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International Agreement Report

Assessment of RELAP5/MOD3 Against Twenty-Five Post-Dryout Experiments Performed at the Royal Institute of Technology

Prepared by
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Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission
Washington, DC 20555

May 1993

Prepared as part of
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under the International Thermal-Hydraulic Code Assessment
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Lars Nilsson

ICAP

Assessment of RELAP5/MOD3 against twenty-five post-dryout experiments performed at the Royal Institute of Technology

Swedish Nuclear Power Inspectorate
Project No. 90021, Ref.No. 13.3-917/84

Abstract

Assessment of RELAP5/MOD2 has been made against various experimental data, among others data from twenty-five post-dryout experiments conducted at the Royal Institute of Technology (RIT) in Stockholm. As the MOD3 version of RELAP5 has now been released, incorporating a different method of calculating critical heat flux compared to RELAP5/MOD2, it seemed justified to make another assessment against the same RIT-data.

The results show that the axial dryout position is generally better predicted by the MOD3 than by the MOD2 version. The prediction is, however, still nonconservative, i.e. the calculated dryout position falls in most cases downstream the actual measured point. While the pre-dryout heat transfer seems to be equal for MOD2 and MOD3, both versions giving slightly higher wall temperatures than the experiments, there is a considerable difference in the post-dryout heat transfer. The results of the RIT data comparison indicate that MOD3 underpredicts the post-dryout wall temperatures remarkably while Mod2 gave reasonable agreement. In this respect RELAP5/MOD3 shows no improvement over RELAP5/MOD2.

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Executive summary

Assessment of RELAP5/MOD3 has been made against twenty-five post-dryout experiments conducted at the Royal Institute of Technology (RIT) in Stockholm. A similar assessment has earlier been performed of RELAP5/MOD2. As the MOD3 version of RELAP5 has now been released, incorporating another method of calculating critical heat flux (CHF), it seemed justified to make another assessment against the same RIT-data.

In the experiments wall temperatures were measured on an electrically heated, 7 m long tube with an inner diameter of 14.9 mm. The tube was cooled by upwards flow of water with mass fluxes from 500 to 2000 kg/m²s. The cases selected for this assessment covered pressures ranging from 3 to 14 MPa, heat fluxes from 400 to 1060 kW/m² and inlet subcoolings from 8.5 to 12 K.

The RELAP5 model used for the simulations comprised 47 axial fluid cells. A fine nodalization was employed for the upper part of the test section where post-dryout conditions took place.Time dependent pressure, temperature and flow boundary conditions were imposed to simulate the fluid entering the test section. The region downstream of the test section was modelled by a time dependent pressure boundary condition. The axial heat flux distribution was uniform. An insulated boundary condition was imposed upon the outside edge of the tube wall while the inner edge received its boundary condition - a heat transfer coefficient and a temperature sink - from the RELAP5 heat transfer package. Once the RELAP5 simulations reached steady state the axial temperature distribution along the tube was compared to experimental values.

The new method for calculating critical heat flux in RELAP5/MOD3 uses a four-dimensional table with the heat flux as a function pressure, mass flux and steam quality based upon "Groenevelds CHF Look-up Table". This procedure replaces the Biasi correlation in RELAP5/MOD2. After interpolation has been done in the table eight multipliers are imposed on the CHF value to account for effects of diameter, bundle geometry, heat flux distribution etc. All of the analyzed RIT data were within the range of the MOD3 tables.

The results of the RELAP5/MOD3 assessment show some improvement in the CHF prediction compared to MOD2. The axial dryout position is generally better predicted by the MOD3 than by the MOD2 version. The prediction is, however, still non-conservative, i.e. the calculated dryout position falls in most

cases downstream the actual measured point. Especially at the lowermost pressure, 3 MPa, the new dryout calculational method in MOD3 showed no improvement over the MOD2 method. In both cases overpredictions of the dryout heat flux by as much as a factor of three could be obtained.

While the pre-dryout heat transfer seem to be equal for MOD2 and MOD3, both versions giving slightly higher wall temperatures than the experiments, there is a considerable difference in the post-dryout heat transfer. In order to make a relevant comparison the point of onset of dryout should be correctly predicted. In the MOD2 assessment this was achieved through a code modification forcing the measured dryout position into the calculations. In the present case with MOD3 one of the CHF multipliers, was used to adjust the calculated CHF to agree with the observed one. With this condition RELAP5/MOD2 gave a satisfactory agreement between calculated and measured post-dryout wall temperatures, in general within 10 K. The results from RELAP5/MOD3, however, show a considerable underprediction of the temperatures. There has obviously been an exchange of the models in the subroutine PSTDNB which leads to larger post-dryout heat transfer coefficients in MOD3 than in MOD2. In this respect RELAP5/MOD3 shows no improvement over RELAP5/MOD2. The differences in the coding seen in the source code list is not explained here as the model description of MOD3 was not released at this moment. The reasons for the changes are also unclear.

Nodalization studies with longer test section cells show that increasing the length from 0.10 to 0.5 m did not remarkably impair the temperature predictions. The larger cell length, which is typical in nuclear reactor simulations, lead of course to a less good resolution for the calculated axial dryout point and for regions with steep temperature gradients.

The computational efficiency seem to have been improved from MOD2 to MOD3. One reason is that the CHF calculation is now less time consuming as the CHF value from MOD3 is directly compared with the actual surface heat flux, instead of as in MOD3 use a iteration scheme for the wall temperatures. However there still remains an inconsistency in the steady state convergence algorithm, which if improved could further reduce the computation time.

Nomenclature

Symbol	Definition	Units
G	Mass flux	kg/(m^2,s)
L	Length	m
p	Pressure	Pa
q'''	Volumetric heat generation	W/m^3
q/A	Heat flux	W/m^2
R	Radius	m
T	Temperature	K
U	Voltage	V
x	Steam quality	-
z	Axial coordinate	m
λ	Thermal conductivity	W/(m,K)
ρ	Electric resistivity	Ω m

Subscripts

c	calculated
m	measured

1 Introduction

The International Thermal-Hydraulic Code Assessment and Applications Program (ICAP) is beeing conducted by several countries and is coordinated by the US NRC. The goal of ICAP is to make quantitative statements regarding the accuracy of the current state-of-the-art thermal-hydraulic computer programs developed under the auspices of the US NRC.

Sweden's contribution to ICAP relate both to TRAC-PWR and to RELAP5. The assessment calculations are being performed by Studsvik AB for the Swedish Nuclear Power Inspectorate. The currrent assessment matrix is shown in Table 1.

Table 1

ICAP Assessment Matrix - Sweden

Code	Facility	Type		Description
		Sep. effect	Integral	
RELAP5	Marviken22	x		Subcooled critical flow
RELAP5	Marviken11	x		Critical flow, level swell
RELAP5	FIX-II		x	Recirculation line (10%) braek
RELAP5	FIX-II		x	Recirculation line (31%) braek
RELAP5	FIX-II		x	Recirculation line (200%) braek
RELAP5	LOFT		x	Cold leg braek (4"), pumps off
RELAP5	LOFT		x	Cold leg break (4"), pumps on
RELAP5	FRIGG	x		Subcooled void distribution
RELAP5	FRIGG	x		Critical heat flux
RELAP5	RIT	x		Post dryout heat transfer
TRAC/PF1	Ringhals		x	Loss of load
TRAC/PF1	Ringhals		x	Feed water line isolation
TRAC/PF1	Ringhals		x	Steam line isolation

All of the RELAP5 assessments were made with the MOD2-version. The simulations of 25 selected RIT post dryout experiments were thus made with RELAP5/MOD2, cycle 36.02. This assessment was published in ref. 1.

As the MOD3 version of RELAP5 has an entirely different method for calculatating critical heat flux (CHF) it was considered of importance to make another assessment against the RIT-data. The new CHF method was claimed to be superior to the one in MOD2, which was based on Biasi's correlation.

This work comprises recalculation of the same twenty-five post-dryout experiments, which were employed in the RELAP5/MOD2 assessment, now with RELAP5/MOD3.

2 Facility and test description

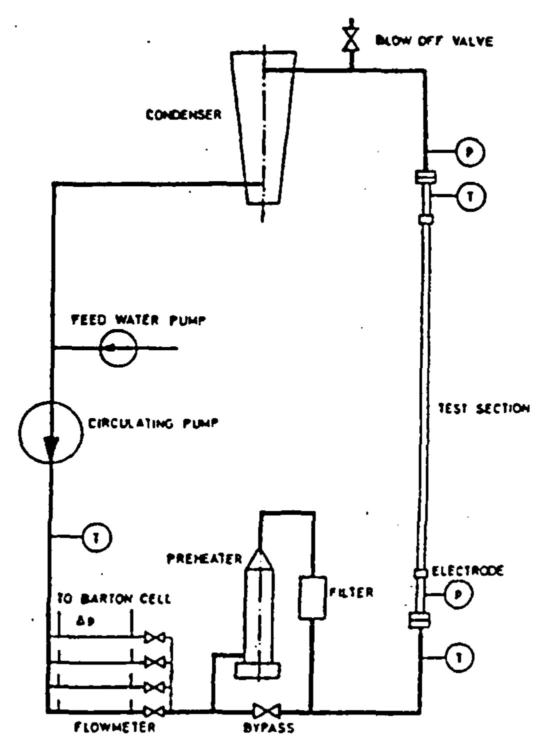
The post-dryout experiments analysed in the present report were obtained at the department of Nuclear Reactor Engineering at the Royal Institute of Technology in Stockholm. The experimental studies included the measurements of 510 post-dryout wall temperature distributions for 7 meter long uniformly heated round ducts as well as 999 temperature distributions for axially non-uniformly heated ducts of the same length. The latter measurements include six axial heat flux distributions. The results for uniform heat flux were reported by Becker et al (2), and another report (3) concerning the non-uniform axial heat flux measurements is now in progress. The investigations covered the pressure range between 10 and 205 bar. The 25 post-dryout experiments used in the present assessment are all with axially uniform heat flux and are selected from ref. 2. The description of the experimental facility, which is given in paragraphs 2.1 and 2.2, is reproduced from ref. 2.

2.1 The loop

The loop employed for the post-CHF experiments was designed for an operating pressure of 250 bar. All parts of the loop in contact with water were made from stainless steel. A simplified flow diagram for the loop is shown i Figure 1. Test sections with heated lengths up to 7 300 mm can be accommodated. Power is supplied from a direct current generator. The maximum available current is 6 000 amps and voltages ranging from 0 to 140 volts can be supplied.

Figure 1

Test loop flow diagram



Before entering the test section the water passes a 150-kW preheater and a filter. The preheater is used for adjusting the inlet water temperature.

After the test section the steam-water then enters a circulation pump, which has a pressure head of 100 meters of water. The major portion of this pressure head is used in the duct system between the pump and the test section inlet, thus providing sufficient throttling in order to secure stable operation of the loop.

The flowmeter system consists of four 1 000 mm long ducts of 3.80, 6.29, and 13.2 mm inner diameter. The flow rate measurements were based on measuring the pressure drop over one of these ducts with a Barton cell. The accuracy of this flowmeter system is said to be better than 1 per cent over the whole range of application.

The static pressure of the loop was measured with Barton cells connected to pressure taps, which were located just below and above the test section. The accuracy of the pressure measurements is 0.1 per cent.

The water temperature was measured before the flowmeter, before the test section and after the test section. This was accomplished by means of thermocouples mounted in wells 100 mm deep and 3 mm inner diameter. The accuracy of the fluid temperature measurement is 0.5 K.

The power input was obtained by measuring the current through and the voltage over the test section. The voltage was measured with a precision voltmeter of 0.25 per cent rated accuracy, and the current was obtained by measuring the voltage over a calibrated shunt. For the latter measurements a millivoltmeter with a rated accuracy of 0.25 per cent was used.

In order to check the accuracy of the instrumentation, heat balances for single-phase flow, relating the electric heat input to the enthalpy increase of the water were taken every day before starting the ordinary measurements. The error of the heat balances was generally less than 1 per cent. If larger errors were encountered, the instrumentation was checked and new heat balances were taken before carrying out the experimental program.

2.2 Test sections

Three electrically heated round tubes with the following dimensions were employed.

Test section	Heated length	Inner diameter	Outer diameter
1	7 000 mm	14.9 mm	20.8 mm
2	7 000 mm	10.0 mm	14.0 mm
3	7 100 mm	24.69 mm	31.7 mm

Test sections 1 and 2 were made from Nimonic and test section 3 from stainless steel.

The twenty-five experiments chosen for the RELAP 5 assessment were all obtained with test section No. 1.

In order to make it possible to mount the thermocouples on the outer wall of the test sections, a 0.1 mm thick layer of ZrO_2 was sprayed on the outer walls. Fifty-five Chromel-Alumel thermocouples were placed along the heated length of test section 1 and 2 in accordance with the axial positions given in Figure 2.

Two copper rings were silver soldered to the test sections. The distance between these rings are referred to as the heated length. Finally, a 10 cm thick layer of stone wool insulation was mounted around the test section, keeping the heat losses at a low level, which was verified by means of the earlier mentioned one-phase flow heat balances.

The outer wall thermocouples were according to Ref. 2 calibrated by means of adiabatic single phase flow experiments at 100, 200 and 300 C. The majority of the thermocouples indicated temperature dependent correction terms less than 1.5 C. The maximum correction term , which was observed at 300 C, was 3.6 C.

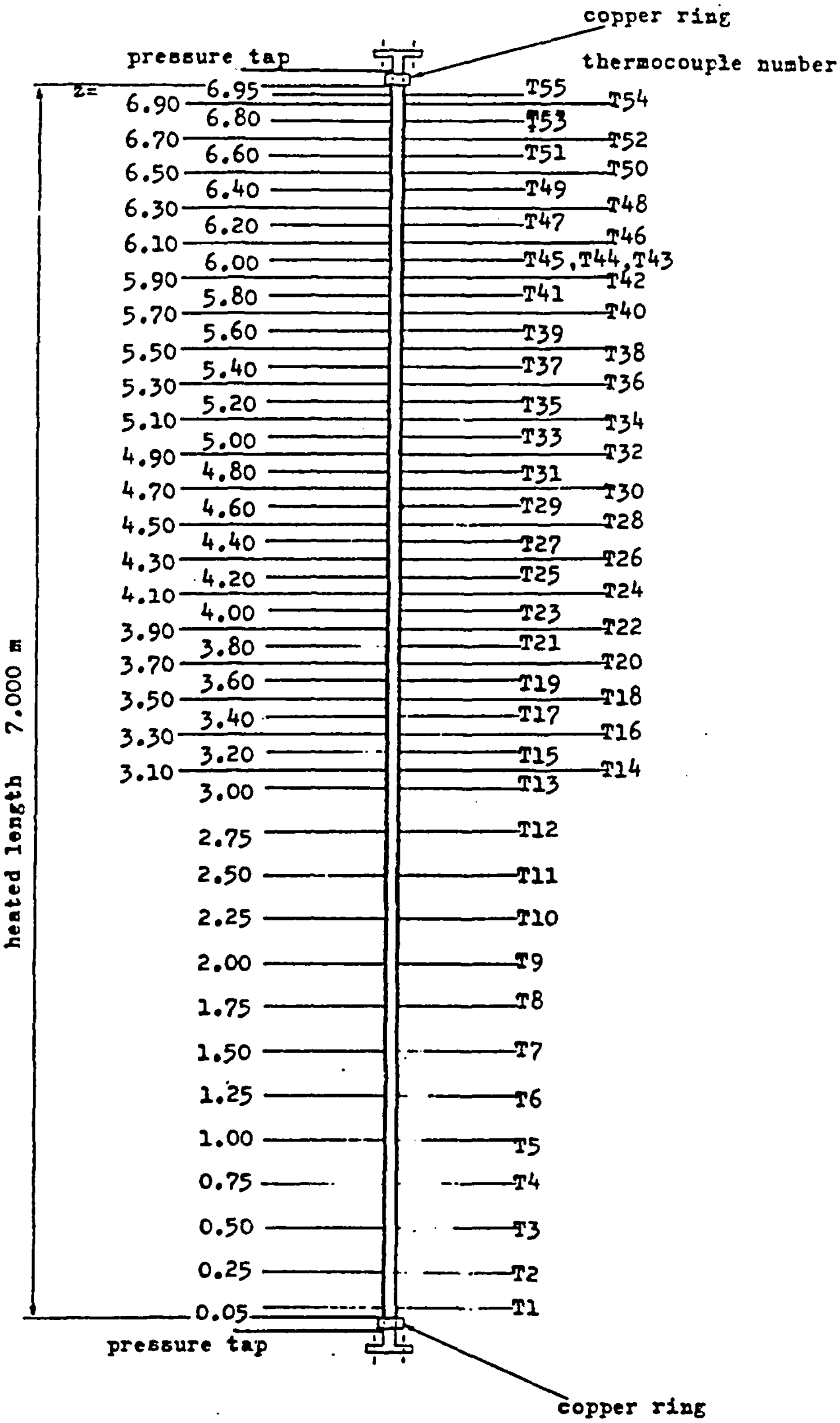


Figure 2

Location of thermocouples in test section 1 and 2

All of the data were recorded by a 100 channel Schlumberger data recorder, punched on paper tape and evaluated by an IBM-360/60 computer.

The inner wall temperatures were obtained from the outer wall temperatures by stepwise integration of the following equation:

$$\frac{\partial^2 T}{\partial R^2} + \frac{1}{R}\frac{\partial T}{\partial R} = - \frac{q'''}{\lambda\ (T)} = \frac{U^2}{\rho L^2} \cdot \frac{1}{\lambda(T)})$$

This calculation involved the division of the tube into 20 concentric tubes, and demanded information about the temperature-dependent electrical resistivity and thermal conductivity of the test sections' materials. With regard to test sections 1 and 2, the manufacturer's curve for Nimonic 75 was used for the thermal conductivity, while the electrical resistivity was measured in a temperature regulated oven. The thermal properties are given in Table 2.

Table 2

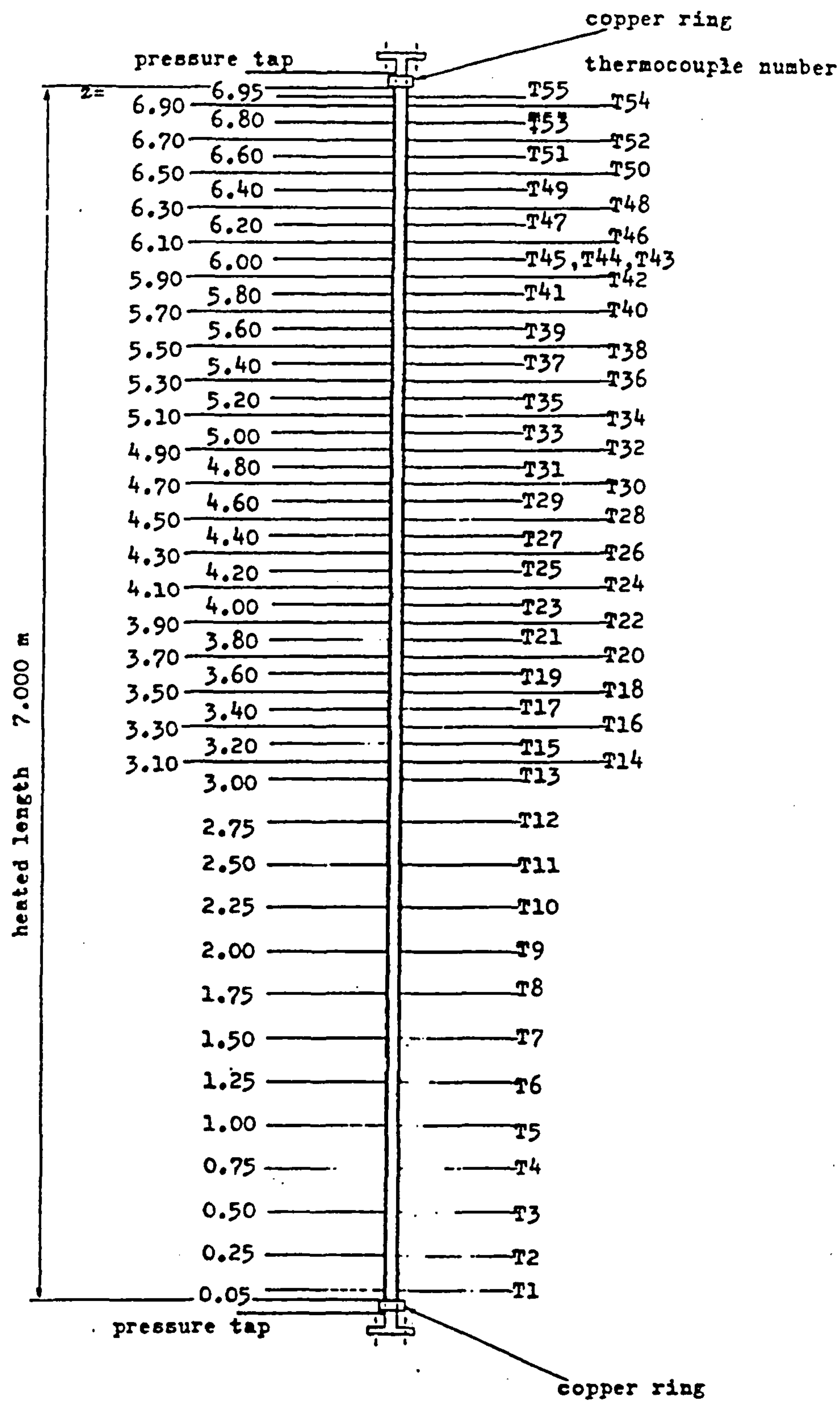
Thermal properties of test section wall material

Temp C	Thermal conductivity W/(m,C)	Electric resistivity Ohm mm²/m
100	14.0	1.118
200	15.9	1.130
300	17.6	1.142
400	19.0	1.154
500	21.1	1.160
600	22.4	1.146
700	24.2	1.139
800	26.0	1.138

2.3 Experimental program

In all, 334 runs were carried out with test section 1 in the following ranges of variables:

Heated length	7.000 m
Inner diameter	14.9 mm
Outer diameter	20.8 mm
Inlet subcooling	10 ± 3 C
Pressure	30, 50, 70, 100, 120, 140, 160, 180 and 200 bar
Mass velocity	500, 1000, 1500, 2000, 2500 and 3000 kg/(m²,s)
Heat flux	10 - 125 W/cm²
Post-dryout steam quality	0.03 - 1.60



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Pressure	30, 50, 70, 100, 120, 140, 160, 180 and 200 bar
Mass velocity	500, 1000, 1500, 2000, 2500 and 3000 $kg/(m^2,s)$
Heat flux	10 - 125 W/cm^2
Post-dryout steam quality	0.03 - 1.60

For each combination of pressure and mass velocity (9 x 6 = 54), 4-8 axial temperature profiles were obtained by variation of the heat flux in steps of 5-10 W/cm². The maximum obtainable heat flux was limited by the requirement not to exceed a wall temperature of about 700 C.

2.4 Tests selected for the assessment

The twenty-five post-dryouts test which were chosen for the assessment of both MOD2 and MOD3 of RELAP5 were all obtained with test section No. 1. The measured data have been published in ref. 2 and the parameter range covered by the selected tests is given in Table 3 below.

