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International Agreement Report

Study of Unusual Occurrence of a Partial Core Uncovery in an SBLOCA Scenario

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Abstract

The Polytechnical University of Catalonia (UPC) has been cooperating since 1992 with the Asociación Nuclear Ascó (ANA) improving its plant model.

Ascó NPP is a two unit, three loop Pressurized Water Reactor (PWR) plant of Westinghouse design operated by ANA. Its model, developed for RELAP5/MOD3.2, includes thermal-hydraulics, kinetics and protection and control systems and has been qualified in previous calculations of several actual plant transients.

This report shows the results obtained with the Ascó NPP model for a 5 inch Loss of Coolant Accident using RELAP5/MOD3.2.

It also includes two different sensitivity studies performed to show the singularity of the phenomenology identified in the base case: the first study analyzes the influence of Main Coolant Pumps (MCPs) coast-down start; the second, the influence of the code itself (of its flow regime prediction).

Executive Summary

Ascó Nuclear Power Plant is a nuclear station with two PWR of 930 MWe of Westinghouse design.

The thermal-hydraulic analysis group of the Asociación Nuclear Ascó (ANA) has developed a model of the plant using RELAP5/MOD3.2, which has been recently improved thanks to the collaboration between ANA and the Polytechnical University of Catalonia (UPC). This model includes thermal-hydraulics, kinetics and protection and control systems.

The aim of the study presented in this report is to fullfill UPC's commitment with the Code Assessment and Maintenance Program (CAMP).

The transient selected to be analyzed for this purpose is a Loss of Coolant Accident at Ascó NPP with RELAP5/MOD3.2.

In the following pages the results obtained for a base case calculation and two sensitivity studies will be presented. Both studies help to prove the singularity of the phenomenology identified and described in the base case calculation:

· A first sentitivity study is performed to determine the influence of the Main Coolant Pumps (MCPs) coast-down start.

· A second analysis shows the influence of flow regime transitions on RELAP's simulation.

The main conclusions are as follows:

- this study presents an unusual phenomenon of SBLOCA scenarios with injection of all emergency systems (a partial core dryout) for a full size PWR.
- the unusual occurrence of this phenomenon has been related to loop seal clearing and for this reason the clearing mechanism and its relation to flow regime change has been analyzed in more detail.
- Influence of the code has also been determined. By slightly changing the conditions of flow regime transition, the partial dryout disappears.
- RELAP5/MOD3.2 is a valuable tool to analyze plant transients.

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List of Abreviations

ANA:	Asociación Nuclear Ascó
CAMP:	Code Application and Maintenance Program
EOPs:	Emergency Operating Procedures
FW:	Feed Water
HPIS:	High Pressure Injection System
MCPs:	Main Coolant Pumps
MOL:	Middle Of Life
NPP:	Nuclear Power Plant
PRA:	Probabilistic Risk Assessment
PRZ:	Pressurizer
PWR:	Pressurized Water Reactor
SBLOCA:	Small Break Loss Of Coolant Accident
SG:	Steam Generator
UPC:	Universitat Politècnica de Catalunya

1. Introduction

Since 1992 the Polytechnical University of Catalonia (UPC) has been cooperating with the Asociación Nuclear Ascó (ANA) in different activities of plant and core thermal-hydraulic analysis. The main objective of the combined team has been to improve the capabilities of Ascó NPP models. The most important cooperation studies performed are as follows:

1• Update and review of plant thermal-hydraulic models based on best-estimate criteria /1/.

2• Support to ANA's participation in the International Code Assessment and Application Program /2/.

3• Participation as part of the coordinated team UPC-ANA, in LOBI Data Users Group. During this period different analyses have been performed in two main directions: post-test analysis of LOBI experiments /3//4/ and calculations of equivalent scenarios in full size reactors /5//6/.

4• Collaboration in the migration of RELAP5/MOD2 models to RELAP5/MOD3.2 as well as the qualification process of the final model /7//8/.

5• Calculation of an extensive set of Small Break LOCA scenarios /9/ for Ascó NPP taking into account:

   a) Break sizes.

   b) Emergency operating procedures /10/.

   c) Availability of emergency systems.

   d) Manual actuations/11/.

6• Participation in the Code Assessment and Maintenance Program (CAMP).

Once the adjustment and qualification process is considered to be completed following the above mentioned sets of calculations, sufficiently accurate predictions with meaningful sets of measured data provide validation of both the model and the procedures to be used in the future to analyze various transient and accident scenarios of general interest.

This report refers to the results obtained with the Ascó NPP model for a 5 inch Loss of Coolant Accident using RELAP5/MOD3.2.

A transient explanation is given in section 2.2 after a brief description of the plant itself (section 2.1).

Chapter 3 is a summary of what is included in the model and chapter 4 explains the steady state calculation for nominal conditions.

Chapter 5 includes a 5" LOCA base case calculation using the standard RELAP5/MOD3.2 version. Two different sensitivity studies are presented in chapter 6: section 6.1 shows a first study performed to determine the influence of the Main Coolant Pumps (MCPs) coast-down start (using the standard RELAP5/MOD3.2 version). Section 6.2 presents the results obtained for a second sensitivity study, using a modified version of RELAP which includes slight changes in the prediction of flow regime transitions.

Run statistics, conclusions and references can be found in chapters 7, 8 and 9 while diagrams showing the nodalization used are in annex 1 .

2. Plant and transient description

2.1. Plant description

Ascó Nuclear Power Plant is a two unit station of three loop Pressurized Water Reactors (PWR) of Westinghouse design. The first criticality was reached in June 1983 in Ascó I and in September 1985 in Ascó II. Today, unit I is in its twelfth cycle and unit II in its eleventh of normal operation.

The main characteristics of both units are given in Table 1. The core contains 157 fuel assemblies of (17x17 -25) fuel rods.

The steam generators have been recently changed, in October of 1995 for Unit I and in October of 1996 for Unit II. The new ones are SIEMENS-FRAMATOM (61W/D3).

At the same time a deep upgrade of the original control systems has been performed. The new controls are fully digital and allow to establish sets of data more suitable for assessment.

All other major components are standard Westinghouse components.

Main Characteristics of Ascó I and II Nuclear Stations	
Thermal reactor power	2686 MWth
Fuel	UO2
Number of assemblies	157
Fuel rods per fuel assembly	(17x17 – 25) = 264
Active length of fuel rods	3.657 m
Outside diameter of fuel rods	9.5e^{-3} m
Cladding tube material	Zr-4
Cladding tube wall thickness	0.5715e^{-3} m
Average linear heat generation rate	17750 W/m
Absorber rods per control assembly	24
Absorber material	Ag – In – Cd
Number of coolant loops	3
Reactor operating pressure (PRZ)	15.51 MPa
Coolant Average Temperature	581.3 K
Coolant flow rate	14287 Kg/s
Steam Generator	
Type	61W/D3
Number	3
Reactor coolant pumps	
Type	Westinghouse 93-DS
Discharge head	86.25 m
Design flow rate	5.928 m^3/s
Speed	155 rad/s
Pressurizer	
Height	12.835 m
Diameter (inner)	2.134 m
Volume	39.64 m^3
Operating saturation pressure	15.51 MPa
Heating power of the heater rods	1.40 Mwe
Steam/Power Conversion Plant	
Feed Water flow rate	497.5 Kg/s (loop)
Main steam flow rate	1492 Kg/s
Steam moisture at steam generator outlet	0.25 %
Feedwater temperature	497.05 K

Table 1: Main Characteristics of Ascó I and II Nuclear Stations.

2.2. Transient description

The transient simulates a 5 inch break located at the cold leg of the first loop which causes a quick depressurization of the primary system and reactor trip. Due to the rapid evolution of the transient no significant intervention of the plant Emergency Operating Group has been simulated.

Table 2 shows a list of the main events identified in the RELAP calculation:

Event	Time (seconds)
Break	0
HPIS starts to inject	7.5
Saturation conditions	26
MCPs trip	60
Loss of natural circulation	~170
Loop seal clearing (loops 2 and 3)	260 / 240
Break uncovery	~275
Primary pressure falls bellow secondary pressure	325
Beginning of core dryout	460
Accumulator injection	470
Maximum Clad temperature (640 ºK)	550
Core rewetting	565

Table 2: Sequence of events for a 5" Loss of Coolant Accident.

3. Model Description

The model corresponds to the plant configuration explained in section 2.1. It includes the new SGs as well as the new controls.

