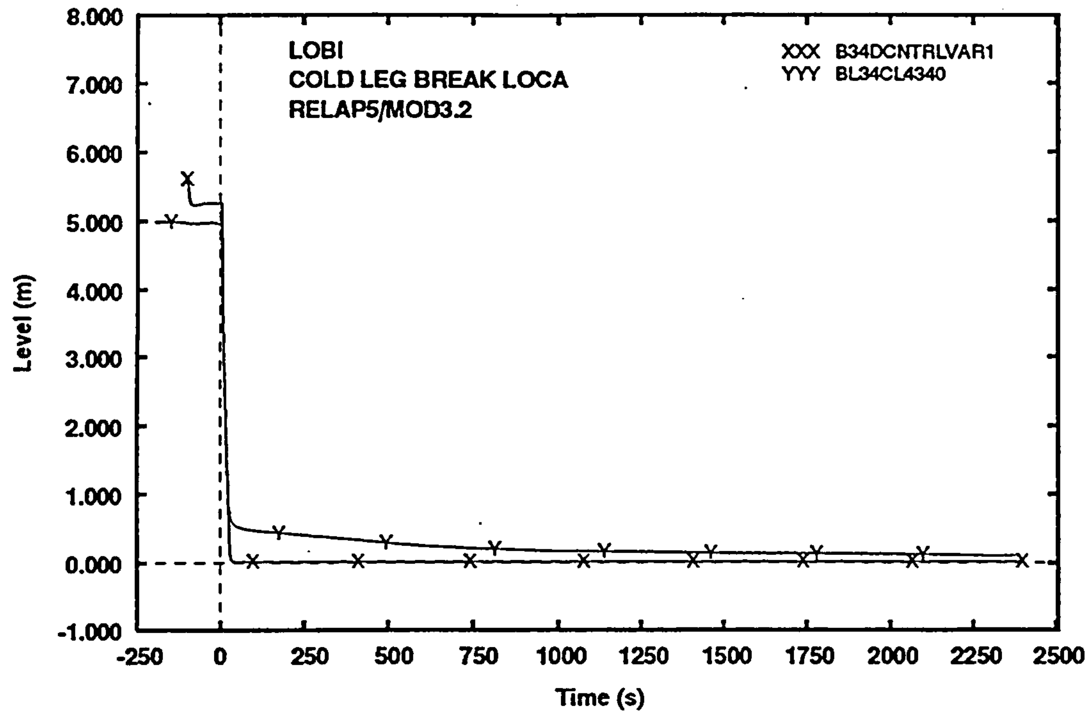

Fig. 21- PRZ level

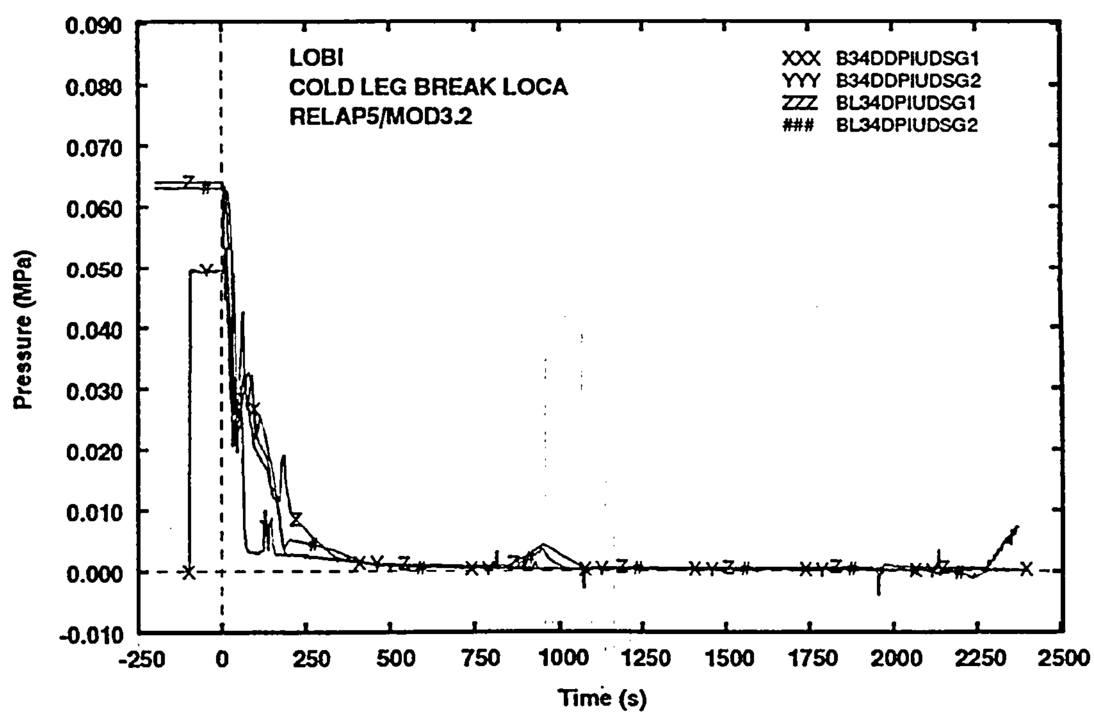

Fig. 22- Pressure drop between SG inlet plenum and Utubes top

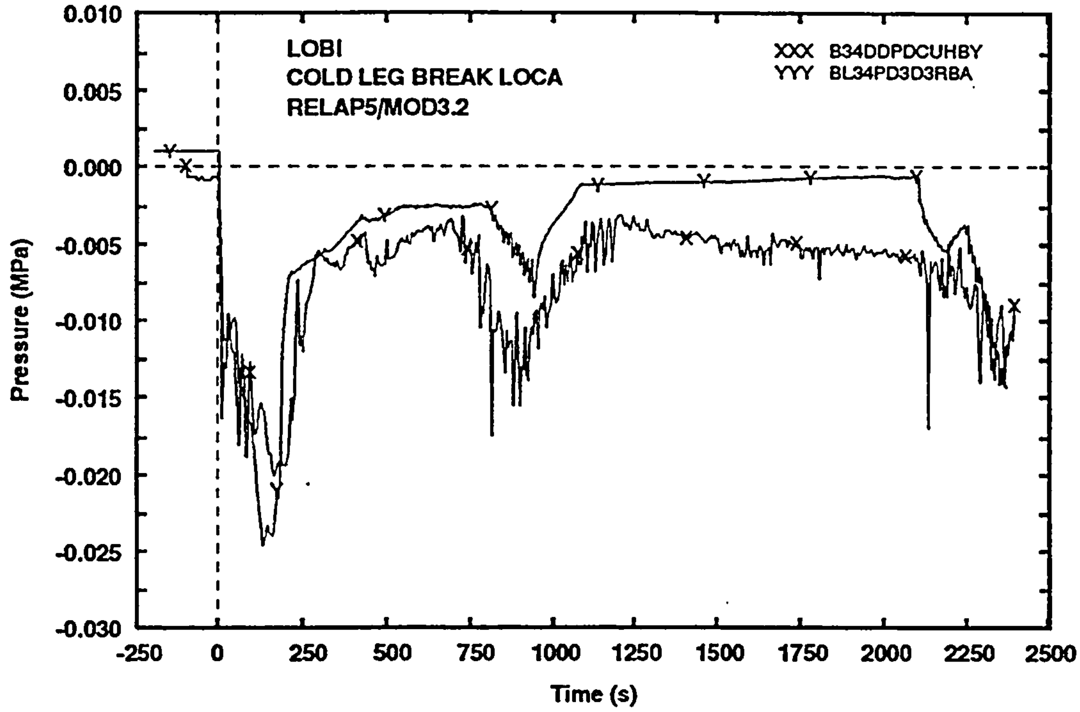

Fig. 23- Pressure drop across DC-UH bypass

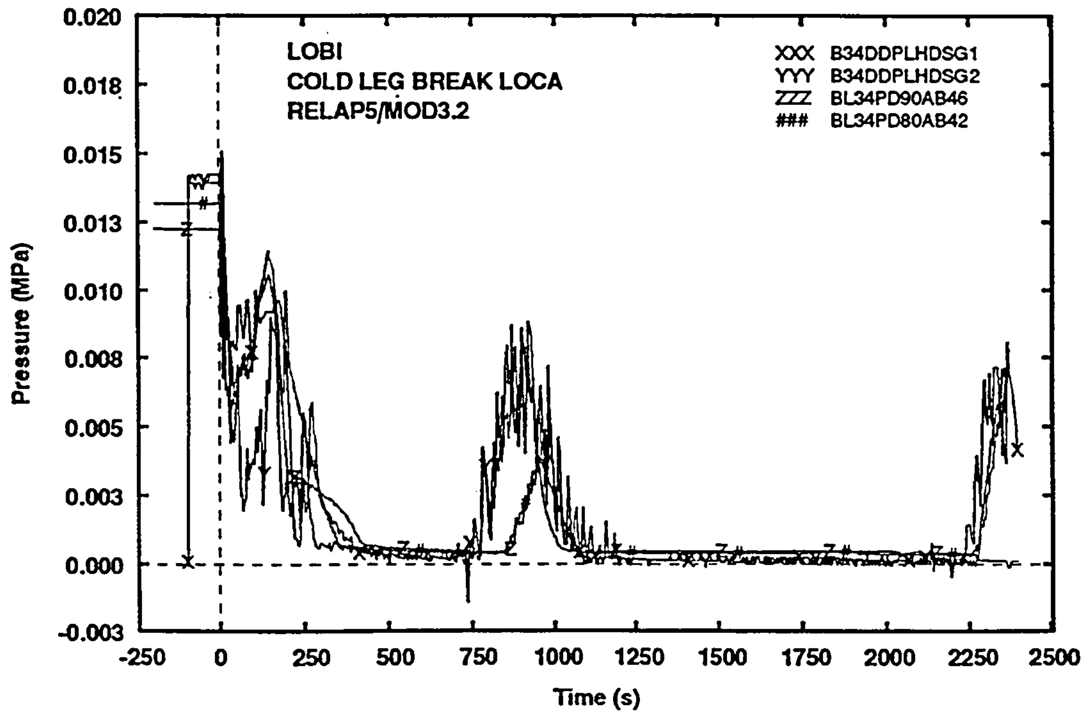

Fig. 24- Liquid hold up in SG (primary side)

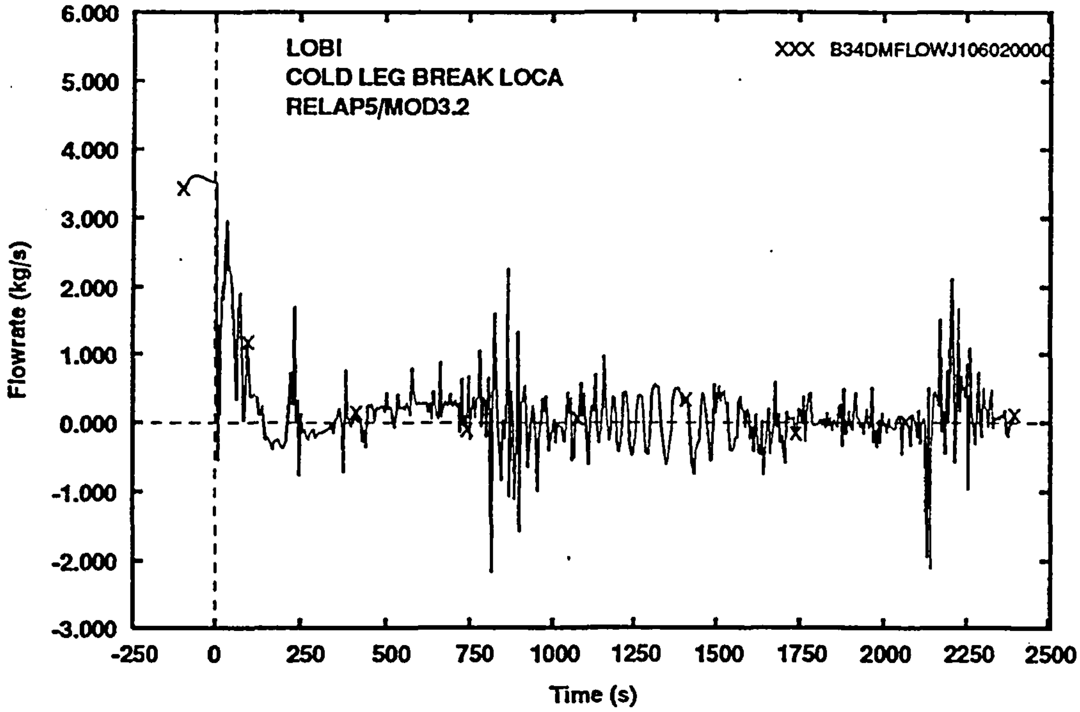

Fig. 25- Core inlet flow rate

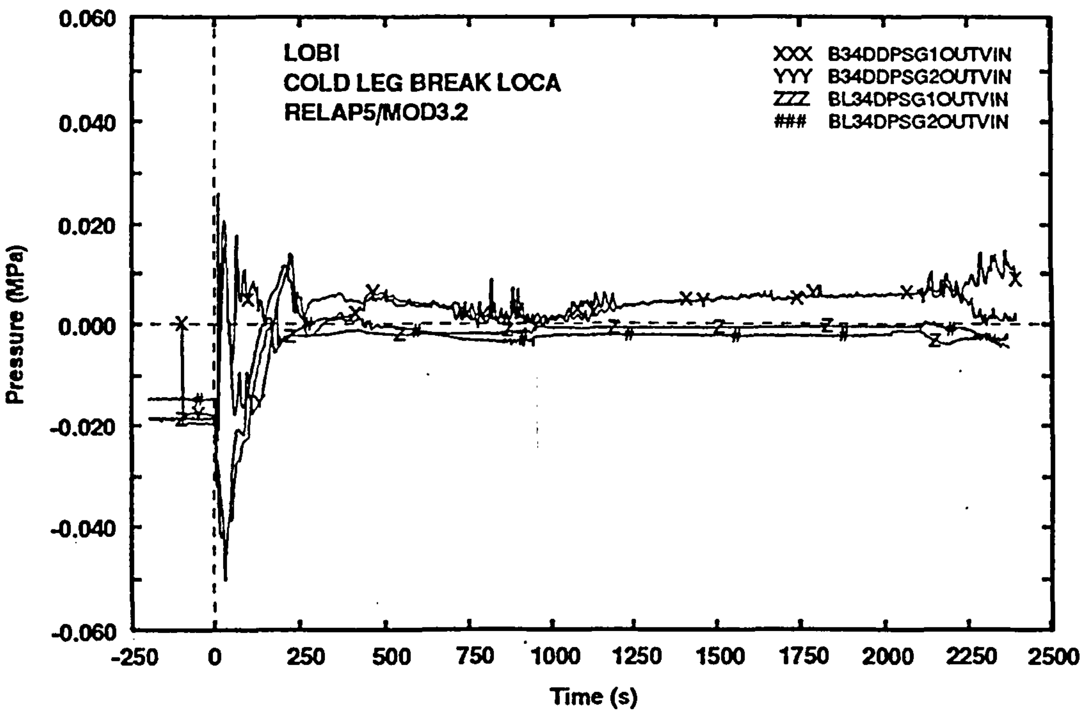

Fig. 26- pressure drop across SG outlet and vessel nozzle.

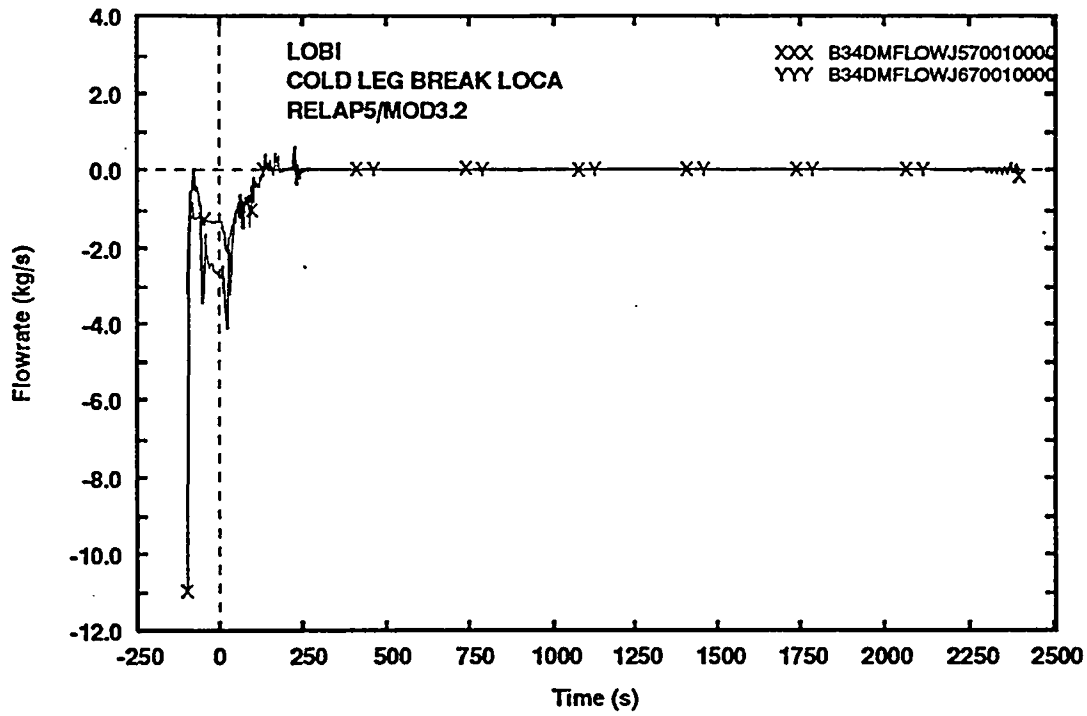

Fig. 27- SG DC flowrate

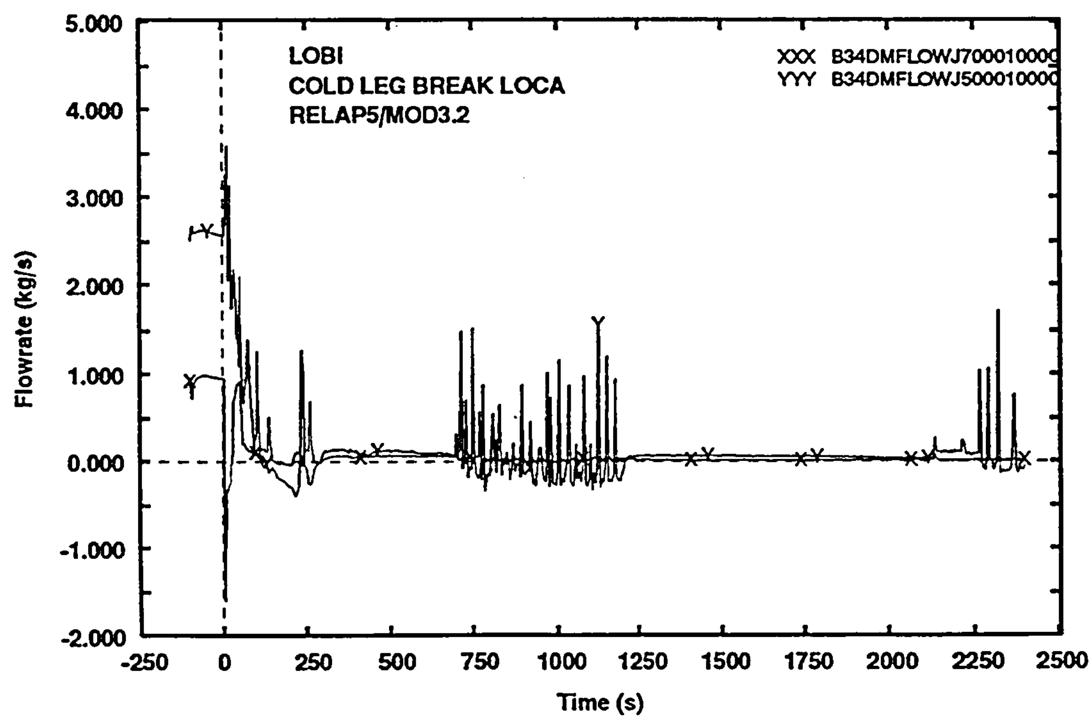

Fig. 28- Hot leg mass flowrate

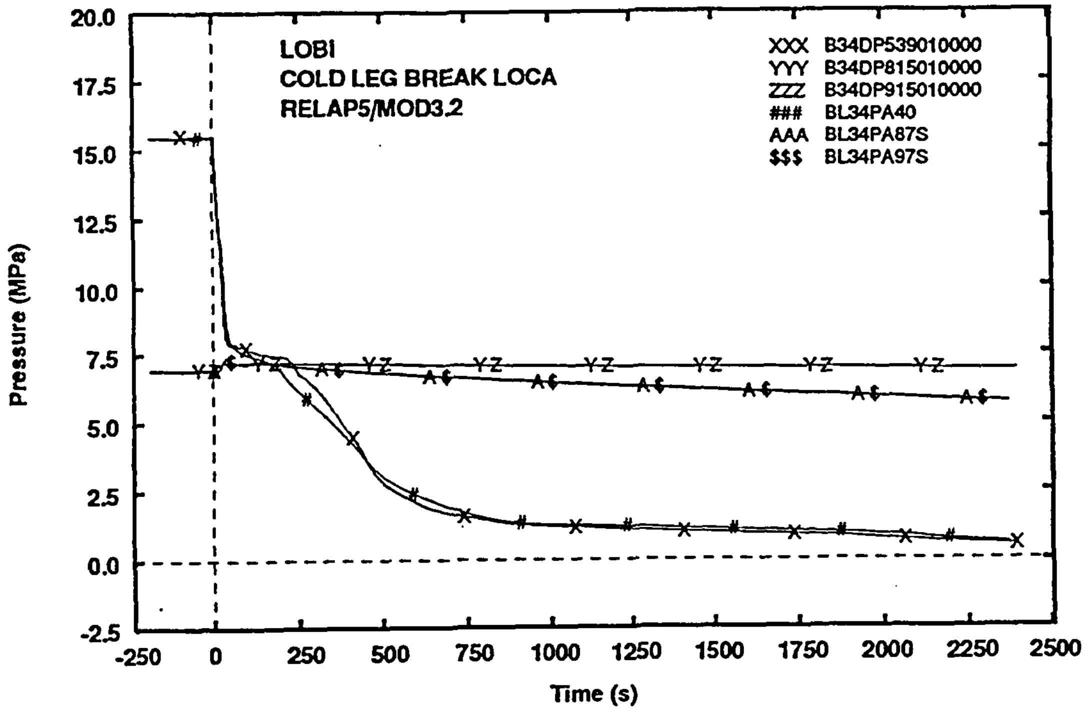

Fig. 29- Primary and secondary pressure

Appendix 3

Results of the sensitivity analyses (runs B341, B342, B343, B344, B345 and B346)

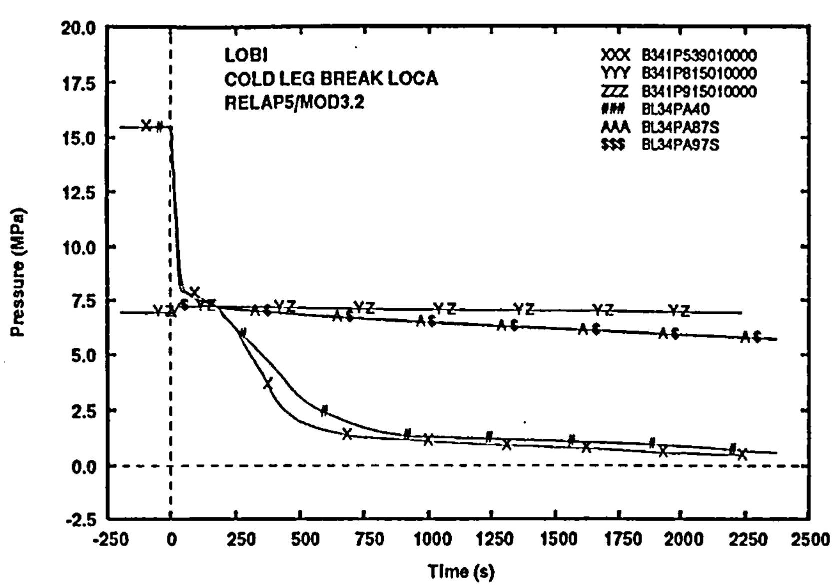

Fig. 1- B341 case : Primary and secondary side pressure

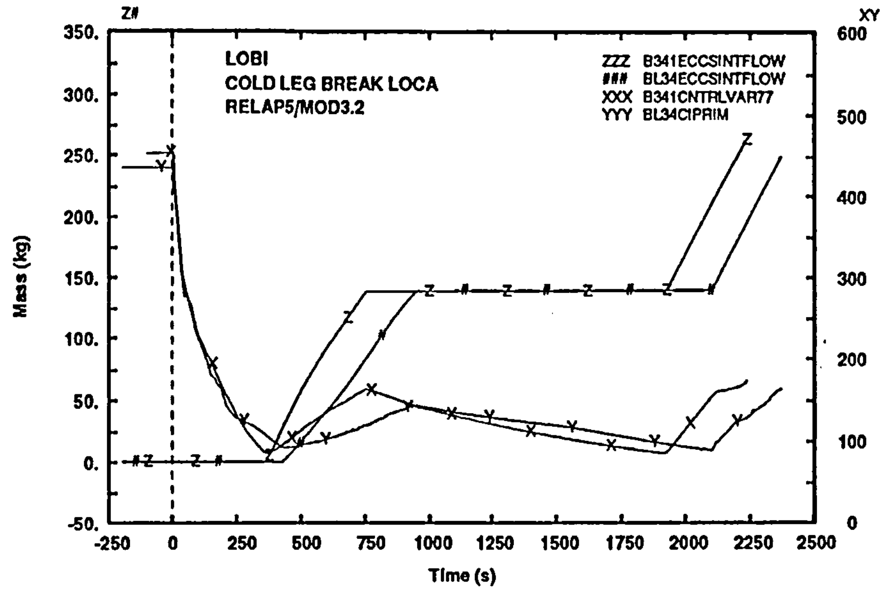

Fig. 2- B341 case : ECCS integral flowrate and primary side total mass

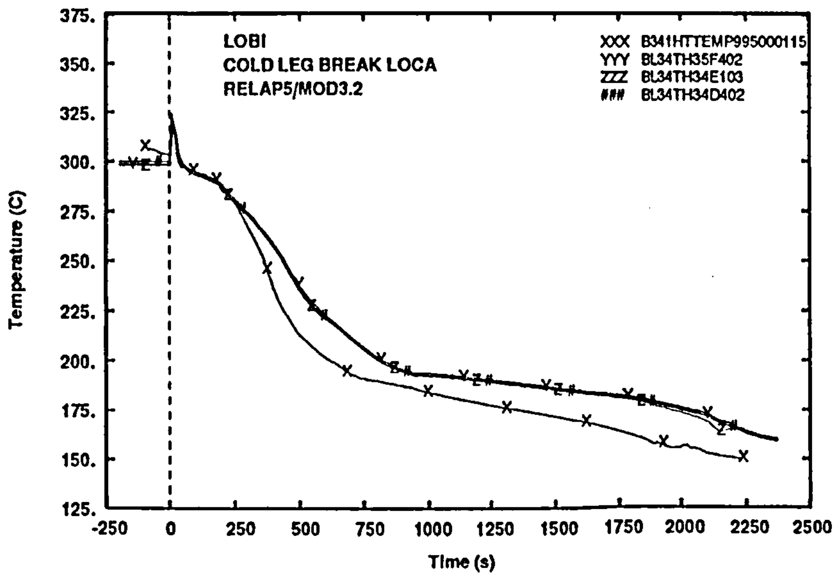

Fig. 3- B341 case : Heater rod temperature (bottom level)

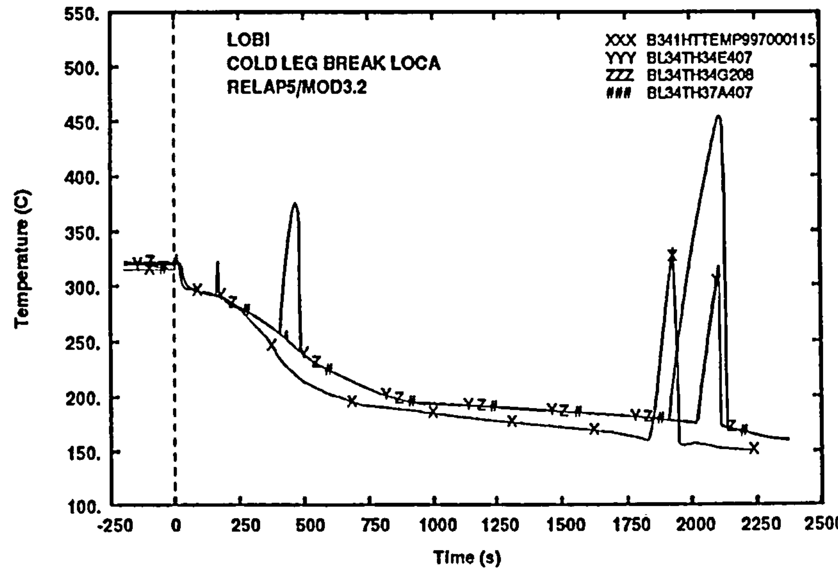

Fig. 4- B341 case : Heater rod temperature (middle level)

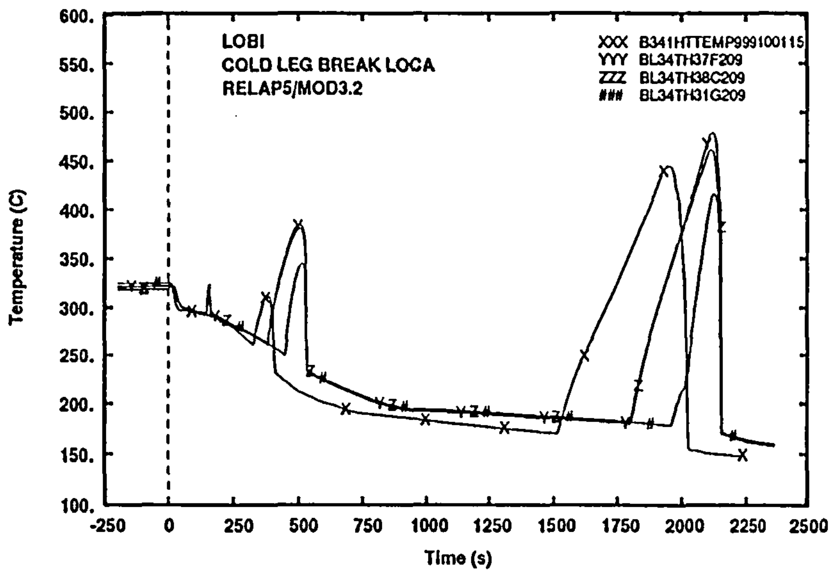

Fig. 5- B341 case : Heater rod temperature (high level)

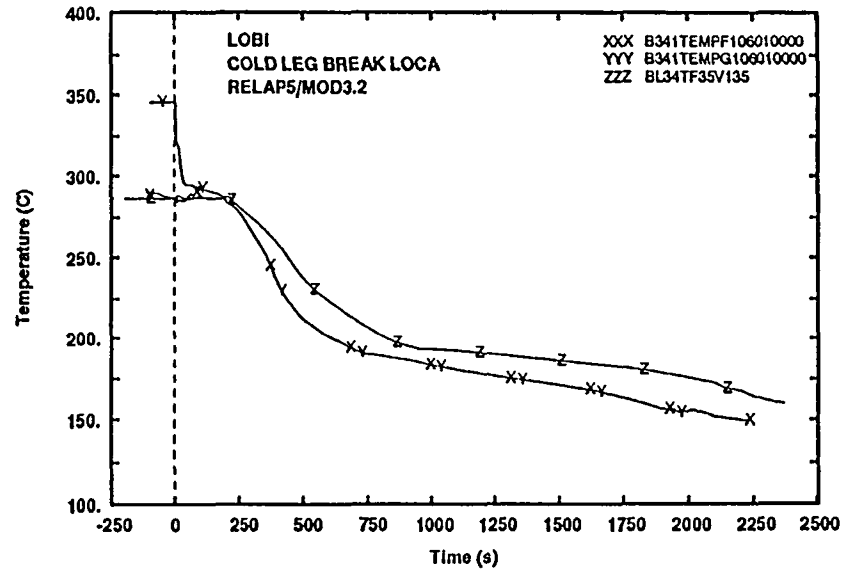

Fig. 6- B341 case : Core inlet fluid temperature

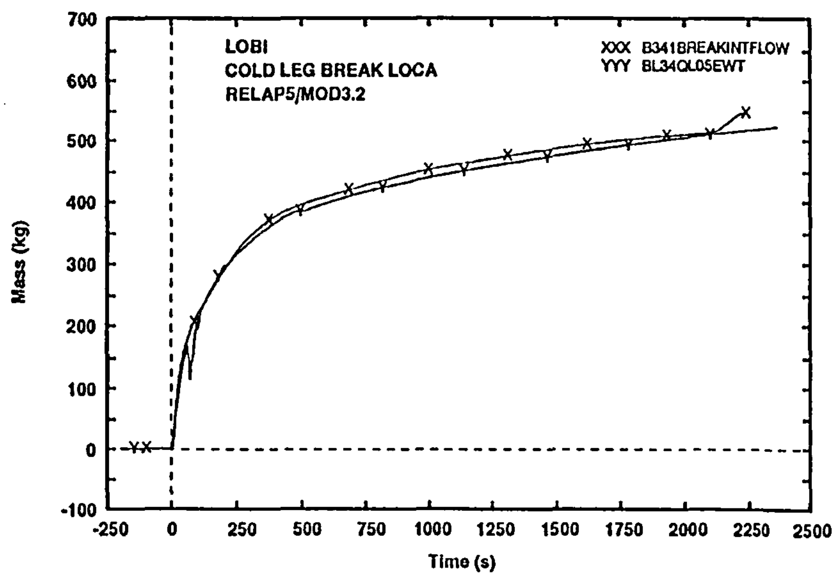

Fig. 7- B341 case : Integral break flowrate

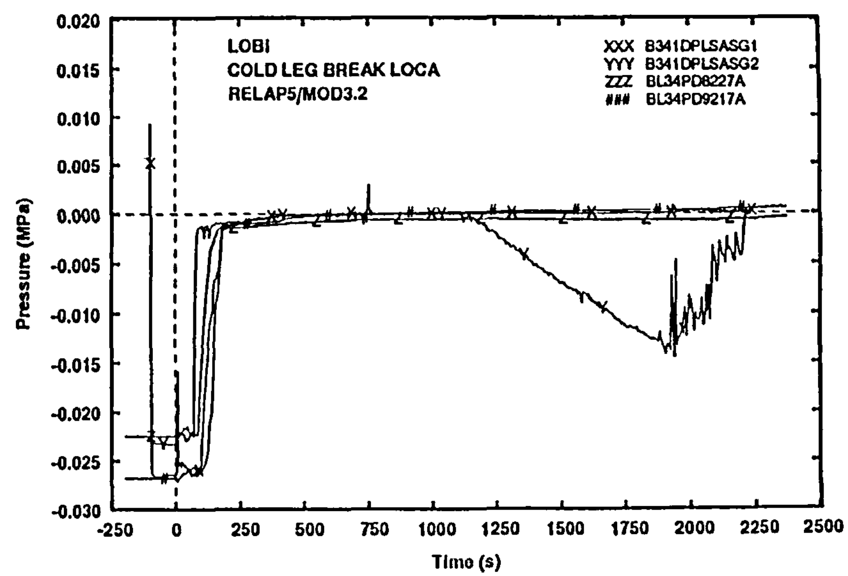

Fig. 8- B341 case : Pressure drop across loop seal (ascendig side)