Table 3

Range of parameters for the selected RIT experiments.

Run No.	Pressure MPa	Mass flux kg/m²,s	Inlet temp K	Heat flux kW/m²	Measured CHF location m	Outlet steam quality x
136	13.99	1977.0	599.6	509	5.55	0.384
139	14.00	1970.5	600.0	757	2.88	0.608
147	14.00	1494.3	600.0	704	2.88	0.761
154	13.98	1006.6	600.4	552	3.15	0.896
161	13.99	503.2	600.2	405	2.88	1.347
220	10.00	1981.2	574.4	511	*	0.324
221	10.01	1973.8	574.2	665	5.55	0.434
224	10.02	1990.3	573.4	860	4.25	0.567
232	10.00	1499.8	573.8	758	4.15	0.673
238	10.01	997.3	572.2	556	4.85	0.740
244	9.98	502.0	573.	405	5.05	1.099
259	6.99	1989.3	549.0	870	6.05	0.510
261	7.02	1988.2	548.4	1053	4.65	0.624
264	6.99	1500.2	547.8	766	6.05	0.598
269	7.01	995.4	547.8	564	*	0.667
270	7.02	996.5	547.2	660	5.85	0.785
272	7.02	999.6	547.4	815	4.55	0.977
275	7.04	500.9	547.2	410	6.45	0.980
315	3.01	1986.3	498.0	873	5.95	0.436
317	3.03	1987.3	497.2	1058	5.05	0.532
320	2.99	1499.3	497.6	769	6.05	0.513
325	3.01	1.10.6	496.2	561	*	0.554
327	3.00	1005.6	497.2	667	6.05	0.669
331	3.00	497.2	498.6	413	*	0.847
332	3.00	496.4	497.8	464	6.25	0.954

The inlet temperature was chosen to give sub-cooling around 10 K (Actual range 8.5-12.0 K).

3 Results of previous RELAP5/MOD2 assessment

The assessment of the MOD2 version of RELAP5 has been reported in ref. 1. The geometrical, model, comprising 47 cells for the heated length of the testsection, was originally used there and was adopted also here for the MOD3 simulations.

Two different computations were made with RELAP5/MOD2, a base case simulation with the standard code version and another in which the code had been modified to produce a "forced CHF simulation".

3.1 Standard RELAP5/MOD2 simulation

Calculations of the twenty-five RIT test cases were first made with the original version of RELAP5/MOD2, cycle 36.02. For all, but two, of the twenty-one of the cases in which dryout was measured to occur, the Biasi-correlation heavily overpredicted the dryout heat flux. Reasonable agreement was obtained in two cases only; run No. 136 and 154 at 3 MPa. Large deviations were shown in most cases, especially with elevated pressures. At 14 MPa the calculated dryout heat flux could be as much as a factor of three higher than the experimental value.

An extended study of Biasi's correlation applied on 177 RIT experiments in reference 1 revealed a mean error of 60.8 %.

As a consequence of the non-conservative character of the dryout calculation in RELAP5/MOD2 this version also failed to predict the location of the onset of dryout. MOD2 generally placed the dryout downstream the measured position, and in some cases outside the actual range of the test section, i.e. no dryout was predicted in cases where dryout was actually observed in the tests.

3.2 RELAP5/MOD2 forced CHF simulations

In order to investigate the capability of RELAP5 to predict post-dryout temperatures when the calculated dryout location agreed with the measured one, a modification of the code was made and the simulations were rerun. The update described in ref. 1 made it possible to specify the CHF point to coincide with the measurements, causing a shift in the downstream heat transfer mode.

This modification improved the predictions of the post-dryout heat transfer considerably. The discrepancies between predicted and measured temperatures were reduced to less than 10 % in all cases except one (run 139). It was also shown that RELAP5/MOD2 realistically predicted the steam superheating observed in the experiments.

4 The new critical heat flux model in MOD3

The MOD3 version of RELAP5 incorporates several modifications compared to MOD2. The changes have been made in order to improve both the computational efficiency as well as the capability to model certain phenomena which were unsatisfactory described in the earlier versions. One of the shortcomings was the limitations of the Biasi correlation, which is the only CHF correlation available in MOD2. Although this correlation is based on tube data with upwards flow of water, and for a limited parameter range it is in RELAP5/MOD2 frequently applied to rod bundles at various flow conditions occurring, during e.g. a LOCA transient.

However, despite the fact that the Biasi correlation is based on tube data it failed to predict dryout in the RIT experiments as shown in ref. 1.

In RELAP5/MOD3 the method of calculating CHF has been fundamentally changed. The Biasi correlation has been replaced by a method based on Groeneveld's "Critical Heat Flux Lookup Table" as described in ref. 4. Instead of evaluating CHF from an analytical expression, interpolation is made in a table which, however, even here is based on test data for vertical upflow of water in tubes.

The table in MOD3 has 4410 data points extracted from 15000 points in the original lookup table, and form a three-dimensional array with 15 pressure, 14 mass flux and 21 steam quality values covering the following range:

Pressure	0.1 - 20.0 Mpa
Mass flux	0.0 - 7500 kg/(m²,s)
Steam quality	-0.5 - 1.0

In addition to the interpolation, eight multipliers are applied to account for the influence of hydraulic diameter, rod bundle geometry, direction of flow, axial heat flux distribution, etc.

Another modification is that the Newton iteration method in MOD2 to solve for the temperature at CHF has been replaced by a direct comparison of the calculated CHF and the actual heat flux. When the actual heat flux exceeds the MOD3 CHF value the heat transfer mode changes.

Since the new method is based on tube data, which covered the range of the RIT data, good agreement was expected to be obtained here.

5 Input description and geometrical model

The input used in the MOD2 assessment was adopted here and only changes required by the MOD3 modifications according to ref. 5 were made. A list of the input for RIT run 136 is shown in appendix A.

5.1 Geometrical model

The RELAP5 model of the experimental facility is shown in Figure 3 below.

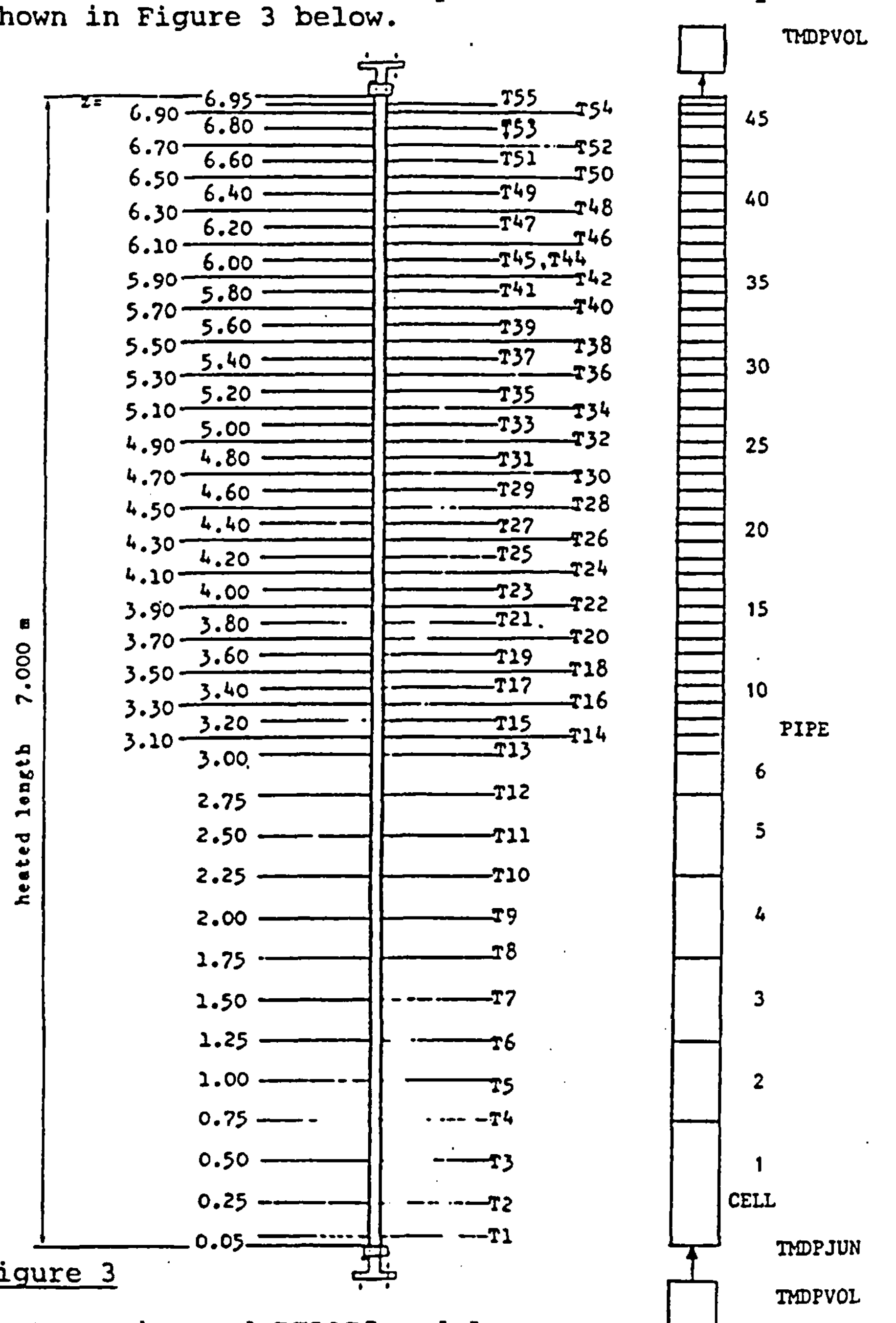

Figure 3

Test section and RELAP5 model

The test section was modelled with 47 fluid cells. Large cell lengths were used in the lower part of the test section because, in the experiments, CHF never occurred below the 2.7 m elevation. The bulk of the test section was modelled by a uniform mesh of cells having a length of 10 cm.

Boundary conditions were imposed upon the lower and upper end of the test section via time dependent volumes. The lower time dependent volume specified the inlet pressure and fluid temperature corresponding to experimental inlet conditions. The experimental flow rate was specified by a time dependent junction at the entrance to the test section.

The heated wall was represented by 47 heat structures (one per fluid volume). Each heat structure used two heat transfer nodes - one at the wall inner edge and one at the wall outer edge. A heat transfer coefficient (determined by RELAP5) was specified at the inner wall edge boundary condition while the outer wall edge was specified to be completely insulated. The latter specification was justified by the experimental heat balances which showed negligible heat loss through the insulation surrounding the test section.

In order to study the effect of nodalization runs were also made with reduced number of test section fluid cells, 22 and 11 cells.

5.2 Changes from MOD2 to MOD3 input

The original MOD2 lines affected by the changes are left within parenthesis in the input list (App. A) for comparison.

Flag options are generally set to default or recommended values. Only those cards which were affected by the modifications from MOD2 into MOD3 are commented.

Card No. 201, Time step control card:

Max. time step was generally kept to 0.0025 s as in MOD2, shorter time steps were used only in a few cases with convergence problems.

The time step control word W4 was set to 0003 instead of 0011 which meant that a semi-implicit solution scheme was chosen insted of the nearly-implicit scheme for the hydrodynamics. This choice made no difference to the results, but reduced the computation time slightly.

Card No. 1001001, Pipe volume control flags:

The number of control flags have been increased from two, (fe) to five (pvbfe) and was now set to 11000 instead of 00. In order, the flags mean: p=1, water packing is not considered, v=1, no vertical stratififation is taken into account and b=0, means that the pipe interphase friction model is applied. fe=00 like in MOD2, that is wall friction and non-equilibrium temperature calculations are applied.

Card No. 1001101, Pipe junction control flags:

The number of flags has been increased from four to five. vcahs=31000 was changed into fvcahs=001000. The new flag f=0 means that CCFL is not taken into account. Flag v was in MOD2 said to specify horizontal stratification options but is not used in MOD3 and should be set to 0. The flags cahs=0000 were kept unchanged, which in turn means that the choking model is used, a smooth area change and a nonhomogeneous momentum equation.

Card No. 11000801, Heat structure additional left boundary information:

MOD2 had here a CHF control flag as word 1, but there was only this option, and the additional three words were actually not used. In MOD3 this card is utilized to take into account the effect of heated length on CHF for short channels (Word 2 and 3, forward and reverse heated lengths, respectively).

The length effect is ignored when a large number i.e >10 is given which was the case for the RIT data. Word 4 - 7 is for grid or spacer losses and was set=0 since there were no spacers. Word 8 is a "local boiling factor" (lbf). According to the manual (Ref.3) this is local heat flux/average heat flux from the start of boiling, and is depending on the axial heat flux distribution. Since uniform heat flux distribution was used in the RIT tests a value of 1.0 should be used.

Card No. 2000101, 3000101, Time-dependent volume control flags

Word 9 had 2 digits (fe) in MOD2, but has now 5 digits (pvbfe). However, the first two flags are not used, the rest have the same implication as in the pipe input. bfe was now set to 010 meaning that interphase friction should be calculated, but not wall friction and that nonequilibrium temperatures are computed.

Card No. 3500101, Single junction geometry

The control flags, now being six, (fvcahs) were set to 001000 like in the pipe junction described before. In the MOD2 input a=1 was used which stands for an abrupt area change instead of a smooth one with a=0. The difference had no effect on the results.

The discharge coefficients are now three instead of two in MOD2. A superheat discharge coefficient has been added to the subcooled and two-phase coefficients, and all are set to 1.0. (A value of zero in MOD2 was by default changed to 1.0)

6 Performance of the calculations and computational efficiency

The calculations with RELAP5/MOD, version m5m were run on a SUN Sparc workstation in a network. Some cases were then run on the server (Sun 330) having a clock frequency of 16 MHz while most cases were run on a SUN4 workstation with 12 MHz.

The test section power was ramped from zero to full power in 5 s to reduce the instability a step function would cause. In this respect MOD3 was less sensitive than MOD2 for which the ramp period was set to 10 s and were a too fast ramp switched over the heat transfer mode into a nonreversible post-dryout condition far upstream the channel.

The code output announced steady state to be achieved after in general 10 to 20 s, i.e. 5 to 15 s after the end of the ramp, with the max. timestep set to 2.5 ms. The table in appenddix B summarizes the times to reach steady state and the corresponding computation times for the 47 cell geometry model. Runs with a reduced number of cells showed that the computation time was roughly proportional to the number of cells.

Like in previous MOD2 runs the steady state algoritm was in many cases found not to be adequate. Stable flow conditions could be prevailing for a large number of timesteps before the code decided to state so, which in some cases was not until the input end time. In other runs steady state was proclaimed despite a considerable instability was seen in the outlet flow. These runs were specially analyzed regarding the stability in CHF.

The average CPU times per timestep and volume cell became 6.1 ms and 8.6 ms on the SUN 330 server and SUN SPARC workstation respectively. This can be compared with a corresponding average time of 45 ms needed for the MOD2 simulations in ref. 1 on a CDC Cyber 180-185, in both cases using a max time-step of 2.5 ms.

7 Results and data comparison

A summary of the results of the MOD3 simulations and comparison with measured RIT data and with earlier MOD2 results from Ref. 1 is given in the table below.

Table 4

Comparison between experimental and RELAP5 results

Run No.	p MPa	q/A kW/m2	G kg/m2 s	Axial dryout position m 1	2	2'	3	Max. wall temperature K 1	2	2'	3
136	14	509	1977	5.55	5.70	5.60	5.80	729	735	738	717
139	14	757	1970	2.88	3.50	2.69	3.10	901	835	1024	782
147	14	704	1494	2.88	3.10	2.69	2.96	914	844	895	790
154	14	552	1007	3.15	2.96	2.96	3.20	886	830	830	780
161	14	405	503	2.88	3.60	2,69	3.20	899	880	883	872
220	10	511	1981	*	*	-	*	590	-	-	596
221	10	665	1974	5.55	*	5.50	5.90	773	-	777	747
224	10	860	1990	4.25	5.70	4.20	3.90	862	777	851	810
232	10	758	1500	4.15	6.30	4.10	4.20	869	756	845	804
238	10	556	997	4.85	*	4.80	5.50	838	597	806	785
244	10	405	502	5.05	5.70	5.00	5.80	872	820	871	783
259	7	870	1989	6.05	*	6.00	6.80	787	576	802	734
261	7	1053	1988	4.65	6.30	4.60	5.20	874	804	888	809
264	7	766	1500	6.05	*	6.00	6.95	801	576	805	717
269	7	564	995	*	*	-	*	568	-	-	574
270	7	660	996	5.85	*	5.80	*	830	576	832	576
272	7	815	1000	4.55	5.60	4.50	6.50	912	886	920	771
275	7	410	501	6.45	6.60	6.40	6.80	759	749	775	718
315	3	873	1986	5.95	*	5.80	6.95	834	532	885	739
317	3	1058	1987	6.05	*	-	6.95	898	538	-	749
320	3	769	1499	6.05	*	6.00	6.95	842	531	872	734
325	3	561	1011	*	*	-	6.95	524	-	-	526
327	3	667	1006	6.05	*	6.00	6.95	854	528	881	728
331	3	413	497	*	*	-	*	521	-	-	711
332	3	464	496	6.25	6.70	6.20	6.80	827	799	880	749

Notes: Column 1 = measured
2 = calculated with RELAP5/MOD2 (MOD2.5)
2'= -"- -"- , modified version (Ref. 1)
3 = -"- RELAP5/MOD3

* No dryout measured or calculated

Plotted results i.e. inner wall temperatures versus axial position are shown in Appendix D.1-D.21 for runs in which dryout occurred.

Ref.1 contained only data of the modified MOD2 calculations, i.e. the cases where the onset of dryout had been adjusted to coincide with the experimental dryout point (Column 2' above). The MOD2 results (Column 2) were therefore regenerated using the original input but with RELAP5/MOD2.5. This can be justified as MOD2.5 and MOD2 employ identical CHF models based on the Biasi correlation and also the same post-dryout heat transfer models.

7.1 Critical Heat Flux prediction

The results show that the new CHF method in MOD3 generally gave a better prediction of the dryout axial location than the original MOD2 method. The onset of dryout was by MOD2 calculated to take place at a point considerably far downstream the measured point, in all cases but one (Run 154, App. D.4). MOD2 predicted no dryout to occur in as many as nine cases in which dryout was really observed in the experiments.

The new critical heat flux model in MOD3 resulted in only one case (Run 270) in which dryout was predicted not to take place contrary to the measurements. However, the dryout axial location was still placed more or less downstream the experimentally observed point for most of the analyzed cases. Only in run 224 did RELAP5/MOD3 compute a dryout point upstream the observed position.

In runs at moderate pressures, 3 and 7 MPa, and for cases in which the dryout took place only about one meter from the testsection exit, the RELAP5/MOD3 model gave dryout in the uppermost 0.05 m long cell only. (In neither of these cases did MOD2 predict dryout). However, MOD3 should not have predicted dryout either, nor have shifted the heat transfer mode into post CHF mode (from mode 4 to 8) since the calculated CHF-value was still larger than the actual local heat flux.

The erraneous dryout prediction was an effect of the location in an exit cell, which was demonstrated by rerunning some cases with the test section lengthened by four extra outlet cells. This check revealed that the axial position for the onset of dryout moved with the number of exit cells, still into the uppermost one. Table 4 therefore shows a false indication of dryout for the position 6.95 m (Run Nos. 264, 315, 317, 320, 325 & 327).

The stability of the dryout predicted by RELAP5/MOD3 is illustrated in figs. 4 to 7. Fig. 4 and 5 show the time history of the outlet mass flow compared with the inlet flow for run 147 and 261. Fig 6 and 7 show the calculated critical heat flux (HTCHF) compared with the actual input heat flux (HTRNR) for the same cases. For both the code message was that stady state was achieved, although the outlet mass flow was steady in run 147, but oscillated considerably in run 261. However, stable CHF was reached within less than 1 s after the end of the ramp for both runs.