Diagrams 1 and 2 show the model used to simulate the plant. It consists of 152 volumes with its correspondent junctions, 51 valves, 27 time dependent volumes, 8 time dependent junctions, 6 heat structures, 466 control variables and 351 trips. The model includes the vessel, the three primary loops, the pressurizer, the three steam generators, the three secondary loops, and the steam lines. The turbine, condenser, moisture separator reheaters, suction lines of main and auxiliary feedwater pumps are modeled as time dependent volumes.

3.1. Thermal-hydraulic model

a) Primary system

The model of the primary system (diagram 1) includes the main components of the plant. The core is modeled by volume 120 and the proper heat structures. Volume 130 simulates the by-pass region between the core baffle and the core barrel. Volume 140 models the upper plenum and volumes 150 and 160 the vessel upper head. The three hot lines depart from the core upper plenum. Loop 3 (volume 410) is connected with the pressurizer through volume 510. The pressurizer is divided into 2 volumes.

The lower one (volume 520) is divided into 19 nodes. Heat structures, simulating the pressurizer actual heaters, are attached to the first three nodes. Volume 525 is a branch in order to model the junctions connecting the pressurizer with the safety and relief valves and with the spray system.

Volume 420 models the remaining hot leg. Volumes 430 and 440 simulate the water boxes of the steam generator. The primary side of the steam generator is modeled by volume 431 divided into 20 nodes. Volume 460 models the primary coolant pump. Proper homologous curves, given by the vendor, have been used for this purpose. Volumes 268, 368, 468 model the HPIS. Time dependent junctions

267, 367, 467 model the high pressure injection pumps by means of the pump characteristic curves. Accumulators are also modeled.

b) Secondary system

The model of the secondary system (diagram 2) starts with time dependent volumes 662 and 654, that represent the suction lines of the main feedwater pumps. Volumes 679, 693, and 682 represent the suction lines of the auxiliary feedwater pumps.

Volumes 664 and 656 model the main feedwater pumps. Proper homologous curves, given by the vendor, have been used for this purpose.

Time dependent junctions 690, 695, 694 model the auxiliary feedwater pumps by means of the pump characteristic curves.

Volumes 665, 666 and 657, 658 represent lines from pumps to hot-collector (volume 668). The feedwater high pressure heater is modeled by a heat structure between the first node of volumes 666 and 658 with volume 942. This last volume is a time dependent volume with a temperature function of the turbine power.

Volumes 869, 870, 872, 875 (loop 3) model lines of main feedwater to the steam generator. Volumes 888, 852 model lines from auxiliary feedwater pumps to main feedwater connection. Their correspondent check, control and isolation valves are also modeled.

The SG downcomer (diagram 1) is simulated by means of volumes 800, 801, 822 and 825. The steam generator riser is modeled by volume 810. The steam separator with volume 820. Volumes 830, 840 and 850 model the steam dryer and the dome of the steam generator. The steam line starts at volume 880. Safety and relief valves (components 886 and 884) are connected to volume 881. Component valve 885 models the isolation valve. Time dependent volumes 994 and 999 represent the free atmosphere. The steam is conducted throughout volume 883 to the steam collector, volumes 900 and 904. Finally valves from 931 to 938, 903 and 907 model the by-pass to condenser valves, the turbine stop and control valves respectively. And valve 917 represents the steam flow to moisture separator reheater.

Proper heat structures are used to thermally connect the primary side of the steam generator with secondary side. Actual values are used for all the variables. Fouling factor coefficient is introduced in order to achieve the actual heat transfer rate without any change in primary average temperature and secondary pressure.

The data used to model volumes, junctions and valves as well as heat structures were taken from plant design information /12/.

3.2. Kinetic model

The kinetic model /13/ was prepared using the RELAP5/MOD3.2 space-independent reactor kinetic option with data from the ANA Nuclear Analysis Group. The model includes a scram table of reactivity versus time. The total control rod drop time is the actual value measured at plant. This table is activated by reactor trip.

The control model supplies the reactivity of the C and D control rod banks.

This control reactivity is added to feedback reactivities calculated by the kinetic model from the data supplied for the specific burn-up condition of each transient.

3.3. Control and protection systems model

The protection and control systems are modeled using RELAP5/MOD3.2 control blocks and following specific setpoint studies, logical diagrams and technical specifications of the plant /13/, /14/, /15/.

The model includes the following systems:

a) Reactor trip system.

The reactor can trip in the RELAP5/MOD3.2 model because of the following effects:

- Power range, low range, high level
- Power range, high range, high level
- Overtemperature

- Over power
- High pressurizer pressure
- High pressurizer water level
- Low pressurizer pressure
- Loss of primary coolant flow
- Low-low steam generator water level
- Turbine trip
- Safety injection
- Manual reactor trip

b) High pressure Injection System

Using the following signals:

- Low pressurizer pressure
- High steam line differential
- High steam line flow coincident with Low steam line pressure or Low-Low average teperature.

c) Turbine Trip and Control System

The position of the turbine control valve is controlled as a function of the difference between the required power and actual power, with the proper control block to model the actual logic of the plant. Turbine run-back signals have also been modeled.

The Turbine Trip (closure of the turbine stop valve) is modeled. The signals of Safety Injection, very high steam generator level, reactor trip, AMSAC signal and manual signal are used to trip the turbine.

d) Feed Water Control System

The feed water control system of the main and by-pass valves as the pumps has been modeled as shown in diagram 2. The auxiliary feed water system is also included in the model.

e) Pressurizer Level and Pressure Control System

The model of the pressure control system actuates upon heaters, spray valve and charging pump. Pressurizer safety and relief valves and level control systems are also simulated.

f) Average Temperature Control System

The average temperature control system modeled with RELAP5/MOD3.2 controls both the primary average temperature and the primary-secondary power mismatch.

Other systems modeled are:

g) Steam Dump Control System

h) Steam line isolation logic.

i) Safety and Relief valves of the secondary.

j) Primary pumps trip.

k) General Variables.

l) Permissive and interlock circuits.

m) Low Pressure Injection System.

4. Steady state calculation

A steady state calculation was performed with the plant at 100% rated condition and kinetic parameters corresponding to MOL /16/ for unit 1. The objective is to obtain a stable condition to start transients.

Table 3 compares the results obtained in the RELAP5 calculation for the main variables with the corresponding plant data.

Steady State		
VARIABLE	MODEL(RELAP5/MOD3.2)	PLANT
Vessel ΔT (K)	33.3	33.7
Primary Pressure (MPa)	15.517	15.516
Primary Avg. Temperature (K)	581.5	581.5
Recirculation ratio	3.64	3.65
SG Narrow Range Level (%)	50.6	50.6
Secondary Pressure (MPa)	6.82	6.733
Steam Mass Flow (kg/s)	495.1	496.1

Table 3: Comparison Steady State between model and actual data plant.

5. Transient calculation

In this section, the results of a base case calculation with ANA's RELAP5/MOD3.2 model will be presented. The calculation has been performed making following assumptions:

- Initial normal full power operation in the middle of core life.
- the scenario chosen corresponds to a 5" cold leg break
- coast-down of the main coolant pumps starting 60s after scram
- HPIS and accumulator injection
- following the old Emergency Operating Procedures (EOPs).[1]

Figure 1 shows the evolution of primary and secondary pressure during the transient and some of the most relevant events.

Shortly after the break and due to the low upper plenum pressure, the reactor is scrammed automatically. A few seconds later injection of the HPIS starts.

As saturation conditions are reached the main coolant pumps are tripped (about 1 minute after scram) and some minutes later loss of natural circulation takes place.

Degradation of the heat transfer between primary and secondary system causes a sharp increase in the void fraction in hot legs. This situation ends with the break uncovery and two of three loop seal clearings.

The quicker depressurization rate of the primary system contributes to a further degradation of the heat transfer and produces decoupling of both systems.

Before the accumulator set point pressure is reached (about 470 s after the break) a partial core uncovery is observed.

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[1] The old recovery procedures do not include any reference to the core level measurement system of Ascó.

Loop seal formation and clearing are closely related to this core uncovery. As shown in figure 2, loop seal clearing takes place in loops 2 and 3 at about 250s, whereas for the broken loop liquid remains trapped in it almost during the whole transient.