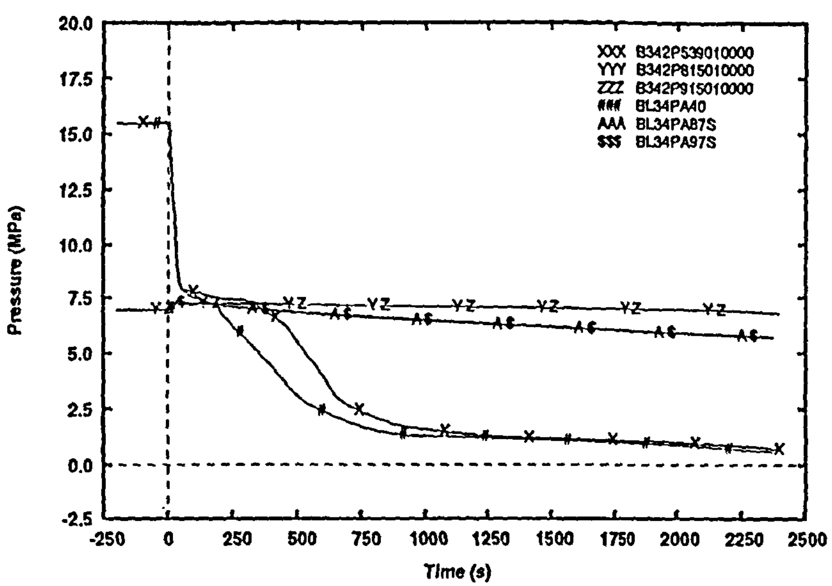

Fig. 1- B342 case : Primary and secondary side pressure

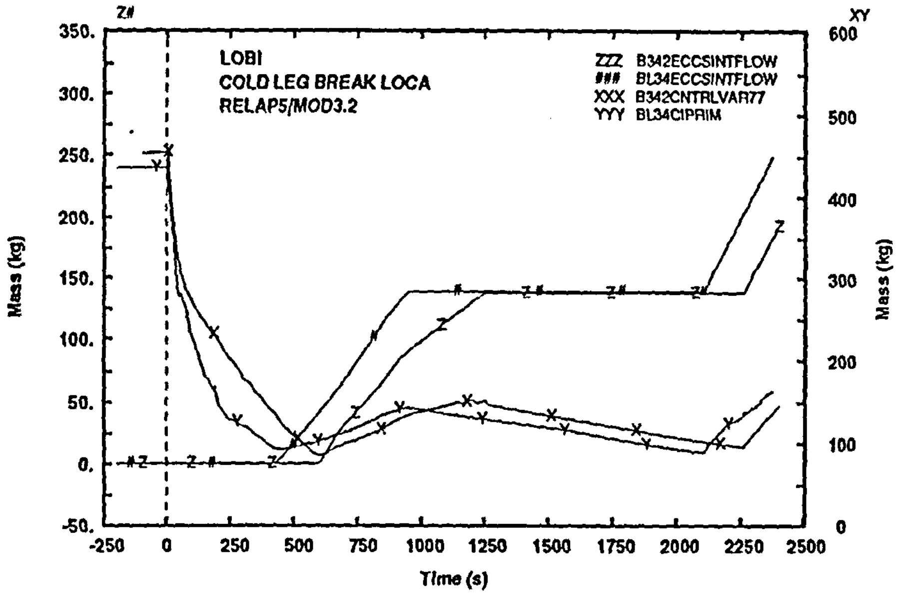

Fig. 2- B342 case : ECCS integral flowrate and primary side total mass

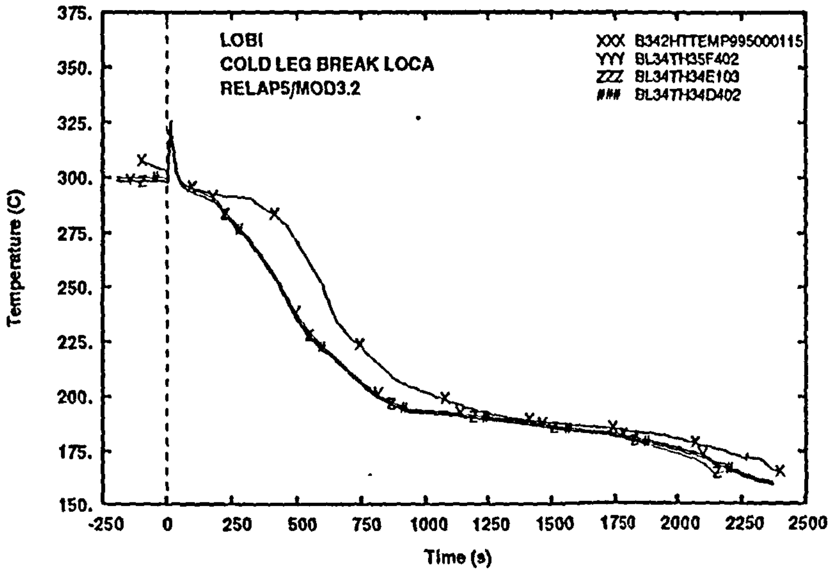

Fig. 3- B342 case : Heater rod temperature (bottom level)

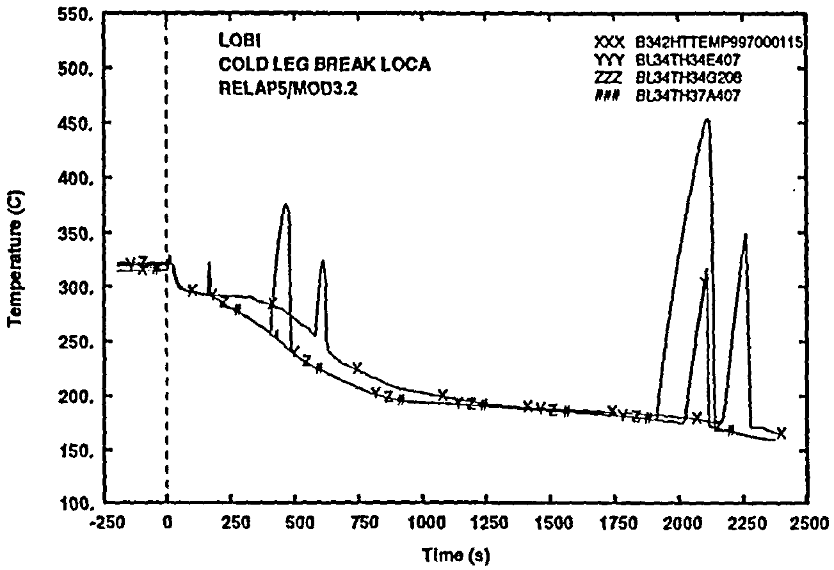

Fig. 4- B342 case : Heater rod temperature (middle level)

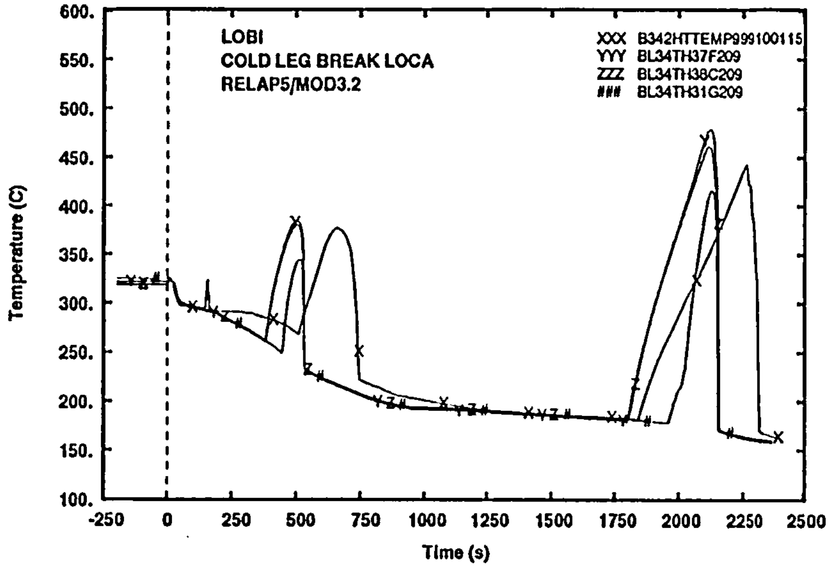

Fig. 5- B342 case : Heater rod temperature (high level)

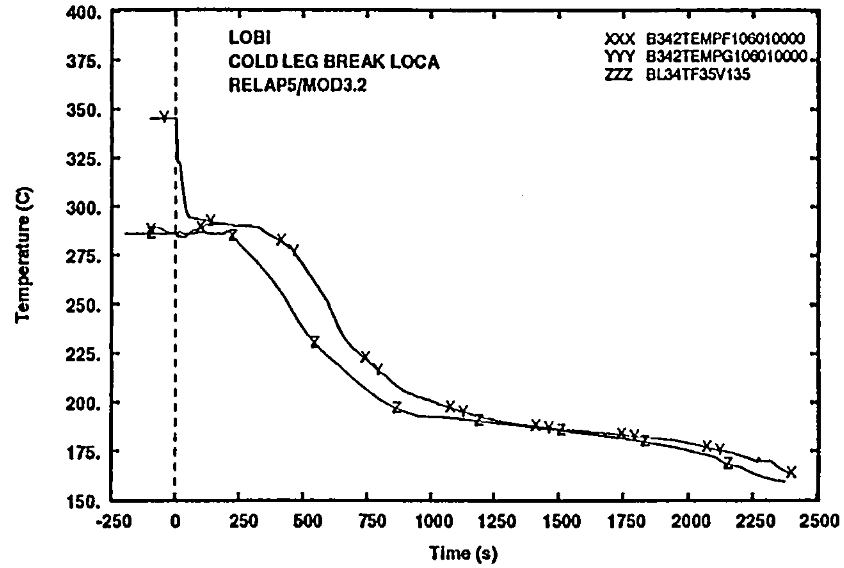

Fig. 6- B342 case : Core inlet fluid temperature

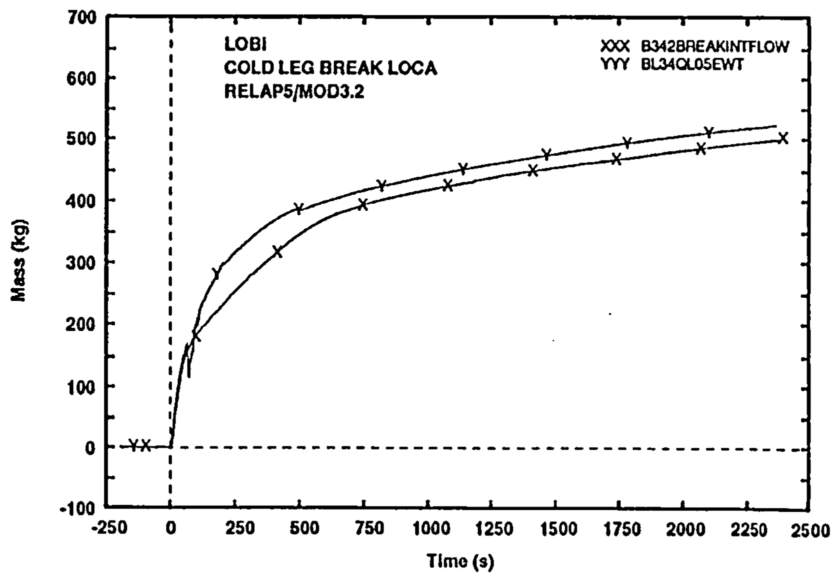

Fig. 7- B342 case : Integral break flowrate

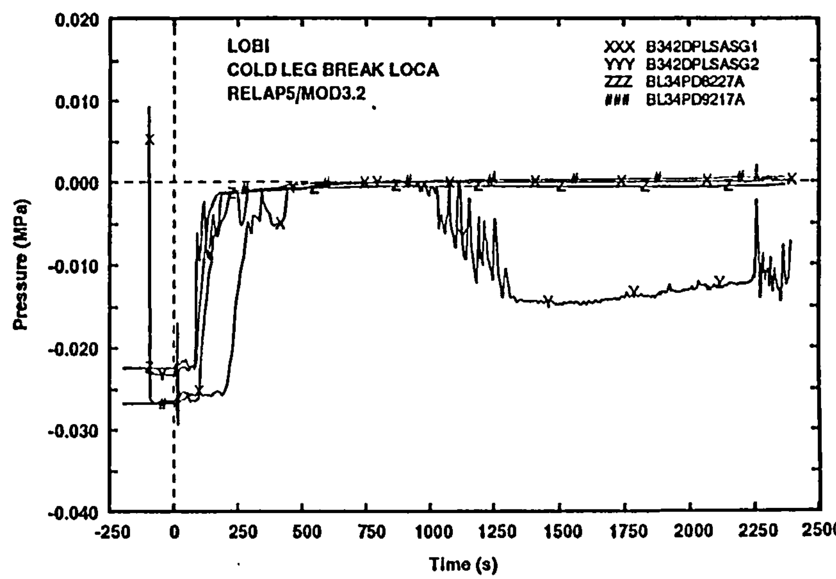

Fig. 8- B342 case : Pressure drop across loop seal (ascendig side)

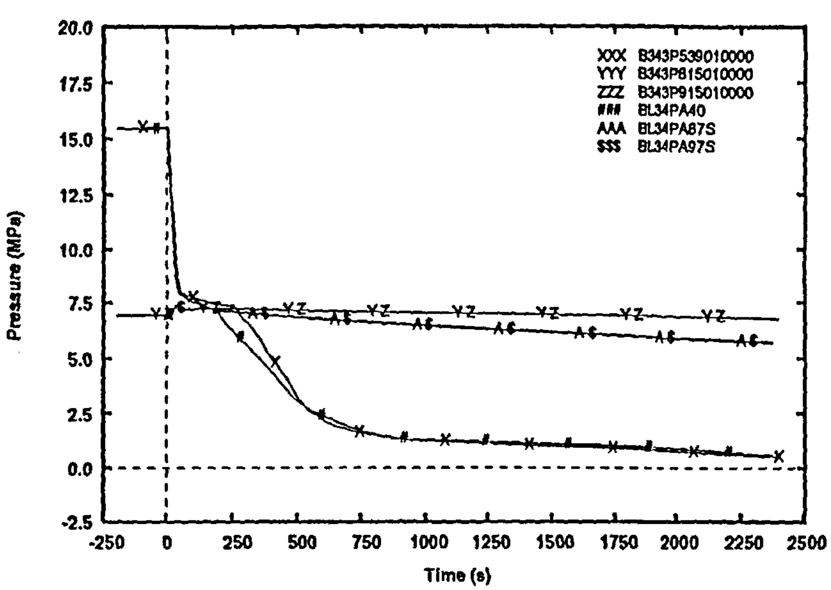

Fig. 1- B343 case : Primary and secondary side pressure

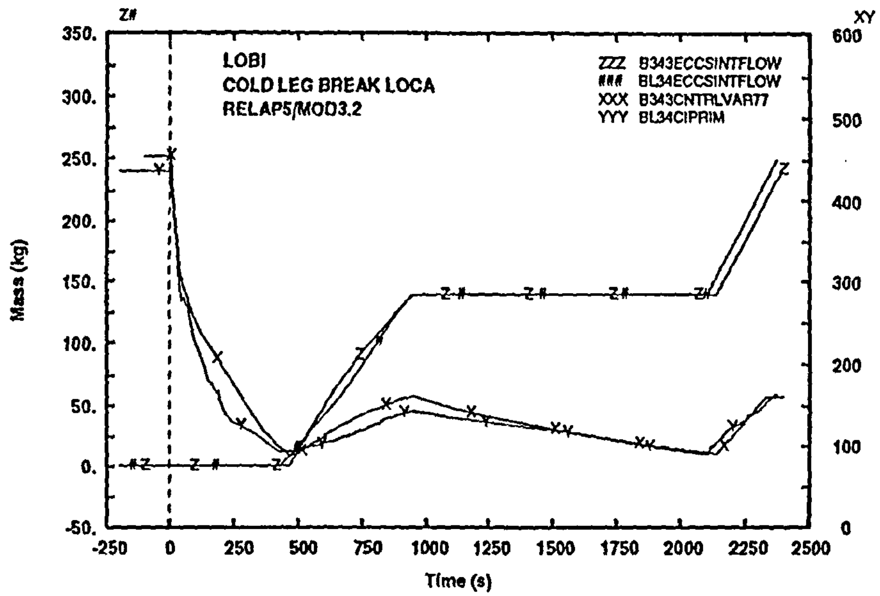

Fig. 2- B343 case : ECCS integral flowrate and primary side total mass

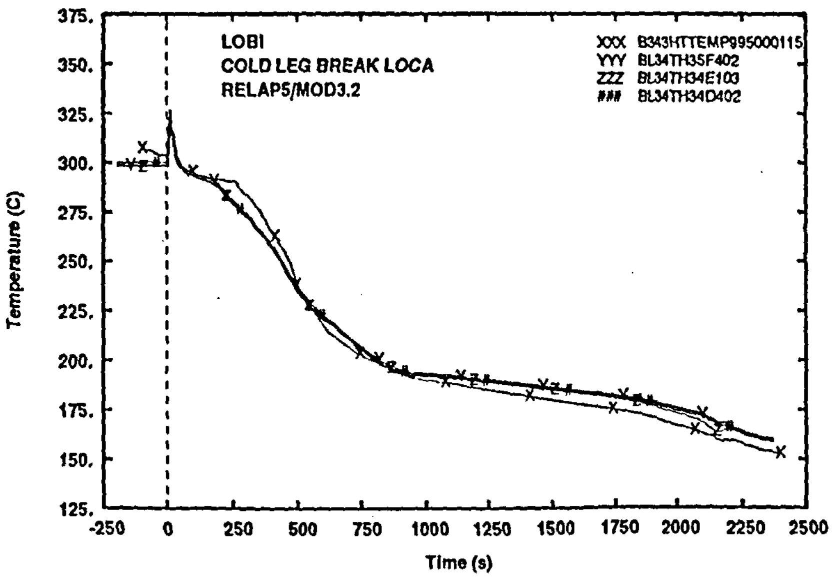

Fig. 3- B343 case : Heater rod temperature (bottom level)

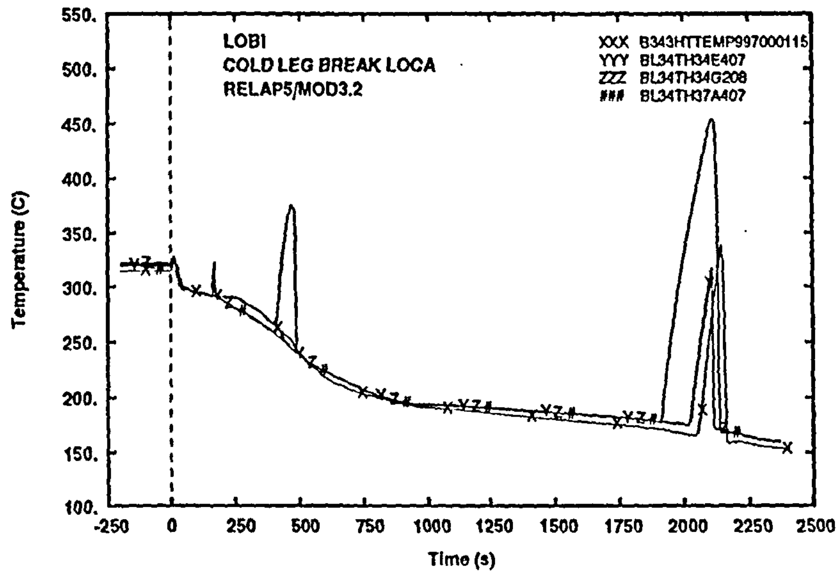

Fig. 4- B343 case : Heater rod temperature (middle level)

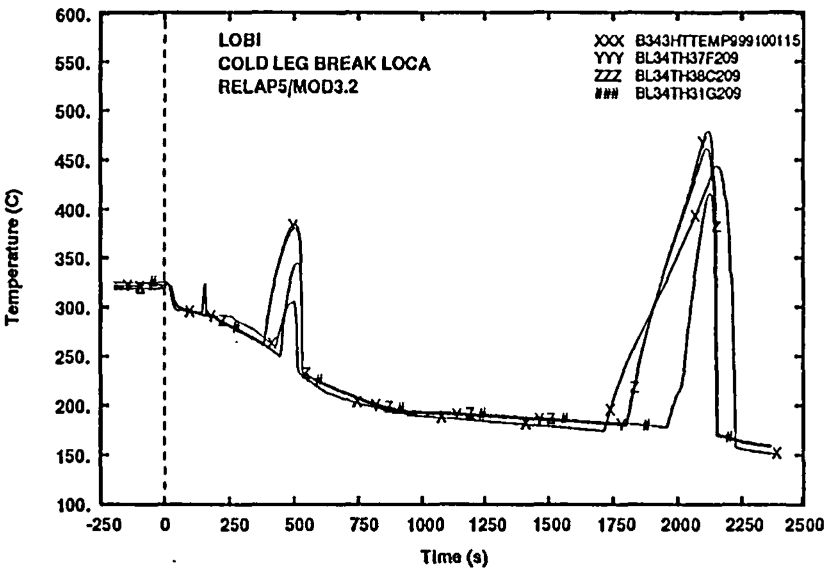

Fig. 5- B343 case : Heater rod temperature (high level)

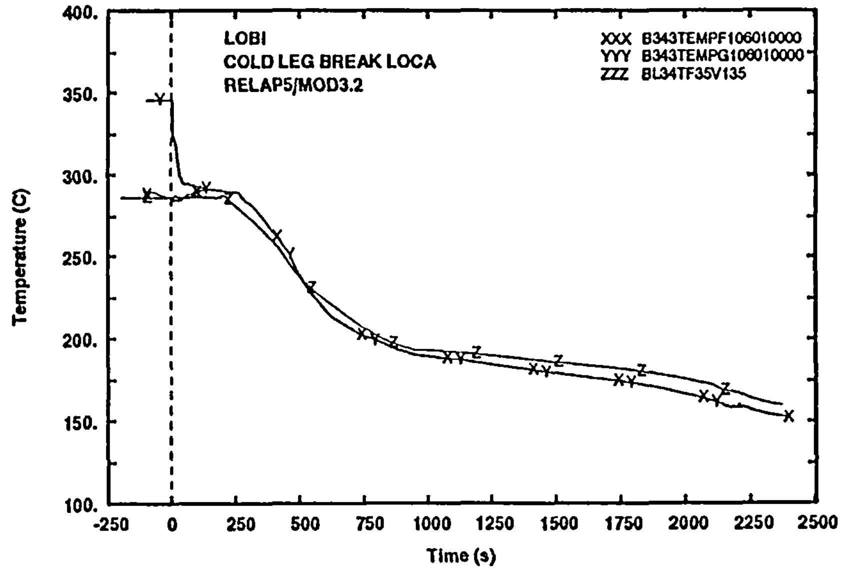

Fig. 6- B343 case : Core inlet fluid temperature

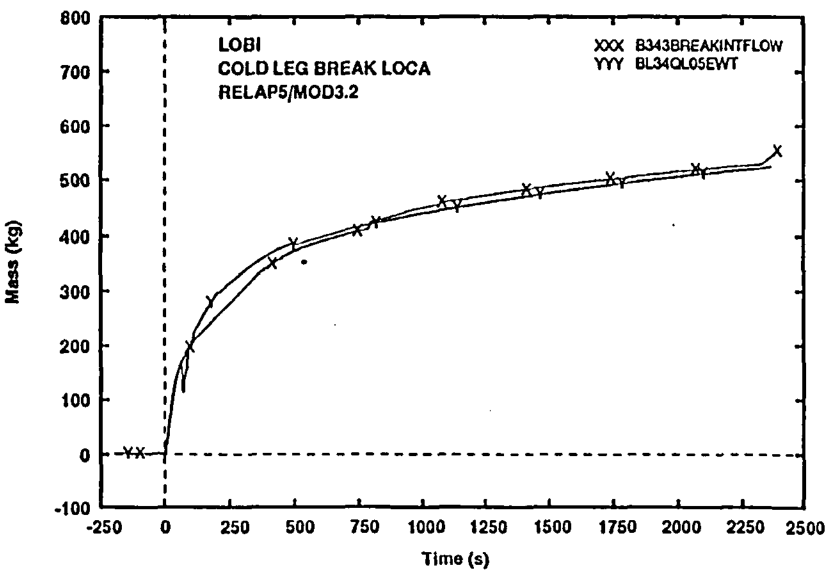

Fig. 7- B343 case : Integral break flowrate

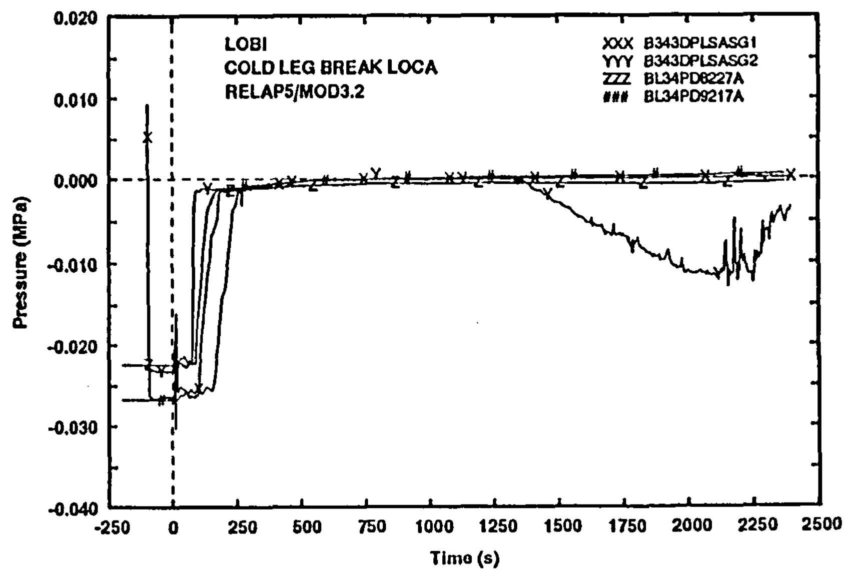

Fig. 8- B343 case : Pressure drop across loop seal (ascendig side)

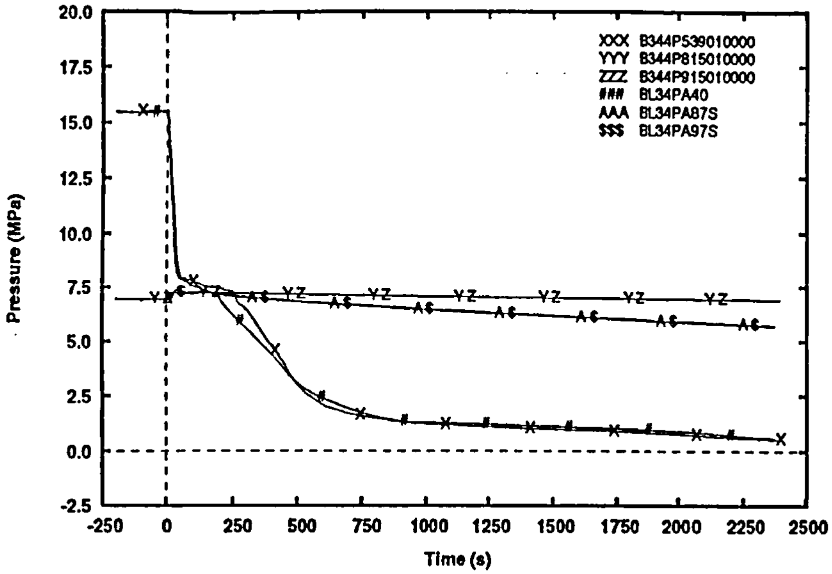

Fig. 1- B344 case : Primary and secondary side pressure

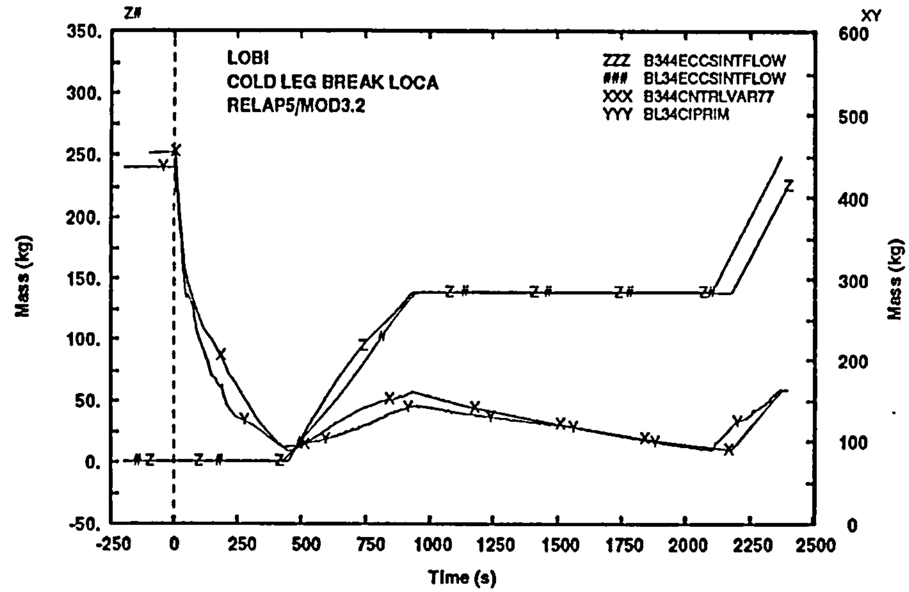

Fig. 2- B344 case : ECCS integral flowrate and primary side total mass

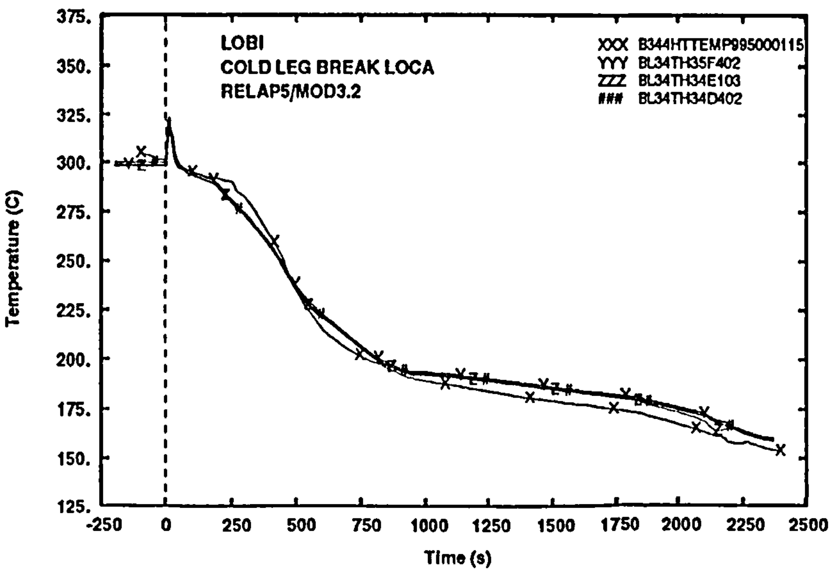

Fig. 3- B344 case : Heater rod temperature (bottom level)

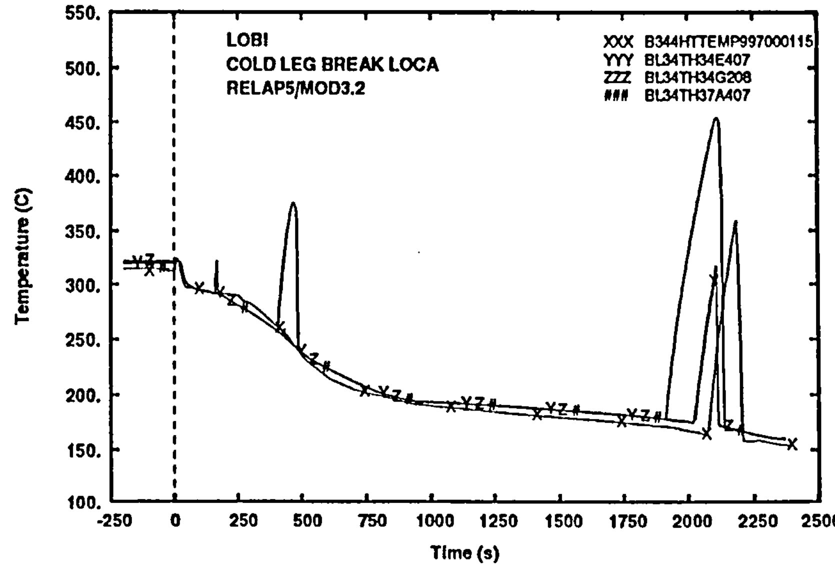

Fig. 4- B344 case : Heater rod temperature (middle level)