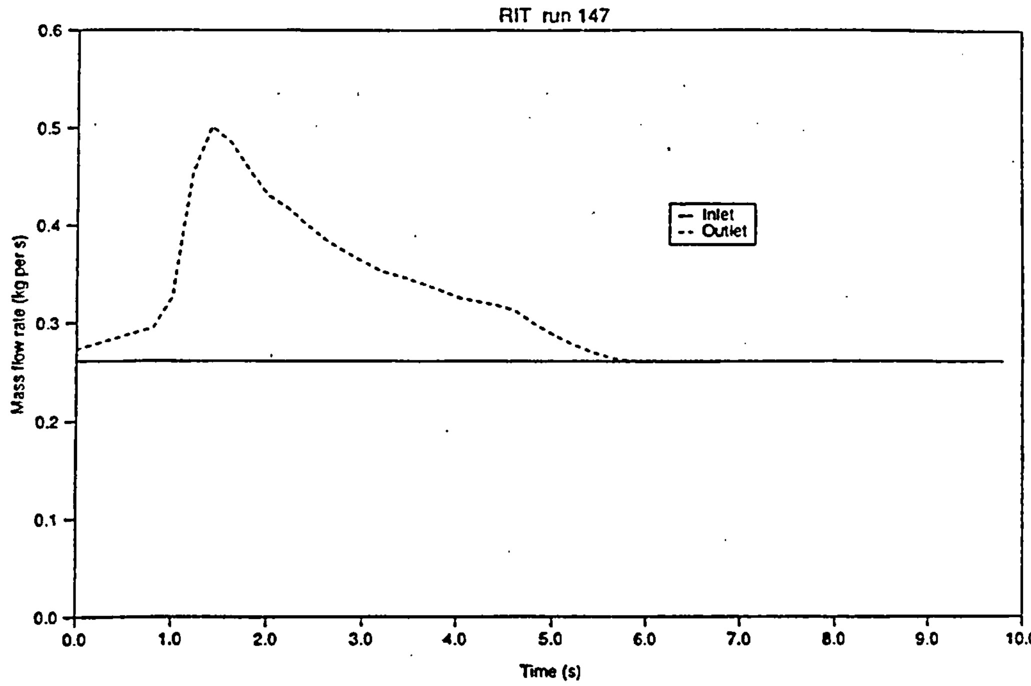

Fig. 4 Mass flow rate at test section inlet (tmdpjun 250) and at outlet (snqljun 350) in run RIT 147

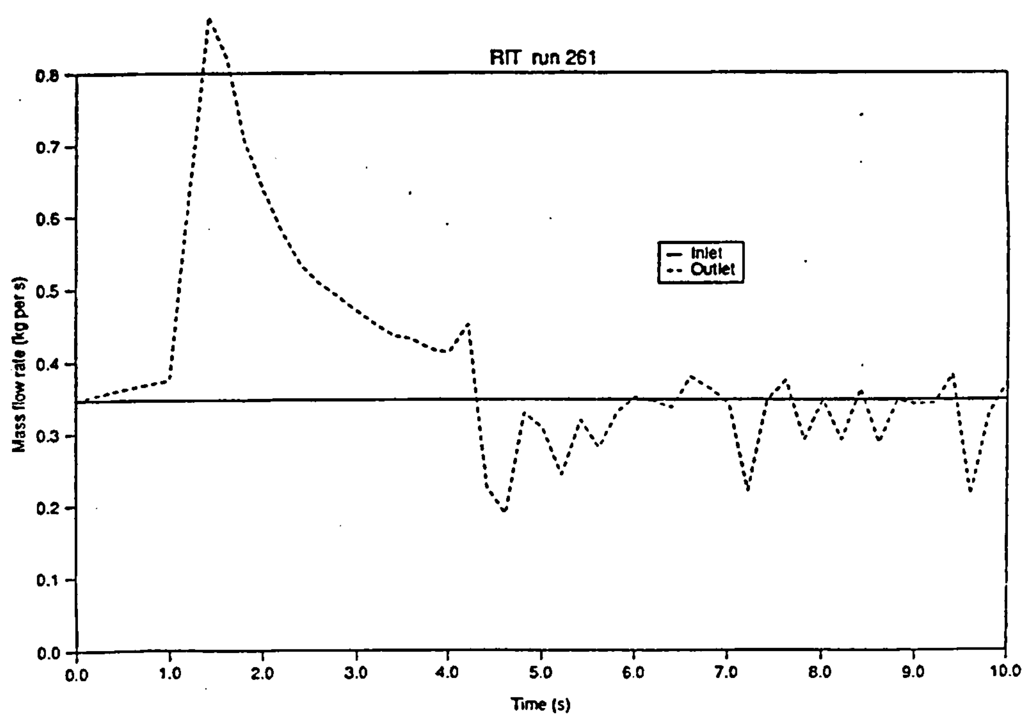

Fig. 5 Mass flow rate at test section inlet (tmdpjun 250) and at outlet (sngljun 350) in run RIT 261

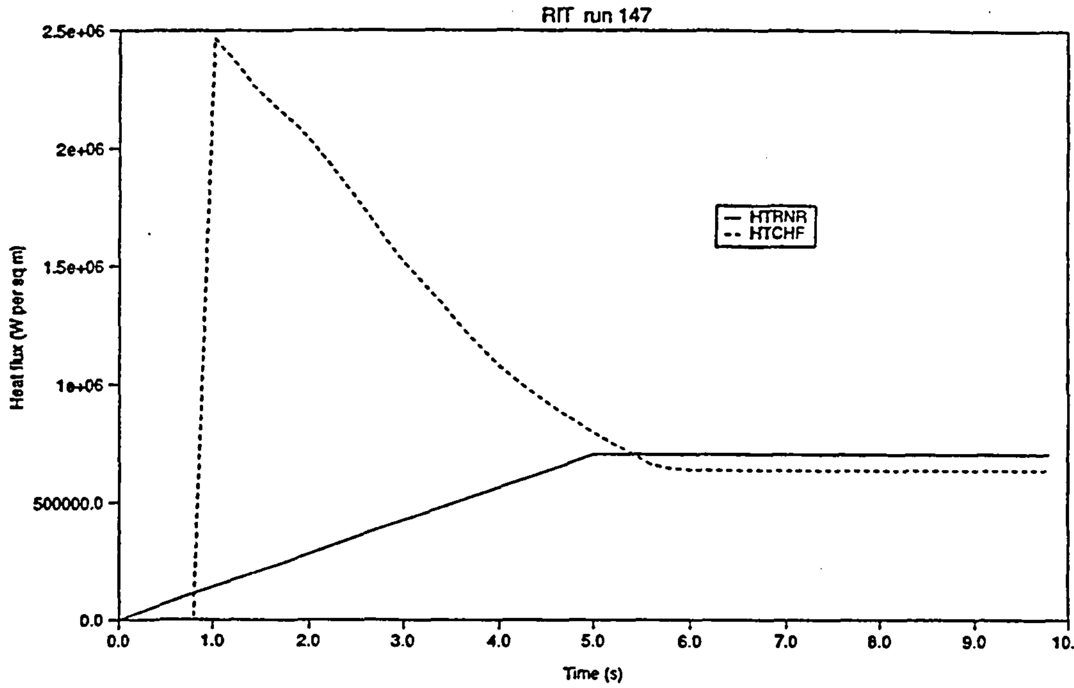

Fig. 6 Actual inside wall heat flux (HTRNR) and calculated critical heat flux (HTCHF) in cell No. 7 for run 147

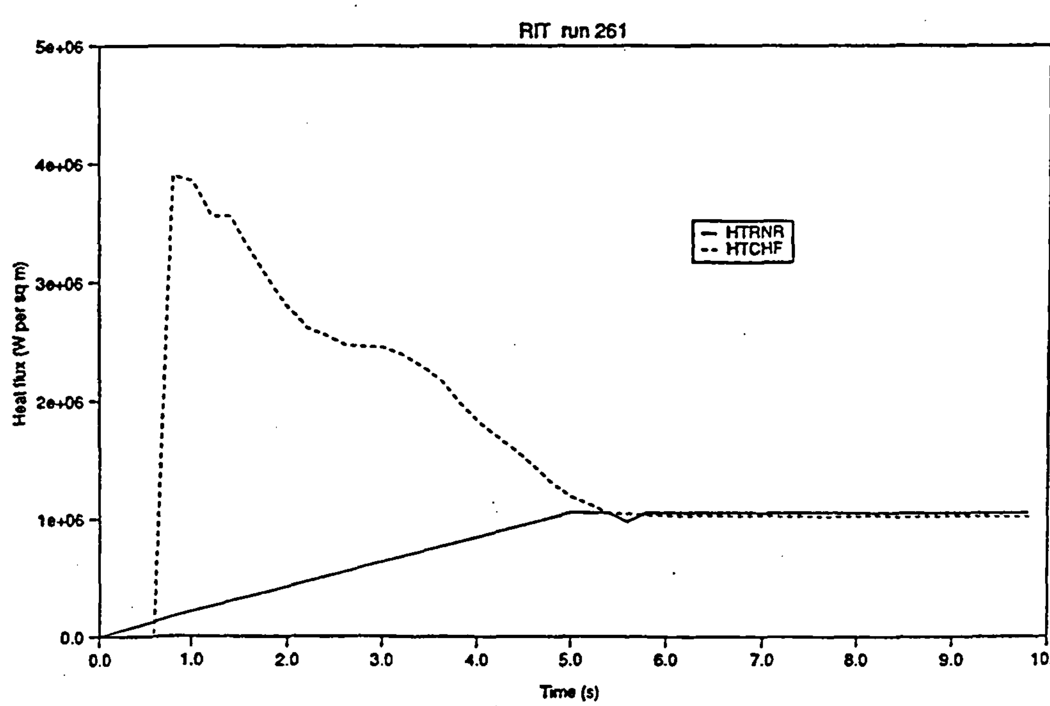

Fig. 7 Actual inside wall heat flux (HTRNR) and calculated critical heat flux (HTCHF) in cell No. 29 for run 261

The fact that the calculated dryout point often appeared downstream the experimentally observed point means that the new CHF method in RELAP5/MOD3 is still non-conservative compared with the RIT data. The calculated critical heat flux is thus higher than the experimental one, as shown in table 5 below. Comparison is there made between calculated and measured dryout heat flux at the experimentally observed dryout location for RELAP5/MOD2.5 and /MOD3 respectively. The error E is defined thus:

$$E = \frac{(q/A)_c - (q/A)_m}{(q/A)_m} - 1$$

Table 5

Comparison between predicted and experimental dryout heat flux

Run No.	p MPa	$(q/A)_m$ $\frac{kW}{m2}$	G $\frac{kg}{m2\ s}$	z_m m	$E_{2.5}$	E_3
136	14	509	1977	5.55	0.30	0.11
139	14	757	1970	2.88	0.64	0.24
147	14	704	1494	2.88	0.46	0.19
154	14	552	1007	3.15	< 0	0.12
161	14	405	503	2.88	0.49	0.86
220	10	511	1981	*	-	-
221	10	665	1974	5.55	0.62	0.13
224	10	860	1990	4.25	0.28	-0.10
232	10	758	1500	4.15	0.54	0.04
238	10	556	997	4.85	1.21	0.30
244	10	405	502	5.05	1.16	0.58
259	7	870	1989	6.05	0.62	0.36
261	7	1053	1988	4.65	0.42	0.29
264	7	766	1500	6.05	0.82	0.58
269	7	564	995	*	-	-
270	7	660	996	5.85	0.96	0.99
272	7	815	1000	4.55	0.78	0.77
275	7	410	501	6.45	0.42	0.97
315	3	873	1986	5.95	2.26	2.10
317	3	1058	1987	6.05	1.18	0.92
320	3	769	1499	6.05	2.56	2.28
325	3	561	1011	*	-	-
327	3	667	1006	6.05	2.52	2.45
331	3	413	497	*	-	-
332	3	464	496	6.25	1.06	1.32

* No dryout measured or calculated

The error in predicted dryout heat flux seem to increase with decreasing pressure as illustrated by Fig. 8. The lines representing the mean errors show that the new method in MOD3 is in fact not any radical improvement compared with MOD2 for the RIT data.

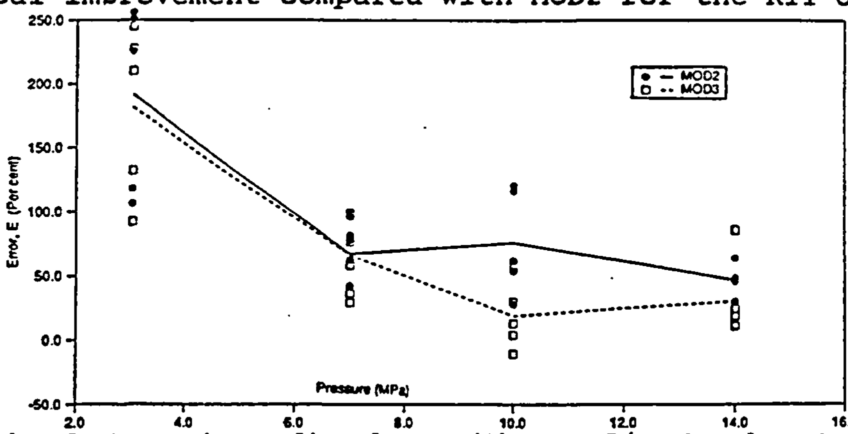

Fig. 8 Error in predicted CHF with RELAP5/MOD2 and MOD3 related to measured CHF

7.2 Post-dryout heat transfer

The pre-CHF heat transfer predicted by RELAP5 agree reasonably well with the experiments. The wall temperatures from MOD3 are equal or slightly higher than those calculated with MOD2. Both RELAP5 versions give higher wall temperatures than the expertimental values. The measured pre-CHF inner wall temperatures reported in ref. 2 seem, however, to be somewhat low compared to fluid saturation temperatures. This is especially the case at high pressures which can be due to uncompensated heat losses.

The post-CHF wall temperatures show much larger deviations from the experimental values. In this region the occurance of small constant errors in the measured temperatures are negligible compared with the large temperature differences between inner wall and coolant.

RELAP5/MOD3 gives noticeably lower temperatures than RELAP5/MOD2 did and less good agreement with the measurements in the post-dryout region. This means that MOD3 uses a larger convective heat transfer coefficient than MOD2 does. A comparison can be made for run 147, at 14 MPa, in which there was a reasonable good agreement between predicted and measured dryout location (App. C.3a). The following ranges were obtained for the convective heat transfer coefficient in the post CHF region:

RELAP5/MOD2, 3196 - 5883 W/(m^2,C)
RELAP5/MOD3, 4506 - 6026 -"-
Experiment, 2475 - 7699 -"-

The low values apply to the immediate post-dryout region, and the heat transfer is then growing towards the exit as the steam quality and thus the fluid velocity increases.

In order to make a relevant comparison of the heat transfer calculations in MOD2 and MOD3 the point of onset of dryout should be correct, or at least equal for the two versions. With the modified MOD2 runs [Ref. 1] the experimental dryout point was forced into the computations. A similar modification was not employed here. Instead, the lbf factor was used to adjust the calculated critical heat flux to be equal to the actual heat flux at the dryout point. The lbf number, intended to account for effects of a non-uniform axial heat flux distribution, just acts as another correction factor for the CHF. It was in this case used to obtain a lower total CHF multiplier. The effect of varying the lbf-factor from 1.0, the recommended value, to 0.5 for run 261 is shown in Fig. 9. The corresponding CHF multiplier then decreased proportionally from 0.82 to 0.41

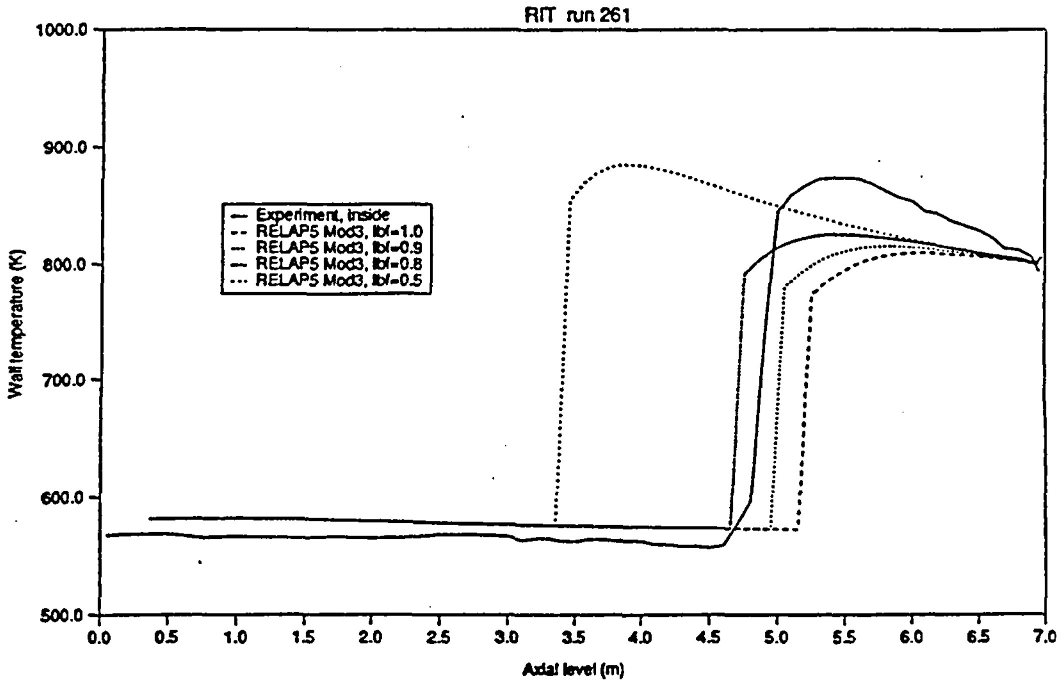

Fig.9 Effect of the lbf-factor in RELAP5/MOD3 on calculated inner wall temperatures for run 261

The cases in which the dryout point has been adjusted in this way are included for comparison in Appendices D.5 and D.10 (runs 161 and 244). Provided that the axial positions of the beginning of the post-dryout region are equal, it is obvious that RELAP5/MOD3 calculates much lower wall temperayures than RELAP5/

MOD2. The MOD2 heat transfer model gave a satisfactory prediction of the maximum temperature when the location of the dryout point was correct, as shown in Table 4 (Column 2').

It is evident that the convective heat transfer calculational method has been changed from MOD2 to MOD3, giving too large convective heat transfer coefficients. The reason for this is unclear as long as no model desription or program manual was available at this moment.

7.3 Nodalization studies

It was shown in ref. 1 that the sensitivity in calculated inner wall temperature for changes in the number of radial nodes in the tube wall was small. Differences less than 0.5 K were seen between runs with two nodes, as in the base cases, and with ten nodes. Since the heat conduction models are not changed, the same conclusion should be valid for results with RELAP/MOD3 as for /MOD2, and therefore only runs with two radial nodes were performed here.

The effect of the number af axial fluid cells was, however, examined. Case RIT 232 was chosen, for which there was good agreement in the calculated dryout position with 47 cells. This nodalization employes cell lengths as short as 0.05 m, that is much finer than is normally used in reactor calculations, where lengths of about 0.5 m are commonly used. Therefore runs were performed also with 22 and 11 cells, i.e. with minimum cell lengths 0.25 and 0.5 m respectively.

Fig. 10 shows that, except for the coarser resolution around the dryout point, there is not much difference in the post-dryout wall temperatures. The disturbance effect of the erraneously calculated exit cell temperature becomes, however more pronounced with a longer exit cell (which can be avoided by adding an extra outlet cell).

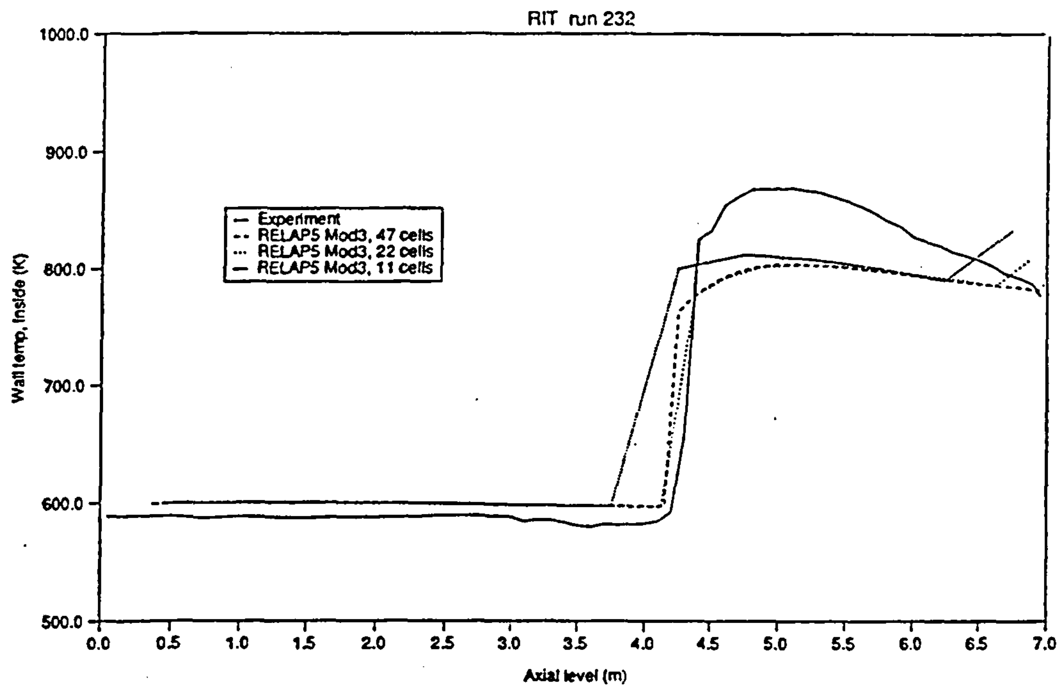

Fig.10 Effect of axial nodalization on inner wall temperature in run 232

7.4 Calculations on experiments with non-uniform axial heat flux distributions

A number of new post-dryout experimental data has been produced at the Royal Institute of Technology in Stockholm in which the effect of various axial heat flux distributions have been studied (Ref. 3). The axial power shapes simulate realistic distributions in power reactors but some with larger form factors.

Same tentative calculations were made on a few experiments with symmetric distributions and form factors around 1.6. Comparison with experimental data underlined the same trend as with the earlier assessment, i.e. RELAP5/MOD3 overpredicted the CHF considerably. In fact, the trend seemed to be more pronounced with the non-uniform data. At low pressures RELAP5/MOD3 was not able to predict CHF at all even when high post-dryout temperatures were measured.

8 Conclusions

Reassessment has been performed of RELAP5 against twenty-five RIT post-dryout experiments, now with version MOD3 5m5 compared to the earlier assessment with version MOD2 cycle 36.02. The following conclusions were drawn:

1. The new dryout calculational method in MOD3, based on "Groenevelds look-up tables" gave better prediction of the dryout heat flux than the method in MOD2, based on Biasi's correlation. Thereby was also an improved prediction of the location of the onset of dryout achieved.

2. The improvement in the dryout calculation is still not satisfactory compared with the measured RIT data. A considerable overprediction is left. For the cases in which dryout occurred the mean error was reduced only from 96 to 74 per cent from MOD2 to MOD3, related to the measured dryout heat flux . The standard deviation became allmost unchanged, about 70 per cent, indicating a large degree of uncertainty.

3. There seem to be a pressure dependence of the error in calculated CHF. The overprediction being around 20 per cent at high pressures increases to as much as a factor of three at 3 MPa.

4. An effect of overpredicted CHF is that the onset of dryout is calculated to take place far downstream the experimentally observed point in most cases. As a consequence of this RELAP5/MOD3, like MOD2, underpredicts the post-dryout wall temperatures.

5. Even in cases where the error in the dryout axial location is small, or when the dryout point is forced to coincide with the experimental one (by adjusing the lbf-factor), the calculated post-dryout wall temperatures with MOD3 are remarably lower than measured values. This is especially noticed immediately downstream the dryout point where MOD3 gives still lower temperatures than MOD2. The difference to measured temperatures decreases then towards the channel exit as the steam superheat increases.

6. The changes of the post-dryout heat transfer models, which have obviously been done from MOD2 into MOD3, have impaired the agreement compared with the RIT experimental data.

With heat transfer mode 8 (saturated film boiling) the heat transfer coefficients in MOD2 gave in general wall temperatures within 10 per cent of observed values, mostly overpredictions at low and underpredictions at high pressures.

All heat transfer coefficients have become larger for MOD3 in this region. Since the model description has not been released for MOD3, no further analysis of modifications or the background for the changes is made here.

7. A nodalization study showed little effect of the number of axial fluid cells in the range 11 to 47 cells on the wall temperature. However, there is a disturbance from the uppermost cell resulting in a increase of the temperature calculated in this cell.

8. The computational efficiency has probably been improved compared with MOD2. One reason might be that the CHF calculation in MOD2 employed an iteration for the wall temperature which in MOD3 is replaced by a direct comparison of calculated CHF and actual surface heat flux. (Comparison of CPU times for the present and the previous assessment is not relevant since different types of computers were used)

   There is still an inconsistency in the steady state convergence criterion like in MOD2.