Analyzing the collapsed liquid level in the vessel (figure 3), after a quick initial decrease a slight recovery is observed, which corresponds to both loop seal clearings. Later, the collapsed level depresses further reaching a value close to the 30%.

The accumulator injection allows a new increase of the level and rewetting of the core.

Heater rod temperature in the last two of six nodes increases reaching a value of about 605 ºK and 644 ºK, respectively, and decreases again thanks to the accumulator injection (figure 4).

In some small break LOCA scenarios with partial core uncovery, this phenomenon of partial uncovery is not accompanied by cladding temperature excursions. In those cases dryout is mitigated by liquid of the vessel's bottom being dragged by the vapor generated.

In the present scenario this drag mechanism is not enough to avoid the temperature increase, as observed in figures 5 and 6. Figure 5 shows the vapor velocity in the core. Although there is an increase after the break uncovery, vapor velocity does not reach a sufficiently high value in order to have a significant drag. The same conclusion can be drawn observing figure 6 in which liquid velocity in the inlet and outlet junctions of the fifth node are represented.

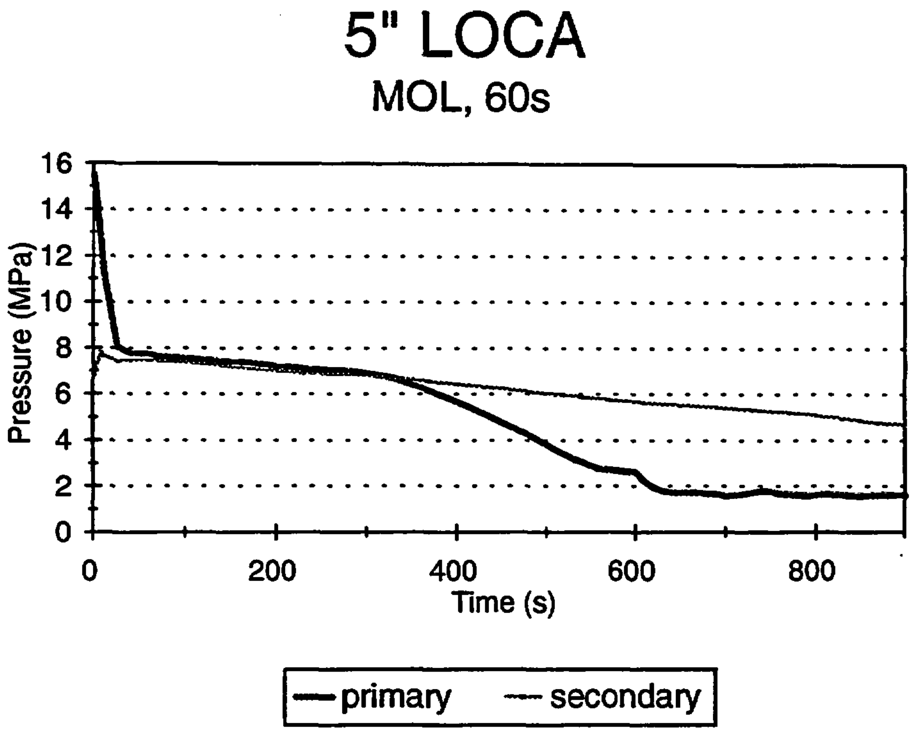


Figure 1: Primary and secondary pressure.

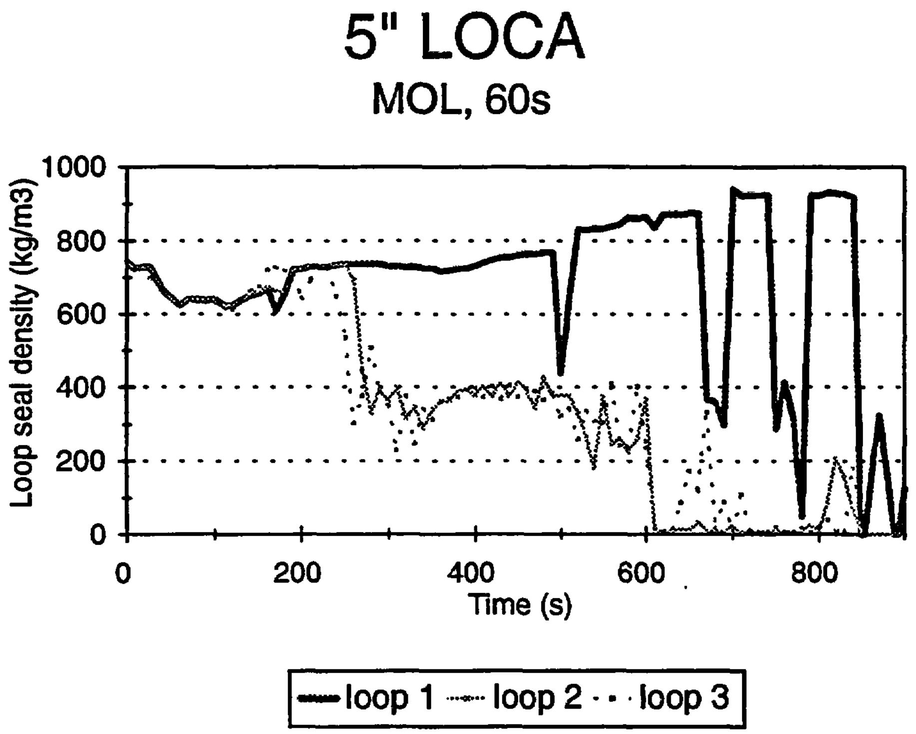


Figure 2: Loop seal density.

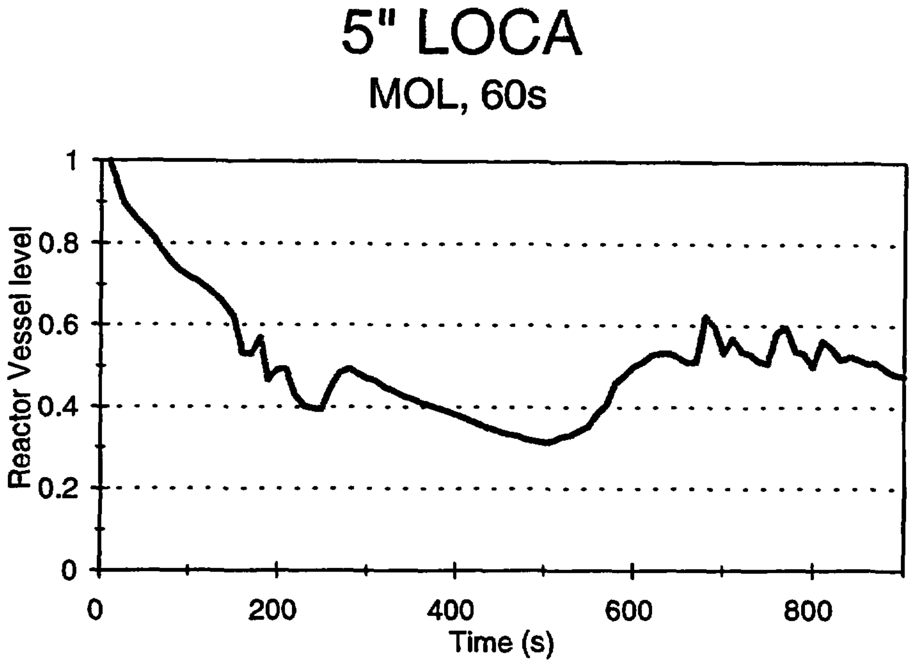


Figure 3: Collapsed liquid level in the vessel.