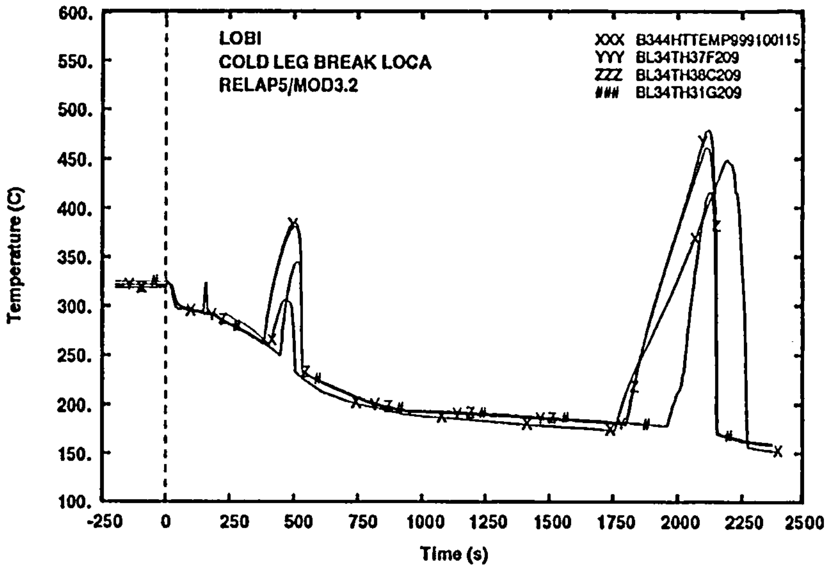

Fig. 5- B344 case : Heater rod temperature (high level)

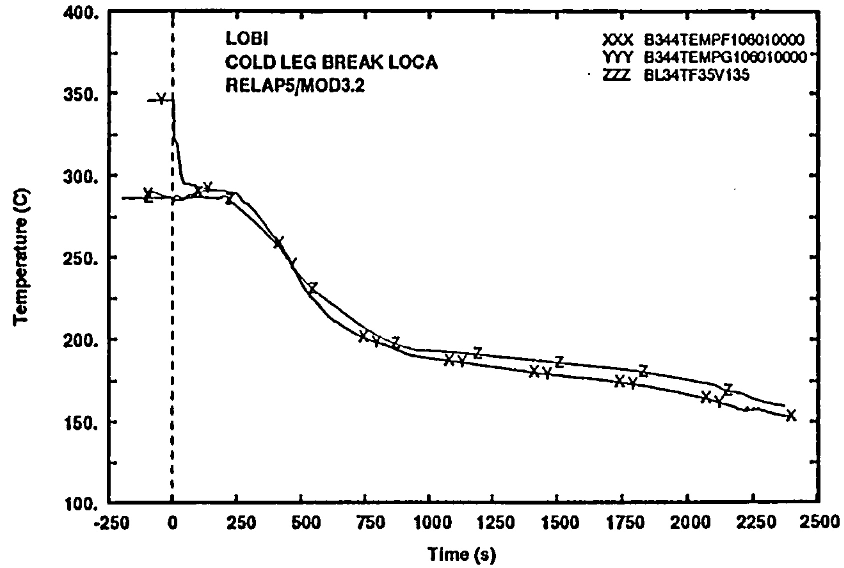

Fig. 6- B344 case : Core inlet fluid temperature

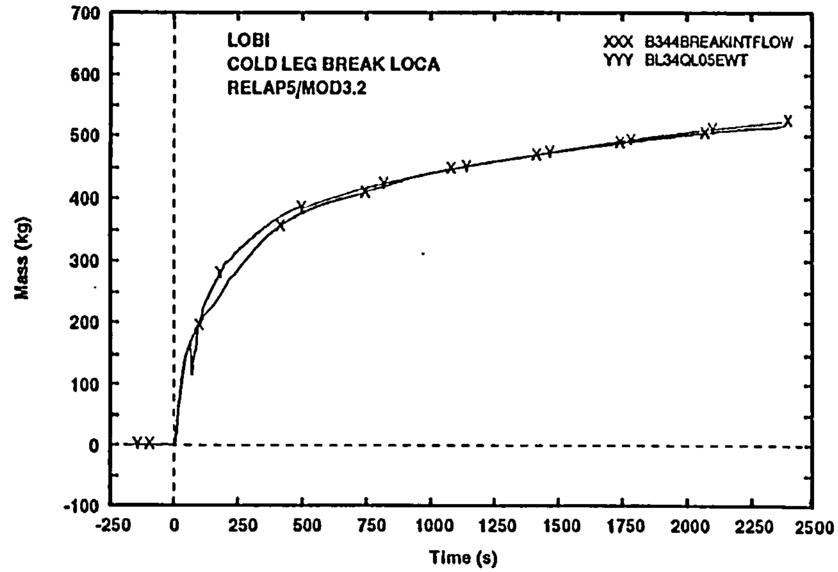

Fig. 7- B344 case : Integral break flowrate

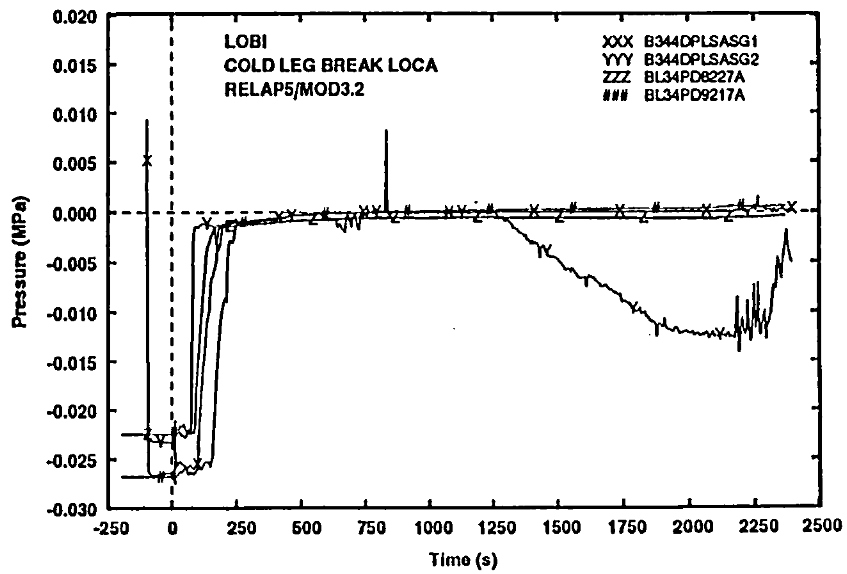

Fig. 8- B344 case : Pressure drop across loop seal (ascendig side)

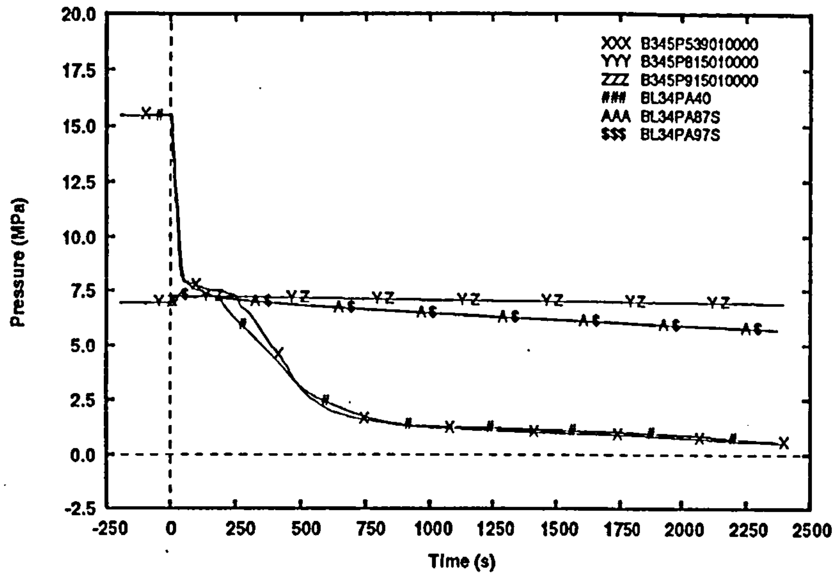

Fig. 1- B345 case : Primary and secondary side pressure

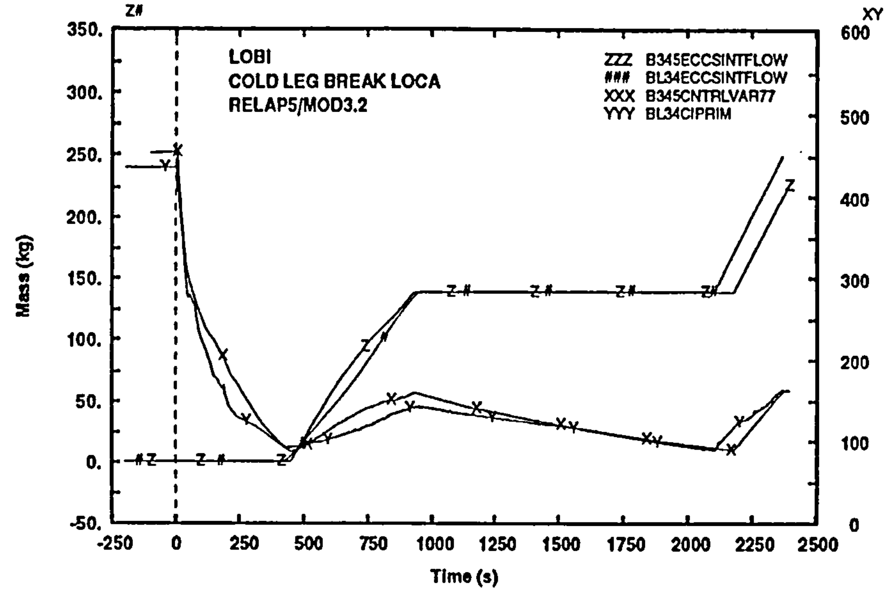

Fig. 2- B345 case : ECCS integral flowrate and primary side total mass

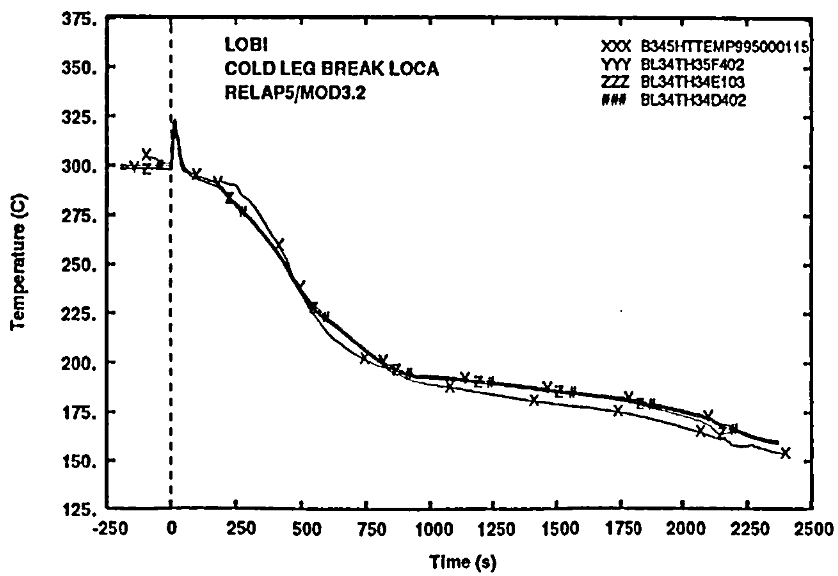

Fig. 3- B345 case : Heater rod temperature (bottom level)

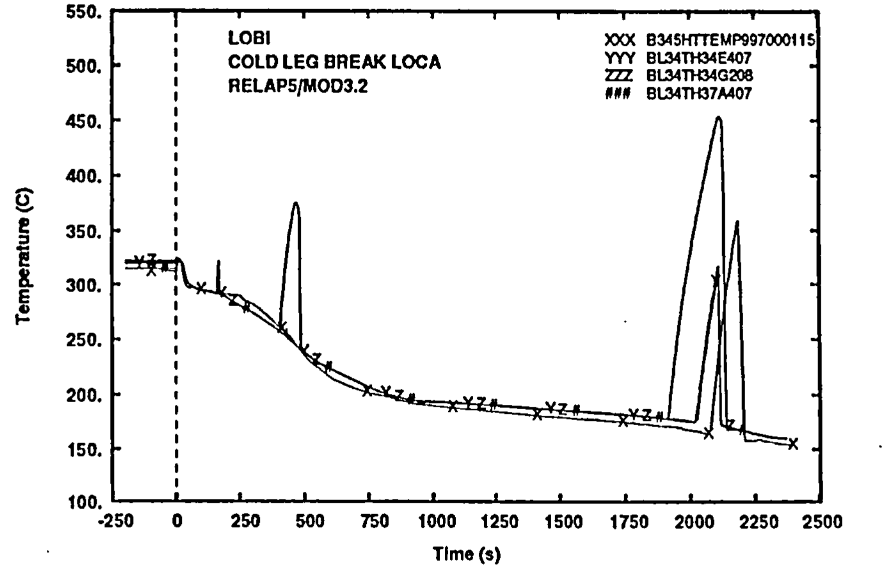

Fig. 4- B345 case : Heater rod temperature (middle level)

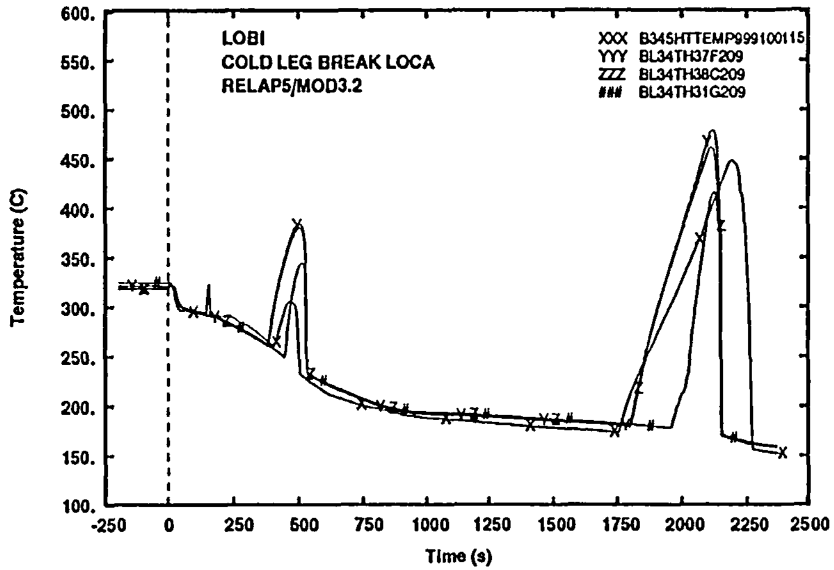

Fig. 5- B345 case : Heater rod temperature (high level)

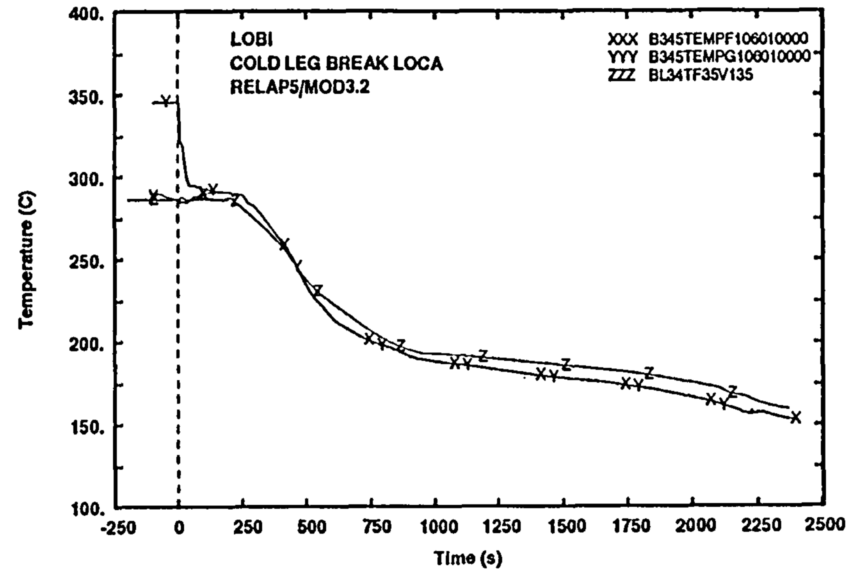

Fig. 6- B345 case : Core inlet fluid temperature

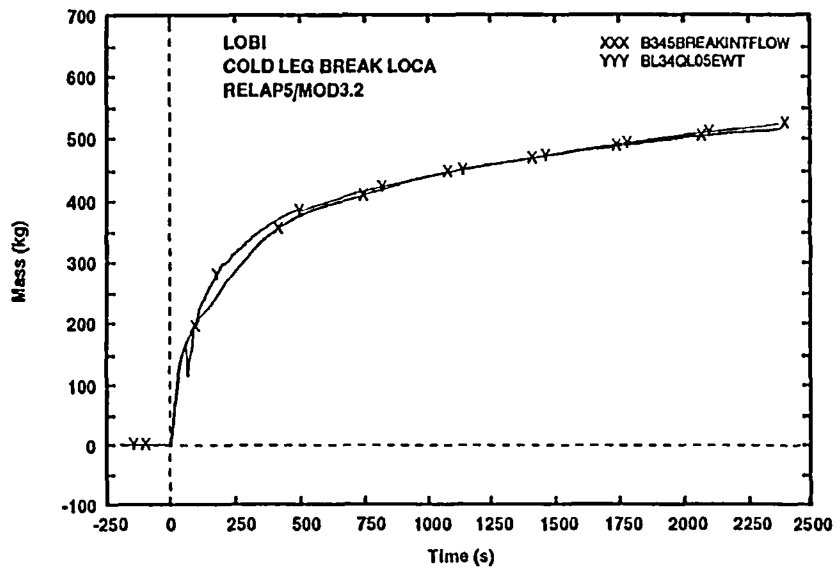

Fig. 7- B345 case : Integral break flowrate

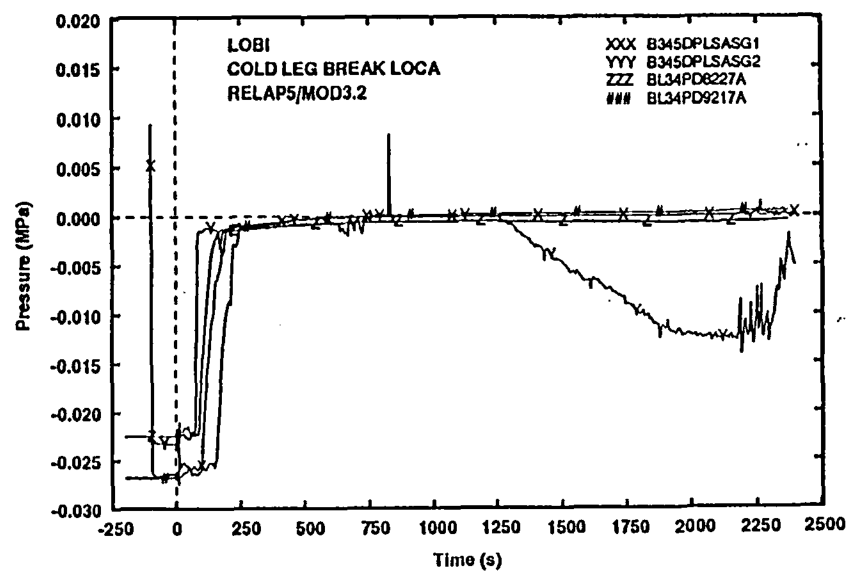

Fig. 8- B345 case : Pressure drop across loop seal (ascendig side)

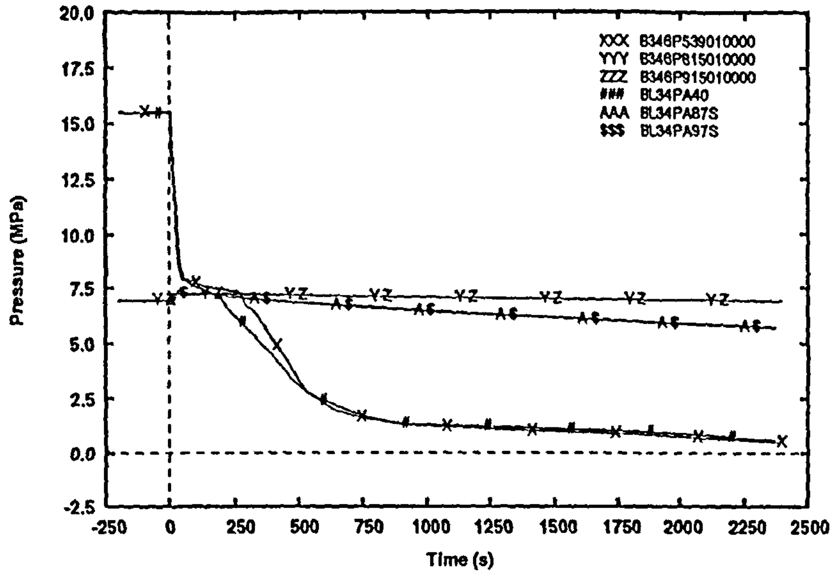

Fig. 1- B346 case : Primary and secondary side pressure

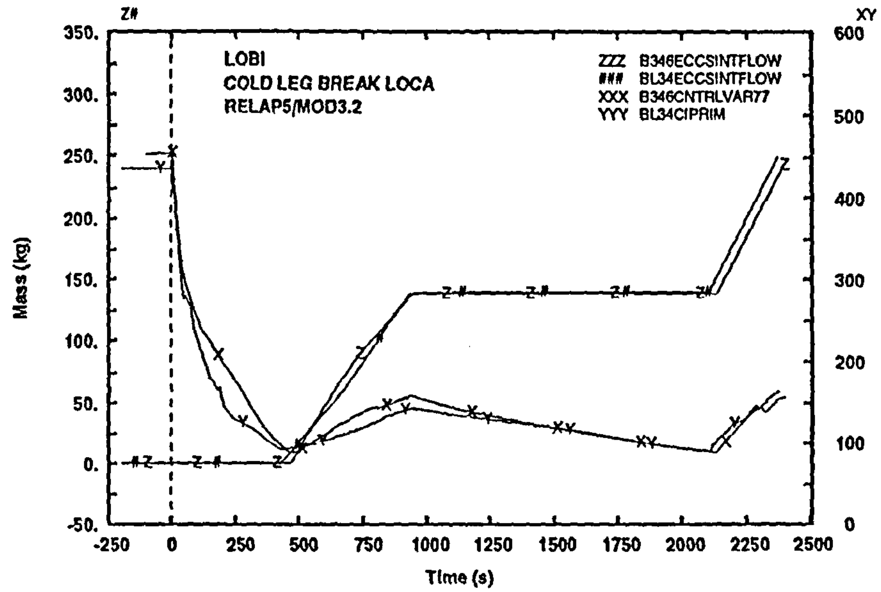

Fig. 2- B346 case : ECCS integral flowrate and primary side total mass

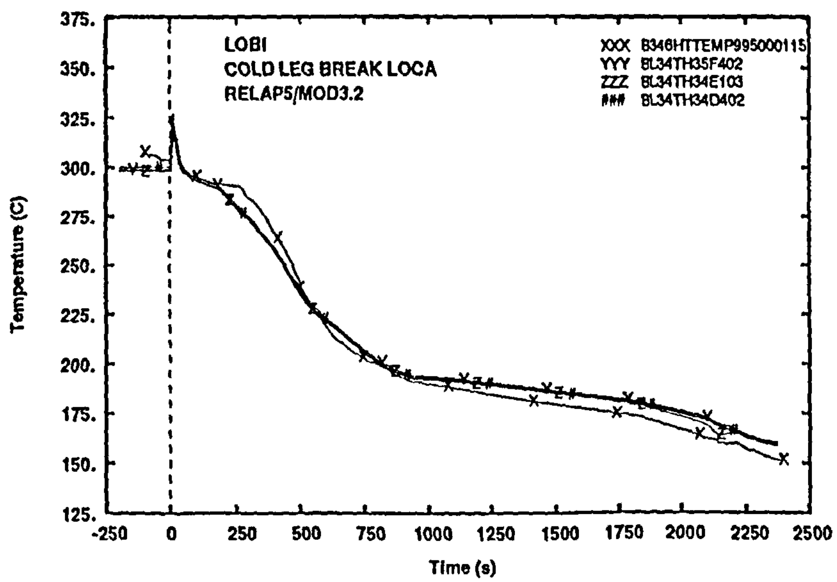

Fig. 3- B346 case : Heater rod temperature (bottom level)

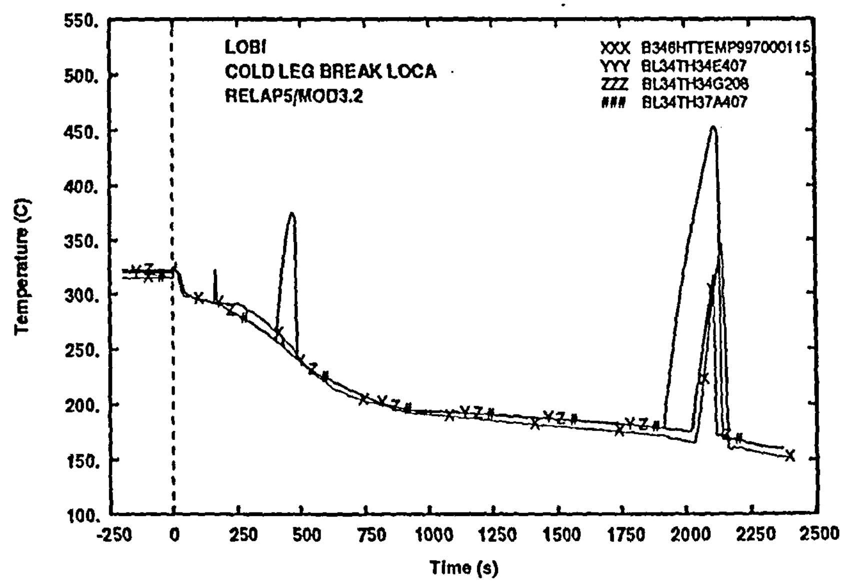

Fig. 4- B346 case : Heater rod temperature (middle level)

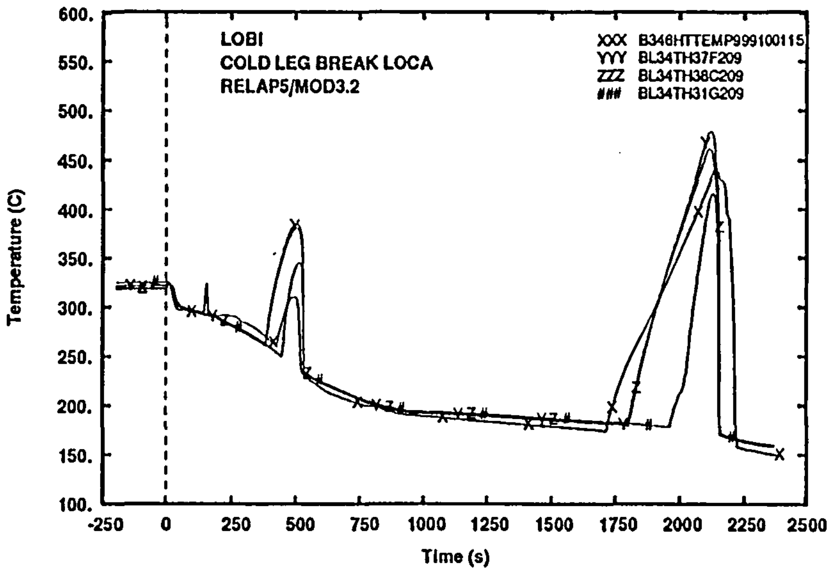

Fig. 5- B346 case : Heater rod temperature (high level)

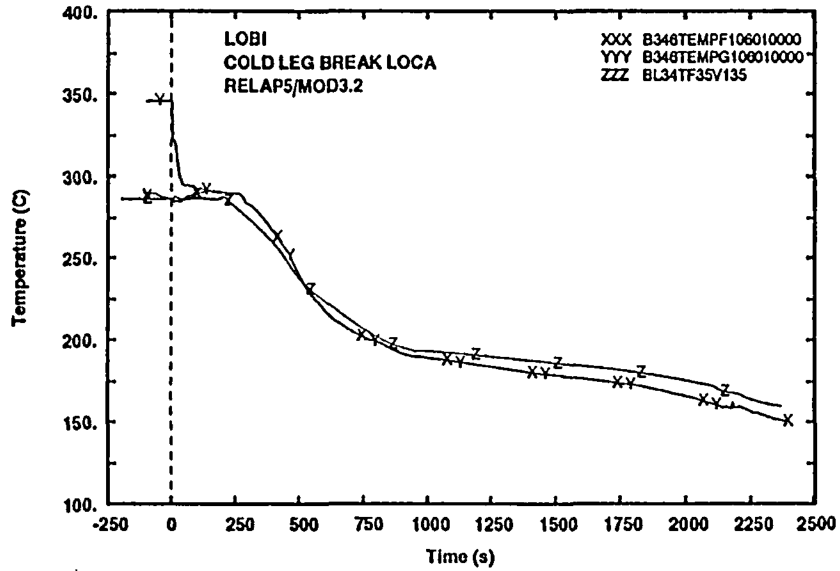

Fig. 6- B346 case : Core inlet fluid temperature

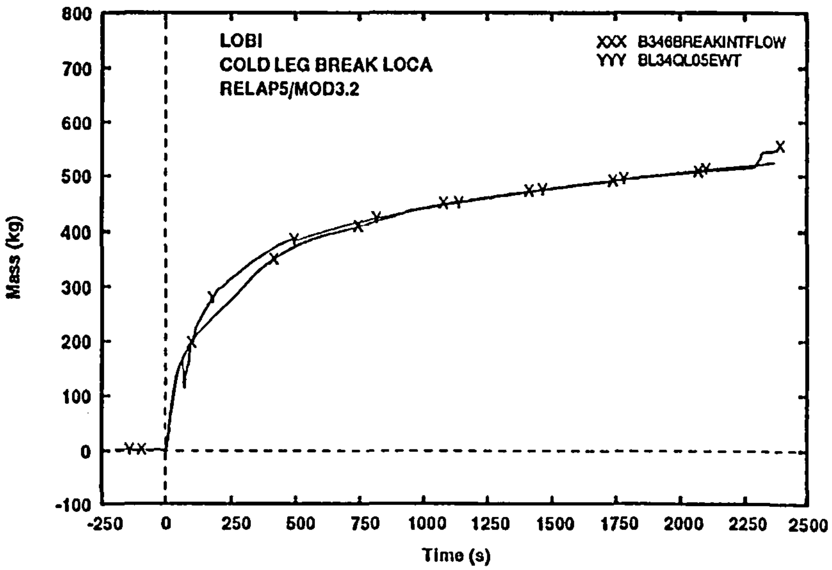

Fig. 7- B346 case : Integral break flowrate

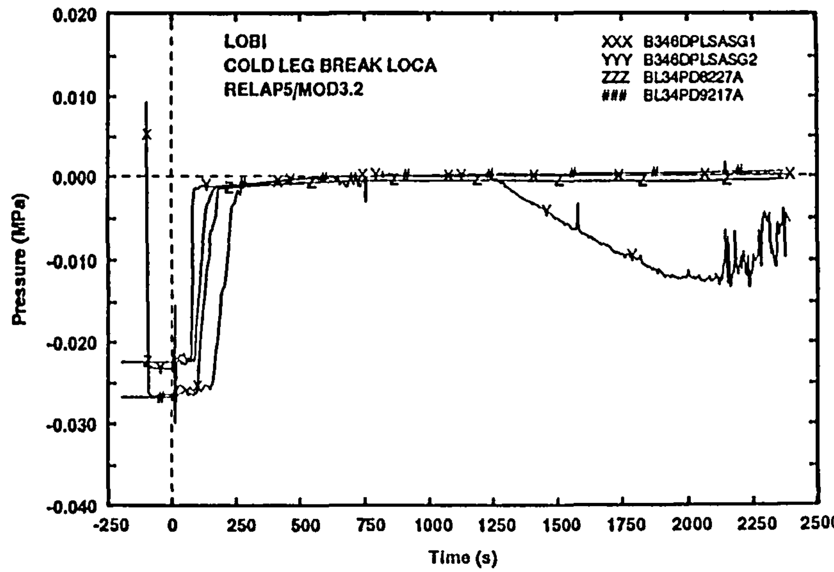

Fig. 8- B346 case : Pressure drop across loop seal (ascendig side)