References

1 SJÖBERG, A. and CARAHER, D
ICAP. Assessment of RELAP5/MOD2 against twenty five dryout experiments conducted at the Royal Institute of Technology.
Studsvik Report STUDSVIK/NP-86/66

2 BECKER, K.M., et. al.
An experimental investigation of post dryout heat transfer
KTH-NEL -33. Royal Institute of Technology, Stockholm, May 1983

3 BECKER, K.M. et. al.
Post dryout heat transfer measurements in vertical round ducts with non-uniform axial heat flux distributions.
Royal Institute of Technology, Stockholm
Report in progress

4 SHUMWAY, R.
New critical heat flux method for RELAP5/MOD2
EGG-EAST-8443 (Informal Report)
EGG&G Idaho Inc., Idaho Falls, Jan. 1989

5 Appendix A. RELAP5 input data requirements.
Prepared for release of RELAP5/MOD3.
EG&G Idaho Inc. Idaho Falls, Idaho, Jan. 1990

List of tables

List of figures

```
=         RELAP5/Mod3/5m5      RIT PDO-case 136
*
*         Changed Mod2 input lines within ()
*
*         This case is a simulation of a post dry-out experiment
*         conducted by K.M. Becker et al. in the Nuclear Engineering
*         Laboratory at the Royal Institute of Technology  (RIT) in
*         Stockholm and is reported in ref (2). The test section
*         comprised a seven meter long heated vertical pipe with wall
*         thermocouples located throughout the heated length. The
*         inner diameter was 0.0149 m.
*
*         The experiment was run with time-invariant boundary conditions
*         with an uniform axial power distribution and the data were
*         recorded when the conditions in the test section were stable.
*
*         The constant boundary conditions for the case number 136 were:
*
*                    outlet pressure     13.99  mpa
*                    massflux           1976.6  kg/m2/s
*                    inlet temperature   599.65 k
*                    heat flux           0.509  mw/m2
*
*         The test section was modeled as a pipe component with 47
*         volumes. The heated wall was modeled by using conducting
*         material with a cylindrical geometry including two mesh
*         points, one on each surface. The inner surface was connected
*         to the hydro-dynamic pipe volumes through the heat transfer
*         package while the outer surface was assumed completely insulated.
*         Checking of heat balance was part of the experimental routine
*         and revealed an insignificant level of heat losses to the
*         ambient thus justifying the assumption of the insulated outer
*         surface.
*
*         Reference 1  K.M. Becker
*
*
*                    An experimental investigation of post dryout
*                    heat transfer
*                    KTH-NEL-33
*                    Department of Nuclear Reactor Engineering
*                    Royal Institute of Technology
*                    Stockholm, Sweden
*                    May 1983
*
*
0000100   new  stdy-st
0000101   run
*
*         cpu time remaining card
0000105   10.0      20.0
*
*         time step control cards
*         time-end  dt-min  dt-max  ssdxx  min-edit  maj-edit  restart
0000201   8.0      1.0e-6  0.0025  00003  80        2000      4000
*
(*         time-end  dt-min  dt-max  ssdxx  min-edit  maj-edit  restart)  MOD2
(0000201   0.1      1.0e-6  0.0025  00011  80        2000      4000)
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* ====================================================================
*
*         minor edit requests
*
0000301   cputime   0                    * cpu-time
0000302   p         100010000            * inlet node pressure
0000303   p         100470000            * outlet node pressure
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0000305   voidgj    350000000            * outlet junc. void fraction
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0000307   tempg     100470000            * outlet node tempg
0000308   sattemp   100470000            * outlet node t-sat
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0000310   httemp    100000501            * wall temp t12
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0000313   httemp    100002001            * wall temp t27
```

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0000317   httemp    100004001          * wall temp t49
0000318   httemp    100004501          * wall temp t54
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0000320   htrnr     100000500          * heat flux
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0000322   htrnr     100001500          * heat flux
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0000325   htrnr     100003000          * heat flux
0000326   htrnr     100003500          * heat flux
0000327   htrnr     100004000          * heat flux
0000328   htrnr     100004500          * heat flux
0000329   htchf     100000100          * critical heat flux
0000330   htchf     100000500          * critical heat flux
0000331   htchf     100001000          * critical heat flux
0000332   htchf     100001500          * critical heat flux
0000333   htchf     100002000          * critical heat flux
0000334   htchf     100002500          * critical heat flux
0000335   htchf     100003000          * critical heat flux
0000336   htchf     100003500          * critical heat flux
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0000338   htchf     100004500          * critical heat flux
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0000342   hthtc     100001500          * htc
0000343   hthtc     100002000          * htc
0000344   hthtc     100002500          * htc
0000345   hthtc     100003000          * htc
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0000347   hthtc     100004000          * htc
0000348   hthtc     100004500          * htc
0000349   floreg    100010000          * flow regime number
0000350   floreg    100050000          * flow regime number
0000351   floreg    100100000          * flow regime number
0000352   floreg    100150000          * flow regime number
0000353   floreg    100200000          * flow regime number
0000354   floreg    100250000          * flow regime number
0000355   floreg    100300000          * flow regime number
0000356   floreg    100350000          * flow regime number
0000357   floreg    100400000          * flow regime number
0000358   floreg    100450000          * flow regime number
0000359   mflowj    250000000          * mflow inlet
0000360   mflowj    350000000          * mflow outlet
*
* ==================================================================
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*
*    ***** hydrodynamic components *****
*
*
*
*         the heated pipe is modeled as a pipe component nr 100
*
1000000   hot-cha   pipe
*
*         nvol
1000001   47
*
*         area           nvol
1000101   1.74366e-04    47
*
*         length         nvol
1000301   0.750          1
1000302   0.500          5
1000303   0.250          6
1000304   0.100          45
1000305   0.050          47
*
*         v-angle        nvol
1000601   90.0           47
*
```

```
*         rough     d-hyd     nvol
1000801   20.0e-06  0.0149    47
*
*         pipe volume control flags
*         pvbfe        nvol
1001001   11000        47
(*         fe        nvol)          MOD2
(1001001   00        47)
*
*         pipe junction control flags
*         fvcahs     nvol-1
1001101   001000     46
(*         vcahs     nvol-1)        MOD2
(1001101   31000     46)
*
*         pipe volume initial conditions
*         ebt  pressure  temp.    dummy1    dummy2    dummy3    nvol
1001201   003  13.99e+06 599.65   0.0       0.0       0.0       47
*
*         pipe junction data
*         ctrl-wrd
1001300   1
*
*         initial cond.
*         flow-f    flow-g    flow-fg    njunc
1001301   3.4465e-1 0.0       0.0        46
*
*
*     * * heat structure data * *
*
*         nh   np   type  ss-fl  lcoord
11000000  47   2    2     1      7.45e-03
*
*         loc  fmt
11000100  0    1
*
*         nint - rcoord
11000101  1      1.04e-02
*
*         composition - interval
11000201  1    1
*
*         source - interval
11000301  1.0  1
*
*         tflg
11000400  0
*
*         initemp for each heat-str.
*         initemp   mesh
11000401  599.65    2
*
*         bndvol    incr      bndcon    sac  factor   hsnr
11000501  100010000 010000    1         1    0.750    1      * left
11000502  100020000 010000    1         1    0.500    5      * left
11000503  100060000 010000    1         1    0.250    6      * left
11000504  100070000 010000    1         1    0.100    45     * left
11000505  100460000 010000    1         1    0.050    47     * left
*
11000601  0         0         0         1    0.750    1      * right
11000602  0         0         0         1    0.500    5      * right
11000603  0         0         0         1    0.250    6      * right
11000604  0         0         0         1    0.100    45     * right
11000605  0         0         0         1    0.050    47     * right
*
*         srctyp    mult      dhl     dhr     hsnr
11000701  1         0.750     0.0     0.0     1
11000702  1         0.500     0.0     0.0     5
11000703  1         0.250     0.0     0.0     6
11000704  1         0.100     0.0     0.0     45
11000705  1         0.050     0.0     0.0     47
*
*         de   hlf     hlr     grid factors          lbf     hsnr
11000801  0    20.0    10.0    0.0  0.0  0.0  0.0    1.0     47
(*         chf     de      dh      length    hsnr)                MOD2
(11000801  0       0.0     0.0     0.0       47)
*
```

```
*           heat structure th. prop.  composition is nimonic 75
*           material-type          for-flg1          for-flg2
20100100    tbl/fctn               1                 1
*
*           temp.        th.cond.
20100101    270.0        12.0
20100102    5000.0       93.4
*
*           vol.heat-cap.
20100151    4.0e+06
*
*           general table for heat structure power (srctyp 1)
*           tbl-type  trip    factor-t    factor-p
20200100    power     0       1.0         1.0
*
*           time      linear power (w/m)
20200101    0.0       0.0
20200102    5.0       23.8262e+03
20200103    20.0      23.8262e+03
*
*     * * end of heat structure data * *
*
* ======================================================================
*
*           lower boundary condition
*
*           tmdpvol - component 200
*           tmdpjun - component 250
*
2000000     lo-bndry  tmdpvol
*
*           area      length vol. h-angle v-angle elev. rough d-hyd pvbfe
2000101     1.0       1.0    0.0  0.0     90.0    1.0   0.0   1.0   00010
(*           area      length vol. h-angle v-angle elev. rough d-hyd fe)      MOD2
(2000101     1.0       1.0    0.0  0.0     90.0    1.0   0.0   1.0   10)
*
*           abt  tbl-nr
2000200     003  0
*
*           time      pressure    temp.
2000201     0.0       13.99e+06   599.65
*
*
*
*
2500000     lo-flow   tmdpjun
*
*           from-code      to-code       area
2500101     200000000      100000000     0.0
*
*           ctrl-wrd
2500200     1
*
*           time      flow-f     flow-g     flow-fg
2500201     0.0       3.4465e-1  0.0        0.0
*
*
* ======================================================================
*
*           upper boundary condition
*
*           tmdpvol - component 300
*           sngljun - component 350
*
3000000     up-bndry  tmdpvol
*
*           area      length vol. h-angle v-angle elev. rough d-hyd pvbfe
3000101     1.0       1.0    0.0  0.0     90.0    1.0   0.0   1.0   00010
(*           area      length vol. h-angle v-angle elev. rough d-hyd fe)      MOD2
(3000101     1.0       1.0    0.0  0.0     90.0    1.0   0.0   1.0   10)
*
*           abt  tbl-nr
3000200     003  0
*
*           time      pressure    temp.
3000201     0.0       13.99e+06   700.0
```

