NUREG/IA-0016

International Agreement Report

Assessment of RELAP5/MOD2, Cycle 36.04 Against FIX-II Guillotine Break Experiment No. 5061

Prepared by
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Office of Nuclear Regulatory Research
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Prepared as part of
The Agreement on Research Participation and Technical Exchange
under the International Thermal-Hydraulic Code Assessment
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Swedish Nuclear Power Inspectorate

ICAP
Assessment of RELAP5/MOD2, Cycle 36.04 Against FIX-II Guillotine Break Experiment No 5061

ABSTRACT

The FIX-II guillotine break experiment No. 5061 has been analyzed using the RELAP5/Mod2 code. The code version used, Cycle 36.04, is a frozen version of the code.

Four different calculations were carried out to study the sensitivity of initial coolant mass, junction options and break discharge line nodalization. The differences between the calculations and the experiment have been quantified over intervals in real time for a number of variables available from the measurements during the experiment.

The break mass flows were generally underpredicted at the same time as the depressurization rate was overpredicted.

87 May 14

Approved by Kjell Johansson

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APPENDICES

1. INTRODUCTION

An International Thermal-Hydraulic Code Assessment and Applications Program (ICAP) is during the present years being conducted by several countries under the coordination of the USNRC (1). The goal of the program is to make quantitative statements regarding the prediction capabilities of current best-estimate thermal-hydraulic computer codes. Such codes have been used for many years as state-of-the-art instruments to study and verify numerical and correlative computation models against results obtained in experiment. Some of those codes have reached a high degree of sofistication and do comprise models for mainly all processes which are essential to thermal-hydraulic scenarios in nuclear reactor application. So far, however, those codes did not achieve the status as reactor licensing tools, such as fulfilling the Appendix K rules (2), although they are often applied for other calculations. The present ICAP aims to quantify uncertainties of the codes to allow their use for licensing purposes.

Sweden's countributions to ICAP encompass assessment calculations using the two thermal-hydraulic codes TRAC-PWR (3) and RELAP5/MOD2 (4). The assessment calculations are conducted by Studsvik Energiteknik AB sponsored by the Swedish Nuclear Power Inspectorate.

The calculation presented in this report concerns a FIX-II experiment for a 200 % double-ended guillotine break. This experiment, Test No. 5061, was conducted during the second experimental period. Table 1 gives a short information about experiments done during that period.

A description of the test facility and this particular test is provided in Chapter 2. A description of the input model is given in Chapter 3. The base case and sensitivity calculations are discussed in Chapters 4 and 5. Run statistics are given in Chapter 6. General conclusions are drawn in Chapter 7.

Appendix A contains the complete input lists. The data comparison plots are included in Appendix B. Results of the statistical analyses of differences between experiment and predictions for discrete time intervals are included in Appendix C. Finally, Appendix D describes the data package on magnetic tape prepared for use on the ICAP evaluation work.

2. FACILITY AND TEST DESCRIPTION

The FIX-II integral test facility was completed at the end of 1981. It has been run by Studsvik Energiteknik AB under contract to the Swedish Nuclear Power Inspectorate. The experimental program comprises investigations of the fuel-to-coolant heat transfer. Various blowdown and pump trip situations conceivable in Swedish BWR's are simulated.

2.1 Test facility

The test facility itself is shown in Figure 1. The volume scaling is 1:777 of the Oskarshamn-II reactor, which is of the ASEA-ATOM external recirculation pump design. An exhaustive description of the FIX-II test facility may be obtained from Ref (5), which also provides additional references where various problems pertaining to the construction period are discussed. Therefore, only some fundamental aspects of the facility will be presented here.

The core model involves a full length rod bundle, which in the geometry is closely related to a fuel element of the ASEA-ATOM design and electrically heated by DC. Here, however, there are only 6 x 6 rod simulators instead of the 8 x 8 rods in a fuel element. Figures 2 and 3a show details from the core simulator design. As seen, filler bodies are placed between the square-section fuel channel and the circular-section pressure vessel to reduce the water-filled volume, which otherwise may influence the test by the leakage of steam to the upper plenum. The water surrounding the fillers is externally recirculated and cooled by 200 to 250 kW.

The upper part of the pressure vessel, Figure 3b, holds the steam separator and the steam condenser volume with its three sprinklers. During steady state power operation the steam outlet is closed. The turbine power is modelled by the partial circulation of water from the downcomer through an external 6 MW cooler with feedback to the sprinklers of the steam condenser and into the upper part of the downcomer. The flow rate in the two branches with cooled water is adjusted to control the pressure and the inlet subcooling. The remaining downcomer flow, representing the recirculation coolant flow in the reference reactor, splits at the lower downcomer end into two loops. One loop represents three of the intact recirculation lines of the reference reactor, while the other loop, representing a fourth recirculation line, incorporates the break devices. Both loops have a recirculation pump. The intact loop pump speed is regulated according to a predetermined speed history.

The FIX-II has, as part of the core model, an external bypass simulator through which about 12 % of the recirculation mass flow is diverted through a control valve. This bypass is heated separately to represent the channel wall heat transfer. At the lower end of the bypass, Figure 3c, there is a stagnant water volume to simulate the reference reactor space for the control rod guide tubes.

Since the FIX-II facility has been designed for blowdown experiments only, no emergency core cooling equipment is installed.

The data collection system is constructed around a signal processor controlling 192 measurement channels. The selection of measurements is made in a signal exchange terminal. A multipurpose minicomputer transfers the raw-data of measured parameters to a magnetic tape. From this tape, the final analysis at the central computer gives the desired tables and plots from an experiment. The data acquisition system includes measurements to obtain:

- pressures (PT)
- differential pressures (dPT)
- temperatures of fluids (TE)
- mass flows (dPT, PT, TE)
- electric currents (I) and voltages (U)
- pump speeds (nT)
- water level positions (CE)
- valve positions

at places shown in the instrumentation diagram, Figure 4.

For recording clad temperatures there were about 100 thermocouples engaged at 16 axial levels of the heated length in the 36-rod bundle.

2.2 The experiment

The preparation of the experiment is initiated several hours before the actual blowdown. For the heat-up of the facility, a 200 kW preheater is involved for a period lasting about 5 h. The recirculation pumps are running during this period too. Initial conditions are then established by switching the power supplies to the bundle and to the bypass with the 6 MW cooler and the condenser spray in operation. The preheater is now disconnected. For about 10 to 30 minutes, the electric power to the rod bundle and the bypass heating is gradually increased until the initial test conditions are reached. Necessary calibrations are made, and once the equilibrium conditions are finally approved, the sequency control equipment is activated for break opening, valve manoeuvres, power reduction, pump speed changes and so forth, according to a programmed scheme for the test. For the guillontine break test No. 5061, the transient ends 27.3 s after opening of the break.

In the present FIX-II experiment, the speed of the pump in the intact recirculation line decreased from the break time to about 20 % of the initial speed at end of the transient. The speed of the broken recirculation line pump was not explicitly controlled.

The break flow escaping through the fast opening break valves, Figure 1, are discharged into the receiving tanks, T2 and T3. Initially, the tanks are partly filled with cold water for efficient pool condensation of the break flows.

The guillotine break assembly consists of one connection to the line from pump P2 and one connection to the lower plenum. Break flow limiting orifices, downstream of the break isolation valves, consist of an exchangeable conical inlet part followed by a restriction pipe. In experiment No. 5061, each restriction pipe and flange diameter were 21.6 mm corresponding to a 100 % area of one recirculation line. The total break area for both connections is thus 200%.

Apart from the heat removal from the filler body space, see Chapter 2.1, some 100 kW are also lost by the non-perfect insulation encapsulating the recirculation lines and the pressure vessel. The magnitude of the steady state heat losses was one argument for not performing experiments with very small break areas at FIX-II.

The main measured parameters for the steady state before break are reproduced from Ref (6) in Table 4. The test performance chronology, related to the programming of the sequence control equipment, is given in Table 5.

Experimental raw data were collected for the whole period of the transient. However, internal flows were then only evaluated until about 7 s due to uncertainties in the two-phase flow rate measurements.

A summary of the main results (including event times, maximum cladding temperatures and some peak mass flows) is given in Table 6.

2.3 Measurement uncertainty

To obtain estimates for the accuracy of the measured data, test procedures were adapted within the experimental program. Probable errors and errors corresponding to a 95 % confidence level as derived from these tests are summarized in Table 2a. The probable errors of derived quantities, mostly mass flows, are given in Table 2b. The pump speeds are measured using a tachometer of a 1 r/s accuracy. The pump characteristics were verified against the manufacturer's data for cold water single phase operation.

3. CODE AND MODEL DESCRIPTIONS

The assessment calculation for the FIX-II experiment No. 5061 was done using the RELAP5/Mod2, Cycle 36.04 code received at the beginning of February 1985. The code was implemented in June 1986 on a CDC 170-810 computer. The descriptive document available for this code at the time of preparing the calculation input was the rather detailed code manual (4) also explicitly containing an input data requirements manual. The code features are discussed in Chapter 3.1.

The calculation model is closely related to the two previous ICAP calculations for the FIX-II experiments No. 3027 Ref (7) and No. 3051 Ref (8). The main differences in the input concern the double-ended break geometry. Details of the input are discussed in Chapter 3.2.

3.1 The Code Features

An extensive code description for the RELAP5/Mod2 is given in the Ref 4. The main characteristics of the code are summarized in Table 3.

Since the RELAP5/Mod2 code is primarily developed for PWR application, the question arises whether some important features are missing in the code for a BWR-type application like the present FIX-II experiment. One such feature could be deficient modeling of droplet flow in RELAP5/MOD2 for reflood and core top spray. The FIX-II facility does not have a core top spray cooling as the facility is designed for experiments until end of blowdown only. The steady state cooling, however, is accomplished by a cold water injection at the top of an internal condenser space above the core and the steam separator. The condenser space is voluminous; and it is assumed that the condenser spray partly vaporizes while the rest, reaching saturation, has no impact on the core behaviour. Modelling of droplet flows is therefore in actuality not addressed in this study.

3.2 The Input Model

The model geometry used in the present calculations is closely related to geometries used in several previous calculations for FIX-II experiments using previous RELAP5/Mod1 code versions (7 and 8). The nodalization diagram for the geometric modelling used is shown in Figure 5. Figures 6 and 7 depict the modelling of the geometry of the test facility.

To reproduce fundamental measured steady state quantities, see Table 4, the input for the steady state runs was modified by some additional components and control systems:

I To obtain the steady state dome pressure, a time dependent volume outside the opened steam relief valve was added. This volume had the experimentally measured dome pressure.

II The speed of the pumps P1 and P2 were controlled using the RELAP5 control system to reproduce the measured mass flows.

III To divert the correct mass flow into the core bypass, the junction from the lower plenum was modelled as a motor valve. By trip logic, the opening of that valve was controlled to give the experimental bypass mass flow. When entering into the transient calculation, the valve setting was fixed.

IV The measured steam separator collapsed level was satisfied by connecting an auxiliary time dependent volume to the top of the steam separator. The connecting junction was modelled to adjust the collapsed level by water addition depending on the level offset.

V To eliminate the mass flow of the pressurizer discussed under item I the common temperature of the condenser spray water and the feedwater was adjusted within a span of 2K from the measured temperature. The level control flow, item IV, then also became negligible.

For the condenser spray water and the feedwater temperature control (item V) had not been applied for any previous FIX-II calculation. For the present experiment this was necessary because of an inconsistency in the heat balance in the measured initial conditions, Table 4. The temperature of the coolants, had to be increased by 1.8 K to match the heat balance. This is, within the measurement error limits for fluid temperatures, Table 2a.

Another difference from the previous FIX-II calculations is the lower fluid temperature in the two break flow lines Plot B.34. The experimental temperature on the plot obtained at the T-piece measures the recirculated water temperature under steady state. The first calculations indicated too low break flows during the first one or two seconds. By the lower fluid temperature in the discharge lines, the initial break discharge was better predicted. For temperature stability in the initial steady state the boundary heat structures of the discharge pipes were assumed to have insulated outer boundary conditions.

The input of the steady state was in the present calculation made as complete as possible to also cover the transient actions. The steady state controls were disconnected by a first trip and the remaining trips followed to simulate the system actions. In the transient restart the first trip is set at zero time with a new initiation of the time scale. Until the second trip, which is the one initiating the physical transient, the transient calculation is run at the initial state as test for stability. The sensitivity calculations also start with steady state calculations from inputs having complete sensitivity updates.

The discharge flow from the downcomer side break did in the first test calculations give rise to some doubt about the pump P2 head curve dependence of the volume flow (9). From the initial single-phase discharge flows of some split break FIX-II experiments (Nos 3025, 3027, 3031, 3051 and 3061 at lower flow rates) the accuracy of the most important parts of the single-phase head curves were confirmed.

4. THE BASE CASE CALCULATION

The transient calculation of the base case (called Case A) was based on the restart file obtained from the steady state calculation. To verify the quality of the steady state, the opening of the break was delayed by 5 s.

The calculation of the transient was carried out without any particular problems. The smooth lapse of the CPU-time, Plot B.37 and of the computation mass error, Plot B.39, indicate that.

A set of results from the base case calculation and the sensitivity calculations were selected to fulfil the requirement on assessment parameters given in Table 3 of Ref 1. Those parameters are listed in Table 8 and the comparison plots are reproduced in Appendix B. Since some of the parameters are not available from the experimental data, only comparisons between different calculations are shown in some of the plots. For the internal mass flow comparisons, it should be emphasized that the experimental data are not reliable after voiding has begun which for most measurements occurs about 7 s after the break opening.

The spray flow and the feedwater valves, were closed immediately after the break, see Table 5. The break signal also initiates closure of the valve in the broken recirculation line (V103). There is a good agreement between calculation and experiment of the mass flow rate through the steam relief valve, plot B.28. However, the break mass flows which in the experiment are measured by the increasing content of flow receiving tanks, plots B.32 and B.33, have obviously been underestimated in the base case calculation.

A problem with the determination of break flow should be noted. The discharge flows enter two collection tanks filled with a large amount of cold water. The discharged mass is evaluated using the pressure difference from the bottom to the water level in the tanks. The discharge pipes also include perforated tubes inside the collecting tanks. The volumes of these pipes amount abcut .037 m^3 for the downcomer side and about .042 m^3 for the vessel side tubes. These volumes are probably steam-filled and small steam jets may even occur outside of the perforated parts during the blowdown. The actual level fall back at end of the transient when the break valves close, is less than the volumes of the perforated tubes. Consequently, at the end of the transient same water was present in each of the discharge pipes.

It can be concluded that the bias in the break mass loss must have varied during the transient. However, the initial bias, was apparently nearly the same as the bias near the end of the test. The mass flow rates which are obtained from the differentiated mass inventory history may contain large errors in instantaneous values.

The calculated system pressure, Plots B.21, B.22 and B.36, is in the base case decreasing too rapidly. The depressurization rate responds on the break mass flow and quality, on the continued system heating and on the initial fluid mass as the main quantities. The entalpy increase comes partly from the core and partly from the by-pass heating. The filler body space cooling is also rather well defind during the transient becuase of the know intitial cooling capability. Least well known is the heat from passive structures. Plot B.3 shows that this heating is considerable and is even larger than the decay heat after 13 s. The heat structure modelling has been developed based on previous FIX-II calculations for smaller break areas. From the results of these calculations the heat structure modelling can be assumed to be adequate. Therefore, errors in the initial system mass content is suspected to be responsible for the underpredicted system pressure. The first sensitivity calculation is devoted to this question.

The predicted core inlet temperature, Plot B.11, and the core outlet temperature are close to saturation temperatures. The same applies for other system fluid temperatures, Plots B.19, B.20 and B.34. The core inlet temperatures show, Plot B.11, larger initial subcooling in the experiment than is predicted. A minor part of the discrepancy is a consequence of the slight overtemperature of the feedwater necessary to maintain the initial heat balance, see Chapter 3.2. As the core inlet mass flow reverses immediately after break, Plot B.2, a faster core inlet temperature rise in the experiment had been expected than Plot B.11 shows.

Plots B.1, B.14 and B.29 show calculated fluid densities at the core bottom, at the reactor vessel bottom and upstream of the break. Fluid densities were not directly measured in the experiment.

The fluid inventories of the core, Plot B.13, the upper plenum, Plot B.17, the downcomer, Plot B.15, and of the lower plenum, Plot B.16, are compared as differential pressures which are directly measured in the experiment.

Notable is the discrepancy in the lower plenum pressure difference in the time interval up to 5 s, Plot B.16. This, together with the discrepancy in the differential pressure over the core inlet restriction, Plot B.2, verifies that the vessel inlet mass flow, Plot B.26, is larger than predicted for this time interval. The mass flow escaping from the lower plenum towards the break appears in the experiment not to be completely consistent with the break flow (compare with Plot B.33).

The comparisons of the rod clad temperatures are done at the clad inner surface which is closest to the thermocouple positions of the electrically heated rods in the experiment. Above the core midplane, levels 7, 9, 12 and 15, the dryouts are predicted to occur later than in the experiment. Actually, the calculated dryout of all levels was delayed until the void was .985 or higher. In RELAP5/Mod2 the critical heat flux is calculated according to a correlation using $1-\alpha$ (α is the steam void) as a factor. This should be compared with the corresponding RELAP5/Mod1 correlation using $.96-\alpha$ as a factor in the critical heat flux expression. The latter gave better agreement with FIX-data. The delay in the calculated dryouts is probably a result of the critical heat flux correlation rather than of core voids.

5 SENSITIVITY RESULTS AND DISCUSSIONS

By variation of the calculation model from the base case, Case A, three additional calculations were carried out. These sensitivity calculations are characterized by the following changes:

Case B Increased initial liquid mass

Case C As Case B and changes in the pumps outlet restriction modelling

Case D As Case B and a denser nodalization on the downcomer side main break flow path

5.1 Case B

The base case calculation failed to predict several parameters reasonably well. The depressurization did proceed too fast while the fluid mass discharged through the breaks was underpredicted. The reason could be an underestimate of the initial fluid mass which corresponded to the measured downcomer collapsed liquid level. The same problem had previously been recognized for the FIX-II split break No. 3027, Ref (7).

The underestimate of the initial mass is mainly a consequence of the calculated droplet content in the spray condenser. The condenser constitutes about three quarters of the total system volume.

The water droplets entering the condenser before experiment are formed by injection nozzles giving droplet diameters smaller than assumed by the code which uses a fixed Weber-number for the annular mist flow regime. For the FIX-II experiment No. 3027 an underestimate of the condenser water mass by 26 kg had followed from an estimated difference in the droplet falling velocity Ref (7).

The total loss of mass through the two guillotine breaks and the steam relief valve was estimated to have been 298 kg in the experiment Ref (6). The remaining mass in the system after test end is not accurately known. The lower plenum volume, however, contains no water after test termination. No water could be identified elsewhere in the system. Thus, assuming saturated steam in the system implies additionally 12.5 kg which added to the total transient mass discharge gives an initial system mass of 310 kg.

In the split break calculation for the FIX-II experiment No. 3027 water had been added by assuming a higher initial water level in the downcomer than measured in the experiment. For the present calculation it was assumed that the higher water content in the condenser was a consequence of a lower droplet velocity in the experiment as compared to the water velocity predicted by the code. This means that the water transit time through the condenser volumes should be extended. Therefore the lengths of the condenser volumes 11 and 12, see Figure 5, were increased by a common factor while retaining their volumes. A length factor of 4.8 gave an initial mass of about 314 kg. The factor 4.8 was just a little less than that factor by which the code would start water accumulation in the condenser.

The results from the Case B calculation did generally compare better with the experiment than the base case results. The depressurization, Plot B.22, was fairly well predicted. The vessel side break flow, Plot B.33, turned out quite well while the downcomer side break flow, Plot B.32, still was underestimated.

5.2 Case C

The break discharge from the vessel side compared well in the Case B with the experiment, Plot B.33, while that from the downcomer side, Plot B.32, still was underestimated. There were no obvious reasons to introduce additional discharge coefficients since piping geometries close to the two break regions were very similar.

From the downcomer to the break the fluid passes the pump P2 outlet restriction. A pressure loss of more than .5 MPa is caused by the restrictions during the transient. An increased flashing in the pipes downstream of the restriction could produce different discharge conditions compared to the vessel side break opening.

The outlet restriction at the pump P2 has a diameter of 22 mm which is nearly the same as the diameter of the break opening. The junction options used at the previous two calculations had been choked flow, smooth area change and unequal phase velocities. In addition a flow loss coefficient also used in some previous applications had been utilized. With this modelling of the flow restriction the pressure drop had been slightly overpredicted during the first part of the transient in previous calculations.

The pressure loss of the pump P2 outlet restrictions had been measured at various flow conditions during the running-in experiment Ref (9). A best fit loss coefficient was determined as:

$$\zeta = 347 \times Re^{-.056}$$

Assuming a water flow of 12 kg/s to be representative for the first part of the transient a loss coefficient of 165 was calculated. A test calculation showed that assuming abrupt area change with choked flow, and no explicit extra loss coefficient, gave just that loss coefficient. For the Case C calculations these junction options, also assuming homogeneous two phase flow and the restriction areas as in the experiment, were used at the outlet restrictious of both recirculation pumps.

5.3 Case D

The Case D sensitivity calculation addresses the nodalization density. The steam separator (vol 21), the downcomer (vol 71), and broken line (vols 95 and 96) volumes were on the downcomer side further divided to give about the double amount of nodes. These model changes were done to the Case B input data deck.

5.4 Discussion

The experimental rod temperatures in the plots B.4 through B.10 are mean values of all available temperature measurements at the individual core levels. The absolute maxima of the rod temperatures measured at each level are indiciated on the plots. The individual temperature maxima at a level do distribute over ranges of even more than 100 K. Plots of the individual rod temperature measured in the experiment are found in Ref (6).

In view of the temperature distribution in the experiment the predicitions obtained from the calculations Cases A, B and C are acceptable at the high peak temperature levels. At the lowest core level, Plot B.4, all the predictions failed with the exception of the very early temperature rise. Actually, one rod close to the box shows a similar level 1 temperature behaviour as the predictions. The reason for the disagreement to the other rod temperatures at the lowest core level may be due to three-dimensional flow effects or to the erronesously early core inlet flow reversal.

The quite different core temperature predictions in the Case D calculation, using a denser nodalization in the downcomer side discharge path, is remarkable. The depressurization rate of that calculation was most badly predicted during the later half of the transient but rather good during the times of high clad temperatures. No core data like the fluid density at the bottom, Plot B.1, the boundary fluid temperatures, Plots B.11 and B.12, or the core pressure difference, Plot B.13, are in the Case D results significantly different from the previous calculation cases. Typical of the Case D calculations are lower break flow fluid densities, compare Plots B.14 and B.29, causing a larger amount of remaining water in the core although the break flow was similar to that of the previous calculations.

6. RUN STATISTICS

The transient calculation model used with the base case RELAP5/Mod2 prediction for the FIX-II test No. 5061 was modelled by:

60	volumes
62	junctions
70	heat structures

The volumes number includes two pump components and six time dependent volumes and among the junctions there are three valve components and four time dependent junctions.

The computer efficiency is summarized in Table 7 from the Major Edit printouts, see also Plot B.37. The table also gives the number of time step reductions from requested time steps forced by the code internal stability control.

The transient calculation needs were:

computer time CPU = 1 289 s
number of time steps DT = 726
number of volumes C = 60
transient real time RT = 28 s

from which also a code efficiency factor (3) of

$$CPU \times 10^3 = 29.6\ C \times DT$$

is obtained. The computer used was a Cyber 170-810.

7 CONCLUSIONS

A double ended quillotine break in the FIX-II facility was assessed in the present calculations using the RELAP5/Mod2 code. Four calculations were carried out; one base case and three sensitivity calculations with variations in initial mass content and nodalization.

In the steady state a small inconsistency with the heat balance appeared using the initial conditions from the experiment. Using previosly evaluated data for the heat losses, a 1.8 K hotter feedwater temperature had to be assumed. This is within the experimental uncertainty.

Concerns about the system total mass and pressure behaviour arose in all the calculations. For the base case the measured initial water level was used. The calculated system pressure decreased significantly faster than in the experiment. The reason was that the base case calculation had a too low initial fluid mass. By using more elongated spray condenser volume a realistic droplet veloccity could be simulated. This increased the mass content by about 16 kg. The true initial mass of the experiment is uncertain.

The two last sensitivity calculations were conducted to achieve better agreement in the discharge mass flow and distribution of the flow contributions from the two sides. None of these calculations actually gave a better prediction than Case B. Particularly the reduction in prediction quality of the calculations using smaller control volumes along one discharge flow path (Case D) was unexpected.

As for previous FIX-II calculations the predicted dryout was delayed at the higher core levels as a consequence of the void dependence of the RELAP5/Mod2 dryout correlation.

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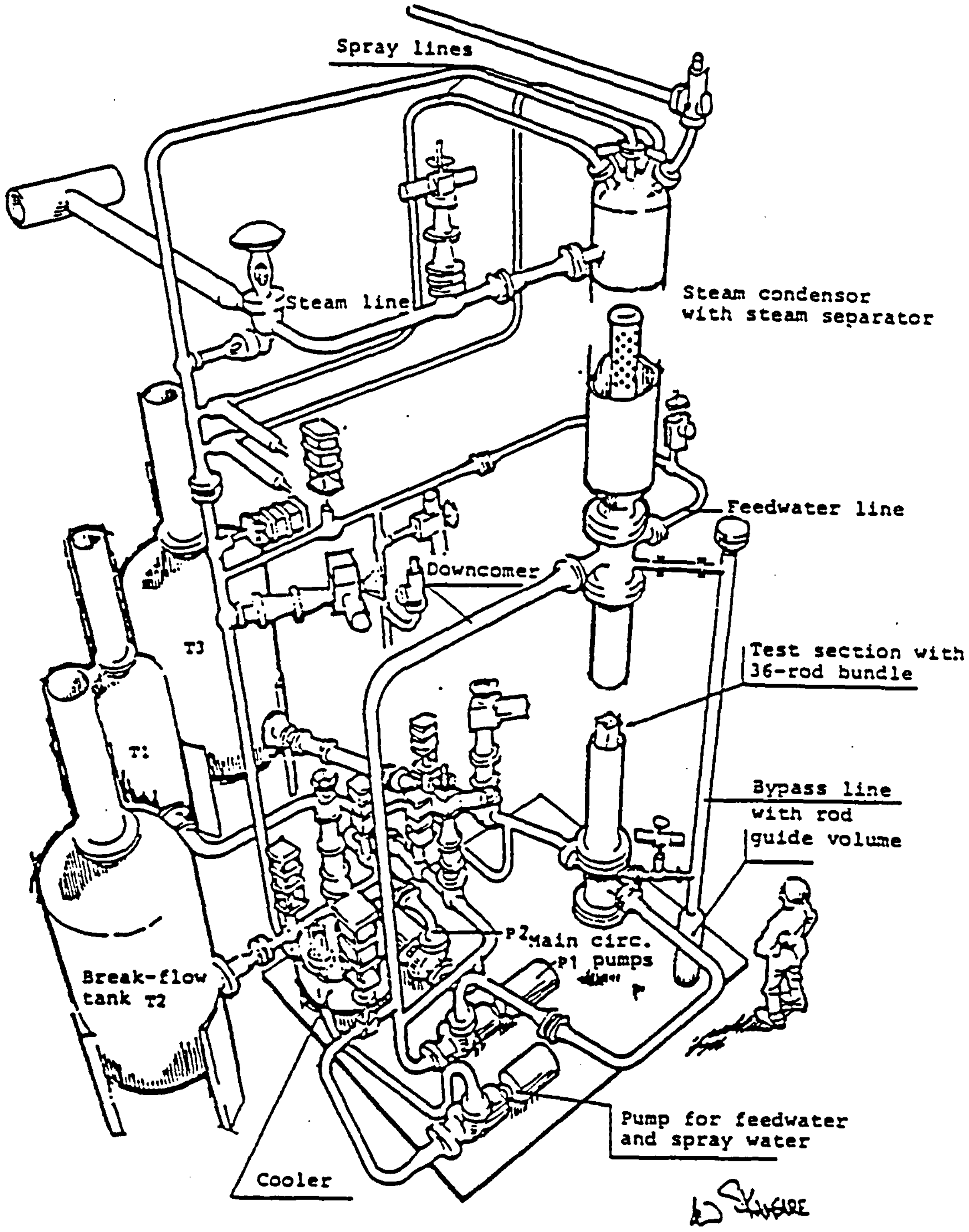


Figure 1

General view of the FIX-II facility.

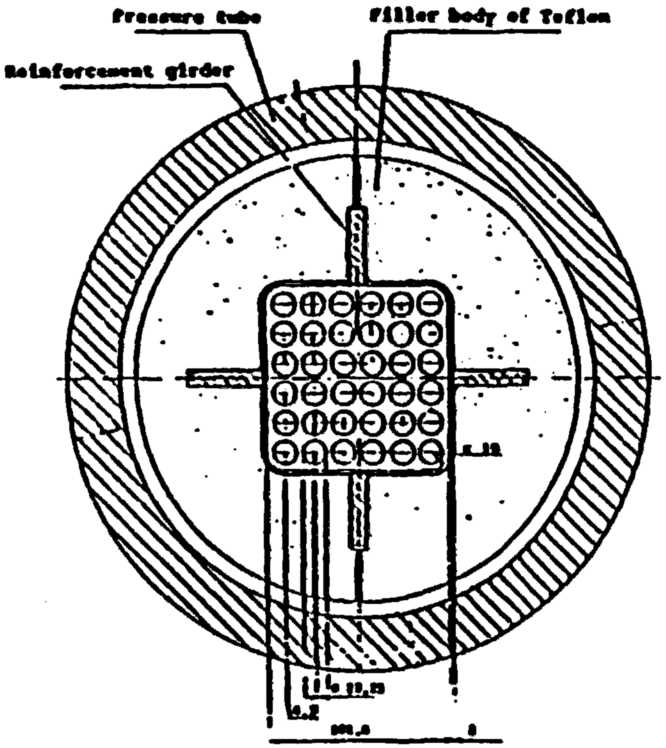


Figure 2.a

Cross section of pressure vessel and rod bundle.

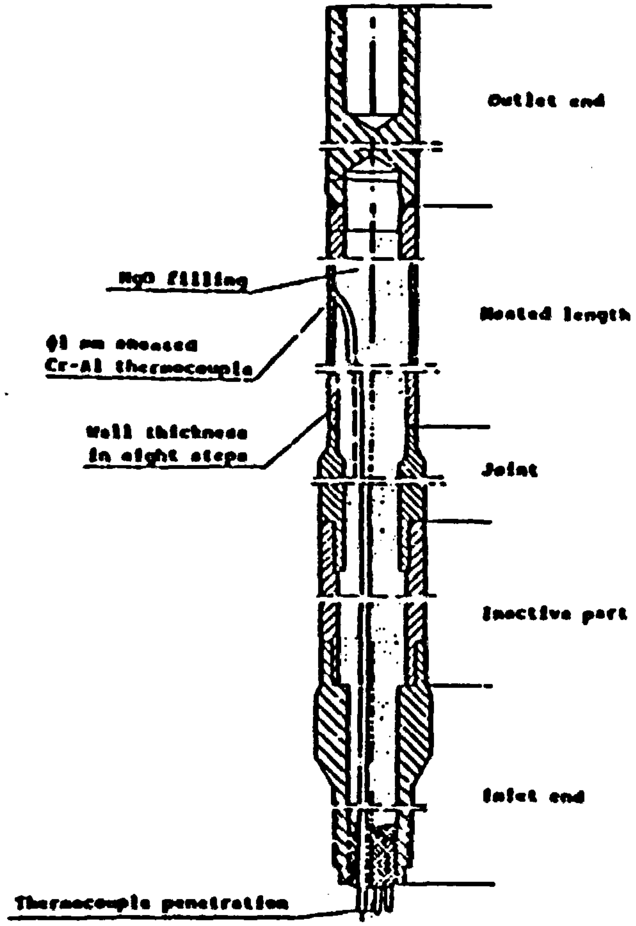


Figure 2.b

Design of a fuel rod simulator.

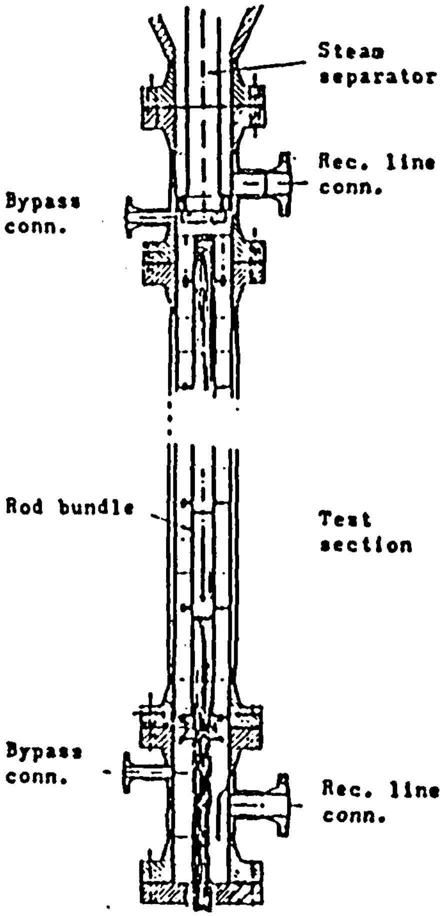


Figure 3.a

Lower plenum and core region.

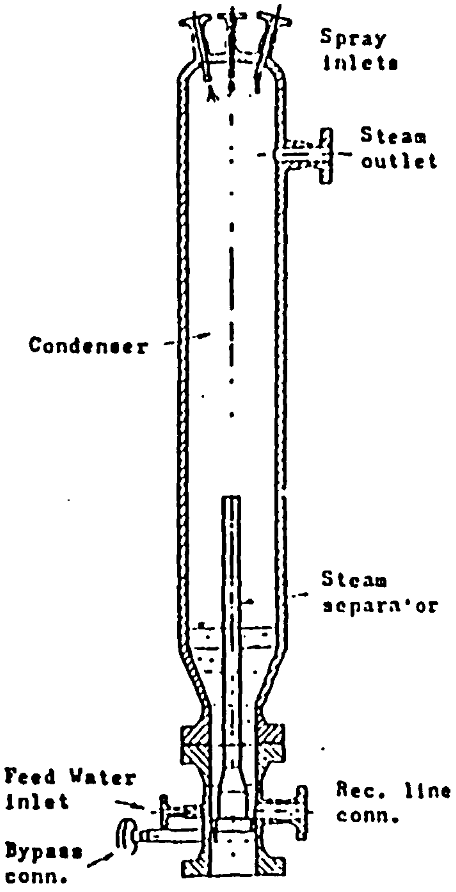


Figure 3.b

Steam separator and steam condenser.

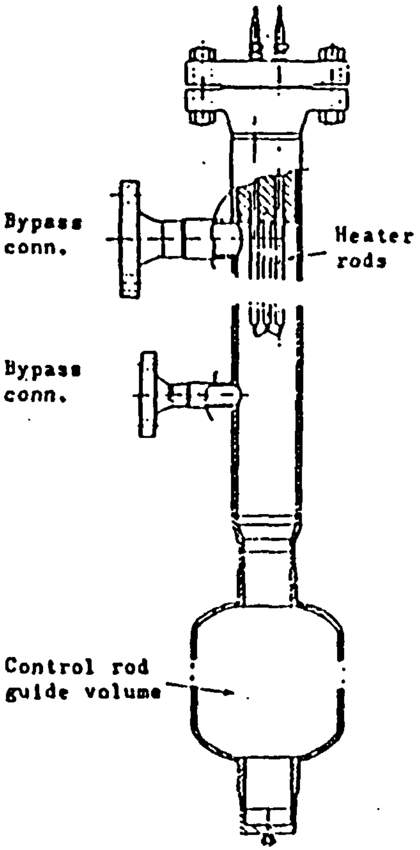


Figure 3.c

The external core bypass.