Appendix 4

Reference calculation input deck

```
=lobi-m0d2 bl34 post
* lobi.bt17 nodalization used
*
0000100 new transnt
*
*01 inp-chk
*
*
110 nitrogen
*
* time steps                min mj re
0000201 100. .5e-7 0.5 07003 10 40 40
0000202 200. .5e-7 0.1 07003 20 500 500
0000203 700. .5e-5 0.1 07003 50 500 500
0000204 1050. .5e-5 0.5 07003 10 100 100
0000205 1700. .5e-5 0.5 07003 10 100 100
0000206 2200. .5e-5 0.5 07003 10 100 100
0000207 1.e6 .5e-5 0.5 07003 10 100 100
*
* minor edits
*** pressures ***
301 p       539010000     * pressurizer top
302 p       815010000     * sg il steam dome
303 p       915010000     * sg bl steam dome
304 p       615010000     * il accumulator
305 p       768010000     * bl accumulator
*** fluid temperature ***
306 tempf   106010000     * core inlet
307 tempg   106010000     *  "  "
308 tempf   540010000     * pressurized
309 tempg   540010000     *  "
310 tempf   500010000     * il hot leg
311 tempg   500010000     *  "
312 tempf   700010000     * bl hot leg
313 tempg   700010000     *  "
314 tempf   900050000     * sg bl downcomer
315 tempg   900050000     *  "
316 tempf   915010000     * sg bl steam dome
317 tempg   915010000     *  "
318 tempf   934010000     * sg bl feedwater
319 tempf   936010000     * sg bl auxiliary fw
320 tempf   615010000     * il accumulator
321 tempf   768010000     * bl accumulator
*** mass flowrates ***
322 mflowj  202010000     * rpv downcomer
323 mflowj  106010000     * core inlet
324 mflowj  430020000     * dc-up holes by-pass
325 cntrlvar 176          * dc-up gap by-pass
326 mflowj  440010000     * dc-uh by-pass 1
327 mflowj  430030000     * dc-uh by-pass 2
328 mflowj  700010000     * bl hot leg
329 mflowj  500010000     * il hot leg
330 mflowj  940010000     * sg bl downcomer
331 mflowj  935000000     * sg bl feedwater
332 mflowj  928000000     * sg bl steam line
333 mflowj  840010000     * sg il downcomer
334 mflowj  835000000     * sg il feedwater
335 mflowj  828000000     * sg il steam line
***  liquid levels ***
336 cntrlvar 001          * pressurizer
338 cntrlvar 002          * sg il downcomer
339 cntrlvar 003          * sg bl downcomer
340 cntrlvar 177          * il accumulator
341 cntrlvar 178          * bl accumulator
*** mass inventory ***
342 cntrlvar 077          * primary system
343 cntrlvar 059          * sg il mass
344 cntrlvar 058          * ss total mass
345 cntrlvar 179          * il accumulator
346 cntrlvar 180          * bl accumulator
*** pressure drop ***
347 cntrlvar 181          * il total
348 cntrlvar 182          * bl total
349 cntrlvar 026          * il pump
350 cntrlvar 025          * bl pump
351 cntrlvar 183          * sg il u-tubes
352 cntrlvar 184          * sg bl u-tubes
353 cntrlvar 016          * across core
354 cntrlvar 185          * across sg il riser
355 cntrlvar 186          * across sg bl riser
*** power ***
356 cntrlvar 036          * core power
357 cntrlvar 064          * sg il exchanged power
358 cntrlvar 067          * sg bl exchanged power
359 cntrlvar 093          * heat losses primary side
360 mflowj 543000000      *
361 mflowj 545000000      *
362 cntrlvar 060          * heat losses sg il
363 cntrlvar 061          * heat losses sg bl
*** varie per plots ***
364 cntrlvar 057          * sgb mass
365 tempf   430010000     * up temperature
366 tempf   460010000     * uh temperature
367 tempf   720130000     * bl u-tubes top temp
368 tempf   570130000     * il u-tubes top temp
369 tempf   745010000     * bl cl temp
370 tempf   605010000     * il cl temp
371 tempf   834010000     * sg il fw temp
372 tempf   850050000     * sg il dc bot temp
373 tempg   820010000     * sg il sd temp
374 velf    730060000     * fluid vel bl loop
375 mflowj  531000000     * prz lvl contr
376 mflowj  542000000     * prz pre contr
377 mflowj  923000000     * sg bl pre contr
378 mflowj  823000000     * sg bl pre contr
379 mflowj  870000000     * il-bl sg connection
*** rod surface temperatures
380 httemp  995000115     * vol 400-03
381 httemp  996000115     * vol 400-04
382 httemp  997000115     * vol 400-05
383 httemp  998000115     * vol 400-06
384 httemp  999000115     * vol 400-07
385 httemp  999100115     * vol 400-08
386 httemp  999300215     * vol 420-01
387 mflowj  757000000     *
388 mflowj  431000000     *
389 mflowj  871000000     *
*
*
*** trips ***
*
* break valve actuation bl34
401 time 0 ge null 0 100. 1   * break on
402 time 0 lt null 0 -1. 1    * break off
*
* shutoff valve
501 time 0 ge null 0 10.e5 1   * shutoff valve
502 time 0 ge null 0 10.e6 1   * shutoff valve
601 501 xor 502 n              * shutoff valve uh (477)
*
* pressurizer control
503 time 0 ge null 0  0. 1     * valve 542 open
504 time 0 ge null 0  99. 1    * valve 542 closure
602  503 xor  504        n     * valve 542 open
*
* il pump
505 time 0 lt null 0 -1.  n    * pump il trip (600)
*
506 time 0 ge null 0  0. 1     * seal wat. il (601)
*
507 p 539010000 lt null 0  11.6e6  n  * bl34 pu decay vel. il
*
*
* lpis actuation
509 httemp 995000115 ge null 0 769. 1 *
517 httemp 996000115 ge null 0 769. 1 *
518 httemp 997000115 ge null 0 769. 1 *
521 httemp 999000115 ge null 0 769. 1 *
534 httemp 999100115 ge null 0 769. 1 *
670 509  or 517            1 *
671 670  or 518            1 *
672 671  or 521            1 *
673 672  or 534            1 * lpis actuation (625)
*
* bl pump
510 time 0 ge null 0  0.        1 * seal wat. bl (744)
```

```
*
511 time 0 lt null 0  -1.            n * pump bl trip (740)
*
512 time 0 ge null 0  101.1          n * bl34 pu decay vel. bl
*
* prz internal heaters actuation
513 time 0 ge null 0 0.              l * prz heaters
539 cntrlvar 001 ge null 0 100.      n *
603 513 and 539                      n * prz heaters actuation
*
514 time 0 ge null 0 1.e6            l * bt17 ps leak
*
*
*  sg - controllo pressione (stazionario)
515 time 0 ge null 0 0.              l * sgil
516 p 539010000 lt null 0  11.2e6    n * bl&il sg p=const (vlvs clo
604 515 xor 516                      n * sgil s.s. sim., up to 13.2
*                                    (vlvs 823&923)
*
519  p 539010000 lt null 0  11.2e6   n * bl34 sl bl&il closure (828)
*
520  time 0 ge null 0 0.             l * bl34 pump seal discharge(604
*
*
522 time 0 ge null 0 0.              l  * lvl control prez
523 time 0 ge null 0  99.9           l  * lvl control stop
606 522 xor 523                      n  * lvl control prez. (531)
*
*  controllo livello sg (stazionario)& fw
524 time 0 ge null 0  0.             l  * lvl control sgs
525 time 0 ge null 0  100.           l  * lvl control stop
607 524 xor 525                      n  * lvl control sgs ss (835,935)
*
526 time 0 ge null 0 100.            l  * sg safety tank (active trip)
*                                    and transient sl (not used)
*
527 p 539010000 ge null 0 1.e9       n  * prz porv (543)
*
528 time 0 ge null 0 1.e6            l  * sgtr break valve bl21 (719)
*
*  rotor block
529 time 0 lt null 0 -1.             l  * bl pump locked rotor sim.
530 time 0 ge timeof 512  10.e6      l  * delay time for opening
608 529 and 530                      n  * ball valve sim. (747)
531 time 0 ge timeof 512  2.5        l  * ball valve closure init.
532 time 0 ge timeof 512  3.5        l  * ball valve closure end
609 531 xor 532                      n  * ball valve closure trip
*
* separatore
533 time 0 ge null 0 -1.             l  * sep. control trip (814-819)+
*
* (non usati)
535 time 0 ge null 0 1.e6            l  * 2nd break opening (758)
536 time 0 ge null 0 10.e5           l  * 2nd break closure (758)
610 535 xor 536                      n  * 2nd break trip open. (758)
*
537 time 0 ge null 0 100.            l  * vlv between sg ss  open.
*                                    (870)
*
538 time 0 ge null 0 1.e6            n  * lvl contr. in bl sg ss
*                                    during transient bl21
*  end programm
540 time 0 ge null 0 2500.  n  * lvl contr. in bl sg ss
600  540                        * end program
*
* prz srv (not utilized in bl34)
541 p 539010000 ge null 0 26.7e6     n  * 16.7
542 p 539010000 ge null 0 20.0e6     l  *
543 p 539010000 lt null 0 16.4e2     n  *
605 541 xor 542                      n  * trip utilized
*
* prz porv+srv (not utiliz. in bl21 , bt17 and bl34)
544 time 0 ge null 0 1.e6            l  *
545 cntrlvar 002 ge null 0 8.0       n  *
546 time 0 ge timeof 611  0.         l  * trip utilized
611 544 and 545                      n  *
*
* il sl during transient  (not active in bl21 , bt17 and bl34)
```

```
557 time 0 ge null 0 1.e6           l  *
558 p 820010000 lt null 0 1.5e1      l  *
559 p 820010000 lt null 0 1.0e1      n  * closure trip
621 557 xor 558                      n  * opening trip
*
* il  sg safety
560 p 820010000 ge null 0 7.20e6     n  * opening il sg sa
*
* bl  sg safety
561 p 920010000 ge null 0 7.20e6     n  * opening bl sg sa
*
*
* bl sl during transient (not active in bl21 , bt17 and bl34)
567 time 0 ge null 0 1.e6            l  *
568 p 920010000 lt null 0 1.5e1      l  *
569 p 920010000 lt null 0 1.0e1      n  * closure trip
631 567 xor 568                      n  * opening trip
*
* il afw actuation  (not active in bl21 , bt17 and bl34)
574 time 0 ge null 0 1.e6            l  *
570 cntrlvar 002 lt null 0 8.0       n  *
571 time 0 ge timeof 574 1.e6        l  *
651 570 and 571                      n  * trip utilized
*
* bl afw actuation  (not active in bl21 , bt17 and bl34)
572 cntrlvar 003 lt null 0 8.4       n  *
573 time 0 ge timeof 574 1.e6        l  *
653 572 and 573                      n  * trip utilized
*
* bt17 core power table
575 p 539010000 lt null 0 13.e6      l  * elect. power
*
* ssn opening
576 time 0 ge null 0      1.e6       l  * ssn opening in bl21
*
* ps vessel up bleed actuation
580 httemp 995000115 ge null 0 3000.   n *
583 httemp 996000115 ge null 0 3000.   n *
584 httemp 997000115 ge null 0 3000.   n *
585 httemp 999000115 ge null 0 3000.   n *
586 httemp 999100115 ge null 0 3000.   n *
674 580  or 583                        n *
675 674  or 584                        n *
676 675  or 585                        n *
677 676  or 586                        n *
581 httemp 999100115 lt null 0 3000.   n * clos.
582 httemp 999100115 ge null 0 2000.   l *
660 677 xor 582                        n * opening trip
*
* sg ss relief actuation in bt17 (non active in bl34)
590 httemp 995000115 ge null  0 3000. n
591 httemp 996000115 ge null  0 3000. n
592 httemp 997000115 ge null  0 3000. n
593 httemp 999000115 ge null  0 3000. n
594 httemp 999100115 ge null  0 3000. n
661 590 or 591  l
662 661 or 592  l
663 662 or 593  l
664 663 or 594  l                       * opening trip (831)
*
*  afw actuation in bt-17 (non active in bl34)
595 p 820010000 lt null 0 -1.        l * afw actuation in bt17
*
* ss pre contr in bt-17 (up to dep. system intervention)
* closure trip (end of pre. contr.) is the 664 trip (start of dep.)
596 time 0 ge null 0      10.e5      l  * control start
597 time 0 ge null 0      10.e6      l  * vlv op. trip end of val.
665 596 xor 597  n                      * vlv op. trip
*
* control of leak nr 2 from up in bt17 (leak nr 1 is in bl cl)
547 time 0 ge null 0    10.e5        l  *
548 time 0 ge null 0    10.e6        l  *
681 547 xor 548  n                      * vlv op. trip
*
* control of leak nr 3 from up in bt17 (leak nr 1 is in bl cl)
549 time 0 ge null 0    10.e5        l  *
550 time 0 ge null 0    10.e6        l  *
682 549 xor 550  n                      * vlv op. trip
```

```
*
* il acc. vlv actuation in bl34
485 p 539010000 lt null 0 3.96e6    1  *
*486 acvliq 615 lt null 0  0.09     1  * vlv clo.
*486 time  0  ge null 0  1057.      1  * vlv clo.
486 cntrlvar 006 ge null 0  138.    1  * vlv clo
487  acvliq 615 lt null 0  1.e-4    1  * vlv clo
749 486 or 487                      1
750 485 xor 749                     n  * vlv op. (675)
*
* hydraulic components
*
*
* lower plenum
1020000 lo.pl. branch
1020001 1 1
1020101 0.0764  0.373 0. 0. -90. -.373 4.e-5 0.3436 0000000
1020200 0 15.47e6  1.252e6  2.447e6  0.
1021101 200010000 102000000 .011252 1.44 0.34 0000000
1021201 3.4 0. 0.
*
*
* core inlet
1060000 core.in. branch
1060001 2 1
1060101 0.02495 1.002 0. 0. 90. 1.002 4.e-5 0.120 0000000
1060200 0 15.47e6  1.252e6  2.447e6  0.
1061101 102000000 106000000 0. 0.1 0.1 0000000
1062101 106010000 400000000 0. 0.7 0.7 0000000
1061201 3.4 0. 0.
1062201 3.4 0. 0.
*
*
* downcomer
2000000 dwncmr  annulus
2000001 6
2000101 0.011308 6
2000301 0.7900  1
2000302 0.8425  2
2000303 1.2460  3
2000304 1.1670  4
2000305 1.2750  5
2000306 1.0020  6
2000401 0. 6
2000601 -90. 6
2000801 4.e-5 0.024 6
2001001 0000000 6
2001101 0000000 5
2001201 0 15.47e6  1.252e6  2.447e6  0. 0. 6
2001300 1
2001301 3.4 0. 0. 5
*
*
* vessel dc top
2020000 vs.dc.tp branch
2020001 1 1
2020101 0.011308 0.7945 0. 0. -90. -.7945 4.e-5 0.024  0000000
2020200 0 15.47e6  1.252e6  2.447e6  0.
2021101 202010000 200000000 0. 0.  0. 0000000
2021201 3.4 0. 0.
*
*
* downcomer top
2100000 downc.tp branch
2100001 1 1
2100101 0.011308 0.315  0. 0.  90.  .315  4.e-5 0.024  0000000
2100200 0 15.47e6  1.252e6  2.447e6  0.
2101101 210000000 202000000 0. 0.  0. 0000000
2101201 0.  0. 0.
*
*
*
* core active length (except  the first 200 mm)
4000000  core  pipe
4000001 9
4000101 .0081152  9
4000301 .200     1
4000302 .412     2
4000303 .663     3
4000304 .583     4
4000305 .584     5
4000306 .583     6
4000307 .663     7
4000308 .412     8
4000309 .4305    9
4000401 0. 9
4000601 90. 9
4000801 1.27e-7 0.01233 9
4000901 0.1 0.1     1
4000902 0.2 0.2     2
4000903 0.56 0.56   3
4000904 0.37 0.37   4
4000905 0.37 0.37   5
4000906 0.37 0.37   6
4000907 0.15 0.15   7
4000908 0.15 0.15   8
4001001 0000000 9
4001101 0000000 8
4001201 0  15.47e6   1.268e6  2.447e6  0. 0.    1
4001202 0  15.47e6   1.284e6  2.447e6  0. 0.    2
4001203 0  15.47e6   1.300e6  2.447e6  0. 0.    3
4001204 0  15.47e6   1.316e6  2.447e6  0. 0.    4
4001205 0  15.47e6   1.332e6  2.447e6  0. 0.    5
4001206 0  15.47e6   1.349e6  2.447e6  0. 0.    6
4001207 0  15.47e6   1.365e6  2.447e6  0. 0.    7
4001208 0  15.47e6   1.383e6  2.447e6  0. 0.    8
4001209 0  15.47e6   1.406e6  2.447e6  0. 0.    9
4001300 1
4001301 3.4 0. 0. 8
*
*
* upper plenum 1
4100000 up.pl.1  branch
4100001 2 1
4100101 0.0240 0.790  0. 0. 90. 0.790   4.e-5 0.035   0011000
4100200 0 15.47e6  1.406e6  2.447e6  0.
4101101 400010000 410000000 0. 0.79 0.70 0000000
4102101 410010000 420000000 0. 0.00 0.00 0000000
4101201 3.4 0. 0.
4102201  0. 0. 0.
*
*
* upper plenum 2
4200000 up.pl.2  branch
4200001 0
4200101 0.024 0.7945 0.0 0.0 90. 0.7945 4.e-5 0.035 0000000
4200200 0 15.47e6  1.406e6  2.447e6  0.
*
* up leak valve (period 3000. - 3800. s)
4210000 up.bl.v   valve
4210101 430000000 422000000 1.5e-6   0. 0. 0000100  1.  1.
4210201 1 0. 0. 0.
4210300 trpvlv
4210301 681
*
* bt17 ps leak tank nr 2 (non active in bl34)
4220000 bl.le.t2   tmdpvol
4220101 1. 1. 0. 0.  90.  1. 4.e-5  0. 0000000
4220200 0 0
4220201 0.  1.e5  120.e3 2.71e6 0.
*
* up leak valve (period 3800. - 6000. s)
4230000 up.bl.v   valve
4230101 430000000 424000000  1.50e-7 0. 0. 0000100 1.  1.
4230201 1 0. 0. 0.
4230300 trpvlv
4230301 682
*
* bt17 ps leak tank nr 3  (non active in bl34)
4240000 bl.le.t3   tmdpvol
4240101 1. 1. 0. 0.  90.  1. 4.e-5  0. 0000000
4240200 0 0
4240201 0.  1.e5  120.e3 2.71e6 0.
*
*
* upper plenum 3
```

```
4300000 up.pl.3  branch
4300001 3 1
4300101 0.024 0.315 0. 0. 90. 0.315 4.e-5 0.035 0000000
4300200 0 15.47e6  1.262e6  2.447e6  0.
4301101 420010000 430000000 0. 0.5 0.5          0000000
4302101 210010000 430010000 .011308 11.1e4 11.1e4 0000000 *2
f: .38 kg/s
4303101 430010000 450000000 3.14e-4  50.   50.  0000000 *uhby
.34 "
4301201 0. 0. 0.
4302201 0. 0. 0.
4303201 0. 0. 0.
*
* up bleed valve
4310000 up.bl.v   valve
4310101 430000000 432000000  2.64e-5 0. 0. 0000100 1.  1.
4310201 1 0. 0. 0.
4310300 mtrvlv
4310301 660 581 0.8 0.
*
*
* up bleed tank
4320000 up.bl.t tmdpvol
4320101 0.0121 2. 0. 0. 0.   0. 4.e-5 0. 0000000
4320200 2
4320201 0. 1.0e5   1.0
*
*
* upper head lo.pipe
4400000 uh.lo.in branch
4400001 2 1
4400101 3.14e-4 0.0 .440e-3 0. 90. .655 4.e-5 0. 0000000
4400200 0 15.47e6  1.262e6  2.447e6  0.
4401101 210010000 440000000 0. 1.e4 1.e4 0000000 *uhby .34 kg/s
4402101 440010000 455000000 0. 0.   0.  0000000 * "   "  "
4401201 0.   0. 0.
4402201 0.   0. 0.
*
*
* upp. head lo. in.
4500000 uh.lo.in branch
4500001 1 1
4500101 3.14e-4 0.0 .570e-3 0. 90. 0.655 4.e-5 0. 0000000
4500200 0 15.47e6  1.262e6  2.447e6  0.
4501101 450010000 455000000 0. 0. 0. 0000000 *uhby .34 kg/s
4501201 0. 0. 0.
*
*
* upp. head inlet branch
4550000 uh.brani branch
4550001 1 1
4550101 1.13e-2 .85 0.     0. 90. 0.85  4.e-5 0. 0000000
4550200 0 15.47e6  1.262e6  2.447e6  0.
4551101 455010000 460000000 0. 0. 0. 0000000
4551201 0. 0. 0.
*
*
* upper head
4600000 upp.head pipe
4600001 2
4600101 0.0113 2
4600301 0.850  1
4600302 0.866  2
4600401 0. 2
4600601 90. 2
4600801 4.e-5 0.12 2
4600901 0. 0. 1
4601001 0000000 2
4601101 0000000 1
4601201 0 15.47e6  1.262e6  2.447e6  0. 0. 2
4601300 1
4601301 0. 0. 0. 1
*
*
* up head up. ju.
4650000 uh.up.j sngljun
4650101 466000000 470000000 0. 1. 1. 0000000
4650201 1 0. 0. 0.
*
*
* upp. head top hor. bran.
4660000 uh.top   branch
4660001 1 1
4660101 1.48e-4 .85 0.     0.  0. 0.   4.e-5 0. 0000000
4660200 0 15.47e6  1.262e6  2.447e6  0.
4661101 466010000 460010000 0. 0. 0. 0000000
4661201 0. 0. 0.
*
*
* upp. head conn. with dc pipe (upper)
4700000 uh.dc.cn snglvol
4700101 1.48e-3 0. 1.29e-3 0.   0.  0.   4.e-5 0. 0000000
4700200 0 15.47e6 1.262e6  2.447e6  0.
*
*
* il.hl.vessel out meas.ins.n.11
5000000 il.ve.ou branch
5000001 3 1
5000101 0.004266 0.906 0. 0. 0. 0. 4.e-5 0. 0000000
5000200 0 15.47e6  1.406e6  2.447e6  0.
5001101 420010000 500000000 0. .9 1.5 0000000
5002101 500010000 510000000 0. 0. 0.  0000000
5003101 500000000 210000000 0.004266 6.19e4 6.19e4 0000000
*gap dcil 1. kg
5001201 2.5 0. 0.
5002201 2.5 0. 0.
5003201  0. 0. 0.
*
*
* conn betw. prez and bl
5070000 il.bl.pr branch
5070001 1 1
5070101 0. 2.5 7.1e-4 0. -90. -2.5 4.e-5 0. 0000000
5070200 0 15.47e6   1.406e6  2.447e6  0.
5071101 510000000 507000000 0. 0. 0. 0000000
5071201 0. 0. 0.
*
*
* hl il sg. upstream 1
5100000 hl.il.g1 branch
5100001 1 1
5100101 0.004266 0.673 0. 0. 0. 0. 4.e-5 0.0737 0000000
5100200 0 15.47e6  1.406e6  2.447e6  0.
5101101 510010000 511000000 0. 0. 0.  0000000
5101201 2.5 0. 0.
*
*
* hl il sg. upstream 2
5110000 hl.il.g2 branch
5110001 1 1
5110101 0.004266 0.673 0. 0. 0. 0. 4.e-5 0.0737 0000000
5110200 0 15.47e6  1.406e6  2.447e6  0.
5111101 511010000 512000000 0. 0. 0.    0000000
5111201 2.5  0. 0.
*
*
* hl il sg. upstream 3
5120000 hl.il.g3 branch
5120001 1 1
5120101 0.004266 0.673 0. 0. 0. 0. 4.e-5 0.0737 0000000
5120200 0 15.47e6  1.406e6  2.447e6  0.
5121101 512010000 550000000 0. 0.5  0.5 0000000
5121201 2.5  0. 0.
*
*
* surge line
5200000 su.li.hl pipe
5200001 3
5200101 1.36848e-4 3
5200301 0.700   1
5200302 3.600   2
5200303 2.800   3
5200401  0.  3
5200601  90.    1
5200602  -90.   2
5200603  90.    3
```

```
5200701 0.630   1
5200702 -3.380  2
5200703 2.500   3
5200801 4.e-5 0.0125 3
5200901 0. 0. 2
5201001 0000000 3
5201101 0000000 2
5201201 0 15.47e6  1.473e6  2.447e6  0. 0. 3
5201300 1
5201301 0. 0. 0. 2
*
*
* prez bot
5300000 pre.bot. branch
5300001 1 1
5300101 0.00823 0.790 0. 0. 90. 0.790 4.e-5 0. 0000000
5300200 0 15.47e6  1.487e6  2.447e6  0.
5301101 530010000 535000000 0. 0. 0. 0000000
5301201 0. 0. 0.
*
*
* prez level control j
5310000 prz.lec  tmdpjun
5310101 534000000 530010000 0.
5310200 1  606  cntrlvar 001
5310201 -1.    0.  0.  0.
5310202   1.   4.5  0.  0.
5310203   4.8   3.2  0.  0.
5310204   5.0   0.0  0.  0.
5310205   5.3   0.  0.  0.
*
*
*
* surge line inlet
5320000 su.li.in sngljun
5320101 530010000 520000000 0. 0. 0. 0000000
5320201 1  0. 0. 0.
*
*
*
* prez lvl control vol
5340000 prz.cvvo   tmdpvol
5340101 0. 10. 10. 0. 90. 10. 4.e-5 0. 0000000
5340200 2
5340201 0. 16.00e6 0.
*
*
* prez middle
5350000 prez.m  pipe
5350001 4
5350101 0.00840  1
5350102 0.01210  4
5350301 0.6300  1
5350302 1.120   2
5350303 1.500   3
5350304 1.500   4
5350401 0. 4
5350601 90. 4
5350801 4.e-5 0.1 4
5350901 0. 0. 3
5351001 0000000 4
5351101 0000000 3
5351201 0 15.47e6  1.597e6  2.447e6  0. 0.   4
5351300 1
5351301 0. 0. 0. 3
*
*
* top prez conn. junction
5370000 tp.c.ju sngljun
5370101 535010000 540000000 0.0121 0. 0. 0000000
5370201 1 0. 0. 0.
*
*
* prz top
5390000 prz.top  branch
5390001 1 1
5390101 0.0121  1.0 0.  0. 90. 1.0  4.e-5 0. 0000000
5390200 0 15.47e6  1.597e6  2.447e6  1.
5391101 540010000 539000000 0. 0.  0.  0000000
5391201 0.  0. 0.
*
*
* prz top inf
5400000  prz.topi snglvol
5400101 .0121  1.040 0. 0. 90. 1.040 4.e-5 0.   0000000
5400200 0 15.47e6 1.597e6  2.447e6  0.95
*
*
* stabilizzatore per lo stazionario
5410000 prez.t  tmdpvol
5410101 0.0121 2. 0. 0. 0.   0. 4.e-5 0. 0000000
5410200 2
5410201 0. 15.47e6 1.0
*
*
* tmdp conn valve to prez
5420000 pr.tmv  valve
5420101 539010000 541000000 0.0121 0. 0. 0000100
5420201 1 0. 0. 0.
5420300 trpvlv
5420301 602
*
*
* prz porv
5430000 prz.porv  valve
5430101 539010000 544000000  1.50e-5 0. 0. 0000100  0.8 0.8
*bt17
5430201 1 0. 0. 0.
5430300 trpvlv
5430301 527
*
*
* prz porv tank
5440000 porv.ta  tmdpvol
5440101 0.0121 2. 0. 0. 0.   0. 4.e-5 0. 0000000
5440200 2
5440201 0. 1.5e6   1.0
*
*
* prz srv
5450000 prz.srv   valve
5450101 539010000 546000000  33.2e-6 0. 0. 0000100 1.2 1. *era
9.7
5450201 1 0. 0. 0.
5450300 mtrvlv
5450301 605 543 0.8 0.
*
*
* prz srv  tank
5460000 srv.ta  tmdpvol
5460101 0.0121 2. 0. 0. 0.   0. 4.e-5 0. 0000000
5460200 2
5460201 0. 1.5e6   1.0
*
*
* prz srv+porv (ssn)
5470000 prz.srpo  valve
5470101 539010000 548000000 33.20e-6 0. 0. 0000100 1.   1.
5470201 1 0. 0. 0.
5470300 trpvlv
5470301 576
*
*
* prz srv+porv tank
5480000 srvpo.t tmdpvol
5480101 0.0121 2. 0. 0. 0.   0. 4.e-5 0. 0000000
5480200 2
5480201 0. 1.5e5   1.0
*
*
* il vert. meas. ins. sg.in. n.12
5500000 il.v.hi snglvol
5500101 .00407 .828 0. 0. 90. .828 4.e-5 .06 0000000
5500200 0 15.47e6  1.406e6  2.447e6  0.
*
*
```

```
* sg inlet hl ju.
5550000 il.sg.ij sngljun
5550101 550010000 560000000 0. 0. 0. 0000000
5550201 1 2.5 0. 0.
*
*
* il sg inlet
5600000 il.sg.in pipe
5600001 3
5600101 .01089 3
5600301 0.574 3
5600401 0. 3
5600601 90. 3
5600701 0.574 3
5600801 4.e-5 .1177 3
5600901 0. 0. 2
5601001 0000000 3
5601101 0000000 2
5601201 0 15.47e6 1.406e6 2.447e6 0. 0. 3
5601300 1
5601301 2.5 0. 0. 2
*
*
* il sg. lp. inlet
5650000 il.sg.lp branch
5650001 2 1
5650101 0. .338 .009054 0. 90. .338 4.e-5 0. 0000000
5650200 0 15.47e6 1.406e6 2.447e6 0.
5651101 560010000 565000000 0. 0.2 0.05 0000000
5652101 565010000 570000000 0. 0.25 0.45 0000000
5651201 2.5 0. 0.
5652201 2.5 0. 0.
*
*
* il sg. tubes
5700000 il.sg.p1 pipe
5700001 24
5700101 .0072412 24
5700301 0.5 6
5700302 0.75 10
5700303 0.656 14
5700304 0.75 18
5700305 0.5 24
5700401 0. 24
5700601 90. 12
5700602 -90. 24
5700701 0.5 6
5700702 0.75 10
5700703 0.656 12
5700704 -.656 14
5700705 -.75 18
5700706 -.5 24
5700801 4.e-5 .019 24
5700901 0. 0. 11
5700902 .08 .08 12
5700903 0. 0. 23
5701001 0000000 24
5701101 0000000 23
5701201 000 15.47e6 1.396e6 2.447e6 0. 0. 1
5701202 000 15.47e6 1.387e6 2.447e6 0. 0. 2
5701203 000 15.47e6 1.378e6 2.447e6 0. 0. 3
5701204 000 15.47e6 1.369e6 2.447e6 0. 0. 4
5701205 000 15.47e6 1.360e6 2.447e6 0. 0. 5
5701206 000 15.47e6 1.351e6 2.447e6 0. 0. 6
5701207 000 15.47e6 1.351e6 2.447e6 0. 0. 7
5701208 000 15.47e6 1.342e6 2.447e6 0. 0. 8
5701209 000 15.47e6 1.342e6 2.447e6 0. 0. 9
5701210 000 15.47e6 1.333e6 2.447e6 0. 0. 10
5701211 000 15.47e6 1.324e6 2.447e6 0. 0. 11
5701212 000 15.47e6 1.316e6 2.447e6 0. 0. 12
5701213 000 15.47e6 1.316e6 2.447e6 0. 0. 13
5701214 000 15.47e6 1.307e6 2.447e6 0. 0. 14
5701215 000 15.47e6 1.307e6 2.447e6 0. 0. 15
5701216 000 15.47e6 1.299e6 2.447e6 0. 0. 16
5701217 000 15.47e6 1.299e6 2.447e6 0. 0. 17
5701218 000 15.47e6 1.290e6 2.447e6 0. 0. 18
5701219 000 15.47e6 1.290e6 2.447e6 0. 0. 19
5701220 000 15.47e6 1.278e6 2.447e6 0. 0. 20
5701221 000 15.47e6 1.273e6 2.447e6 0. 0. 21
5701222 000 15.47e6 1.268e6 2.447e6 0. 0. 22
5701223 000 15.47e6 1.263e6 2.447e6 0. 0. 23
5701224 000 15.47e6 1.258e6 2.447e6 0. 0. 24
5701300 1
5701301 2.5 0. 0. 23
*
*
* il.sg.lp. outlet
5750000 il.sg.lo branch
5750001 2 1
5750101 0. .338 .009054 0. -90. -0.338 4.e-5 0. 0.
5750200 0 15.47e6 1.252e6 2.447e6 0.
5751101 570010000 575000000 0. .45 .25 0000000
5752101 575010000 580000000 0. .05 .2 0000000
5751201 2.5 0. 0.
5752201 2.5 0. 0.
*
*
* il sg outlet
5800000 il.sg.ou pipe
5800001 3
5800101 .01089 3
5800301 0.574 3
5800401 0. 3
5800601 -90. 3
5800701 -.574 3
5800801 4.e-5 .1177 3
5800901 0. 0. 2
5801001 0000000 3
5801101 0000000 2
5801201 0 15.47e6 1.252e6 2.447e6 0. 0. 3
5801300 1
5801301 2.5 0. 0. 2
*
*
* il sg outlet
5820000 il.sg.ou sngljun
5820101 580010000 585000000 0. 0. 0. 0000000
5820201 1 2.5 0. 0.
*
*
* il vert. meas. ins. sg. ou. n.13
5850000 il.v.n2 snglvol
5850101 .00407 .828 0. 0. -90. -0.828 4.e-5 0.06 0000000
5850200 0 15.47e6 1.252e6 2.447e6 0.
*
*
* il cl. meas. ins.-loop seal ju
5870000 il.loo.s sngljun
5870101 585010000 590000000 0. 0. 0. 0000000
5870201 1 2.5 0. 0.
*
*
* il. loop seal
5900000 il.s.sea pipe
5900001 6
5900101 4.266e-3 6
5900301 .950 1
5900302 .7825 3
5900303 .855 4
5900304 .7825 6
5900401 0. 6
5900601 -90. 3
5900602 0. 4
5900603 90. 6
5900801 4.e-5 .073 6
5900901 0. 0. 5
5901001 0000000 6
5901101 0000000 5
5901201 0 15.47e6 1.252e6 2.447e6 0. 0. 6
5901300 1
5901301 2.5 0. 0. 5
*
*
* il. pump. p1 inlet meas. ins n.14
5950000 il.pu.in branch
5950001 1 1
```

```
5950101 0.00407 0.750 0. 0. 90. 0.750 4.e-5 0. 0.
5950200 0 15.47e6  1.252e6  2.447e6  0.
5951101 590010000 595000000 0. 0. 0. 0000000
5951201 2.5 0. 0.
*
*
* il pump
6000000 il-pump pump
6000101 0. 0.2 2.e-3 0. 90. 0.2 0
6000108 595010000 .00407 .060 .02 0000000
6000109 605000000 .0 0.02 0.06 0000000
6000200 0 15.47e6  1.252e6  2.447e6  0.
6000201 1 2.5 0. 0.
6000202 1 2.5 0. 0.
6000301 0 0 0 -1 0 505 1
6000302 745.6 0.05740 0.027878 139.9 45.47  0.157
6000303 747.3 0. 0. 0. 0. 0.
*** head curves ***
6001100  1 1
6001101 0.    1.055
6001102 0.05  1.064
6001103 0.1   1.079
6001104 0.2   1.102
6001105 0.3   1.12
6001106 0.4   1.131
6001107 0.5   1.131
6001108 0.6   1.123
6001109 0.7   1.104
6001110 0.8   1.0785
6001111 0.9   1.043
6001112 1.0   1.
*
6001200  1 2
6001201  0.   -.78
6001202  0.1  -.6285
6001203  0.2  -.478
6001204  0.3  -.323
6001205  0.31  -.308
6001206  0.4  -.169
6001207  0.6   .173
6001208  0.7   .365
6001209  0.8   .556
6001210  0.9   .768
6001211  1.    1.
*
6001300  1 3
6001301  -1.   2.11
6001302  -.9   1.927
6001303  -.8   1.758
6001304  -.7   1.6105
6001305  -.6   1.489
6001306  -.5   1.38
6001307  -.4   1.282
6001308  -.3   1.20
6001309  -.2   1.133
6001310  -.1   1.0805
6001311  -.05  1.0615
6001312   0.   1.055
*
6001400  1 4
6001401 -1.   2.11
6001402 -.9   1.862
6001403 -.8   1.65
6001404 -.7   1.474
6001405 -.6   1.332
6001406 -.5   1.212
6001407 -.4   1.105
6001408 -.3   1.002
6001409 -.2   0.911
6001410 -.1   0.83
6001411 0.    0.761
*
6001500  1 5
6001501 0.    .424
6001502 .2    .543
6001503 .3    .603
6001504 .4    .66
6001505 .487   .702
6001506 .5    .7095
6001507 .55    .7305
6001508 .6    .7495
6001509 .65   .762
6001510 .7    .777
6001511 .75   .789
6001512 .8    .804
6001513 .85   .828
6001514 .9    .861
6001515 .95   .901
6001516 1.    .948
*
6001600  1 6
6001601 0.    .761
6001602 .1    .71
6001603 .2    .664
6001604 .3    .644
6001605 .35   .646
6001606 .4    .653
6001607 .5    .6795
6001608 .6    .707
6001609 .7    .746
6001610 .8    .799
6001611 .9    .861
6001612 .95   .901
6001613 1.    .948
*
6001700  1 7
6001701 -1.   -.11
6001702 -.7   -.46
6001703 -.6   -.283
6001704 -.5   -.147
6001705 -.45  -.081
6001706 -.384  0.
6001707 -.35   0.041
6001708 -.30   .106
6001709 -.25   .17
6001710 -.20   .233
6001711 -.15   .29
6001712 -.1    .3395
6001713 -.05   .384
6001714  0.    .424
*
6001800  1 8
6001801 -1.  -1.11
6001802 -.7  -1.4
6001803 -.5  -1.34
6001804 -.3  -1.17
6001805 -.1  -0.91
6001806  0.  -0.78
*** torque curves ***
6001900  2 1
6001901 0.   .439
6001902 .05  .442
6001903 .1   .46
6001904 .2   .515
6001905 .3   .5825
6001906 .4   .647
6001907 .5   .706
6001908 .6   .764
6001909 .7   .823
6001910 .8   .882
6001911 .9   .9415
6001912 1.   1.
*
6002000 2 2
6002001 0.   -.518
6002002 .1   -.35
6002003 .2   -.184
6002004 .3   -.018
6002005 .31   0.
6002006 .4    .151
6002007 .6    .464
6002008 .7    .5985
6002009 .8    .731
6002010 .9    .864
6002011 1.    1.
*
```