```
*
*
*
*
3500000   up-flow   sngljun
*
*         from-code  to-code    area  f-loss  r-loss  fvcahs  dis-coeffs.
3500101   100010000  300000000 0.0   0.0     0.0     001000  1.0 1.0 1.0
(*         from-code  to-code    area  f-loss  r-loss  vcahs   dis-coeffs.)  MOD2
(3500101   100010000  300000000 0.0   0.0     0.0     31100   0.0    0.0)
*
*         cw   flow-f     flow-g    flow-fg
3500201   1    3.4465e-1 0.0       0.0
*
*
*         =================================================================
*
.         end of case
```

RIT RELAP5/Mod3 runs. CPU-times on SUN system
47 cell model

Run	dt-max (s)	time to s.s. (s)	cputime (s)	time steps No.
136	0.0025	17.9975	2739.6	7199
139	0.0025	20.0000	2624.1	8000
147	0.0025	10.0000	1256.7	4000
154	0.0025	12.7100	1598.9	5084
161	0.0025	13.9125	2412.9	5565
220	0.0025	11.7775	1417.2	4711
221	0.0025	12.4375	2099.9	4975
224	0.0025	20.0000	3832.3	8613
232	0.0025	12.4375	2193.4	4975
238	0.0025	11.7775	2011.3	4711
244	0.0025	14.3975	2456.0	5759
259	0.0025	17.1100	2405.8	8134
261	0.0025	10.0000 *	2017.6	6456
264	0.0025	17.6832	2089.7	7236
269	0.0025	19.3800	2233.5	7752
270	0.0025	13.2425	1520.3	5297
272	0.0025	11.2925	1496.7	5057
275	0.0025	13.0175	1534.4	5207
315	0.0010	10.4985 *	2587.6	8883
317	0.0010	30.0000 *	10005.	34012
320	0.0025	10.5675	2328.1	7975
325	0.0025	25.0000 **	5454.7	18730
327	0.0025	17.6700	3710.3	12784
331	0.025	25.0000 *	4186.6	13832
332	0.0025	10.1450	1715.1	5642

Notes: * Outlet flow not stable, steady state claimed to be reached

** Steady state not achieved, terminated by end of time card, however, relatively stable outlet flow

Average CPU-time per timestep and cell = 6.1 ms on SUN 330 server
= 8.6 ms on SUN SPARC workstation

RIT run 136

Inside wall temperatures, T (K) versus axial level, z (m)

Experiment		RELAP5-results	MOD3	MOD2	MOD2 mod.
z	T	z	T	T	T
0.05	611.2	0.375	619.58	614.34	614.3
0.25	611.4	1.00	620.24	614.57	614.6
0.50	611.7	1.50	620.52	614.65	614.6
0.75	609.7	2.00	620.52	614.85	614.8
1.00	610.6	2.50	620.33	615.14	615.1
1.25	610.4	2.875	620.12	615.25	615.2
1.50	609.9	3.05	620.01	615.29	615.3
1.75	610.8	3.15	619.95	615.34	615.3
2.00	610.5	3.25	619.88	615.39	615.4
2.25	610.1	3.35	619.82	615.44	615.4
2.50	608.4	3.45	619.75	615.49	615.5
2.75	608.9	3.55	619.65	615.54	615.5
3.00	608.4	3.65	619.55	615.59	615.6
3.1	608.3	3.75	619.46	615.63	615.6
3.2	609.0	3.85	619.36	615.68	615.7
3.3	608.9	3.95	619.27	615.72	615.7
3.4	608.5	4.05	619.18	615.77	615.8
3.5	608.0	4.15	619.10	615.81	615.8
3.6	606.7	4.25	619.01	615.86	615.9
3.7	609.0	4.35	618.93	615.90	615.9
3.8	608.3	4.45	618.85	615.94	615.9
3.9	608.9	4.55	618.77	615.98	616.0
4.0	608.9	4.65	618.69	616.03	616.0
4.1	608.9	4.75	618.62	616.07	616.1
4.2	609.3	4.85	618.54	616.11	616.1
4.3	609.4	4.95	618.47	616.15	616.1
4.4	609.4	5.05	618.40	616.19	616.2
4.5	607.3	5.15	618.33	616.21	616.2
4.6	608.5	5.25	618.26	616.31	616.3
4.7	609.9	5.35	618.19	616.46	616.4
4.8	609.0	5.45	618.13	616.58	616.6
4.9	609.4	5.55	618.06	616.68	616.6
5.0	609.4	5.65	618.00	616.75	721.7
5.1	610.0	5.75	617.94	718.70	725.8
5.2	609.6	5.85	682.78	722.68	729.2
5.3	610.1	5.95	688.23	726.07	732.2
5.4	607.2	6.05	693.90	729.00	734.7
5.5	610.6	6.15	699.38	731.40	736.5
5.6	658.5	6.25	703.34	733.20	737.7
5.7	706.9	6.35	706.41	734.40	737.8
5.8	718.2	6.45	708.95	734.80	737.4
5.9	723.6	6.55	710.87	734.43	736.6
6.0	725.5	6.65	712.28	733.79	735.6
6.1	726.4	6.75	713.29	732.83	734.4
6.2	729.1	6.85	714.10	732.04	733.4
6.3	727.4	6.925	712.96	730.74	732.0
6.4	727.8	6.975	716.59	730.61	731.8
6.5	728.9				
6.6	727.2				
6.7	724.3				
6.8	722.7				
6.9	721.5				
6.95	717.1				

RIT run 139

Inside wall temperatures, T (K) versus axial level, z (m)

Experiment		RELAP5-results			
			MOD3	MOD2	MOD2 mod.
z	T	z	T	T	T
0.05	611.3	0.375	623.19	615.94	616.0
0.25	610.9	1.000	623.68	616.04	616.0
0.50	611.1	1.500	623.81	616.61	616.6
0.75	609.1	2.000	623.61	617.18	617.2
1.00	610.1	2.500	623.10	617.77	617.8
1.25	609.9	2.875	622.54	617.99	943.3
1.50	609.4	3.05	622.30	618.06	958.0
1.75	610.2	3.15	737.37	618.17	978.0
2.00	609.3	3.25	748.77	618.29	996.5
2.25	609.6	3.35	759.07	618.36	1013.
2.50	607.8	3.45	765.85	618.62	1024.
2.75	608.3	3.55	771.35	804.98	1024.
3.00	625.8	3.65	775.50	820.49	1010.
3.1	856.3	3.75	778.66	832.22	983.8
3.2	885.8	3.85	780.72	833.86	948.6
3.3	884.5	3.95	781.89	834.88	921.8
3.4	881.6	4.05	782.31	834.43	901.4
3.5	886.1	4.15	782.11	832.35	884.4
3.6	885.4	4.25	781.43	829.42	870.2
3.7	901.1	4.35	780.38	825.97	858.1
3.8	897.4	4.45	779.08	822.15	847.6
3.9	899.8	4.55	777.62	818.09	838.2
4.0	895.5	4.65	776.05	813.90	830.0
4.1	891.2	4.75	774.42	809.65	822.5
4.2	886.7	4.85	772.76	805.41	815.8
4.3	881.3	4.95	771.10	801.23	809.6
4.4	873.3	5.05	769.45	797.14	804.0
4.5	-	5.15	767.82	793.15	798.8
4.6	855.3	5.25	766.21	789.29	793.9
4.7	848.1	5.35	764.64	785.56	789.4
4.8	838.6	5.45	763.11	781.97	785.1
4.9	828.0	5.55	761.61	778.52	781.1
5.0	818.3	5.65	760.16	775.21	777.4
5.1	809.7	5.75	758.74	772.03	773.8
5.2	800.8	5.85	757.37	769.00	770.5
5.3	793.3	5.95	756.04	766.09	767.4
5.4	-	6.05	754.74	763.31	764.4
5.5	775.5	6.15	753.49	760.66	761.6
5.6	768.5	6.25	752.28	758.12	758.9
5.7	759.9	6.35	751.10	755.69	756.4
5.8	751.2	6.45	749.97	753.38	754.0
5.9	744.5	6.55	748.87	751.16	751.6
6.0	738.5	6.65	747.81	749.08	749.5
6.1	730.2	6.75	746.77	746.94	747.3
6.2	726.9	6.85	745.88	745.39	745.7
6.3	720.2	6.925	743.68	743.39	743.7
6.4	717.0	6.975	746.96	743.66	744.0
6.5	715.1				
6.6	710.3				
6.7	705.5				
6.8	702.6				
6.9	698.4				
6.95	693.3				

RIT run 147

Inside wall temperatures, T (K) versus axial level,z (m)

Experiment		RELAP5-results			
			MOD3	MOD2	MOD2 mod.
z	T	z	T	T	T
0.05	611.0	0.375	622.32	615.80	615.8
0.25	611.3	1.000	623.03	616.18	616.2
0.50	611.5	1.500	623.26	616.90	616.9
0.75	609.5	2.000	623.15	617.65	617.6
1.00	610.5	2.500	622.85	618.60	618.6
1.25	610.3	2.875	622.52	619.27	889.5
1.50	609.8	3.05	744.40	619.58	894.6
1.75	610.6	3.15	755.32	810.11	893.4
2.00	610.4	3.25	765.34	823.26	890.8
2.25	610.0	3.35	771.30	835.51	887.3
2.50	608.2	3.45	776.39	840.79	882.4
2.75	610.0	3.55	780.22	843.67	876.8
3.00	815.3	3.65	783.49	844.34	870.8
3.1	894.5	3.75	786.10	843.31	864.6
3.2	913.6	3.85	788.07	841.30	858.3
3.3	906.7	3.95	789.45	838.53	852.1
3.4	902.7	4.05	790.20	835.20	846.1
3.5	906.5	4.15	790.37	831.42	840.2
3.6	899.7	4.25	790.07	827.41	834.5
3.7	911.8	4.35	789.41	823.29	829.0
3.8	905.5	4.45	788.47	819.15	823.8
3.9	904.3	4.55	787.32	815.03	818.9
4.0	899.4	4.65	786.02	810.99	814.1
4.1	894.5	4.75	784.63	807.04	809.6
4.2	889.4	4.85	783.19	803.22	805.4
4.3	882.8	4.95	781.72	799.53	801.3
4.4	875.4	5.05	780.25	795.99	797.5
4.5	-	5.15	778.79	792.60	793.8
4.6	858.1	5.25	777.35	789.36	790.4
4.7	851.5	5.35	775.94	786.26	787.2
4.8	842.1	5.45	774.57	783.32	784.1
4.9	832.7	5.55	773.23	780.52	781.2
5.0	823.6	5.65	771.94	777.85	778.4
5.1	816.8	5.75	770.69	775.33	775.8
5.2	808.6	5.85	769.49	772.93	773.3
5.3	801.8	5.95	768.33	770.66	771.0
5.4	-	6.05	767.22	768.51	768.8
5.5	785.8	6.15	766.17	766.49	766.8
5.6	779.4	6.25	765.17	764.57	764.8
5.7	771.5	6.35	764.22	762.76	763.0
5.8	762.8	6.45	763.31	761.07	761.2
5.9	756.8	6.55	762.45	759.45	759.6
6.0	745.9	6.65	761.64	757.99	758.1
6.1	742.5	6.75	760.87	756.47	756.6
6.2	739.8	6.85	760.08	755.54	755.7
6.3	733.1	6.925	759.12	753.77	753.9
6.4	730.5	6.975	760.51	754.47	754.6
6.5	727.4				
6.6	723.2				
6.7	719.7				
6.8	716.2				
6.9	712.6				
6.95	706.9				

RIT run 154

Inside wall temperatures, T (K) versus axial level,z (m)

Experiment		RELAP5-results			
			MOD3	MOD2	MOD2 mod.
z	T	z	T	T	T
0.05	611.7	0.375	619.57	615.00	615.0
0.25	611.3	1.000	620.45	615.59	615.6
0.50	611.6	1.500	621.11	616.37	616.4
0.75	610.2	2.000	621.15	617.52	617.5
1.00	611.1	2.500	621.02	619.19	619.0
1.25	610.3	2.875	620.87	619.87	619.7
1.50	609.8	3.05	620.79	793.39	792.2
1.75	611.3	3.15	620.75	805.51	805.1
2.00	610.4	3.25	736.24	817.64	817.3
2.25	610.6	3.35	745.25	823.84	823.6
2.50	608.9	3.45	753.44	827.95	827.8
2.75	608.8	3.55	758.58	829.80	829.7
3.00	608.9	3.65	761.68	830.34	830.3
3.1	608.2	3.75	764.03	829.91	829.9
3.2	673.5	3.85	765.68	828.57	828.6
3.3	774.4	3.95	766.97	826.64	826.7
3.4	812.7	4.05	768.23	824.34	824.4
3.5	831.6	4.15	769.57	821.76	821.8
3.6	-	4.25	770.91	819.02	819.1
3.7	846.4	4.35	772.29	816.17	816.2
3.8	856.6	4.45	773.72	813.26	813.3
3.9	868.7	4.55	775.12	810.35	810.4
4.0	877.2	4.65	776.39	807.49	807.6
4.1	882.1	4.75	777.50	804.71	804.8
4.2	884.8	4.85	778.43	802.01	802.1
4.3	886.2	4.95	779.14	799.42	799.5
4.4	883.8	5.05	779.63	796.94	797.0
4.5	-	5.15	779.90	794.58	794.6
4.6	875.0	5.25	779.99	792.33	792.4
4.7	870.3	5.35	779.94	790.19	790.2
4.8	862.8	5.45	779.77	788.18	788.2
4.9	855.9	5.55	779.50	786.29	786.3
5.0	848.6	5.65	779.17	784.51	784.6
5.1	843.1	5.75	778.81	782.85	782.9
5.2	836.8	5.85	778.42	781.30	781.3
5.3	831.2	5.95	778.02	779.86	779.9
5.4	-	6.05	777.63	778.53	778.6
5.5	817.8	6.15	777.25	777.32	777.4
5.6	812.7	6.25	776.90	776.21	776.2
5.7	806.7	6.35	776.59	775.21	775.2
5.8	799.3	6.45	776.31	774.31	774.3
5.9	793.8	6.55	776.07	773.50	773.5
6.0	784.3	6.65	775.89	772.85	772.9
6.1	782.1	6.75	775.75	772.13	772.2
6.2	778.9	6.85	775.76	772.04	772.0
6.3	772.2	6.925	774.04	770.63	770.6
6.4	769.7	6.975	778.38	771.72	771.7
6.5	766.5				
6.6	762.4				
6.7	758.3				
6.8	754.2				
6.9	751.2				
6.95	745.6				

RIT run 161

Inside wall temperatures, T (K) versus axial level, z (m)

Experiment

z	T
0.05	611.2
0.25	611.5
0.50	611.7
0.75	610.4
1.00	611.9
1.25	611.1
1.50	610.6
1.75	611.4
2.00	611.2
2.25	611.4
2.50	612.8
2.75	613.2
3.00	630.4
3.1	796.2
3.2	817.9
3.3	832.2
3.4	845.0
3.5	854.1
3.6	-
3.7	869.5
3.8	871.2
3.9	877.8
4.0	882.0
4.1	884.4
4.2	887.2
4.3	890.3
4.4	891.5
4.5	-
4.6	894.9
4.7	897.4
4.8	897.8
4.9	897.5
5.0	897.5
5.1	898.7
5.2	897.8
5.3	898.9
5.4	-
5.5	895.7
5.6	896.1
5.7	894.9
5.8	893.0
5.9	891.2
6.0	893.1
6.1	888.5
6.2	888.9
6.3	885.9
6.4	887.6
6.5	886.8
6.6	886.9
6.7	887.7
6.8	887.2
6.9	889.1
6.95	883.5

RELAP5-results

	MOD3 lbf=1.0	MOD3 lbf=0.75	MOD2	MOD2 mod.
z	T	T	T	T
0.375	616.82	616.82	614.55	614.6
1.000	617.79	617.79	615.34	615.3
1.500	618.49	618.49	616.64	616.6
2.000	618.89	618.89	618.81	618.8
2.500	619.08	619.08	619.07	619.1
2.875	619.09	619.09	619.10	803.6
3.05	619.07	742.08	619.09	808.6
3.15	619.06	753.58	619.08	817.5
3.25	619.05	764.21	619.07	824.3
3.35	734.40	771.24	619.06	829.7
3.45	744.44	776.92	619.05	833.9
3.55	754.85	781.60	619.04	837.0
3.65	761.38	785.36	732.22	839.4
3.75	766.90	788.44	743.44	841.2
3.85	771.15	790.77	755.80	842.4
3.95	774.53	792.42	765.03	843.2
4.05	777.17	793.42	773.27	843.7
4.15	779.09	793.97	780.58	844.0
4.25	780.34	793.97	787.21	844.2
4.35	781.05	793.55	793.24	844.3
4.45	781.39	792.85	798.76	844.3
4.55	781.52	792.05	803.81	844.4
4.65	781.61	791.29	808.40	844.5
4.75	781.77	790.74	812.60	844.7
4.85	782.17	790.53	816.45	844.9
4.95	782.88	790.74	820.00	845.1
5.05	784.00	791.45	823.30	845.5
5.15	785.59	792.73	826.39	846.1
5.25	787.68	794.61	829.34	846.8
5.35	790.32	797.11	832.10	847.6
5.45	793.51	800.25	834.77	848.7
5.55	797.26	804.08	837.43	849.9
5.65	801.61	808.54	840.12	851.2
5.75	806.48	813.82	842.85	852.6
5.85	812.06	819.66	845.56	854.1
5.95	818.11	825.16	848.22	855.8
6.05	823.84	830.42	850.91	857.7
6.15	829.37	835.61	853.72	859.8
6.25	834.83	840.75	856.64	862.1
6.35	840.24	845.85	859.69	864.6
6.45	845.63	850.93	862.90	867.3
6.55	851.01	855.90	866.25	870.2
6.65	856.23	860.77	869.76	873.2
6.75	861.38	865.61	873.15	876.1
6.85	866.58	870.53	876.98	879.7
6.925	867.87	871.66	877.53	880.0
6.975	871.77	874.54	880.25	882.6

RIT run 220

Inside wall temperatures, T (K) versus axial level,z (m)

Experiment z	Experiment T	RELAP5/MOD3 z	RELAP5/MOD3 T
0.05	588.1	0.375	595.79
0.25	588.3	1.000	596.55
0.50	588.6	1.500	596.69
0.75	587.8	2.000	596.46
1.00	588.8	2.500	596.05
1.25	588.5	2.875	595.69
1.50	588.1	3.05	595.52
1.75	588.3	3.15	595.42
2.00	588.0	3.25	595.32
2.25	588.7	3.35	595.21