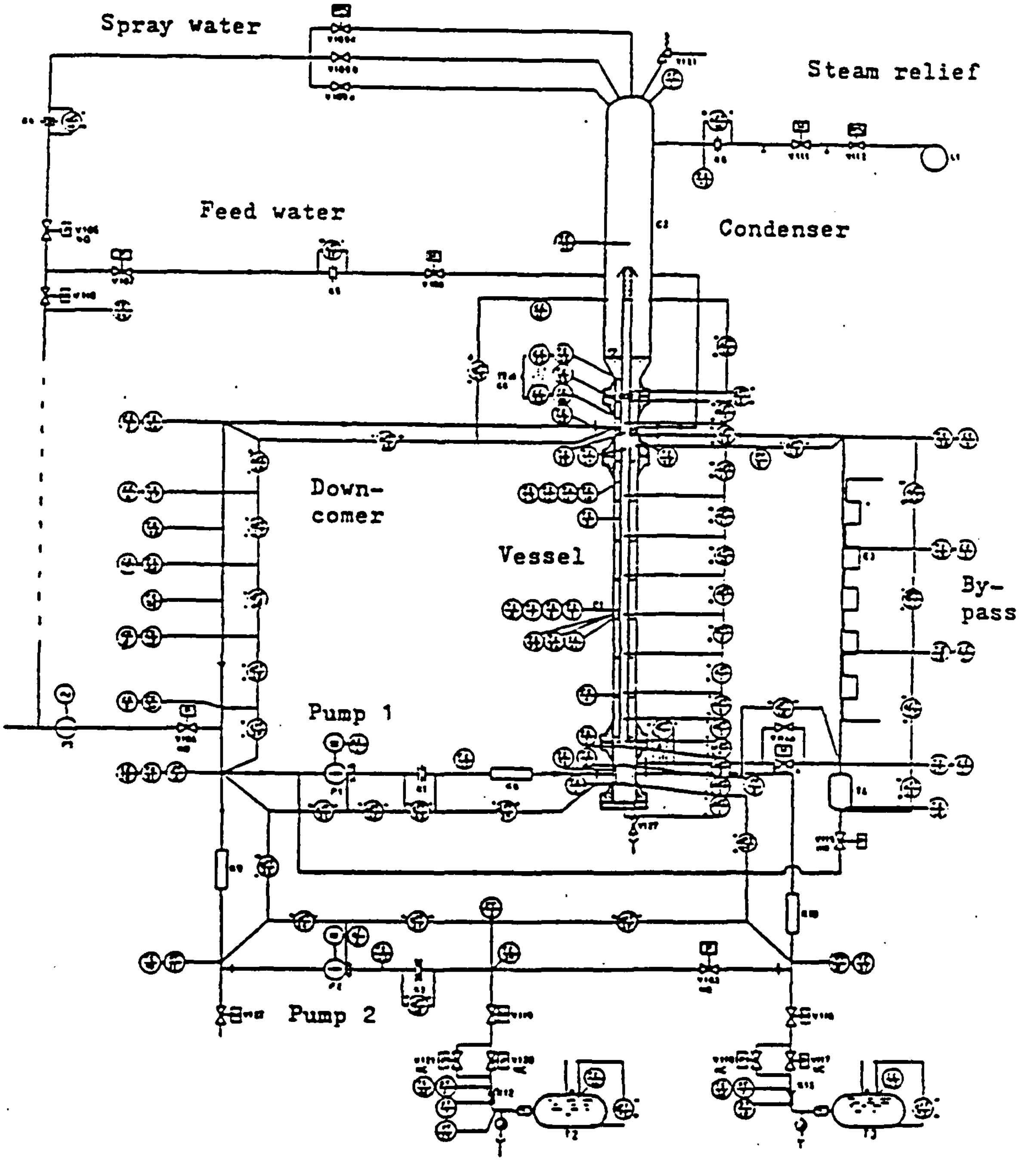


Figure 4

Instrumentation diagram for FIX-II experiment No. 5061.

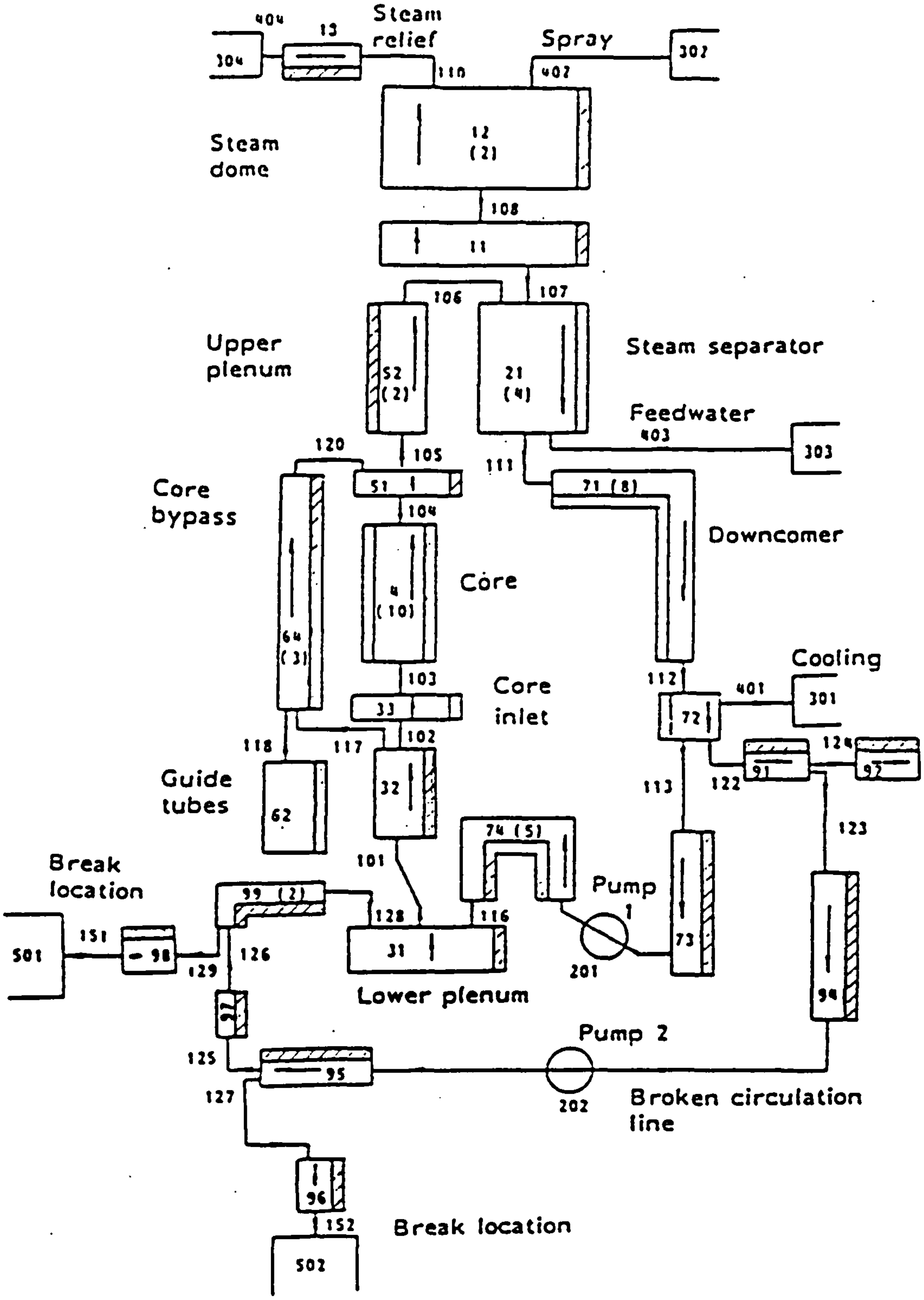


Figure 5

The nodalization diagram for FIX-II experiment No. 5061.

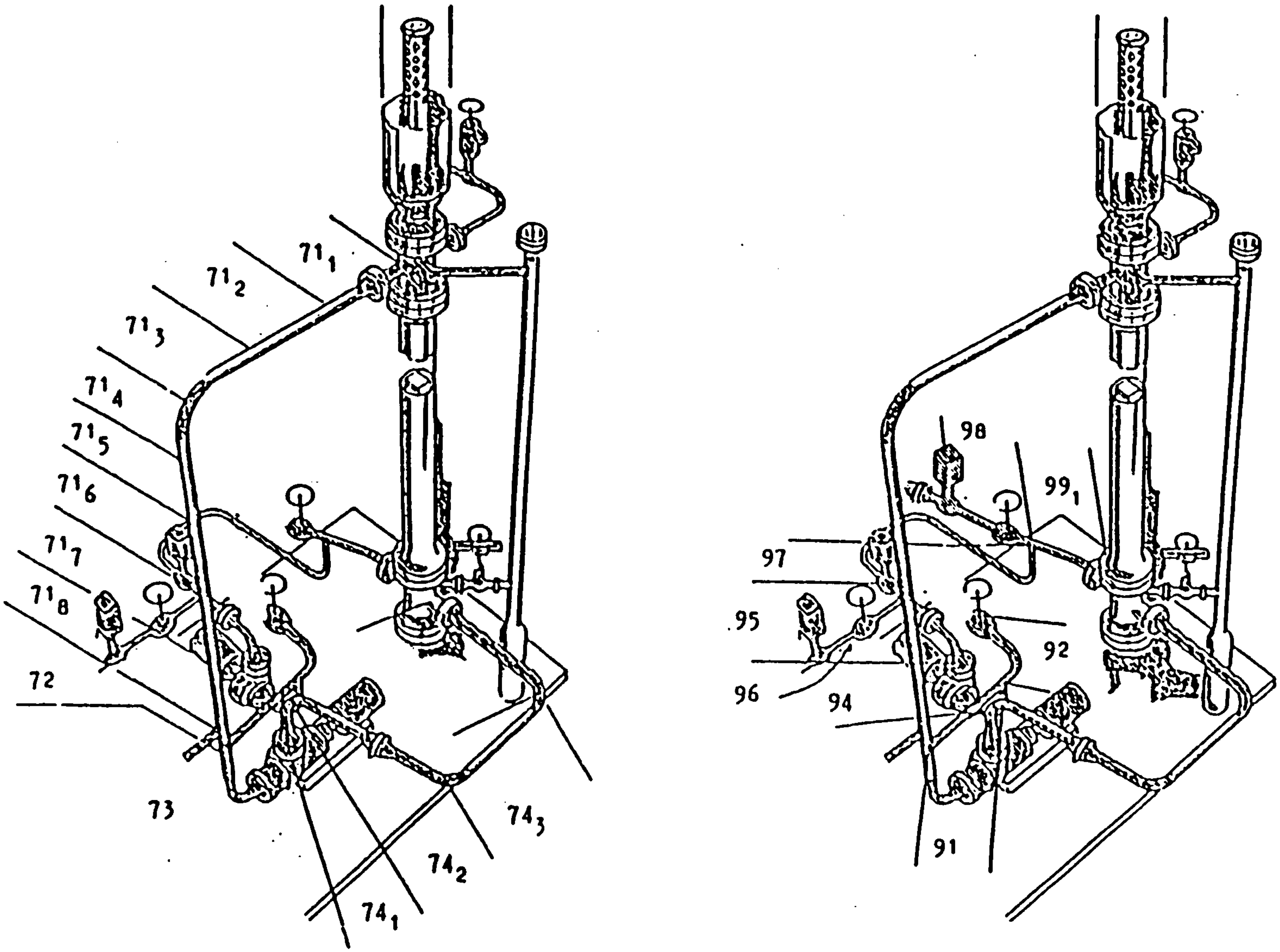


Figure 6

Nodalization of the recirculation lines

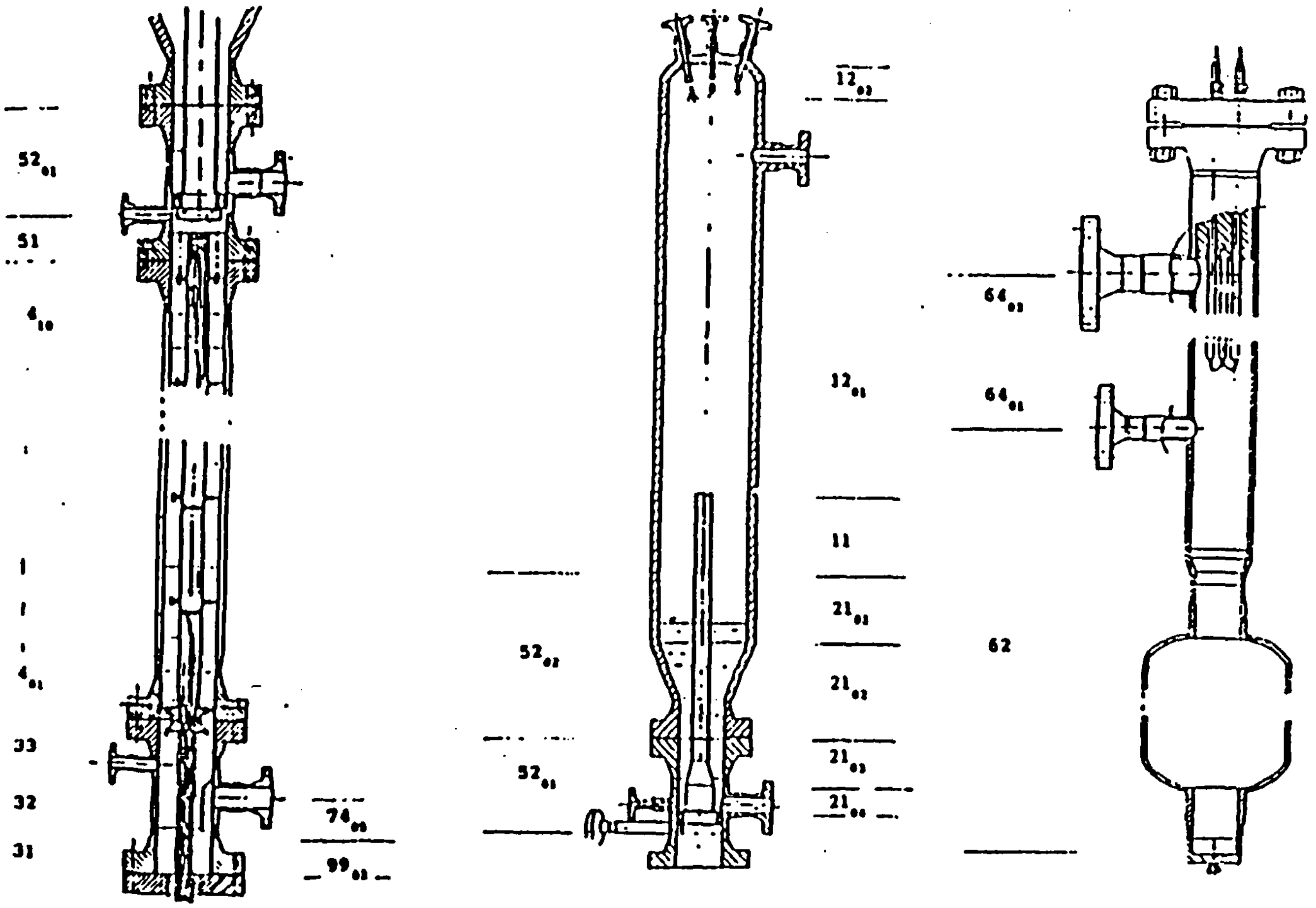


Figure 7

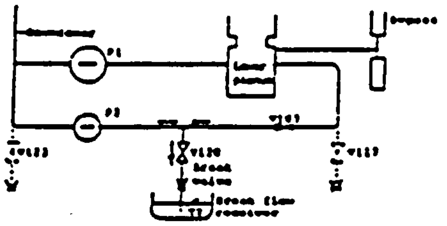
Nodalization of the volumes of the FIX-II (compare Figure 3).

Table 1

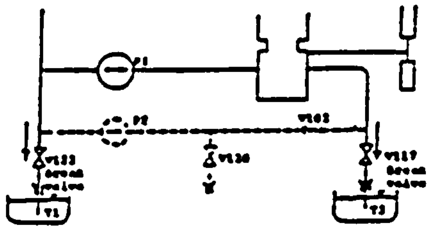
The test matrix for the first FIX-II LOCA experimental period. Test No. 3027 is one matrix No. 2 experiment.

Break classification	Split breaks							Guillotine		
Type of simulation (see Figure 13)	A							B	C	
Relative break area (%)	10	31		48	100	150	200	155*	200	
Breaks I.D. (mm)	6.8	12.0		15.0	21.6	26.4	30.5	16.0+ 21.6	21.6+ 21.6	
Inital bundel power (MW) -hot channel -average	2.35	2.35	3.35	3.35	2.35	2.35	2.35	2.35	2.35	3.35
LOCA test ident. No.	3051	3013	3024 3025 3026 3027	3031	3061	3071	3041	4011	5061	5051 5052

Break type A
Split break



Break type B
Simplified guillotine break



Break type C
Guillotine break

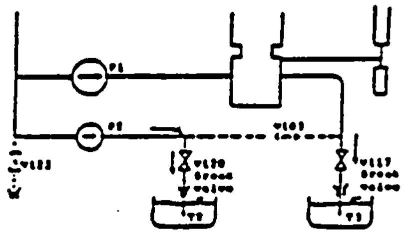


Table 2.a

Evaluated measurement errors.

Quantity	Probable error	Error corresponding to 95 % confidence level
Pressures	0.014 MPa	0.04 MPa
Fluid temperatures	1°C	2°C
Cladding temperatures	1.6°C	3.2°C
Small range differential pressures (5 to 7.5 kPa)	0.13 kPa	0.3 kPa
Medium range differential pressures (25 to 50 kPa)	0.22 kPa	0.5 kPa
High range differential pressures (100 to 700 kPa)	0.26 kPa	0.65 kPa

Table 2.b

Errors in derived quantities.

Quantity	Probable error
Mass flow rate in orifice meter K1 (P1)	0.2 kg/s
Mass flow rate in orifice meter K2 (P2)	0.14 kg/s
Mass flow rate in orifice meter K6 (steam flow)	~10 % of actual value
Mass flow rate in orifice meter K7 (Bypass)	~10 % of actual value
Break mass flow rate	~10 % of actual value
Electric power to bundle and bypass heaters	1 % of max value

Table 3

RELAP5/Mod 2 code features.

COMPUTATION PROCESSING FEATURES

- Several problem type and execution control options as
  - a. steady state initialisation using fictitious structure heat capacities for faster convergence
  - b. transient calculation
  - c. strip type execution, to select requested parameters from a restart file
  - d. trip system, to decide on actions during calculation due to reaching specified conditions in calculation parameters.
  - e. ability to delete or add hydrodynamic components, structure components and control variables at a restart of calculation.

CLASSIFICATION OF HYDRODYNAMIC MODEL

- One-dimensional, with provisions for
  - a. choked flow model
  - b. abrupt area change model
  - c. cross flow junctions.
- Two-fluid, six equation, space-time numerical solution scheme.
- flow regime oriented field characteristics depending on mass flux and void fraction for
  - a. horizontal flow with bubbly, slug, mist and stratified fields
  - b. vertical flow with bubbly, slug, annular-mist (and stratified) fields
  - c. high mixing flow with bubbly and mist fields (for pumps).

Table 3 cont'd

HYDRODYNAMIC COMPONENENTS (Input systematics)

- Volume type components
  - a. single volume
  - b. pipe and annulus, for condensed input of several similar single volumes
  - c. time dependent volume, for defining a boundary source with a time dependent fluid state
  - d. branch, a volume capable of two or more connecting junctions at either end
  - e. pump, characterized by rated values for flow, head, torque, density and moment of inertia. The single phase homologous curve, two-phase multipliers and phase difference tables to model the dynamic pump behaviour
  - f. special system components for steam separator, jetmixer, turbine and accumulator.
- Junction type components
  - a. single junction
  - b. time dependent junction, for a time dependent junction flow whith a time dependent or controlled flow state
  - c. cross-flow junction, to model a small cross flow, a tee branch or a small leak flow
  - d. valve, various operation characteristics available for check valve, trip valve, inertial valve and relief valve.

INTERPHASE CONSTITUTIVE EQUATIONS

- Interphase drag
  - a. steady drag due to viscous shear depending on flow regime. Semi-empirical mechanisms to describe flow regime transitions
  - b. dynamic drag due to virtual mass effect.
- Interphase mass and heat transfer depending on flow regime and the fluid fields to saturation temperature differences

Table 3 cont'd

FLUID TO WALL CONSTITUTIVE EQUATIONS

- Wall friction due to wall shear effects formulated for flow regimes and based on a two-phase multiplier approach.

- Wall heat transfer depending on flow characteristics defined for

  a. single-phase forced convection (Dittus-Boelter)

  b. saturated nucleate boiling (Chen)

  c. subcooled nucleate boiling (modified Chen)

  d. critical heat flux (Biasi or modified Zuber)

  e. transition film boiling (Chen)

  f. film boiling (Bromley-Pomeranz and Dougall-Rohsenow)

  g. condensation (partly Dittus-Boelter).

- Interfacial mass transfer at the wall depending on wall, fluid and saturation temperatures for

  a. subcooled and saturated boiling

  b. transition film and film boiling

  c. condensation.

HEAT STRUCTURES

These may be rectangular, cylindrical or spherical in shape. The structure position is defined through component numbers of left and right hand side hydraulic components. A structure is physically defined by the geometry and the temperature dependent conductivity and volumetric heat capacity data. The structure model is further specified by the number of internal mesh points in the direction of heat flow.

CONTROL COMPONENTS

By these new (control) variables are defined from calculated parameters using algebra, standard functions, trip type operands or integrals.

Table 4

Initial conditions for test No. 5061.

Quantity		Measured	Predicted Case A	Case B	Case C	Case D
Pressure in the steam dome	(MPa)	6.97	6.97	6.97	6.97	6.97
Power to the 36-rod bundle (incl connections)	(MW)	2.37	2.37	2.37	2.37	2.37
Power to the bypass heaters	(kW)	60.4	60.4	60.4	60.4	60.4
Cooling power in the filler body space	(kW)	234.	232.	233.	233.	233.
Mass flow rate through pump P1	(kg/s)	4.74	4.74	4.74	4.74	4.74
Mass flow rate through pump P2	(kg/s)	1.53	1.53	1.53	1.53	1.53
Mass flow rate in the bypass	(kg/s)	.67	.67	.67	.67	.67
Mass flow rate in the 36-rod bundle	(kg/s)	5.60	5.60	5.60	5.60	5.60
Mass flow rate in the spray line	(kg/s)	3.35	3.35	3.35	3.35	3.35
Mass flow rate in the feed water line	(kg/s)	1.80	1.80	1.80	1.80	1.80
Temperature of water at the bundle inlet	(C)	266.	269.9	269.9	269.8	269.6
Temperature of feed and spray water	(C)	181.	181.8	182.5	182.4	182.6
Water level in the spray condenser	(m)	.898	.897	.892	.895	.898
Rotational speed of pump P1	(/s)	23.72	24.97	24.98	23.40	24.97
Rotational speed of pump P2	(/s)	31.93	32.48	32.50	30.58	32.48
Head of pump P1	(kPa)	112.3	118.3	118.4	103.7	118.3

Table 5

List of events in test No. 5061.

	Time (s)					
Event	Imposed action	System reaction		Predicted		
			Case A	Case B	Case C	Case D
The break valve V117 starts to open	.0		.0	.0	.0	.0
Start of coast down of pump P1	.0		.0	.0	.0	.0
Start of power decay in the rod bundle	.0		.0	.0	.0	.0
Flow reversal in the bundle and bypass inlets		.0	.0	.0	.0	.0
The break valve V120 starts to open	.1		.1	.1	.1	.1
The valve V103 in the broken RCL is closed	.3		.3	.3	.3	.3
Start of power decay in the bypass heaters	.3		.3	.3	.3	.3
The SRV starts to open	.7		.7	.7	.7	.7
Dryout occurs		.9	1.	.5	.5	1.
The SRV is fully open	1.2-27.4		1.2-	1.2-	1.2-	1.2-
Flashing starts in the LP (at saturation) *		1.8	5.6	6.3	5.7	6.3
The spray flow is closed	2.2		2.2	2.2	2.2	2.2
The feed water flow is closed	2.3		2.3	2.3	2.3	2.3
Valve V104 to the evaporation cooler is closed	2.3		2.3	2.3	2.3	2.3
Cavitation in pump P1		6.5	5.8	6.7	5.4	7.3
The downcomer is depleted of water (two-phase)		9.	7.9	9.2	8.7	6.9
Flashing starts in the bypass guide tubes volume		10.8	9.5	10.4	10.1	9.5
Core uncovery begins		23.	24.	26.	25.	23.
Test stop signal		27.3	-	-	-	-

* Determined from exp. temperature curves and from predicted changes to positive vapor generation.

Abrevations:
LP = Lower plenum
UP = Upper plenum
RCL = Recirculation line
SRV = Steam relief valve

Table 6

Summary of the main results in test No. 5061.

		Measured	Predicted			
			Case A	Case B	Case C	Case D
Total time of transient (break discharge)	(s)	27.8	-	-	-	-
Time to initial dryout	(s)	.9	1.0	.5	.5	1.0
Time to beginning of bundle uncovery	(s)	23.	24.	26.	25.	23.
Break mass flow 1 s after the break *	(kg/s)	33.	30.	31.	35.	34.
Max. break flow rate from lower plenum	(kg/s)	19.	22.	22.	24.	26.
Max. break flow rate from the downcomer	(kg/s)	14.	-	-	14.	11.
Dome pressure at the end of test (27.4 s)	(Mpa)	2.0	12.6	1.7	1.4	1.3
Max. rod dryout temperture	(C)	460. (526.)**	487.	463.	489.	408.
Max. rod temperature, end of blowdown	(C)	278. (451.)**	244.	227.	227.	234.
Integrated break mass flow	(kg)	290.	258.	277.	286.	286.
Integrated steam relief mass flow	(kg)	8.	8.6	9.1	8.6	8.4

* Approx. at the maximum break flow of the test

** Max. compared mean temperature. Max. of all exp. measurements put in brackets.

Table 7

Run statistics data (Case C).

Time (s)	Computer CPU time (s)	No. of time steps	No. of time step reductions in interval				
			quality	extrap.	mass	propty.	Courant
-20.	-498.	-320	-	-	-	-	-
0.*	0.	0	0	0	0	0	0
10.	322.	170	0	0	3	0	0
20.	1103.	586	32	0	16	15	149
28.	1562.	858	7	0	5	1	124

* Time of break opening

Table 8

Parameters used in the assessment comparisons for FIX-II No. 5061.

COMPONENT	CONTINOUS PARAMETER *	EXPERIMENT (IDENTIFIER)	PREDICTION (MINOR EDIT)	PLOT IDENTIF. EXP.	PLOT IDENTIF. CALC.	PLOT NO.
CORE	FLUID DENSITY, BOTTOM	***	RHO 04.01		RH1?	B. 1
	MASS FLOW RATE, INLET *	DPT 4	P 33.01 - P04.01	D 4	PD4?	B. 2
	HEATING POWER	X 801	CNTRLVAR 57	X801	HP1?	B. 3
	CLAD TEMPERATURE, LEVEL 1	TE 191, TE 206, TE 211, TE 246	HTTEMP 4.01000105	TC 1	HT1?	B. 4
	-"- , LEVEL 3	TE 108, TE 183, TE 243, TE 248	HTTEMP 4.03000105	TC 3	HT2?	B. 5
	-"- , LEVEL 5	TE 202, TE 227, TE 232, TE 237, TE 252	HTTEMP 4.04000105	TC 5	HT3?	B. 6
	-"- , LEVEL 7	TE 101, TE 110, TE 114, TE 136, TE 171, TE 186, TE 196, TE 204, TE 210, TE 215, TE 220, TE 239, TE 245, TE 250, TE 259, TE 271	HTTEMP 4.05000105	TC 7	HT4?	B. 7
	-"- , LEVEL 9	TE 102, TE 137, TE 167, TE 172, TE 187, TE 197, TE 272	HTTEMP 4.06000105	TC 9	HT5?	B. 8
	-"- , LEVEL 12	TE 118, TE 123, TE 128, TE 148, TE 223	HTTEMP 4.07000105	TC12	HT6?	B. 9
	-"- , LEVEL 15	TE 175, TE 190, TE 275	HTTEMP 4.10000105	TC15	HT7?	B.10
	INLET TEMPERATURE	TE 3	TEMPF 33.01	T 3	TF1?	B.11
	OUTLET TEMPERATURE	TE 14	TEMPF 51.01	T 14	TF2?	B.12
	CORE INVENTORY *	DPT 5 + DPT 6 + DPT 7 + DPT 8 + DPT 9 + DPT 10 + DPT 11 + DPT 12	P 04.01- P 51.01 **	D CO	PDC?	B.13
VESSEL	FLUID DENSITY, BOTTOM	***	RHO 31.01		RH2?	B.14
	DOWNCOMER MASS INVENTORY *	DPT 27 + DPT 28 + DPT 29 + DPT 30	P 71.03 - P 72.01 **	D DC	PDD?	B.15
	LOWER PLENUM MASS INVENTORY *	DP 2 + DP3 - DP 1	P 31.01 - P 32.01 **	D LP	PDL?	B.16
	UPPER PLENUM MASS INVENTORY *	DP 13 + DP 14	P 51.01 - P 52.01 **	D UP	PDU?	B.17
	PRESSURE LOSS, S.S. ORIFICE	DP 58	P 52.01 - P 52.02	D 58	PDS?	B.18
	DOWNCOMER TEMPERATURE, BOTTOM	TE 31	TEMPF 71.08	T 31	TF3?	B.19
	UPPER PLENUM TEMPERATURE	TE 15	TEMPF 52.01	T 15	TF4?	B.20
	LOWER PLENUM PRESSURE	PT 3	P 31.01	P 3	P 1?	B.21
	UPPER PLENUM PRESSURE	PT 4	P 52.01	P 4	P 2?	B.22
	MASS FLOW RATE, BYPASS	X 602	MFLOWJ 117	X602	MF1?	B.23
RECIRCULATION LINE	MASS FLOW RATE, I. L. PUMP (ORIFICE K1)	X 603	MFLOWJ 201.02	X603	MF2?	B.24
	MASS FLOW RATE, B. L. PUMP (ORIFICE K2)	X 604	MFLOWJ 202.02	X604	MF3?	B.25
	MASS FLOW RATE, B. L. VESSEL INLET (SPOOL PIECE K10)	X 610	MFLOWJ 97.02	X610	MF4?	B.26
SYSTEM	MASS INVENTORY	***	TMASS		MAT?	B.27
	MASS FLOW RATE, STEAM RELIEF	X 607	MFLOWJ 404	X607	MF5?	B.28
	HEAT LOSS, PASSIVES	***	CNTRLVAR 53		HL1?	B. 3

Table 8 cont'd

COMPONENT	CONTINOUS PARAMETER *	EXPERIMENT (IDENTIFIER)	PREDICTION (MINOR EDIT)	PLOT IDENTIF. EXP.	PLOT IDENTIF. CALC.	PLOT NO.
BREAK	FLUID DENSITY	***	RHO 96.01		RH37	B.29
	MASS FLOW RATE TO T2	X 636	MFLOWJ 152	X636	MF67	B.30
	MASS FLOW RATE TO T3	***	MFLOWJ 151		MF77	B.31
	MASS FLOW RATE, INTEGR. T2	X 661	CNTRLVAR 55	X661	ML17	B.32
	MASS FLOW RATE, INTEGR. T3	***	CNTRLVAR 60		ML27	B.33
	INLET TEMPERATURE	TE 34	TEMPF 96.01	T 34	TF57	B.34
	INLET SUBCOOLING	***	TEMPG 96.01 - TEMPF 96.01		TSU7	B.35
	INLET PRESSURE	PT 6	P 96.01	P 6	P 37	B.36
RELAP5/MOD2	COMPUTAION CPU TIME	***	CPUTIME		CPU7	B.37
	COMPUTATION MASS ERROR	***	EMASS		MAE7	B.38

* THE COMPARISON PARAMETERS ARE THOSE REPORTED AS DIRECTLY MEASURED OR AS COMPUTED RESULTS FROM THE EXPERIMENT.
PRESSURE DIFFERENCE INSTEAD OF MASS FLOW RATE OR OF MASS INVENTORY.