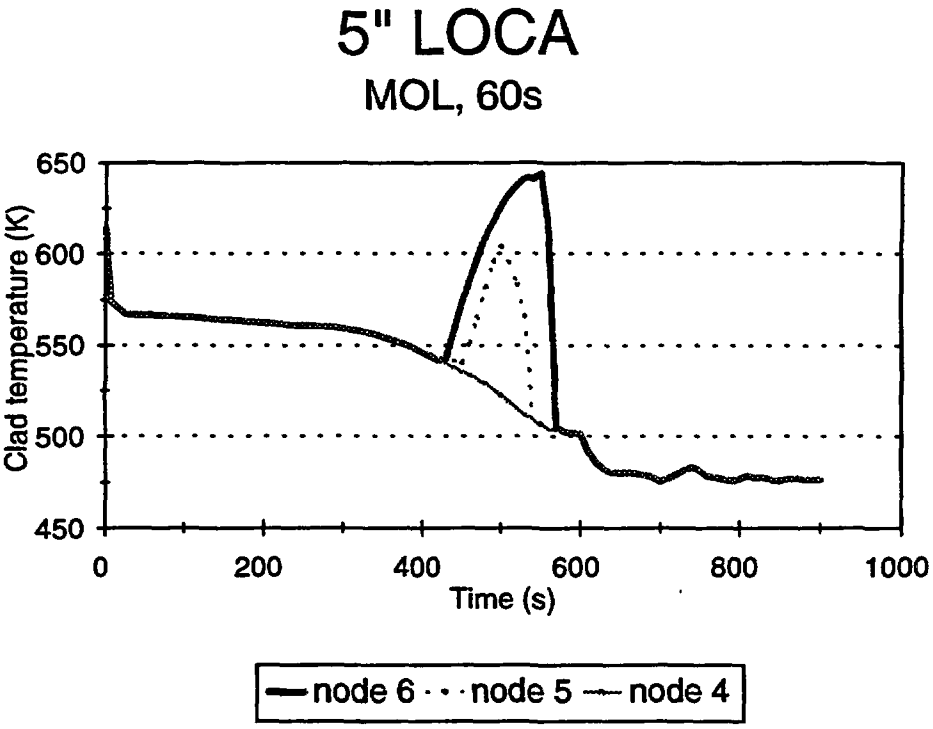


Figure 4: Evolution of the clad temperature

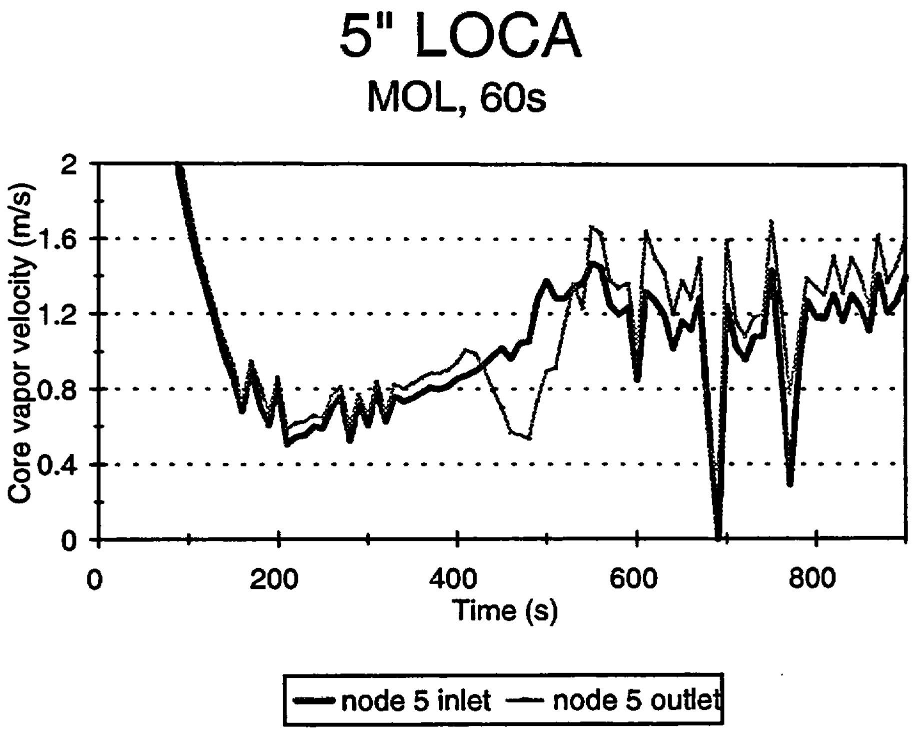


Figure 5: Vapor velocity in the core.

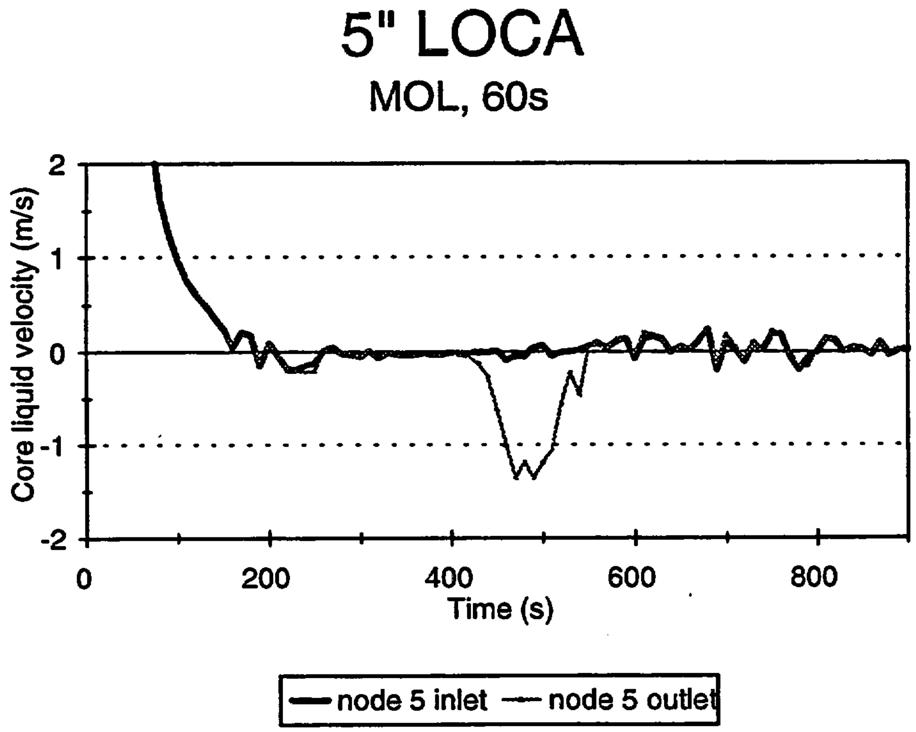


Figure 6: Liquid velocity in the core.

6. Singularity of the analyzed scenario

6.1. Sensitivity study to MCPs coast-down

The singularity of this particular scenario is due to the liquid retained in the loop seal of the broken loop, which affects considerably the later evolution of the transient, specifically in the temperature excursion.

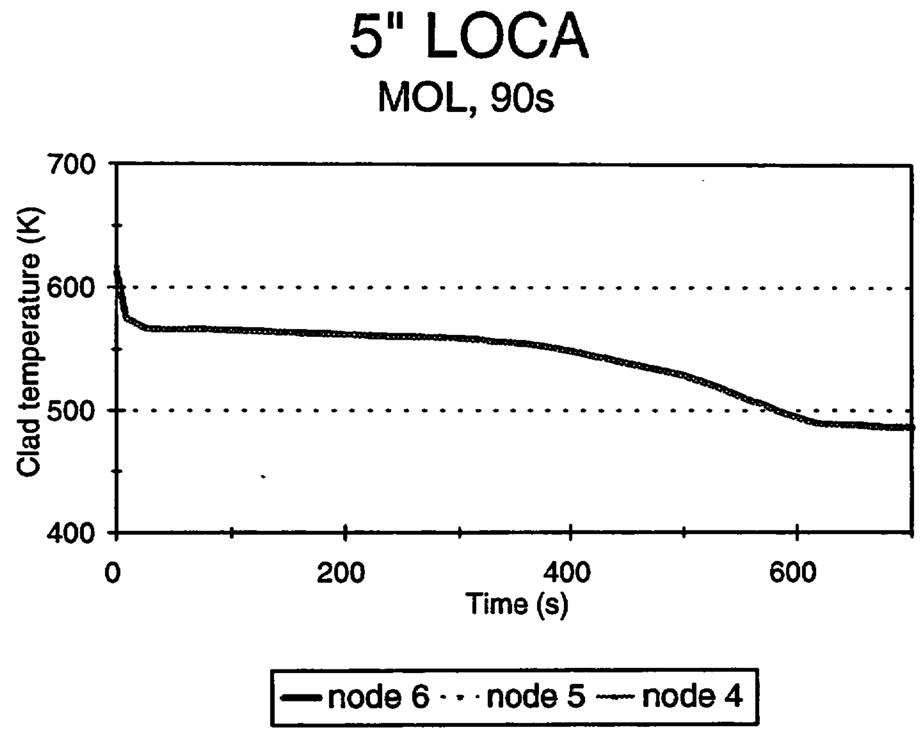
A proof of the singular and unusual of this transient is the fact that the same scenario with a different time of MCPs coast-down start (earlier as well as later) does not show any temperature excursion

Figure 7 and 8 correspond to a 5" LOCA scenario in which pumps are tripped 90 and 30 seconds after scram, respectively. Both show a continuosly decreasing evolution of the heater rod temperature all through the transient.