2.50	589.0	3.45	595.11
2.75	588.9	3.55	595.00
3.00	589.0	3.65	594.87
3.1	587.0	3.75	594.75
3.2	587.7	3.85	594.63
3.3	587.6	3.95	594.52
3.4	586.6	4.05	594.41
3.5	587.4	4.15	594.30
3.6	587.3	4.25	594.19
3.7	589.0	4.35	594.09
3.8	587.6	4.45	593.98
3.9	587.6	4.55	593.88
4.0	587.6	4.65	593.79
4.1	588.3	4.75	593.69
4.2	588.0	4.85	593.60
4.3	588.1	4.95	593.50
4.4	588.1	5.05	593.41
4.5	587.9	5.15	593.32
4.6	588.5	5.25	593.24
4.7	588.6	5.35	593.15
4.8	588.3	5.45	593.07
4.9	588.1	5.55	592.99
5.0	588.1	5.65	592.90
5.1	588.7	5.75	592.82
5.2	587.8	5.85	592.75
5.3	588.2	5.95	592.67
5.4	587.2	6.05	592.59
5.5	588.1	6.15	592.52
5.6	588.5	6.25	592.44
5.7	588.5	6.35	592.37
5.8	588.4	6.45	592.30
5.9	587.8	6.55	592.23
6.0	588.5	6.65	592.16
6.1	588.7	6.75	592.09
6.2	589.1	6.85	592.03
6.3	589.1	6.925	591.98
6.4	589.6	6.975	591.95
6.5	589.5		
6.6	589.6		
6.7	589.7		
6.8	589.9		
6.9	589.9		
6.95	588.5		

RIT run 221

Inside wall temperatures, T (K) versus axial level, z (m)

Experiment		RELAP5-results	MOD3	MOD2	MOD2 mod.
z	T	z	T	T	T
0.05	589.1	0.375	598.54	591.39	591.4
0.25	589.3	1.000	599.13	591.69	591.7
0.50	589.6	1.500	599.12	592.38	592.4
0.75	588.2	2.000	598.71	593.01	593.0
1.00	589.1	2.500	598.12	593.59	593.6
1.25	588.9	2.875	597.57	593.77	593.8
1.50	587.8	3.05	597.28	593.79	593.8
1.75	588.6	3.15	597.11	593.88	593.9
2.00	588.4	3.25	596.96	593.97	594.0
2.25	588.0	3.35	596.80	594.14	594.2
2.50	589.4	3.45	596.66	594.35	594.4
2.75	589.9	3.55	596.51	594.55	594.5
3.00	589.3	3.65	596.37	594.77	594.7
3.1	586.7	3.75	596.24	594.97	594.8
3.2	587.5	3.85	596.10	595.12	594.9
3.3	587.4	3.95	595.97	595.24	595.0
3.4	587.0	4.05	595.85	595.36	596.1
3.5	587.1	4.15	595.72	595.48	596.2
3.6	587.6	4.25	595.60	595.59	595.3
3.7	589.3	4.35	595.49	595.63	595.4
3.8	587.4	4.45	595.37	595.52	595.5
3.9	587.4	4.55	595.26	595.40	595.4
4.0	588.0	4.65	595.15	595.30	595.3
4.1	589.2	4.75	595.04	595.19	595.2
4.2	588.4	4.85	594.94	595.08	595.1
4.3	588.5	4.95	594.83	594.98	595.0
4.4	589.1	5.05	594.73	594.88	594.9
4.5	588.8	5.15	594.63	594.78	594.8
4.6	588.8	5.25	594.54	594.68	594.7
4.7	589.0	5.35	594.45	594.59	594.6
4.8	589.3	5.45	594.36	594.50	594.5
4.9	588.5	5.55	594.27	594.40	758.4
5.0	589.1	5.65	594.19	594.31	765.5
5.1	589.1	5.75	594.10	594.22	770.5
5.2	586.9	5.85	594.02	594.14	774.0
5.3	584.3	5.95	714.36	594.05	776.0
5.4	581.3	6.05	721.47	593.97	776.9
5.5	584.8	6.15	727.51	593.88	777.1
5.6	589.5	6.25	732.35	593.80	776.6
5.7	635.7	6.35	736.18	593.72	775.6
5.8	695.4	6.45	739.03	593.64	774.2
5.9	745.8	6.55	741.09	593.56	772.5
6.0	753.3	6.65	742.47	593.49	770.7
6.1	762.6	6.75	743.25	593.41	768.5
6.2	769.7	6.85	743.75	593.34	767.0
6.3	770.3	6.925	741.86	593.27	764.5
6.4	771.4	6.975	746.85	593.24	764.6
6.5	773.1				
6.6	772.0				
6.7	767.9				
6.8	768.0				
6.9	768.7				
6.95	761.2				

RIT run 224

Inside wall temperatures, T (K) versus axial level,z (m)

Experiment z	Experiment T	RELAP5-results z	MOD3 T	MOD2 T	MOD2 mod. T
0.05	589.3	0.375	601.52	592.77	592.8
0.25	589.6	1.000	602.06	593.53	593.6
0.50	589.8	1.500	601.92	594.55	594.6
0.75	587.8	2.000	601.30	595.58	595.6
1.00	588.8	2.500	600.27	596.81	596.8
1.25	588.5	2.875	599.46	597.55	597.3
1.50	588.1	3.05	599.12	597.66	597.4
1.75	588.9	3.15	598.94	597.89	597.6
2.00	588.0	3.25	598.76	598.11	597.8
2.25	588.3	3.35	598.59	598.34	598.0
2.50	589.6	3.45	598.42	598.55	598.3
2.75	590.1	3.55	598.26	598.39	598.4
3.00	589.0	3.65	598.10	598.23	598.2
3.1	585.1	3.75	597.95	598.08	598.1
3.2	586.5	3.85	597.80	597.93	598.0
3.3	587.0	3.95	775.82	597.79	597.8
3.4	586.0	4.05	787.28	597.64	597.7
3.5	586.7	4.15	796.20	597.51	597.5
3.6	587.3	4.25	802.60	597.37	826.8
3.7	589.0	4.35	806.75	597.24	837.5
3.8	587.0	4.45	809.11	597.11	844.6
3.9	587.0	4.55	810.12	596.99	848.7
4.0	587.6	4.65	810.07	596.86	850.5
4.1	585.1	4.75	809.30	596.75	850.7
4.2	584.2	4.85	808.02	596.63	849.6
4.3	603.7	4.95	806.40	596.52	847.6
4.4	729.4	5.05	804.56	596.40	844.8
4.5	825.1	5.15	802.57	596.30	841.5
4.6	849.7	5.25	800.50	596.18	837.9
4.7	857.8	5.35	798.40	596.09	834.2
4.8	862.5	5.45	796.28	595.97	830.4
4.9	861.1	5.55	794.18	595.89	826.5
5.0	861.1	5.65	792.10	595.76	822.6
5.1	861.0	5.75	790.06	752.13	818.9
5.2	857.6	5.85	788.07	759.42	815.1
5.3	855.6	5.95	786.12	765.32	811.5
5.4	-	6.05	784.23	769.75	808.0
5.5	846.9	6.15	782.39	772.92	804.6
5.6	841.7	6.25	780.61	775.10	801.3
5.7	836.2	6.35	778.88	776.46	798.1
5.8	828.1	6.45	777.20	777.13	795.1
5.9	821.9	6.55	775.57	777.24	792.1
6.0	812.2	6.65	773.99	777.02	789.4
6.1	808.2	6.75	772.45	776.24	786.5
6.2	804.8	6.85	771.15	775.90	784.5
6.3	798.1	6.925	767.87	773.81	781.5
6.4	794.9	6.975	767.56	774.78	782.0
6.5	789.9				
6.6	785.0				
6.7	777.2				
6.8	773.6				
6.9	768.1				
6.95	758.1				

RIT run 232

Inside wall temperatures, T (K) versus axial level,z (m)

Experiment		RELAP5-results	MOD3	MOD2	MOD2 mod.
z	T	z	T	T	T
0.05	588.6	0.375	599.53	592.19	592.2
0.25	588.8	1.000	600.51	593.30	593.3
0.50	589.1	1.500	600.49	594.47	594.5
0.75	587.1	2.000	600.04	596.05	596.0
1.00	588.7	2.500	599.41	598.29	597.9
1.25	587.8	2.875	598.80	598.91	598.6
1.50	587.3	3.05	598.50	598.59	598.6
1.75	588.2	3.15	598.33	598.42	598.4
2.00	587.9	3.25	598.17	598.26	598.3
2.25	588.2	3.35	598.02	598.11	598.1
2.50	589.5	3.45	597.87	597.96	598.0
2.75	589.4	3.55	597.72	597.81	597.8
3.00	588.3	3.65	597.58	597.67	597.7
3.1	584.4	3.75	597.45	597.53	597.6
3.2	585.8	3.85	597.31	597.40	597.4
3.3	585.6	3.95	597.18	597.27	597.3
3.4	584.0	4.05	597.06	597.15	597.2
3.5	581.0	4.15	596.93	597.02	813.7
3.6	579.7	4.25	763.63	596.90	825.4
3.7	582.0	4.35	774.30	596.79	833.9
3.8	581.3	4.45	783.15	596.67	839.7
3.9	581.9	4.55	790.20	596.56	843.2
4.0	582.5	4.65	795.53	596.46	844.0
4.1	584.4	4.75	799.31	596.35	845.4
4.2	592.2	4.85	801.78	596.25	844.6
4.3	657.8	4.95	803.24	596.15	843.2
4.4	824.7	5.05	803.94	596.05	841.2
4.5	833.0	5.15	803.97	595.96	838.8
4.6	854.4	5.25	803.54	595.87	836.0
4.7	861.9	5.35	802.77	595.78	833.1
4.8	868.4	5.45	801.76	595.69	830.1
4.9	868.1	5.55	800.58	595.61	827.0
5.0	868.8	5.65	799.28	595.52	824.0
5.1	869.3	5.75	797.90	595.44	820.9
5.2	867.2	5.85	796.47	595.36	818.0
5.3	865.8	5.95	795.03	595.29	815.1
5.4	858.3	6.05	793.61	595.20	812.3
5.5	853.8	6.15	792.20	595.15	809.6
5.6	848.3	6.25	790.81	595.05	806.9
5.7	841.3	6.35	789.46	724.77	804.4
5.8	836.6	6.45	788.16	732.01	802.0
5.9	827.5	6.55	786.90	738.38	799.7
6.0	823.5	6.65	785.69	743.89	797.6
6.1	820.2	6.75	784.52	748.49	795.2
6.2	814.7	6.85	783.56	752.72	793.8
6.3	811.5	6.925	780.70	753.35	791.1
6.4	807.7	6.975	786.16	755.79	792.0
6.5	802.9				
6.6	796.3				
6.7	792.2				
6.8	786.8				
6.9	776.8				
6.95					

RIT run 238

Inside wall temperatures, T (K) versus axial level,z (m)

Experiment		RELAP5-results	MOD3	MOD2	MOD2 mod.
z	T	z	T	T	T
0.05	588.4	0.375	595.81	591.00	591.0
0.25	588.7	1.000	596.83	592.00	592.0
0.50	588.9	1.500	597.54	593.18	593.2
0.75	587.5	2.000	597.49	594.74	594.7
1.00	588.5	2.500	597.18	596.98	596.6
1.25	588.3	2.875	596.89	596.94	597.0
1.50	587.8	3.05	596.75	596.79	596.8
1.75	588.0	3.15	596.67	596.71	596.7
2.00	588.4	3.25	596.59	596.63	596.7
2.25	588.0	3.35	596.51	596.55	596.6
2.50	589.3	3.45	596.43	596.48	596.5
2.75	589.2	3.55	596.35	596.40	596.4
3.00	588.7	3.65	596.27	596.32	596.3
3.1	584.9	3.75	596.19	596.24	596.3
3.2	585.6	3.85	596.12	596.17	596.2
3.3	583.6	3.95	596.04	596.09	596.1
3.4	582.7	4.05	595.97	596.02	596.0
3.5	582.2	4.15	595.89	595.94	596.0
3.6	-	4.25	595.82	595.87	595.9
3.7	583.1	4.35	595.74	595.80	595.8
3.8	583.0	4.45	595.67	595.73	595.8
3.9	583.6	4.55	595.58	595.64	595.7
4.0	583.6	4.65	595.49	595.55	595.6
4.1	584.3	4.75	595.41	595.47	595.5
4.2	584.0	4.85	595.32	595.38	760.3
4.3	584.1	4.95	595.24	595.31	770.7
4.4	584.8	5.05	595.17	595.23	779.4
4.5	583.9	5.15	595.09	595.15	786.5
4.6	583.9	5.25	595.02	595.08	792.1
4.7	584.0	5.35	594.95	595.01	796.6
4.8	586.8	5.45	594.88	594.94	799.9
4.9	704.3	5.55	723.70	594.88	802.3
5.0	783.5	5.65	731.70	594.81	804.0
5.1	801.0	5.75	739.14	594.75	805.1
5.2	812.2	5.85	745.98	594.69	805.7
5.3	821.1	5.95	752.13	594.64	805.9
5.4	-	6.05	757.59	594.58	805.8
5.5	831.9	6.15	762.36	594.53	805.5
5.6	837.1	6.25	766.45	594.48	805.0
5.7	837.7	6.35	769.95	594.43	804.4
5.8	837.6	6.45	772.91	594.38	803.6
5.9	838.2	6.55	775.40	594.34	802.8
6.0	834.7	6.65	777.48	594.30	802.0
6.1	836.1	6.75	779.24	594.26	800.9
6.2	837.1	6.85	780.85	594.23	800.6
6.3	835.3	6.925	779.58	594.18	798.5
6.4	834.6	6.975	785.37	594.17	799.7
6.5	833.8				
6.6	832.1				
6.7	828.6				
6.8	825.7				
6.9	824.1				
6.95	815.9				

RIT run 244

Inside wall temperatures, T (K) versus axial level, z (m)

Experiment		RELAP5-results	MOD3	MOD2	MOD2 mod.
z	T	z	T	T	T
0.05	589.1	0.375	592.46	590.24	590.2
0.25	589.4	1.000	593.62	591.45	591.5
0.50	589.6	1.500	594.34	592.97	593.1
0.75	588.9	2.000	594.66	594.68	594.7
1.00	589.2	2.500	594.76	594.78	594.8
1.25	588.4	2.875	594.71	594.74	594.8
1.50	587.3	3.05	594.65	594.68	594.7
1.75	587.5	3.15	594.62	594.65	594.7
2.00	587.9	3.25	594.59	594.62	594.6
2.25	588.1	3.35	594.56	594.59	594.6
2.50	588.8	3.45	594.53	594.55	594.6
2.75	588.7	3.55	594.49	594.52	594.5
3.00	588.8	3.65	594.46	594.49	594.5
3.1	585.0	3.75	594.43	594.46	594.5
3.2	584.5	3.85	594.40	594.43	594.4
3.3	584.4	3.95	594.37	594.40	594.4
3.4	583.4	4.05	594.34	594.38	594.4
3.5	583.5	4.15	594.31	594.35	594.4
3.6	578.5	4.25	594.29	594.32	594.3
3.7	583.9	4.35	594.26	594.30	594.3
3.8	583.8	4.45	594.24	594.28	594.3
3.9	583.8	4.55	594.21	594.25	594.3
4.0	585.0	4.65	594.19	594.23	594.2
4.1	584.4	4.75	594.17	594.22	594.2
4.2	584.8	4.85	594.16	594.20	594.2
4.3	584.9	4.95	594.14	594.19	594.2
4.4	584.9	5.05	594.13	594.18	731.5
4.5	584.0	5.15	594.12	594.17	742.9
4.6	584.0	5.25	594.12	594.16	753.8
4.7	584.1	5.35	594.11	594.17	764.3
4.8	584.5	5.45	594.12	594.17	774.3
4.9	584.3	5.55	594.12	594.18	783.8
5.0	584.9	5.65	594.14	594.19	792.8
5.1	685.0	5.75	594.16	712.79	801.3
5.2	747.6	5.85	710.69	722.55	809.3
5.3	767.9	5.95	717.39	732.20	816.8
5.4	775.9	6.05	723.64	741.76	823.8
5.5	793.6	6.15	729.69	751.20	830.4
5.6	804.8	6.25	735.71	760.51	836.5
5.7	812.0	6.35	741.78	769.65	842.3
5.8	818.4	6.45	747.95	778.62	847.7
5.9	825.6	6.55	754.30	787.38	852.8
6.0	831.2	6.65	760.89	795.94	857.7
6.1	835.0	6.75	767.73	804.19	862.1
6.2	842.6	6.85	774.84	812.40	866.9
6.3	846.8	6.925	778.16	815.29	867.6
6.4	852.1	6.975	782.60	819.50	870.7
6.5	856.7				
6.6	861.6				
6.7	866.0				
6.8	869.1				
6.9	872.2				
6.95	867.2				

RIT run 259

Inside wall temperatures, T (K) versus axial level,z (m)

Experiment		RELAP5-results	MOD3	MOD2	MOD2 mod.
z	T	z	T	T	T
0.05	566.7	0.375	578.75	569.76	569.8
0.25	567.6	1.000	579.20	571.22	571.3
0.50	567.9	1.500	578.59	572.66	572.7
0.75	565.2	2.000	577.48	574.32	574.2
1.00	566.2	2.500	576.04	576.15	575.7
1.25	565.3	2.875	575.06	575.39	575.4
1.50	564.8	3.05	574.65	574.94	575.0
1.75	565.7	3.15	574.42	574.71	574.7
2.00	564.8	3.25	574.20	574.49	574.5
2.25	565.0	3.35	573.99	574.27	574.3
2.50	567.0	3.45	573.78	574.07	574.1
2.75	566.9	3.55	573.58	573.87	573.9
3.00	566.4	3.65	573.39	573.68	573.7
3.1	563.1	3.75	573.20	573.49	573.5
3.2	563.9	3.85	573.01	573.30	573.3
3.3	564.4	3.95	572.83	573.12	573.2
3.4	562.7	4.05	572.66	572.95	573.0
3.5	562.2	4.15	572.49	572.77	572.8
3.6	563.4	4.25	572.33	572.61	572.6
3.7	563.9	4.35	572.17	572.44	572.5
3.8	562.5	4.45	572.01	572.28	572.3
3.9	562.5	4.55	571.85	572.12	572.2
4.0	562.5	4.65	571.70	571.97	572.0
4.1	560.0	4.75	571.55	571.82	571.8
4.2	559.7	4.85	571.40	571.67	571.7
4.3	558.6	4.95	571.25	571.52	571.6
4.4	558.6	5.05	571.11	571.38	571.4
4.5	559.0	5.15	570.97	571.24	571.3
4.6	557.7	5.25	570.83	571.10	571.1
4.7	557.8	5.35	570.69	570.96	571.0
4.8	558.2	5.45	570.55	570.83	570.9
4.9	558.6	5.55	570.42	570.70	570.7
5.0	558.6	5.65	570.29	570.57	570.6
5.1	559.2	5.75	570.16	570.44	570.5
5.2	558.8	5.85	570.03	570.31	570.3
5.3	558.7	5.95	569.90	570.18	570.2
5.4	557.0	6.05	569.78	570.06	778.1
5.5	557.3	6.15	569.65	569.94	786.5
5.6	557.1	6.25	569.53	569.82	792.8