** CORRECTIONS APPLIED TO RESUME THE CORRECT PRESSURE SENSOR LEVELS.

*** NO DATA AVAILABEL FROM THE EXPERIMENT.

Steady state input, Case A

```
*       INPUT FOR RELAP5/MOD2   (ON FILE FIX6135)
*       FIX-II GUILLOTINE BREAK STEADY-STATE (TEST NO. 5061)
*       200 % SPLIT BREAK
*       CASE A
*
0000100  NEW  STDY-ST
0000101  RUN
0000105  10.        20.
0000201  20.  1.0E-6   .0625     00001    16  400   400
*
*
0000302  P           032010000   *PRESSURE LOWER PLENUM VOL 2
0000303  P           004010000   *PRESSURE CORE VOL 1
0000312  P           004100000   *PRESSURE CORE VOL 10
0000315  P           051010000   *PRESSURE UPPER PLENUM
0000316  P           011010000   *PRESSURE STEAM DOME VOL11
0000317  P           012010000   *PRESSURE STEAM DOME VOL12-1
0000318  P           021040000   *PRESSURE DC ANNULUS VOL4
0000320  CNTRLVAR    041         *LIQUID LEVEL IN DC ANNULUS
0000321  VLVAREA     000000117   *VALVE AREA BY-PASS INLET
0000331  VOIDG       004010000   *VOID CORE VOL 1
0000332  VOIDG       004020000   *VOID CORE VOL 2
0000333  VOIDG       004030000   *VOID CORE VOL 3
0000334  VOIDG       004040000   *VOID CORE VOL 4
0000335  VOIDG       004050000   *VOID CORE VOL 5
0000336  VOIDG       004060000   *VOID CORE VOL 6
0000337  VOIDG       004070000   *VOID CORE VOL 7
0000338  VOIDG       004080000   *VOID CORE VOL 8
0000339  VOIDG       004090000   *VOID CORE VOL 9
0000340  VOIDG       004100000   *VOID CORE VOL 10
0000341  VOIDG       064030000   *VOID BY-PASS OUTLET
0000342  VOIDG       052020000   *VOID RISER TOP
0000343  VOIDG       011010000   *VOID STEAM DOME VOL11
0000344  VOIDG       012010000   *VOID STEAM DOME VOL12-1
0000345  VOIDG       012020000   *VOID STEAM DOME VOL12-2
0000346  VOIDG       021010000   *VOID DC ANNULUS VOL1
0000347  VOIDG       021020000   *VOID DC ANNULUS VOL2
0000348  VOIDG       021030000   *VOID DC ANNULUS VOL3
0000349  VOIDG       021040000   *VOID DC ANNULUS VOL 4
0000350  VOIDG       064010000   *VOID BYPASS VOL1
0000351  VOIDG       063010000   *VOID GUID TUBE VOL
0000352  VOIDG       032010000   *VOID LOWER PLENUM VOL2
0000353  VOIDG       031010000   *VOID LOWER PLENUM VOL1
0000354  VOIDG       086010000   *VOID BREAK VOLUME
0000355  QUALS       013010000   *QUALITY STEAM LINE
0000356  VOIDG       073010000   *VOID PUMP P1 SUCTION LINE
0000357  VOIDG       074010000   *VOID PUMP P2 SUCTION LINE
0000358  MFLOWJ      404000000   *MASS FLOW STEAM VALVE
0000359  MFLOWJ      405000000   *MASS FLOW SS LEVEL HOLD
0000360  MFLOWJ      110000000   *MASS FLOW STEAM RELIEF
0000361  MFLOWJ      103000000   *MASS FLOW CORE INLET
0000362  MFLOWJ      004020000   *MASS FLOW CORE JUN 2
0000363  MFLOWJ      004040000   *MASS FLOW CORE JUN 4
0000364  MFLOWJ      004060000   *MASS FLOW CORE JUN 6
0000365  MFLOWJ      004080000   *MASS FLOW CORE JUN 8
0000366  MFLOWJ      104000000   *MASS FLOW CORE OUTLET
0000367  MFLOWJ      117000000   *MASS FLOW BY-PASS INLET
0000368  MFLOWJ      120000000   *MASS FLOW BY-PASS OUTLET
0000369  MFLOWJ      106000000   *MASS FLOW FROM RISER
0000370  MFLOWJ      107000000   *MASS FLOW FROM STEAM DOME VOL11
0000371  MFLOWJ      108000000   *MASS FLOW FROM STEAM DOME VOL12-1
0000372  MFLOWJ      012010000   *MASS FLOW FROM STEAM DOME VOL12-2
0000373  MFLOWJ      021010000   *MASS FLOW DC ANNULUS JUN 1
0000374  MFLOWJ      021020000   *MASS FLOW DC ANNULUS JUN 2
0000375  MFLOWJ      021030000   *MASS FLOW DC ANNULUS JUN 3
```

```
0000376   MFLOWJ     201020000    *MASS FLOW PUMP1 OUTLET
0000377   PMPVEL     000000201    *PUMP1 VELOCITY (RAD/S)
0000378   MFLOWJ     202020000    *MASS FLOW PUMP2 OUTLET
0000379   PMPVEL     000000202    *PUMP2 VELOCITY (RAD/S)
0000380   CNTRLVAR 53             *STRUCTURE HEAT LOSS
0000381   CNTRLVAR 54             *STRUCTURE HEAT LOSS,INTEGRATED
0000383   CNTRLVAR 55             *INTEGRATED BREAK LOSS. T2
0000384   CNTRLVAR 56             *BOX-HEAT LOSS
0000385   CNTRLVAR 57             *COR-POWER
0000386   CNTRLVAR 58             *BY-PASS POWER
0000387   CNTRLVAR 59             *TOTAL POWER
0000391   CNTRLVAR  042           *LIQUID LEVEL IN UPPER PLENUM
0000392   CNTRLVAR  043           *LIQUID LEVEL IN CORE
0000393   CNTRLVAR  044           *LIQUID LEVEL IN LOWER PLENUM
0000394   CNTRLVAR 60             *INTEGRATED BREAK LOSS. T3
*0000394   CNTRLVAR  014          *FLOW QUAL CORE VOL5
*0000395   CNTRLVAR  015          *FLOW QUAL CORE VOL6
*0000396   CNTRLVAR  016          *FLOW QUAL CORE VOL7
*0000397   CNTRLVAR  017          *FLOW QUAL CORE VOL8
*0000398   CNTRLVAR  018          *FLOW QUAL CORE VOL9
*0000399   CNTRLVAR  019          *FLOW QUAL CORE VOL10
*
**********************
*        |
*     TRIPS
*
*        REGULATED STEADY STATE
0000501    TIME     0 .        GE    NULL 0    25.     L  *STEADY STATE
*
*        RUPTURE TRIPS
0000504    TIME     0          GE    TIMEOF  501   5. N *TRANSIENT START
0000505    TIME     0          LT    NULL 0     0.    N
0000506    TIME     0          GE    TIMEOF  504   .5 N *START OPEN V120
0000507    TIME     0          GE    TIMEOF  504   .3 N *BYPASS POWER DECA
*
*         LOGICAL TRIPS
0000601    -501   AND    -501  N                      *STEADY STATE
0000604    501    AND     504  L                      *TRANSIENT STA
0000606    504    AND     506  L
0000607  ` 506    AND     507  L
*
*
*************************
*
0310000   VOL31      BRANCH
0310001   0
0310101   0.   0.181     0.00743   0.   90.   0.181     0.   0.0573    00
*************************
*
0320000   VOL32      BRANCH
0320001   0
0320101   0.   0.325     0.01147   0.   90.   0.325     0.   0.0562    00
*************************.
*
0330000   VOL33      SNGLVOL
0330101   0.   0.271     0.01250   0.   90.   0.271     0.   0.0573    00
*************************
*
0040000   VOL4       PIPE
0040001   10
0040101   0.0 10
0040301   0.360 10
0040401   0.0022344 10
0040601   90. 10
0040801   1.E-4   0.0136   10
```

```
0040901   0.65 0.65  2   0.00 0.00  3   0.65 0.65  7   0.00 0.00  8
0040902   0.65 0.65  9
0041001   00   10
0041101   1000  9
*************************
*
0510000   VOL51      BRANCH
0510001   0
0510101   0.   0.159     0.00525   0.   90.   0.159     0.   0.0617.   00
*************************
*
0520000   VOL52      PIPE
0520001   2
0520101   0.0  2
0520201   0.002734   1
0520301   0.525      1     0.053     2
0520401   0.00036    1     0.007405   2
0520601   90.  2
0520801   0.   0.    2
0520901   1.70   1.70    1
0521001   00   2
0521101   0000 1
*************************
*
0110000   VOL11      ANNULUS
0110001   1
0110101   0.0  1
0110301   0.463 1
0110401   0.04070 1
0110601   90.  1
0110801   0.   0.    1
0111001   00 1
*************************
*
0120000   VOL12      PIPE
0120001   2
0120101   0.0  2
0120301   2.200      1     0.130     2
0120401   0.43700    1     0.02410   2
0120601   90.  2
0120801   0.   0.    2
0121001   00   1     01    2
0121101   1000 1
*************************
*
0130000   VOL13      SNGLVOL
0130101   0.    2.054      0.01031   0   0.    .0   0  0. 00
*************************
*
0210000   VOL21      ANNULUS
0210001   4
0210101   0.0  4
0210201   0.   1     0.035132   2    0.    3
0210301   0.404 1    0.549 2   0.286 3   0.146 4
0210401   0.07569 1      0.04205 2      0.01250 3      0.00527 4
0210601   -90. 4
0210801   0. 0.2960 1    0. 0.2592 2    0. 0.1516 3    0. 0.1117 4
0210901   0    0     1   0.96   0.96   2   0    0.    3
0211001   00 4
0211101   1000 3
*************************
*
0710000   VOL71      PIPE
0710001   8
0710101   0.0  8
```

```
0710301   0.9987 3   0.0198 8
0710401   0 005146 3 0.007726 8
0710601   0. 3 -90  8
0710801   0. 0. 8
0710901   0.00 0.00 3    0.10 0.10 3    0.00 0 00 7
0711001   00 8
0711101   1000  7
************************
*
0720000   VOL72      BRANCH
0720001   0
0720101   0.   0.300    0.001026  0.  -90. -0.300    0.   0.        00
************************
*
0730000   VOL73      SNGLVOL
0730101   0.   1.240    0.01139    0.  -90. -0.760    0.   0.   00
************************
*
0740000   VOL74      PIPE
0740001   5
0740101   0.00 5
0740201   0.   1    0.001385  3    0.    4
0740301   0.833 1   1.117 2   2.076 3   1.800 4   0.318 5
0740401   0.00340 1 0.00175 2 0 01335 3 0.00023 4 0.00315 5
0740601   90. 1     0. 4    -90. 5
0740801   0. 0. 4   0. 0.0015 5
0740901   0.17 0.17 1    0.70 0.70 2    0.22 0.22 3    1.00 1.00 4
0741001   00 5
0741101   1000  1   1000  2    1000  3    1000  4
************************
*
0620000   VOL62      SNGLVOL
0620101   0.   1.221      0.03227   0.  -90. -1.221    0.   0.        00
************************
*
0640000   VOL64      PIPE
0640001   3
0640101   0.0 3
0640301   1.487 1   1.335 2    1.300 3
0640401   0.01101 1 0.00943 2 0.01187 3
0640601   90.  3
0640801   0. 0.0650 1    0. 0.0672 2    0.   0.0639 3
0640901   0.00 0.00 2
0641001   00 3
0641101   1000 2
*
* BROKEN CIRCULATION LINE
************************
*
0910000   VOL91      BRANCH
0910001   0
0910101   0.   1.246    0.00570   0.   0.   0.   0.   0.   00
************************
*
0920000   VOL92      SNGLVOL
0920101   0.   1.330    0.00580   0.   0.   0.   0.   0.   00
************************
*
0940000   VOL94      SNGLVOL
0940101   0.   1.100    0.00256   0.  -45. -0.870    0.   0.   00
************************
*
0950000   VOL95      BRANCH
0950001   0
0950101   0.   1.690    0.00336      0.   14.3  0.417  0.   0.   00
```

```
************************
*
0960000   VOL96      BRANCH
0960001   0
0960101   0.   1.475     0 00419   0.   0.   0.   0    0.   00
************************
*
0970000   VOL97      BRANCH
0970001   0
0970101   0.   3.062     0.00535      0.   4.5    0 161   0.   0.   00
************************
*
0980000   VOL98      BRANCH
0980001   0
0980101   0.   1.101     0.00450   0.   0.   0.   0.   0.   00
************************
*
0990000   VOL99      PIPE
0990001   2
0990101   0.0  2
0990301   1.422     1     0.218     2
0990401   0.00767   1     0.00220   2
0990601   0.   1   -90. 2
0990701   0.        1    -0.218    2
0990801   0.   0.   1    0.   0.006012  2
0990901   1.00   1.00    1
0991001   00   2
0991101   0000 1
*
************************
*
2010000   PUMP1      PUMP
2010101   0.         0.750     0.01010   0.    18.4 0.202     0
2010108   073010000    0.00437  0.17       0.37      0000
2010109   071000000    0.000900  3.00      3.00      0000
2010201   1    4.74   0.    0.
2010202   1    4.74   0.    0.
2010301   0    0    0   -1    0    0    0
2010302   303.83   0.5280     0.0383    50.   81.7    1.   1000.
2010303   0.   0.   0.   0.   0.
*  NYA HOMOLOGA PUMPKURVOR, DATA KOMMER FRÅN ASEA-ATOMS GCOLIN-BER.
*  TORQUE-KURVORNA SAKNAR BETYDELSE I DETTA FALL OCH HAR DÄRFÖR INTE
* KONTROLLERATS. KÄLLAN FÖR EN DEL DATA ÄR OKÄND
2011100   1    1
2011101   0.00,1.101     0.27,1.100     0.47,1.160
2011102   0.84,1.130     1.00,1.000
2011200   2    1
2011201   0.00,0.04      0.09,0.07      0.19,0.09
2011202   0.38,0.92      0.58,0.962     0.80,0.98      1.00,1.00
2011300   1    2
2011301   0.0,-0.360    0.41,-0.18    0.51,-0.05    0.76,0.40
2011302   1.00,1.00
2011400   2    2
2011401   0.0,-1.16      0.5,0.00       0.80,0.38      1.00,1 00
2011500   1    3
2011501    -1.00,2.00    -0.85,1.81    -0.62,1.52    -0 50,1.39
2011502     0.00,1.10
2011600   1    4
2011601    -1.00,2.00    -0.79,1.53    -0.63,1.35    -0.30,0.93
2011602     0.00,0.72
2011700   2    3
2011701    -1.00,3.31    -0.83,2.70    -0.68,2.39    -0.56,1.95
2011702    -0.37,1.49    -0.22,1.18    -0.10,0.99     0.00,0.84
2011800   2    4
2011801    -1.00,3.31    -0.70,2.70    -0.59,2.37    -0.41,2.04
```

```
2011802    -0 21,1.70     0 00,1 85
* TWO PHASE MULTIPLIER TABLES
2013000    0
2013001  0.0,0.0  0.1,0 0  0 15,0 05  0 24,0.8  0.3,0.96  0 4,0.98
2013002  0.6,0.97  0.8,0.9  0 9,0 8  0 96,0 5  1 0,0 0
2013100    0
2013101  0.0,0.0  0.1,0 0  0.15,0.05  0 24,0.8  0.3,0.96  0.4,0.98
2013102  0.6,0.97  0.8,0.9  0 9,0.8  0.96,0 5  1.0,0.0
* TWO PHASE DIFFERENCE FOR PUMP HEAD (SEMISCALE)
2014100    1    1
2014101 0.0,0.0  0.1,0.83  0.2,1.09  0.5,1.02  0.7,1.01 0.9,0.94 1.0,1.0
2014200    1    2
2014201 0.0,0.0  0.1,-0.04  0.2,0.0  0.3,0.1  0.4,0.21  0.8,0.67
2014202 0.9,0.80  1.0,1.0
2014300    1    3
2014301 -1.0,-1.16  -0.9,-1.24  -0 8,-1.77  -0.7,-2.36  -0.6,-2.79
2014302 -0.5,-2.91  -0.4,-2 67  -0.25,-1.69  -0.1,-0 5  0.0,0.0
2014400    1    4
2014401 -1.0,-1.16  -0 9,-0.78  -0.8,-0.5  -0.7,-0.31  -0.6,-0.17
2014402 -0.5,-0.08  -0.35,0.0  -0 2,0.05  -0 1,0.08  0.0,0.11
* TWO PHASE DIFFERENCE FOR PUMP TORQUE (= SINGLE PHASE, WHICH MEANS
* THAT FULLY DEGRADED TORQUE IS ZERO)
2014900    2    1
2014901    0 00,0.04       0 09,0.07       0.19,0.09
2014902    0.38,0.92       0.58,0.962      0.80,0.99      1.00,1.00
2015000    2    2
2015001    0.0,-1.16       0.5,0.00        0.80,0.38      1.00,1.00
2015100    2    3
2015101      -1.00,3.31    -0.83,2.70     -0 68,2.39     -0.56,1.95
2015102      -0.37,1.49    -0.22,1.18     -0 10,0 99      0.00,0 84
2015200    2    4
2015201      -1.00,3.31    -0.70,2.70     -0.59,2.37     -0.41,2.04
2015202      -0.21,1.70     0.00,1.85
** PUMP1 REGULATOR
2016100    0          CNTRLVAR  006
2016101    0.   0.          1000.       1000.
** PUMP1 CONTROL SYSTEM
20500100  SSUNIT      TRIPUNIT  1.        1.        0
20500101  601
*
20500200  FLOWDIFFE  SUM        1.        0.        0
20500201  4.74      -1 0       MFLOWJ    201010000
*
20500300  SSMULT      MULT      1.        0.        0
20500301  CNTRLVAR  1
20500302  CNTRLVAR  2
*
20500400  INTEGRAL1  INTEGRAL  80.       150.   0   3   140.   180.
20500401  CNTRLVAR  003
*
20500500  PISPTAB     FUNCTION  1.        0.        1
20500501  TIME      0         201
*
20500600  PIVEL       MULT      1.        0.        1
20500601  CNTRLVAR  4
20500602  CNTRLVAR  5
*
*  PUMP P1 SPEED TABLE
20220100   HTC-T    601   1.   1.
20220101   0.  1.000      4.  .785      8.  .660      12.  .626
20220102   40.  .626
*
************************
*
2020000   PUMP2      PUMP
```

```
2030101   0.         0.700    0.00500   0.   22.0 0.220     0
2030108   054010000    0.0010    0.35     0.35      0000
2030109   055000000    0.000300   3.00     3.00    0000
2030201   1     1.53 0.   0.
2030202   1     1.53 0.   0.
2030301   0     0     -1   -1    0     0     0
2030302   303.69     0.6018    0.01054   35.       13.2      1.        1000.
2030303   0.    0.    0.    0.    0.
2031100   1     1
2031101   0.0   1.136      0.2  1.138      0.4  1.130
2031102   0.6   1.100      0.8  1.055      1.0  1.000
2031200   2     1
2031201   0.0   0.51       1.0  1.00
2031300   1     2
2031301   0.0 -0.560       0.2 -0.365      0.4 -0.180       0.6 -0.055
2031302   0.8  0.145       0.9  0.565      1.0  1.000
2031400   2     2
2031401   0.0 -0.47        0.2 -0.31       0.4  0.07
2031402   0.6  0.36        0.8  0.66       1.0  1.00
2031500   1     3
2031501    -1.00,2.00     -0.85,1.81     -0.62,1.62     -0.50,1.38
2031502     0.00,1.136
2031600   1     4
2031601    -1.00,2.00     -0.70,1.53     -0.63,1.35     -0.30,0.85
2031602     0.00,0.72
2031700   2     3
2031701    -1.00,3.31     -0.83,2.78     -0.66,2.39     -0.56,1.95
2031702    -0.37,1.40     -0.22,1.19     -0.10,0.95      0.00,0.51
2031800   2     4
2031801    -1.00,3.31     -0.70,2.70     -0.60,2.37     -0.41,2.04
2031802    -0.31,1.78      0.00,1.55
2033000   0
2033001   0.0 0.00  0.1 0.00  0.2 0.05  0.3 0.80  0.4 0.96  0.5 0.98
2033002   0.6 0.97  0.7 0.90  0.8 0.80  0.9 0.50  1.0 0.00
2033100   0
2033101   0.0 0.00  0.1 0.10  0.2 0.15  0.3 0.24  0.4 0.30  0.5 0.40
2033102   0.6 0.50  0.7 0.60  0.8 0.90  0.9 0.96  1.0 1.00
** PUMP2 REGULATOR                                    *STEADY STATE C
2036100   0           CNTRLVAR  012
2036101   0.    0.         1000.      1000.
** PUMP2 CONTROL SYSTEM
20500700  FLOWDIFF2  SUM        1.        0.        0
20500701  1.53      -1.0       MFLOWJ    203020000
*
20500800  SSMAR2     MULT       1.        0.        0
20500801  CNTRLVAR   1
20500802  CNTRLVAR   7
*
20500900  INTEGRAL2  INTEGRAL  200.      210.    0   3    170.    230.
20500901  CNTRLVAR  008
*
20501000  P2SPTAB    FUNCTION  1.        0.        1
20501001  TIME       0          202
*
20501200  P2VEL      MULT       1.        0.        1
20501201  CNTRLVAR  9
20501202  CNTRLVAR 10
*
*  PUMP P2 SPEED TABLE
20220200   MIC-T     604   1.   1.
20220201   0.  1.000     2.   .962     4.   .937     8.   .973
20220202   12.  1.049   16.  1.080   37.  1.103   40.  1.064
*
*
************************
```

```
*
1010000   JUN31-32  SNGLJUN
1010101   031010000 032000000 0.         0.         0.         1100
1010201   1         6.37      0.         0.
************************
*
1020000   JUN32-33  SNGLJUN
1020101   032010000 033000000 0.         0.         0.         1100
1020201   1         5.60      0.         0.
************************
*
1030000   JUN33-41  SNGLJUN
1030101   033010000 041000000 0.000473   0.340      0.200      0000
1030201   1         5.60      0.         0.
************************
*
1040000   JUN41-51  SNGLJUN
1040101   041010000 051000000 0.         0.10       0.10       0100
1040201   1         4.025     1.076      0.
************************
*
1050000   JUN51-52  SNGLJUN
1050101   051010000 052000000 0.         0.         0.         1100
1050201   1         5.105     1.076      0.
************************
*
1060000   JUN52-31  SNGLJUN
1060101   052010000 031000000 0.03310    1.         1.         1020
1060201   1         5.105     1.076      0.
************************
*
1070000   JUN11-21  SNGLJUN
1070101   011000000 021000000 0.0        0.0        0.0        1000
1070201   1         4.425     -1.076     0.
************************
*
1080000   JUN12-11  SNGLJUN
1080101   012000000 011010000 0.         0.         0.         1000
1080201   1         4.425     -1.076     0.
************************
*
1100000   JUN12-13  SNGLJUN
1100101   012010000 013000000 0.001433   0.95     0.95    1000     *STEADY 1
1100201   1         0.        0.         0.
************************
*
1110000   JUN21-71  SNGLJUN
1110101   021010000 071000000 0.         1.00       1.00       1100
1110201   1         11.42      0.         0.
************************
*
1120000   JUN71-72  SNGLJUN
1120101   071010000 072000000 0.         0.         0.         1000
1120201   1         11.42      0.         0.
************************
*
1130000   JUN72-73  SNGLJUN
1130101   072010000 073000000 0.00       0.         0.         1000
1130201   1         4.74      0.         0.
************************
*
1160000   JUN74-31  SNGLJUN
1160101   074010000 031010000 0.         0.00       0.00       1100
1160201   1         4.74      0.         0.
*
```

```
************************
*
1170000   BY-PASS   VALVE
1170101   032010000 064000000 0.000501   0.         0.         0000
1170201   1         0.67      0.         0.
1170300   SRVVLV    *    MOTORVALVE IN BY-PASS INLET
1170301   34
1170400   1.0  34.20
1170401   .000 .000 .000 .125 .0906 .0906 .200 .1301 .1301
1170402   .500 .1955 .1955 1.00  2037 .2037
*
20503200  BPFLOWDFF  SUM      1.     0.     0
20503201  0.67      -1.     MFLOWJ     117000000
*
20503300  SSMARBP    MULT     1.     0.     0
20503301  CNTRLVAR   1
20503302  CNTRLVAR   32
*
20503400  INTEGBP    INTEGRAL  .5  0.26  00   3  0.  1.
20503401  CNTRLVAR   33
*
************************
*
1180000   JUN64-62  SNGLJUN
1180101   064000000 062000000 0.00474    0.         0.         1100
1180201   1         0.        0.         0.
************************
*
1200000   JUN64-51  SNGLJUN
1200101   064010000 051010000 0.001790   2.00       2.00       0000
1200201   1         0.69      0.         0.
************************
*
1220000   JUN72-91  SNGLJUN
1220101   072010000 091000000 0.         0.00       0.00       0100
1220201   1         1.53      0.         0.
************************
*
1230000   JUN91-94  SNGLJUN
1230101   091010000 094000000 0.         0.00       0.00       0100
1230201   1         1.53      0.         0.
************************
*
1240000   JUN91-92  SNGLJUN
1240101   091010000 092000000 0.         0.00       0.00       0000
1240201   1         0.        0.         0.
************************
*
1260000   JUN97-99  SNGLJUN
1260101   097010000 099000000 19.0E-4    12.5    12.5    0000
1260201   1         1.53      0.         0.
************************
*
1270000   JUN950-96 SNGLJUN
1270101   095010000 096000000 0          1.00       1.00       0100
1270201   1         0         0.         0
************************
*
1280000   JUN97-31  SNGLJUN
1280101   099010000 031010000 0.         0.00       0.00       0100
1280201   1         1.53      0.         0
************************
*
1290000   JUN99-98 SNGLJUN
1290101   099000000 098000000 0.         1.00       1.00       0100
```

```
1300201   1         0.        0.        0.
**********************
*
* COOLING SYSTEM
**********************
*
3010000   COOLING        TMDPVOL
3010101   0.003959  1.   0.   0.   0.   0.   0.   0.          10
3010200   2
3010201   0.        6970000.  0.
**********************
*
4010000 - COOLING        TMDPJUN
4010101   072000000      301000000      0.
4010200   1     604
4010201   0.    5.15   0.   0.   2.0  5.15   0.   0.   2.3  0.   0.   0.
**********************
*
3020000   SPRAYFLOW      TMDPVOL
3020101   0.002575  1.   0.   0.  90.   1.   0.   0.02576    10
3020200   3   0   CNTRLVAR 30
3020201   453.15    7000000.  453.15
3020202   456.15    7000000.  456.15
**********************
*
4020000   SPRAYFLOW      TMDPJUN
4020101   302000000      012010000      0.
4020200   1  604
4020201   0.    3.35   0.   0.   1.0  3.35   0.   0.   2.2  0.   0.   0.
**********************
*
3030000   SUBCOOLING     TMDPVOL
3030101   0.000531  1.   0.   0.   0.   0.   0.   0.          10
3030200   3   0   CNTRLVAR  30
3030201   453.15    7000000.  453.15
3030202   456.15    7000000.  456.15
**********************
*
4030000   SUBCOOLING     TMDPJUN
4030101   303000000      021010000      0.
4030200   1   604
4030201   0.   1.0000 0.   0.   2.0  1.0000 0.   0.   2.3  0.   0.   0.
*
* STEAM RELIEF
**********************
*
3040000   RELIEF    TMDPVOL
3040101   .00636    1.   0.   0.   0.   0.   0.   0.     00
3040200   2
3040201   0.        100000.   1.
*
*
**********************
*
4040000   RELIEF    TMDPJUN
4040101   013010000  304000000   000014
4040200    1    0     CNTRLVAR   100
4040201   0.    0.    0.    0.
4040202   1.E6  0.    1.E6  0.
*
*  STEAM RELIEF FLOW MODEL
20509300   RHOP   MULT   1.   0.   0
20509301   RHOG   013010000   P   013010000
*
20509400   SQRT   POWERR   1.   0.   0.
```

```
20509401   CNTRLVAR  93     .5
*
20209200   NORMAREA
20209201   0.   0.     .7   0.    1.2   1.
20209202   27 6  1.
*
20509700   TRSTIME   TRIPUNIT   1.   0.   1
20509701   606
*
20509800   RLFTIME    INTEGRAL    1.   0.   1
20509801   CNTRLVAR   97
*
20509900   VLVAREA   FUNCTION   1.034E-4   0.   0
20509901   CNTRLVAR  98     92
*
20510000   MSSFLOW   MULT     .3547   0.   0
20510001   CNTRLVAR  99    CNTRLVAR  94
*
****************
*
* DUMP VOLUMES
**********************
*
5010000    DUMP1     TMDPVOL
5010101   1.00      1.00      0.   0.   0.   0.   0.   0.   00
5010200   2
5010201   0.   100000.   1.0
*
5020000    DUMP2     TMDPVOL
5020101   1.00      1.00      0.   0.   0.   0.   0.   0.   00
5020200   2
5020201   0.   100000.   1.0
*
* GUILLOTINE RUPTURE IN CIRCULATION LINE
**********************
*
1510000   BRKV117   VALVE
1510101   096010000 501000000   0.0003664 0.   0.   0100  1.00  1.00 *01/
1510201   1    0.   0.   0.
1510300   MTRVLV
1510301   0000604   0000505   5.00       0.0   *OPENING TIME .20 SEC
*
1520000   BRKV120   VALVE
1520101   096010000 502000000   0.0003664 0.   0.   0100  1.00  1.00 *01/
1520201   1    0.   0.   0.
1520300   MTRVLV
1520301   0000606   0000505   5.00       0.0   *OPENING TIME .20 SEC
*
1250000   VLV103    VALVE
1250101   095010000 097000000   0.0017  0.  0.   0100  1.00  1.00
1250201   1    1.33   0.   0.
1250300   MTRVLV
1250301   0000505   0000504   3.3333     1.0   *CLOSING TIME .30 SEC
*
*
* HEAT STRUCTURES
14010000       1    7    2    1    0.         * CORE
14010100       0    1
14010101       4  0.004725     2  0.006125
14010201       1  4           -2  6
14010301       0.0 4           1.0 6
14010400       0
14010401       570. 7
14010501       0           0    0    1     13.240    1
14010601       004010000 0    1    1     13.240    1
```

```
14010701      1     0.0764    0.   0.   1
14010901      0     0.01742   0.   0    1
14020000      1     7    2    1    0.
14020100      0     1
14020101      4  0.005175     2  0.006125
14020201      1  4           -2  6
14020301      0.0 4           1.0 6
14020400      4010
14020501      0           0    0    1     13.240    1
14020601      004020000 0    1    1     13.240    1
14020701      1     0.1030    0.   0.   1
14020901      0     0.01742   0.   0.   1
14030000      1     7    2    1    0.
14030100      0     1
14030101      4  0.005375     2  0.006125
14030201      1  4           -2  6
14030301      0.0 4           1.0 6
14030400      4010
14030501      0           0    0    1     13.240    1

14030601      004030000 0    1    1     13.240    1
14030701      1     0.1130    0.   0.   1
14030901      0     0.01742   0.   0.   1
14040000      1     7    2    1    0.
14040100      0     1
14040101      4  0.005375     2  0.006125
14040201      1  4           -2  6
14040301      0.0 4           1.0 6
14040400      4010
14040501      0           0    0    1     13.240    1
14040601      004040000 0    1    1     13.240    1
14040701      1     0.1200    0.   0.   1
14040901      0     0.01742   0.   0.   1
14050000      1     7    2    1    0.
14050100      4040
14050400      4010
14050501      0           0    0    1     13.240    1
14050601      004050000 0    1    1     13.240    1
14050701      1     0.1190    0.   0.   1
14050901      0     0.01742   0.   0.   1
14060000      1     7    2    1    0
14060100      4030
14060400      4010
14060501      0           0    0    1     13.240    1
14060601      004060000 0    1    1     13.240    1
14060701      1     0.1133    0.   0.   1
14060901      0     0.01742   0.   0.   1
14070000      1     7    2    1    0.
14070100      4030
14070400      4010
14070501      0           0    0    1     13.240    1
14070601      004070000 0    1    1     13.240    1
14070701      1     0.1130    0.   0.   1
14070901      0     0.01742   0.   0.   1
14080000      1     7    2    1    0
14080100      4020
14080400      4010
14080501      0           0    0    1     13.240    1
14080601      004080000 0    1    1     13.240    1
14080701      1     0.1024    0    0.   1
14080901      0     0.01742   0.   0.   1
14090000      1     7    2    1    0.
14090100      0     1
14090101      4  0.004975     2  0.006125
14090201      1  4           -2  6
```

```
14090301        0 0 4         1 0 6
14090400        4010
14090501        0          0    0    1    13.240     1
14090601        004090000 0    1    1    13.240     1
14090701        1    0 0817    0.   0.   1
14090901        0     0.01742   0.   0.    1
14100000        1    7    2    1    0
14100100        0    1
14100101        4  0.003875     2  0.006125
14100201        1  4           -2  6
14100301        0.0 4          1.0 6
14100400        4010
14100501        0          0    0    1    13.240     1
14100601        004100000 0    1    1    13.240     1
14100701        1    0.0514    0.   0.   1
14100901        0    0.01742   0.   0.   1
*
10640000        1    2    2    1    0.    *  BY PASS
10640100        0    1
10640101        1    0.006125
10640201        2    1
10640301        1 0 1
10640400        0
10640401        570. 2
10640501        0          0    0    1    2.67       1
10640601        064010000 0    1    1    2.67       1
10640701        2    0.35      0.        0.         1
10640901        0    0.        0.        0.          1
*    HYDR DIA IN HEAT AND HYDR STRUCTURE THE SAME
10650000        1    2    2    1    0.
10650100        0640
10650400        0640
10650501        0          0    0    1    2.67       1
10650601        064020000 0    1    1    2.67       1
10650701        2    0.40      0.        0.         1
10650901        0    0.01742   0.        0.          1
10660000        1    2    2    1    0.
10660100        0640
10660400        0640
10660501        0          0    0    1    2.67       1
10660601        064030000 0    1    1    2 67       1
10660701        2    0 27      0.        0.         1
10660901        0    0.01742   0.        0.          1
*
*
* BOX WALL TO ACCOUNT FOR HEAT LOSSES
14000000    10   2   1   1   0.
14000100     0   1
14000101     1   0.002
14000201     3   1
14000301     0.  1
14000401   450.  1
14000402   540.  2
14000501   -401              -1  3400   0   0.15     10
14000601    004010000  010000    1   0   0.15  .  10
14000701     0   0   0.   0.       10
14000901     0   0   0.   0.       10
*
*  GENERAL TABLE GIVING HEAT TRANSFER COEFF. AT OUTSIDE OF BOX WALL.
*
20240000    HTC-T
20240001    0.     2.0400E3  * HTC DETERMINED TO GIVE HEAT LOSS OF APPROX. 2
*
*  GENERAL TABLES GIVING THE TEMPERATURES AT THE OUTSIDE OF THE
*  BOX WALL. TEMPERATURE IS SUPPOSED TO VARY LINEARLY BETWEEN 403 K
```

```
*  AT INLET TO 493 K AT OUTLET.
*
20240100   TEMP
20240101   0.      407.5
*
20240200   TEMP
20240201   0.      416.5
*
20240300   TEMP
20240301   0.      425 5
*
20240400   TEMP
20240401   0.      434.5
*
20240500   TEMP
20240501   0.      443.5
*
20240600   TEMP
20240601   0.      452.5
*
20240700   TEMP
20240701   0.      461.5
*
20240800   TEMP
20240801   0.      470.5
*
20240900   TEMP
20240901   0.      479.5
*
20241000   TEMP
20241001   0.      488.5
*
*
13100000  1    4    1    1    0.00
13100100  0    2
13100101  0.005  1   0.015  2   0 06   3
13100201  3    3
13100301  .0   3
13100401  560.   4
13100501  31010000   0    1    0    .170    1
13100601 -13    0   3014   0     .170    1
13100701  0    .0    .0    .0    1
13100801  0    .0    .0    .0    1
*
13200000  1    4    2    1    .132
13200100  0    2
13200101  0.005   1   0.015  2   0.01   3
13200201  3    3
13200301  .0   3
13200401  560.   4
13200501  32010000   0    1    1    .325    1
13200601 -13    0   3014   1     .325    1
13200701  0    .0    .0    .0    1
13200801  0    .0    .0    .0    1
*
13300000  1    4    2    1    .132
13300100  0    2
13300101  0.005  1   0.015  2   0.03   3
13300201  3    3
13300301  .0   3
13300401  560.   4
13300501  33010000   0    1    1    .271    1
13300601 -13    0   3014   1     .271    1
13300701  0    .0    .0    .0    1
13300801  0    .0    .0    .0    1
```

```
*
15100000  1    3    2    1    .132
15100100  0    1
15100101  2    .182
15100201  3    2
15100301  .0   2
15100401  560.   3
15100501  51010000   0    1    1    .170    1
15100601 -13    0   3014   1     .170    1
15100701  0    .0    0    .0    1
15100801  0    .0    .0    .0    1
*
15210000  1    3    2    1    .063
15210100  0    1
15210101  2    .065
15210201  3    2
15210301  .0   2
15210401  560    3
15210501  52010000   0    1    1    .437    1
15210601  0    0    0    1    .437    1
15210701  0    .0    .0    .0    1
15210801  0    .0    0    .0    1
*
15220000  1    3    2    1    .050
15220100  0    1
15220101  2    .052
15220201  3    2
15220301  .0   2
15220401  560.   3
15220501  52020000   0    1    1    .953    1
15220601  0    0    0    1    .953    1
15220701  0    .0    .0    .0    1
15220801  0    .0    .0    .0    1
*
11100000  1    4    2    1    .350
11100100  0    2
11100101  0.005  1   0.015  2   0.033   3
11100201  3    3
11100301  .0   3
11100401  560.   4
11100501  11010000   0    1    1    .450    1
11100601 -13    0   3014   1     .450    1
11100701  0    .0    .0    .0    1
11100801  0    .0    .0    .0    1
*
11210000  1    4   2    1    .250
11210100  0    2
11210101  0.005  1   0.015  2   0.033   3
11210201  3    3
11210301  .0   3
11210401  560.   4
11210501  12010000   0    1    1    2.200    1
11210601 -13    0   3014   1     2 200    1
11210701  0    .0    .0    .0    1
11210801  0    .0    .0    .0    1
*
11220000  1    4    1    1    0.00
11220100  0    2
11220101  0.005  1   0.015  2   0.033   3
11220201  3    3
11220301  .0   3
11220401  560.   4
11220501  12020000   0    1    0    .400       1
11220601 -13    0   3014   0     .400    1
11220701  -    .0    .0    .0    1
```

```
11270801  0    0    0    .0   1
*
12110000  1    4    2    1    .250
12110100  0    2
12110101  0.005  1   0.015  2   0.033  3
12110201  3    3
12110301  .0   3
12110401  560.   4
12110501  21010000  0    1    1    .404    1
12110601 -13    0   3014   1     .404    1
12110701  0    .0   .0   .0   1
12110801  0    .0   .0   .0   1
*
12120000  1    4    2    1    .170
12120100  0    2
12120101  0.005  1   0.015  2   0.033  3
12120201  3    3
12120301  .0   3
12120401  560.   4
12120501  21020000  0    1    1    .549    1
12120601 -13    0   3014   1     .549    1
12120701  0    .0   .0   .0   1
12120801  0    .0   .0   .0   1
*
12130000  1    4    2    1    .132
12130100  0    2
12130101  0.005  1   0.015  2   0.01  3
12130201  3    3
12130301  .0   3
12130401  560.   4
12130501  21030000  0    1    1    .386    1
12130601 -13    0   3014   1     .386    1
12130701  0    .0   .0   .0   1
12130801  0    .0   .0   .0   1
*
12140000  1    4    2    1    .132
12140100  0    2
12140101  0.005  1   0.015  2   0.01  3
12140201  3    3
12140301  .0   3
12140401  560.   4
12140501  21040000  0    1    1    .146    1
12140601 -13    0 3014   1     .146    1
12140701  0    .0   .0   .0   1
12140801  0    .0   .0   .0   1
*
17100000  0    3    2    1    .0548
17100100  0    1
17100101  2    .0707
17100201  3    2
17100301  .0   2
17100401  560.   3
17100501  71010000  010000   1    1    0.998   3
17100502  71040000  010000   1    1    0.020   6
17100601 -13    0   3014   1     0.998   3
17100602 -13    0   3014   1     0.020   6
17100701  0    .0   .0   .0   6
17100801  0    .0   .0   .0   6
*
17200000  1    3    2    1    .0548
17200100  0    1
17200101  2    .0707
17200201  3    2
17200301  .0   2
17200401  560.   3
```

```
17200501  72010000  0    1    1     300    1
17200601 -13    0   3014   1     .300    1
17200701  0    .0   .0   .0   1
17200801  0    .0   .0   .0   1
*
17300000  1    3    2    1     0548
17300100  0    1
17300101  2    .0707
17300201  3    2
17300301  .0   2
17300401  560.   3
17300501  73010000  0    1    1    .718    1
17300601 -13    0   3014   1     .718    1
17300701  0    .0   .0   .0   1
17300801  0    .0   .0   .0   1
*
17400000  4    3    3    1    .0368
17400100  0    1
17400101  2    .0445
17400201  3    2
17400301  .0   2
17400401  560    3
17400501  74010000  0    1    1    .873    1
17400502  74020000  0    1    1    1.117   2
17400503  74030000  0    1    1    2.874   3
17400504  74040000  0    1    1    1.580   4
17400601 -13    0   3014   1     .873    1
17400602 -13    0   3014   1     1.117   2
17400603 -13    0   3014   1     2.870   3
17400604 -13    0   3014   1     1.580   4
17400701  0    .0   .0   .0   4
17400801  0    .0   .0   .0   4
*
17450000  1    3    1    1    0.00
17450100  0    1
17450101  2    .003
17450201  3    2
17450301  .0   2
17450401  560.   3
17450501  74050000  0    1    0    .055    1
17450601 -13    0   3014   0     .055    1
17450701  0    .0   .0   .0   1
17450801  0    .0   .0   .0   1
*
16200000  1    3    2    1    .0678
16200100  0    1
16200101  2    .0895
16200201  3    2
16200301  .0   2
16200401  560.   3
16200501  62010000  0    1    1    1.231   1
16200601  0     0     0    1     1.231   1
16200701  0    .0   .0   .0   1
16200801  0    .0   .0   .0   1
*
16400000  3    3    2    1     0486
16400100  0    1
16400101  2    .0572
16400201  3    2
16400301  .0   2
16400401  560.   3
16400501  64010000  0    1    1    1.440   1
16400502  64020000  0    1    1    1.335   2
16400503  64030000  0    1    1    1.363   3
16400601 -13    0   3014   1     1.440   1
```

```
16400602 -13    0   3014   1     1.335   2
16400603 -13    0   3014   1     1.363   3
16400701  0    .0    0    0   3
16400801  0    .0   .0    0   3
*
19100000  1    3    2    1    .0369
19100100  0    1
19100101  2    .0445
19100201  3    2
19100301  .0   2
19100401  560    3
19100501  91010000  0    1    1    1.246    1
19100601 -13    0    3014 1     1.246    1
19100701  0    .0   .0   .0   1
19100801  0    .0   .0   .0   1
*
19200000  1    3    2    1    .0369
19200100  0    1
19200101  2    .0445
19200201  3    2
19200301  .0   2
19200401  560    3
19200501  92010000    0    1    1    1.339   1
19200601 -13       0    3014    1    1.339   1
19200701  0              0.   0.   0.          1
19200801  0              0    0.   0.          1
*
19400000  1    3    2    1    .0246
19400100  0    1
19400101  2    .0301
19400201  3    2
19400301  .0   2
19400401  560.   3
19400501  94010000  0    1    1    1.188   1
19400601 -13    0   3014   1     1.188    1
19400701  0    .0   .0   .0   1
19400801  0    .0   .0   .0   1
*
19500000  1    3    2    1    .0246
19500100  0    1
19500101  2    .0301
19500201  3    2
19500301  .0   2
19500401  560    3
19500501  95010U00  0    1    1    1.683   1
19500601 -13    0   3014   1     1.683   1
19500701  0    .0   .0    0   1
19500801  0    .0   .0   .0   1
*
19600000  1    3    2    1    .0369
19600100  0    1
19600101  2    .0445
19600201  3    2
19600301  .0   2
19600401  560.0    3
19600501  96010000    0    1    1    1.475   1
19600601  0          0    0    1    1.475   1
19600701  0              0.   0.   0.          1
19600801  0              0    0.   0.          1
*
19700000  1    3    2    1    .0246
19700100  0    1
19700101  2    .0301
19700201  3    2
19700301  .0   2
```

```
18700401  560.  3
18700501  87010000  0   1   1   3.062   1
18700601 -13   0  3014  1    3.062   1
18700701  0   .0   .0   .0   1
18700801  0   .0   .0   .0   1
*
19800000  1   3   2   1    .0360
19800100  0   1
19800101  2   .0445
19800201  3   2
19800301  .0  2
19800401  560.0   3
19800501  98010000   0   1   1   1.181   1
19800601  0       0    0   1   1.181   1
19800701  0            0.  0.  0.           1
19800801  0            0.  0.  0.           1
*
19810000  1   3   2   1    .0406
19810100  0   1
19810101  2   .050
19810201  3   2
19810301  .0  3
19810401  560.  3
19810501  99010000  0   1   1   1.420   1
19810601 -13   0  3014  1    1.420   1
19810701  0   .0   .0   .0   1
19810801  0   .0   .0   .0   1
*
19820000  1   3   1   1   0.00
19820100  0   1
19820101  2   .003
19820201  3   2
19820301  .0  2
19820401  560   3
19820501  99020000  0   1   0   .055   1
19820601  -13  0  3014  0    .055   1
19820701  0   .0   .0   .0   1
19820801  0   .0   .0   .0   1
*
13010000  1   3   1   1   0.00
13010100  0   1
13010101  2   .020
13010201  3   2
13010301  .0  2
13010401  560.   3
13010501  201010000  0   1   0   0.50    1
13010601 -13   0  3014  0    0.50    1
13010701  0   .0   .0   .0   1
13010801  0   .0   .0   .0   1
*
13020000  1   3   1   1   0.00
13020100  0   1
13020101  2   .020
13020201  3   2
13020301  .0  2
13020401  560.   3
13020501  202010000  0   1   0   0.300  1
13020601  -13  0  3014  0    0.30   1
13020701  0   .0   .0   .0   1
13020801  0   .0   .0   .0   1
*
13110000       3   5    2    1    0.          * COPPER RODS
13110100       0   1
13110101       3  0.0045     2  0.0070
13110201       1  3             4  5
```

```
13110301        0.0 5
13110400        0
13110401        570. 6 ..
13110501        0         0     0     1     5.40     1
13110502        0         0     0     1    11.70     2
13110503        0         0     0     1     9.00     3
13110601        031010000 0  1     1     5.40     1
13110602        032010000 0  1     1    11.70     2
13110603        033010000 0  1     1    9.00     3
13110701        0     0.00    0.    0.    3
13110901        00  0.01742   0.    0.    3
15110000        1     5     2     1     0.          * COPPER CABLES
15110100        0     1
15110101        4  0.004
15110201        4   4
15110301        0.0 4
15110400        0
15110401        570. 5
15110501        0         0     0     1     7.40     1
15110601        051010000 0  1     1     7.40     1
15110701        0     0.00    0.    0.    1
15110901        00  0.01742   0.    0.    1
*
*
*
20100100  TBL/FCTN  1   -1    * MGO
20100101   0.     5.60      473.  5.50      573.  4.64      673.  3.78
20100102   773.  3.18      873.  2.75      973.  2.60     1073.  2.30
20100151   3300000.        3300000.        3300000.        3328000.
20100152   3460000.        3630000.        3713000.        3740000.
*
20100200  TBL/FCTN  2    2    * INCONEL 600
20100201  293. 1088.      10.974     0.0122     0.000002062 0. 0. 0. 0.
20100251  293. 1088.      2665370.  4173.5   -1.7262      0. 0. 0. 0.
*
20100300  S-STEEL
*
20100400  TBL/FCTN    1  1     * COPPER
20100401  390.0
20100451  3.48E+06
*
*
* CORE POWER REDUCTION
20200100  POWER   604            1.          2 370E6
20200101    0.00 1.000  0.40 0.995  1.00 0.937  2.50 0.688  5.00 0.492
20200102    7.50 0.355  10.0 0.241  13.5 0.169  15.0 0.127 20.0 0.083
20200103  25.00 0.063 30.00 0.059 50.00 0.060
* BY-PASS POWER REDUCTION
20200200  POWER   607            1.          60.4E3
20200201    0.00 1.000  1.00 0.581  1.50 0.490  2.25 0.0  100. 0.0
*
*
*LIQUID LEVEL IN DOME DC ANNULUS AND DOWNCOMER TO BREAK
*HEIGHT OF LIQUID = FCT OF LIQUID VOID
20201100  NORMAREA        *VOL21-2
20201101  0.    0.    .3960      .2740      1.0        0.549
20201200  NORMAREA        *VOL31-3
20201201  0.    0.    0.490      0.150      1.0        0.206
20201300     TEMP
20201301   0.       290.
20201400   HTC-T
20201401    0.       10.00      *AUXILIARY HEAT TRANSFER COEFF. TO QUIT
*                                FLOWS THROUGH SS-JUN 405 AND 406
20501100  LIQH21-2      .FUNCTION  1.   0.   1
20501101  VOIDF      021020000       011
```

```
20501200  LIQH21-3          FUNCTION  1.   0    1
20501201  VOIDF      021030000        012
20504100  LIQLEVDC          SUM       1.   0    1
20504101  1.115   0.300              VOIDF      072010000
20504102  0.020             VOIDF     071080000
20504103  0.020             VOIDF     071070000
20504104  0.020             VOIDF     071060000
20504105  0.020             VOIDF     071050000
20504106  0.020             VOIDF     071040000
20504107  .146              VOIDF     021040000
20504108  1.                CNTRLVAR  012
20504109  1.                CNTRLVAR  011
20504110          0.404     VOIDF     021010000
*LIQUID LEVEL IN UPPER PLENUM AND STEAM PIPE
*HEIGHT OF LIQUID = FCT OF LIQUID VOID
20702100  NORMAREA          *VOL52-1
20702101  0.    0.    0.180      0.023      0.336      0.000
20702102  0.654       0.239      0.875      0.389      1.0        0.525
20502100  LIQH52-1          FUNCTION  1.   0.   1
20502101  VOIDF      052010000        021
20504200  LIQLEVUP          SUM       1.   0.   1
20504201  0.    0.170       VOIDF     051010000
20504202  1.0               CNTRLVAR  021
20504203  0.957             VOIDF     052020000
*LIQUID LEVEL IN CORE
20504300  LIQLCORE          SUM       0.360     0.   1
20504301  0.    1.    VOIDF      004010000
20504302  1.          VOIDF      004020000
20504303  1.          VOIDF      004030000
20504304  1.          VOIDF      004040000
20504305  1.          VOIDF      004050000
20504306  1.          VOIDF      004060000
20504307  1.          VOIDF      004070000
20504308  1.          VOIDF      004080000
20504309  1.          VOIDF      004090000
20504310  1.          VOIDF      004100000
*LIQUID LEVEL IN LOWER PLENUM
20504400  LIQLEVLP          SUM       1.   0.   1
20504401  0.    0.150       VOIDF     031010000
20504402  0.325             VOIDF    32010000
20504403  0.271             VOIDF    33010000
*
*ROD CLADDING TEMP SAVE UP
20506100  CLADTEMP1         MULT      1.   0.   1
20506101  HTTEMP      401000105       *ROD CLADDING INNER TEMP VOL1
20506200  CLADTEMP2         MULT      1.   0.   1
20506201  HTTEMP      402000105       *ROD CLADDING INNER TEMP VOL2
20506300  CLADTEMP3         MULT      1.   0.   1
20506301  HTTEMP      403000105       *ROD CLADDING INNER TEMP VOL3
20506400  CLADTEMP4         MULT      1.   0.   1
20506401  HTTEMP      404000105       *ROD CLADDING INNER TEMP VOL4
20506500  CLADTEMP5         MULT      1.   0.   1
20506501  HTTEMP      405000105       *ROD CLADDING INNER TEMP VOL5
20506600  CLADTEMP6         MULT      1.   0.   1
20506601  HTTEMP      406000105       *ROD CLADDING INNER TEMP VOL6
20506700  CLADTEMP7         MULT      1    0.   1
20506701  HTTEMP      407000105       *ROD CLADDING INNER TEMP VOL7
20506800  CLADTEMP8         MULT      1.   0    1
20506801  HTTEMP      408000105       *ROD CLADDING INNER TEMP VOL8
20506900  CLADTEMP9         MULT      1.   0    1
20506901  HTTEMP      409000105       *ROD CLADDING INNER TEMP VOL9
20507000  CLADTEMP10        MULT      1.   0    1
20507001  HTTEMP      410000106       *ROD CLADDING MIDDLE TEMP VOL10
*
*HEAT TRANSFER COEFF (HEAT RATE/(SURFACE TEMP-FLUID TEMP))
```

```
20508100  HTCOEF1   SUM        1.  0.   1
20508101     0.     1.            HTHTC     401000101
20508200  HTCOEF2   SUM        1.  0.   1
20508201     0.     1.            HTHTC     402000101
20508300  HTCOEF3   SUM        1.  0.   1
20508301     0.     1.            HTHTC     403000101
20508400  HTCOEF4   SUM        1.  0.   1
20508401     0.     1.            HTHTC     404000101
20508500  HTCOEF5   SUM        1.  0.   1
20508501     0.     1.            HTHTC     405000101
20508600  HTCOEF6   SUM        1.  0.   1
20508601     0.     1.            HTHTC     406000101
20508700  HTCOEF7   SUM        1.  0.   1
20508701     0.     1.            HTHTC     407000101
20508800  HTCOEF8   SUM        1.  0.   1
20508801     0.     1.            HTHTC     408000101
20508900  HTCOEF9   SUM        1.  0.   1
20508901     0.     1.            HTHTC     409000101
20509000  HTCOEF10  SUM        1.  0.   1
20509001     0.     1.            HTHTC     410000101
* LIQUID LEVEL CONTROL SYSTEM FOR DC (STEADY STATE ONLY)
3050000   LEVCTRVOL   TMDPVOL
3050101   1.  1.  0.  0.  0.  0.  0.  0.   00
3050200   2
3050201   0.     7.0E6   0.
*
4050000   LEVCTRJUN   TMDPJUN
4050101   305000000   071000000   0.2
4050200   1    0      CNTRLVAR  048
4050201   -1.      -1.      0.   0.
4050202    1.       1.      0.   0.
*
*
20504800   LEVCTR   SUM   1.   0.   0
20504801   6.412  -1.    CNTRLVAR  041
*
20504900   SSLEV   MULT   25.  0.   0  3   -2.   2.
20504901   CNTRLVAR  48
20504902   CNTRLVAR   1
*
*  SPRAY-FEED TEMPERATURE REGULATION
*  DEL-T=(DT/UU302)/5.15*DUSS*MFLOWJ404
*  DT/DU302=.000220 KG/J
*  DUSS=UG306-UF305=1.32 MJ/KG
20502800  DTSPRAY  INTEGRAL  -80.8  454.15  0  3  452.15  456.15
20502801  MFLOWJ   406000000
*
*  STEAM RELIEF MASS LOSS SAVE UP
20502900  SRVLOSS  INTEGRAL  1.  0.  1
20502901  MFLOWJ   404000000
*
3060000   RELIEF     TMDPVOL
3060101   0.00636   1.   0.   0.  90.   1.   0.   0.   00   *STEADY STATE
3060200   2
3060201   0.       6870000.   1.0   *REGULATED STEADY STATE
*
*
4060000   DOMECNTRL  VALVE      *STEADY STATE CARD
4060101   013010000        306000000      0.   0.   0.  1000  *STEADY STATE
4060201   1   0.   0.   0.   *STEADY STATE CARD
4060300   TRPVLV
4060301   601
*
*
*
```

```
20505000    STR-HTLOSS    SUM    1.     0.     1
20505001   0.     .17800    HTRNR   310000100
20505002          .26856    HTRNR   320000100
20505003          .22676    HTRNR   330000100
20505004          .14848    HTRNR   510000100
20505005          .17298    HTRNR   521000100
20505006          .20830    HTRNR   522000100
20505007          .21043    HTRNR   110000100
20505008         3.41578    HTRNR   121000100
20505009          .40000    HTRNR   122000100
20505010          .63460    HTRNR   211000100
20505011          .86641    HTRNR   212000100
20505012          .23731    HTRNR   213000100
20505013          .12180    HTRNR   214000100
20505014          .34363    HTRNR   710000100
20505015          .34363    HTRNR   710000200
20505016          .34363    HTRNR   710000300
20505017          .28234    HTRNR   710000400
20505018          .28234    HTRNR   710000500
20505019          .28234    HTRNR   710000600
20505020          .28234    HTRNR   710000700
20505100    STR-HTLOSS   SUM   1.    0     0
20505101   0.     .28234    HTRNR   710000800
20505102          .10330    HTRNR   720000100
20505103          .24653    HTRNR   730000100
20505104          .13286    HTRNR   740000100
20505105          .25890    HTRNR   740000200
20505106          .66634    HTRNR   740000300
20505107          .36632    HTRNR   740000400
20505108          .05500    HTRNR   745000100
20505109          .67130    HTRNR   620000100
20505110          .43072    HTRNR   640000100
20505111          .40766    HTRNR   640000200
20505112          .41621    HTRNR   640000300
20505113          .26880    HTRNR   810000100
20505114          .50000    HTRNR   201000100
20505115         -.22751    HTRNR   311000101
20505116         -.51458    HTRNR   311000201
20505117         -.43102    HTRNR   311000301
20505118         -.18599    HTRNR   811000101
20505119          .30000    HTRNR   202000100
20505120          .31046    HTRNR   820000100
*
20505200    STR-HTLOSS   SUM   1.    0.    0
20505201   0.     .18383    HTRNR   840000100
20505202          .26013    HTRNR   850000100
20505203          .34198    HTRNR   960000100
20505204          .41969    HTRNR   870000100
20505205          .27382    HTRNR   880000100
20505206          .36224    HTRNR   891000100
20505207          .05500    HTRNR   892000100
*
20505300   TOTAL      SUM    1.   0.    0.
20505301   0.    1.    CNTRLVAR 50
20505302         1.    CNTRLVAR 51
20505303         1.    CNTRLVAR 52
*
20505400   STR-HTINT    INTEGRAL    1.    0.    0
20505401   CNTRLVAR   50
*
20505500   BREAK-LOSS   INTEGRAL    1.    0.    0
20505501   MFLOWJ   152000000
*
20505600    BOX-HTLOSS     SUM     1.     0.     0
20505601    0.     .150       HTRNR       400000100
```

```
20505602          .150        HTRNR      400000200
20505603          .150        HTRNR      400000300
20505604          .150        HTRNR      400000400
20505605          .150        HTRNR      400000500
20505606          .150        HTRNR      400000600
20505607          .150        HTRNR      400000700
20505608          .150        HTRNR      400000800
20505609          .150        HTRNR      400000900
20505610          .150        HTRNR      400001000
*
20505700    COR-POW       FUNCTION     1.          0.     0
20505701    TIME    0       001
*
20505800    BYPASS-POW    FUNCTION    1.         0.     0
20505801    TIME      0       002
*
20505900    TOT-POW        SUM     1.     0.     0
20505901    0.           1.     CNTRLVAR 57
20505902                 1.     CNTRLVAR 58
*
20506000   BREAK-LOSS   INTEGRAL   1.   0.   0
20506001   MFLOWJ   151000000
*
*
*********** INITIAL VALUES
*
0310200    3     7067230.  542.44
0320200    3     7065410.  542.32
0330200    3     7063160.  542.10
0510200    2     6997000.  0.07627
0130200    2     6970000.  1.0
0720200    3     7007320.  543.27
0730200    3     7011380.  543.21
0620200    3     7026950.  539 00
0910200    3     7008660.  543.05
0920200    3     7008730.  539.67
0940200    3     7011350.  542.90
0950200    3     7024150.  542.55
0960200    3     7072960.  400.
0970200    3     7071130.  542.10
0980200    3     7065110.  400.
2010200    3     7072020.  543.10
2020200    3     7061580.  542.77
0041201    3     7029080.  546.78    0.       0.       0.   1
0041202    2     7025560.  0.007889  0.       0.       0.   2
0041203    2     7022150.  0.019922  0.       0.       0.   3
0041204    2     7019260.  0.038597  0.       0.       0.   4
0041205    2     7015620.  0.060237  0.       0.       0.   5
0041206    2     7011610.  0.081132  0.       0.       0.   6
0041207    2     7007200.  0.099708  0.       0.       0.   7
0041208    2     7002430.  0.12384   0.       0.       0.   8
0041209    2     6996460.  0.15144   0.       0.       0.   9
0041210    2     6992610.  0.14148   0.       0.       0.   10
0521201    2     6990640.  0.074352  0.       0.       0.    1
0521202    2     6971140.  0.17403   0.       0.       0.    2
0111201    2     6571090.  0.85025   0        0.       0.    1
0121201    2     6970500.  0.77374   0.       0.       0.    1
0121202    2     6969990.  0.72654   0        0.       0.    2
0211201    2     6971470   0 23091   0.       0.       0.    1
0211202    2     6973090.  0.02366   0.       0.       0.    2
0211203    2     6975540.  0 0       0.       0.       0.    3
0211204    3     6977140.  543.64    0.       0.       0.    4
0711201    3     6980000.  543.40    0.       0.       0.    6
0741201    3     7065300.  542.82    0.       0.       0.    5
0641201    3     7016790.  545.55    0.       0.       0.    1
```

```
0641202  3    7006350   553.00    0.     0      0    2
0641203  3    6996760   556.50    0.     0.     0.   3
0901201  3    7065440   541.50    0.     0.   . 0.   2
*
*  JUNCTION INITIAL VALUES
0041300   0
0041301  1.252     1.454    0.    1   1.406     1.618    0.    2
0041302  1.708     2.021    0.    3   2.140     2.645    0.    4
0041303  2.647     3.262    0.    5   3.114     4.004    0.    6
0041304  3.505     4.652    0.    7   4.050     5.441    0.    8
0041305  4.711     5.066    0.    9
0521300  1
0521301  6.188     1.002     0.   1
0131300  1
0131301 -3.54       .19    0.    1
0211300  1
0211301  0.62    0.      0.   3
0711300  1
0711301  11.42   0.    0.    7
0741300  1
0741301  4.74   0.    0.    4
0641300  1
0641301  0.67    0.    0.  2
0901300  1
0901301  1.53     0    0.      1
*
.
```