6002100 2 3
6002101 -1. 1.182
6002102 -.9 1.037
6002103 -.8 .911
6002104 -.7 .804
6002105 -.6 .712
6002106 -.5 .632
6002107 -.4 .567
6002108 -.3 .513
6002109 -.2 .473
6002110 -.1 .4495
6002111 -.05 .441
6002112 0. .439
*
6002200 2 4
6002201 -1. 1.182
6002202 -.9 1.12
6002203 -.8 1.013
6002204 -.7 1.104
6002205 -.6 1.24
6002206 -.5 1.323
6002207 -.4 1.34
6002208 -.3 1.256
6002209 -.2 1.122
6002210 -.1 1.041
6002211 0. 0.984
*
6002300 2 5
6002301 0. -.569
6002302 .2 -.318
6002303 .3 -.202
6002304 .4 -.098
6002305 .487 0.
6002306 .5 .013
6002307 .55 .0695
6002308 .6 .121
6002309 .65 .173
6002310 .7 .229
6002311 .75 .284
6002312 .8 .345
6002313 .85 .409
6002314 .9 .474
6002315 .95 .549
6002316 1. .630
*
6002400 2 6
6002401 0. .984
6002402 .1 .9505
6002403 .2 .929
6002404 .3 .905
6002405 .35 .89
6002406 .4 .873
6002407 .5 .84
6002408 .6 .802
6002409 .7 .761
6002410 .8 .7205
6002411 .9 .678
6002412 .95 .653
6002413 1. .630
*
6002500 2 7
6002501 -.6 -1.59
6002502 -.5 -1.39
6002503 -.45 -1.297
6002504 -.384 -1.18
6002505 -.35 -1.1205
6002506 -.3 -1.04
6002507 -.25 -.956
6002508 -.2 -.87
6002509 -.15 -.7905
6002510 -.1 -.716
6002511 -.05 -.64
6002512 0. -.569
*
6002600 2 8
6002601 -1. -0.518
6002602 0. -0.518
*** two-phase curves multipliers ***
6003000 0
6003001 0. 0.
6003002 .2 0.
6003003 .43 1.
6003004 .95 1.
6003005 1. 0.
*
6003100 0
6003101 0. 0.
6003102 1. 0.
*** two-phase curves differences ***
6004100 1 1
6004101 0. .165
6004102 .05 .774
6004103 .1 .81
6004104 .3 .773
6004105 .5 .804
6004106 .7 .828
6004107 1. .816
*
6004200 1 2
6004201 0. .22
6004202 .1 .2285
6004203 .3 .248
6004204 .5 .329
6004205 .7 .477
6004206 1. .816
*
6004300 1 3
6004301 -1. -.82
6004302 -.8 -1.491
6004303 -.7 -1.6695
6004304 -.5 -1.78
6004305 -.3 -1.5
6004306 -.2 -1.137
6004307 -.1 -.5895
6004308 0. 0.165
*
6004400 1 4
6004401 -1. -.82
6004402 -.90 -.538
6004403 -.8 -.33
6004404 -.6 -.098
6004405 -.4 -.045
6004406 -.2 -.039
6004407 0. -.039
*
6004500 1 5
6004501 0. -.046
6004502 .2 -.366
6004503 .4 -.58
6004504 .6 -.6805
6004505 .7 -.693
6004506 .8 -.676
6004507 1. -.482
*
6004600 1 6
6004601 0. -.039
6004602 .2 -.066
6004603 .3 -.095
6004604 .4 -.097
6004605 .6 -.173
6004606 .8 -.331
6004607 1. -.482
*
6004700 1 7
6004701 -1. .89
6004702 -.7 .87
6004703 -.5 .653
6004704 -.3 .366
6004705 -.1 .1
6004706 0. -.046
*
6004800 1 8
6004801 -1. .89
6004802 -.7 .37
6004803 -.5 .03
6004804 -.3 .2

```
6004805 -.1    .22
6004806 0.    .22
*** two-phase torque curve differences *** (loft l2-5)
6004900 2 1
6004901 0. 1.
6004902 1. 1.
*
6005000 2 2
6005001 0. 1.
6005002 1. 1.
*
6005100 2 3
6005101 -1.    1.9843
6005102 -.80096  1.394
6005103 -.60638  1.0975
6005104 -.40686  0.82
6005105 -.19928  0.6648
6005106 0.    0.6032
*
6005200 2 4
6005201 -1.0000 1.9843
6005202 -.82234 1.8308
6005203 -.63371 1.6824
6005204 -.45853 1.557
6005205 -.26702 1.436
6005206 -.17610 1.3879
6005207 -.0893  1.3481
6005208 0.    1.2336
*
6005300 2 5
6005301 0. -.45
6005302 .4 -.25
6005303 .5 0.
6005304 1. .3569
*
6005400 2 6
6005401 0.    1.2336
6005402 .09    1.1965
6005403 .1885   1.1096
6005404 .2734   1.0416
6005405 .4586   0.8958
6005406 .5744   .7807
6005407 .7381   .6134
6005408 .7685   .5849
6005409 .87    .4877
6005410 1.    .357
*
6005500 2 7
6005501 -1. -1.
6005502 -.3 -.9
6005503 -.1 -.5
6005504 0. -.45
*
6005600 2 8
6005601 -1. -1.
6005602 -.25 -.9
6005603 -.08 -.8
6005604 0. -.67
*** decay velocity pump intact loop ***
6006100   507
6006101   0.    42.8
6006102   1.1   42.8
6006103   3.1   0.
6006104   1.e6   0.
*
*
* pump seal water ju. il
6010000 pu.seax   tmdpjun
6010101 603000000 605000000 0.
6010200 1 506
6010201  0.    11.e-3  0. 0.
6010202  12.   16.2e-3  0. 0.
6010203  20.   12.0e-3  0. 0.
6010204  160.   9.7e-3  0. 0.
6010205  325.   8.0e-3  0. 0.
6010206  700.   5.3e-3  0. 0.
6010207  1200.  4.8e-3  0. 0.
6010208  2400.  4.2e-3  0. 0.
```

```
6010209  1.e6   4.2e-3  0. 0.
*
*
* tmdpvol for pump seal water exit
6020000 pu.s.exv  tmdpvol
6020101 0. 1. 5. 0. 90. 1. 4.e-5 0. 0000000
6020200 0 0
6020201 0. 0.9e6 120.e3 2.71e6 0.
*
*
* pump seal water tank il
6030000 pu.se.i  tmdpvol
6030101 0. 1. 5. 0. 90. 1. 4.e-5 0. 0000000
6030200 0 0
6030201 0. 19.4e6 120.e3 2.71e6 0.
*
*
* junction sim. pump seal water exit
6040000 pu.s.exj  tmdpjun
6040101 102010000 602000000 6.0e-4
6040200 1 520 cntrlvar 175
6040201 0. 0.0   0. 0.
6040202 1. 1.   0. 0.
*
*
* il. pump. pump exit
6050000 pu.il.e  branch
6050001 1 1
6050101 0.00426 1.035 0. 0. 0. 0. 4.e-5 0. 0000000
6050200 0 15.47e6  1.252e6  2.447e6 0.
6051101 605010000 610000000 0. 0. 0. 0000000
6051201 2.5 0. 0.
*
* meas. ins n. 15 and cold leg il
6100000 mcl.il   pipe
6100001 4
6100101 4.266e-3 4
6100301 .65625  4
6100401 0.  4
6100601 0.  4
6100801 4.e-5 0.  4
6100901 0. 0. 3
6101001 0000000  4
6101101 0000000 3
6101201 0 15.47e6  1.252e6  2.447e6  0. 0. 4
6101300 1
6101301 2.5 0. 0. 3
*
*
* meas. ins. n. 16 il cl ves. side
6120000 m.ins.16  branch
6120001 2 1
6120101 0.004266 0.670 0. 0. 0. 0. 4.e-5 0.068 0000000
6120200 0 15.47e6  1.252e6  2.447e6  0.
6121101 610010000 612000000 0. 0. 0. 0000000
6122101 612010000 202000000 0. 1.05 0.7 0000000
6121201 2.5 0. 0.
6122201 2.5 0. 0.
*
*
* accumulator il   (active in bl34)
6150000 il.acc  accum
6150101 0. 4.68  279.85e-3  0. 90. 4.68  2.3e-5  0. 0000000
6150200 3.97e6 300. 0.                * 4.1e6
6151101 670010000 4.83e-4  10.  10. 0000000
6152200 0.222  0. 0.01 0.01  0.01 0 0. 0.
*
*
* junction sim. lpis
6250000 hpis.j  tmdpjun
6250101 630000000 612000000 6.0e-4
6250200 1  673
6250201 -1.  0.   0. 0.
6250202 0.  0.4  0. 0.
6250203 1.e6  0.4  0. 0.
*
* lpis tank
6300000 hpis.t  tmdpvol
```

```
6300101 0. 10. 10. 0. 90. 10. 4.e-5 0. 0000000
6300200 0 0
6300201 0. 19.4e6 120.e3 2.71e6 0.
*
*
* il accum injection line (active in bl34)
6700000 il.accl    pipe
6700001 2
6700101 0.483e-3 2
6700301 5.7195   1
6700302 4.925    2
6700401 0.       2
6700601 90.      2
6700801 4.e-5 0. 2
6700901 1.  1.  1
6701001 0000000       2
6701101 0000000  1
6701201 000 4.2e6 1.996e5 2.44e6 0. 0. 2
6701300 1
6701301 0. 0. 0.  1
*
*
* il accum valve
6750000 il.accv    valve
6750101 670000000 200000000 5.150e-5 180. 1.e6 0000100 1. 1.
6750201 1 0. 0. 0.
6750300 mtrvlv
6750301 750 486 2. 0.
*
*
* broken loop hl vess conn half
7000000 bl.ve.ou branch
7000001 3 1
7000101 1.6691e-3 0.5 0. 0. 0. 0. 4.e-5 0. 0000000
7000200 0 15.47e6  1.406e6  2.447e6  0.
7001101 420010000 700000000 0. 1.30 1.47 0000000
7002101 700010000 702000000 0. 0.1 0.1 0000000
7003101 700000000 210000000 1.6691e-3 4.40e4 4.40e4 0000000
*gap dcbl
7001201 0.9 0. 0.
7002201 0.9 0. 0.
7003201 0. 0. 0.
*
* broken loop prz connection tee
7020000 prz.bl.c branch
7020001 2 1
7020101 1.6691e-3 0.563 0. 0. 0. 0. 4.e-5 0. 0000000
7020200 0 15.47e6  1.406e6  2.447e6  0.
7021101 520010000 702000000 0. 0.  0.  0000000
7022101 702010000 705000000 0. 0.  0.  0100000
7021201 0. 0. 0.
7022201 0.90 0. 0.
*
*
* bl hl meas. ins is. vol n.1 of the pipe
7050000 bl.hl     pipe
7050001 3
7050101 1.669e-3 3
7050301 0.563    3
7050401 0. 3
7050601 0. 3
7050801 4.e-5 0.    3
7050901 0.  0. 2
7051001 0000000 3
7051101 0000000 2
7051201 0 15.47e6  1.406e6  2.447e6  0. 0. 3
7051300 1
7051301 0.90 0. 0. 2
*
*
* broken loop sg inlet 1
7100000 sg.bl.i1 branch
7100001 2 1
7100101 1.6691e-3 0.842  0.   0.  90.  0.842   4.e-5 0. 0000000
7100200 000 15.47e6  1.406e6   2.447e6  0.
7101101 705010000 710000000 0. 0.35 0.35  0000000
7102101 710010000 712000000 0. 0.01 0.01  0000000
7101201 0.9 0. 0.
7102201 0.9 0. 0.
*
*
* bl sg inlet
7120000 sg.bl.in  pipe
7120001 3
7120101 3.668e-3  3
7120301 0.639    2
7120302 0.6395    3
7120401 0. 3
7120601 90. 3
7120801 4.e-5 0.04610 3
7120901 0.  0.  2
7121001 0000000  3
7121101 0000000 2
7121201 0 15.47e6   1.406e6   2.447e6   0. 0. 3
7121300 1
7121301 0.9 0. 0. 2
*
*
* bl.sg lower ple inlet
7180000 sg.bl.il  branch
7180001 2 1
7180101 0. 0.221 3.01e-3 0. 90. 0.221 4.e-5 0. 0000000
7180200 0 15.47e6   1.406e6   2.447e6   0.
7181101 712010000 718000000 0. 0.30 0.1 0000000
7182101 718010000 720000000 0. 0.6 0.8  0000000
7181201 0.9 0. 0.
7182201 0.9 0. 0.
*
*
* sgtr break bl21 0.4%  (non active in bl34)
7190000 sgtr.bre  valve
7190101 718010000 948000000 0.0039   1.e-6 1.e-6 0000100 1.  1.
7190201 1 0. 0. 0.
7190300 trpvlv
7190301 528
*
*
* bl sg. tubes
7200000 bl.sg.p1 pipe
7200001 24
7200101 .0024137 24
7200301 0.5     6
7200302 0.75    10
7200303 0.656   14
7200304 0.75    18
7200305 0.5     24
7200401 0.      24
7200601 90.     12
7200602 -90.    24
7200701 0.5     6
7200702 0.75    10
7200703 0.656   12
7200704 -.656   14
7200705 -.75    18
7200706 -.5     24
7200801 4.e-5 .019 24
7200901 0. 0. 11
7200902 .08 .08 12
7200903 0. 0. 23
7201001 0000000  24
7201101 0000000 23
7201201 000  15.47e6   1.396e6   2.447e6   0. 0. 1
7201202 000  15.47e6   1.387e6   2.447e6   0. 0. 2
7201203 000  15.47e6   1.378e6   2.447e6   0. 0. 3
7201204 000  15.47e6   1.369e6   2.447e6   0. 0. 4
7201205 000  15.47e6   1.360e6   2.447e6   0. 0. 5
7201206 000  15.47e6   1.351e6   2.447e6   0. 0. 6
7201207 000  15.47e6   1.351e6   2.447e6   0. 0. 7
7201208 000  15.47e6   1.342e6   2.447e6   0. 0. 8
7201209 000  15.47e6   1.342e6   2.447e6   0. 0. 9
7201210 000  15.47e6   1.333e6   2.447e6   0. 0. 10
7201211 000  15.47e6   1.324e6   2.447e6   0. 0. 11
7201212 000  15.47e6   1.316e6   2.447e6   0. 0. 12
7201213 000  15.47e6   1.316e6   2.447e6   0. 0. 13
7201214 000  15.47e6   1.307e6   2.447e6   0. 0. 14
7201215 000  15.47e6   1.307e6   2.447e6   0. 0. 15
```

```
7201216 000  15.47e6   1.299e6   2.447e6  0. 0. 16
7201217 000  15.47e6   1.299e6   2.447e6  0. 0. 17
7201218 000  15.47e6   1.290e6   2.447e6  0. 0. 18
7201219 000  15.47e6   1.290e6   2.447e6  0. 0. 19
7201220 000  15.47e6   1.278e6   2.447e6  0. 0. 20
7201221 000  15.47e6   1.273e6   2.447e6  0. 0. 21
7201222 000  15.47e6   1.268e6   2.447e6  0. 0. 22
7201223 000  15.47e6   1.263e6   2.447e6  0. 0. 23
7201224 000  15.47e6   1.258e6   2.447e6  0. 0. 24
7201300 1
7201301 0.9 0. 0. 23
*
*
* bl sg lower plenum outlet
7220000 sg.bl.po   branch
7220001 2 1
7220101 0. 0.221 3.01e-3 0. -90. -0.221 4.e-5 0. 0000000
7220200 0 15.47e6   1.252e6   2.447e6  0.
7221101 720010000 722000000 0. 0.8 0.6 0000000
7222101 722010000 725000000 0. 0.1 0.3 0000000
7221201 0.9 0. 0.
7222201 0.9 0. 0.
*
*
* bl sg outet
7250000 sg.bl.ou  pipe
7250001 3
7250101 3.668e-3  3
7250301 0.6395    1
7250302 0.639     3
7250401 0. 3
7250601 -90. 3
7250801 4.e-5 0.04610 3
7250901 0.  0.  2
7251001 0000000  3
7251101 0000000 2
7251201 000 15.47e6   1.252e6   2.447e6  0. 0. 3
7251300 1
7251301 0.9 0. 0. 2
*
*
* bl sg outlet meas ins n. 23 inl ju
7270000 sg.m.23j   sngljun
7270101 725010000 730000000 0. 0. 0. 0000000
7270201 1 0.9 0. 0.
*
*
* loop seal bl
7300000 bl.ls       pipe
7300001 6
7300101 1.6691e-3 6
7300301 1.042 1
7300302 1.151 2
7300303 0.701 3
7300304 0.884 4
7300305 0.701 5
7300306 1.151 6
7300401 0. 6
7300601 -90. 3
7300602 0. 4
7300603 90. 6
7300801 4.e-5 0.0460 4
7300802 4.e-5 0.0400 6
7300901 0. 0. 3
7300902 0.04 0.04 4
7300903 0.04 0.04 5
7301001 0000000 6
7301101 0000000 5
7301201 0 15.47e6   1.252e6   2.447e6  0. 0. 6
7301300 1
7301301 0.9 0. 0. 5
*
*
* bl pump
7400000 bl-pump    pump
7400101 0. 0.2 2.e-3 0. 90. 0.2 0
7400108 730010000 1.66e-3 0.03 0.075 0000000
7400109 745000000 0.      0.075 0.03 0000000
7400200 0 15.47e6   1.252e6   2.447e6  0.
7400201 1 0.9 0. 0.
7400202 1 0.9 0. 0.
7400301 600 600 600 -1 0 511 1
7400302 745.6 0.02428 0.027878 139.9 45.47 0.157
7400303 747.3 0. 0. 0. 0. 0.
*
*
* pump bl decay velocity
7406100   512
7406101    0.    18.1
7406102    1.1   18.1
7406103    3.1   0.
7406104    1.e6  0.
*
*
* bl loop seal tank
7420000 bl.pu.st   tmdpvol
7420101 0. 1. 5. 0. 90. 1. 4.e-5  0. 0000000
7420200 0 0
7420201 0. 19.4e6 120.e3 2.71e6 0.
*
*
* bl pump seal water ju
7440000 bl.pusx    tmdpjun
7440101 742000000 745000000 0.
7440200 1 510
7440201    0.       9.0e-3  0. 0.
7440202    5.      10.6e-3  0. 0.
7440203   20.       8.5e-3  0. 0.
7440204   50.       7.5e-3  0. 0.
7440205  200.       7.9e-3  0. 0.
7440206  400.       6.0e-3  0. 0.
7440207  600.       5.0e-3  0. 0.
7440208  1300.      4.7e-3  0. 0.
7440209  2000.      4.5e-3  0. 0.
7440210  2400.      4.3e-3  0. 0.
7440211  1.e6       4.3e-3  0. 0.
*
*
* bl pump outlet
7450000 bl.pu.ou    branch
7450001 0
7450101 1.6691e-3 0.503 0. 0. 0. 0. 4.e-5 0. 0000000
7450200 0 15.47e6   1.252e6   2.447e6  0.
*
*
* blocked rotor bl pump resist. sim.
7470000 bl.bps    valve
7470101 745010000 750000000 1.669e-3  0.  0. 0000100 1. 1.
7470201 1 0.9 0. 0.
7470300 mtrvlv
7470301 608 609 .8285 1.
*
*
* bl meas ins 25 break upstream
7500000 bl.me.25   pipe
7500001 5
7500101 1.6691e-3 5
7500301 0.369 5
7500401 0. 5
7500601 0. 5
7500801 4.e-5 0.042 5
7500901 0. 0. 4
7501001 0000000 5
7501101 0000000 4
7501201 0 15.47e6   1.252e6   2.447e6  0. 0. 5
7501300 1
7501301 0.9 0. 0. 4
*
* bt17 ps leak (non active in bl34)
7570000 ps.leak    tmdpjun
7570101 770000000 765000000 0.
7570200 1 514
7570201   0.      .0      0. 0.
7570202   0.1     .0165   0. 0.
7570203   3164.   .0165   0. 0.
7570204   3165.   .0001   0.001  0.          * gtot = .059
```

```
7570205 3846.   .0001  0.001 0.        * gtot = .059
7570206 3847.   .0    0.001 0.         * gtot = .0044
7570207 6013.   .0    0.001 0.         * "  "
7570208 6014.   .00001  0.078 0.
7570209 1.e6    .00001  0.078 0.
*
* break valve (bl34)
7600000 break.v  valve
7600101 774000000 761000000 4.254400e-5 1.2 1.2 0000100 1.15
0.7 1.0
7600201 1 0. 0. 0.
7600300 mtrvlv
7600301 401 402 0.8  0.
*
*
* containment simulator
7610000 contain.  tmdpvol
7610101 1. 1. 0. 0. 0. 0. 4.e-3 0. 0000000
7610200 0 0
7610201 0. 3.5e5 1.2e5 2.6e6 1.
*
*
* bt17 ps leak tank (non active in bl34)
7650000 bl.lea.t  tmdpvol
7650101 1. 1. 0. 0.  90.  1. 4.e-5  0. 0000000
7650200 0 0
7650201 0.  1.e5  120.e3 2.71e6 0.
*
* accumulator bl (not active in bl34)
7680000 bl.acc  accum
7680101 0. 6.794  94.35e-3  0. 90. 6.794 2.3e-5  0. 0000000
7680200 0.1e6 300. 0.                  * 4.1
7681101 770000000 1.84e-4  196.  196.  0000000
7682200 0.0599 0. 10.  6.68   0.01 0 0. 0.
*
*
* bl loop vessel inlet ins. n.26
7700000 bl.ve.i1    branch
7700001 2 1
7700101 1.66e-3 0.5072  0. 0. 0. 0. 4.e-5 0.04 0000000
7700200 0 15.47e6   1.252e6   2.447e6  0.
7701101 750010000 770000000 0. 0. 0.  0000000
7702101 770010000 772000000 0. 0. 0.  0000000
7701201 0.9 0. 0.
7702201 0.9 0. 0.
*
*
* bl loop vessel inlet ins. n.26
7720000 bl.ve.i2    branch
7720001 1 1
7720101 1.66e-3 0.5072  0. 0. 0. 0. 4.e-5 0.04 0000000
7720200 0 15.47e6   1.252e6   2.447e6  0.
7721101 772010000 774000000 0. 0. 0.  0000000
7721201 0.9 0. 0.
*
*
* bl loop vessel inlet ins. n.26
7740000 bl.ve.i3    branch
7740001 1 1
7740101 1.66e-3 0.5072  0. 0. 0. 0. 4.e-5 0.04 0000000
7740200 0 15.47e6   1.252e6   2.447e6  0.
7741101 774010000 776000000 0. 0. 0.  0000000
7741201 0.9 0. 0.
*
*
* bl loop vessel inlet ins. n.26
7760000 bl.ve.i4    branch
7760001 1 1
7760101 1.66e-3 0.5072  0. 0. 0. 0. 4.e-5 0.04 0000000
7760200 0 15.47e6   1.252e6   2.447e6  0.
7761101 776010000 202000000 0. 1.25 2.3 0000000
7761201 0.9 0. 0.
*
*
* il sg sec side
8000000 sg.tu.sl   annulus
8000001 12
8000101 0.029905 10
8000102 0.045    12
8000301 0.5   6
8000302 0.75  10
8000303 0.656 11
8000304 0.746 12
8000401 0.   12
8000601 90.  12
8000801 4.e-5 .0122 12
8000901 0.12 0.12   11
8001001 0000000  12
8001101 0000000 11
8001201 000    6.9749e6   1235000.8 2.582e6  4.99625e-2  0.  1
8001202 000    6.9729e6   1235000.8 2.582e6  9.46827e-2  0.  2
8001203 000    6.9709e6   1.255e5   2.582e6  0.13673     0.  3
8001204 000    6.9649e6   1.255e6   2.582e6  0.17439     0.  4
8001205 000    6.9609e6   1.255e6   2.582e6  0.20671     0.  5
8001206 000    6.9549e6   1.255e6   2.582e6  0.23317     0.  6
8001207 000    6.9549e6   1.255e6   2.582e6  0.26170     0.  7
8001208 000    6.9549e6   1.255e6   2.582e6  0.26438     0.  8
8001209 000    6.9549e6   1.255e6   2.582e6  0.27176     0.  9
8001210 000    6.9549e6   1.255e6   2.582e6  0.26627     0.  10
8001211 000    6.9449e6   1.255e6   2.582e6  0.25648     0.  11
8001212 000    6.9489e6   1.255e6   2.582e6  0.25592     0.  12
8001300 1
8001301 11.   .0  0. 1
8001302 11.0 .0   0. 2
8001303 11.0 .0   0. 3
8001304 10.70  .193 0. 11
*
*
* il sg sec side tube out. ju
8050000 sgi.tuou  sngljun
8050101 800010000 810000000 0. 1. 1. 0000000
8050201 1 10.20 .800 0.
*
*
* il. sg. sec side tube outlet
8100000 sgi.tuv   pipe
8100001 2
8100101 .023   1
8100102 .000   2
8100301 .645   1
8100302 .946   2
8100401 0.     1
8100402 0.050  2
8100601 90. 2
8100801 4.e-5 0. 2
8100901 0. 0. 1
8101001 0000000 2
8101101 0000000 1
8101201 0 6.856e6  1435000.  2.582e6  .465 0. 1
8101202 0 6.856e6  1435000.  2.582e6  .824 0. 2
8101300 1
8101301 10.20 0.800 0. 1
*
*
*
* il sg  fine separator
8150000 fn.sep separatr
8150001 3 1
8150101 .1538 .791 0. 0. 90. .791 4.e-5 .0 0000000
8150200 0 6.852e6 1435000.   2.582e6  0.99
8151101 815010000 820000000 0. .0 .0 0000000 0.5
8152101 815000000 830000000 0. .0 .0 0000000 0.15
8153101 810010000 815000000 98.52e-4 0. 0. 0000000
8151201 0. 0.193 0.
8152201 9. 0. 0.
8153201 9. 0.193 0.
*
*
* il. sg. ss. up plenum
8200000 sgi.upl  branch
8200001 0 1
8200101 .1538  0.424 0. 0. 90. 0.424 4.e-5 0. 0000000
8200200 0 6.852e6 1435000.  2.582e6  0.99
*
*
* valve conn il sg to tmdpvol (p=const.)
```

```
8230000 il.sgcx    valve
8230101 820010000 824000000 .1538  0. 0. 0000100 1. 1.
8230201 1 0. 0. 0.
8230300 mtrvlv
8230301 604 516 1.5    1.
*
*
* il sg. const vol
8240000 il.sg.v     tmdpvol
8240101 0. 1.  10. 0.  90.   1. 4.e-5 0. 0000000
8240200 2 0
8240201 0. 69.4e5        0.9999
*
*
* sl il sim tmdpjun
8280000 sl.il.j    tmdpjun
8280101 820010000 829000000 0.
8280200 1 519
8280201 -1. 0. 0.193 0.
8280202 0.  0. 0.193 0.
8280203 1.5 0. 0.  0.
8280204 1.e6   0.  0. 0.
*
*
* sl il sim tmdpvol
8290000 sl.il.v tmdpvol
8290101 0. 10. 10. 0. 90. 10. 4.e-5 0. 0000000
8290200 0 0
8290201 0. 10.e5 7.61e5 2.58e6 1.
*
*
* il. sg. top.dc
8300000 ilsg.tdc branch
8300001  1 1
8300101 .130 .946 0. 0. -90. -.946 4.e-5 .0  0000000
8300200 0 6.856e6 1.435e6  2.582e6  1.0
8301101 830010000 840000000 0. .1 .1 0000000
8301201 9.  0. 0.
*
*
* sg il feedwater tank
8340000 sg.fw.ta  tmdpvol
8340101 0. 10. 10. 0. 0. 0. 4.e-5  0. 0000000
8340200 0 0
8340201 0. 80.40e5  9.19e5 2.57e6 0.
*
*
* feed water main
8350000 il.mfw    tmdpjun
8350101 834000000 840010000 0.
8350200 1  607  cntrlvar 002
8350201  -1.0    0.   0.   0.
8350202   1.0    1.0  0.   0.
8350203   6.9    0.4  0.   0.
8350204   8.14   0.193 0.  0.
8350205   8.4    0.   0.   0.
8350206   12.    0.   0.   0.
*
*
* sg il afw      tank
8360000 sg.afwta   tmdpvol
8360101 0. 10. 10. 0. 0. 0. 4.e-5  0. 0000000
8360200 0 0
8360201 0. 90.40e5   6.70e5 2.7e6 0.
*
*
* auxiliary feedwater sg il
8370000 il.afw    tmdpjun
8370101 836000000 840010000 0.
8370200 1  595
8370201  -1.0    0.   0.   0.
8370202   0.0   0.079 0.   0.
8370203   1.e6  0.079 0.   0.
*
*
* il sg safety valve
8380000 il.sg.sa     valve
8380101 820010000 839000000 3.e-5  9. 9. 0000100 * come bl21
rest
8380201 1 0. 0.  0.
8380300 trpvlv
8380301 560
*
*
* il sg safety tank
8390000 il.sg.st  tmdpvol
8390101 0. 10. 10. 0. 90. 10. 4.e-5 0. 0000000
8390200 2   526
8390201     -1.     3.9e5   0.99
8390202      0.     3.9e5   0.99
8390203     1.e6    3.9e5   0.99
*
*
* il. top      dc
8400000 il.t.dc  branch
8400001  1 1
8400101 .100 .645 0. 0. -90. -.645 4.e-5 .0  0000000
8400200 0 6.856e6 1.251e6   2.582e6  0.001
8401101 840010000 850000000 0. .0 .0 0000000
8401201 11. 0. 0.
*
*
* sg. il. dc. tube ju. ss
8450000 sg.sg.tu    sngljun
8450101 850010000 800000000 0. 35. 35. 0000000
8450201 1 11. 0. 0.
*
*
* sg il dc
8500000 sg.il.dc   annulus
8500001 5
8500101 .01195 5
8500301 1.402 1
8500302 1.5   5
8500401 0. 5
8500601 -90. 5
8500801 4.e-5 .02 5
8500901 0. 0. 4
8501001 0000000 5
8501101 0000000 4
8501201 0 6.8890e6 1.213e6   2.582e6  0. 0. 5
8501300 1
8501301 11. 0. 0. 4
*
*
* il.bl.sg connetion (attiva nel periodo di isolamento)
8700000 il.bl.cn  valve
8700101 820010000 920010000 0.003 1.  1. 0000100
8700201 1  0.   0.   0.
8700300 trpvlv
8700301 537
*
* sg ss relief valve for bt17  (non active in bl34)
8710000 ss.re.v   valve
8710101 820010000 872000000 6.5e-5 1. 1. 0000100 0.8 0.8
8710201 1  0.   0.   0.
8710300 trpvlv
8710301 664
*
* sg ss relief tank (non active in bl34)
8720000 rel.tank  tmdpvol
8720101 0. 10. 10. 0. 90. 10. 4.e-5 0. 0000000
8720200 2  0
8720201 0. 1.e5   0.99
*
*
* bl sg sec side
9000000 sg.tu.bl   annulus
9000001 12
9000101 0.0094   10
9000102 0.017    12
9000301 0.5   6
9000302 0.75  10
9000303 0.656 11
9000304 0.746 12
```

```
9000401 0.  12
9000601 90.  12
9000801 4.e-5 .0122 12
9000901 0.12 0.12  11
9001001 0000000  12
9001101 0000000 11
9001201 000    6.9749e6  1235000.8 2.582e6  4.91362e-2  0.  1
9001202 000    6.9729e6  1235000.8 2.582e6  9.37175e-2  0.  2
9001203 000    6.9709e6  1.255e6   2.582e6  0.13693     0.  3
9001204 000    6.9649e6  1.255e6   2.582e6  0.17456     0.  4
9001205 000    6.9609e6  1.255e6   2.582e6  0.20618     0.  5
9001206 000    6.9549e6  1.255e6   2.582e6  0.23260     0.  6
9001207 000    6.9549e6  1.255e6   2.582e6  0.24087     0.  7
9001208 000    6.9549e6  1.255e6   2.582e6  0.24694     0.  8
9001209 000    6.9549e6  1.255e6   2.582e6  0.24006     0.  9
9001210 000    6.9549e6  1.255e6   2.582e6  0.22404     0.  10
9001211 000    6.9449e6  1.255e6   2.582e6  0.21991     0.  11
9001212 000    6.9489e6  1.255e6   2.582e6  0.21410     0.  12
9001300 1
9001301  3.24  .0   0. 1
9001302  3.24  .0   0. 2
9001303  3.24  .0   0. 3
9001304  3.14  .1   0. 11
*
*
* bl sg sec side tube out. ju
9050000 sgb.tuou  sngljun
9050101 900010000 910000000 0. 1. 1. 0000000
9050201 1  2.94 .300 0.
*
*
* bl. sg. sec side tube outlet
9100000 sgi.tuv   pipe
9100001 2
9100101 .01098 1
9100102 .000  2
9100301 .450  1
9100302 1.164  2
9100401 0.    1
9100402 0.020  2
9100601 90. 2
9100801 4.e-5 0. 2
9100901 0. 0. 1
9101001 0000000 2
9101101 0000000 1
9101201 0 6.856e6  1435000.  2.582e6  .465 0. 1
9101202 0 6.856e6  1435000.  2.582e6  .824 0. 2
9101300 1
9101301  2.94 0.300 0. 1
*
*
*
* bl sg  fine separator
9150000 bl.sep separatr
9150001 3 1
9150101 .05832 .567 0. 0. 90. .567 4.e-5 .0 0000000
9150200 0 6.852e6 1435000.  2.582e6  0.99
9151101 915010000 920000000 0. .0 .0 0000000  .5
9152101 915000000 930000000 0. .0 .0 0000000  .15
9153101 910010000 915000000 33.183e-4 0. 0. 0000000
9151201 0.   0.72 0.
9152201 2.52  0.  0.
9153201 2.52  0.72 0.
*
*
*
* bl. sg. ss. up plenum
9200000 sgb.upl  branch
9200001 0 1
9200101 .05834 0.5   0. 0. 90. 0.500 4.e-5 0. 0000000
9200200 0 6.852e6 1435000.  2.582e6  0.99
*
*
* valve conn bl sg to tmdpvol (p=const.)
9230000 bl.sgcx    valve
9230101 920010000 924000000 5.6e-2 0. 0. 0000100 1. 1.
9230201 1 0. 0. 0.
9230300 mtrvlv
9230301 604 516 1.5   1.
*
*
* bl sg. const vol
9240000 bl.sg.v     tmdpvol
9240101 0. 1.  10. 0.  90.  1. 4.e-5 0. 0000000
9240200 2 0
9240201 0. 69.4e5       0.9999
*
*
* sl bl sim tmdpjun
9280000 sl.bl.j    tmdpjun
9280101 920010000 929000000 0.
9280200 1 519
9280201 -1.   0.  0.064 0.
9280202 0.    0.  0.064 0.
9280203 1.5   0.  0.  0.
9280204 1.e6  0.  0.  0.
*
*
* sl bl sim tmdpvol
9290000 sl.bl.v  tmdpvol
9290101 0. 10. 10. 0. 90. 10. 4.e-5 0. 0000000
9290200 0 0
9290201 0. 10.e5 7.61e5 2.58e6 1.
*
*
* bl.  sg.  top.dc
9300000 blsg.tdc  branch
9300001  1 1
9300101 .03874 1.164 0. 0. -90. -1.164 4.e-5 .0  0000000
9300200 0 6.856e6 1435000.   2.582e6  0.61
9301101 930010000 940000000 0. .1 .1 0000000
9301201 2.52 0. 0.
*
*
*
* sg bl  main fedwater tank
9340000 sg.mfwta   tmdpvol
9340101 0. 10. 10. 0. 0. 0. 4.e-5  0. 0000000
9340200 0 0
9340201 0. 80.40e5  9.195e5 2.57e6 0.
*
*
* main feedwater
9350000 bl.mfw    tmdpjun
9350101 934000000 940010000 0.
9350200 1  607  cntrlvar 003
9350201  -1.0   0.   0.   0.
9350202   1.0   0.4   0.   0.
9350203   8.2   0.15  0.   0.
9350204   8.48  0.064 0.   0.
9350205   9.6   0.    0.   0.
9350206  12.0   0.    0.   0.
*
*
* sg bl  aux feedwater tank
9360000 sg.afwta   tmdpvol
9360101 0. 10. 10. 0. 0. 0. 4.e-5  0. 0000000
9360200 0 0
9360201 0. 90.40e5   6.70e5 2.70e6 0.    *check !!
*
*
* aux  feedwater
9370000 bl.afw    tmdpjun
9370101 936000000 940010000 0.
9370200 1  595
9370201  -1.0   0.   0.   0.
9370202   0.0   0.030 0.   0.
9370203   1.e6  0.030 0.   0.
*
*
* bl sg safety valve
9380000 bl.sg.sa    valve
9380101 920010000 939000000 1.0e-5 9. 9. 0000100
9380201 1 0. 0.  0.
9380300 trpvlv
9380301 561
```

```
*
*
* bl sg safety tank
9390000 bl.sg.st tmdpvol
9390101 0. 10. 10. 0. 90. 10. 4.e-5 0. 0000000
9390200 2 526
9390201 -1. 3.9e5 0.99
9390202 0. 3.9e5 0.99
9390203 1.e6 3.9e5 0.99
*
*
* bL top dc
9400000 bl.t.dc branch
9400001 1 1
9400101 .0387 .450 0. 0. -90. -.450 4.e-5 .0 0000000
9400200 0 6.856e6 1.251e6 2.582e6 0.
9401101 940010000 950000000 0. .0 .0 0000000
9401201 2.4 0. 0.
*
*
* sg. bL dc. tube ju. ss
9450000 sg.sg.tu sngljun
9450101 947000000 900000000 0. 55. 55. 0000000
9450201 1 3.24 0. 0.
*
*
* added volume for simulating sgtr break
9470000 sgtrbrv branch
9470001 1 1
9470101 .0039 .300 0. 0. 0. 0.0 4.e-5 0.008 0000000
9470200 0 6.490e6 1228713.5 2.5856e6 0.
9471101 947010000 950010000 0. .0 .0 0000000
9471201 3.2 0. 0.
*
*
* added volume for simulating sgtr break line
9480000 sgtrbpv branch
9480001 1 1
9480101 .0039 .300 0. 0. 0. 0.0 4.e-5 0.008 0000000
9480200 0 6.490e6 1228713.5 2.5856e6 0.
9481101 948010000 947000000 2.835e-6 0.01 1.01 0000000
9481201 0. 0. 0.
*
*
* sg bl dc
9500000 sg.bl.dc annulus
9500001 5
9500101 .00398 5
9500301 1.402 1
9500302 1.5 5
9500401 0. 5
9500601 -90. 5
9500801 4.e-5 .02 5
9500901 0. 0. 4
9501001 0000000 5
9501101 0000000 4
9501201 0 6.8890e6 1.213e6 2.582e6 0. 0. 5
9501300 1
9501301 2.4 0. 0. 4
*
*
* drainage tank during sgtr bl21 transient in sgbl ss (non active in bl34
9600000 sgtrdrai tmdpvol
9600101 0. 10. 10. 0. 0. 0. 4.e-5 0. 0000000
9600200 0 0
9600201 0. 3.50e5 1.200e5 2.60e6 0.5
*
*
* drainage water from sg ss bl during bl21 (non active in bl34)
9650000 sgtrdrj tmdpjun
9650101 940010000 960000000 0.
9650200 1 538 cntrlvar 003
9650201 -1.0 0. 0. 0.
9650202 8.0 0.0 0. 0.
9650203 8.7 0.0 0. 0.
9650204 9.0 0.2 0. 0.
9650205 9.6 0.4 0. 0.
9650206 12.0 0.4 0. 0.
*
***** structures *****
*
*
* lower plenum bottom
11021000 1 7 1 1 0.
11021100 0 1
11021101 6 0.0158
11021201 1 6
11021301 0. 6
11021400 0
11021401 567. 7
11021501 102010000 0 1 1 0.1529 1
11021601 000000000 0 0 1 0.1529 1
11021701 0 0. 0. 0. 1
11021801 0. 10. 10. 0. 0. 0. 0. 1. 1
*
*
*
* lower plenum walls
11022000 1 7 2 1 0.156
11022100 0 1
11022101 6 0.1718
11022201 1 6
11022301 0. 6
11022400 0
11022401 567. 7
11022501 102010000 0 1 1 0.274 1
11022601 000000000 0 0 1 0.274 1
11022701 0 0. 0. 0. 1
11022801 0. 10. 10. 0. 0. 0. 0. 1. 1
*
*
* int. low zone stru
11061000 1 7 2 1 0.081
11061100 0 1
11061101 6 0.124
11061201 1 6
11061301 0. 6
11061400 0
11061401 567. 7
11061501 106010000 0 1 1 1.0020 1
11061601 200060000 0 1 1 1.0020 1
11061701 0 0. 0. 0. 1
11061801 0. 10. 10. 0. 0. 0. 0. 1. 1
11061901 0. 10. 10. 0. 0. 0. 0. 1. 1
*
*
* by-dc structure
11082000 4 7 2 1 0.098
11082100 0 1
11082101 6 0.119
11082201 1 6
11082301 0. 6
11082400 0
11082401 585. 7
11082501 000000000 0000 0 1 1.275 1
11082502 000000000 0000 0 1 1.167 2
11082503 000000000 0000 0 1 1.246 3
11082504 000000000 0000 0 1 0.8425 4
11082601 200050000 0000 1 1 1.275 1
11082602 200040000 0000 1 1 1.167 2
11082603 200030000 0000 1 1 1.246 3
11082604 200020000 0000 1 1 0.8425 4
11082701 0 0. 0. 0. 4
11082901 0. 10. 10. 0. 0. 0. 0. 1. 1
11082902 0. 10. 10. 0. 0. 0. 0. 1. 2
11082903 0. 10. 10. 0. 0. 0. 0. 1. 3
11082904 0. 10. 10. 0. 0. 0. 0. 1. 4
*
*
* filler
11083000 9 7 2 1 0.074
11083100 0 1
11083101 6 .099
11083201 2 6
11083301 0. 6
11083400 0
```

```
11083401 580.7
11083501 400010000  0 1 1 .200  1
11083502 400020000  0 1 1 .412  2
11083503 400030000  0 1 1 .663  3
11083504 400040000  0 1 1 .583  4
11083505 400050000  0 1 1 .584  5
11083506 400060000  0 1 1 .583  6
11083507 400070000  0 1 1 .663  7
11083508 400080000  0 1 1 .4112  8
11083509 400090000  0 1 1 .4305  9
11083601 000000000  0 0 1 .200  1
11083602 000000000  0 0 1 .412  2
11083603 000000000  0 0 1 .663  3
11083604 000000000  0 0 1 .583  4
11083605 000000000  0 0 1 .584  5
11083606 000000000  0 0 1 .583  6
11083607 000000000  0 0 1 .663  7
11083608 000000000  0 0 1 .4112  8
11083609 000000000  0 0 1 .4305  9
11083701 0 0. 0. 0. 9
11083801 0. 10. 10. 0. 0. 0. 0. 1.  1
11083802 0. 10. 10. 0. 0. 0. 0. 1.  2
11083803 0. 10. 10. 0. 0. 0. 0. 1.  3
11083804 0. 10. 10. 0. 0. 0. 0. 1.  4
11083805 0. 10. 10. 0. 0. 0. 0. 1.  5
11083806 0. 10. 10. 0. 0. 0. 0. 1.  6
11083807 0. 10. 10. 0. 0. 0. 0. 1.  7
11083808 0. 10. 10. 0. 0. 0. 0. 1.  8
11083809 0. 10. 10. 0. 0. 0. 0. 1.  9
*
*
* vessel wall middle
12001000 6 7  2 1 0.156
12001100 0 1
12001101 6 0.1718
12001201 1 6
12001301 0. 6
12001400 0
12001401 567. 7
12001501 202010000 0 1 1 0.7945 1
12001502 200010000 0 1 1 0.7900 2
12001503 200020000 0 1 1 0.8425 3
12001504 200030000 0 1 1 1.2460 4
12001505 200040000 0 1 1 1.1670 5
12001506 200050000 0 1 1 1.2750 6
12001601 -999    0  3200  1 0.7945  1
12001602 -999    0  3200  1 0.7900  2
12001603 -999    0  3200  1 0.8425  3
12001604 -999    0  3200  1 1.2460  4
12001605 -999    0  3200  1 1.1670  5
12001606 -999    0  3200  1 1.2750  6
12001701 0 0. 0. 0. 6
12001801 0. 10. 10. 0. 0. 0. 0. 1. 1
12001802 0. 10. 10. 0. 0. 0. 0. 1. 2
12001803 0. 10. 10. 0. 0. 0. 0. 1. 3
12001804 0. 10. 10. 0. 0. 0. 0. 1. 4
12001805 0. 10. 10. 0. 0. 0. 0. 1. 5
12001806 0. 10. 10. 0. 0. 0. 0. 1. 6
*
*
* vessel wall bott
12002000 1 7  2 1 0.156
12002100 0 1
12002101 6 0.191
12002201 1 6
12002301 0. 6
12002400 0
12002401 567. 7
12002501 200060000 0 1 1 1.0020 1
12002601 000000000 0 0 1 1.0020 1
12002701 0 0. 0. 0. 1
12002801 0. 10. 10. 0. 0. 0. 0. 1. 1
*
*
* dc.top wall struct.
12101000 1 7  2 1 0.156
12101100 0 1
12101101 6 0.176
12101201 1 6
12101301 0. 6
12101400 0
12101401 567. 7
12101501 210010000 0 1 1 0.315  1
12101601 000000000 0 0 1 0.315  1
12101701 0 0. 0. 0. 1
12101801 0. 10. 10. 0. 0. 0. 0. 1. 1
*
*
* up ple - dc stru
14201000 3 7  2 1 0.098
14201100 0 1
14201101 6 0.119
14201201 1 6
14201301 0. 6
14201400 0
14201401 599. 7
14201501 410010000 0        1 1 .790    1
14201502 420010000 0        1 1 .7945   2
14201503 430010000 0        1 1 .315    3
14201601 200010000 0        1 1 .790    1
14201602 202010000 0        1 1 .7945   2
14201603 210010000 0        1 1 .315    3
14201701 0 0. 0. 0. 3
14201801 0. 10. 10. 0. 0. 0. 0. 1.  1
14201802 0. 10. 10. 0. 0. 0. 0. 1.  2
14201803 0. 10. 10. 0. 0. 0. 0. 1.  3
14201901 0. 10. 10. 0. 0. 0. 0. 1.  1
14201902 0. 10. 10. 0. 0. 0. 0. 1.  2
14201903 0. 10. 10. 0. 0. 0. 0. 1.  3
*
*
* vessel upper ple. top  (modificato per sottrarre 16.3 kw)
14301000 1 7  1 1 0.
14301100 0 1
14301101 6 0.007     ** per avere uguale volume
14301201 1 6
14301301 0. 6
14301400 0
14301401 599. 7
14301501 430010000 0        1 1 3.000   1  ** area x 100
14301601 -999      0     3430  1 3.000   1  ** area x 100
14301701 0 0. 0. 0. 1
14301801 0. 10. 10. 0. 0. 0. 0. 1.  1
*
*
* uh. lo conn. struct
14401000 1 6 2 1 .016
14401100 0 1
14401101 5 .0225
14401201 1 5
14401301 0. 5
14401400 0
14401401 597. 6
14401501 440010000 0 1 1 .655 1
14401601 0 0 0 1 .655 1
14401701 0 0. 0. 0. 1
14401801 0. 10. 10. 0. 0. 0. 0. 1. 1
*
*
* uh.by stru
14501000 1 6  2 1 .00475
14501100 0 1
14501101 5 .00675
14501201 1 5
14501301 0. 5
14501400 0
14501401 597. 6
14501501 450010000 0     1 1 1.814 1
14501601 0       0    0 1 1.814 1
14501701 0 0. 0. 0. 1
14501801 0. 10. 10. 0. 0. 0. 0. 1.  1
*
*
* up head stru
14601000 3 7  2 1 .06
14601100 0 1
```

```
14601101 6 .08
14601201 1 6
14601301 0. 6
14601400 0
14601401 597. 7
14601501 455010000 5000000 1 1 .850 2
14601502 460020000 0   1 1 .866 3
14601601 0      0   0 1 .850 2
14601602 0      0   0 1 .866 3
14601701 0 0. 0. 0. 3
14601801 0. 10. 10. 0. 0. 0. 0. 1. 2
14601802 0. 10. 10. 0. 0. 0. 0. 1. 3
*
*
* uh.up. conn stru
14701000 1 7 2 1 .00475
14701100 0 1
14701101 6 .00675
14701201 1 6
14701301 0. 6
14701400 0
14701401 597. 7
14701501 470010000 0    1 1 2.6660 1
14701601 000000000 0    0 1 2.6660 1
14701701 0 0. 0. 0. 1
14701801 0. 10. 10. 0. 0. 0. 0. 1. 1
*
*
* il hl vessel connection stru
15001000 1 7 2 1 0.03685
15001100 0 1
15001101 6 0.05385
15001201 3 6
15001301 0. 6
15001400 0
15001401 599. 7
15001501 500010000 0      1 1 0.906 1
15001601 -999    0 3500 1   0.906 1
15001701 0 0. 0. 0. 1
15001801 0. 10. 10. 0. 0. 0. 0. 1. 1
*
*
* il. hl pip stru
15101000 3 7 2 1 0.03685
15101100 0 1
15101101 6 0.04445
15101201 3 6
15101301 0. 6
15101400 0
15101401 599. 7
15101501 510010000 1000000 1 1 0.673 3
15101601 0      0     0 1 0.673 3
15101701 0 0. 0. 0. 3
15101801 0. 10. 10. 0. 0. 0. 0. 1. 3
*
*
* surgeline prez struct.
15201000 2 7 2 1 0.0066
15201100 0 1
15201101 6 0.0086
15201201 3 6
15201301 0. 6
15201400 0
15201401 599. 7
15201501 520020000 0         1 1 3.600 1
15201502 520030000 0         1 1 2.800 2
15201601 0      0        0 1 3.600 1
15201602 0      0        0 1 2.800 2
15201701 0 0. 0. 0. 2
15201801 0. 10. 10. 0. 0. 0. 0. 1.  1
15201802 0. 10. 10. 0. 0. 0. 0. 1.  2
*
*
* prez structure lower part plate
15301000 1 7 1 1 0.
15301100 0 1
15301101 6 0.06
15301201 3 6
15301301 0. 6
15301400 0
15301401 619. 7
15301501 530010000 0        1 1 0.0097 1
15301601 0      0        0 1 0.0097 1
15301701 0 0. 0. 0. 1
15301801 0. 10. 10. 0. 0. 0. 0. 1.  1
*
*
* prez stru lower part. cyl
15302000 1 7 2 1 0.05550
15302100 0 1
15302101 6 0.07770
15302201 3 6
15302301 0. 6
15302400 0
15302401 619. 7
15302501 530010000 0        1 1 0.790  1
15302601 0      0        0 1 0.790  1
15302701 0 0. 0. 0. 1
15302801 0. 10. 10. 0. 0. 0. 0. 1.  1
*
*
* prez heaters
15303000 2 7 2 1 0.01
15303100 0 1
15303101 6 0.0125
15303201 4 6
15303301 1. 6
15303400 0
15303401 619. 7
15303501 000000000 0        0 1 6.320  1
15303502 000000000 0        0 1 6.848  2
15303601 530010000 0        1 1 6.320  1
15303602 535010000 0        1 1 6.848  2
15303701 950 1.  0. 0. 1
15303702 0  0.  0. 0. 2
15303901 0. 10. 10. 0. 0. 0. 0. 1.  1
15303902 0. 10. 10. 0. 0. 0. 0. 1.  2
*
*
* prez structures (middle)
15351000 4 7 2 1 .06220
15351100 0 1
15351101 6 0.08
15351201 3 6
15351301 0. 6
15351400 0
15351401 619. 7
15351501 535010000 0        1 1 0.630  1
15351502 535020000 0        1 1 1.120  2
15351503 535030000 10000       1 1 1.500  4
15351601 -999    0      3535 1 0.630  1
15351602 -999    0      3535 1 1.120  2
15351603 -999    0      3535 1 1.500  3
15351604 -999    0      3535 1 1.500  4
15351701 0 0. 0. 0. 4
15351801 0. 10. 10. 0. 0. 0. 0. 1.    1
15351802 0. 10. 10. 0. 0. 0. 0. 1.    2
15351803 0. 10. 10. 0. 0. 0. 0. 1.    4
*
*
* prez structures (top)
15401000 2 7 2 1 .06220
15401100 0 1
15401101 6 0.08
15401201 3 6
15401301 0. 6
15401400 0
15401401 619. 7
15401501 540010000 0        1 1 1.0400 1
15401502 539010000 0        1 1 1.0000 2
15401601 -998    0      3535 1 1.0400 1
15401602 -998    0      3535 1 1.0000 2
15401701 0 0. 0. 0. 2
15401801 0. 10. 10. 0. 0. 0. 0. 1.  1
15401802 0. 10. 10. 0. 0. 0. 0. 1.  2
*
```

```
*
* iL hl sg conn stru
15501000 1 7 2 1 0.03685
15501100 0 1
15501101 6 0.05385
15501201 3 6
15501301 0. 6
15501400 0
15501401 599. 7
15501501 550010000 0     1 1 0.8280 1
15501601 0       0       0 1 0.8280 1
15501701 0 0. 0. 0. 1
15501801 0. 10. 10. 0. 0. 0. 0. 1. 1
*
*
* iL hl sg inl stru
15601000 3 7 2 1 0.05885
15601100 0 1
15601101 6 0.06985
15601201 3 6
15601301 0. 6
15601400 0
15601401 599. 7
15601501 560010000 10000  1 1 0.574 3
15601601 -999   0   3560 1 0.574 3
15601701 0 0. 0. 0. 3
15601801 0. 10. 10. 0. 0. 0. 0. 1. 3
*
*
* iL sg lp stru
15651000 2 7 1 1 0.
15651100 0 1
15651101 6 0.03
15651201 3 6
15651301 0. 6
15651400 0
15651401 599. 7
15651501 565010000 10000000 1 1 .0656 2
15651601 0       0       0 1 .0656 2
15651701 0 0. 0. 0. 2
15651801 0. 10. 10. 0. 0. 0. 0. 1. 2
*
*
* iL sg lp str2
15652000 2 7 2 1 0.156
15652100 0 1
15652101 6 0.235
15652201 3 6
15652301 0. 6
15652400 0
15652401 567. 7
15652501 565010000 10000000 1 1 .0910 2
15652601 0       0       0 1 .0910 2
15652701 0 0. 0. 0. 2
15652801 0. 10. 10. 0. 0. 0. 0. 1. 2
*
*
* iL sg plat stru
15653000 2 7 1 1 0.
15653100 0 1
15653101 6 0.090
15653201 3 6
15653301 0. 6
15653400 0
15653401 580. 7
15653501 565010000 10000000 1 1 .0379 2
15653601 0       0       0 1 0.0379 2
15653701 0 0. 0. 0. 2
15653801 0. 10. 10. 0. 0. 0. 0. 1. 2
*
*
* iL sg lp subd. pla stru
15654000 1 7 1 1 0.
15654100 0 1
15654101 6 0.025
15654201 3 6
15654301 0. 6
15654400 0
15654401 599. 5
15654402 567. 7
15654501 565010000 0     1 1 0.0666 1
15654601 575010000 0     1 1 0.0666 1
15654701 0 0. 0. 0. 1
15654801 0. 10. 10. 0. 0. 0. 0. 1. 1
15654901 0. 10. 10. 0. 0. 0. 0. 1. 1
*
*
* iL sg tubes stru
15701000 24 7 2 1 0.0098
15701100 0 1
15701101 6 0.011
15701201 3 6
15701301 0. 6
15701400 0
15701401 596. 6
15701402 543. 7
15701501 570010000 10000  1 1 12.000 6
15701502 570070000 10000  1 1 18.000 10
15701503 570110000 10000  1 1 15.744 14
15701504 570150000 10000  1 1 18.000 18
15701505 570190000 10000  1 1 12.000 24
15701601 800010000 10000  1 1 12.000 6
15701602 800070000 10000  1 1 18.000 10
15701603 800110000 10000  1 1 15.744 12
15701604 800120000 -10000  1 1 15.744 14
15701605 800100000 -10000  1 1 18.000 18
15701606 800060000 -10000  1 1 12.000 24
15701701 0 0. 0. 0. 24
15701801 0. 10. 10. 0. 0. 0. 0. 1.   24
15701901 0. 10. 10. 0. 0. 0. 0. 1.   24
*
*
* sg.iL outlet
15801000 3 7 2 1 0.05885
15801100 0 1
15801101 6 0.06985
15801201 3 6
15801301 0. 6
15801400 0
15801401 567. 6
15801402 567. 7
15801501 580010000 10000  1 1 0.574 3
15801601 -999   0   3580 1 0.574 3
15801701 0 0. 0. 0. 3
15801801 0. 10. 10. 0. 0. 0. 0. 1. 3
*
*
* sg.ins n.13 il cl stru
15851000 1 7 2 1 0.03685
15851100 0 1
15851101 6 0.0517
15851201 3 6
15851301 0. 6
15851400 0
15851401 567. 6
15851402 567. 7
15851501 585010000 0     1 1 0.828 1
15851601 000000000 0     0 1 0.828 1
15851701 0 0. 0. 0. 1
15851801 0. 10. 10. 0. 0. 0. 0. 1. 1
*
*
* il loop seal struct
15901000 6 7 2 1 0.03685
15901100 0 1
15901101 6 0.04445
15901201 3 6
15901301 0. 6
15901400 0
15901401 567. 6
15901402 567. 7
15901501 590010000 0     1 1 .950 1
15901502 590020000 0     1 1 0.7825 2
15901503 590030000 0     1 1 0.7825 3
15901504 590040000 0     1 1 0.855 4
15901505 590050000 0     1 1 0.7825 5
```

```
15901506 590060000 0      1 1 0.7825 6
15901601 000000000 0      0 1 0.950  1
15901602 000000000 0      0 1 0.7825 2
15901603 000000000 0      0 1 0.7825 3
15901604 000000000 0      0 1 0.855  4
15901605 000000000 0      0 1 0.7825 5
15901606 000000000 0      0 1 0.7825 6
15901701 0 0. 0. 0. 6
15901801 0. 10. 10. 0. 0. 0. 0. 1. 6
*
*
* bl cl pump inl ins. n. 14 stru
15951000 1 7  2 1 0.03685
15951100 0 1
15951101 6 0.05385
15951201 3 6
15951301 0. 6
15951400 0
15951401 567. 7
15951501 595010000 0        1 1 0.750  1
15951601 -999    0      3595 1 0.750  1
15951701 0 0. 0. 0. 1
15951801 0. 10. 10. 0. 0. 0. 0. 1.  1
*
*
* il pump stru
16001000 1 7  2 1 0.03685
16001100 0 1
16001101 6 0.13685
16001201 3 6
16001301 0. 6
16001400 0
16001401 567. 7
16001501 600010000 0        1 1 0.200  1
16001601 -999    0      3600 1 0.200  1
16001701 0 0. 0. 0. 1
16001801 0. 10. 10. 0. 0. 0. 0. 1.  1
*
*
* il cl pump ou stru.
16051000 1 7  2 1 0.03685
16051100 0 1
16051101 6 0.05385
16051201 3 6
16051301 0. 6
16051400 0
16051401 567. 7
16051501 605010000 0        1 1 1.035  1
16051601 -999    0      3605 1 1.035  1
16051701 0 0. 0. 0. 1
16051801 0. 10. 10. 0. 0. 0. 0. 1.  1
*
*
* il cl stru.
16101000 4 7  2 1 0.03685
16101100 0 1
16101101 6 0.04445
16101201 3 6
16101301 0. 6
16101400 0
16101401 567. 7
16101501 610010000 10000     1 1 0.65625 4
16101601 0      0        0 1 0.65625 4
16101701 0 0. 0. 0. 4
16101801 0. 10. 10. 0. 0. 0. 0. 1. 4
*
*
* il cl vessel inlet stru.
16121000 1 7  2 1 0.03685
16121100 0 1
16121101 6 0.05385
16121201 3 6
16121301 0. 6
16121400 0
16121401 567. 7
16121501 612010000 0        1 1 0.670  1
16121601 -999    0      3612 1 0.670  1
16121701 0 0. 0. 0. 1
16121801 0. 10. 10. 0. 0. 0. 0. 1.   1
*
*
* bl hl vess conn stru.
17001000 1 7  2 1 0.023
17001100 0 1
17001101 6 0.04
17001201 3 6
17001301 0. 6
17001400 0
17001401 599. 7
17001501 700010000 0        1 1 0.500  1
17001601 -999    0      3700 1 0.500  1
17001701 0 0. 0. 0. 1
17001801 0. 10. 10. 0. 0. 0. 0. 1.  1
*
*
* bl hl stru
17051000 4 7  2 1 0.023
17051100 0 1
17051101 6 0.03
17051201 3 6
17051301 0. 6
17051400 0
17051401 599. 7
17051501 705010000 10000      1 1 0.563  3
17051502 702010000 10000      1 1 0.563  4
17051601 0      0        0 1 0.563  4
17051701 0 0. 0. 0. 4
17051801 0. 10. 10. 0. 0. 0. 0. 1.   4
*
*
* bl hl meas. ins
17101000 4 7  2 1 0.023
17101100 0 1
17101101 6 0.035
17101201 3 6
17101301 0. 6
17101400 0
17101401 599. 7
17101501 710010000 0        1 1 0.842  1
17101502 712010000 10000      1 1 0.639  4
17101601 0      0        0 1 0.842  1
17101602 -999    0      3710 1 0.639  4
17101701 0 0. 0. 0. 4
17101801 0. 10. 10. 0. 0. 0. 0. 1. 1
17101802 0. 10. 10. 0. 0. 0. 0. 1. 4
*
*
* bl sg in lo. plate struc
17181000 2 7  1 1 0.
17181100 0 1
17181101 6 0.018
17181201 3 6
17181301 0. 6
17181400 -1
17181401 599. 599. 599. 599. 599. 599. 599.
17181402 568. 568. 568. 568. 568. 568. 568.
17181501 718010000 4000000    1 1 0.029  2
17181601 0      0        0 1 0.029  2
17181701 0 0. 0. 0. 2
17181801 0. 10. 10. 0. 0. 0. 0. 1.    2
*
*
* bl sg in lo. cyl
17182000 2 7  2 1 0.102
17182100 0 1
17182101 6 0.122
17182201 3 6
17182301 0. 6
17182400 -1
17182401 599. 599. 599. 599. 599. 599. 599.
17182402 568. 568. 568. 568. 568. 568. 568.
17182501 718010000 4000000    1 1 0.1105 2
17182601 0      0        0 1 0.1105 2
17182701 0 0. 0. 0. 2
17182801 0. 10. 10. 0. 0. 0. 0. 1.   2
*
```

```
*
* bl sg conn plate
17183000 1 7 1 1 0.
17183100 0 1
17183101 6 0.122
17183201 3 6
17183301 0. 6
17183400 -1
17183401 599. 589. 585. 580. 575. 574. 574.
17183501 718010000 0 1 1 0.0284 1
17183601 722010000 0 1 1 0.0284 1
17183701 0 0. 0. 0. 1
17183801 0. 10. 10. 0. 0. 0. 0. 1. 1
17183901 0. 10. 10. 0. 0. 0. 0. 1. 1
*
*
* bl sg tube plate structure
17184000 2 7 1 1 0.
17184100 0 1
17184101 6 0.06
17184201 3 6
17184301 0. 6
17184400 -1
17184401 599. 599. 599. 599. 599. 599. 599.
17184402 568. 568. 568. 568. 568. 568. 568.
17184501 718010000 4000000 1 1 0.0163 2
17184601 0 0 0 1 0.0163 2
17184701 0 0. 0. 0. 2
17184801 0. 10. 10. 0. 0. 0. 0. 1. 2
*
*
* bL sg tubes stru 1
17201000 24 7 2 1 0.0098
17201100 0 1
17201101 6 0.011
17201201 3 6
17201301 0. 6
17201400 0
17201401 596. 6
17201402 543. 7
17201501 720010000 10000 1 1 4.00 6
17201502 720070000 10000 1 1 6.00 10
17201503 720110000 10000 1 1 5.248 14
17201504 720150000 10000 1 1 6.00 18
17201505 720190000 10000 1 1 4.00 24
17201601 900010000 10000 1 1 4.00 6
17201602 900070000 10000 1 1 6.00 10
17201603 900110000 10000 1 1 5.248 12
17201604 900120000 -10000 1 1 5.248 14
17201605 900100000 -10000 1 1 6.00 18
17201606 900060000 -10000 1 1 4.00 24
17201701 0 0. 0. 0. 24
17201801 0. 10. 10. 0. 0. 0. 0. 1. 24
17201901 0. 10. 10. 0. 0. 0. 0. 1. 24
*
*
* bl hl sg exit
17251000 3 7 2 1 0.0342
17251100 0 1
17251101 6 0.0413
17251201 3 6
17251301 0. 6
17251400 0
17251401 569. 7
17251501 725010000 10000 1 1 0.639 3
17251601 -999 0 3725 1 0.639 3
17251701 0 0. 0. 0. 3
17251801 0. 10. 10. 0. 0. 0. 0. 1. 3
*
*
* bl loop seal
17301000 6 7 2 1 0.023
17301100 0 1
17301101 6 0.031
17301201 3 6
17301301 0. 6
17301400 0
17301401 569. 7
17301501 730010000 0 1 1 1.042 1
17301502 730020000 0 1 1 1.151 2
17301503 730030000 0 1 1 0.701 3
17301504 730040000 0 1 1 0.884 4
17301505 730050000 0 1 1 .701 5
17301506 730060000 0 1 1 1.151 6
17301601 0 0 0 1 1.042 1
17301602 0 0 0 1 1.151 2
17301603 0 0 0 1 0.701 3
17301604 0 0 0 1 0.884 4
17301605 0 0 0 1 .701 5
17301606 -999 0 3730 1 1.151 6
17301701 0 0. 0. 0. 6
17301801 0. 10. 10. 0. 0. 0. 0. 1. 1
17301802 0. 10. 10. 0. 0. 0. 0. 1. 2
17301803 0. 10. 10. 0. 0. 0. 0. 1. 3
17301804 0. 10. 10. 0. 0. 0. 0. 1. 4
17301805 0. 10. 10. 0. 0. 0. 0. 1. 5
17301806 0. 10. 10. 0. 0. 0. 0. 1. 6
*
*
* bl pump stru
17401000 1 7 2 1 0.03685
17401100 0 1
17401101 6 0.13685
17401201 3 6
17401301 0. 6
17401400 0
17401401 567. 7
17401501 740010000 0 1 1 0.200 1
17401601 -999 0 3740 1 0.200 1
17401701 0 0. 0. 0. 1
17401801 0. 10. 10. 0. 0. 0. 0. 1. 1
*
*
* bl pump exit stru
17451000 1 7 2 1 0.023
17451100 0 1
17451101 6 0.05
17451201 3 6
17451301 0. 6
17451400 0
17451401 567. 7
17451501 745010000 0 1 1 0.503 1
17451601 -999 0 3745 1 0.503 1
17451701 0 0. 0. 0. 1
17451801 0. 10. 10. 0. 0. 0. 0. 1. 1
*
*
* bl break upstream volume
17501000 5 7 2 1 0.023
17501100 0 1
17501101 6 0.04
17501201 3 6
17501301 0. 6
17501400 0
17501401 569. 7
17501501 750010000 10000 1 1 0.369 5
17501601 0 0 0 1 0.369 5
17501701 0 0. 0. 0. 5
17501801 0. 10. 10. 0. 0. 0. 0. 1. 5
*
*
* bl break downstream structure
17701000 4 7 2 1 0.023
17701100 0 1
17701101 6 0.033
17701201 3 6
17701301 0. 6
17701400 0
17701401 567. 7
17701501 770010000 2000000 1 1 0.5072 4
17701601 -999 0 3770 1 0.5072 4
17701701 0 0. 0. 0. 4
17701801 0. 10. 10. 0. 0. 0. 0. 1. 4
*
*
* sg il filler shell s.s. stru
```

```
18000000 12 7 2 1 0.076
18000100 0 1
18000101 6 .08415
18000201 3 6
18000301 0. 6
18000400 0
18000401 553. 7
18000501 800010000 10000 1 1 0.5 6
18000502 800070000 10000 1 1 0.75 10
18000503 800110000 0 1 1 0.656 11
18000504 800120000 0 1 1 0.746 12
18000601 0 0 0 1 0.5 6
18000602 0 0 0 1 0.75 10
18000603 0 0 0 1 0.656 11
18000604 0 0 0 1 0.746 12
18000701 0 0. 0. 0. 12
18000801 0. 10. 10. 0. 0. 0. 0. 1. 12
*
*
* sg il dc shell stru (bot)
18001000 12 7 2 1 .15
18001100 0 1
18001101 6 .152
18001201 3 6
18001301 0. 6
18001400 0
18001401 543. 7
18001501 800010000 10000 1 1 0.5 6
18001502 800070000 10000 1 1 0.75 10
18001503 800110000 0 1 1 0.656 11
18001504 800120000 0 1 1 0.746 12
18001601 850050000 0 1 1 0.5 3
18001602 850040000 0 1 1 0.5 6
18001603 850030000 0 1 1 0.75 8
18001604 850020000 0 1 1 0.75 10
18001605 850010000 0 1 1 0.656 11
18001606 850010000 0 1 1 0.746 12
18001701 0 0. 0. 0. 12
18001801 0. 10. 10. 0. 0. 0. 0. 1. 12
18001901 0. 10. 10. 0. 0. 0. 0. 1. 12
*
*
* sg il dc shell stru (top)
18101000 1 7 2 1 .15
18101100 0 1
18101101 6 .152
18101201 3 6
18101301 0. 6
18101400 0
18101401 543. 7
18101501 810010000 0 1 1 .645 1
18101601 840010000 0 1 1 .645 1
18101701 0 0. 0. 0. 1
18101801 0. 10. 10. 0. 0. 0. 0. 1. 1
18101901 0. 10. 10. 0. 0. 0. 0. 1. 1
*
*
* sg il dc shell stru (sep)
18102000 1 7 2 1 .15
18102100 0 1
18102101 6 .152
18102201 3 6
18102301 0. 6
18102400 0
18102401 543. 7
18102501 810020000 0 1 1 .946 1
18102601 830010000 0 1 1 .946 1
18102701 0 0. 0. 0. 1
18102801 0. 10. 10. 0. 0. 0. 0. 1. 1
18102901 0. 10. 10. 0. 0. 0. 0. 1. 1
*
*
* il sg top pla stru
18200000 1 7 1 1 0.
18200100 0 1
18200101 6 .032
18200201 3 6
18200301 0. 6
18200400 0
18200401 554.3 7
18200501 820010000 0 1 1 .217 1
18200601 0 0 0 1 .217 1
18200701 0 0. 0. 0. 1
18200801 0. 10. 10. 0. 0. 0. 0. 1. 1
*
*
* sg il vessel stru (top)
18201000 2 7 2 1 .1645
18201100 0 1
18201101 6 .1915
18201201 3 6
18201301 0. 6
18201400 0
18201401 543. 7
18201501 815010000 0 1 1 .791 1
18201502 820010000 0 1 1 .424 2
18201601 0 0 0 1 .791 1
18201602 0 0 0 1 .424 2
18201701 0 0. 0. 0. 2
18201801 0. 10. 10. 0. 0. 0. 0. 1. 1
18201802 0. 10. 10. 0. 0. 0. 0. 1. 2
*
*
* sg il vessel stru (mid)
18301000 1 7 2 1 .1645
18301100 0 1
18301101 6 .1915
18301201 3 6
18301301 0. 6
18301400 0
18301401 543. 7
18301501 830010000 0 1 1 .946 1
18301601 0 0 0 1 .946 1
18301701 0 0. 0. 0. 1
18301801 0. 10. 10. 0. 0. 0. 0. 1. 1
*
*
* sg il vessel stru (mid)
18401000 1 7 2 1 .1645
18401100 0 1
18401101 6 .1915
18401201 3 6
18401301 0. 6
18401400 0
18401401 533. 7
18401501 840010000 0 1 1 .645 1
18401601 0 0 0 1 .645 1
18401701 0 0. 0. 0. 1
18401801 0. 10. 10. 0. 0. 0. 0. 1. 1
*
*
* sg il vess stru (bot)
18500000 5 7 2 1 .1645
18500100 0 1
18500101 6 .1915
18500201 3 6
18500301 0. 6
18500400 0
18500401 533. 7
18500501 850010000 0 1 1 1.402 1
18500502 850020000 10000 1 1 1.500 5
18500601 -999 0 3780 1 1.402 1
18500602 -999 0 3780 1 1.500 5
18500701 0 0. 0. 0. 5
18500801 0. 10. 10. 0. 0. 0. 0. 1. 1
18500802 0. 10. 10. 0. 0. 0. 0. 1. 5
*
*
* sg bl filler shell s.s. stru
19000000 12 7 2 1 0.0629
19000100 0 1
19000101 6 .070
19000201 3 6
19000301 0. 6
19000400 0
19000401 553. 7
```

```
19000501 900010000 10000  1 1 0.5  6
19000502 900070000 10000  1 1 0.75 10
19000503 900110000 0      1 1 0.656 11
19000504 900120000 0      1 1 0.746 12
19000601 0      0     0 1 0.5  6
19000602 0      0     0 1 0.75  10
19000603 0      0     0 1 0.656 11
19000604 0      0     0 1 0.746 12
19000701 0 0. 0. 0. 12
19000801 0. 10. 10. 0. 0. 0. 0. 1.  12
*
*
* sg bl dc shell stru (bot)
19001000 12 7 2 1 .1005
19001100 0 1
19001101 6 .102
19001201 3 6
19001301 0. 6
19001400 0
19001401 543. 7
19001501 900010000 10000 1  1  0.5   6
19001502 900070000 10000 1  1  0.75  10
19001503 900110000 0   1  1  0.656 11
19001504 900120000 0   1  1  0.746 12
19001601 950050000 0   1  1  0.5   3
19001602 950040000 0   1  1  0.5   6
19001603 950030000 0   1  1  0.75  8
19001604 950020000 0   1  1  0.75  10
19001605 950010000 0   1  1  0.656 11
19001606 950010000 0   1  1  0.746 12
19001701 0 0. 0. 0. 12
19001801 0. 10. 10. 0. 0. 0. 0. 1.  12
19001901 0. 10. 10. 0. 0. 0. 0. 1.  12
*
*
* sg bl dc shell stru (top)   **?
19101000 1  7 2 1 .1005
19101100 0 1
19101101 6 .102
19101201 3 6
19101301 0. 6
19101400 0
19101401 543. 7
19101501 910010000 0   1  1  .450  1
19101601 940010000 0   1  1  .450  1
19101701 0 0. 0. 0.  1
19101801 0. 10. 10. 0. 0. 0. 0. 1. 1
19101901 0. 10. 10. 0. 0. 0. 0. 1. 1
*
*
* sg bl dc shell stru (sep)    **?
19102000 1  7 2 1 .1005
19102100 0 1
19102101 6 .102
19102201 3 6
19102301 0. 6
19102400 0
19102401 543. 7
19102501 910020000 0   1  1  1.164  1
19102601 930010000 0   1  1  1.164  1
19102701 0 0. 0. 0.  1
19102801 0. 10. 10. 0. 0. 0. 0. 1. 1
19102901 0. 10. 10. 0. 0. 0. 0. 1. 1
*
*
* bl sg top pla stru     **?
19200000 1 7  1 1 0.
19200100 0 1
19200101 6 .020
19200201 3 6
19200301 0. 6
19200400 0
19200401 554. 7
19200501 920010000 0 1 1 .217 1
19200601 0        0 0 1 .217 1
19200701 0 0. 0. 0. 1
19200801 0. 10. 10. 0. 0. 0. 0. 1. 1
*
*
* sg bl vessel  stru  (top)
19201000 2  7  2 1 .135
19201100 0 1
19201101 6 .152
19201201 3 6
19201301 0. 6
19201400 0
19201401 544. 7
19201501 915010000 0    1  1   .567  1
19201502 920010000 0    1  1   .500  2
19201601 000000000 0    0  1   .567  1
19201602 000000000 0    0  1   .500  2
19201701 0 0. 0. 0.  2
19201801 0. 10. 10. 0. 0. 0. 0. 1.  1
19201802 0. 10. 10. 0. 0. 0. 0. 1.  2
*
*
* sg bl dc shell stru  (mid)
19301000 1  7  2 1 .1195
19301100 0 1
19301101 6 .1345
19301201 3 6
19301301 0. 6
19301400 0
19301401 533. 7
19301501 930010000 0    1  1  1.164  1
19301601 000000000 0    0  1  1.164  1
19301701 0 0. 0. 0.  1
19301801 0. 10. 10. 0. 0. 0. 0. 1.  1
*
*
* sg bl vessel  stru  (mid)
19401000 1  7  2 1 .1195
19401100 0 1
19401101 6 .1345
19401201 3 6
19401301 0. 6
19401400 0
19401401 533. 7
19401501 940010000 0    1  1   .450  1
19401601 000000000 0    0  1   .450  1
19401701 0 0. 0. 0.  1
19401801 0. 10. 10. 0. 0. 0. 0. 1.  1
*
*
* sg bl vess stru  (bot)
19500000 5  7  2 1 .108
19500100 0 1
19500101 6 .122
19500201 3 6
19500301 0. 6
19500400 0
19500401 533. 7
19500501 950010000 0       1  1  1.304    1
19500502 950020000  10000    1  1  1.500    5
19500601 -999     0     3790  1  1.304    1
19500602 -999     0     3790  1  1.500    5
19500701 0 0. 0. 0. 5
19500801 0. 10. 10. 0. 0. 0. 0. 1.  1
19500802 0. 10. 10. 0. 0. 0. 0. 1.  5
*
*
* core structure lower conn. 1
19920000 1 20 2 1 0.
19920100 0 1
19920101 19  0.0045
19920201 4 19
19920301 1. 19
19920400 0
19920401 587. 20
19920501 0           0      0  1   21.120   1
19920601 106010000      0      1  1   21.120   1
19920701 900 0.047   0.  0.  1
19920901 0. 10. 10. 0. 0. 0. 0. 1. 1
*
*
* core structure lower conn. 2
```

```
19930000 1 20 2 1 0.
19930100 0 1
19930101 19 0.005375
19930201 4 19
19930301 1. 19
19930400 0
19930401 589. 20
19930501 0          0     0  1   12.800   1
19930601 400010000     0      1  1   12.800   1
19930701 900 0.005   0.  0.  1
19930901 0. 10. 10. 0. 0. 0. 0. 1.    1
*
*
* core active zone structure  1
19940000 1 15 2 1 0.003225
19940100 0 1
19940101 14  0.005375
19940201 5 14
19940301 1. 14
19940400 0
19940401 595. 15
19940501 0          0     0  1   26.368   1
19940601 400020000     0      1  1   26.368   1
19940701 900  .065   0.  0.  1
19940901 0. 10. 10. 0. 0. 0. 0. 1. 1
*
*
* core active zone structure  2
19950000 1 15 2 1 0.003875
19950100 0 1
19950101 14  0.005375
19950201 5 14
19950301 1. 14
19950400 0
19950401 598. 15
19950501 0          0     0  1   42.432   1
19950601 400030000     0      1  1   42.432   1
19950701 900  0.140   0.  0.  1
19950901 0. 10. 10. 0. 0. 0. 0. 1. 1
*
*
* core active zone structure  3
19960000 1 15 2 1 0.004175
19960100 0 1
19960101 14  0.005375
19960201 5 14
19960301 1. 14
19960400 0
19960401 603. 15
19960501 0          0     0  1   37.312   1
19960601 400040000     0      1  1   37.312   1
19960701 900  0.1502  0.  0.  1
19960901 0. 10. 10. 0. 0. 0. 0. 1. 1
*
*
* core active zone structure  4
19970000 1 15 2 1 0.004175
19970100 0 1
19970101 14  0.005375
19970201 5 14
19970301 1. 14
19970400 0
19970401 603. 15
19970501 0          0     0  1   37.376   1
19970601 400050000     0      1  1   37.376   1
19970701 900  0.1506  0.  0.  1
19970901 0. 10. 10. 0. 0. 0. 0. 1. 1
*
*
* core active zone structure  5
19980000 1 15 2 1 0.004175
19980100 0 1
19980101 14  0.005375
19980201 5 14
19980301 1. 14
19980400 0
19980401 603. 15
19980501 0          0     0  1   37.312   1
19980601 400060000     0      1  1   37.312   1
19980701 900  0.1502  0.  0.  1
19980901 0. 10. 10. 0. 0. 0. 0. 1. 1
*
*
* core active zone structure  6
19990000 1 15 2 1 0.003875
19990100 0 1
19990101 14  0.005375
19990201 5 14
19990301 1. 14
19990400 0
19990401 610. 15
19990501 0          0     0  1   42.432   1
19990601 400070000     0      1  1   42.432   1
19990701 900  0.1420  0.  0.  1
19990901 0. 10. 10. 0. 0. 0. 0. 1. 1
*
*
* core active zone structure  7
19991000 1 15 2 1 0.003225
19991100 0 1
19991101 14  0.005375
19991201 5 14
19991301 1. 14
19991400 0
19991401 613. 15
19991501 0          0     0  1   26.368   1
19991601 400080000     0      1  1   26.368   1
19991701 900  0.0660  0.  0.  1
19991901 0. 10. 10. 0. 0. 0. 0. 1. 1
*
*
* core zone upper part
19993000 4 15 2 1 0.0025
19993100 0 1
19993101 14 0.005375
19993201 5 14
19993301 1. 14
19993400 0
19993401 619. 15
19993501 0          0    0  1  27.552 1
19993502 0          0    0  1  50.560 2
19993503 0          0    0  1  50.848 3
19993504 0          0    0  1  20.160 4
19993601 400090000  0        1  1  27.552 1
19993602 410010000  0        1  1  50.560 2
19993603 420010000  0        1  1  50.848 3
19993604 430010000  0        1  1  20.160 4
19993701 900   0.0155   0.  0.  1
19993702 900   0.02858  0.  0.  3
19993703 900   0.01135  0.  0.  4
19993901 0. 10. 10. 0. 0. 0. 0. 1.   1
19993902 0. 10. 10. 0. 0. 0. 0. 1.   2
19993903 0. 10. 10. 0. 0. 0. 0. 1.   3
19993904 0. 10. 10. 0. 0. 0. 0. 1.   4
*
*
*
* materials tables
*
*
*
20100100  tbl/fctn  1  1
20100200  tbl/fctn  1  1
20100300  tbl/fctn  1  1
20100400  tbl/fctn  1  1
20100500  tbl/fctn  1  1
20100600  tbl/fctn  1  1
20100700  tbl/fctn  1  1
20100800  tbl/fctn  1  1
*
*
* inc 625 (vessel) conductivity (w/m/k)
20100101  93.     12.
20100102 473.     12.5
20100103 573.     13.9
20100104 673.     15.3
```

```
20100105 2073.  16.3
*
*
*   "    heat capacity (j/m3/kg)
20100151 93.  3.46e6
20100152 373.  3.67e6
20100153 473.  3.87e6
20100154 573.  4.05e6
20100155 673.  4.26e6
20100156 2073.  4.36e6
*
*
* filler (al203) conductivity (w/m/k)
20100201 93.  41.9
20100202 373.  35.6
20100203 773.  12.6
20100204 2073.  8.4
*
*
*   "   thermal capacity (j/m3/kg)
20100251 93.  4.04e6
20100252 2073. 4.04e6
*
* piping steel conductivity (w/m/k)
20100301 93. 14.700
20100302 2073. 18.60
*
*
*   "    heat capacity (j/m3/kg)
20100351 93. 3.62e6
20100352 2073. 4.21e6
*
*
* nickel connectors conductivity (w/m/k)
20100401 93.   79.2
20100402 533.   61.9
20100403 813.   59.0
20100404 1088.   64.8
20100405 2800.   67.0
*
*
*   "    heat capacity (j/m3/kg)
20100451 93.  4.05e6
20100452 2073.  4.05e6
*
* heater rods material (ss 1.4949) conductivity (w/m/k)
20100501 293.  16.9
20100502 300.  17.0
20100503 400.  18.3
20100504 500.  18.9
20100505 600.  20.1
20100506 700.  21.2
20100507 800.  22.4
20100508 900.  23.5
20100509 1000.  24.7
20100510 1050.  25.3
20100511 1500.  25.9
*
*
*      "    heat capacity (j/m3/kg)
20100551 293.  3.96e6
20100552 300.  3.99e6
20100553 400.  4.13e6
20100554 500.  4.26e6
20100555 600.  4.40e6
20100556 700.  4.53e6
20100557 800.  4.67e6
20100558 900.  4.79e6
20100559 1000.  4.97e6
20100560 1050.  5.07e6
20100561 1500.  5.10e6
*
*
* uo2 doel data
*
20100601 293. 8.361
20100602 366. 7.27
20100603 373. 7.18
20100604 473. 6.10
20100605 533. 5.6
20100606 573. 5.31
20100607 623. 4.99
20100608 673. 4.70
20100609 723. 4.45
20100610 773. 4.22
20100611 823. 4.02
20100612 873. 3.84
20100613 923. 3.67
20100614 973. 3.52
20100615 1023. 3.38
20100616 1073. 3.26
20100617 1123. 3.14
20100618 1223. 2.94
20100619 1273. 2.85
20100620 1323. 2.76
20100621 1373. 2.69
20100622 1423. 2.62
20100623 1473. 2.55
20100624 1523. 2.5
20100625 1573. 2.44
20100626 1623. 2.39
20100627 1673. 2.35
20100628 1723. 2.31
20100629 1823. 2.25
20100630 1873. 2.22
20100631 1923. 2.20
20100632 1973. 2.22
20100633 2023. 2.25
20100634 2073. 2.29
20100635 2123. 2.33
20100636 2173. 2.37
20100637 2223. 2.42
20100638 2273. 2.47
20100639 2323. 2.52
20100640 2423. 2.65
20100641 2473. 2.73
20100642 2523. 2.81
20100643 2573. 2.90
20100644 2623. 2.99
20100645 2673. 3.10
20100646 2773. 3.35
20100647 2823. 3.49
20100648 2873. 3.65
20100649 3200. 5.29
*
* u02 heat capacity
*
20100651 273. 2.31e6
20100652 323. 2.57e6
20100653 373. 2.75e6
20100654 473. 2.92e6
20100655 673. 3.13e6
20100656 1373. 3.44e6
20100657 4700. 6.80e6
*
* gap doel data
*
20100701   0.56      *ref.:stabilization vessel.
20100751   5.4       *rho-cd  egg-loft-5480
*
*
* zr doel data
*
20100801  273.15   7.
20100802  473.15   1.200438e1
20100803  673.15   1.400510e1
20100804  873.15   1.700793e1
20100805  1073.15   1.900866e1
20100806  1273.15   2.200975e1
20100807  1473.15   2.501085e1
20100808  1673.15   3.001267e1
20100809  1873.15   3.601486e1
20100810  2073.15   4.401777e1
20100811  2273.15   5.502352e1
20100812  2473.15   6.802826e1
*
```

```
20100851  255.3722  1.904141e6
20100852  1077.594  2.312171e6
20100853  1185.928  5.712422e6
20100854  1248.428  2.311769e6
20100855  2199.817  2.312171e6
*
*
*
* power table nuclear power imposed
* core power table  bt17
20290000  power  575  1.0  0.630e6
20290001   0.    1.
20290002   53.   1.
20290003   60.   0.941
20290004   80.   0.783
20290005   100.  0.662
20290006   150.  0.463
20290007   200.  0.359
20290008   400.  0.224
20290009   600.  0.195
20290010   800.  0.186
20290011   1000. 0.178
20290012   1500. 0.163
20290013   2000. 0.148
20290014   2375. 0.144
*
*
*
*
* prez heater power decay table
20295000 power  603  1.0 1.2e3
20295001  -1.  0.
20295002  0.  0.
20295003  0.01 0.01
20295004  1.  1.
20295005  1.e6 1.
*
*
*
* heat losses to environment
*
*
*
* lp heat losses      (102)
*0210200   htc-t
*0210201   0.     121.
*0210202   10000.  121.
*
*
* vessel wall heat losses  dc  (200)
20220000   htc-t
20220001   -1.    7.5
20220002   0.     7.5
20220003   1.e6   7.5
*
*
* vessel upper plate heat losses  (430)
20243000   htc-t
20243001   0.     20.5
20243002   10000.  20.5
*
*
* iL vessel conn. heat losses-hl  (500)
20250000   htc-t
20250001   0.    14.3
20250002   10000.  14.3
*
*
* prz heat losses     (535) (external heaters comp. in bt17)
20253500   htc-t
20253501   0.     1.e-6 *4.71
20253502   10000.  1.e-6
*
*
*                     (560)
20256000   htc-t
20256001   0.     5.8
20256002   10000.  5.8
*
*
*                     (580)
20258000   htc-t
20258001   0.     6.5
20258002   10000.  6.5
*
*
*                     (595)
20259500   htc-t
20259501   0.     37.
20259502   10000.  37.
*
*
*                     (600)
20260000   htc-t
20260001   0.     93.3
20260002   10000.  93.3
*
*
*                     (605)
20260500   htc-t
20260501   0.     27.
20260502   10000.  27.
*
*
*                     (612)
20261200   htc-t
20261201   0.     21.7
20261202   10000.  21.7
*
*
* bl vessel outlet hl heat losses     (700)
20270000   htc-t
20270001   0.     42.33
20270002   10000.  42.33
*
*
* bl                   (710)
20271000   htc-t
20271001   0.     12.64
20271002   10000.  12.64
*
*
* bl          heat losses    (725)
20272500   htc-t
20272501   0.     11.99
20272502   10000.  11.99
*
*
* bl          heat losses    (730)
20273000   htc-t
20273001   0.     63.
20273002   10000.  63.
*
*
* bl          heat losses    (740)
20274000   htc-t
20274001   0.     93.28
20274002   10000.  93.28
*
*
* bl          heat losses    (745)
20274500   htc-t
20274501   0.     63.
20274502   10000.  63.
*
*
* bl      heat losses  (770)
20277000   htc-t
20277001   0.     14.21
20277002   10000.  14.21
*
*
* ss sg il heat losses     (780)
20278000   htc-t
20278001   0.     5.7
20278002   100.   5.7
```

```
20278003  101.   8.7  * 5.7 before bt-17
20278004  1.e6   8.7
*
*
* ss sg bl heat loss      (790)
20279000  htc-t
20279001  0.     8.6
20279002  100.   8.6
20279003  101.   14.6  * 8.6 before bt-17
20279004  1.e6   14.6
*
* environment temperature table (per prez)
20299800 temp
20299801 0.  619.153
20299802 100. 619.153
20299803 100.01  300.
20299804 1.e6   300.
*
* environment temperature table  (for heat-loss)
20299900 temp
20299901 0.  300.
20299902 10000. 300.
*
*
*
* control variables
*
*
*
* 001 prez level
20500100   pzrlvl    sum   1.    0.  1
20500101 0. .790       voidf    530010000
20500102     .630      voidf    535010000
20500103     1.120     voidf    535020000
20500104     1.500     voidf    535030000
20500105     1.500     voidf    535040000
20500106     1.040     voidf    540010000
20500107     1.000     voidf    539010000
*
*
* 002 il sg dc level   (cl93bt)
20500200  ilsgdcl    sum   1.   0.  1
20500201 0.  1.5000      voidf    850050000
20500202     1.5000    voidf    850040000
20500203     1.5000    voidf    850030000
20500204     1.5000    voidf    850020000
20500205     1.4020    voidf    850010000
20500206     0.6450    voidf    840010000
20500207     0.9460    voidf    830010000
20500208     0.7910    voidf    815010000
20500209     0.4240    voidf    820010000
*
*
* 003 bl sg dc level    (cl83bt)
20500300  blsgdcl    sum    1.   0.   1
20500301 0.  1.5000      voidf    950050000
20500302     1.5000    voidf    950040000
20500303     1.5000    voidf    950030000
20500304     1.5000    voidf    950020000
20500305     1.3040    voidf    950010000
20500306     0.4500    voidf    940010000
20500307     1.1640    voidf    930010000
20500308     0.5670    voidf    915010000
20500309     0.5000    voidf    920010000
*
*
* 004 core level
20500400    cor.lev.    sum   1.  0.   1
20500401 0.  .200     voidf     400010000
20500402     .412     voidf    400020000
20500403     .663     voidf    400030000
20500404     .583     voidf    400040000
20500405     .584     voidf    400050000
20500406     .583     voidf    400060000
20500407     .663     voidf    400070000
20500408     .412     voidf    400080000
20500409     .4305    voidf     400090000
*

*
* 005  dc level     (cl3dyb)
20500500  dc.lvl          sum    1.  0.     1
20500501  0. 1.002         voidf       200060000
20500502     1.275       voidf      200050000
20500503     1.167       voidf      200040000
20500504     1.246       voidf      200030000
20500505     .8485       voidf      200020000
20500506     .790       voidf      200010000
20500507     .7945       voidf      202010000
*
*
* 006  acc inj mass
20500600  accmas     integral  1.  0.     1
20500601  mflowj       675000000
*
*
* 007 uh level
20500700   uh.lvl     sum  1.    0.  1
20500701   0.  .850     voidf      455010000
20500702  .850        voidf     460010000
20500703  .866        voidf     460020000
*
*
* 008 vessel riser level    (cl3rya)
20500800  up.lvl        sum   1.  0.     1
20500801   0. .790        voidf      410010000
20500802  .7945          voidf      420010000
20500803  1.             cntrlvar    004         * core level
20500804  0.373          voidf      102010000
20500805  1.002          voidf      106010000
*
*
* 009 il loop seal lev      (cl1792x3)
20500900  il.l.s.l       sum    1.  0.    1
20500901 -2.515  .656  voidf       570130000
20500902  0.656        voidf      570140000
20500903  0.750        voidf      570150000
20500904  0.750        voidf      570160000
20500905  0.750        voidf      570170000
20500906  0.750        voidf      570180000
20500907  0.500        voidf      570190000
20500908  0.500        voidf      570200000
20500909  0.500        voidf      570210000
20500910  0.500        voidf      570220000
20500911  0.500        voidf      570230000
20500912  0.500        voidf      570240000
20500913  .338        voidf      575010000
20500914  0.574        voidf      580010000
20500915  0.574        voidf      580020000
20500916  0.574        voidf      580030000
20500917  .828        voidf      585010000
20500918  0.950        voidf      590010000
20500919  0.7825        voidf      590020000
20500920  0.7825        voidf      590030000
*
*
* 010 bl loop seal lev     (cl2782x2)
20501000  bl.l.s.l        sum    1.  0.    1
20501001 -2.052    .656       voidf       720130000
20501002   0.656         voidf      720140000
20501003   0.750         voidf      720150000
20501004   0.750         voidf      720160000
20501005   0.750         voidf      720170000
20501006   0.750         voidf      720180000
20501007   0.500         voidf      720190000
20501008   0.500         voidf      720200000
20501009   0.500         voidf      720210000
20501010   0.500         voidf      720220000
20501011   0.500         voidf      720230000
20501012   0.500         voidf      720240000
20501013   .221        voidf      722010000
20501014   0.639         voidf      725010000
20501015   0.639         voidf      725020000
20501016   0.639         voidf      725030000
20501017   1.042         voidf      730010000
20501018   1.151         voidf      730020000
20501019   0.701         voidf      730030000
```

```
20501020  0.884     voidf     730040000
*
*
* 011 surge line lvl
20501100  su.l.lv   sum  1. 0.   1
20501101 0. 3.380   voidf     520020000
*
*
* 012 il sg u tube lvl  (asc)   (cl1190x3)
20501200  ilsgutlv  sum  1. 0.   1
20501201 0. 0.5     voidf     570010000
20501202   0.5      voidf     570020000
20501203   0.5      voidf     570030000
20501204   0.5      voidf     570040000
20501205   0.5      voidf     570050000
20501206   0.5      voidf     570060000
20501207   0.75     voidf     570070000
20501208   0.75     voidf     570080000
20501209   0.75     voidf     570090000
20501210   0.75     voidf     570100000
20501211   0.656    voidf     570110000
20501212   0.656    voidf     570120000
20501213   0.828    voidf     550010000
20501214   0.574    voidf     560010000
20501215   0.574    voidf     560020000
20501216   0.574    voidf     560030000
20501217   0.338    voidf     565010000
*
*
* 013 bl sg u tube lvl  (asc)    (cl2180x2)
20501300  blsgutlv  sum   1. 0.   1
20501301 0. 0.5     voidf     720010000
20501302   0.5      voidf     720020000
20501303   0.5      voidf     720030000
20501304   0.5      voidf     720040000
20501305   0.5      voidf     720050000
20501306   0.5      voidf     720060000
20501307   0.75     voidf     720070000
20501308   0.75     voidf     720080000
20501309   0.75     voidf     720090000
20501310   0.75     voidf     720100000
20501311   0.656    voidf     720110000
20501312   0.656    voidf     720120000
20501313   0.842    voidf     710010000
20501314   0.639    voidf     712010000
20501315   0.639    voidf     712020000
20501316   0.639    voidf     712030000
20501317   0.221    voidf     718010000
*
* differenze di pressione
*
* 014 dp core            (brya)
20501400  brya.cal  sum  1. 1.163e5 0
20501401 0. 1.      p   102010000
20501402  -1.       p   420010000
*
*
* 015 dp downcomer         (3dbu)
20501500  dbu.cal   sum  1. -2.926e4 0
20501501 0. 1.      p   202010000
20501502  -1.       p   200060000
*
*
* 016 dp core inferiore     (3rug)
20501600  rug.cal   sum  1. 1.229e5  0
20501601 0. 1.      p   106010000
20501602  -1.       p   410010000
*
*
* 017 dp core superiore     (3rga)
20501700  rga.cal   sum  1.  1.001e4 0
20501701 0. 1.      p   410010000
20501702  -1.       p   420010000
*
*
* 018 dp cold leg downcomer il (163db3)
20501800  dp16db.c  sum  1. 4.696e4 0
20501801 0. 1.      p   612010000
20501802  -1.       p   202010000
*
*
* 019 dp up.head-up.plenum    (3r39a)
20501900  r39a.c    sum  1. -1.077e4 0
20501901 0. 1.      p   420010000
20501902  -1.       p   460010000
*
*
* 020 dp cold leg-downcomer bl  (263db7)
20502000  dp26db.c  sum  1.  2.461e4 0
20502001 0. 1.      p   770010000
20502002  -1.       p   202010000
*
*
* 021 dp hot leg-up.plenum il  (3r11a4)
20502100  r11a.c    sum  1.  3.446e4 0
20502101 0. 1.      p   500010000
20502102  -1.       p   420010000
*
*
* 022 dp hot leg-up.plenum bl  (3r21a4)
20502200 r21a.c     sum  1.  3.4630e4 0
20502201 0. 1.      p   700010000
20502202  -1.       p   420010000
*
*
* 023 dp cold leg-hot leg il    (161133)
20502300  dp1611.c  sum  1.  1.926e5 0
20502301 0. 1.      p   612010000
20502302  -1.       p   500010000
*
*
* 024 dp loop seal bl       (2724)
20502400 dp2724.c   sum  1.  2.324e4  0
20502401 0. 1.      p   730040000
20502402  -1.       p   730060000
*
*
* 025 dp pompa bl           (2524)
20502500  dp2524.c  sum  1.  3.435e5  0
20502501 0. 1.      p   730060000
20502502  -1.       p   745010000
*
*
* 026 dp pompa il           (1514)
20502600  dp1514.c  sum  1. 3.178e5  0
20502601 0. 1.      p   605010000
20502602  -1.       p   595010000
*
*
* 027 dp ingresso loop seal il (9217a)
20502700  dp9217.c  sum  1.  4.972e3  0
20502701 0. 1.      p   580030000
20502702  -1.       p   590040000
*
*
* 028 dp u-tube il          (9092aa)
20502800  aa9092.c  sum  1.  6.005e4 0
20502801 0. 1.      p   560010000
20502802  -1.       p   580030000
*
*
* 029 dp loop seal il       (1714)
20502900  dp1714.c  sum  1.  2.152e4 0
20502901 0. 1.      p   590040000
20502902  -1.       p   595010000
*
*
* 030 dp ingresso loop seal bl (8227a)
20503000  dp8227.c  sum  1.  9.175e3 0
20503001 0. 1.      p   725030000
20503002  -1.       p   730040000
*
*
* 031 dp u-tube ascendente il  (90bpx2)
20503100  px290b.c  sum  1.  7.434e4 0
20503101 0. 1.      p   565010000
```

```
20503102 -1.      p   570120000
*
*
* 032 dp u-tube bl          (8082aa)
20503200 aa8082.c   sum  1. 6.815e4 0
20503201 0. 1.      p   712010000
20503202 -1.        p   725030000
*
*
* 033 dp u-tube ascendente bl   (80bpx2)
20503300 px280b.c   sum  1.  7.907e4 0
20503301 0. 1.      p   718010000
20503302 -1.        p   720120000
*
*
* 034 dp secondario bl       (85jp)
20503400 dp85jp.c   sum  1. 1.176e4 0
20503401 0. 1.      p   900070000
20503402 -1.        p   900120000
*
*
* 035 dp secondario il       (95fp)
20503500 dp95fp.c   sum  1.  2.290e4 0
20503501 0. 1.      p   800050000
20503502 -1.        p   800120000
*
*
* heat exchange
*
* 036 core total   power
20503600 core.pw          sum -1.  0.  1
20503601  0.  .59716    htrnr  992000101
20503602      .43228    htrnr  993000101
20503603      .89050    htrnr  994000101
20503604      1.433     htrnr  995000101
20503605      1.2601    htrnr  996000101
20503606      1.2623    htrnr  997000101
20503607      1.2601    htrnr  998000101
20503608      1.433     htrnr  999000101
20503609      .89050    htrnr  999100101
20503610      .93049    htrnr  999300101
20503611      1.70752   htrnr  999300201
20503612      1.71724   htrnr  999300301
20503613      .68085    htrnr  999300401
*
*
* 037 lp    mass  (53.52 l)
20503700 vlp.mas   sum  1.  0.  1
20503701  0.  .0285   rho   102010000
20503702      .0250   rho   106010000
*
*
* 038 vessel dc  mass  (84.04 l)
20503800  dcmass   sum 1. 0. 1
20503801 0.  .00898  rho   202010000
20503802     .00893  rho   200010000
20503803     .00953  rho   200020000
20503804     .01409  rho   200030000
20503805     .01320  rho   200040000
20503806     .01442  rho   200050000
20503807     .01133  rho   200060000
20503808     .00356  rho   210010000
*
* 039 up mass         (45.59 l)
20503900  up.mass  sum  1. 0. 1
20503901  0.  .01896  rho   410010000
20503902      .01907  rho   420010000
20503903      .00756  rho   430010000
*
* 040 core mass        (36.77 l)
20504000  core.ma  sum  1.  0. 1
20504001  0.  .001623  rho   400010000
20504002      .003343  rho   400020000
20504003      .005380  rho   400030000
20504004      .004731  rho   400040000
20504005      .004739  rho   400050000
20504006      .004731  rho   400060000
20504007      .005380  rho   400070000
20504008      .003343  rho   400080000
20504009      .003494  rho   400090000
*
* 041 upper head mass       (31.31 l)
20504100  uh.mass  sum 1. 0. 1
20504101  0.  .00044   rho   440010000
20504102      .00057   rho   450010000
20504103      .00961   rho   455010000
20504104      .00961   rho   460010000
20504105      .00979   rho   460020000
20504106      .00129   rho   470010000
*
*
* 042 il hl mass           (43.66 l)
20504200  ilhlmas  sum  1.  0.  1
20504201 0.  .003865   rho    500010000
20504202     .002871   rho    510010000
20504203     .002871   rho    511010000
20504204     .002872   rho    512010000
20504205     .003370   rho    550010000
20504206     .006251   rho    560010000
20504207     .006251   rho    560020000
20504208     .006251   rho    560030000
20504209     .009050   rho    565010000
*
* 043 il sg mass  asc. part   (105.88 l)
20504300   ilsgma   sum 1. 0. 1
20504301 0.  .00362    rho    570010000
20504302     .00362    rho    570020000
20504303     .00362    rho    570030000
20504304     .00362    rho    570040000
20504305     .00362    rho    570050000
20504306     .00362    rho    570060000
20504307     .005431   rho    570070000
20504308     .005431   rho    570080000
20504309     .005431   rho    570090000
20504310     .005431   rho    570100000
20504311     .00475    rho    570110000
20504312     .00475    rho    570120000
*
* 044 il cl mass          (55.28 l)
20504400   ilclma    sum 1. 0. 1
20504401 0.  .009050   rho    575010000
20504402     .00625    rho    580010000
20504403     .00625    rho    580020000
20504404     .00625    rho    580030000
20504405     .003370   rho    585010000
20504406     .00405    rho    590010000
20504407     .00333    rho    590020000
20504408     .00333    rho    590030000
20504409     .00364    rho    590040000
20504410     .00333    rho    590050000
20504411     .00333    rho    590060000
20504412     .003052   rho    595010000
*
* 045 il cl vess conn mass        (21.45 l)
20504500   ilclvcm    sum 1. 0. 1
20504501 0.  .003      rho    600010000
20504502     .00441    rho    605010000
20504503     .00280    rho    610010000
20504504     .00280    rho    610020000
20504505     .00280    rho    610030000
20504506     .00280    rho    610040000
20504507     .00286    rho    612010000
*
*
* 046 pressurizer and surge line mass  (87.30 l)
20504600  pr.sulma    sum  1. 0. 1
20504601  0.  .000096    rho    520010000
20504602      .000493    rho    520020000
20504603      .000383    rho    520030000
20504604      .006502    rho    530010000
20504605      .005292    rho    535010000
20504606      .013552    rho    535020000
20504607      .018150    rho    535030000
20504608      .018150    rho    535040000
20504609      .012584    rho    540010000
20504610      .012100    rho    539010000
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20504611    .000710   rho   507010000
*
*
* 047 bl hl mass        (17.71 l)
20504700 blhlma     sum 1. 0. 1
20504701 0.  .0008345  rho   700010000
20504702    .0009396  rho   705010000
20504703    .0009396  rho   705020000
20504704    .0009396  rho   705030000
20504705    .0009396  rho   702010000
20504706    .00308    rho   710010000
20504707    .00234    rho   712010000
20504708    .00234    rho   712020000
20504709    .00234    rho   712030000
20504710    .00301    rho   718010000
*
*
*
* 048 bl sg mass asc. part
20504800  blsgma   sum 1. 0. 1
20504801 0.  .001206  rho    720010000
20504802    .001206  rho    720020000
20504803    .001206  rho    720030000
20504804    .001206  rho    720040000
20504805    .001206  rho    720050000
20504806    .001206  rho    720060000
20504807    .00181   rho    720070000
20504808    .00181   rho    720080000
20504809    .00181   rho    720090000
20504810    .00181   rho    720100000
20504811    .001583  rho    720110000
20504812    .001583  rho    720120000
*
*
* 049 bl cl mass (up to pump excluded)
20504900  blclma   sum 1. 0. 1
20504901 0.  .00301    rho    722010000
20504902    .00234    rho    725010000
20504903    .00234    rho    725020000
20504904    .00234    rho    725030000
20504905    .00141    rho    730010000
20504906    .00034    rho    730010000
20504907    .00192    rho    730020000
20504908    .00117    rho    730030000
20504909    .00147    rho    730040000
20504910    .00117    rho    730050000
20504911    .00192    rho    730060000
*
*
* 050 bl cl vess. conn mass (pump included)  (    l)
20505000  blclvcma    sum 1. 0. 1
20505001 0.  .003      rho  740010000
20505002    .00084    rho  745010000
20505003    .0006159  rho  750010000
20505004    .0006159  rho  750020000
20505005    .0006159  rho  750030000
20505006    .0006159  rho  750040000
20505007    .0006159  rho  750050000
20505008    .0008465  rho  770010000
20505009    .0008465  rho  772010000
20505010    .0008465  rho  774010000
20505011    .0008465  rho  776010000
*
*
* 051 sg il dc mass       (275.93 l)
20505100  sgildcma    sum 1. 0. 1
20505101 0.  .12298   rho   830010000
20505102    .06450   rho   840010000
20505103    .016754  rho   850010000
20505104    .017925  rho   850020000
20505105    .017925  rho   850030000
20505106    .017925  rho   850040000
20505107    .017925  rho   850050000
*
*
* 052  sg il riser mass     (382.84 l)
20505200  sgilrima   sum 1. 0. 1
20505201 0.  .01495  rho   800010000
20505202    .01495  rho   800020000
20505203    .01495  rho   800030000
20505204    .01495  rho   800040000
20505205    .01495  rho   800050000
20505206    .01495  rho   800060000
20505207    .02242  rho   800070000
20505208    .02242  rho   800080000
20505209    .02242  rho   800090000
20505210    .02242  rho   800100000
20505211    .02952  rho   800110000
20505212    .03357  rho   800120000
20505213    .01484  rho   810010000
20505214    .05000  rho   810020000
*
*
* 053 sg il steam dome mass   (186.9 l)
20505300  sgilsdma  sum 1. 0. 1
20505301 0.  .12166  rho  815010000
20505302    .06521  rho  820010000
*
* 054 sg bl dc mass        (91.92 l)
20505400  sgbldcma   sum  1. 0. 1
20505401 0.  .04509  rho  930010000
20505402    .01742  rho  940010000
20505403    .00558  rho  950010000
20505404    .00597  rho  950020000
20505405    .00597  rho  950030000
20505406    .00597  rho  950040000
20505407    .00597  rho  950050000
*
* 055 sg bl riser mass      (130.98 l)
20505500  sgblrima   sum  1. 0. 1
20505501 0.  .0047    rho  900010000
20505502    .0047    rho  900020000
20505503    .0047    rho  900030000
20505504    .0047    rho  900040000
20505505    .0047    rho  900050000
20505506    .0047    rho  900060000
20505507    .00705   rho  900070000
20505508    .00705   rho  900080000
20505509    .00705   rho  900090000
20505510    .00705   rho  900100000
20505511    .01115   rho  900110000
20505512    .01268   rho  900120000
20505513    .00494   rho  910010000
20505514    .02000   rho  910020000
*
* 056 sg bl steam dome mass   (62.24 l)
20505600  sgblsdma   sum  1. 0. 1
20505601 0.  .03307  rho  915010000
20505602    .02917  rho  920010000
*
* 057 secondary mass of sg bl
20505700  sgb.mss   sum  1. 0. 1
20505701 0.  1.     cntrlvar  054
20505702    1.     cntrlvar  055
20505703    1.     cntrlvar  056
*
* 058 secondary mass
20505800  ss.mass   sum  1. 0. 1
20505801 0.  1.     cntrlvar  051
20505802    1.     cntrlvar  052
20505803    1.     cntrlvar  053
20505804    1.     cntrlvar  054
20505805    1.     cntrlvar  055
20505806    1.     cntrlvar  056
*
* 059 secondary mass of sg il
20505900  sgi.mss   sum  1. 0. 1
20505901 0.  1.     cntrlvar  051
20505902    1.     cntrlvar  052
20505903    1.     cntrlvar  053
*
*
* 060 sg ss il heat losses
20506000  hl.sg.il   sum   1. 0. 1
20506001 0.   1.687  htrnr  850000101
20506002     1.804  htrnr  850000201
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20506003      1.804  htrnr  850000301
20506004      1.804  htrnr  850000401
20506005      1.804  htrnr  850000501
*
*
* 061 sg ss bl heat losses
20506100 hl.sg.bl   sum   1. 0. 1
20506101 0.   1.   htrnr  950000101
20506102      1.017  htrnr  950000201
20506103      1.017  htrnr  950000301
20506104      1.017  htrnr  950000401
20506105      1.017  htrnr  950000501
*
*
* 062 sgil heat exchange 1
20506200 sgi.he1  sum 1.   0. 1
20506201 0. 1.      q   570010000
20506202   1.       q   570020000
20506203   1.       q   570030000
20506204   1.       q   570040000
20506205   1.       q   570050000
20506206   1.       q   570060000
20506207   1.       q   570070000
20506208   1.       q   570080000
20506209   1.       q   570090000
20506210   1.       q   570100000
20506211   1.       q   570110000
20506212   1.       q   570120000
*
*
* 063 sgil heat exchange dl
20506300 sgi.he2  sum 1.   0. 1
20506301 0. 1.      q   570130000
20506302   1.       q   570140000
20506303   1.       q   570150000
20506304   1.       q   570160000
20506305   1.       q   570170000
20506306   1.       q   570180000
20506307   1.       q   570190000
20506308   1.       q   570200000
20506309   1.       q   570210000
20506310   1.       q   570220000
20506311   1.       q   570230000
20506312   1.       q   570240000
*
*
* 064 sgil heat exchange total
20506400 sgi.he   sum 1.   0. 1
20506401 0. 1.   cntrlvar   062
20506402   1.    cntrlvar   063
*
*
* 065 sgbl heat exchange 1
20506500 sgb.he1  sum 1.   0. 1
20506501 0. 1.      q   720010000
20506502   1.       q   720020000
20506503   1.       q   720030000
20506504   1.       q   720040000
20506505   1.       q   720050000
20506506   1.       q   720060000
20506507   1.       q   720070000
20506508   1.       q   720080000
20506509   1.       q   720090000
20506510   1.       q   720100000
20506511   1.       q   720110000
20506512   1.       q   720120000
*
*
* 066 sgbl heat exchange dl
20506600 sgb.he2  sum 1.   0. 1
20506601 0. 1.      q   720130000
20506602   1.       q   720140000
20506603   1.       q   720150000
20506604   1.       q   720160000
20506605   1.       q   720170000
20506606   1.       q   720180000
20506607   1.       q   720190000
20506608   1.       q   720200000
20506609   1.       q   720210000
20506610   1.       q   720220000
20506611   1.       q   720230000
20506612   1.       q   720240000
*
*
* 067 sgbl heat exchange total
20506700 sgb.he   sum 1.   0. 1
20506701 0. 1.   cntrlvar   065
20506702   1.    cntrlvar   066
*
* 068 il sg mass  desc. part  (105.88 l)
20506800  ilsgma2  sum 1. 0. 1
20506801 0. .00362   rho    570240000
20506802   .00362    rho    570230000
20506803   .00362    rho    570220000
20506804   .00362    rho    570210000
20506805   .00362    rho    570200000
20506806   .00362    rho    570190000
20506807   .005431   rho    570180000
20506808   .005431   rho    570170000
20506809   .005431   rho    570160000
20506810   .005431   rho    570150000
20506811   .00475    rho    570140000
20506812   .00475    rho    570130000
*
*
*
* 069 bl sg mass dec.  part
20506900  blsgmad sum 1. 0. 1
20506901 0. .001206   rho    720240000
20506902   .001206    rho    720230000
20506903   .001206    rho    720220000
20506904   .001206    rho    720210000
20506905   .001206    rho    720200000
20506906   .001206    rho    720190000
20506907   .00181     rho    720180000
20506908   .00181     rho    720170000
20506909   .00181     rho    720160000
20506910   .00181     rho    720150000
20506911   .001583    rho    720140000
20506912   .001583    rho    720130000
*
* 077 primary mass
20507700 pr.mass    sum  1.  0.  1
20507701 0.   1.     cntrlvar  037
20507702      1.     cntrlvar  038
20507703      1.     cntrlvar  039
20507704      1.     cntrlvar  040
20507705      1.     cntrlvar  041
20507706      1.     cntrlvar  042
20507707      1.     cntrlvar  043
20507708      1.     cntrlvar  044
20507709      1.     cntrlvar  045
20507710      1.     cntrlvar  046
20507711      1.     cntrlvar  047
20507712      1.     cntrlvar  048
20507713      1.     cntrlvar  049
20507714      1.     cntrlvar  050
20507715      1.     cntrlvar  068
20507716      1.     cntrlvar  069
*
* 089 heat loss - prez
20508900 pr.ht.ls sum  1.  0.   1
20508901  0.  0.317      htrnr  535100101
20508902      0.563      htrnr  535100201
20508903      0.754      htrnr  535100301
20508904      0.754      htrnr  535100401
20508905      0.522      htrnr  540100101
20508906      0.502      htrnr  540100201
*
* 090 heat loss - vessel
20509000 vs.ht.ls sum 1.  0.   1
20509001  0.  0.85762     htrnr  200100101
20509002      0.85277     htrnr  200100201
20509003      0.90944     htrnr  200100301
20509004      1.3450      htrnr  200100401
20509005      1.2597      htrnr  200100501
```

```
20509006    1.3763    htrnr  200100601
20509007    3.0000    htrnr  430100101
*
* 091 heat loss - il
20509100 il.ht.ls sum 1.  0.   1
20509101  0.  0.30654    htrnr   500100101
20509102     0.35019     htrnr   605100101
20509103     0.227       htrnr   612100101
20509104     0.252       htrnr   560100101
20509105     0.252       htrnr   560100201
20509106     0.252       htrnr   560100301
20509107     0.252       htrnr   580100101
20509108     0.252       htrnr   580100201
20509109     0.252       htrnr   580100301
20509110     0.254       htrnr   595100101
20509111     0.172       htrnr   600100101
*
* 092 heat loss - bl
20509200 bl.ht.ls sum 1.  0.   1
20509201  0.  0.12566    htrnr   700100101
20509202     0.15802     htrnr   745100101
20509203     0.1405      htrnr   710100201
20509204     0.1405      htrnr   710100301
20509205     0.1405      htrnr   710100401
20509206     0.166       htrnr   725100101
20509207     0.166       htrnr   725100201
20509208     0.166       htrnr   725100301
20509209     0.224       htrnr   730100601
20509210     0.172       htrnr   740100101
20509211     0.1052      htrnr   770100101
20509212     0.1052      htrnr   770100201
20509213     0.1052      htrnr   770100301
20509214     0.1052      htrnr   770100401
*
* 093 heat loss - tot
20509300 tt.ht.ls sum -1.  0.   1
20509301  0.  1.        cntrlvar    090
20509302    1.          cntrlvar    091
20509303    1.          cntrlvar    092
20509304    1.          cntrlvar    089
*
*
* heat exchange fluid structures
*
* ves1
20510100  ve.a.hex  sum 1. 0. 1
20510101  0.  1.  q   102010000
20510102      1.  q   202010000
20510103      1.  q   200010000
20510104      1.  q   200020000
20510105      1.  q   200030000
20510106      1.  q   200040000
20510107      1.  q   200050000
20510108      1.  q   200060000
20510109      1.  q   210010000
*
* ves2
20510200  ve.b.hex  sum 1. 0. 1
20510201  0.  .5099  htrnr  106100100
20510202      .09299 htrnr  108300100
20510203      .1915  htrnr  108300200
20510204      .3082  htrnr  108300300
20510205      .2710  htrnr  108300400
20510206      .2715  htrnr  108300500
20510207      .2710  htrnr  108300600
20510208      .3082  htrnr  108300700
20510209      .1912  htrnr  108300800
20510210      .2002  htrnr  108300900
20510211      .4864  htrnr  420100100
20510212      .4892  htrnr  420100200
20510213      .1939  htrnr  420100300
20510214      3.000  htrnr  430100100
*
* uh
20510300  uh.a.hex  sum 1. 0. 1
20510301  0.  1.  q   440010000
20510302      1.  q   450010000
20510303      1.  q   455010000
20510304      1.  q   460010000
20510305      1.  q   460020000
20510306      1.  q   470010000
*
* prz + surge line
20510400  prz.hex  sum 1. 0. 1
20510401  0.  1.  q   520020000
20510402      1.  q   520030000
20510403      1.  q   530010000
20510404      1.  q   535010000
20510405      1.  q   535020000
20510406      1.  q   535030000
20510407      1.  q   535040000
20510408      1.  q   540010000
20510409      1.  q   539010000
*
* il ps 1
20510500  il.hex1  sum 1. 0. 1
20510501  0.  1.  q   500010000
20510502      1.  q   510010000
20510503      1.  q   511010000
20510504      1.  q   512010000
20510505      1.  q   550010000
20510506      1.  q   560010000
20510507      1.  q   560020000
20510508      1.  q   560030000
20510509      1.  q   565010000
20510510      1.  q   575010000
20510511      1.  q   580010000
20510512      1.  q   580020000
*
* il ps 2
20510600  il.hex2  sum 1. 0. 1
20510601  0.  1.  q   580030000
20510602      1.  q   585010000
20510603      1.  q   590010000
20510604      1.  q   590020000
20510605      1.  q   590030000
20510606      1.  q   590040000
20510607      1.  q   590050000
20510608      1.  q   595010000
20510609      1.  q   600010000
20510610      1.  q   605010000
20510611      1.  q   610010000
20510612      1.  q   610020000
20510613      1.  q   610030000
20510614      1.  q   610040000
20510615      1.  q   612010000
*
* il ps
20510700  il.hex  sum 1. 0. 1
20510701  0.  1.  cntrlvar 105
20510702      1.  cntrlvar 106
*
* bl ps heat e205106c 1
20510800  bl.hex1  sum 1. 0. 1
20510801  0.  1.  q   700010000
20510802      1.  q   705010000
20510803      1.  q   705020000
20510804      1.  q   705030000
20510805      1.  q   702010000
20510806      1.  q   710010000
20510807      1.  q   712010000
20510808      1.  q   712020000
20510809      1.  q   718010000
20510810      1.  q   722010000
20510811      1.  q   725010000
20510812      1.  q   725020000
20510813      1.  q   725030000
*
* bl ps heat e205106c 2
20510900  bl.hex2  sum 1. 0. 1
20510901  0.  1.  q   730010000
20510902      1.  q   730020000
20510903      1.  q   730030000
20510904      1.  q   730040000
20510905      1.  q   730050000
20510906      1.  q   730060000
```