5.7	557.1	6.35	569.41	569.70	797.1
5.8	556.9	6.45	569.29	569.58	799.8
5.9	558.2	6.55	569.17	569.46	801.4
6.0	561.4	6.65	569.05	569.35	802.2
6.1	573.1	6.75	568.94	569.23	802.0
6.2	580.3	6.85	725.46	569.13	802.1
6.3	624.6	6.925	728.69	569.02	799.5
6.4	755.0	6.975	733.51	568.98	800.8
6.5	772.1				
6.6	778.4				
6.7	779.8				
6.8	785.4				
6.9	786.7				
6.95	779.8				

RIT run 261

Inside wall temperatures, T (K) versus axial level,z (m)

Experiment		RELAP5-results			
			MOD3	MOD2	MOD2 mod.
z	T	z	T	T	T
0.05	567.9	0.375	581.83	571.87	571.9
0.25	568.8	1.000	582.27	573.80	573.9
0.50	569.1	1.500	581.40	576.14	576.1
0.75	565.7	2.000	579.79	579.17	578.6
1.00	566.7	2.500	578.06	578.52	578.6
1.25	565.8	2.875	577.00	577.37	577.4
1.50	565.4	3.05	576.55	576.87	576.9
1.75	566.2	3.15	576.30	576.61	576.7
2.00	565.3	3.25	576.06	576.37	576.4
2.25	565.6	3.35	575.83	576.14	576.2
2.50	568.2	3.45	575.61	575.92	576.0
2.75	568.1	3.55	575.40	575.70	575.8
3.00	566.9	3.65	575.19	575.49	575.6
3.1	563.0	3.75	574.99	575.28	575.4
3.2	564.4	3.85	574.79	575.08	575.2
3.3	564.9	3.95	574.60	574.89	575.0
3.4	562.6	4.05	574.41	574.69	574.8
3.5	562.1	4.15	574.22	574.51	574.6
3.6	563.9	4.25	574.04	574.33	574.4
3.7	564.4	4.35	573.86	574.15	574.2
3.8	563.0	4.45	573.69	573.97	574.0
3.9	563.0	4.55	573.52	573.80	573.9
4.0	562.4	4.65	573.35	573.64	859.7
4.1	559.8	4.75	573.19	573.47	871.9
4.2	559.6	4.85	573.03	573.31	879.8
4.3	557.8	4.95	572.87	573.15	884.6
4.4	558.4	5.05	572.71	573.00	887.1
4.5	556.9	5.15	572.56	572.85	887.5
4.6	558.8	5.25	774.22	572.70	886.5
4.7	577.3	5.35	784.19	572.55	884.6
4.8	595.9	5.45	792.10	572.41	882.0
4.9	734.5	5.55	798.34	572.27	878.9
5.0	845.2	5.65	802.76	572.13	875.6
5.1	859.4	5.75	805.87	571.99	872.0
5.2	867.2	5.85	807.90	571.85	868.3
5.3	872.7	5.95	809.04	571.73	864.6
5.4	-	6.05	809.45	571.58	860.8
5.5	873.8	6.15	809.34	571.47	857.1
5.6	872.9	6.25	808.84	571.31	853.5
5.7	868.6	6.35	808.05	771.25	849.9
5.8	862.8	6.45	807.04	780.12	846.4
5.9	857.2	6.55	805.89	787.55	843.0
6.0	854.1	6.65	804.65	793.31	839.9
6.1	845.0	6.75	803.34	797.60	836.5
6.2	843.1	6.85	802.18	801.50	834.3
6.3	836.9	6.925	798.84	800.93	830.4
6.4	833.0	6.975	805.18	803.64	831.4
6.5	829.1				
6.6	823.0				
6.7	813.2				
6.8	812.1				
6.9	806.0				
6.95	794.0				

RIT run 264

Inside wall temperatures, T (K) versus axial level, z (m)

Experiment		RELAP5-results	MOD3	MOD2	MOD2 mod.
z	T	z	T	T	T
0.05	567.0	0.375	576.43	569.20	569.2
0.25	567.9	1.000	577.51	570.84	570.9
0.50	568.1	1.500	577.19	572.70	572.7
0.75	566.1	2.000	576.35	575.19	574.8
1.00	566.4	2.500	575.39	575.64	575.7
1.25	566.2	2.875	574.56	574.79	574.8
1.50	565.1	3.05	574.18	574.37	574.4
1.75	565.9	3.15	573.97	574.16	574.2
2.00	565.1	3.25	573.77	573.96	574.0
2.25	565.3	3.35	573.58	573.76	573.8
2.50	567.3	3.45	573.39	573.57	573.6
2.75	567.2	3.55	573.21	573.39	573.4
3.00	566.7	3.65	573.03	573.21	573.2
3.1	563.4	3.75	572.86	573.04	573.1
3.2	564.8	3.85	572.69	572.87	572.9
3.3	564.7	3.95	572.52	572.71	572.7
3.4	563.7	4.05	572.36	572.55	572.6
3.5	562.5	4.15	572.21	572.40	572.4
3.6	564.3	4.25	572.06	572.24	572.3
3.7	564.2	4.35	571.91	572.10	572.1
3.8	562.8	4.45	571.76	571.95	572.0
3.9	562.8	4.55	571.62	571.81	571.8
4.0	560.9	4.65	571.49	571.67	571.7
4.1	560.3	4.75	571.35	571.54	571.6
4.2	560.0	4.85	571.23	571.41	571.4
4.3	558.9	4.95	571.10	571.28	571.3
4.4	559.5	5.05	570.97	571.15	571.2
4.5	559.9	5.15	570.85	571.03	571.0
4.6	559.3	5.25	570.73	570.91	570.9
4.7	560.0	5.35	570.61	570.79	570.8
4.8	560.4	5.45	570.49	570.67	570.7
4.9	560.1	5.55	570.37	570.56	570.6
5.0	559.5	5.65	570.26	570.45	570.5
5.1	559.5	5.75	570.15	570.34	570.4
5.2	559.1	5.85	570.04	570.23	570.2
5.3	559.0	5.95	569.93	570.12	570.1
5.4	558.5	6.05	569.82	570.02	768.6
5.5	558.9	6.15	569.72	569.91	778.1
5.6	558.6	6.25	569.62	569.82	785.8
5.7	558.6	6.35	569.52	569.71	791.6
5.8	558.5	6.45	569.42	569.62	796.1
5.9	559.1	6.55	569.32	569.52	799.5
6.0	562.3	6.65	569.22	569.43	801.8
6.1	589.5	6.75	569.13	569.33	803.0
6.2	684.8	6.85	569.04	569.25	804.5
6.3	760.0	6.925	568.96	569.16	802.7
6.4	775.8	6.975	716.81	569.13	804.6
6.5	786.7				
6.6	792.3				
6.7	794.3				
6.8	799.3				
6.9	801.2				
6.95	794.9				

RIT run 269

Inside wall temperatures, T (K) versus axial level,z (m)

Experiment z	Experiment T	RELAP5-results MOD3 z	RELAP5-results MOD3 T
0.05	566.4	0.375	572.50
0.25	566.7	1.000	573.69
0.50	567.5	1.500	574.18
0.75	565.5	2.000	573.76
1.00	565.9	2.500	573.17
1.25	565.6	2.875	572.71
1.50	565.2	3.05	572.49
1.75	565.4	3.15	572.37
2.00	565.1	3.25	572.25
2.25	565.4	3.35	572.13
2.50	567.3	3.45	572.02
2.75	567.2	3.55	571.90
3.00	567.3	3.65	571.79
3.1	564.1	3.75	571.68
3.2	564.8	3.85	571.56
3.3	565.4	3.95	571.46
3.4	563.7	4.05	571.35
3.5	562.6	4.15	571.24
3.6	564.4	4.25	571.12
3.7	564.2	4.35	571.00
3.8	562.9	4.45	570.88
3.9	562.9	4.55	570.77
4.0	561.6	4.65	570.66
4.1	661.0	4.75	570.55
4.2	560.8	4.85	570.45
4.3	560.9	4.95	570.35
4.4	561.5	5.05	570.25
4.5	561.9	5.15	570.15
4.6	561.2	5.25	570.05
4.7	561.4	5.35	569.96
4.8	561.1	5.45	569.87
4.9	562.1	5.55	569.78
5.0	561.5	5.65	569.70
5.1	562.1	5.75	569.61
5.2	561.1	5.85	569.53
5.3	561.6	5.95	569.45
5.4	561.8	6.05	569.38
5.5	562.1	6.15	569.30
5.6	560.6	6.25	569.23
5.7	561.9	6.35	569.16
5.8	561.8	6.45	569.10
5.9	561.8	6.55	569.03
6.0	563.0	6.65	568.97
6.1	561.5	6.75	568.91
6.2	561.9	6.85	568.85
6.3	563.1	6.925	568.80
6.4	563.6	6.975	568.77
6.5	561.6		
6.6	563.0		
6.7	563.1		
6.8	562.6		
6.9	559.6		
6.95	559.4		

RIT run 270

Inside wall temperatures, T (K) versus axial level, z (m)

Experiment		RELAP5-results			
			MOD3	MOD2	MOD2 mod.
z	T	z	T	T	T
0.05	566.2	0.375	573.98	569.10	569.1
0.25	567.1	1.000	575.48	571.07	571.1
0.50	567.3	1.500	575.84	573.65	573.7
0.75	565.9	2.000	575.28	575.46	575.5
1.00	566.3	2.500	574.58	574.79	574.8
1.25	565.4	2.875	574.06	574.21	574.2
1.50	564.9	3.05	573.81	573.95	574.0
1.75	565.8	3.15	573.68	573.81	573.8
2.00	565.5	3.25	573.54	573.68	573.7
2.25	565.1	3.35	573.41	573.55	573.6
2.50	567.1	3.45	573.28	573.42	573.4
2.75	567.0	3.55	573.16	573.29	573.3
3.00	567.1	3.65	573.01	573.15	573.2
3.1	563.9	3.75	572.86	573.00	573.0
3.2	564.6	3.85	572.71	572.86	572.9
3.3	565.1	3.95	572.57	572.72	572.8
3.4	563.5	4.05	572.44	572.58	572.6
3.5	563.0	4.15	572.31	572.45	572.5
3.6	564.2	4.25	572.18	572.33	572.4
3.7	564.0	4.35	572.06	572.20	572.2
3.8	562.6	4.45	571.94	572.08	572.1
3.9	563.3	4.55	571.82	571.97	572.0
4.0	561.4	4.65	571.71	571.85	571.9
4.1	560.8	4.75	571.60	571.75	571.8
4.2	560.5	4.85	571.49	571.64	571.7
4.3	560.0	4.95	571.39	571.54	571.6
4.4	560.0	5.05	571.29	571.44	571.5
4.5	561.0	5.15	571.19	571.34	571.4
4.6	560.4	5.25	571.10	571.25	571.3
4.7	560.5	5.35	571.01	571.16	571.2
4.8	560.3	5.45	570.93	571.07	571.1
4.9	560.6	5.55	570.85	570.99	571.0
5.0	560.6	5.65	570.77	570.90	570.9
5.1	560.0	5.75	570.69	570.83	570.8
5.2	559.6	5.85	570.61	570.75	763.5
5.3	560.1	5.95	570.54	570.68	775.2
5.4	559.0	6.05	570.47	570.61	785.5
5.5	559.4	6.15	570.41	570.54	794.6
5.6	559.1	6.25	570.34	570.48	802.4
5.7	559.8	6.35	570.28	570.42	809.0
5.8	559.6	6.45	570.22	570.36	814.8
5.9	568.4	6.55	570.17	570.31	819.6
6.0	735.0	6.65	570.12	570.26	823.7
6.1	768.8	6.75	570.07	570.21	826.9
6.2	786.9	6.85	570.03	570.18	830.4
6.3	798.4	6.925	569.99	570.11	829.6
6.4	808.1	6.975	569.98	570.11	832.3
6.5	816.4				
6.6	822.0				
6.7	825.2				
6.8	828.4				
6.9	830.3				
6.95	824.6				

RIT run 272

Inside wall temperatures, T (K) versus axial level,z (m)

Experiment		RELAP5-results			
			MOD3	MOD2	MOD2 mod.
z	T	z	T	T	T
0.05	567.6	0.375	576.22	571.21	571.2
0.25	567.8	1.000	578.21	574.52	574.6
0.50	568.1	1.500	578.12	578.38	578.4
0.75	566.1	2.000	577.35	577.65	577.7
1.00	567.0	2.500	576.50	576.83	576.9
1.25	566.1	2.875	575.88	576.16	576.2
1.50	565.0	3.05	575.53	575.77	575.8
1.75	565.9	3.15	575.34	575.58	575.6
2.00	565.6	3.25	575.15	575.39	575.4
2.25	565.3	3.35	574.98	575.22	575.3
2.50	567.9	3.45	574.81	575.04	575.1
2.75	567.8	3.55	574.64	574.88	574.9
3.00	567.2	3.65	574.48	574.72	574.8
3.1	564.0	3.75	574.33	574.57	574.6
3.2	564.7	3.85	574.18	574.42	574.5
3.3	565.2	3.95	574.04	574.28	574.3
3.4	563.0	4.05	573.91	574.15	574.2
3.5	562.5	4.15	573.78	574.02	574.1
3.6	564.3	4.25	573.65	573.89	573.9
3.7	564.7	4.35	573.54	573.77	573.8
3.8	562.7	4.45	573.42	573.66	573.7
3.9	563.3	4.55	573.32	573.55	833.6
4.0	560.8	4.65	573.22	573.45	850.9
4.1	560.2	4.75	573.12	573.35	865.6
4.2	559.9	4.85	573.02	573.25	877.7
4.3	559.5	4.95	572.93	573.16	887.7
4.4	558.8	5.05	572.85	573.08	895.7
4.5	559.2	5.15	572.77	573.00	901.9
4.6	571.1	5.25	572.70	572.94	906.8
4.7	788.1	5.35	572.63	572.86	910.5
4.8	843.7	5.45	572.57	572.82	913.3
4.9	863.7	5.55	572.52	572.74	915.3
5.0	880.3	5.65	572.47	776.76	916.7
5.1	891.9	5.75	572.43	790.54	917.8
5.2	899.6	5.85	572.40	803.34	918.4
5.3	906.9	5.95	572.38	815.14	918.8
5.4	-	6.05	572.97	825.89	919.1
5.5	911.7	6.15	574.43	835.68	919.2
5.6	912.1	6.25	576.17	844.51	919.2
5.7	910.8	6.35	578.29	852.44	919.2
5.8	908.2	6.45	580.83	859.58	919.2
5.9	905.8	6.55	735.07	866.00	919.1
6.0	907.0	6.65	744.16	871.88	919.3
6.1	901.8	6.75	753.05	877.03	919.1
6.2	901.6	6.85	762.04	882.36	920.1
6.3	899.1	6.925	766.18	882.56	917.8
6.4	899.0	6.975	771.10	886.16	920.0
6.5	897.1				
6.6	895.3				
6.7	892.3				
6.8	890.0				
6.9	885.8				
6.95	877.0				

RIT run 275

Inside wall temperatures, T (K) versus axial level,z (m)

Experiment		RELAP5-results			
			MOD3	MOD2	MOD2 mod.
z	T	z	T	T	T
0.05	565.2	0.375	568.86	566.87	566.9
0.25	566.1	1.000	570.19	568.57	568.6
0.50	566.3	1.500	570.85	570.53	570.6
0.75	565.0	2.000	571.03	571.06	571.1
1.00	565.3	2.500	570.97	571.02	571.0
1.25	565.1	2.875	570.77	570.83	570.8
1.50	564.6	3.05	570.67	570.71	570.7
1.75	564.8	3.15	570.61	570.65	570.6
2.00	565.2	3.25	570.55	570.59	570.6
2.25	564.8	3.35	570.49	570.53	570.5
2.50	566.8	3.45	570.43	570.47	570.5
2.75	566.6	3.55	570.37	570.42	570.4
3.00	566.8	3.65	570.31	570.36	570.4
3.1	564.2	3.75	570.26	570.30	570.3
3.2	564.9	3.85	570.20	570.25	570.2
3.3	564.8	3.95	570.14	570.19	570.2
3.4	563.2	4.05	570.09	570.14	570.1
3.5	562.7	4.15	570.04	570.09	570.1
3.6	563.8	4.25	569.99	570.04	570.0
3.7	563.7	4.35	569.94	569.99	570.0
3.8	562.3	4.45	569.89	569.95	570.0
3.9	562.9	4.55	569.84	569.90	569.9
4.0	561.1	4.65	569.80	569.86	569.9
4.1	561.1	4.75	569.76	569.82	569.8
4.2	561.5	4.85	569.71	569.78	569.8
4.3	561.6	4.95	569.68	569.74	569.7
4.4	561.0	5.05	569.64	569.70	569.7
4.5	561.3	5.15	569.61	569.67	569.7
4.6	561.3	5.25	569.57	569.64	569.6
4.7	560.8	5.35	569.55	569.61	569.6
4.8	560.6	5.45	569.52	569.59	569.6
4.9	561.0	5.55	569.50	569.57	569.6
5.0	561.0	5.65	569.48	569.55	569.6
5.1	560.9	5.75	569.46	569.54	569.5
5.2	560.6	5.85	569.45	569.53	569.5
5.3	561.1	5.95	569.45	569.53	569.5
5.4	561.2	6.05	569.45	569.53	569.5
5.5	560.4	6.15	569.95	569.54	569.5
5.6	560.7	6.25	571.20	569.56	569.6
5.7	560.7	6.35	572.72	569.58	569.6
5.8	561.2	6.45	574.61	569.63	722.6
5.9	561.8	6.55	577.03	569.68	733.8
6.0	562.5	6.65	580.20	717.65	744.9
6.1	562.2	6.75	584.52	728.47	755.8
6.2	562.6	6.85	709.46	739.28	766.4
6.3	563.8	6.925	713.39	743.64	770.6
6.4	565.6	6.975	717.66	749.00	775.8
6.5	571.0				
6.6	695.6				
6.7	728.1				
6.8	744.4				
6.9	757.7				
6.95	759.3				

RIT run 315

Inside wall temperatures, T (K) versus axial level,z (m)

Experiment		RELAP5-results	MOD3	MOD2	MOD2 mod.
z	T	z	T	T	T
0.05	522.9	0.375	534.00	526.02	526.1
0.25	525.7	1.000	534.50	528.89	529.0
0.50	526.0	1.500	532.79	531.43	531.4
0.75	522.0	2.000	530.60	531.72	531.8
1.00	521.8	2.500	528.41	529.47	529.6
1.25	518.9	2.875	526.92	527.86	528.0
1.50	517.8	3.05	526.27	527.15	527.3
1.75	518.0	3.15	525.92	526.79	526.9
2.00	517.1	3.25	525.58	526.45	526.6
2.25	517.4	3.35	525.25	526.13	526.3
2.50	518.8	3.45	524.92	525.81	526.0
2.75	518.0	3.55	524.61	525.49	525.6
3.00	516.9	3.65	524.30	525.19	525.3
3.1	514.2	3.75	524.00	524.89	525.0
3.2	514.9	3.85	523.71	524.59	524.8
3.3	515.5	3.95	523.42	524.30	524.4