Transient input, Case A

```
*        INPUT FOR RELAP5/MOD2
*        FIX-II GUILLOTINE BREAK RESTART (TEST NO 5061)
*        200 % SPLIT BREAK               (FILE FIX6A1)
*
0000100   RESTART  TRANSNT
0000101   RUN
0000103   405
0000105   10.       20.
0000201  23.  1.0E-8    .0625     00001    16  1000  1000
*
*
*********************
*
*    TRIPS
*
0000501   TIME      0            GE   NULL 0     0.    L  *STEADY STATE
*
.  END
```

Steady state input, Case B

```
*        INPUT FOR RELAP5/MOD1
*        FIX-II GUILLOTINE BREAK RESTART (TEST NO. 5061)
*        200 % SPLIT BREAK                (FILE FIX6B5)
*        CASE B, RESTART FROM CASE A STEADY STATE
*
0000100  RESTART  STDY-ST
0000101  RUN
0000103  405
0000105  10.      20.
0000201  40.  1.0E-8   .0625    00001    8  400  400
*
*
**********************
*
*    TRIPS
*
0000501  TIME     0            GE   NULL 0   50.   L  *STEADY STATE
*
************************
*
*  VOL11 AND VOL12 MADE 4.0 TIMES HIGHER FOR MORE TMASS
*
0110000  VOL11     ANNULUS
0110001  1
0110101  0.0  1
0110301  2.2224 1
0110401  0.00270 1
0110601  90.  1
0110801  0.   0.   1
0111001  00 1
************************
*
0120000  VOL12     PIPE
0120001  2
0120101  0.0  2
0120301  10.30    1    .024     2
0120401  0.42200  1    0.02410  2
0120601  90.  2
0120801  0.   0.   2
0121001  00   1    01   2
0121101  1000 1
************************
*
1070000  JUN11-21  SNGLJUN
1070101  011000000 021000000 0.0     0.0     0.0     1000
1070201  1         4.460   -1.110    0.
************************
*
1080000  JUN12-11  SNGLJUN
1080101  012000000 011010000 0.      0.      0.      1000
1080201  1         4.460   -1.110    0.
************************
*
4050000  LEVCTRJUN   TMDPJUN
4050101  205000000   021000000   0.2
4050200  1     0     CNTRLVAR  010
4050201  -1.     -1.    .05    0.
4050202   1.      1.   -.05    0.
*
*  ASSUMED QUALITY FOR MTOT=210 KG
0111201  2    6971090.  0.15000   0.     0.     0.   1
0121201  2    6970500.  0.40000   0.     0.     0.   1
0121202  2    6969990.  0.35000   0.     0.     0.   2
*
0121300  1
0121301  -4.460     1.110  0   1
.  END
```

Steady state input, Case C

```
*        INPUT FOR RELAP5/MOD2
*        FIX-II GUILLOTINE BREAK RESTART (TEST NO 5061)
*        200 % SPLIT BREAK                (FILE FIX5CS)
*        CASE C, RESTART FROM CASE B STEADY STATE
*
0000100  RESTART  STDY-ST
0000101  RUN
0000103  885
0000105  10.       20.
0000201  20.  1.0E-6   .0625    00001    16  1000  1000
*
*
*********************
*
*     TRIPS
*
0000501  TIME      0            GE   NULL 0    75.    L  *STEADY STATE
*
************************
*
************************
*
2010000  PUMP1     PUMP
2010101  0.        0.750    0.01010   0.    10.4 0.203     0
2010108  012010000   0.00427   0.27     0.27      0000
2010109  014000000   0.000500  .0       .0        0120
2010200  3     7003070.  543.66
2010201  1     4.74  0.   0.
2010202  1     4.74  0.   0.
2010301  0     0     0   -1    0     0     0
2010302  303.89  0.5260    0.0303   50.   81.7    1.   1000.
2010303  0.    0.    0.    0.    0.
*  NYA HOMOLOGA PUMPKURVOR, DATA KOMMER FRAN ASEA-ATOMS DOBLIN-DER.
*  TORQUE KURVORNA SAKNAR BETYDELSE I DETTA FALL OCH HAR DARFOR INTE
* KONTROLLERATS. KALLAN FOR EN DEL DATA AR OKAND.
2011100  1     1
2011101  0.00,1.101     0.27,1.100     0.47,1.160
2011102  0.64,1.130     1.00,1.000
2011200  2     1
2011201  0.00,0.04      0.09,0.07      0.19,0.09
2011202  0.30,0.12      0.59,0.962     0.80,0.99      1.00,1.00
2011300  1     2
2011301  0.0,-0.560     0.41,-0.16     0.51,-0.05     0.76,0.48
2011302  1.00,1.00
2011400  2     2
2011401  0.0,-1.16      0.5,0.00       0.80,0.30      1.00,1.00
2011500  1     3
2011501    -1.00,2.00   -0.95,1.01     -0.82,1.52     -0.50,1.39
2011502     0.00,1.18
2011600  1     4
2011601    -1.00,2.00   -0.79,1.53     -0.63,1.25     -0.30,0.93
2011602     0.00,0.72
2011700  2     3
2011701    -1.00,3.31   -0.83,2.70     -0.68,2.29     -0.56,1.95
2011702    -0.37,1.49   -0.22,1.19     -0.10,0.99      0.00,0.84
2011800  2     4
2011801    -1.00,3.31   -0.79,2.70     -0.59,2.37     -0.41,2.04
2011802    -0.21,1.70    0.00,1.55
* TWO PHASE MULTIPLIER TABLES
2013000    0
2013001  0.0,0.0  0.1,0.0  0.15,0.05  0.24,0.8  0.3,0.96  0.4,0.98
2013002  0.6,0.97  0.8,0.9  0.9,0.8  0.96,0.5  1.0,0.0
2013100    0
2013101  0.0,0.0  0.1,0.0  0.15,0.05  0.24,0.8  0.3,0.96  0.4,0.98
2013102  0.6,0.97  0.8,0.9  0.9,0.8  0.96,0.5  1.0,0.0
```

```
* TWO PHASE DIFFERENCE FOR PUMP HEAD (SEMISCALE)
2014100   1   1
2014101 0.0,0.0  0.1,0.83  0.2,1.09  0.5,1.02  0.7,1.01  0.9,0.94  1.0,1.
2014200   1   2
2014201 0.0,0.0  0.1,-0.04  0.2,0.0  0.3,0.1  0.4,0.21  0.8,0.67
2014202 0.9,0.80  1.0,1.0
2014300   1   3
2014301 -1.0,-1.16  -0.9,-1.24  -0.8,-1.77  -0.7,-2.36  -0.6,-2.79
2014302 -0.5,-3.0  -0.4,-2.67  -0.25,-1.69  -0.1,-0.5  0.0,0.0
2014400   1   4
2014401 -1.0,-1.16  -0.9,-0.78  -0.8,-0.5  -0.7,-0.31  -0.6,-0.17
2014402 -0.5,-0.08  -0.35,0.0  -0.2,0.05  -0.1,0.08  0.0,0.11
* TWO PHASE DIFFERENCE FOR PUMP TORQUE (= SINGLE PHASE, WHICH MEANS
* THAT FULLY DEGRADED TORQUE IS ZERO)
2014900   2     1
2014901   0.00,0.04      0.09,0.07      0.19,0.09
2014902   0.30,0.12      0.59,0.962     0.80,0.99      1.00,1.00
2015000   2     2
2015001   0.0,-1.16      0.5,0.00       0.80,0.30      1.00,1.00
2015100   2     3
2015101     -1.00,3.31   -0.83,2.70     -0.68,2.29     -0.56,1.95
2015102     -0.37,1.49   -0.22,1.19     -0.10,0.99      0.00,0.84
2015200   2     4
2015201     -1.00,3.31   -0.79,2.70     -0.59,2.37     -0.41,2.04
2015202     -0.21,1.70    0.00,1.55
** PUMP1 REGULATOR
2016100   0            CNTRLVAR  006
2016101   0.    0.           1000.      1000.
**********************
*
2020000   PUMP2      PUMP
2020101   0.         0.700     0.00500   0.    72.0 0.220     0
2020108.  094010000    0.0019     0.35      0.35      0000
2020109   095000000    0.000310    .0        .0      0120
2020200   3     7072610.   543.31
2020201   1     1.53 0.    0.
2020202   1     1.53 0.    0.
2020301   0     0     -1    -1    0     0     0
2020302   303.69     0.6910     0.01056    25.       13.2       1.         1000
2020303   0.    0.    0.    0.    0.
2021100   1     1
2021101   0.0  1.135      0.2  1.135      0.4  1.120
2021102   0.6  1.100      0.8  1.055      1.0  1.000
2021200   2     1
2021201   0.0  0.81       1.0  1.00
2021300   1     2
2021301   0.0 -0.580      0.2 -0.305      0.4 -0.150      0.6 -0.055
2021302   0.6  0.145      0.8  0.565      1.0  1.000
2021400   2     2
2021401   0.0 -0.47       0.2 -0.21       0.4  0.07
2021402   0.6  0.35       0.8  0.66       1.0  1.00
2021500   1     3
2021501     -1.00,2.00    -0.95,1.01     -0.82,1.57     -0.50,1.39
2021502      0.00,1.136
2021600   1     4
2021601     -1.00,2.00    -0.79,1.53     -0.63,1.25     -0.30,0.93
2021602      0.00,0.72
2021700   2     3
2021701     -1.00,3.31    -0.83,2.77     -0.68,2.29     -0.56,1.95
2021702     -0.37,1.49    -0.22,1.19     -0.10,0.99      0.00,0.81
2021800   2     4
2021801     -1.00,3.31    -0.79,2.70     -0.59,2.37     -0.41,2.04
2021802     -0.21,1.70     0.00,1.55
2023000   0
2023001   0.0 0.00  0.1 0.00  0.2 0.05  0.3 0.80  0.4 0.94  0.5 0.98
```

```
2023002   0.6 0.97  0.7 0.90  0.8 0.80  0.9 0.50  1.0 0.00
2023100   0
2023101   0.0 0.00  0.1 0.10  0.2 0.15  0.3 0.24  0.4 0.30  0.5 0.40
2023102   0.6 0.60  0.7 0.80  0.8 0.90  0.9 0.96  1.0 1.00
** PUMP2 REGULATOR                                    *STEADY STATE CARD
2026100   0            CNTRLVAR  010
2026101   0.    0.           1000.      1000.
************************
*
.  END
```

Steady state input, Case D

```
*       INPUT FOR RELAP5/MOD2
*       FIX-II GUILLOTINE BREAK RESTART (TEST NO  5061)
*       200 % SPLIT BREAK                 (FILE FIX6D5)
*       CASE D. RESTART FROM CASE B STEADY STATE
*
0000100  RESTART  STDY-ST
0000101  RUN
0000103  885
0000105  10.        20.
0000201  70.  1.0E-6    .0020    00001    10  1000  1000
*
*
**********************
*
*    TRIPS
*
0000501  TIME     0          GE   NULL 0   75.   L  *STEADY STATE
*
************************
*
0210000  VOL21     ANNULUS
0210001  8
0210101  0.0  8
0210201  0.   1   0.038132   2   0.   7
0210301  0.404 1  0.549 2  .0718 6  .0730 8
0210401  0.07509 1     0.04305 2     0.003125 6     0.002635 8
0210601  -90. 8
0210801  0. 0.3960 1   0. 0.2692 2   0. 0.1016 6   0. 0.1117 8
0210901  0.   0.   1  0.96  0.96  2  0.   0.   7
0211001  00 8
0211101  1000 7
************************
*
0710000  VOL71     PIPE
0710001  16
0710101  0.0  16
0710301  .45935 8   .40990 16
0710401  0.004573 8 0.003063 16
0710601  0. 8 -90. 16
0710801  0. 0. 16
0710901  0.00 0.00 5    0.10 0.10 6    0.00 0.00 15
0711001  00 16
0711101  1000  15
************************
*
0950000  VOL95     PIPE
0950001  2
0950101  0.0  2
0950301  0.0418 2
0950401  0.00158  2
0950601  14.2  2
0950701  .2085  2
0950801  0. 0. 2
0950901  0.00 0.00 1
0951001  00 2
0951101  1000  1
************************
*
0960000  VOL96     PIPE
0960001  3
0960101  0.0  3
0960301  0.4917 3
0960401  0.002097 3
0960601  0. 3
0960801  0. 0. 3
```

```
0960901  0.00 0.00 2
0961001  00 3
0961101  1000  2
************************
*
12130000  4   4   2   1   .132
12130100  0   2
12130101  0.005  1   0.018  2   0.01   3
12130201  3   3
12130301  .0  3
12130401  560.  4
12130501  21030000  010000   1   1   .0718  4
12130601 -13   0  3014  1    .0718  4
12130701  0   .0   .0   .0   4
12130801  0   .0   .0   .0   4
*
12140000  2   4   2   1   .132
12140100  0   2
12140101  0.005  1   0.018  2   0.01   3
12140201  3   3
12140301  .0  3
12140401  560.  4
12140501  21070000  010000   1   1   .073   2
12140601 -13   0  3014   1    .073   2
12140701  0   .0   .0   .0   2
12140801  0   .0   .0   .0   2
*
17100000  16  3   2   1   .0140
17100100  0   1
17100101  2   .0707
17100201  3   2
17100301  .0  2
17100401  560.   3
17100501  71010000  010000   1   1   0.45935 8
17100502  71070000  010000   1   1   0.4099 16
17100601 -13   0  3014   1    0.45935 8
17100602 -13   0  3014   1    0.4099 16
17100701  0   .0   .0   .0  16
17100801  0   .0   .0   .0  16
*
19500000  2   3   2   1   .0240
19500100  0   1
19500101  2   .0301
19500201  3   2
19500301  .0  2
19500401  560.   2
19500501  95010000  010000   1   1   .0418   2
19500601 -13   0  3014   1    .0418   2
19500701  0   .0   .0   .0   2
19500801  0   .0   .0   .0   2
*
19600000  3   3   2   1   .0369
19600100  0   1
19600101  2   .0445
19600201  3   2
19600301  .0  2
19600401  560.0   3
19600501  96010000   010000   1   1   .4917  3
19600601    0      0    0    1    .4917  3
19600701  0         0.  0.  0.          3
19600801  0         0.  0.  0.          3
*
0211201   2    6902560.  0.24309   0.     0.     0.   1
0211202   2    6903950.  0.02756   0.     0.     0.   2
0211203   2    6906340.  0.0       0.     0.     0.   8
```

```
0211204   3    6907940.  543.97    0.     0.     0.   8
0711201   3    6906110.  543.94    0      0      0    2
0711202   3    6906000.  543.90    0      0      0.   4
0711203   3    6905900   543.87    0      0      0    6
0711204   3    6900850.  543.84    0      0.     0    8
0711205   3    6994950.  543.82    0      0.     0.  10
0711206   3    7001030.  543.79    0.     0.     0.  12
0711207   3    7007160.  543.77    0.     0.     0   14
0711208   3    7013260.  543.74    0.     0.     0.  16
0951201   3    7065410.  547.13    0.     0.     0.   2
0961201   3    7073250.  400.      0      0.     0.   3
*
0211300   1
0211301   9.62     0.      0.   7
0711300   1
0711301   11.42    0.    0.   15
0951300   1
0951301   1.53     0.    0.    1
0961300   1
0961301   0.0      0.    0.    2
.   END
```