The vessel's collapsed liquid level (figure 9) decreases in a similar way as in the previous scenario, but now core uncovery is compensated by the accumulator injection prior to the temperature increase.

The cause of this different behaviour is again the loop seal clearing (figure 10). In this new transient loop seal clearing occurs for all three loops, in such a way that liquid retained previously in the broken loop is able now to reach the core, delaying its uncovery and allowing accumulators injection before the temperature increase.

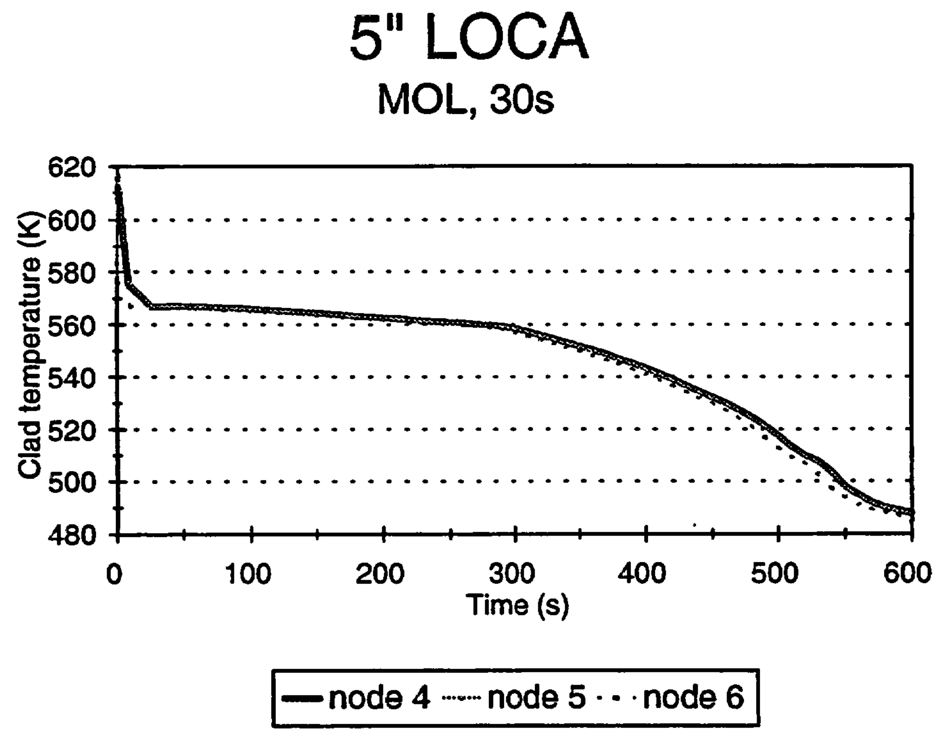
Even now drag of liquid is not a significant phenomenon.



5" LOCA

MOL, 90s

Figure 7: Evolution of the clad temperature. MCPs at 90s.



5" LOCA

MOL, 30s

Figure 8: Evolution of the clad temperature. MCPs at 30s.

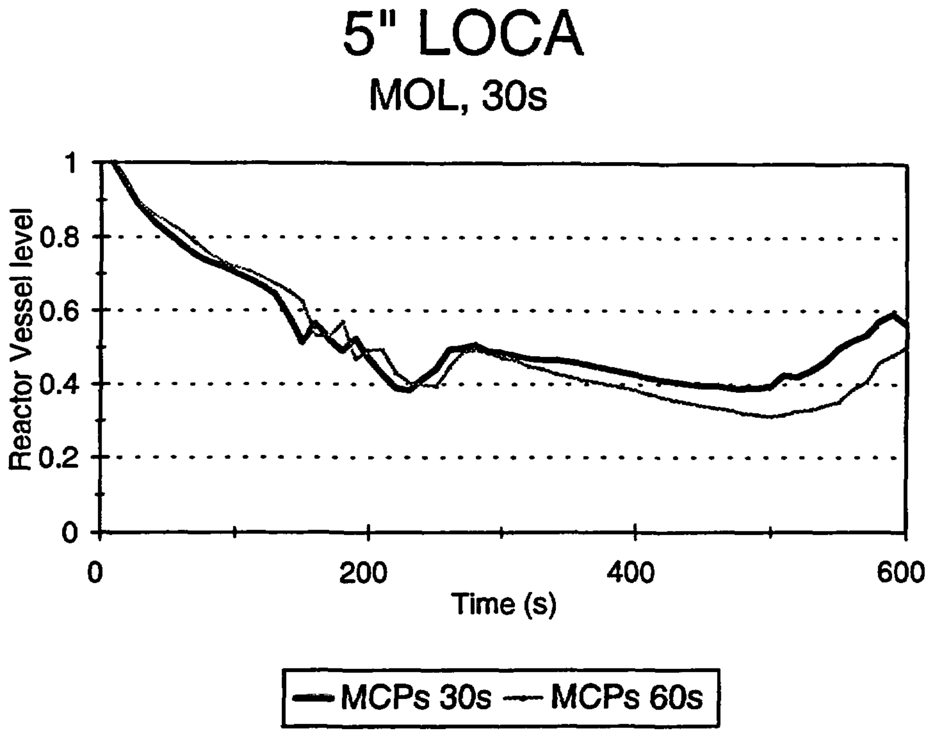


Figure 9: Collapsed liquid level. MCPs at 30 and 60s.

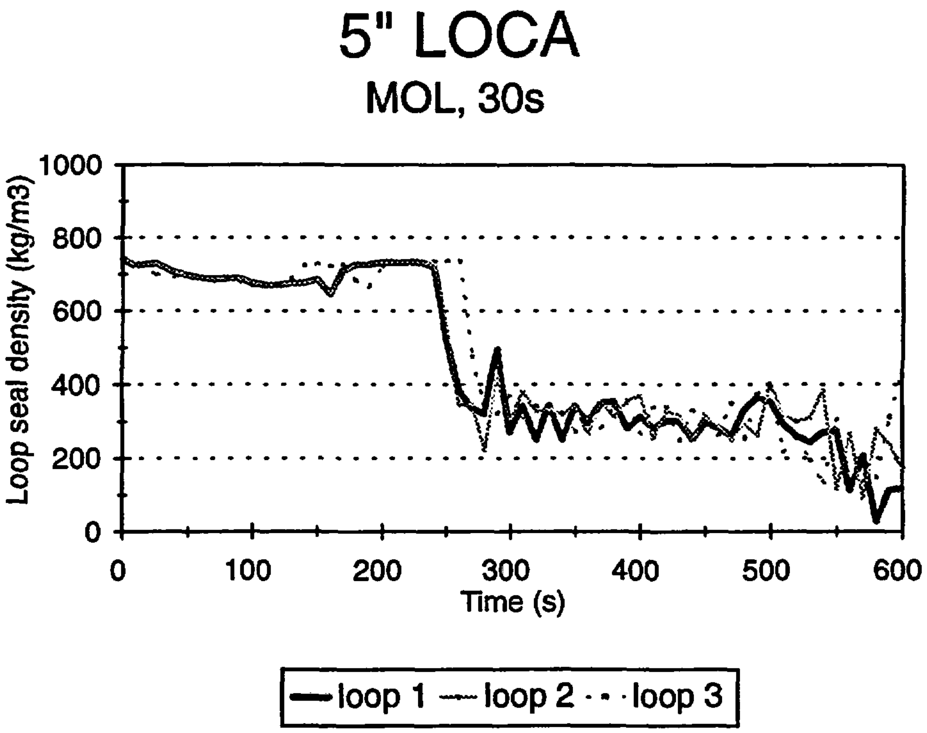


Figure 10: Loop seal density. MCPs at 30s.

6.2. Sensitivity study to RELAP version

As mentioned before, the singularity of the base case calculation is strongly related to the loop seal clearing. A deeper analysis of this phenomenon proves its relation not only to the break uncovery, but also to the pressure generated in the hot legs (delta-P in the loop seals) and even in some way to the code itself.