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20510907     1.  q   740010000
20510908     1.  q   745010000
20510909     1.  q   750010000
20510910     1.  q   750020000
20510911     1.  q   750030000
20510912     1.  q   750040000
20510913     1.  q   750050000
20510914     1.  q   770010000
20510915     1.  q   772010000
20510916     1.  q   774010000
*
* bl ps heat e205106c
20511000 bl.hex  sum 1. 0. 1
20511001 0.   1.  cntrlvar 108
20511002      1.  cntrlvar 109
*
* il sg ss first part
20511100 ilsg.hea  sum 1. 0. 1
20511101  0.   1.  q   850010000
20511102       1.  q   850020000
20511103       1.  q   850030000
20511104       1.  q   850040000
20511105       1.  q   850050000
20511106       1.  q   840010000
20511107       1.  q   830010000
20511108       1.  q   815010000
20511109       1.  q   820010000
20511110       1.  q   810010000
20511111       1.  q   810020000
*
* il sg ss second part 1
20511200 ilsg.he1  sum 1. 0. 1
20511201  0. .2388  htrnr  800000100
20511202     .2388  htrnr  800000200
20511203     .2388  htrnr  800000300
20511204     .2388  htrnr  800000400
20511205     .2388  htrnr  800000500
20511206     .2388  htrnr  800000600
20511207     .3581  htrnr  800000700
20511208     .3581  htrnr  800000800
20511209     .3581  htrnr  800000900
20511210     .3581  htrnr  800001000
20511211     .3132  htrnr  800001100
20511212     .3562  htrnr  800001200
*
* il sg ss second part 2
20511300 ilsg.he2  sum 1. 0. 1
20511313 0.  .4712  htrnr  800100100
20511314     .4712  htrnr  800100200
20511315     .4712  htrnr  800100300
20511316     .4712  htrnr  800100400
20511317     .4712  htrnr  800100500
20511318     .4712  htrnr  800100600
20511319     .7068  htrnr  800100700
20511320     .7068  htrnr  800100800
20511321     .7068  htrnr  800100900
20511322     .7068  htrnr  800101000
20511323     .6183  htrnr  800101100
20511324     .7031  htrnr  800101200
*
* il sg ss second part
20511400 ilsg.heb  sum 1. 0. 1
20511413 0.  1.    cntrlvar 112
20511414     1.    cntrlvar 113
*
*
* bl sg ss first part
20511500 blsg.hea  sum 1. 0. 1
20511501  0.   1.  q   950010000
20511502       1.  q   950020000
20511503       1.  q   950030000
20511504       1.  q   950040000
20511505       1.  q   950050000
20511506       1.  q   940010000
20511507       1.  q   930010000
20511508       1.  q   915010000
20511509       1.  q   920010000
20511510       1.  q   910010000
20511511       1.  q   910020000
*
* bl sg ss second part 1
20511600 blsg.he1  sum 1. 0. 1
20511601 0. .1976  htrnr  900000100
20511602    .1976  htrnr  900000200
20511603    .1976  htrnr  900000300
20511604    .1976  htrnr  900000400
20511605    .1976  htrnr  900000500
20511606    .1976  htrnr  900000600
20511607    .2964  htrnr  900000700
20511608    .2964  htrnr  900000800
20511609    .2964  htrnr  900000900
20511610    .2964  htrnr  900001000
20511611    .2592  htrnr  900001100
20511612    .2948  htrnr  900001200
*
* bl sg ss second part 2
20511700 blsg.he2  sum 1. 0. 1
20511713 0.  .3157  htrnr  900100100
20511714     .3157  htrnr  900100200
20511715     .3157  htrnr  900100300
20511716     .3157  htrnr  900100400
20511717     .3157  htrnr  900100500
20511718     .3157  htrnr  900100600
20511719     .4736  htrnr  900100700
20511720     .4736  htrnr  900100800
20511721     .4736  htrnr  900100900
20511722     .4736  htrnr  900101000
20511723     .4142  htrnr  900101100
20511724     .4711  htrnr  900101200
*
* bl sg ss second part
20511800 blsg.heb  sum 1. 0. 1
20511813 0.  1.    cntrlvar 116
20511814     1.    cntrlvar 117
*
* ps heat exchange fluid - structures
20512000 ps.hex  sum 1. 0. 1
20512001  0.  1.  cntrlvar  101
20512002      1.  cntrlvar  102
20512003      1.  cntrlvar  103
20512004      1.  cntrlvar  104
20512005      1.  cntrlvar  107
20512006      1.  cntrlvar  110
*
*
* ss heat exchange fluid - structures  il
20512100 ss.he.il sum 1. 0. 1
20512101  0.  1.  cntrlvar  111
20512102      1.  cntrlvar  114
*
* ss heat exchange fluid - structures  bl
20512200 ss.he.bl sum 1. 0. 1
20512201  0.  1.  cntrlvar  115
20512202      1.  cntrlvar  118
*
* system  exchange fluid - structures
20513000 syst.hex sum 1. 0. 1
20513001  0.  1.  cntrlvar  120
20513002      1.  cntrlvar  121
20513003      1.  cntrlvar  122
*
* overall mass loss from the break bl21
20514000 break.ml integral 1. 0. 0
20514001           mflowj 719000000
*
*
* overall mass loss from safety of sgss il
20514100 sgsailit integral 1. 0. 0
20514101           mflowj 838000000
*
* overall pump seal (inlet & outlet)
20514200 pusea.ba sum 1. 0. 1
20514201  0.  1.  mflowj  601000000
20514202      1.  mflowj  744000000
20514203     -1.  mflowj  604000000
*
```