APPENDIX B

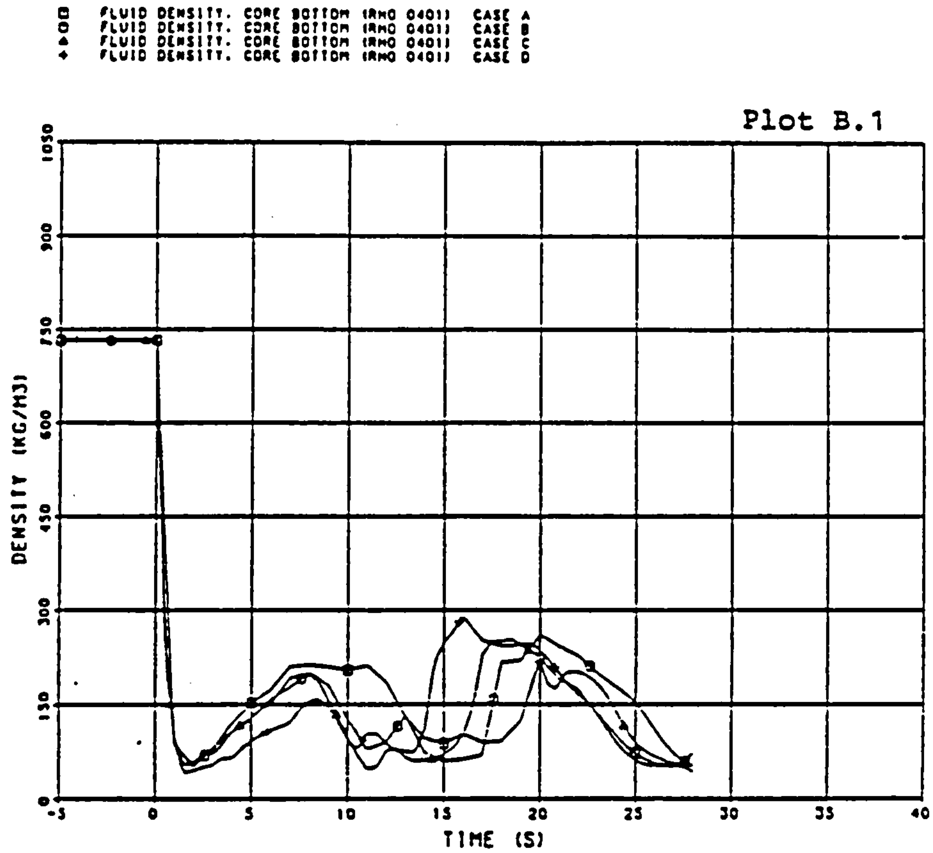
Data comparison plots

```
PLOT    IDENT.  QUANTITY        (EXPERIMENT)
NO.                             (CALCULATIONS)
-------------------------------------------------------------------

B. 1    ----     - - - - - - - - - -
        RH1?    FLUID DENSITY, CORE BOTTOM (RHO 0401)  CASE ?

B. 2    D  4    DIFF. PRESSURE, CORE INLET RESTRICTION (DPT 4) - EXPERIMENT
        PD4?    DIFF PRESSURE, CORE INLET RESTRICTION (P 3301 - P 401)  CASE ?

B. 3    X801    ELECTRIC POWER, CORE - EXPERIMENT
        HP1?    CORE HEATING POWER (CNTRLVAR 57)  CASE ?
        HL1?    HEAT LOSS FROM PASSIVES (CNTRLVAR 53)  CASE ?

B. 4    TC 1    MEAN CLAD TEMP., LEVEL 1 (T191 T206 T211 T246) - EXPERIMENT
        HT1?    MEAN CLAD TEMPERATURE, LEVEL 1 (HTTEMP 401000105)  CASE ?

B. 5    TC 3    MEAN CLAD TEMP., LEVEL 3 (T108 T183 T243 T248) - EXPERIMENT
        HT2?    MEAN CLAD TEMPERATURE, LEVEL 3 (HTTEMP 403000105)  CASE ?

B. 6    TC 5    MEAN CLAD TEMP., LEVEL 5 (T202 T227 T232 T237 T252) - EXPERIMENT
        HT3?    MEAN CLAD TEMPERATURE, LEVEL 5 (HTTEMP 404000105)  CASE ?

B. 7    TC 7    MEAN CLAD TEMP., LEVEL 7 (T101 TO T271, 16 RODS) - EXPERIMENT
        HT4?    MEAN CLAD TEMPERATURE, LEVEL 5 (HTTEMP 405000105)  CASE ?

B. 8    TC 9    MEAN CLAD TEMP., LEVEL 9 (T102 T137 T167 T172 T187 T197 T272) - EXPERIMENT
        HT5?    MEAN CLAD TEMPERATURE, LEVEL 9 (HTTEMP 406000105)  CASE ?

B. 9    TC12    MEAN CLAD TEMP., LEVEL 12 (T118 T123 T128 T148 T223) - EXPERIMENT
        HT6?    MEAN CLAD TEMPERATURE, LEVEL 12 (HTTEMP 408000105)  CASE ?

B.10    TC15    MEAN CLAD TEMP., LEVEL 15 (T175 T190 T275) - EXPERIMENT
        HT7?    MEAN CLAD TEMPERATURE, LEVEL 15 (HTTEMP 410000105)  CASE ?

B.11    T  3    FLUID TEMPERATURE, CORE INLET (TE 3) - EXPERIMENT
        TF1?    FLUID TEMPERATURE, CORE INLET (TEMPF 3301)  CASE ?

B.12    T 14    FLUID TEMPERATURE, CORE OUTLET (TE 14) - EXPERIMENT
        TF2?    FLUID TEMPERATURE, CORE OUTLET (TEMPF 5101)  CASE ?

B.13    D CO    DIFF. PRESSURE, CORE (DPT 5 + DPT 6 + .... + DPT 12) - EXPERIMENT
        PDC?    DIFF PRESSURE, CORE (FROM  P 401 - P 5101)  CASE ?

B.14    ----     - - - - - - - - - -
        RH2?    FLUID DENSITY, VESSEL BOTTOM (RHO 3101)  CASE ?

B.15    D DC    DIFF. PRESSURE, DOWNCOMER (DPT 27 + .... + DPT 30) - EXPERIMENT
        PDD?    DIFF PRESSURE, DOWNCOMER (FROM  P 7103 - P 7201)  CASE ?

B.16    D LP    DIFF. PRESSURE, LOWER PLENUM (DPT 2 + DPT 3 - DPT 1) - EXPERIMENT
        PDL?    DIFF PRESSURE, LOWER PLENUM (FROM  P 3101 - P 3301)  CASE ?

B.17    D UP    DIFF. PRESSURE, UPPER PLENUM (DPT 13 + DPT 14) - EXPERIMENT
        PDU?    DIFF PRESSURE, UPPER PLENUM (FROM  P 5101 - P 5201)  CASE ?

B.18    D 56    DIFF. PRESSURE, STEAM SEPARATOR ORIFICE (DPT 56) - EXPERIMENT
        PDS?    DIFF PRESSURE, STEAM SEPARATOR ORIFICE (P 5201 - P 5202)  CASE ?

B.19    T 31    FLUID TEMPERATURE, DOWN COMER BOTTOM (TE 31) - EXPERIMENT
        TF3?    FLUID TEMPERATURE, DOWNCOMER BOTTOM (TEMPF 7108)  CASE ?
```

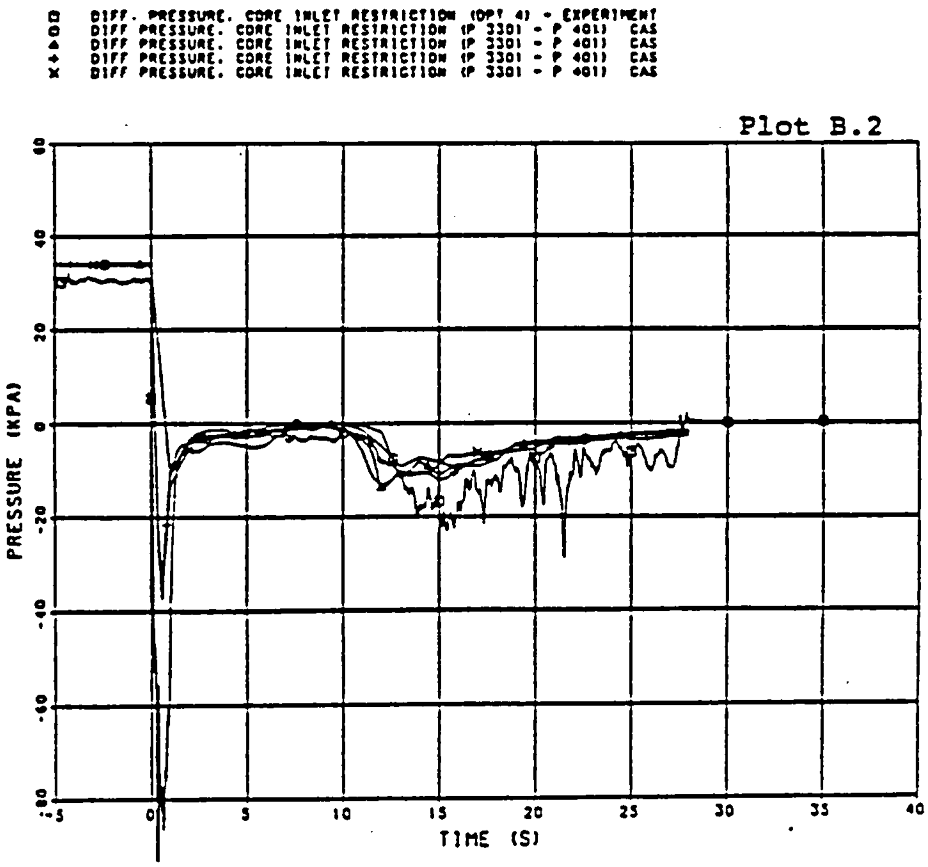
PLOT NO.	IDENT.	QUANTITY (EXPERIMENT) (CALCULATIONS)
B.20	T 15	FLUID TEMPERATURE. UPPER PLENUM (TE 15) - EXPERIMENT
	TF4?	FLUID TEMPERTURE. UPPER PLENUM (TEMPF 5201) CASE ?
B.21	P 3	PRESSURE. LOWER PLENUM (PT 3) - EXPERIMENT
	P 1?	PRESSURE LOWER PLENUM (P 3101) CASE ?
B.22	P 4	PRESSURE. UPPER PLENUM (PT 4) - EXPERIMENT
	P 2?	PRESSURE. UPPER PLENUM (P 5201) CASE ?
B.23	X602	MASS FLOW RATE. BYPASS - EXPERIMENT
	MF1?	MASS FLOW RATE. BYPASS (MFLOWJ 117) CASE ?
B.24	X603	MASS FLOW RATE. I.L. PUMP - EXPERIMENT
	MF2?	MASS FLOW RATE. I.L. PUMP (MFLOWJ 20102) CASE ?
B.25	X604	MASS FLOW RATE. B.L. PUMP - EXPERIMENT
	MF3?	MASS FLOW RATE. B.L. PUMP (MFLOWJ 20202) CASE ?
B.26	X610	MASS FLOW RATE. B.L. VESSEL INLET (SPOOL PIECE K10) - EXPERIMENT
	MF4?	MASS FLOW RATE. B.L. VESSEL INLET (MFLOWJ 9901) CASE ?
B.27	----	- - - - - - - - - - -
	MAT?	TOTAL MASS. IN SYSTEM CASE ?
B.28	X607	MASS FLOW RATE. STEAM RELIEF - EXPERIMENT
	MF5?	MASS FLOW RATE. STEAM RELIEF (MFLOWJ 404) CASE ?
B.29	----	- - - - - - - - - - -
	RM3?	FLUID DENSITY. BREAK (RHO 9601) CASE ?
B.30	X636	MASS FLOW RATE. BREAK FROM T2 INVENTORY - EXPERIMENT
	MF6?	MASS FLOW RATE. BREAK (MFLOWJ 152) CASE ?
B.31	----	- - - - - - - - - - -
	MF7?	MASS FLOW RATE. BREAK (MFLOWJ 151) CASE ?
B.32	X671	MASS LOSS. BREAK FLOW RECIEVER T2 - EXPERIMENT
	ML1?	BREAK TOTAL MASS LOSS (CNTRLVAR 55) CASE ?
B.33	----	- - - - - - - - - - -
	ML2?	BREAK TOTAL MASS LOSS (CNTRLVAR 60) CASE ?
B.34	T 34	FLUID TEMPERATURE. BREAK INLET (TE 34) - EXPERIMENT
	TF5?	FLUID TEMPERTURE. BREAK INLET (TEMPF 9601) CASE ?
B.35	----	- - - - - - - - - - -
	TSU?	SUBCOOLING. BREAK INLET (TEMPG 9101 - TEMPF 9101) CASE ?
B.36	P 6	PRESSURE. BREAK INLET (PT 6) - EXPERIMENT
	P 3?	PRESSURE. BREAK INLET (P 9601) CASE ?
B.37	----	- - - - - - - - - - -
	CPU?	CPUTIME CASE ?
B.38	----	- - - - - - - - - - -
	MAE?	MASS ERROR CASE ?