While flow through the break is basically liquid, vapor accumulates in the hot legs producing a pressure increase that favours loop seal clearing. However, if break uncovery occurs before the clearing, this reasoning results more complex.

Figure 11 presents fluid density at the break and shows that break uncovery does not occur instantaneously: after a quick initial decrease, density continues decreasing slowly proving the presence of a two-phase mixture in the cold leg of this loop. In such a situation pressure does not favour loop seal clearing clearly enough to expain it from a strictly mechanical point of view. This may be, to some extent, the reason of the arbitrariness of this phenomenon.

In this specific scenario the evolution of the loop seal void fraction (figure 12) shows some situations of initiation of loop seal clearing that do not progress. In order to progress, and here is where the code can influence, it is not only necessary to have appropriate pressure conditions, but also the suitable flow regime.

In low flow conditions, as it is the case in this transient, RELAP sets a void fraction of 25% for the transition from bubbly to slug regime in the considered vertical volume. This minimum 25% necessary to change into the flow regime that will enable loop seal clearing is reached in loops 2 and 3, but not in the first (the broken loop), where the maximum void fractions in this initial period are about 20%. The code influence seems thus to be determinant in the transient's evolution.

According to what is mentioned in the code's manual /17/, choosing this particular transition value is somewhat of arbitrary although it lies in the range of values suggested by different studies (from 18% up to 30%).

All this suggests the possibility of changing this transition value in the corresponding RELAP routine, to check its effect in the transient's evolution.

In the study presented next the void fraction value for the transition from bubbly to slug flow regime has been set to 18%.

Using this modified recompiled version of RELAP a new calculation has been performed simulating again a 5" LOCA with MCPs tripped 60 s after scram.

The reduction of the transition value has an impact in the timing of all three loop seal clearings (see figure 13). In this case, even the third loop seal clears just short before the accumulator injection.

As a result of this, the vessel's collapsed level decreases less than in the base case calculation, so that no temperature excursion is observed (figures 14 and 15).

All these results help to prove the suitability of the new EOPs of Ascó: following the new procedures, the operator would have started cooling at a maximum rate when detecting a vessel's collapsed level bellow 39%, avoiding then the temperature increase.

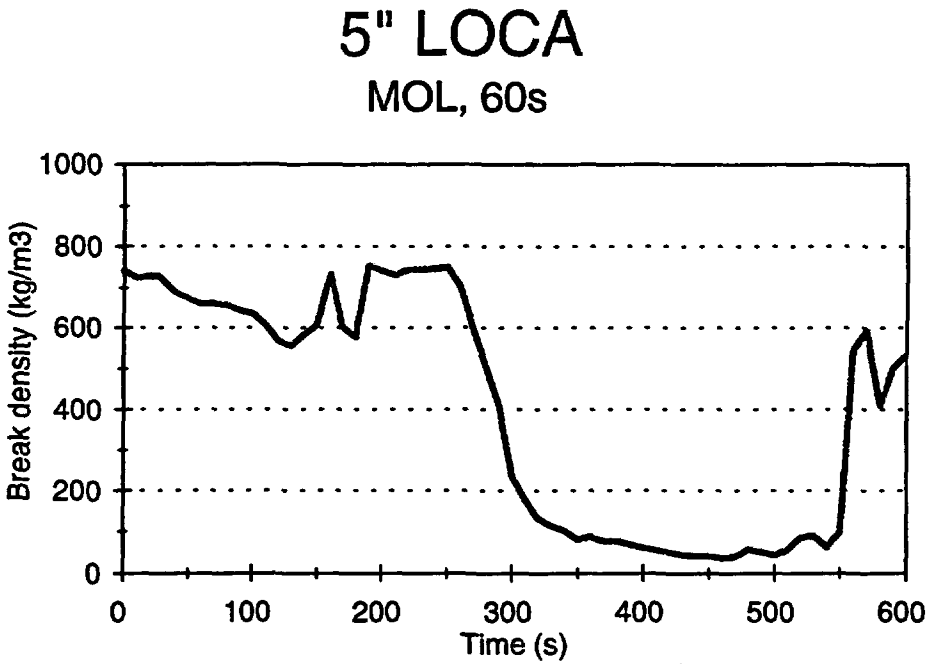


Figure 11: Fluid density at the break. Standard RELAP.

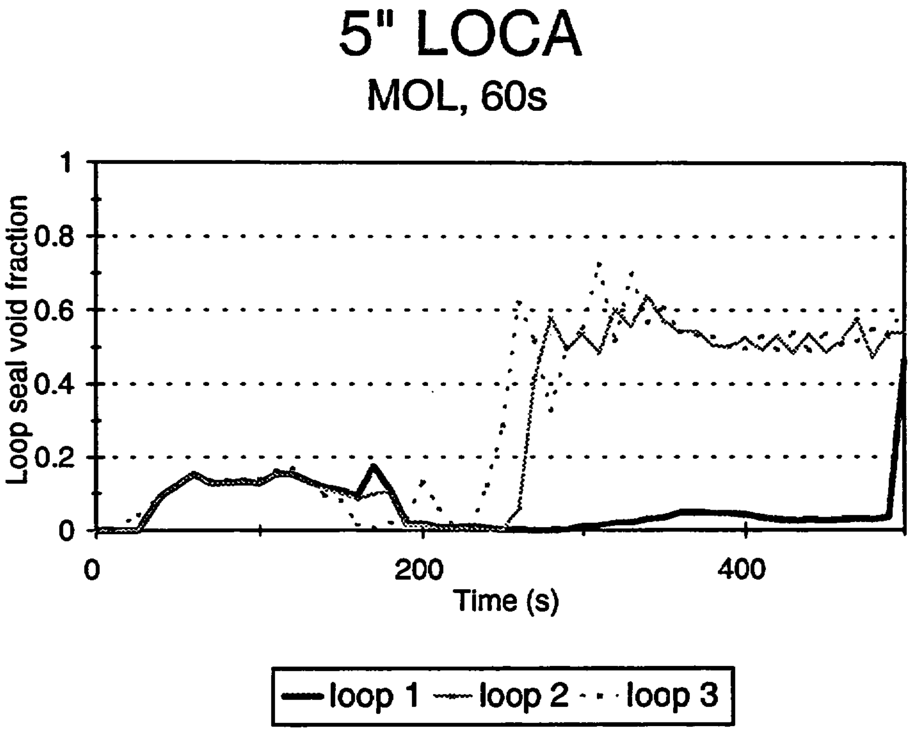


Figure 12: Void fraction in the loop seal. Standard RELAP.

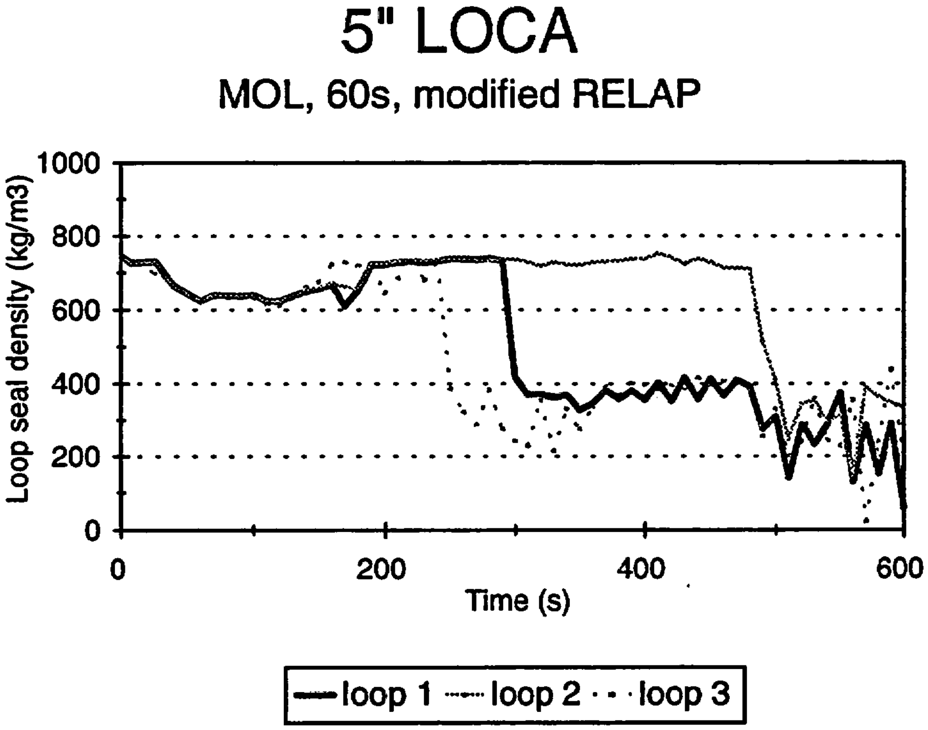


Figure 13: Loop seal density. Modified RELAP.