```
*
* mass balance of pump seal water
20514300 pu.se.in integral 1. 0. 0
20514301         cntrlvar 142
*
* mass balance of ps (senza accumulatori)
20514400 ps.ma.ba sum 1. 0. 1
20514401 0. -1. cntrlvar 157
20514402    1. cntrlvar 143
20514403    1. cntrlvar 161
*
* power loss from the srv 1 (energy of the node upstream-1)
20515000 po.srva sum 1. 0. 1
20515001 0. 1. ug 539010000
20515002   -1. uf 539010000
*
* power loss from the srv 1 (energy of the node upstream-2)
20515100 po.srvb mult 1. 0. 1
20515101 quals 539010000 cntrlvar 150
*
*
* power loss from the srv 1 (energy of the node upstream-3)
20515200 po.srvc sum 1. 0. 1
20515201 0. 1. uf     539010000
20515202    1. cntrlvar 151
*
*
* power loss from the srv 2
20515300 po.srvd mult 1. 0. 1
20515301 mflowj 543000000 cntrlvar 152
*
*
* overall mass loss from the prz porv
20515400 porvint integral 1. 0. 0
20515401         mflowj 543000000
*
* overall mass loss from the prz srv
20515500 srv.int integral 1. 0. 0
20515501         mflowj 545000000
*
*
* overall mass loss from the prz porv+srv
20515600 po.srv.i integral 1. 0. 0
20515601         mflowj 547000000
*
* loss form prz top (porv, srv, porv+srv)
20515700 prz.loss sum 1. 0. 1
20515701 0. 1. cntrlvar 154
20515702    1. cntrlvar 155
20515703    1. cntrlvar 156
*
*
* mass balance il acc
20515800 ac.ma.il integral 1. 0. 0
20515801         mflowj 615010000
*
* mass balance bl acc
20515900 ac.ma.bl integral 1. 0. 0
20515901         mflowj 768010000
*
* sg bl ss mass
20516000 sg.bl.ma sum 1. 0. 1
20516001 0. 1. cntrlvar 54
20516002    1. cntrlvar 55
20516003    1. cntrlvar 56
*
* mass inlet in ps from accs
20516100 accs.min sum 1. 0. 1
20516101 0. 1. cntrlvar 158
20516102    1. cntrlvar 159
*
* sl sg il overall flowrate
20516200 sg.il.fl sum 1. 0. 1
20516201 0. 1. mflowj 828000000
20516202    1. mflowj 838000000
*
* sl sg bl overall flowrate
20516300 sg.bl.fl sum 1. 0. 1
20516301 0. 1. mflowj 928000000
20516302    1. mflowj 938000000
*
* sg il ss drift velocity
20517000 sg.il.dv sum 1. 0. 1
20517001 0. -1. velfj   805000000
20517002    1. velgj    805000000
*
* pump sat control
20517100 pu.sa.co sum 1. 0. 1
20517101 0. 1. sattemp 595010000
20517102   -1. tempf   595010000
*
*
* variabile a cas0
20517200 rp.perc mult 0.192 0. 1
20517201 mflowj 530010000
*
*
* overall mass loss from safety of sgss bl
20517300 sgblsait integral 1. 0. 0
20517301         mflowj 938000000
*
*
*
* overall mass drained from sg ss bl dc (to maintain lvl at 9.0m)
20517400 sgbldrit integral 1. 0. 0
20517401         mflowj 965000000
*
*
* 175 total pump seal water flowrate (for bt-17 55% of p.s.in)
20517500 pu.s.wt sum 1.   0. 1
20517501 0. 0.50 mflowj    601000000
20517502   0.50 mflowj    744000000
*
*
* 176 dc-up gap by-pass total
20517600 dc-upg  sum 1.   0. 1
20517601 0. 1.  mflowj    500030000
20517602    1.  mflowj    700030000
*
*
* 177 il accumulator level
20517700 iac-lev  sum 1.   0. 1
20517701 0. 4.680 voidf    615010000
*
*
* 178 bl accumulator level
20517800 bac-lev  sum 1.   0. 1
20517801 0. 6.794 voidf    768010000
*
*
* 179 bl accumulator mass
20517900 iac-mas  sum 1.   0. 1
20517901 0. 279.85e-3 rho   615010000
*
*
* 180 bl accumulator mass
20518000 bac-mas  sum 1.   0. 1
20518001 0. 94.35e-3 rho   768010000
*
*
* 181 dp il total
20518100 il.tot   sum 1. 1.751e5 0
20518101 0. 1.    p  612010000
20518102 -1.      p  500010000
*
*
* 182 dp bl total
20518200 bl.tot   sum 1. 1.926e5 0
20518201 0. 1.    p  776010000
20518202 -1.      p  700010000
*
*
* 183 dp sg il u-tube
20518300 I.utube  sum 1. 6.005e4 0
20518301 0. 1.    p  565010000
20518302 -1.      p  575010000
```