RELAP5/MOD2 CALCULATION FOR FIX-II. EXP 5061

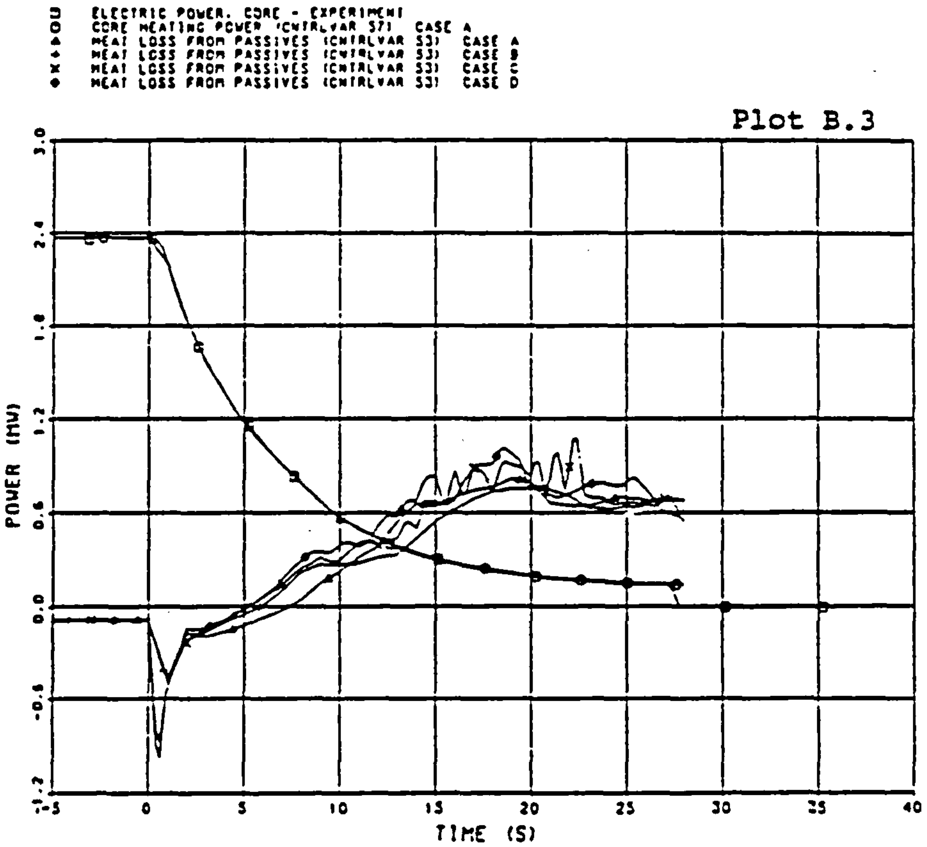
Plot B.1



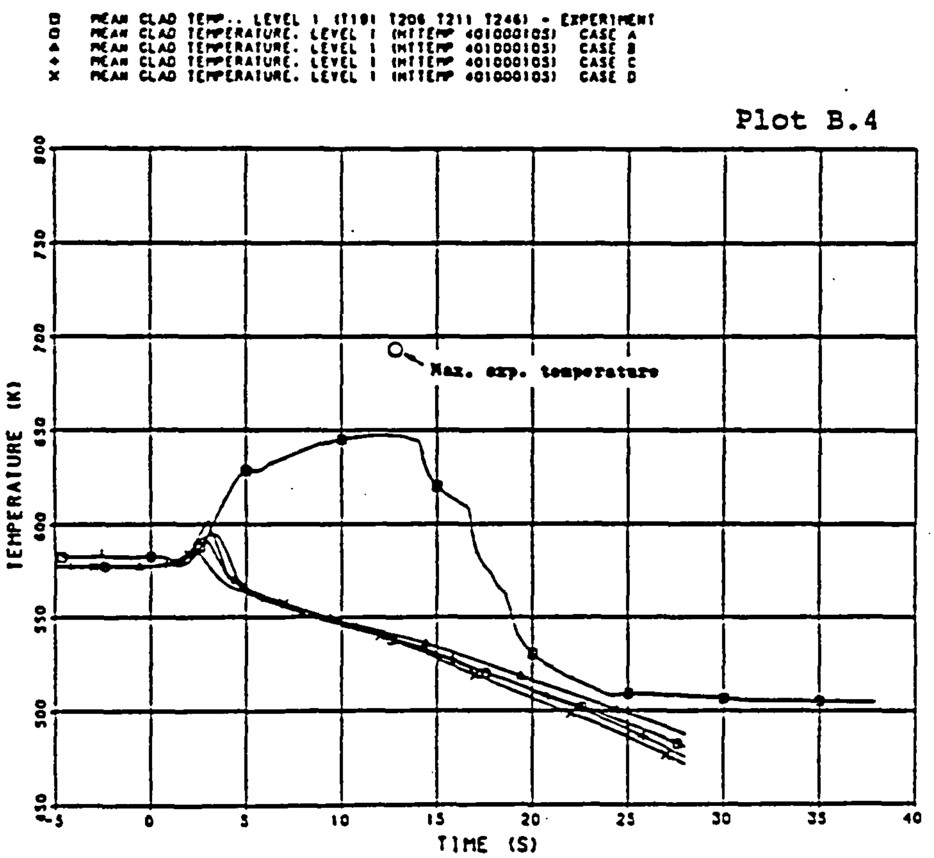
Plot B.2



RELAP5/MOD2 CALCULATION FOR FIX-II. EXP 5061

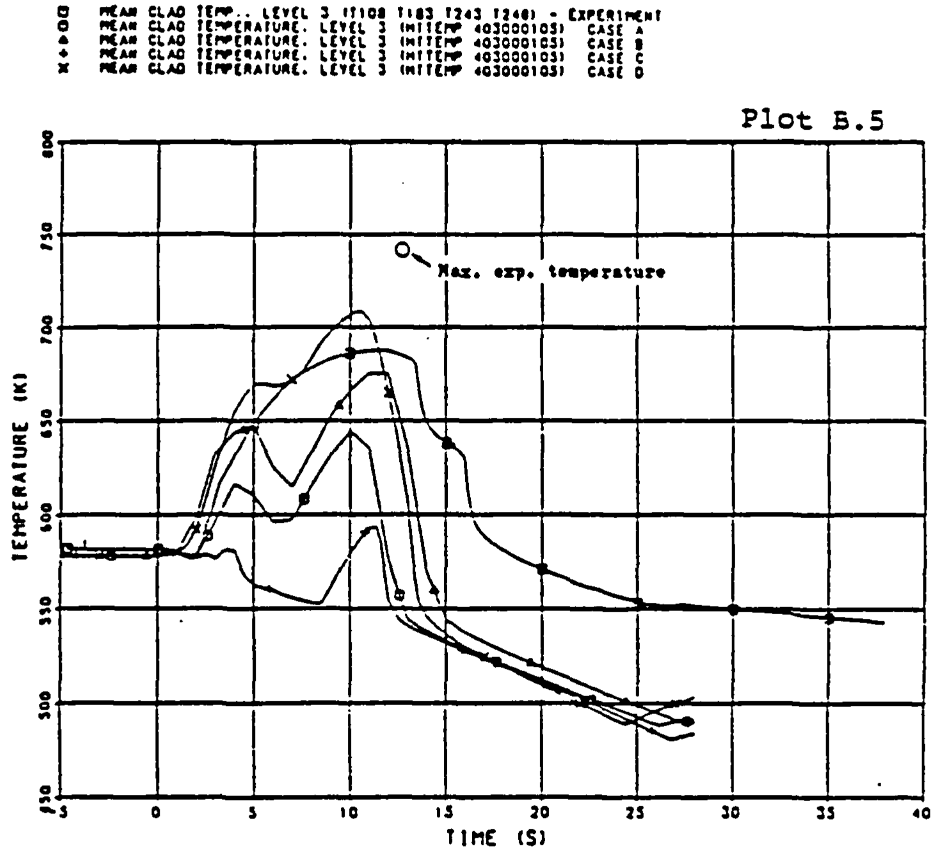


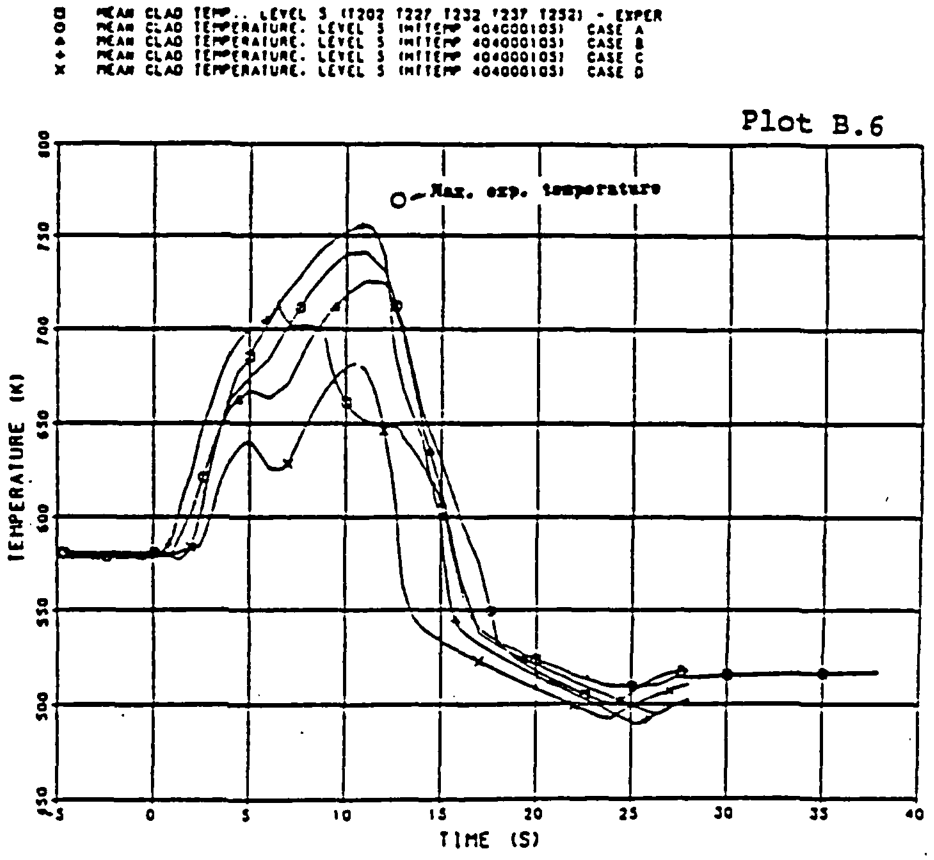
Plot B.3



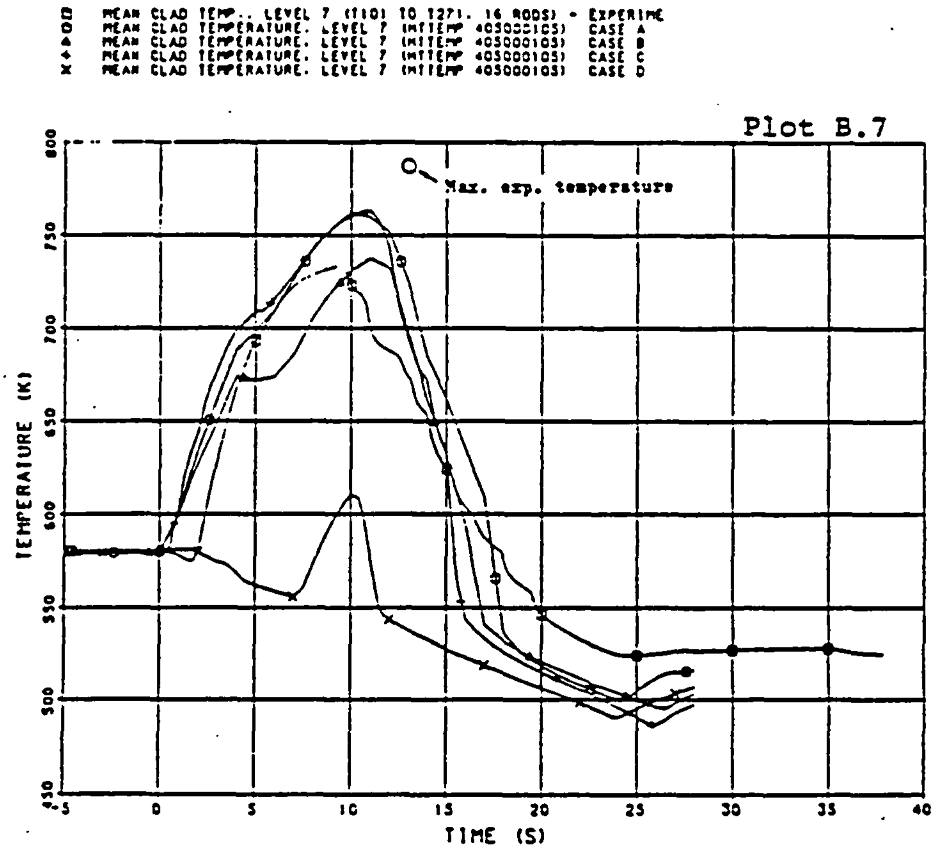
Plot B.4

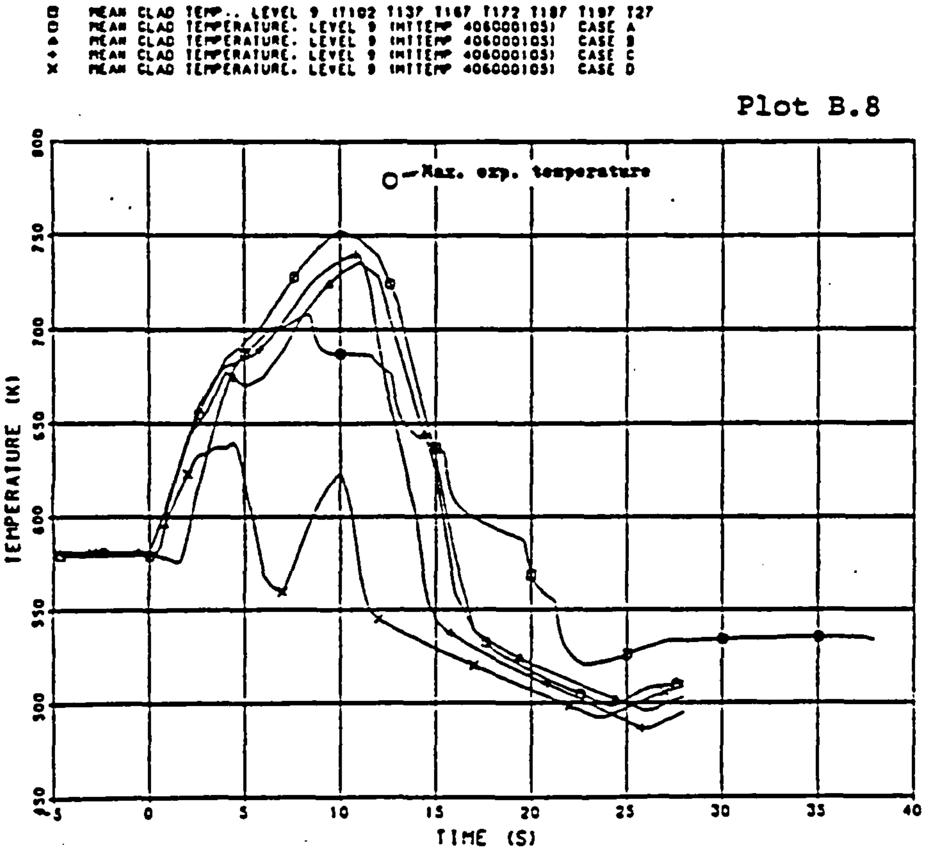
RELAP5/MOD2 CALCULATION FOR FIX-II. EXP 5061


Plot B.5

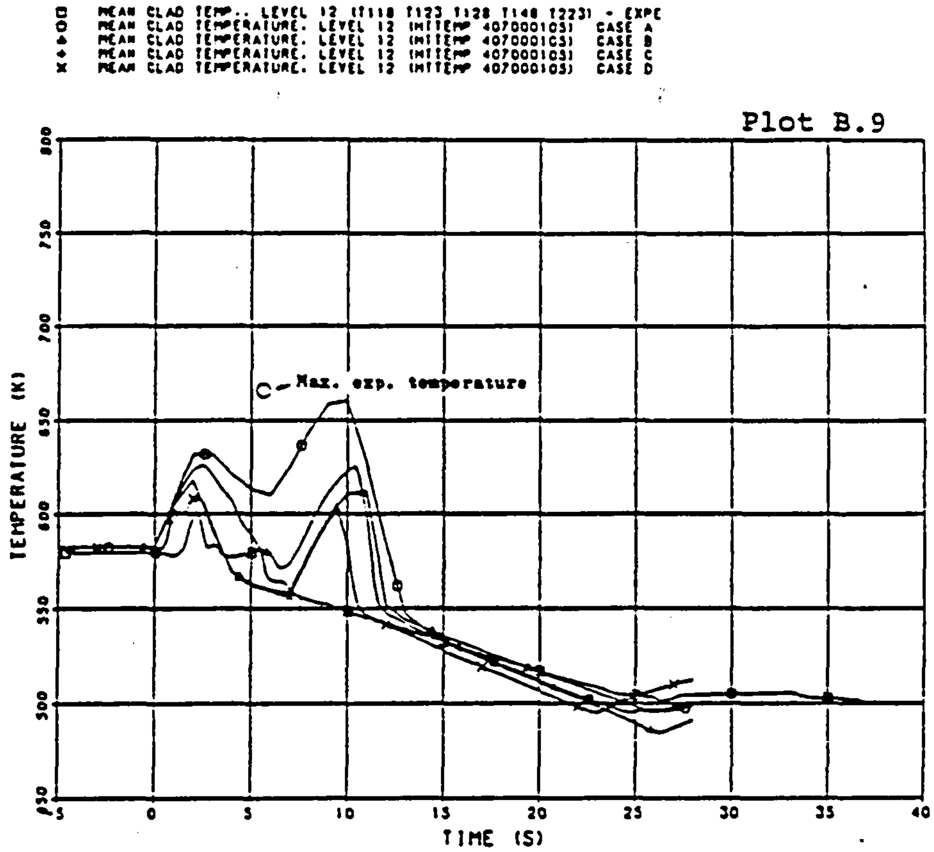

Plot B.6

RELAP5/MOD2 CALCULATION FOR FIX-II. EXP 5061

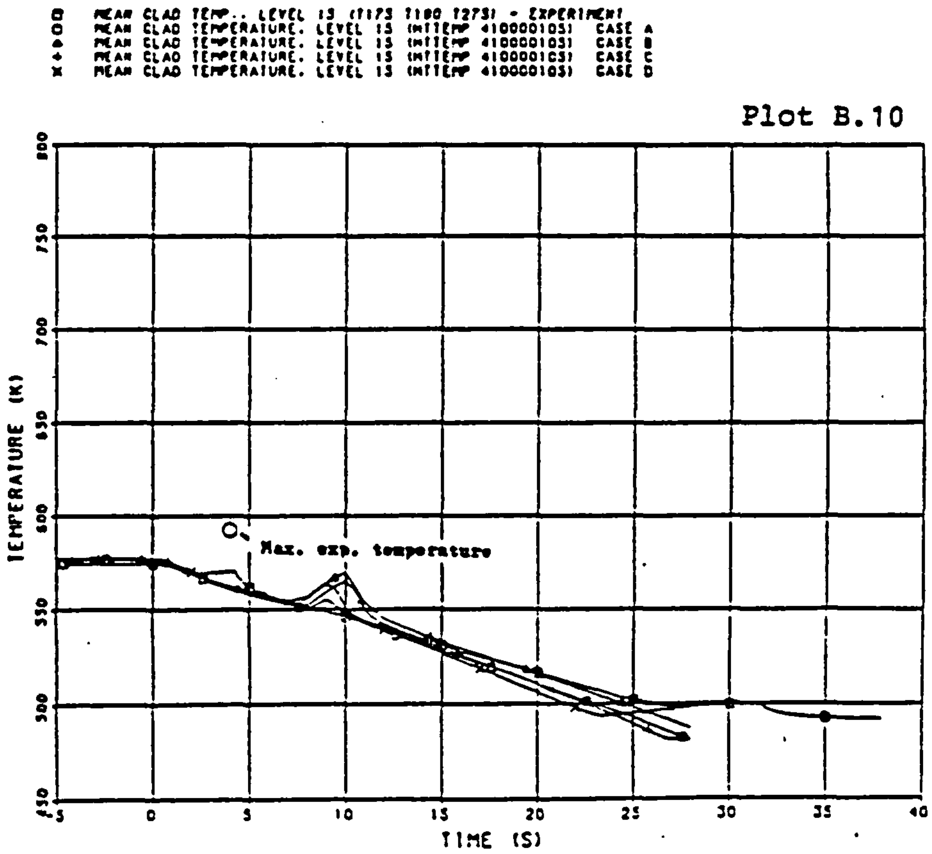

Plot B.7


Plot B.8

RELAP5/MOD2 CALCULATION FOR FIX-II. EXP 5061

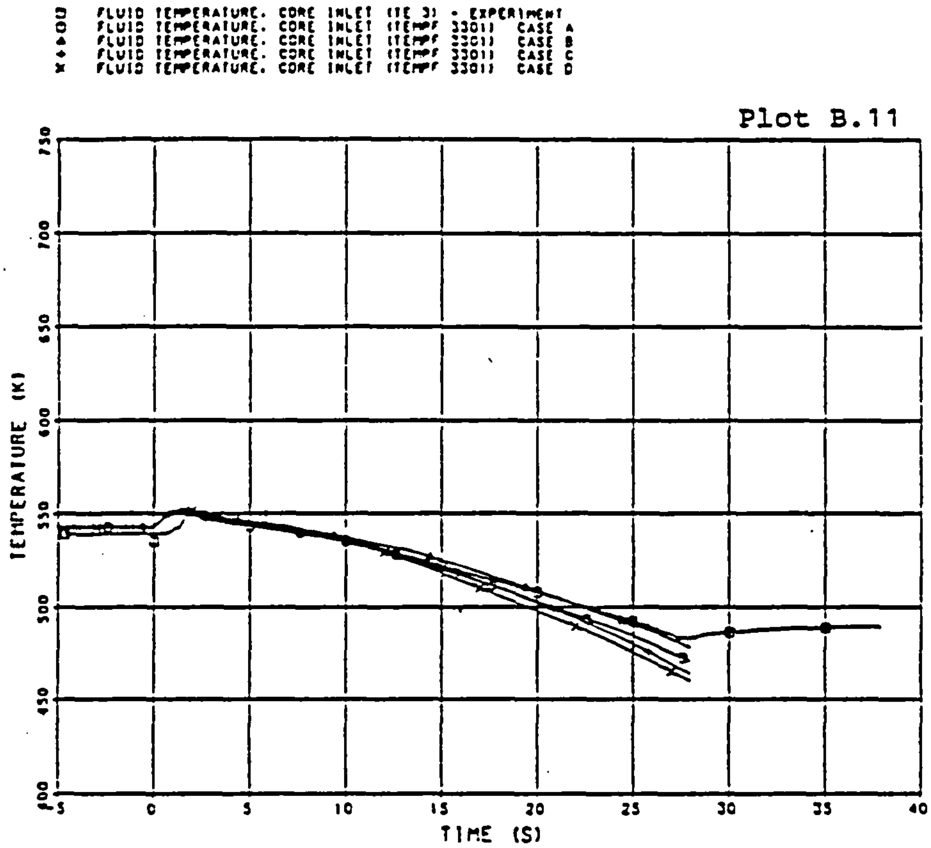


Plot B.9

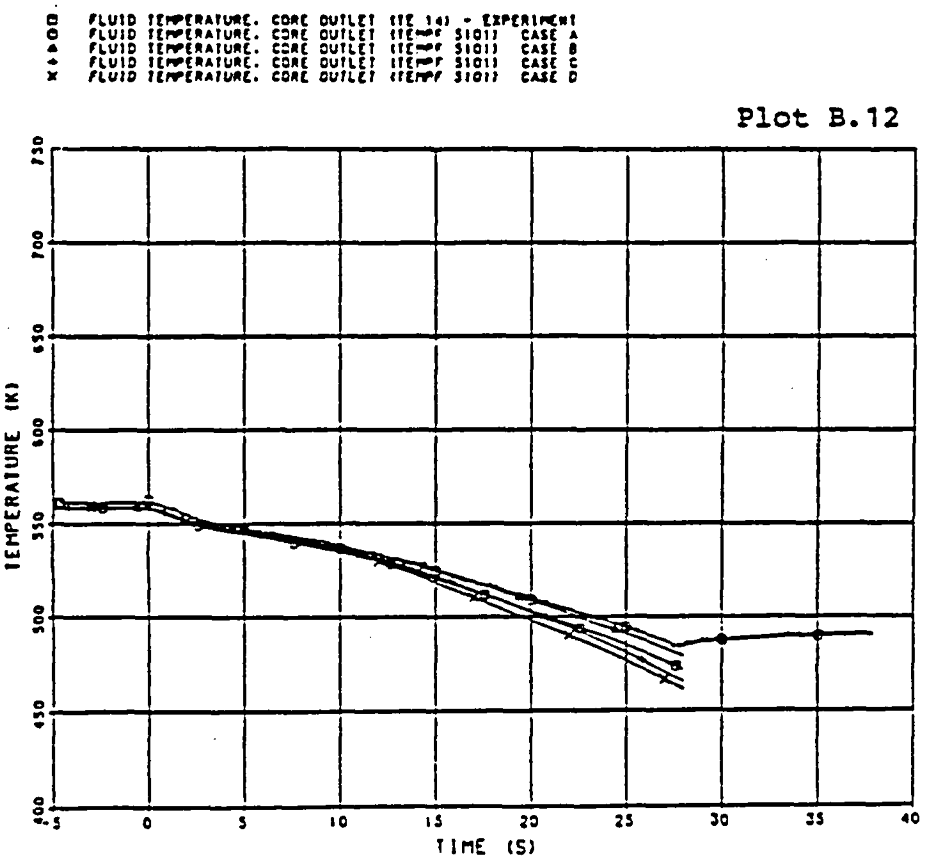


Plot B.10

RELAP5/MOD2 CALCULATION FOR FIX-II. EXP 5061

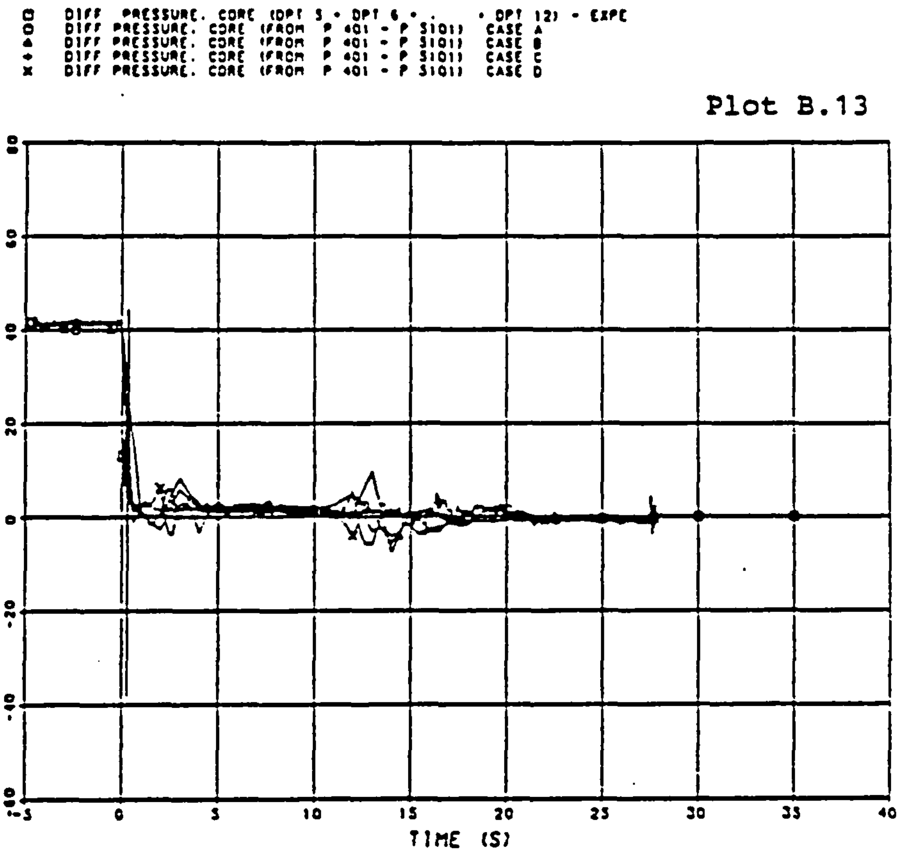


Plot B.11

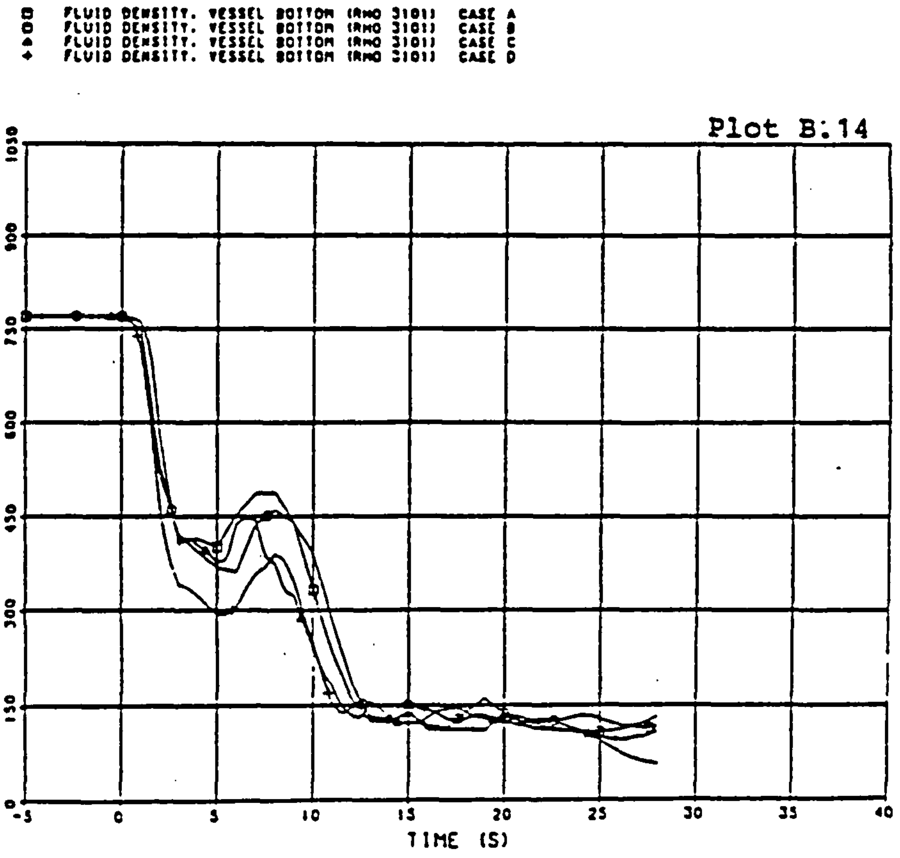


Plot B.12

RELAP5/MOD2 CALCULATION FOR FIX-II. EXP 5061

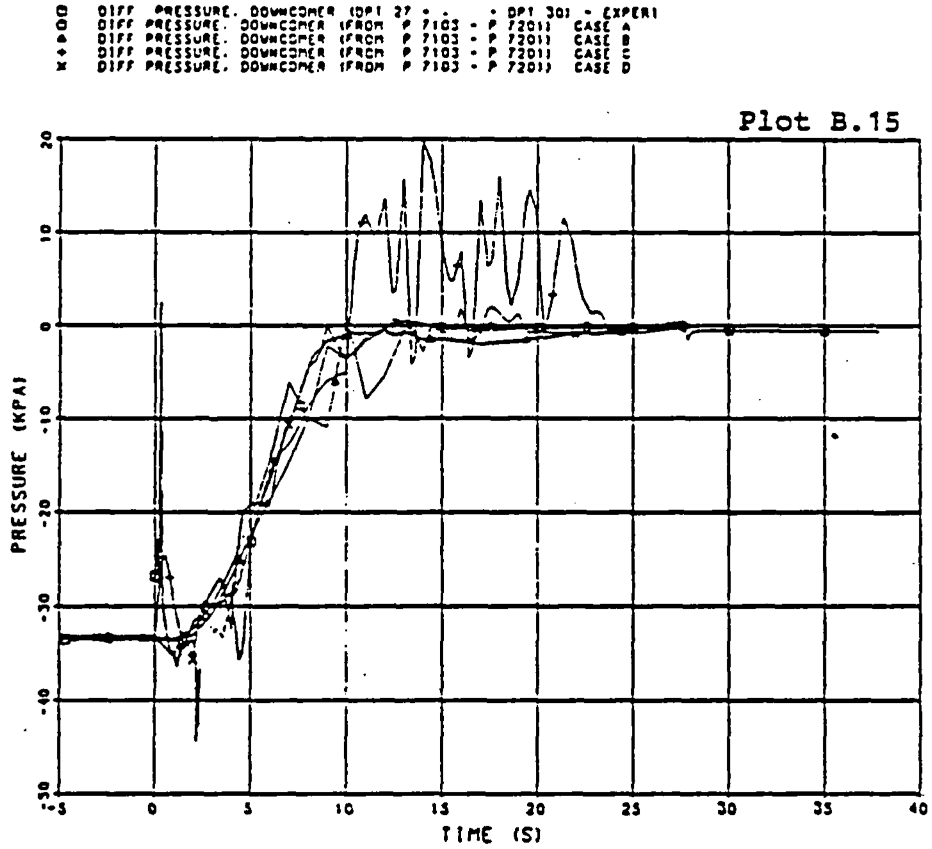


Plot B.13

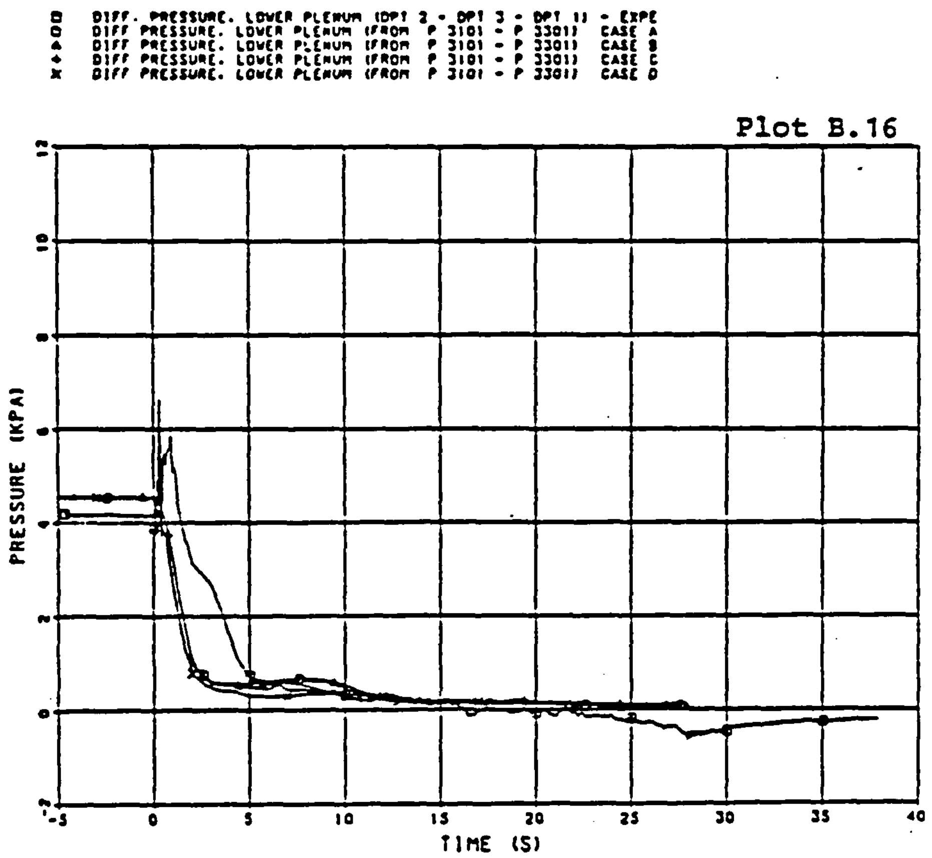


Plot B.14

RELAP5/MOD2 CALCULATION FOR FIX-II. EXP 5061



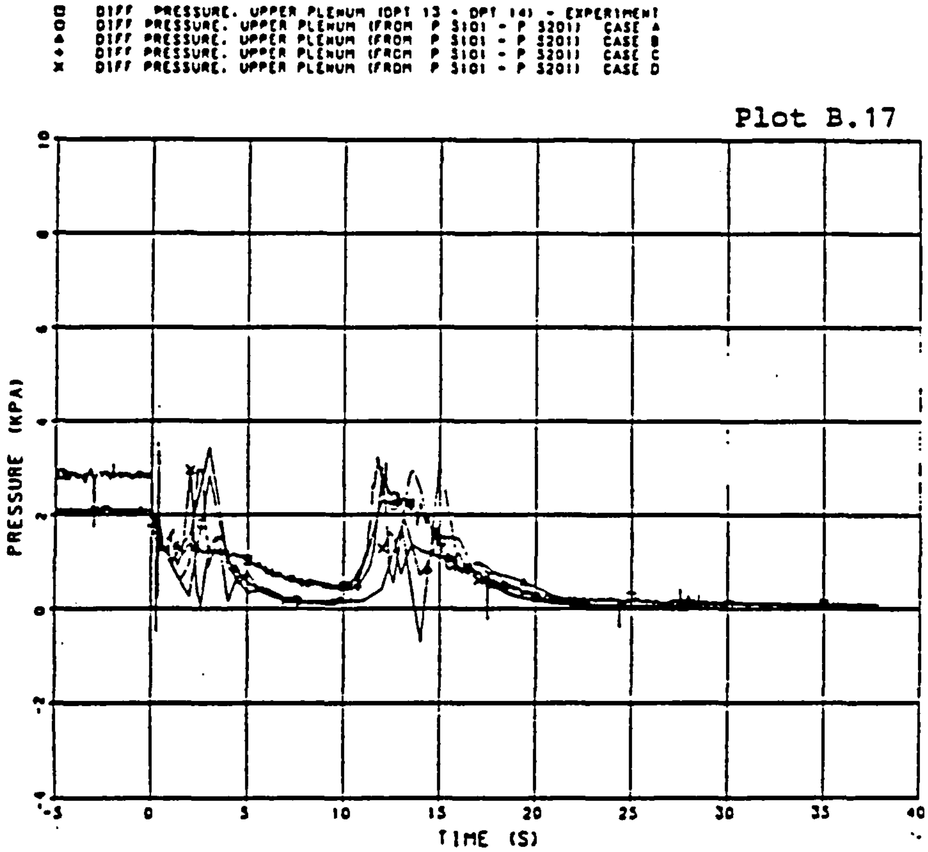
Plot B.15



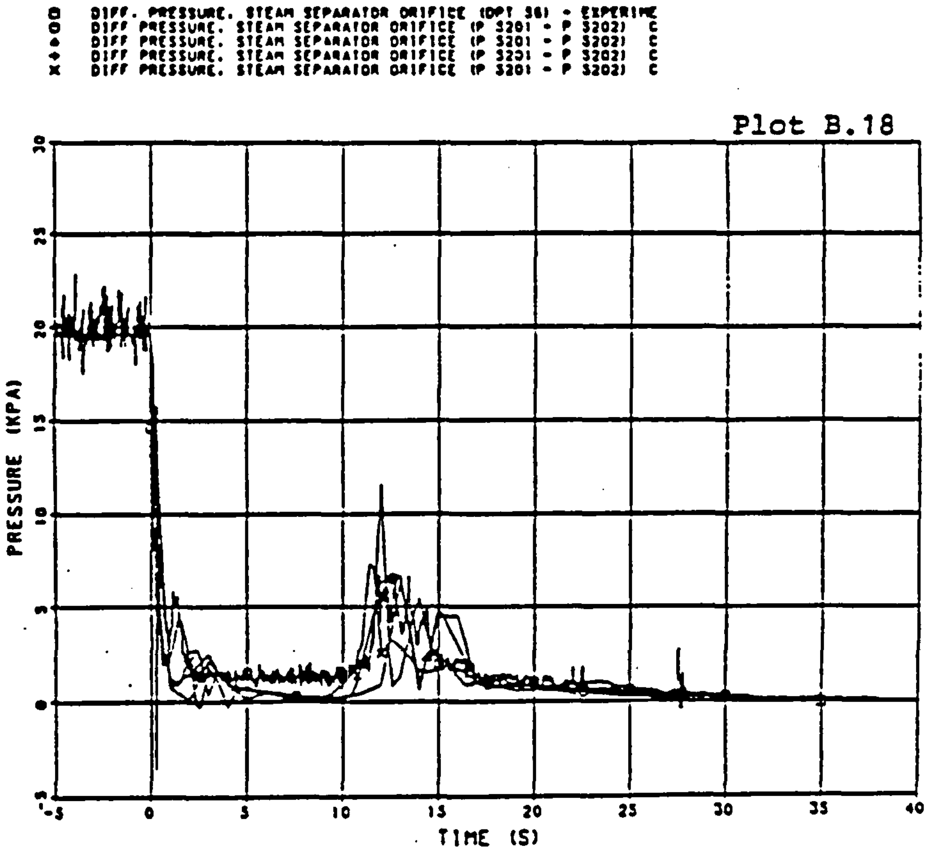
Plot B.16

RELAP5/MOD2 CALCULATION FOR FIX-II. EXP 5061

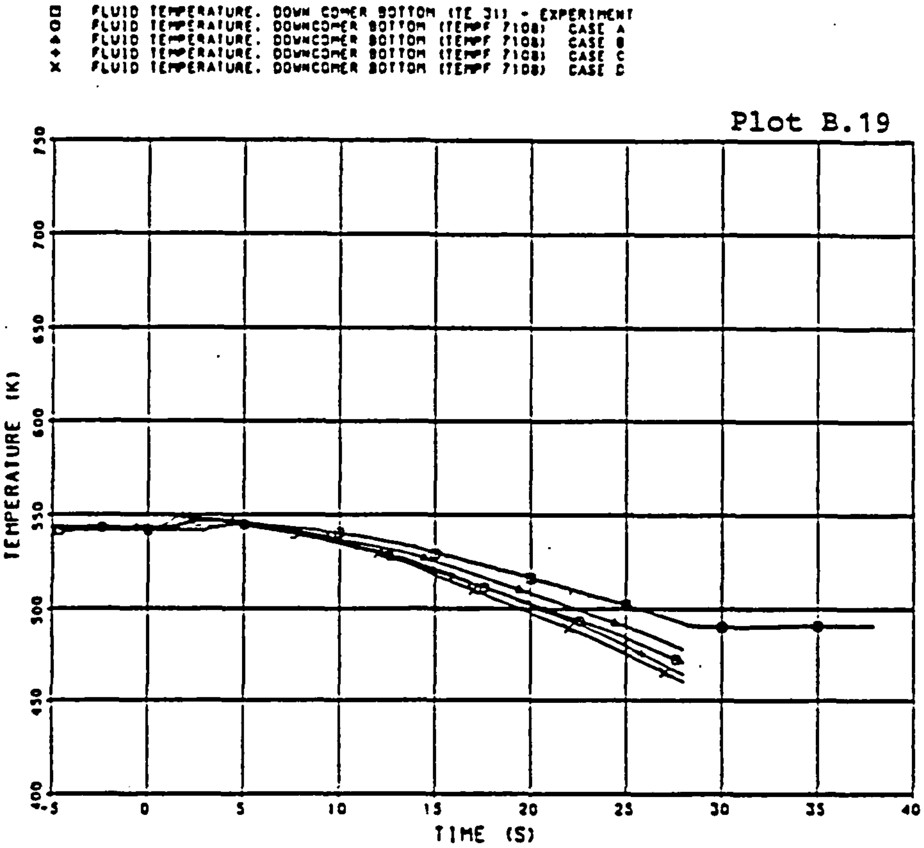
Plot B.17

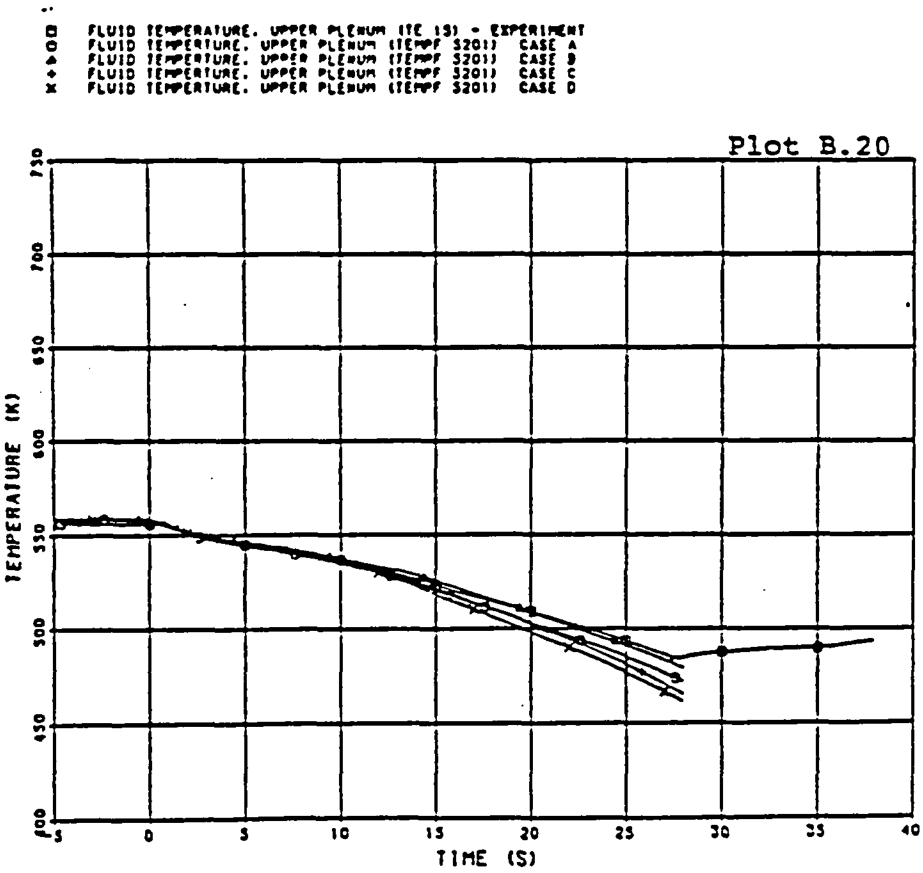


Plot B.18



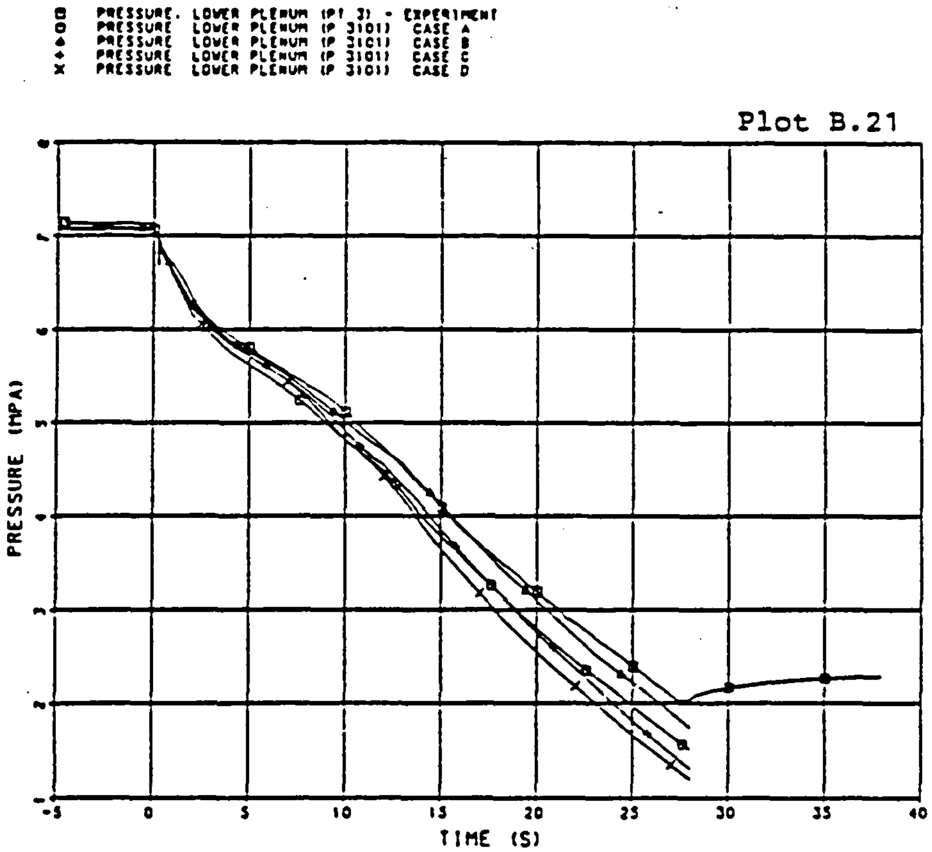
RELAP5/MOD2 CALCULATION FOR FIX-II. EXP 5061



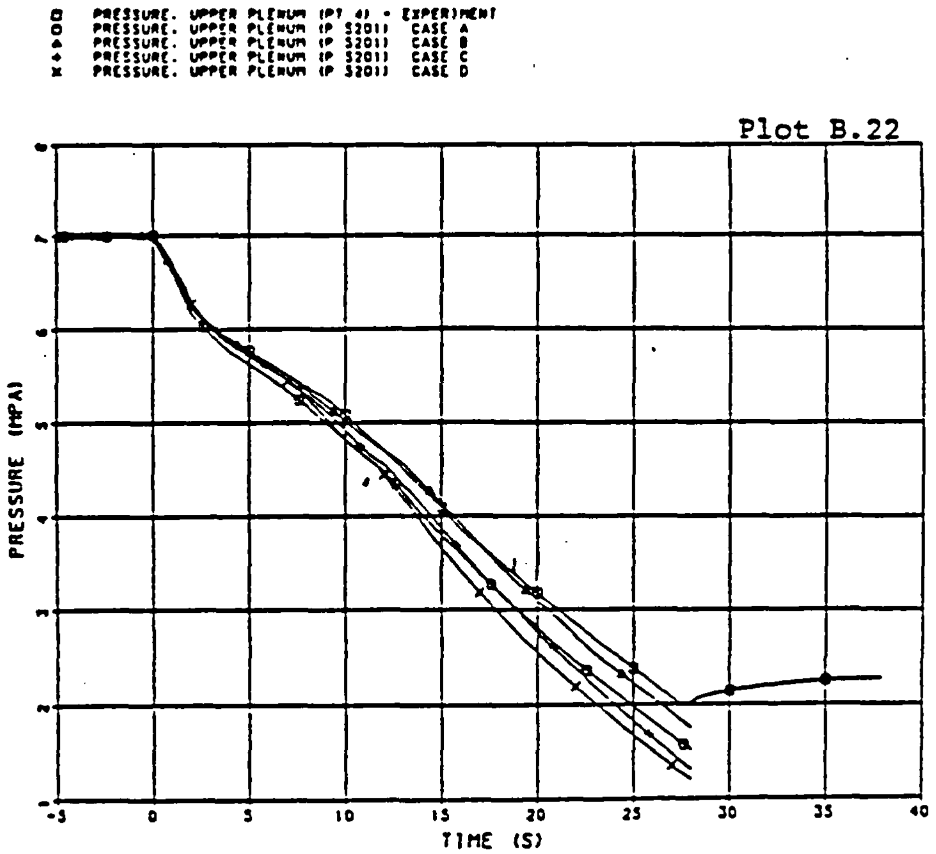


RELAP5/MOD2 CALCULATION FOR FIX-II, EXP 5061

Plot B.21

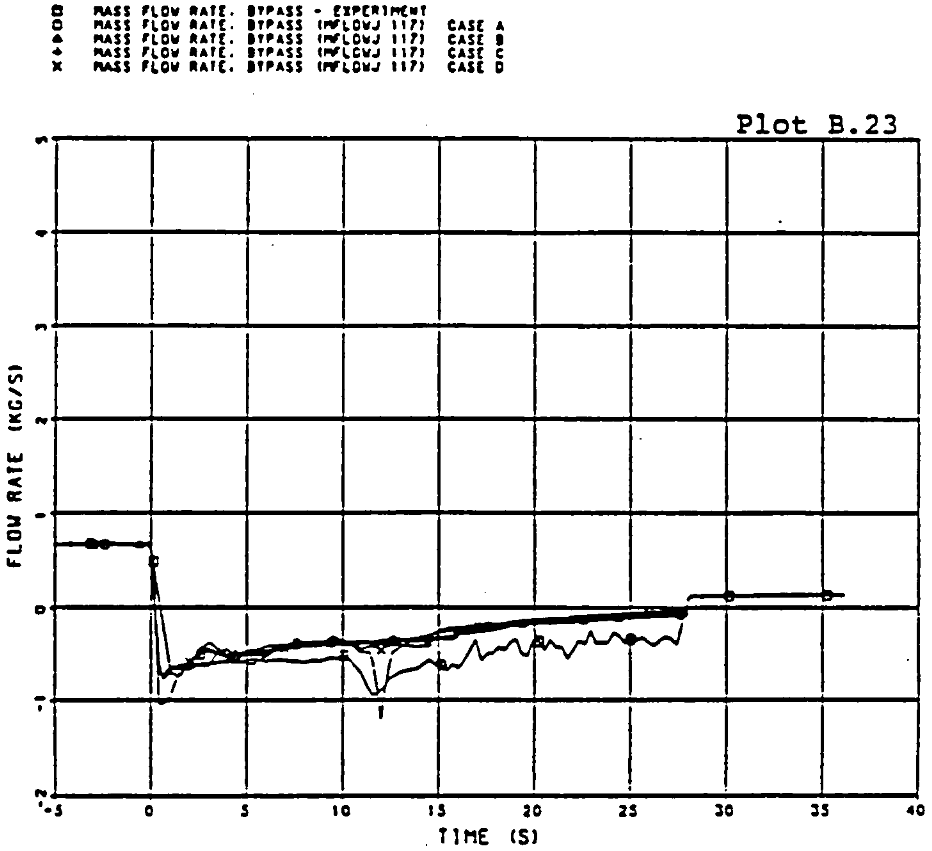


Plot B.22

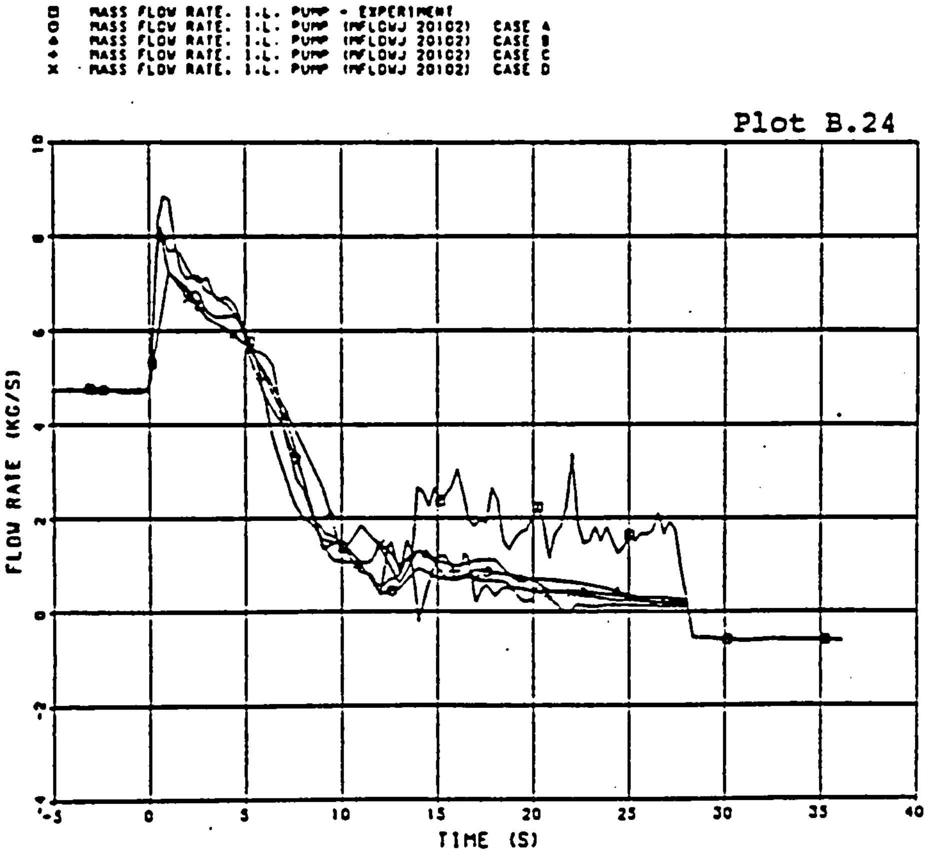


RELAP5/MOD2 CALCULATION FOR FIX-II. EXP 5061

Plot B.23

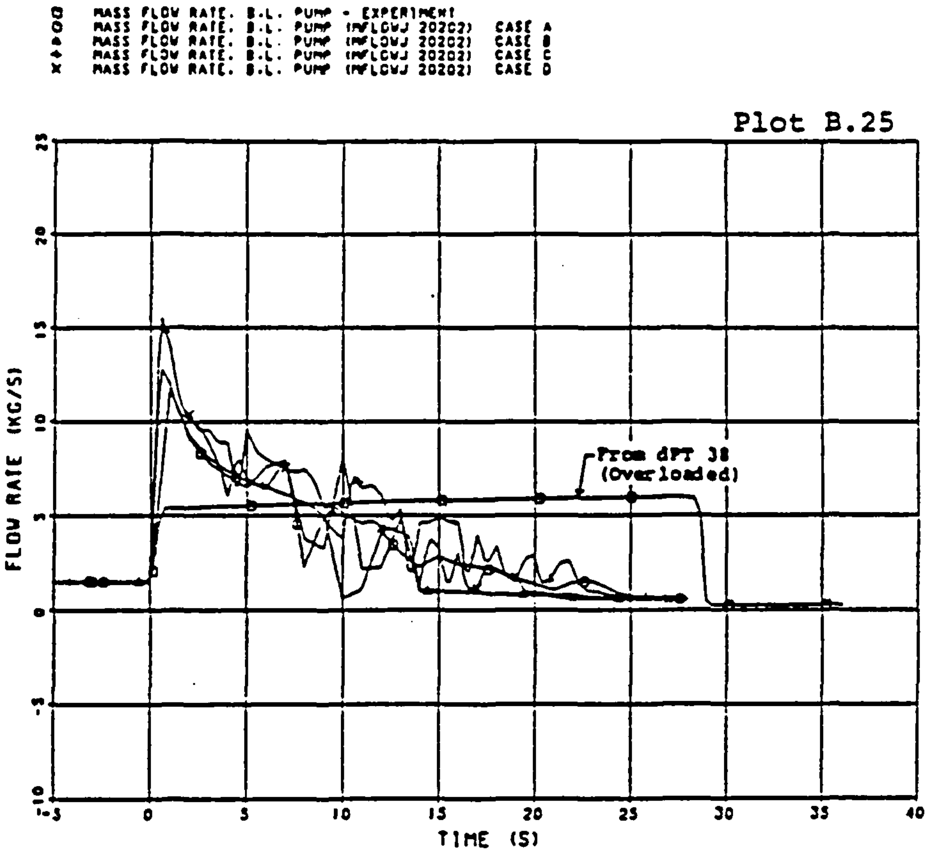


Plot B.24

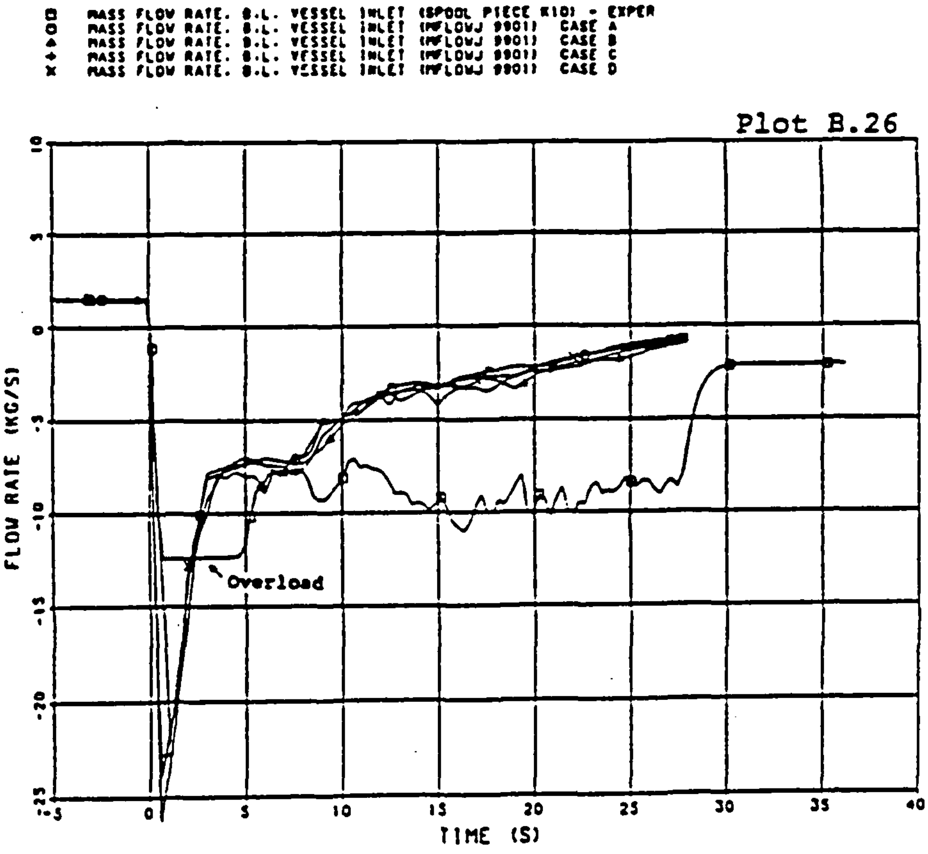


RELAP5/MOD2 CALCULATION FOR FIX-II. EXP 5061

Plot B.25

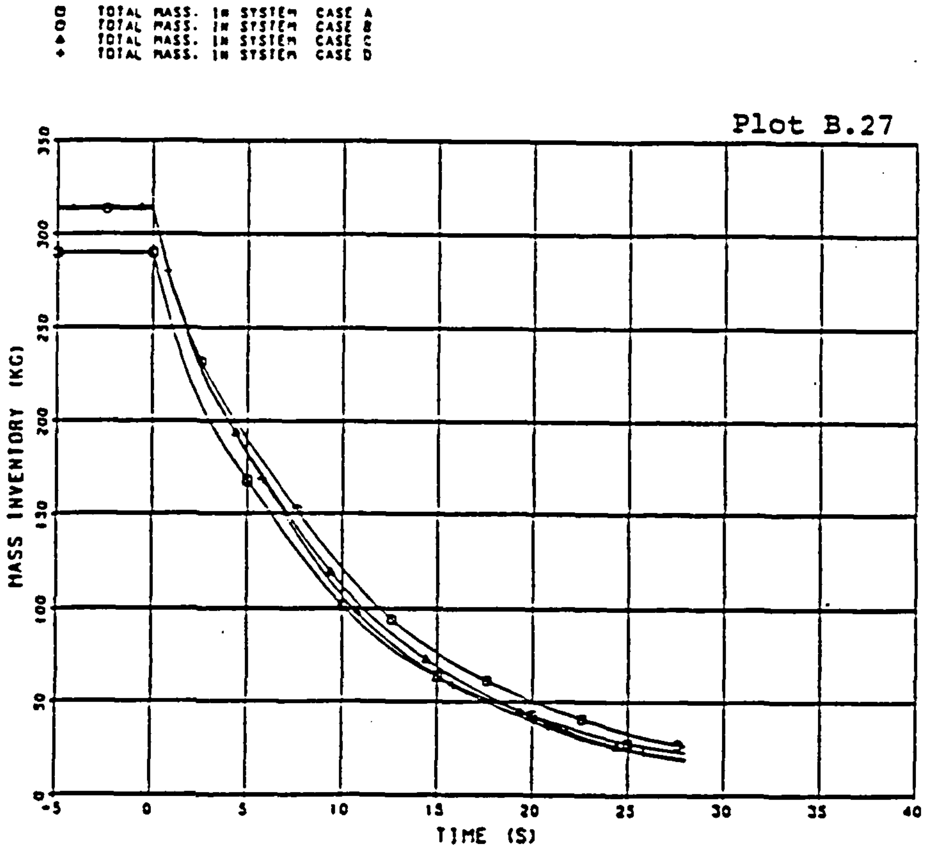


Plot B.26

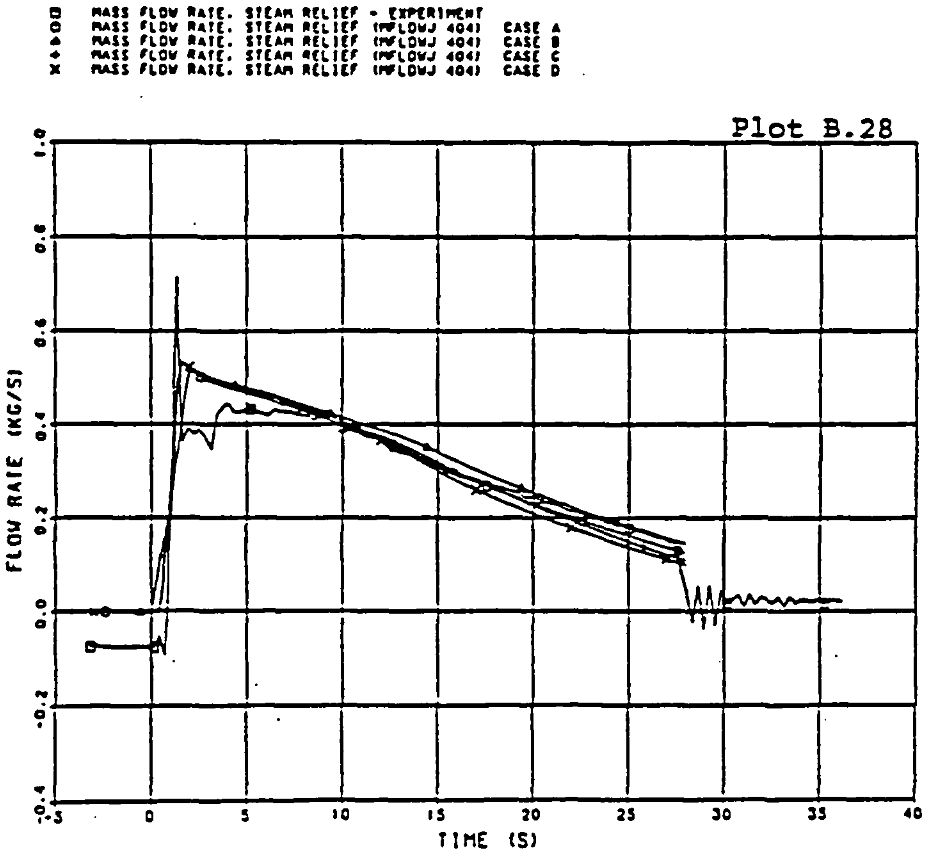


RELAP5/MOD2 CALCULATION FOR FIX-II. EXP 5061

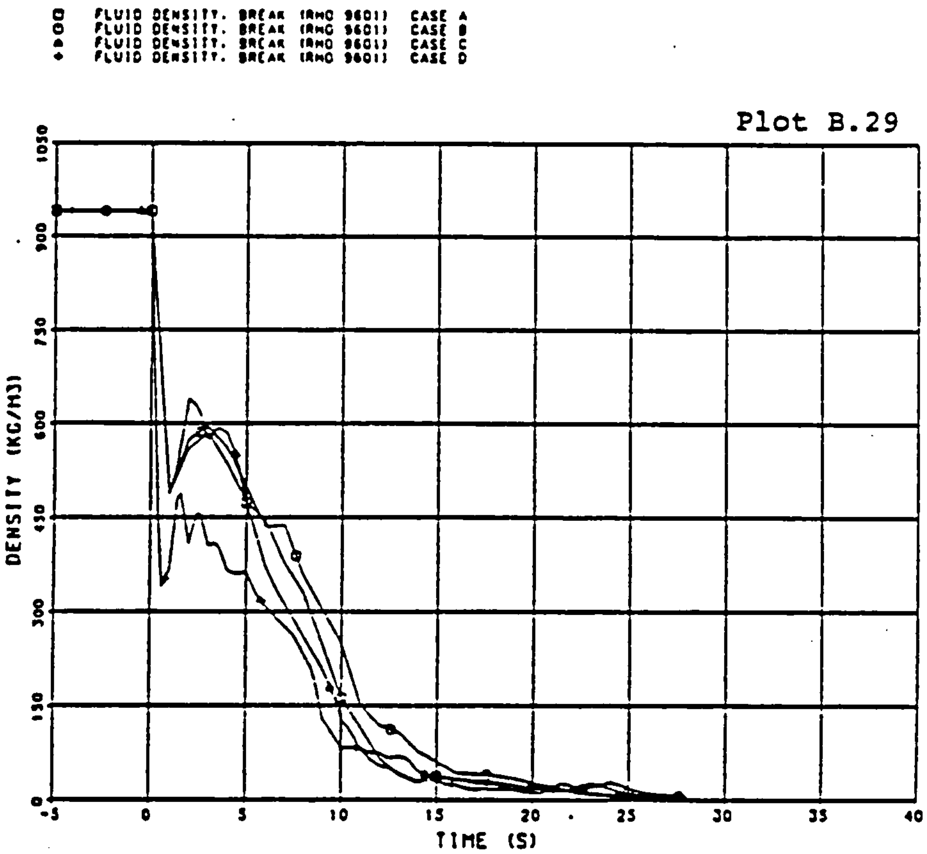
Plot B.27



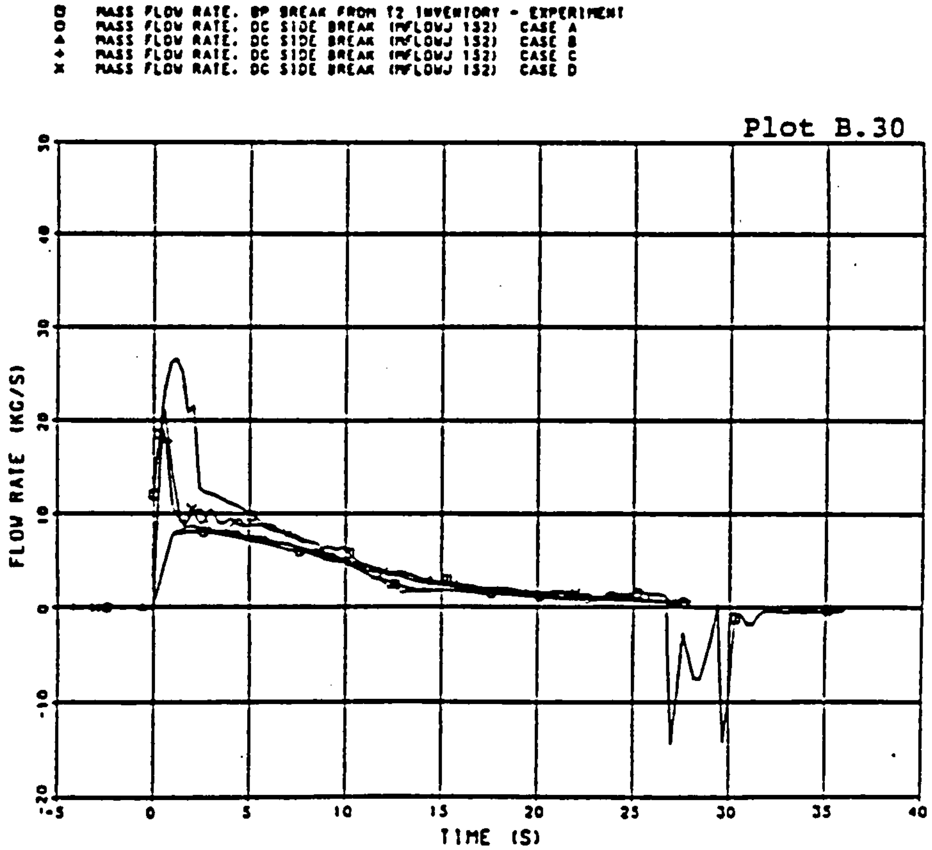
Plot B.28



RELAP5/MOD2 CALCULATION FOR FIX-II. EXP 5061

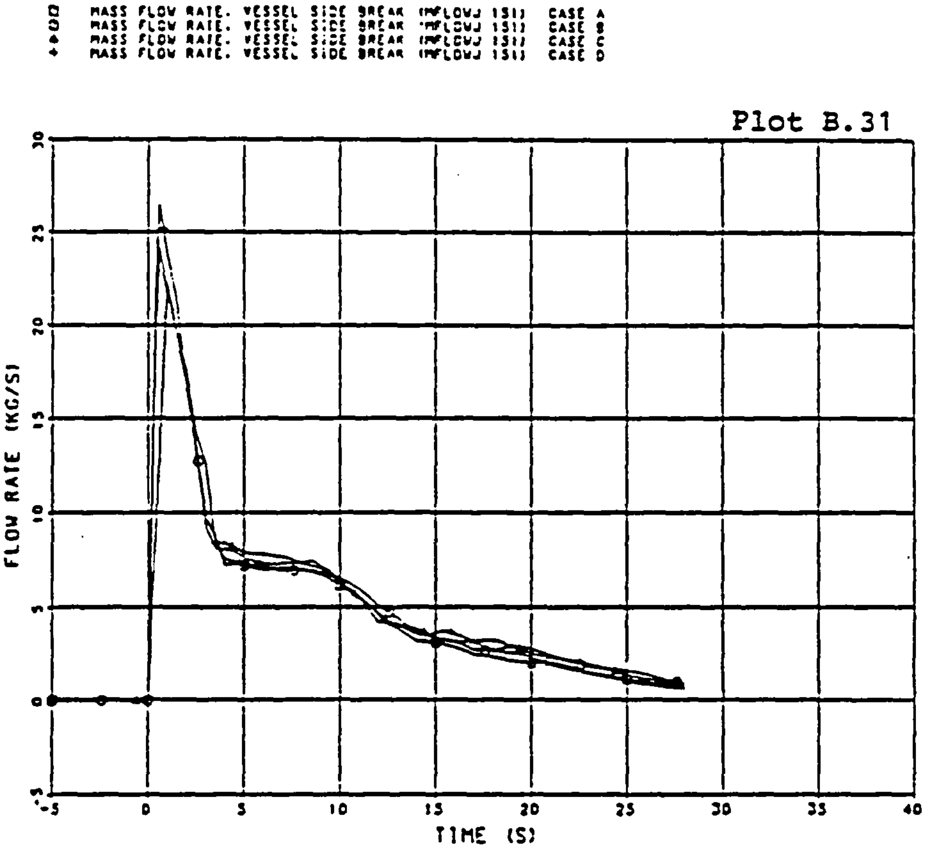


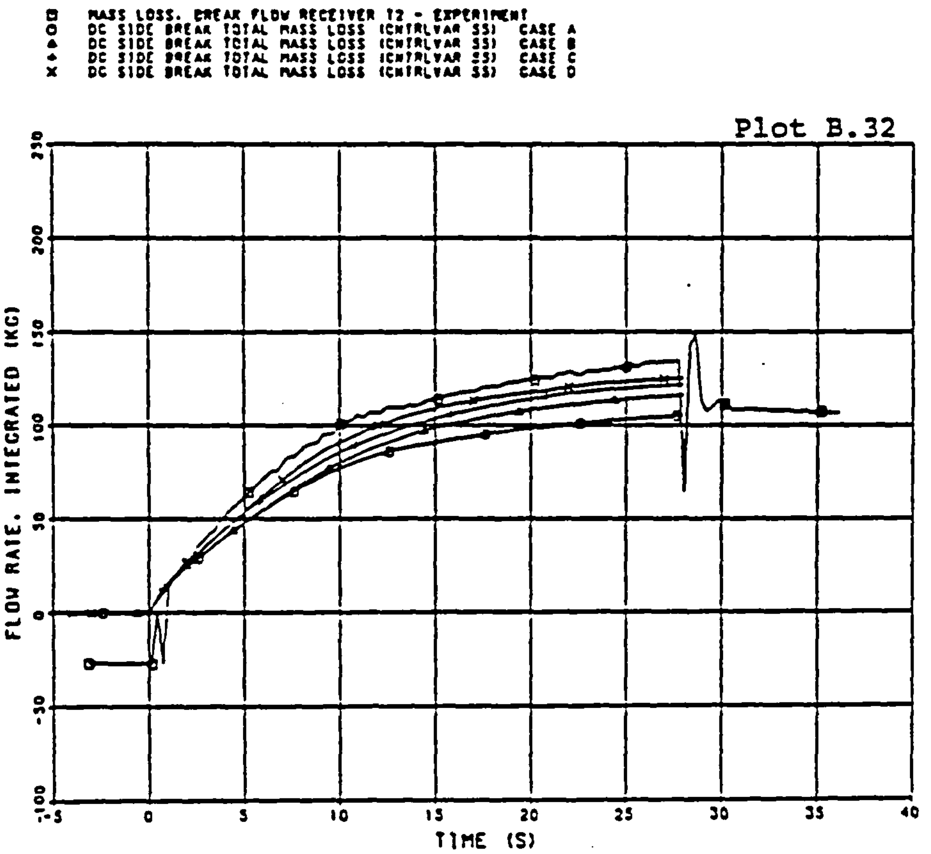
Plot B.29



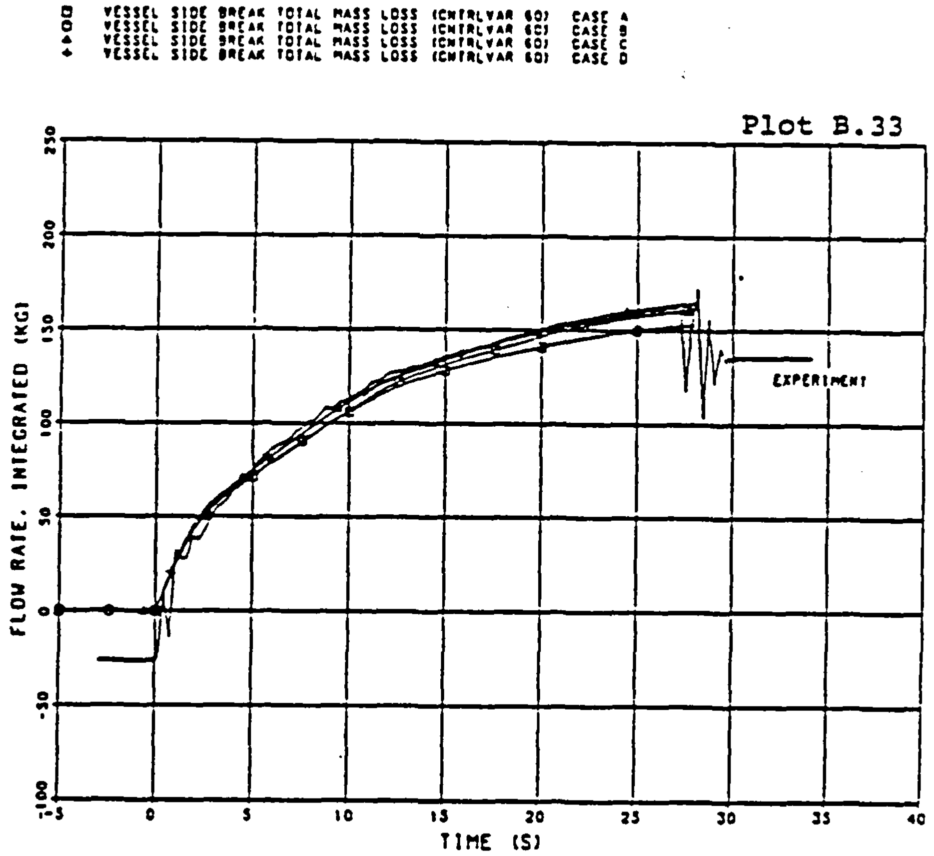
Plot B.30

RELAP5/MOD2 CALCULATION FOR FIX-II. EXP 5061

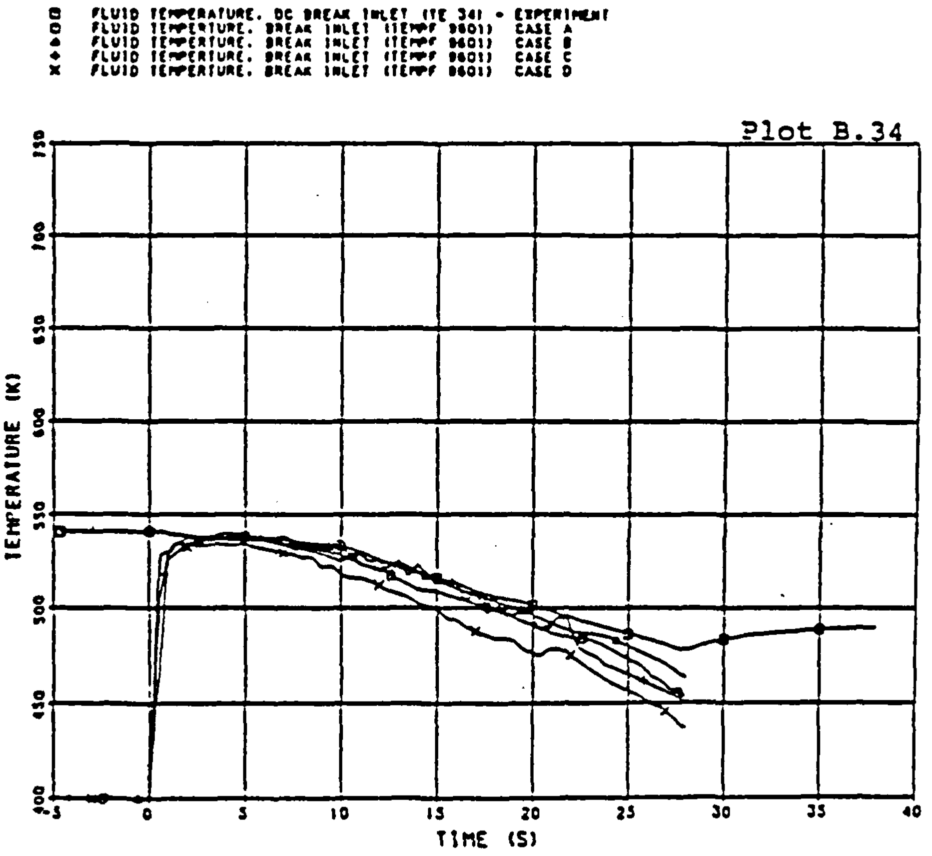

Plot B.31


Plot B.32

RELAP5/MOD2 CALCULATION FOR FIX-II. EXP 5061



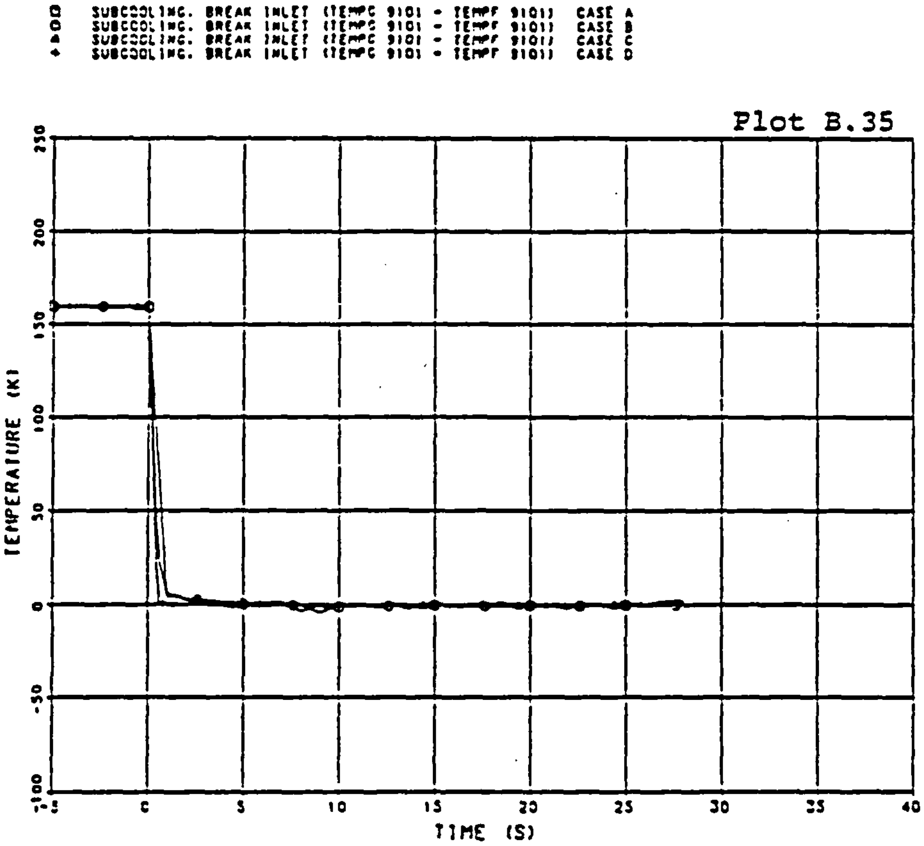
Plot B.33



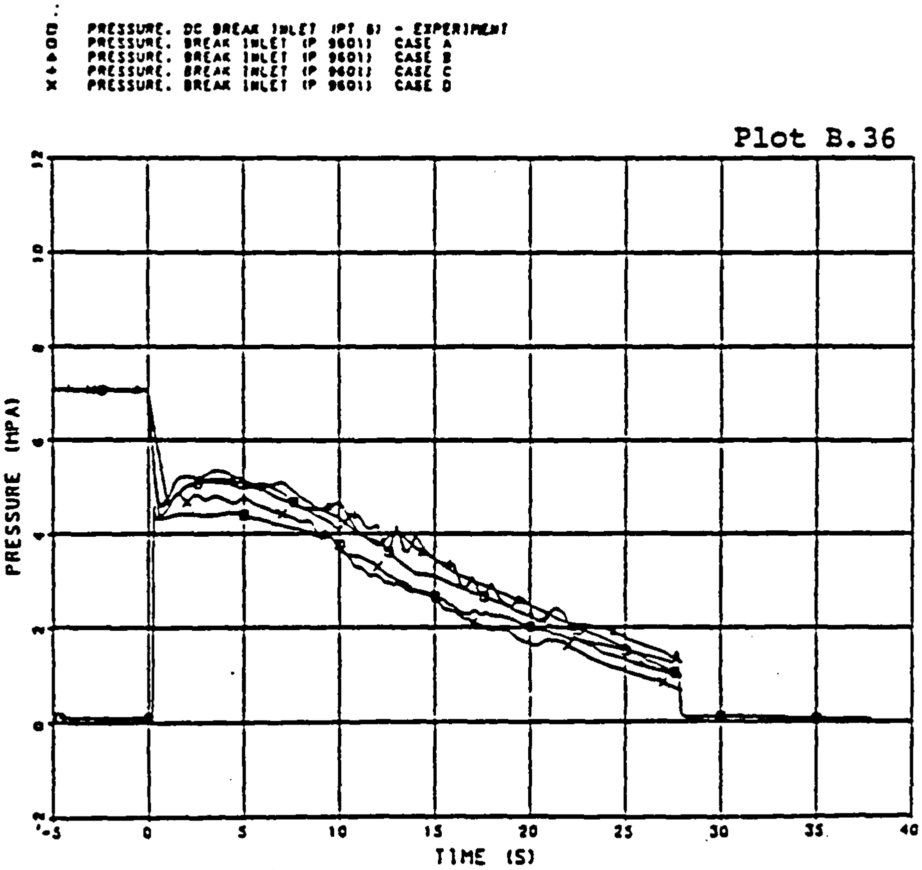
Plot B.34

RELAP5/MOD2 CALCULATION FOR FIX-II. EXP 5061

Plot B.35

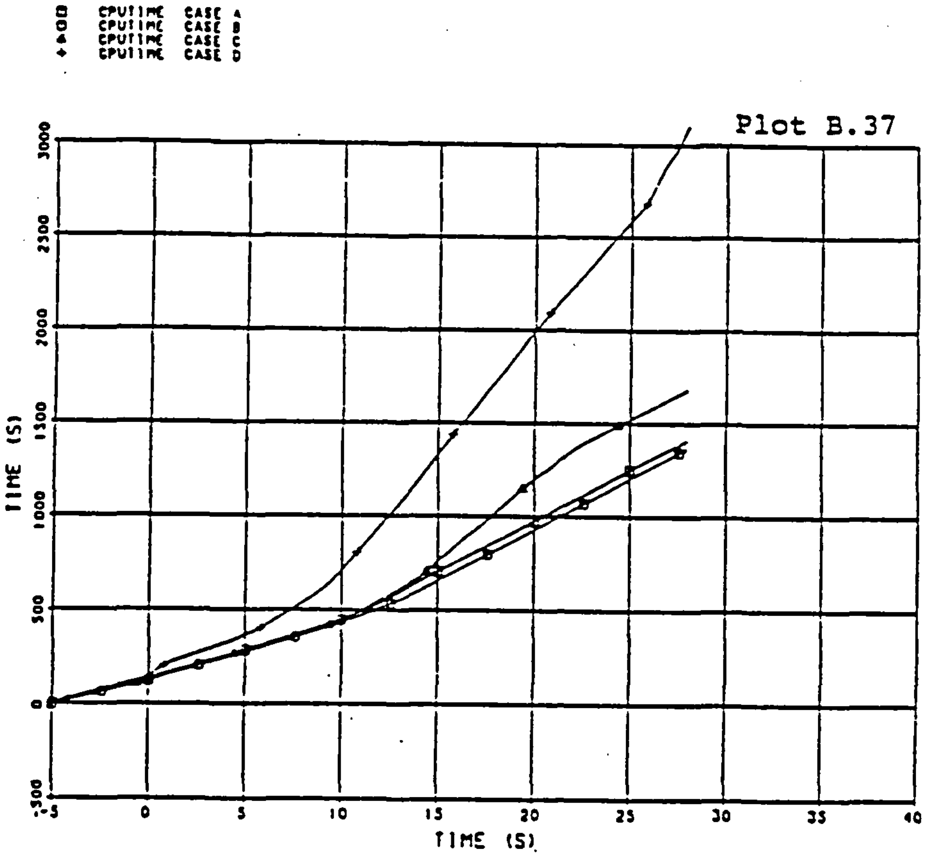


Plot B.36

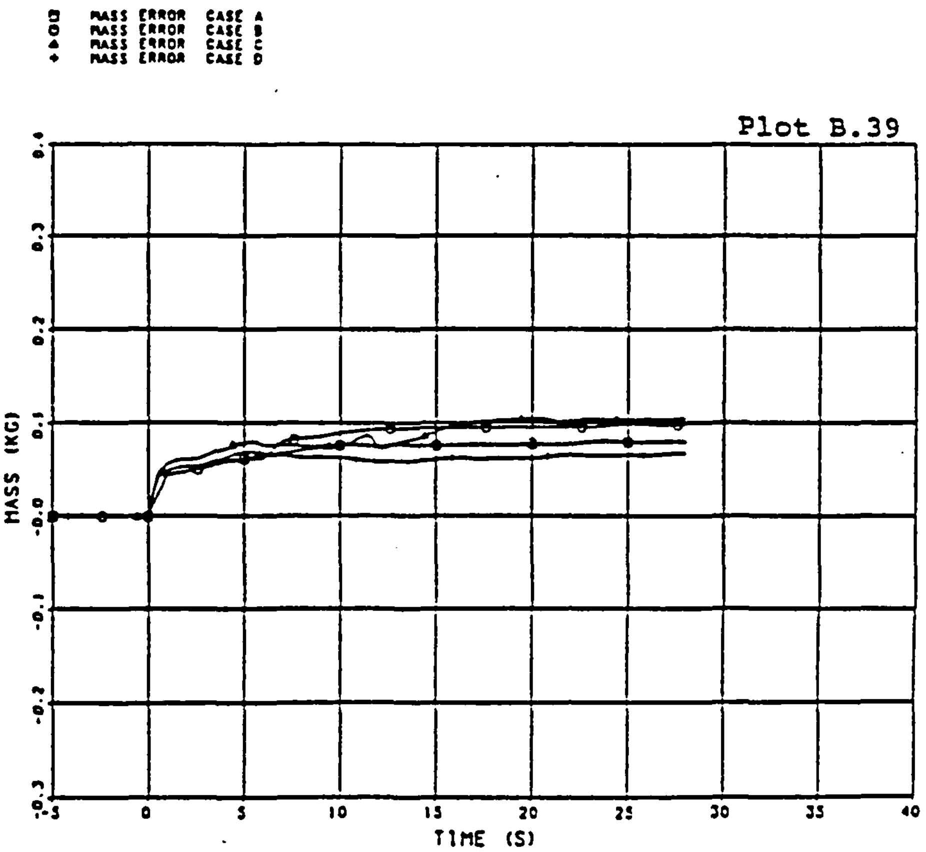


RELAP5/MOD2 CALCULATION FOR FIX-II. EXP 5061

Plot B.37



Plot B.39



APPENDIX C

Calculations to experiment data uncertainties

Case A

```
CALCULATION-TO-EXPERIMENT DATA UNCERTAINTY ANALYSIS FOR NRC/ICAP.
*****************************************************************

  FIRST LINE  : DIFFERENCE BETWEEN CALCULATED AND (AVERAGED) EXPERIMENTAL DATA AT END OF THE INTERVAL
  SECOND LINE : MEAN DIFFERENCE OVER THE INTERVAL
  THIRD LINE  : MEAN SIGMA OVER THE INTERVAL  (ROOT MEAN SQUARE OF THE DIFFERENCE)


 - CODES -                            - - - - TIME INTERVAL - - - -

CALC.  EXP     0.0 - 2.000    - 4.000     - 7.000     - 10.00     - 15.00     - 20.00     - 27 00
*****************************************************************************************************

P 1A - P  3     -.105       -.137       -.170       -.264       -.277       -.383       -.394
                -.205E-01   -.115       -.158       -.224       -.243       -.297       -.381
                 .694E-01    .116        .184        .227        .243        .299        .381

P 2A - P  4     -.609E-01   -.105       -.143       -.238       -.252       -.338       -.366
                -.277E-01   -.754E-01   -.121       -.196       -.217       -.281       -.364
                 .363E-01    .764E-01    .121        .199        .218        .285        .364

P 3A - P  5      .524        .677        .749        .594        .436        .251       -.110
                1.81         .676        .693        .559        .633        .383        .132
                2.78         .678        .698        .565        .651        .406        170

PD4A - D  4     -.737       -.783       2.49        1 75        6.94        1.37        7.45
                39.9       -1.09         .482       3.08        4.57        8.55        5.49
                54.8        1.10        1.01        3.10        5.50        7.47        6.37

PDLA - D LP    -1.68        -.978        .293        .168        .491E-01    .194        .447
               -1.17       -1.79        -.150        .227        .243E-02    .126        .270
                1.35        1.81         .325        .229        .631E-01    .148        .287

PDCA - D CO    -3.41         .685       1.73         .829       -.826      -2.21         .979
                6.56         .665       -.183E-01   1.17        -.103      -1.48         .324E-01
                11.1        2.70        1.17        1.40        3.25        2.01         .617

PDUA - D UP     -.959        .200E-02   -.393       -.181       -.287       -.103       -.922E-01
                -.152        .410       -.432       -.340       -.498        .873E-01   -.103
                 .636        .897        .481        .344        .638        .276        .108

PDDA - D DC     1.13        2.27        2.78       -2.45         .282E-01    .392        .259
               -1.02        3.34        1.40       -2.08         .487E-01    .200        .225
                4.08        4.08        1.88        3.34        1.17         .247        .244

PD5A - D 56    -1.83        -.584       - 730       -.639       1.24        -.400       -.507E-02
                1.12        -.295       -.799       -.791        .985E-01    .313       -.202
                4.67         .796        .825        .839       1.41        1.32         .234

MF1A - X602      .588E-01    .496E-01    .154        .189        .344        .161        .220
                 .353        .945E-01    .106        .187        .352        .275        .247
                 .448        .898E-01    .113        .187        .373        .284        .248

MF2A - X603     -.122       -.556       -.323       -.371E-01  -1.31       -1.31       -1.43
               -1.11        -.473       -.546        .574E-01   - 461      -1.33       -1.37
                1.40         .487        .675        .249        .781       1.41        1.41

MF3A - X604     4.18        1.75        2.31       -4.14       -3.06       -4.45       -5.35
                3.24        2.71        1.62       -1.30       -3.35       -3.57       -4.84
                3.82        2.79        1.67        2.14        3.48        3.69        4.86

MF5A - X607      .855E-01    .498E-01    .196E-01   -.100E-02    .848E-02   -.121E-01   -.167E-01
                 .166E-01    .107        .347E-01    .700E-02    .805E-02   -.270E-02   -.148E-01
                 .187        .112        .357E-01    .846E-02    .689E-02    .803E-02    .148E-01

MF4A - X610    -2.79        4.82         .470       3.61        6.35        7.98        7.66
               -3.16        2.52        2.80        2.17        4.76        7.11        7.51
                4.78        3.43        3.42        2.63        4.88        7.14        7.52

MF6A - X636    -12.8       -3.49       -1.52       -1.88        -.783       -.462       15.1
               -16.8       -5.50       -2.64       -1.17        -.144       -.623       -.265
                17.0        5.28        2.84        1.20         .836        .637       1.38

TF1A - T  3     1.25        1.83        1.14        -.480      -2.04       -4.19       -8.88
                5.47        1.58        1.26         .317       -.683      -2.59       -6.24
                5.84        1.60        1.28         .717        .871       2.72        6.37

TF2A - T 14    -3.04       -2.74       -2.77       -2.83       -3.54       -5.94       -10.6
               -3.01       -2.83       -2.86       -3.34       -3.27       -4.66       -7.85
                3.01        2.95        2.86        3.36        3.28        4.74        7.94

TF4A - T 15      .120       -.200E-01   -.600      -1.48       -2.78       -4.81       -8.11
                1.20         .301       -.382      -1.11       -1.71       -3.51       -4.99
                1.39         .381        .428       1.20        1.77        3.61        7.08

TF3A - T 31     2.87        2.00        -.980      -6.41       -8.60       -13.2       -18.8
                1.68        3.69        -.616      -3.88       -7.25       -11.1       -15.7
                1.72        3.76        1.30        4.09        7.36        11.2        15.8

TF5A - T 34    -6.51       -1.58       -1.49       -3.41       -4.98       -9.40       -19.9
               -68.9       -2.82       -1.21       -2.74       -4.01       -7.31       -11.8
                75.6        3.12        1.27        2.83        6.16        7.37        12.2

HT1A - TC 1     2.07       -39.3       -78.9       -98.9       -80.1       -18.5       -22.5
               -2.12       -10.5       -65.0       -69.9       -105.       -58.8       -14.9
                3.42        16.2        68.8        90.1        105.        63.5        15.3

HT2A - TC 3    -1.39       -18.4       -74.4       -44.2       -104.       -68.2       -62.2
                -.722      -13.6       -48.3       -60.7       -93.8       -71.0       -59.5
                2.18        14.7        81.8        61.4        99.2        73.1        59.5

HT3A - TC 5     14.4       -8.21       -6.63        78.7        30.0       -5.18        3.03
                3.50        1.73       -15.5        29.1        65.5        19.5       -5.04
                6.73        7.59        16.2        38.0        69.2        27.4        6.49

HT4A - TC 7     46.8        16.7         .800       38.8        42.0       -28.2       -11.4
                20.7        29.5        3.31        14.8        52.9        2.04       -21.7
                26.2        31.0        6.49        17.3        53.7        31.0        22.1

HT5A - TC 9     45.3        12.4        14.3        84.2        3.13       -60.9       -23.9
                25.0        27.8        6.70        37.8        50.4       -47.1       -26.4
                29.7        29.5        7.33        41.7        53.2        52.0        28.1

HT6A - TC12     29.2        46.4        82.0        112.        3.01       -3.93       -4.72
                21.3        44.7        43.0        92.8        43.3       -1.09       -4.61
                23.8        46.3        43.6        93.9        58.1        2.38        6.75

HT7A - TC15     -.400E-01  -4.31        -.570       3.23       -2.61       -4.73       -13.1
                1.96       -3.53       -3.52        2.19        -.830      -3.43       -7.93
                2.00        4.82        4.35        3.66        1.36        3.53        8.19

ML1A - X871    -4.96       -10.8       -16.1       -20.4       -23.3       -26.0       -29.4
                14.2       -7.80       -15.5       -20.2       -22.8       -24.5       -27.3
                20.0        7.96        15.6        20.2        22.9        24.5        27.3

HP1A - X801      .622E-01   -.281E-01   -.713E-02   -.766E-02   -.907E-02   -.237E-02   -.153E-02
                -.141E-02    .350E-02   -.335E-02    .379E-02   -.366E-02    .267E-02   -.156E-02
                 .373E-01    .136E-01    .135E-01    .763E-02    .738E-02    .581E-02    .248E-02
```

Case B

```
CALCULATION-TO-EXPERIMENT DATA UNCERTAINTY ANALYSIS FOR NRC/ICAP.
*****************************************************************

  FIRST LINE  : DIFFERENCE BETWEEN CALCULATED AND (AVERAGED) EXPERIMENTAL DATA AT END OF THE INTERVAL
  SECOND LINE : MEAN DIFFERENCE OVER THE INTERVAL
  THIRD LINE  : MEAN SIGMA OVER THE INTERVAL  (ROOT MEAN SQUARE OF THE DIFFERENCE)


 - CODES -                                - - - - TIME INTERVAL - - - -

CALC.  EXP.    0.0 - 2.000     - 4.000      - 7.000      - 10.00      - 15.00      - 20.00      - 27.00
---------------------------------------------------------------------------------------------------------

P 18 - P  3    -.252E-01    -.193E-01    -.970E-02    -.697E-01    .627E-01     -.692E-01    -.145
                .196E-01    -.101E-01    -.176E-01    -.485E-01    .178E-01      .674E-02    -.123
                .495E-01     .184E-01     .194E-01     .544E-01    .553E-01      .551E-01     .127

P 28 - P  4     .166E-01     .123E-01     .186E-01    -.408E-01    .895E-01     -.471E-01    -.117
                .122E-01     .279E-01     .201E-01    -.195E-01    .439E-01      .228E-01    -.105
                .134E-01     .298E-01     .215E-01     .310E-01    .653E-01      .674E-01     .110

P 38 - P  5     .551         .740         .914         .865        .823          .493         .200
               1.83          .719         .737         .723        .920          .655         .341
               2.79          .722         .738         .737        .929          .666         .349

PO48 - D  4    -1.40        -1.33         1.70        1.79         4.62          2.40         7.27
               39.5         -1.74        -.508        2.82         4.50          6.15         5.29
               54.6          1.75         .867        2.84         5.10          6.93         6.04

POL8 - D LP    -1.71        -1.00         .172         .217        .580E-01      .228         .456
               -1.18        -1.81        -.236         .211        .233E-01      .154         .285
                1.36         1.84         .349         .211        .888E-01      .175         .299

POC8 - D CO    -1.21         1.48         .984         .237       -.842         -.243        1.17
                6.96         2.80         .673         .414        .974E-01    -1.80          .409
               11.0          3.69         .776         .886       3.97          2.80          .673

POU8 - D UP     .106         .243        -.446        -.250        .765          .180        -.959E-01
                .574E-01    1.18         -.358        -.367      -1.27           .395        -.396E-01