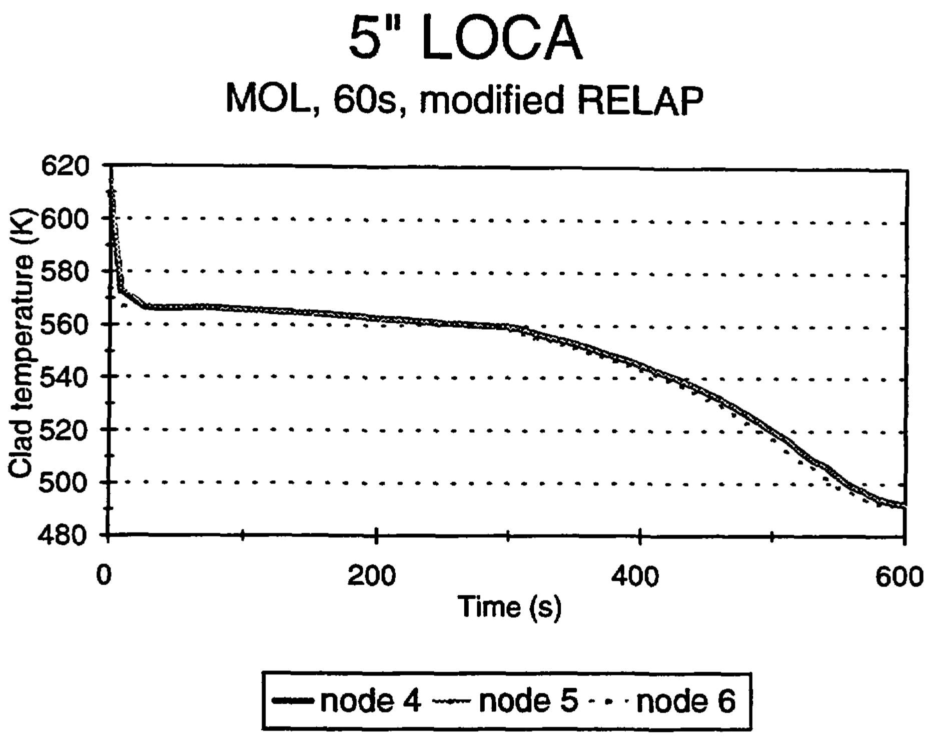


Figure 14: Evolution of the clad temperature. Modified RELAP.

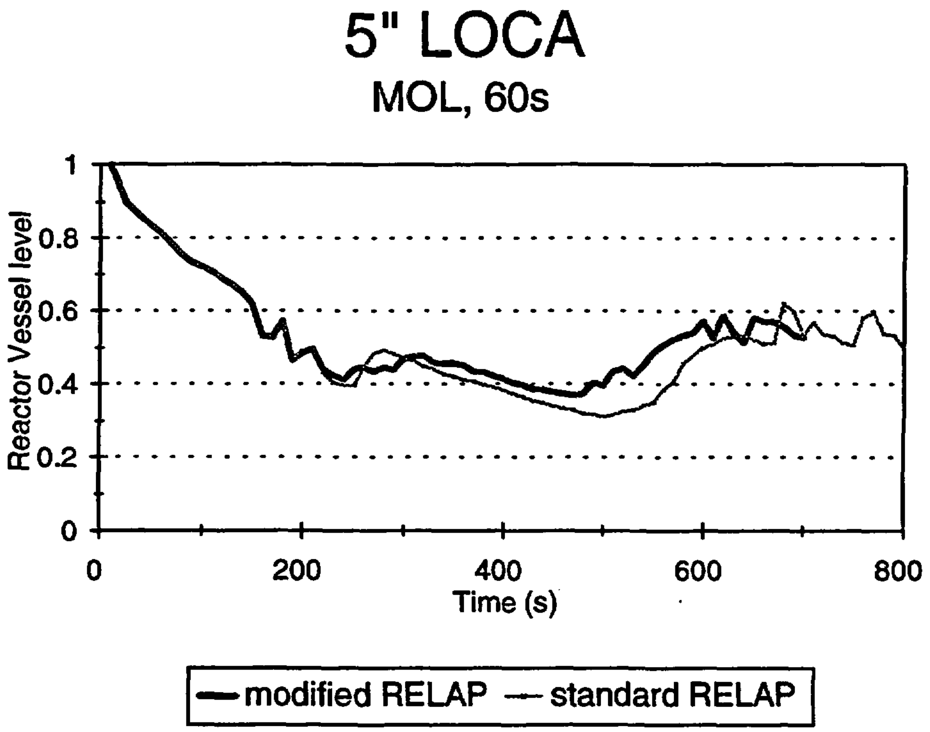


Figure 15: Collapsed liquid level. Modified and standard RELAP.

7. Run Statistics

Calculations were carried out on a DecAlpha with UNIX OSF/1 AXP.

RELAP5/MOD3.2 was used in all the calculations, with minor changes in the second sensitivity study.

Base case **MOL, MCPs at 60s, standard RELAP version**	
TRANSIENT TIME (s)	900
CPUTIME (s)	3272,1
Total number of time steps	19836
CPUTIME/TRANSIENT TIME	3,64
Sensitivity Study 1 **MOL, MCPs at 30s, stardard RELAP version**	
TRANSIENT TIME (s)	700
CPUTIME (s)	2749,2
Total number of time steps	15921
CPUTIME/TRANSIENT TIME	3,93
Sensitivity Study 1 **MOL, MCPs at 90s, stardard RELAP version**	
TRANSIENT TIME (s)	700
CPUTIME (s)	2577,5
Total number of time steps	15902
CPUTIME/TRANSIENT TIME	3,68
Sensitivity Study 2 **MOL, MCPs at 60s, modified RELAP version**	
TRANSIENT TIME (s)	700
CPUTIME (s)	2866,0
Total number of time steps	16528
CPUTIME/TRANSIENT TIME	4,09

Table 4: Run Statistics.

8. Conclusions

This study presents an unusual phenomenon (a partial core dryout) of SBLOCA scenarios with injection of all emergency systems for a full size PWR: Ascó.

- The unusual occurrence of this phenomenon has been related to loop seal clearing and for this reason the clearing mechanism and its relation to flow regime change has been analyzed in more detail.
- Influence of the code has also been determined. By slightly changing the transition value a new phenomenology is predicted and the partial dryout disappears.
- The results obtained in the study of this transient prove the suitability of the new EOPs of Ascó.
- The study of this transient helps to improve the knowledge of plant dynamics.
- The model of Ascó using RELAP5/MOD3.2 is a valuable tool to analyze plant transients and to provide engineering support to plant operation.