```
*
*
* 184 dp sg bl u-tube
20518400 b.utube   sum 1. 6.815e4 0
20518401 0. 1.       p   718010000
20518402 -1.         p   722010000
*
*
* 185 dp across sg il riser
20518500 sgil.r    sum 1. 3.6971e4 0
20518501 0. 1.       p   800010000
20518502 -1.         p   800120000
*
*
* 186 dp across sg bl riser
20518600 sgbl.r    sum 1. 2.9226e4 0
20518601 0. 1.       p   900010000
20518602 -1.         p   900120000
*
*
.
/*
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10. SUPPLEMENTARY NOTES

11. ABSTRACT *(200 words or less)*

The present document deals with the RELAP5/MOD3.2 analysis of the small break LOCA experiment BL-34 performed in LOBI/MOD2 facility. LOBI/MOD2 was a PWR simulator (Integral Test Facility) installed at JRC Joint Research Center) in Ispra Establishment (I). Volume scaling and core power scaling factors are 1/712, with respect to the KWU Siemens 1300 MWe (3900 MWt) standard reactor. The experiment is originated by a small break in the cold leg (2" equivalent break area in the plant) without the actuation of the high pressure injection system. Low pressure injection system actuation occurs after core dry-out and accumulators intervention is foreseen when primary pressure falls below 4 MPa. The RELAP5 code has been extensively used at University of Pisa; the nodaliztion of LOBI facility has been qualified through the application of the version RELAP5/MOD2 to the same experiment and another test performed in the same facility. Sensitivity analyses have been addressed to the influence of several parameters (like discharge break coefficient, time of accumulators start, etc.) upon the predicted transient evolution. Qualitative and quantitative code calculation accuracy evaluation has been performed.

12. KEY WORDS/DESCRIPTORS *(List words or phrases that will assist researchers in locating the report.)*

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PWR

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