                .501        1.32          .381         .368       1.53           .580         .104

POD8 - D DC     .580        1.20         -5.01        -.247      -1.17         -1.06         -.236
               -1.17        2.68         -1.79       -6.30       -2.29         -1.37         -.593
                4.03        3.39          2.89        6.56        3.33          1.38          .646

PO58 - D 56    -.402        -.611        -.850       -1.14        1.58          -.197        -.111
                1.34         .326        -.669        -.952      -1.49           .396        -.135
                4.57         .554         .681         .894       2.22          1.03          .228

MF18 - X602     .822E-01     .872E-01     .124         .167        .276          .161         .206
                .332         .142         .964E-01     .161        .315          .242         .231
                .480         .148         .975E-01     .161        .342          .251         .237

MF28 - X603    -.193        -.531        -.480E-01   -.417E-01   -1.54          -1.31         -1.34
               -1.11        -.513        -.303         .784       -.127E-01     -1.14         -1.24
                1.38         .526         .339         .842        .761          1.20          1.29

MF38 - X604     4.36        2.01          2.12        1.58        -4.79         -5.07         -5.41
                3.31        2.36          1.42        -.573       -2.48         -4.93         -5.26
                4.00        3.03          1.46        1.66         3.13          4.93          5.26

MF58 - X607     .704E-01     .549E-01     .288E-01     .156E-01    .336E-01      .115E-01     .352E-02
                .202E-01     .115         .460E-01     .216E-01    .278E-01      .223E-01     .519E-02
                .196         .119         .467E-01     .223E-01    .284E-01      .234E-01     .680E-02

MF48 - X610    -2.88         4.53         .758        2.89         8.22          7.37         7.37
               -3.27         1.82        2.78         1.64         4.46          6.65         7.13
                4.89         2.74        3.28         1.95         4.72          6.71         7.14

MF68 - X636   -12.3         -3.09        -.886       -1.33         .508E-01     -.147        15.1
              -16.7         -6.19       -2.24         -.808        .823         -.221         -.126
               18.9          6.92        2.32          .827       1.20           .238         1.30

TF18 - T  3     2.07         3.13        3.01         1.96         3.00          1.25         -1.88
                6.77         2.72        2.87         2.44         2.89          2.43          -.487
                6.18         2.74        2.88         2.48         2.96          2.36          1.08

TF28 - T 14    -2.27        -1.45        -.900        -.420        1.55          -.530        -3.30
               -2.50        -1.85       -1.27        -1.21          .294          .389        -2.10
                2.82         1.91        1.31         1.25          .879          .889         2.29

TF48 - T 16     .880         1.28        1.30          .880        2.34           .580        -2.32
                1.61         1.37        1.22         1.04         1.32          1.58         -1.24
                1.89         1.37        1.23         1.08         1.38          1.80          1.51

TF38 - T 31     2.98         2.96        1.03        -2.96        -4.83         -7.79        -11.9
                1.71         4.09         .865       -1.74        -3.61         -6.06         -8.95
                1.78         4.13        1.29         1.82         3.83          6.18         10.0

TF58 - T 34    -6.14        -.740        1.63          .250        -.430        -4.06         -8.28
              -66.8         -2.34        -.301        -.367       -1.46         -2.26         -6.09
               75.8          2.73         .702        1.18         3.17          2.44          6.24

HT18 - TC 1     4.10        -35.9       -76.5       -96.5       -85.7         -13.6         -16.2
               -1.38        -3.89       -43.2       -87.4      -101.          -64.1          -8.64
                3.59        13.0         64.0        87.6       102.           68.3          10.1

HT28 - TC 3    15.4         10.8        -65.0       -22.7       -88.8         -61.5         -60.2
                2.84        15.6        -18.0       -41.5       -37.9         -62.8         -53.4
                7.14        15.8         28.0        43.0        46.0          64.8          53.5

HT38 - TC 5    14.0        -11.5        -34.5        54.6        15.3          -2.17         -16.7
                3.66         1.55       -28.9         3.08       65.0           3.87          -6.75
                6.69         7.91        31.0        27.1        56.7           7.61           8.33

HT48 - TC 7    40.6          2.86       -38.4         5.01       12.9          -24.3         -30.2
               18.5         18.8        -25.4       -21.0        28.3          -24.6         -23.3
               23.3         22.1         28.8        24.1        30.8           30.4          23.6

HT58 - TC 9    46.1          5.47       -15.8        40.8        -6.06         -47.1         -34.7
               23.9         22.8        -15.3        11.2        34.7          -50.6         -25.7
               30.7         26.2         17.7        22.8        38.0           53.0          27.8

HT68 - TC12    17.6         -3.41        -1.42       58.8         4.89           .170         -5.18
               17.4         12.0         -8.34       30.6        36.7           2.19          -2.95
               18.2         14.0         10.5        35.7        37.2           2.66           3.71

HT78 - TC15     .340        -7.25        1.34        22.8         2.19           .440         -6.91
                2.20        -3.21       -2.06        10.2         7.83           1.42          -2.50
                2.22         4.11        3.44        12.3        10.3            1.63           3.11

ML18 - X671    -4.83       -10.4        -14.8       -17.7       -15.5          -16.2         -18.7
               14.2         -7.36       -14.8       -18.3       -17.9          -15.7         -17.0
               20.0          7.69        14.9        18.3        18.0           16.7          17.0

MP18 - X801     .822E-01    -.251E-01    -.713E-02   -.766E-02   -.907E-02     -.237E-02     -.153E-02
               -.141E-02     .350E-02    -.335E-02    .379E-02   -.366E-02      .267E-02     -.160E-02
                .373E-01     .136E-01     .135E-01    .763E-02    .738E-02      .581E-02      .256E-02
```

Case C

```
CALCULATION-TO-EXPERIMENT DATA UNCERTAINTY ANALYSIS FOR NRC/ICAP.
=================================================================

  FIRST LINE  : DIFFERENCE BETWEEN CALCULATED AND (AVERAGED) EXPERIMENTAL DATA AT END OF THE INTERVAL
  SECOND LINE : MEAN DIFFERENCE OVER THE INTERVAL
  THIRD LINE  : MEAN SIGMA OVER THE INTERVAL  (ROOT MEAN SQUARE OF THE DIFFERENCE)


 - CODES -                               - - - - TIME INTERVAL - - - -

CALC.  EXP.     0.0 - 2.000     - 4.000      - 7.000      - 10.00      - 15.00      - 20.00      - 27.00
==========================================================================================================

P 1C - P  3     -.483E-01    -.581E-01    -.617E-01    -.158        -.199        -.406        -.379
                -.472E-02    -.487E-01    -.658E-01    -.105        -.164        -.286        -.495
                 .644E-01     .309E-01     .668E-01     .110         .164         .294         .499

P 2C - P  4     -.590E-02    -.271E-01    -.334E-01    -.176        -.170        -.383        -.350
                 .337E-02    -.881E-02    -.284E-01    -.748E-01    -.134        -.259        -.477
                 .183E-01     .129E-01     .266E-01     .816E-01     .134         .280         .480

P 3C - P  5      .814         .922         .598         .330         .850         .523        -.214
                1.51          .867         .745         .436         .937         .606         .429E-01
                2.66          .869         .750         .466         .957         .636         .273

P04C - D  4     -.334       -1.22         1.51          .640        3.40         1.31         6.37
                28.4        -1.64         -.416        2.10         1.34         5.87         4.95
                38.7         1.91         1.01         2.15         3.87         6.49         6.82

P0LC - D LP    -1.64         -.997         .182        -.112E-01     .377E-01     .201         .406
               -1.03        -1.77         -.192         .831E-01    -.412E-01     .142         .281
                1.24         1.80          .337         .900E-01     .828E-01     .168         .275

P0CC - D CO    -1.88         1.85         1.07         -.707       -1.35        -1.72          .586
                2.24         1.40          .810        -.131       -1.31        -2.31          .379E-01
                6.75         2.36         1.13         1.06         2.65         2.98          .579

P0UC - D UP     -.684         .103        -.415        -.272        -.932E-01     .447E-01    -.106
                -.110         .460        -.337        -.373        -.388         .803E-01    -.779E-01
                 .552         .793         .368         .374         .820         .155         .827E-01

P0DC - D DC      .903       -1.25        -2.63        -4.23        12.0         13.4           .333
                2.16         4.14         -.867       -4.40         9.34         7.30         2.79
                6.62         4.66         2.90         4.44        11.3          8.87         4.90

P03C - D 36      .168         -.441        -.819       -1.21          .148        -.838E-01     .164E-01
                -.123          .209        -.855        -.979        -.377        -.192         .933E-01
                3.81          .718         .887        1.02         1.90          .390         .292

WP1C - X602      .206E-01     .112         .123         .183         .300         .167         .248
                 .190         .106         .831E-01     .156         .209         .253         .257
                 .211         .114         .884E-01     .156         .230         .280         .283

WP2C - X603      .383         .601E-01   -1.37         -.827E-01   -1.72        -1.78        -1.34
                -.266         .641E-01    -.371        -.402        -.377       -1.46        -1.39
                 .819         .160         .885         .506        1.02         1.49         1.63

WP3C - X604     5.05         1.23          .616       -1.74         -.890       -3.03        -5.38
                6.20         3.36         1.26         -.293        -.653       -2.71        -4.65
                6.88         3.71         1.36          .742        1.48         2.32         4.71

WP5C - X607      .134         .514E-01     .243E-01     .827E-02     .121E-01    -.162E-01    -.316E-01
                 .278E-01     .115         .616E-01     .168E-01     .129E-01    -.179E-02    -.241E-01
                 .148         .118         .426E-01     .160E-01     .134E-01     .846E-02     .246E-01

WP4C - X610    -4.63         4.38          .134        3.53         6.32         7.72         7.50
               -6.94         1.26         1.99         2.13         4.44         6.55         7.22
                7.82         2.90         2.35         2.65         4.63         6.58         7.32

WP6C - X636   -11.6         -2.84        -1.02        -1.81         -.199E-01    -.145E-01    18.1
              -10.4         -4.37        -1.71         -.730         .607        -.129        -.866E-01
               11.0          5.18         1.78          .773        1.11          .175        1.31

TP1C - T  3     2.38         2.71         2.41          .850        -.880       -6.06       -14.2
                6.15         2.34         2.32         1.77          .414       -2.44        -9.10
                6.81         2.34         2.33         1.86          .386        2.79         9.50

TP2C - T 14    -2.46        -1.80        -1.49        -1.47        -2.24        -4.79       -18.1
               -2.62        -2.33        -1.82        -1.86        -2.09        -4.45       -10.7
                2.63         2.27         1.83         1.81         2.11         4.67        11.0

TP4C - T 16      .810         .820         .710        -.110       -1.47        -6.89       -14.8
                1.32         1.00          .670         .390        -.551       -3.29        -9.63
                1.66         1.02          .863         .556         .646        3.59        10.2

TP3C - T 31     3.52         2.89          .390       -3.58        -6.47       -14.3        -24.3
                1.74         4.79          .396       -3.46        -6.23       -11.9        -18.5
                1.83         4.87         1.08         2.82         6.34        11.2         18.9

TP5C - T 34    -2.63         1.30        -2.11        -6.83        0.          -3.29       -24.9
              -46.8          -.290         .352       -4.41        -1.33        -3.07       -14.9
               56.7           .879        1.52         4.61         3.23         3.35        18.6

HT1C - TC  1    -.800       -46.1        -77.8        -66.9        -68.6        -19.1       -27.0
               -3.11        -17.4        -46.1        -68.0       -103.         -56.5       -17.1
                3.38         23.1         56.5         68.2        103.          63.1        17.8

HT2C - TC  3   -2.22        -49.5       -118.        -110.        -106.         -69.5       -71.4
                -.718       -27.9        -69.3       -122.        -115.         -72.2       -62.4
                1.78         31.6         91.3        122.         116.          74.2        62.4

HT3C - TC  5   34.1          17.5         14.4         89.0        -2.31        -7.89       -15.7
               11.2          27.5          9.28        44.7        59.1         -9.70       -13.0
               17.6          28.0         10.1         80.1        71.0         11.2         13.7

HT4C - TC  7   57.0          29.2          3.76        35.4        13.8        -30.0        -35.3