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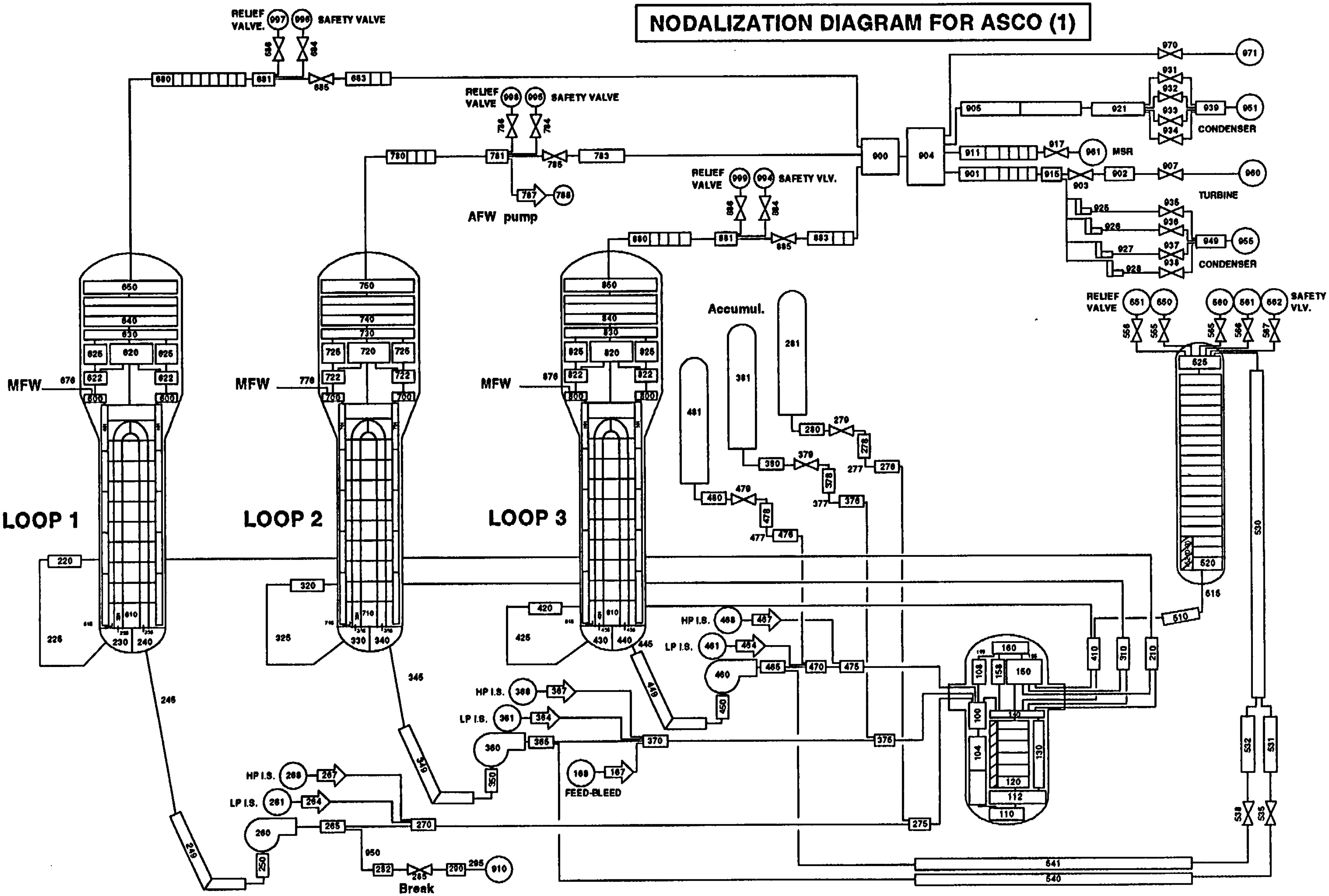
10. Annex 1

- Nodalization Diagrams for Ascó:

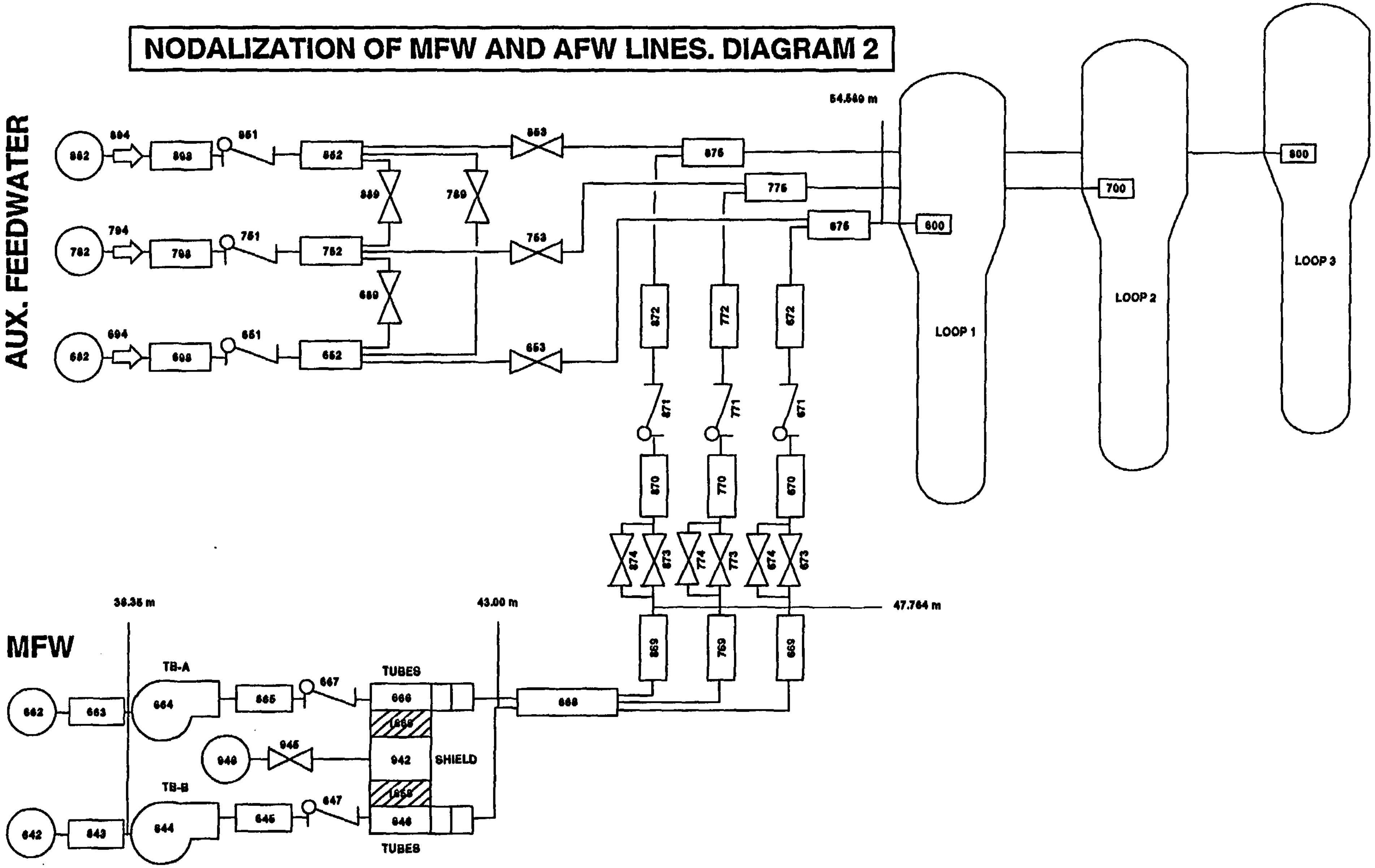
  (1) Plant Diagram

  (2) Main Feedwater and Auxiliary Feedwater Systems



NODALIZATION DIAGRAM FOR ASCO (1)

NODALIZATION OF MFW AND AFW LINES. DIAGRAM 2



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10. SUPPLEMENTARY NOTES

11. ABSTRACT *(200 words or less)*

The Polytechnical University of Catalonia (UPC) has been cooperating since 1992 with the Asociacion Nuclear Asco (ANA) improving its plant model. Asco NPP is a two unit, three loop Pressurized Water Reactor (PWR) plant of Westinghouse design operated by ANA. Its model, developed for RELAP5/MOD3.2, includes thermal-hydraulics, kinetics and protection and control systems and has been qualified in previous calculations of several actual plant transients. This report shows the results obtained with the Asco NPP model for a 5 inch Loss of Coolant Accident using RELAP5/MOD3.2. It also includes two different sensitivity studies performed to show the singularity of the phenomenology identified in the base case: the first study analyzes the influence of Main Coolant Pumps (MCPs) coast-down start; the second, the influence of the code itself (of its flow regime prediction).

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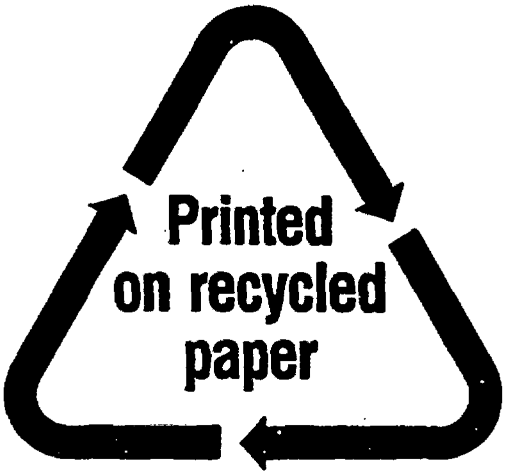
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