               22.4          43.7         11.0         15.7        39.9        -40.6        -30.6
               31.3          44.4         13.6         17.5        43.8         43.7         30.9

HT5C - TC  9   46.3          10.5          -.520       48.5       -46.0        -64.2        -43.6
               21.3          29.4         -2.83        22.6         2.98       -71.8        -34.1
               28.4          31.0          6.46        78.6        43.3         72.2         35.7

HT6C - TC12    22.5          33.3         12.2         72.3         1.85        -6.16       -16.5
               15.8          33.3         14.1         44.2        33.3         -2.09       -10.7
               19.2          35.6         15.6         47.7        37.5          2.63        11.4

HT7C - TC15      .480        -7.72          .520       16.1        -1.08        -4.00       -17.5
                2.48         -3.47        -2.55         6.29        4.35        -2.86       -10.1
                3.53          4.40         3.78         6.87        7.93         3.16        10.6

WL1C - X871    -3.08         -6.53        -8.48       -12.1        -10.7        -10.6        -12.9
               15.1          -4.27        -8.68       -12.8        -12.7        -10.4        -11.3
               20.3           4.86         8.77        12.8         12.9         10.4         11.0

HP1C - X801      .822E-01    -.251E-01    -.713E-02    -.788E-02    -.907E-02    -.237E-02    -.153E-02
                 .100E-01    -.649E-02    -.338E-02     .282E-02    -.435E-02     .267E-02    -.158E-02
                 .280E-01     .178E-01     .138E-01     .701E-02     .823E-02     .541E-02     .248E-02
```

Case D

```
CALCULATION-TO-EXPERIMENT DATA UNCERTAINTY ANALYSIS FOR NRC/ICAP.
*****************************************************************

  FIRST LINE  : DIFFERENCE BETWEEN CALCULATED AND (AVERAGED) EXPERIMENTAL DATA AT END OF THE INTERVAL
  SECOND LINE : MEAN DIFFERENCE OVER THE INTERVAL
  THIRD LINE  : MEAN SIGMA OVER THE INTERVAL  (ROOT MEAN SQUARE OF THE DIFFERENCE)

 - CODES -                                  - - - - TIME INTERVAL - - - -
CALC.  EXP     0.0 - 2.000     - 4.000      - 7.000     - 10.00     - 15.00     - 20.00     - 27.00
*********************************************************************************************************
P 10 - P  3    -.710E-02     -.427E-01    -.861E-01    -.256       -.410       -.610       -.702
                .523E-02     -.218E-01    -.592E-01    -.156       -.295       -.502       -.666
                .305E-01      .262E-01     .594E-01     .168        .299        .507        .667
P 20 - P  4     .319E-01     -.530E-02    -.355E-01    -.225       -.383       -.588       -.674
                .161E-01      .215E-01    -.178E-01    -.126       -.263       -.486       -.648
                .173E-01      .242E-01     .180E-01     .140        .268        .494        .649
P 30 - P  6     .370          .349         .266        -.940E-02   -.132E-01   -.328       -.434
               1.42           .375         .306         .141        .142       -.188       -.315
               2.62           .377         .310         .183        .181        .216        .336
PO40 - D  4   -2.06         -2.58          .419         .816       5.57        2.84        7.61
               25.4         -3.29        -2.42         2.29         .683       7.70        5.68
               37.1          3.33         2.60         2.35        4.34        8.63        6.39
POLO - D LP   -2.05         -1.13         -.141        -.229E-02    .753E-01    .197        .422
              -1.41         -1.96         -.407        -.626E-01   -.291E-01    .153        .260
               1.66          1.99          .466         .769E-01    .447E-01    .171        .277
POCO - D CO    3.37         -2.82          .161        -.334      -1.13       -1.17         .883
               2.76          -.401        -.912        -.154      -2.43       -1.00        -.134
               6.31          2.73         1.61          .635       2.93        1.59         .969
POUO - D UP     .712         -.543        -.457        -.121       -.485       -.115       -.126
                .126          .534E-01    -.510        -.362       -.732       -.870E-01   -.124
                .419          .693         .533         .365        .897        .124        .126
PODO - D DC    -.427         -.240E-01   -1.21        -2.13         .262       -.324        .196
              -1.62          2.83        -3.03         -.802       -.596        .468       -.274
               3.99          3.06         4.11         1.19        1.15        1.16         .415
POSO - D 56    1.51         -1.52         -.063        -.458       -.821       -.180       -.212
                .615         -.463        -.853        -.899       -.647       -.306       -.232
               3.17           .911         .820         .932       1.84         .377        .272
MF10 - X602     .174E-01      .477E-01     .112         .203        .349        .202        .266
                .120          .284E-01     .687E-01     .174        .324        .301        .285
                .184          .813E-01     .739E-01     .176        .341        .310        .290
MF20 - X603    -.303         -.338        -.238        -.466      -1.82       -1.58       -1.47
               -.399         -.376        -.229         .801E-01   -.127      -1.44       -1.44
                .756          .378         .271         .389        .891       1.48        1.47
MF30 - X604    4.93          3.38         2.05         -.397      -2.31       -4.95       -5.43
               4.82          4.38         2.55         1.01       -1.68       -3.95       -5.27
               5.42          4.11         2.65         1.35        1.93        4.00        5.27
MF50 - X607     .138          .638E-01     .239E-01    -.810E-03   -.570E-02   -.330E-01   -.419E-01
                .375E-01      .116         .427E-01     .123E-01    .164E-02   -.200E-01   -.382E-01
                .147          .122         .436E-01     .149E-01    .480E-02    .216E-01    .383E-01
MF40 - X610   -3.12          4.56          .158        3.42        5.51        7.83        7.80
              -7.94          2.51         2.56         1.82        4.53        6.62        7.81
               9.08          3.26         3.21         2.20        4.68        6.66        7.82
MF60 - X636  -11.0          -1.98          .179       -1.44        -.184       -.384       15.0
             -11.7          -3.89         -.896         .875E-02    .616       -.417       -.118
              12.2           4.78         1.11          .618       1.06         .430       1.33
TF10 - T  3    2.86          2.88         2.36         -.380      -4.10       -8.12      -18.2
               6.36          2.64         2.38         1.15       -1.44       -4.23      -13.3
               6.72          2.64         2.40         1.48        1.78        6.46       13.6
TF20 - T 14   -2.14         -1.82        -1.53        -2.86       -6.35      -10.9       -20.1
              -2.32         -1.89        -1.69        -2.48       -3.91       -8.31      -14.9
               2.35          1.94         1.70         2.56        3.98        8.47       15.2
TF40 - T 15     .980         1.06          .680       -1.36       -4.80       -9.79      -18.7
               1.57          1.27          .795        -.244      -2.39       -7.17      -14.1
               1.75          1.28          .810         .816       2.58        7.37       14.3
TF30 - T 31    7.18          2.72          .700E-01   -6.32      -11.6       -18.2       -28.3
               3.52          4.91          .308       -3.24       -7.83      -14.8       -22.8
               4.07          5.17         1.14         3.46        8.13       14.9        23.0
TF50 - T 34   -4.83         -4.06        -4.53       -12.6       -18.9       -24.3       -33.6
             -38.0          -4.30        -4.78        -6.98      -14.3       -20.3       -25.9
              62.1           4.35         4.89         8.18       14.3        20.4        26.3
MT10 - TC 1    1.67        -28.3        -76.5        -87.7       -91.7       -23.0       -30.9
              -2.80         -4.86       -41.0        -67.9      -105.        -62.1       -21.2
               3.60          8.63        62.3         88.1       105.         64.3        21.5
MT20 - TC 3    6.98         16.8          -.870       18.1       -89.8       -61.0       -83.1
               1.31         11.6         12.2          7.46      -40.4       -71.0       -61.3
               4.34         12.0         14.4         10.3        64.1        72.7        61.4
MT30 - TC 5   -1.73        -29.5        -76.6         16.0       -70.5       -14.9        -6.32
                .858       -27.4        -60.8        -37.2       -27.2       -24.5       -13.4
               1.80         28.5         63.0         46.8        54.4        29.3        13.9
MT40 - TC 7    -.360       -95.8       -166.        -116.        -95.3       -39.3       -24.3
               2.64        -60.6       -138.        -150.       -122.        -64.9       -32.5
               3.42         57.6        139.         180.        133.         66.6        32.8
MT50 - TC 9   29.0         -30.5       -141.         -65.5      -107.        -61.5       -28.1
              15.9            .947       -67.7      -106.       -110.        -61.8       -33.8
              20.3          17.6         96.2        109.        112.         82.3        35.4
MT60 - TC12    6.62         -2.99        -3.40        42.2        -2.80       -9.62        6.48
              10.5          10.8        -10.0         27.6         3.12       -6.50       -6.00
              12.7          12.9         11.1         32.7        10.5         6.74        9.03
MT70 - TC15     .800        -7.46          .520        8.61       -3.94       -8.07       -1.41
               2.32         -3.35        -2.42         7.73        -.485      -6.40       -9.11
               2.34          4.29         3.60         9.47        2.60        6.62        9.73
ML10 - X671   -3.77         -6.36        -6.51        -6.82       -6.37       -6.97       -9.41
              15.1          -4.75        -6.46        -6.35       -7.16       -5.88       -7.46
              20.7           4.96         8.44         8.39        7.46        5.92        7.52
MP10 - X801     .822E-01     -.251E-01    -.713E-02    -.788E-02   -.807E-02   -.237E-02   -.133E-02
                .100E-01     -.649E-02    -.335E-02     .282E-02   -.435E-02    .267E-02   -.152E-02
                .280E-01      .175E-01     .138E-01     .791E-02    .823E-02    .581E-02    .243E-02
```

APPENDIX D

Description of the accompanying data package

```
STUDSVIK
THIS TAPE CONTAINS DATA FROM THE ICAP PREDICTION CALCULATION
WITH THE RELAP5/MOD2/36.04 FOR THE FIX-II EXPERIMENT NO. 5061.

CONTENTS, FILE  1.           THIS DESCRIPTIVE TEXT
                2.           INPUT CASE A, STEADY STATE
                3.              - " -   A, TRANSIENT
                4.              - " -   B, STEADY STATE
                5.              - " -   C,     - " -
                6.              - " -   D,     - " -
                7.           DATA, EXPERIMENT
                8.           -"- , CASE A
                9.           -"- , CASE B
               10.           -"- , CASE C
               11.           -"- , CASE D

I.   COMPUTER
        NAME                 CYBER 170-810
        WORD SIZE            60

II.  TAPE FORMAT
        NUMBER OF TRACKS     9
        PACKING DENSITY      1600 BPI
        RECORD SIZE          80
        BLOCKING FACTOR      64
        CODED                EBCDIC
        CONTROL WORDS        NO

III. DATA FORMAT, FOR EACH OF THE FILES 5 THROUGH 8

       TITLE RECORD(S), (FORMAT I5,A75)
           FIELD 1, THE NUMBER OF DATA CHANNELS ON THE FILE
           FIELD 2, PROBLEM IDENTIFICATION
                    UP TO FIVE ADDITIONAL IDENTIFICATION RECORDS
                    MAY BE ADDED BY 'C' IN COLUMN 1 OF FIELD 1

       DATA SET RECORD 1, (FORMAT 2I5,A60)
           FIELD 1, NUMBER OF DATA POINTS
           FIELD 2, THE ENGINEERING UNIT CODE (EUC) FOR THE
                    VARIABLE
           FIELD 3, IDENTIFYING TEXT OF THE DATA
       REMAINING DATA SET RECORDS FORMAT 5(E16.9)

     EACH DATA CHANNEL SUBMITTED IS GIVEN THROUGH TWO DATA
     SETS, THE FIRST OF WHICH IS THE TIME DATA SET.
     THE TWO SETS HAVE THE SAME NUMBER OF DATA POINTS.
     THE TIME DATA SET IS IDENTIFIED BY EUC=77 (FIELD 2)
     AND THE IDENTIFYING TEXT 'TIME' (FIELD 3).
```

NRC FORM 335 (2-84) NRCM 1102, 3201, 3202

U.S. NUCLEAR REGULATORY COMMISSION

BIBLIOGRAPHIC DATA SHEET

SEE INSTRUCTIONS ON THE REVERSE

1. REPORT NUMBER (Assigned by TIDC, add Vol. No., if any)
NUREG/IA-0016
STUDSVIK/NP-86/109

2. TITLE AND SUBTITLE
Assessment of RELAP5/MOD2, Cycle 36.04 Against
FIX-II Guillotine Break Experiment No. 5061

3. LEAVE BLANK

4. DATE REPORT COMPLETED
MONTH | YEAR

5. AUTHOR(S)
John Eriksson

6. DATE REPORT ISSUED
MONTH: July
YEAR: 1989

7. PERFORMING ORGANIZATION NAME AND MAILING ADDRESS (Include Zip Code)
Swedish Nuclear Power Inspectorate
P.O. Box 27106
S-102 52 Stockholm, Sweden

8. PROJECT/TASK/WORK UNIT NUMBER

9. FIN OR GRANT NUMBER

10. SPONSORING ORGANIZATION NAME AND MAILING ADDRESS (Include Zip Code)
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission
Washington, DC 20555

11a. TYPE OF REPORT
Technical Report

b. PERIOD COVERED (Inclusive dates)

12. SUPPLEMENTARY NOTES

13. ABSTRACT (200 words or less)

The FIX-II guillotine break experiment No. 5061 has been analyzed using the RELAP5/MOD2 code. The code version used, Cycle 36.04, is a frozen version of the code.

Four different calculations were carried out to study the sensitivity of initial coolant mass, junction operations and break discharge line nodalization. The differences between the calculations and the experiment have been quantified over intervals in real time for a number of variables available from the measurements during the experiment.

The break mass flows were generally underpredicted at the same time as the depressurization rate was overpredicted.

14. DOCUMENT ANALYSIS – a. KEYWORDS/DESCRIPTORS
RELAP5/MOD2, ICAP Program, FIX-II, Guillotine Break

b. IDENTIFIERS/OPEN ENDED TERMS

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