3.4	513.1	4.05	523.13	524.01	524.2
3.5	512.6	4.15	522.84	523.73	523.9
3.6	514.4	4.25	522.56	523.45	523.6
3.7	513.7	4.35	522.28	523.17	523.3
3.8	510.3	4.45	522.00	522.89	523.1
3.9	512.9	4.55	521.72	522.62	522.8
4.0	514.2	4.65	521.45	522.35	522.5
4.1	514.8	4.75	521.17	522.08	522.2
4.2	513.9	4.85	520.90	521.82	522.0
4.3	513.4	4.95	520.63	521.55	521.7
4.4	509.6	5.05	520.36	521.28	521.4
4.5	511.2	5.15	520.09	521.02	521.2
4.6	509.3	5.25	519.83	520.76	520.9
4.7	509.4	5.35	519.56	520.49	520.7
4.8	509.2	5.45	519.29	520.23	520.4
4.9	508.3	5.55	519.02	519.97	520.1
5.0	508.3	5.65	518.75	519.70	519.9
5.1	508.9	5.75	518.49	519.44	519.6
5.2	507.3	5.85	518.22	519.18	519.4
5.3	507.8	5.95	517.95	518.91	872.0
5.4	507.9	6.05	517.68	518.65	879.8
5.5	507.6	6.15	517.41	518.38	883.8
5.6	506.7	6.25	517.13	518.12	885.1
5.7	507.4	6.35	516.86	517.85	884.5
5.8	507.3	6.45	516.58	517.58	882.6
5.9	508.5	6.55	516.30	517.30	879.7
6.0	517.5	6.65	516.03	517.04	876.4
6.1	625.4	6.75	515.74	516.75	872.2
6.2	781.0	6.85	515.46	516.49	869.3
6.3	801.3	6.925	515.24	516.26	863.6
6.4	812.9	6.975	738.79	516.13	864.3
6.5	825.7				
6.6	828.9				
6.7	833.5				
6.8	832.3				
6.9	819.2				
6.95					

RIT run 317

Inside wall temperatures, T (K) versus axial level, z (m)

Experiment		RELAP5-results		
			MOD3	MOD2
z	T	z	T	T
0.05	525.4	0.375	538.16	529.44
0.25	526.9	1.000	538.59	533.38
0.50	527.2	1.500	536.40	537.63
0.75	522.6	2.000	533.60	534.98
1.00	522.3	2.500	531.09	532.33
1.25	519.4	2.875	529.47	530.54
1.50	518.3	3.05	528.76	529.76
1.75	518.5	3.15	528.37	529.36
2.00	517.0	3.25	528.01	528.99
2.25	517.3	3.35	527.65	528.63
2.50	519.6	3.45	527.30	528.27
2.75	518.5	3.55	526.96	527.93
3.00	516.7	3.65	526.62	527.59
3.1	514.0	3.75	526.28	527.25
3.2	515.4	3.85	525.95	526.92
3.3	515.3	3.95	525.63	526.60
3.4	513.0	4.05	525.31	526.28
3.5	511.8	4.15	524.99	525.97
3.6	514.3	4.25	524.68	525.65
3.7	513.5	4.35	524.37	525.35
3.8	509.5	4.45	524.06	525.04
3.9	512.7	4.55	523.76	524.74
4.0	514.0	4.65	523.45	524.43
4.1	514.0	4.75	523.15	524.13
4.2	513.1	4.85	522.85	523.84
4.3	512.6	4.95	522.55	523.54
4.4	509.7	5.05	522.25	523.24
4.5	511.0	5.15	521.96	522.95
4.6	509.4	5.25	521.66	522.65
4.7	508.6	5.35	521.36	522.36
4.8	509.3	5.45	521.06	522.06
4.9	507.4	5.55	520.76	521.77
5.0	508.1	5.65	520.46	521.47
5.1	552.9	5.75	520.15	521.17
5.2	761.2	5.85	519.85	520.88
5.3	857.5	5.95	519.54	520.58
5.4	863.9	6.05	519.23	520.28
5.5	886.7	6.15	518.92	519.98
5.6	897.6	6.25	518.60	519.68
5.7	897.6	6.35	518.29	519.37
5.8	897.5	6.45	517.97	519.07
5.9	894.4	6.55	517.65	518.75
6.0	887.1	6.65	517.32	518.45
6.1	884.8	6.75	517.00	518.13
6.2	887.7	6.85	516.66	517.83
6.3	870.9	6.925	516.41	517.56
6.4	863.9	6.975	748.68	517.42
6.5	858.2			
6.6	847.7			
6.7	-			
6.8	836.1			
6.9	823.8			
6.95	806.1			

RIT run 320

Inside wall temperatures, T (K) versus axial level,z (m)

Experiment		RELAP5-results	MOD3	MOD2	MOD2 mod.
z	T	z	T	T	T
0.05	523.4	0.375	530.64	524.77	524.9
0.25	524.9	1.000	531.40	527.92	528.0
0.50	525.2	1.500	529.88	530.67	530.8
0.75	521.9	2.000	528.00	528.86	529.0
1.00	521.6	2.500	526.27	527.08	527.2
1.25	519.5	2.875	524.94	525.65	525.8
1.50	518.3	3.05	524.37	525.02	525.2
1.75	519.2	3.15	524.07	524.71	524.8
2.00	518.3	3.25	523.77	524.41	524.5
2.25	518.6	3.35	523.49	524.12	524.2
2.50	519.3	3.45	523.21	523.84	524.0
2.75	518.6	3.55	522.93	523.57	523.7
3.00	517.4	3.65	522.67	523.30	523.4
3.1	515.4	3.75	522.40	523.03	523.2
3.2	516.1	3.85	522.15	522.78	522.9
3.3	516.6	3.95	521.89	522.52	522.6
3.4	515.0	4.05	521.65	522.27	522.4
3.5	513.8	4.15	521.41	522.03	522.2
3.6	516.3	4.25	521.17	521.79	521.9
3.7	514.9	4.35	520.94	521.55	521.7
3.8	511.6	4.45	520.71	521.31	521.4
3.9	514.1	4.55	520.48	521.08	521.2
4.0	515.4	4.65	520.25	520.85	521.0
4.1	515.4	4.75	520.02	520.62	520.8
4.2	514.5	4.85	519.80	520.40	520.5
4.3	514.0	4.95	519.58	520.18	520.3
4.4	510.1	5.05	519.35	519.95	520.1
4.5	511.2	5.15	519.13	519.73	519.9
4.6	509.2	5.25	518.91	519.51	519.6
4.7	510.0	5.35	518.69	519.30	519.4
4.8	509.8	5.45	518.47	519.08	519.2
4.9	509.5	5.55	518.25	518.87	519.0
5.0	509.5	5.65	518.04	518.65	518.8
5.1	510.1	5.75	517.82	518.44	518.6
5.2	508.5	5.85	517.60	518.22	518.4
5.3	509.6	5.95	517.38	518.01	518.1
5.4	509.8	6.05	517.16	517.80	850.1
5.5	509.5	6.15	516.94	517.59	860.0
5.6	508.6	6.25	516.72	517.37	866.3
5.7	509.3	6.35	516.50	517.16	870.0
5.8	509.1	6.45	516.28	516.95	871.7
5.9	509.1	6.55	516.05	516.73	871.9
6.0	511.7	6.65	515.83	516.53	871.2
6.1	535.6	6.75	515.61	516.31	869.3
6.2	657.2	6.85	515.39	516.11	868.2
6.3	788.2	6.925	515.22	515.92	863.6
6.4	807.1	6.975	733.64	515.83	864.9
6.5	822.3				
6.6	829.1				
6.7	-				
6.8	837.3				
6.9	841.7				
6.95	832.3				

RIT run 325

Inside wall temperatures, T (K) versus axial level,z (m)

Experiment		RELAP5-results MOD3	
z	T	z	T
0.05	522.5	0.375	525.06
0.25	524.0	1.000	526.13
0.50	524.3	1.500	525.75
0.75	522.2	2.000	524.49
1.00	522.6	2.500	523.27
1.25	520.5	2.875	522.41
1.50	519.3	3.05	522.02
1.75	520.2	3.15	521.80
2.00	519.9	3.25	521.58
2.25	519.6	3.35	521.37
2.50	520.3	3.45	521.17
2.75	519.6	3.55	520.97
3.00	518.4	3.65	520.77
3.1	517.0	3.75	520.57
3.2	517.8	3.85	520.37
3.3	517.7	3.95	520.17
3.4	516.0	4.05	519.98
3.5	515.5	4.15	519.79
3.6	517.3	4.25	519.61
3.7	516.5	4.35	519.43
3.8	515.8	4.45	519.25
3.9	515.8	4.55	519.08
4.0	516.4	4.65	518.91
4.1	516.4	4.75	518.74
4.2	516.1	4.85	518.57
4.3	516.3	4.95	518.41
4.4	516.3	5.05	518.25
4.5	516.7	5.15	518.09
4.6	515.4	5.25	517.93
4.7	515.5	5.35	517.77
4.8	515.3	5.45	517.62
4.9	515.0	5.55	517.47
5.0	515.0	5.65	517.33
5.1	515.0	5.75	517.18
5.2	515.3	5.85	517.04
5.3	515.1	5.95	516.89
5.4	514.6	6.05	516.75
5.5	514.4	6.15	516.60
5.6	514.1	6.25	516.46
5.7	513.5	6.35	516.31
5.8	513.4	6.45	516.17
5.9	513.4	6.55	516.02
6.0	512.9	6.65	515.87
6.1	512.5	6.75	515.72
6.2	511.6	6.85	515.58
6.3	512.2	6.925	515.46
6.4	512.1	6.975	720.07
6.5	512.6		
6.6	511.5		
6.7	508.4		
6.8	509.0		
6.9	510.6		
6.95	508.4		

RIT run 327

Inside wall temperatures, T (K) versus axial level,z (m)

Experiment		RELAP5-results	MOD3	MOD2	MOD2 mod.
z	T	z	T	T	T
0.05	524.5	0.375	527.19	523.98	524.1
0.25	526.0	1.000	528.37	527.57	527.7
0.50	525.6	1.500	527.42	527.98	528.1
0.75	523.6	2.000	525.93	526.55	526.6
1.00	523.3	2.500	524.55	525.12	525.2
1.25	520.6	2.875	523.56	524.04	524.1
1.50	520.1	3.05	523.12	523.55	523.7
1.75	520.9	3.15	522.87	523.30	523.4
2.00	520.1	3.25	522.61	523.04	523.2
2.25	520.3	3.35	522.37	522.80	522.9
2.50	521.1	3.45	522.13	522.56	522.7
2.75	519.7	3.55	521.90	522.33	522.4
3.00	518.5	3.65	521.67	522.10	522.2
3.1	516.5	3.75	521.45	521.88	522.0
3.2	517.2	3.85	521.23	521.66	521.8
3.3	517.8	3.95	521.02	521.45	521.6
3.4	516.1	4.05	520.81	521.25	521.4
3.5	515.6	4.15	520.61	521.05	521.2
3.6	517.4	4.25	520.41	520.85	521.0
3.7	516.6	4.35	520.22	520.66	520.8
3.8	515.2	4.45	520.03	520.47	520.6
3.9	515.8	4.55	519.85	520.28	520.4
4.0	516.5	4.65	519.67	520.10	520.2
4.1	516.5	4.75	519.49	519.92	520.0
4.2	516.2	4.85	519.32	519.74	519.8
4.3	516.4	4.95	519.15	519.57	519.7
4.4	516.4	5.05	518.98	519.40	519.5
4.5	516.7	5.15	518.81	519.23	519.3
4.6	515.5	5.25	518.64	519.06	519.2
4.7	515.0	5.35	518.48	518.90	519.0
4.8	514.7	5.45	518.32	518.73	518.8
4.9	514.5	5.55	518.16	518.57	518.7
5.0	514.5	5.65	518.00	518.42	518.5
5.1	515.1	5.75	517.84	518.26	518.4
5.2	515.3	5.85	517.69	518.11	518.2
5.3	514.6	5.95	517.53	517.95	518.0
5.4	514.1	6.05	517.38	517.80	834.2
5.5	513.8	6.15	517.23	517.65	847.2
5.6	513.6	6.25	517.08	517.51	857.5
5.7	511.7	6.35	516.93	517.36	865.2
5.8	510.3	6.45	516.79	517.22	870.9
5.9	509.0	6.55	516.64	517.07	875.0
6.0	512.2	6.65	516.50	516.93	878.0
6.1	576.0	6.75	516.36	516.78	879.5
6.2	754.5	6.85	516.22	516.66	881.4
6.3	790.4	6.925	516.11	516.52	878.5
6.4	809.2	6.975	727.74	516.48	880.9
6.5	826.1				
6.6	834.1				
6.7	838.5				
6.8	846.5				
6.9	853.9				
6.95	847.0				

RJT run 331

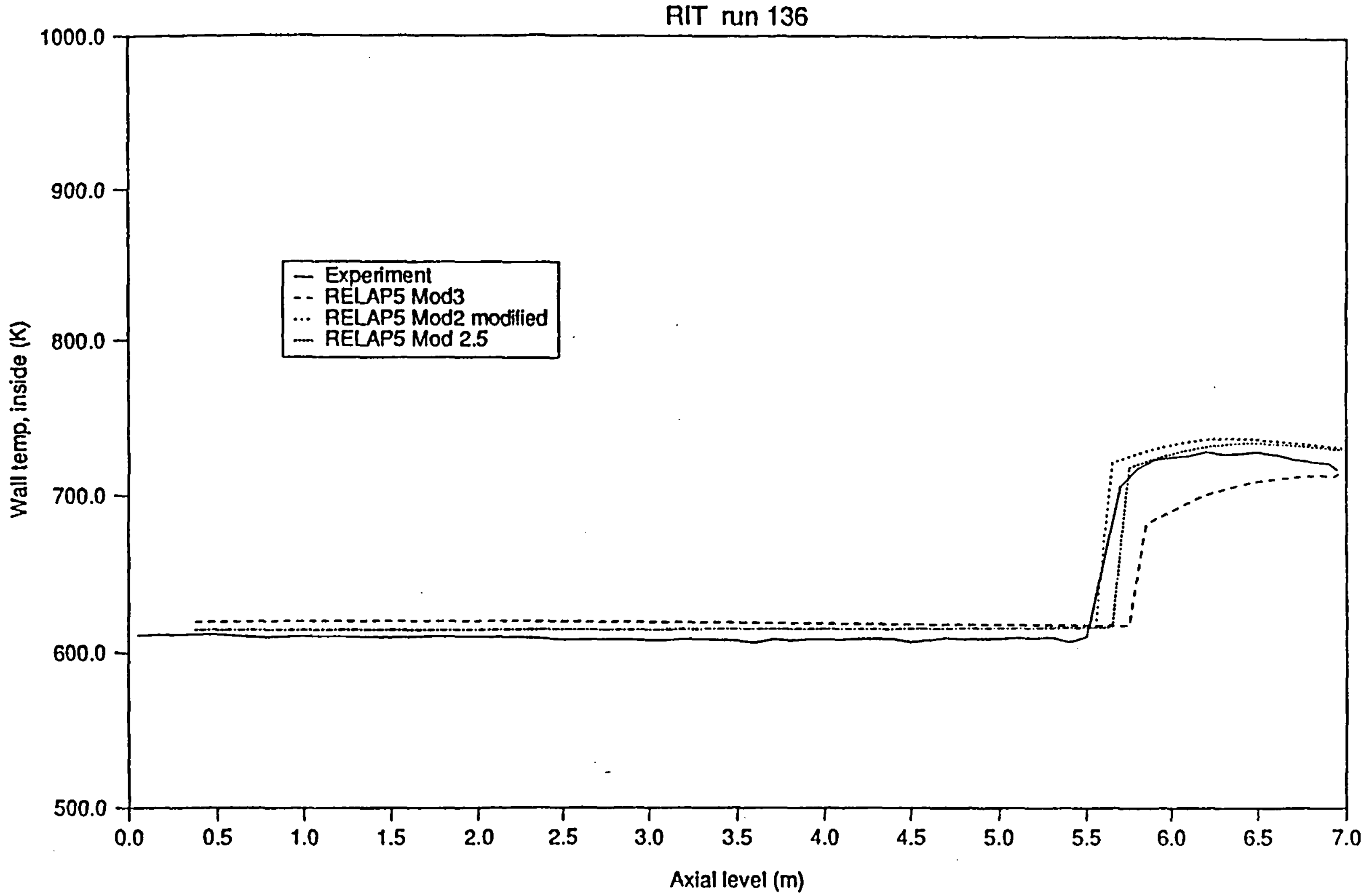
Inside wall temperatures, T (K) versus axial level,z (m)

Experiment z	Experiment T	RELAP5-results MOD3 z	RELAP5-results MOD3 T
0.05	519.4	0.375	520.31
0.25	520.8	1.000	521.50
0.50	520.5	1.500	521.48
0.75	517.2	2.000	521.03
1.00	515.7	2.500	520.35
1.25	514.8	2.875	519.82
1.50	514.3	3.05	519.58
1.75	514.6	3.15	519.45
2.00	514.3	3.25	519.32
2.25	513.9	3.35	519.19
2.50	519.1	3.45	519.06
2.75	517.7	3.55	518.94
3.00	518.4	3.65	518.81
3.1	516.4	3.75	518.69
3.2	515.3	3.85	518.57
3.3	514.6	3.95	518.46
3.4	512.9	4.05	518.35
3.5	511.8	4.15	518.24
3.6	511.7	4.25	518.13
3.7	511.5	4.35	518.02
3.8	510.8	4.45	517.92
3.9	512.0	4.55	517.82
4.0	513.3	4.65	517.73
4.1	512.7	4.75	517.63
4.2	511.8	4.85	517.54
4.3	511.9	4.95	517.45
4.4	511.9	5.05	517.36
4.5	512.9	5.15	517.28
4.6	511.7	5.25	517.20
4.7	511.8	5.35	517.12
4.8	511.5	5.45	517.04
4.9	511.9	5.55	516.96
5.0	511.9	5.65	516.89
5.1	511.9	5.75	516.98
5.2	512.2	5.85	517.58
5.3	512.0	5.95	518.24
5.4	512.8	6.05	518.98
5.5	513.2	6.15	519.80
5.6	512.3	6.25	520.72
5.7	512.3	6.35	521.75
5.8	512.2	6.45	522.91
5.9	512.2	6.55	524.19
6.0	512.3	6.65	525.61
6.1	513.2	6.75	527.17
6.2	512.3	6.85	529.19
6.3	513.5	6.925	530.26
6.4	514.7	6.975	711.10
6.5	512.7		
6.6	514.2		
6.7	513.5		
6.8	513.7		
6.9	510.6		
6.95	510.4		

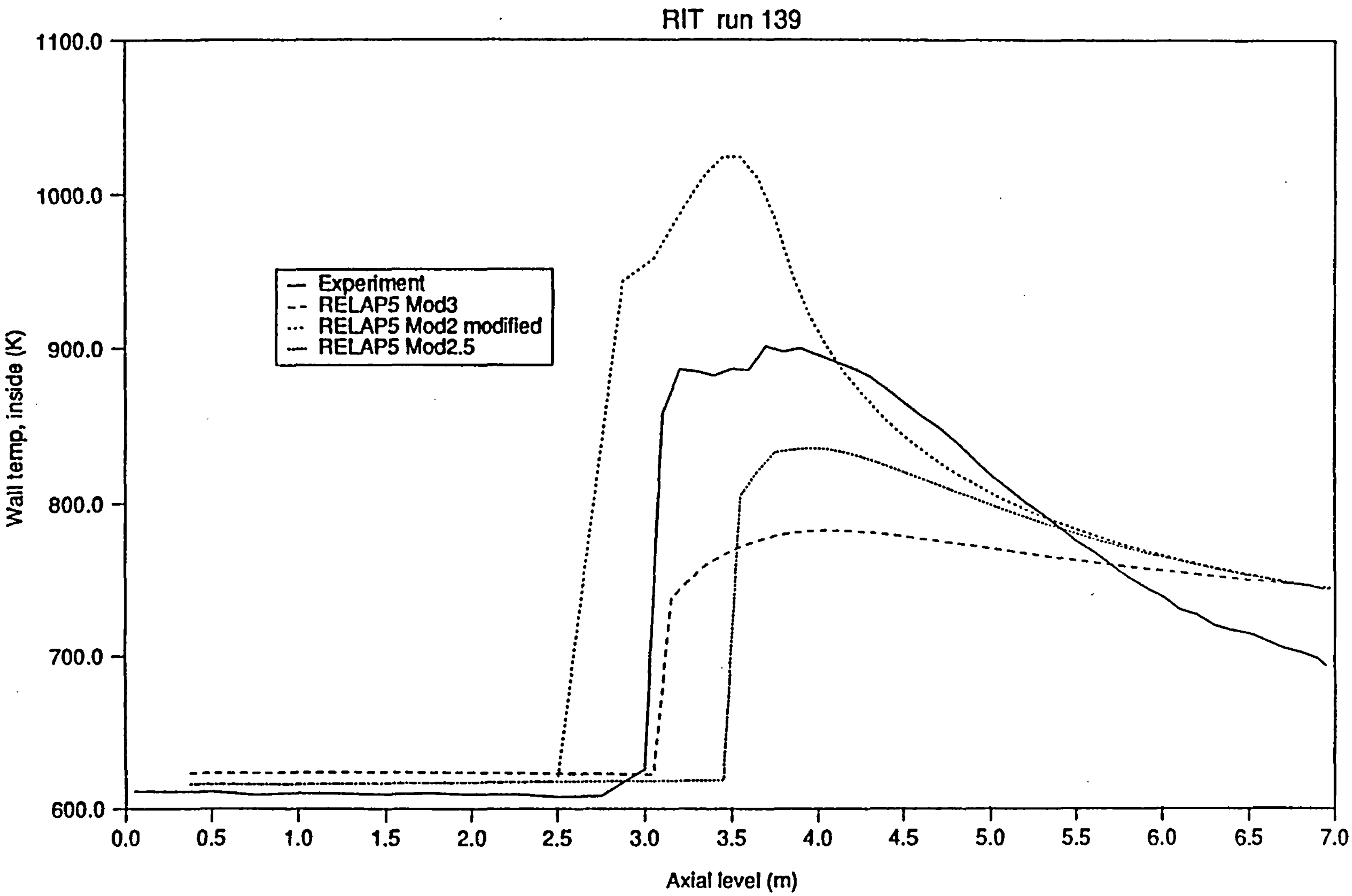
RIT run 332

Inside wall temperatures, T (K) versus axial level, z (m)

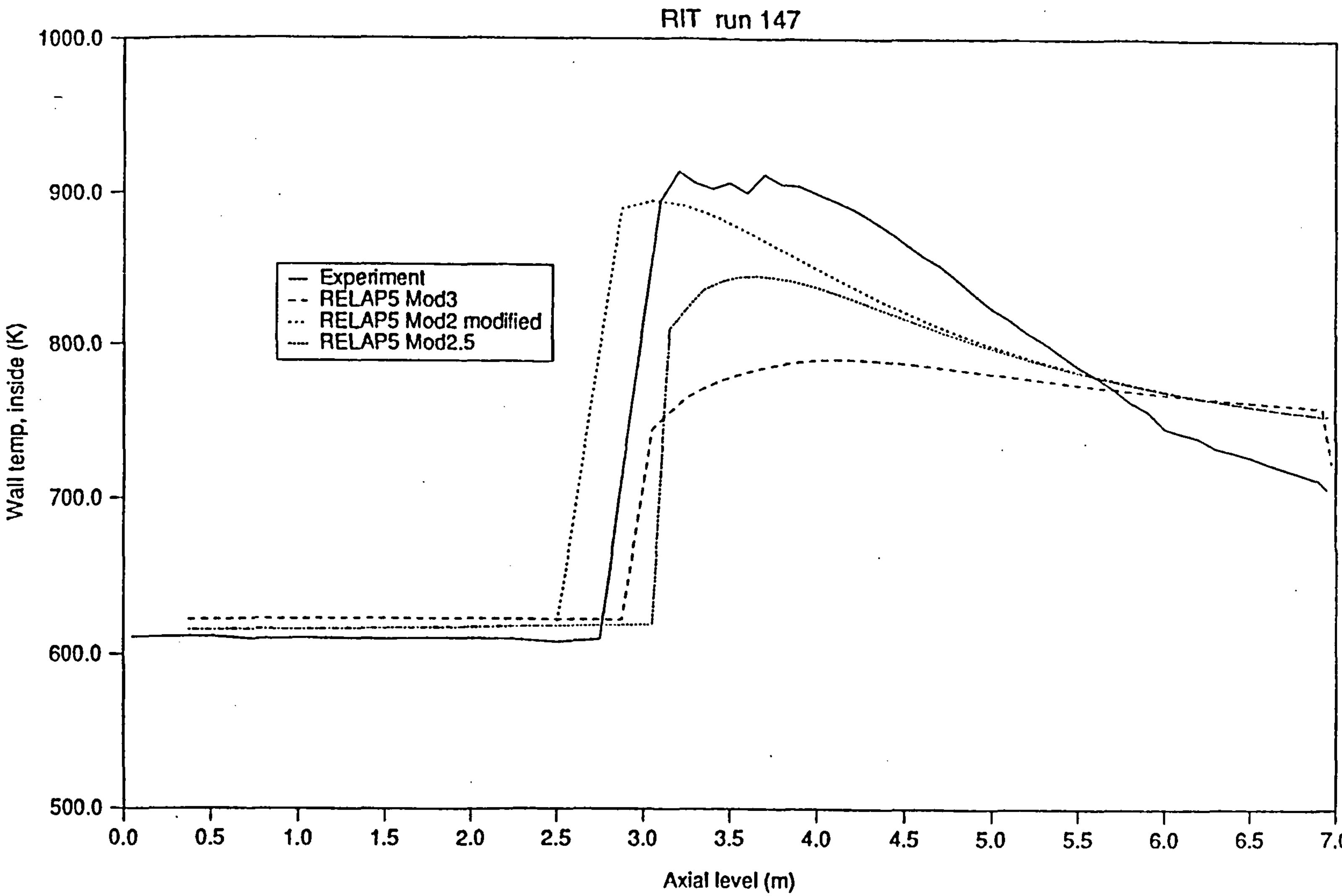
Experiment		RELAP5-results	MOD3	MOD2	MOD2 mod.
z	T	z	T	T	T
0.05	520.1	0.375	521.30	520.66	520.7
0.25	521.6	1.000	522.66	522.80	522.8
0.50	521.3	1.500	522.59	522.77	522.8
0.75	517.4	2.000	522.04	522.32	522.4
1.00	515.9	2.500	521.24	521.54	521.6
1.25	514.3	2.875	520.66	520.88	520.9
1.50	514.5	3.05	520.40	520.56	520.6
1.75	514.1	3.15	520.26	520.42	520.5
2.00	514.5	3.25	520.12	520.28	520.3
2.25	514.1	3.35	519.98	520.15	520.2
2.50	519.2	3.45	519.84	520.02	520.0
2.75	518.5	3.55	519.71	519.89	519.9
3.00	518.6	3.65	519.58	519.76	519.8
3.1	516.6	3.75	519.46	519.64	519.7
3.2	515.5	3.85	519.34	519.52	519.6
3.3	514.7	3.95	519.22	519.40	519.4
3.4	513.1	4.05	519.11	519.29	519.3
3.5	511.3	4.15	518.99	519.18	519.2
3.6	513.1	4.25	518.89	519.07	519.1
3.7	511.7	4.35	518.78	518.97	519.0
3.8	510.3	4.45	518.68	518.87	518.9
3.9	512.2	4.55	518.58	518.77	518.8
4.0	514.1	4.65	518.49	518.68	518.7
4.1	512.8	4.75	518.40	518.59	518.6
4.2	511.9	4.85	518.31	518.50	518.5
4.3	512.1	4.95	518.22	518.42	518.4
4.4	512.1	5.05	518.14	518.34	518.4
4.5	513.1	5.15	518.43	518.26	518.3
4.6	511.8	5.25	519.20	518.19	518.2
4.7	511.3	5.35	520.06	518.12	518.2
4.8	511.7	5.45	521.04	518.06	518.1
4.9	511.4	5.55	522.15	518.00	518.0
5.0	512.1	5.65	523.40	517.94	518.0
5.1	512.7	5.75	524.82	517.90	517.9
5.2	511.7	5.85	526.41	517.85	517.9
5.3	512.2	5.95	528.20	517.82	517.8
5.4	512.3	6.05	530.24	517.79	517.8
5.5	512.7	6.15	532.57	517.77	517.8
5.6	511.8	6.25	535.26	517.76	793.6
5.7	513.1	6.35	538.44	517.77	809.7
5.8	511.1	6.45	542.23	517.78	824.5
5.9	511.1	6.55	546.87	517.83	838.0
6.0	512.4	6.65	552.72	517.87	850.4
6.1	513.3	6.75	559.80	772.15	861.6
6.2	515.0	6.85	737.31	787.13	872.2
6.3	613.4	6.925	743.21	792.44	874.7
6.4	745.7	6.975	749.42	799.47	879.9
6.5	772.7				
6.6	788.4				
6.7	803.6				
6.8	816.3				
6.9	826.6				
6.95	824.6				



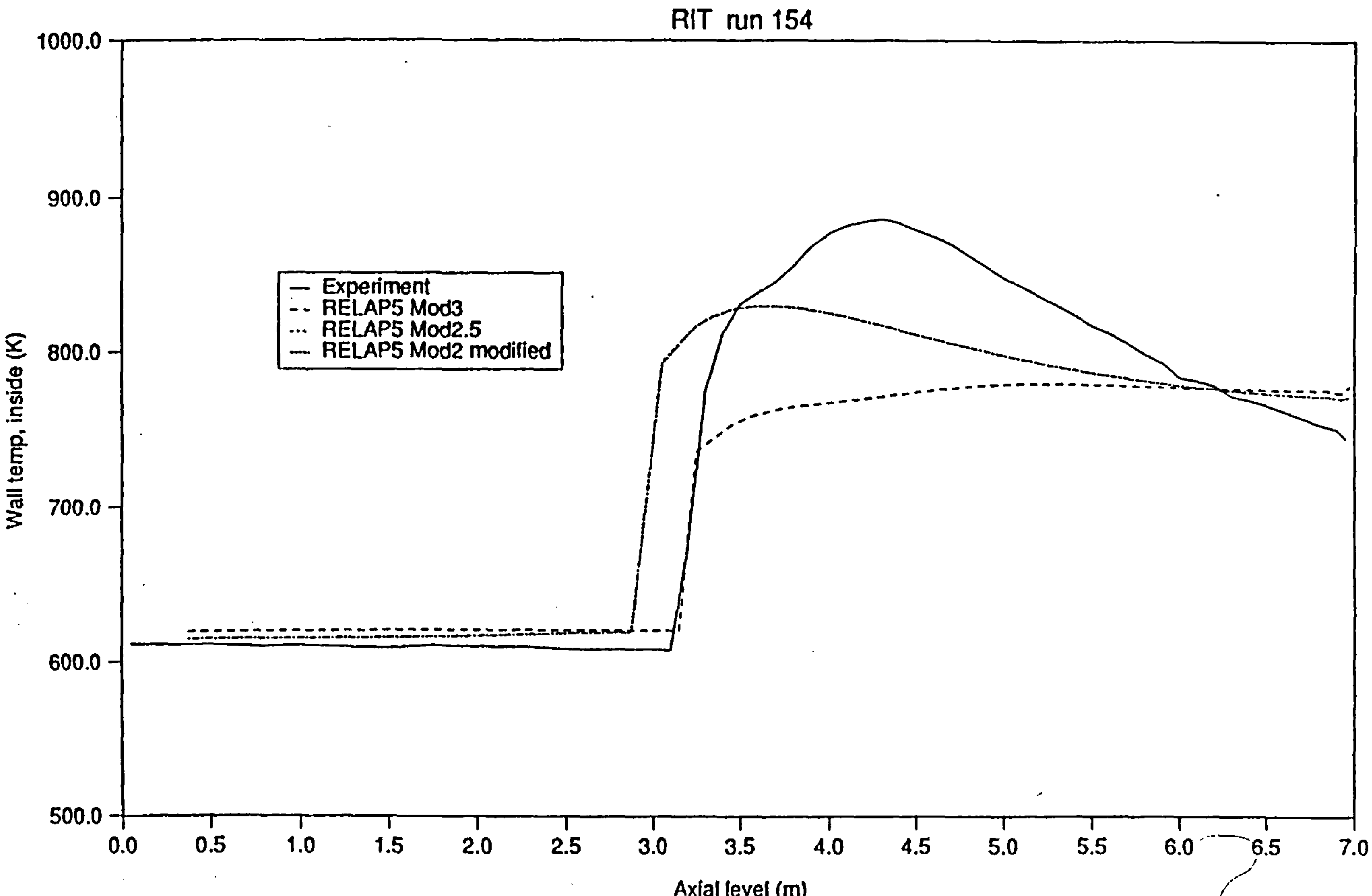
Inner wall temperatures for run 136
p=13.99 MPa, G=1976.6 kg per sqm-s
delta-t=10 K, heat flux=509 kW per sqm



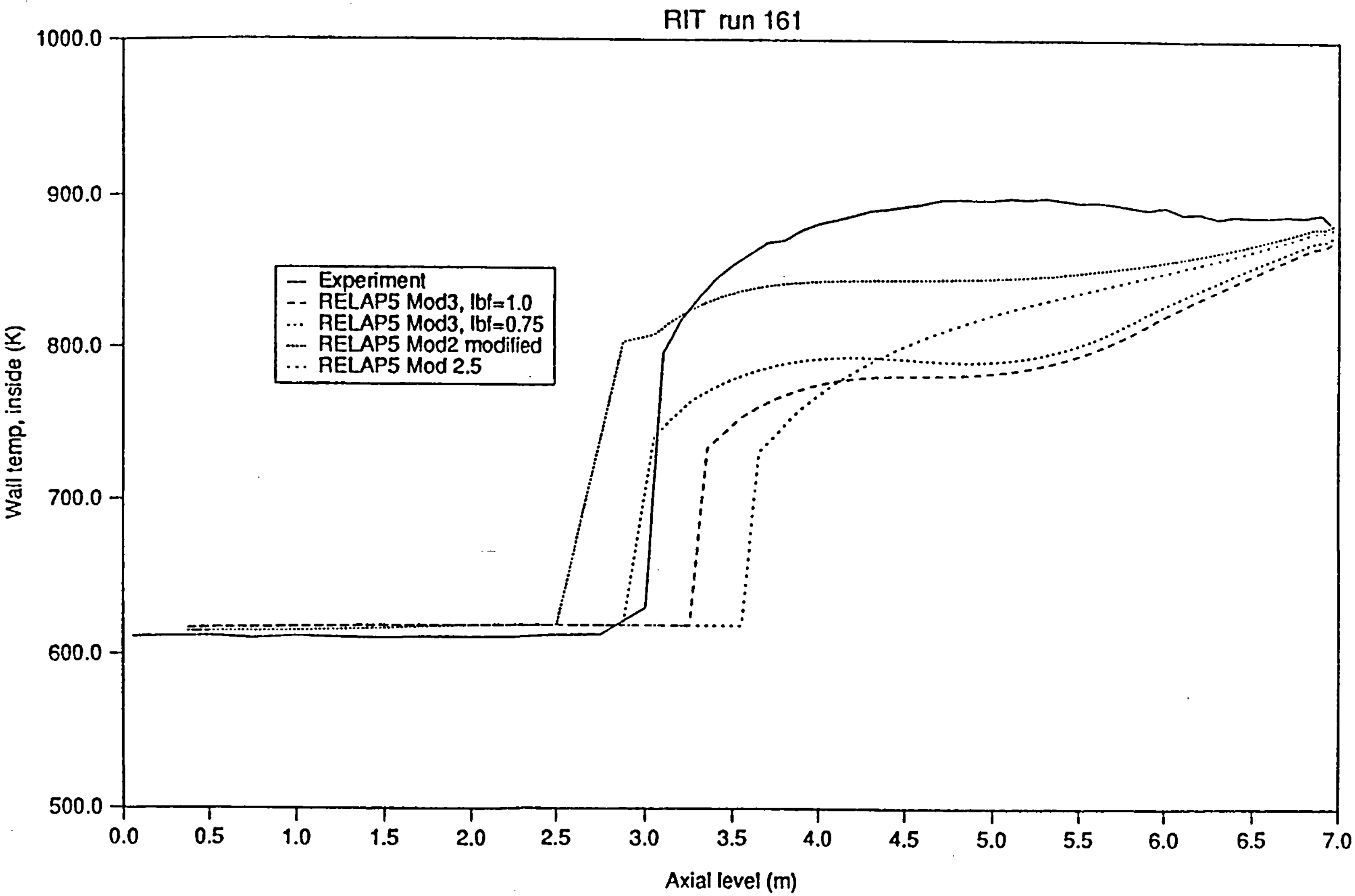
Inner wall temperatures for run 139
p=14.00 MPa, G=1970.5 kg per sqm-s
delta-t=9.8 K, heat flux=757 kW per sqm



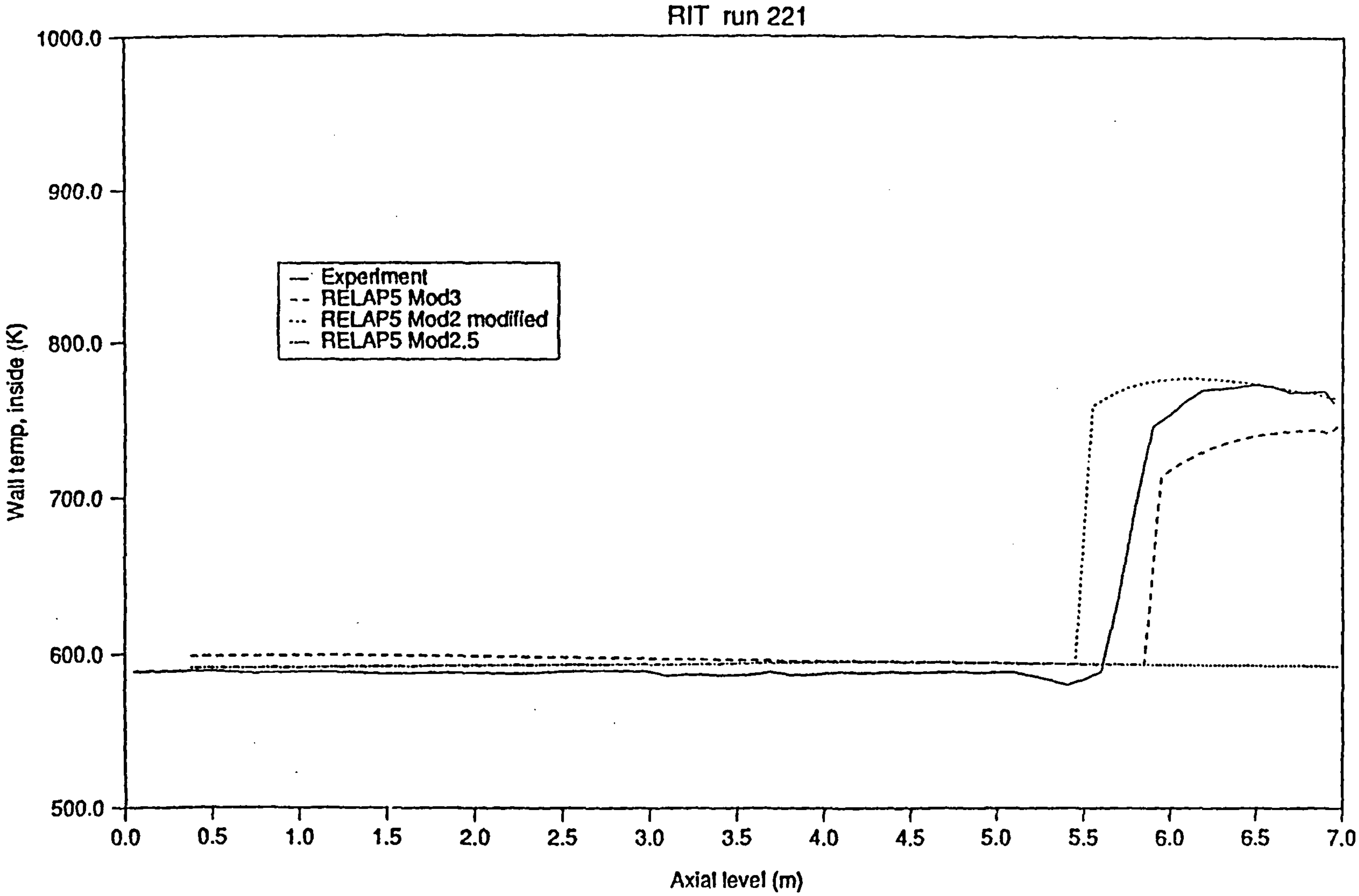
Inner wall temperatures for run 147
p=14.00 MPa, G=1494.3 kg per sqm-s
delta-t=9.7 K, heat flux=704 kW per sqm



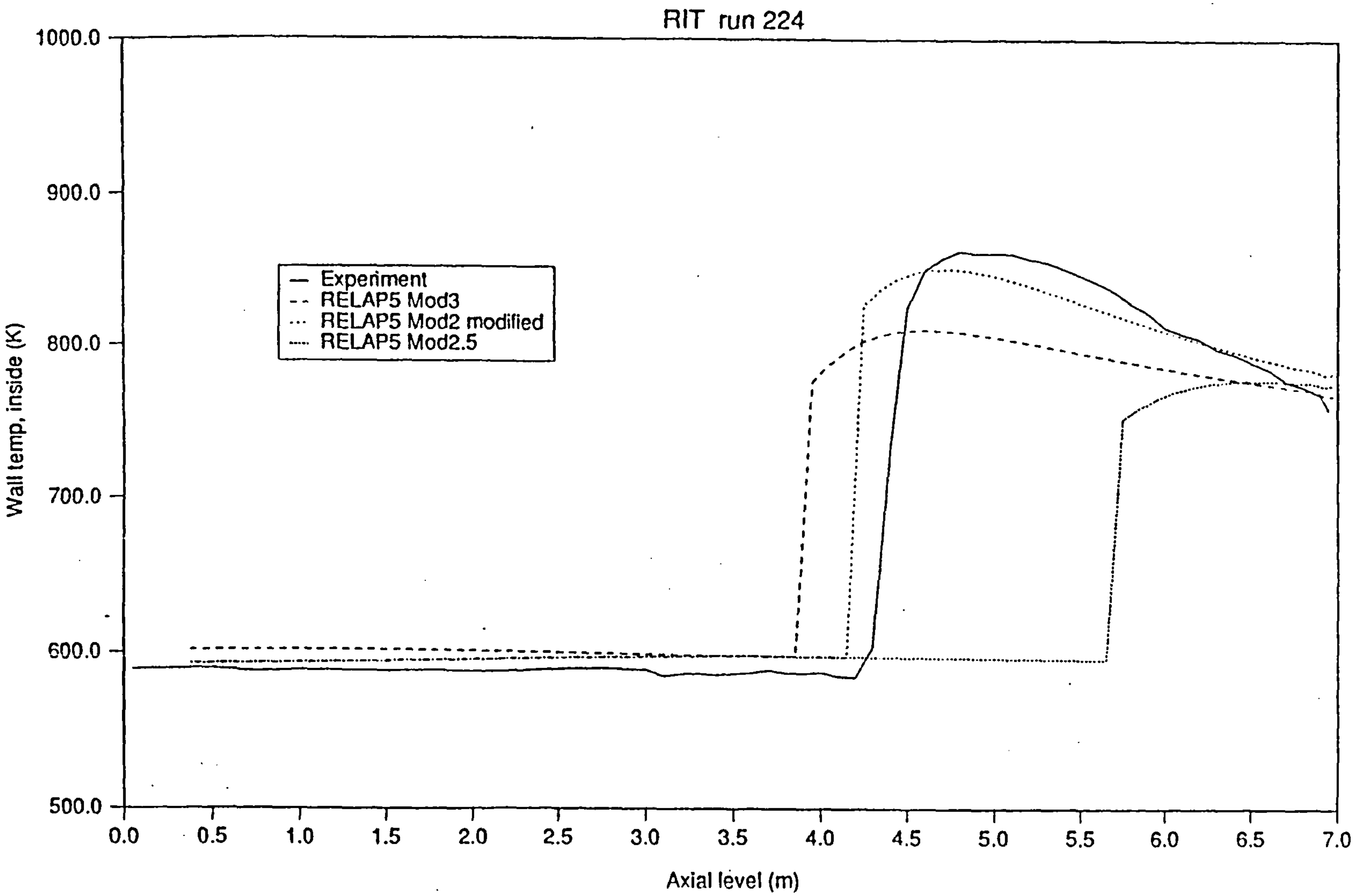
Inner wall temperatures for run 154
p=13.98 MPa, G=1006.6 kg per sqm-s
delta-t=9.3 K, heat flux=552 kW per sqm



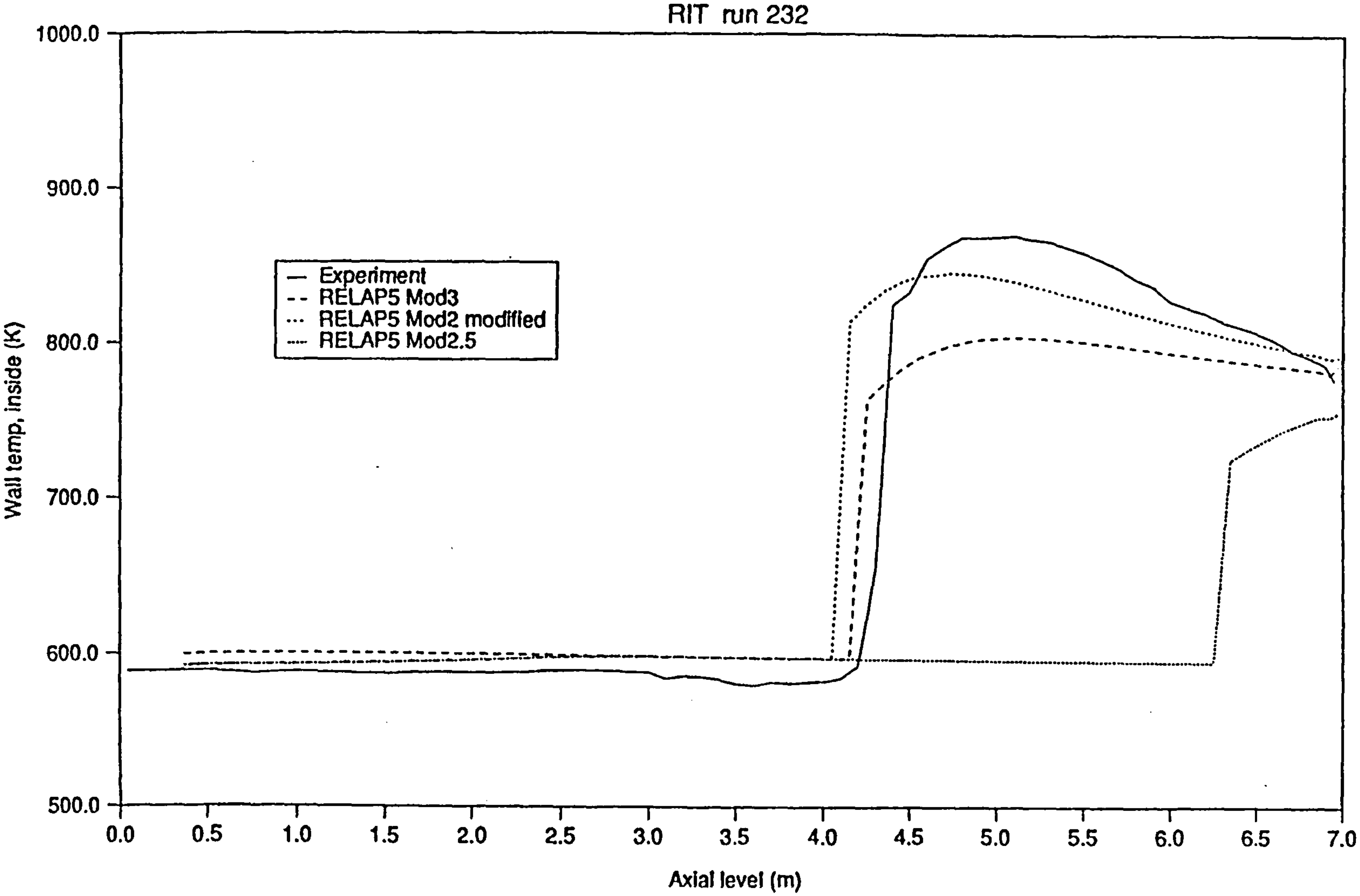
Inner wall temperatures for run 161
p=13.99 MPa, G=503.2 kg per sqm-s
delta-t=9.5 K, heat flux=405 kW per sqm



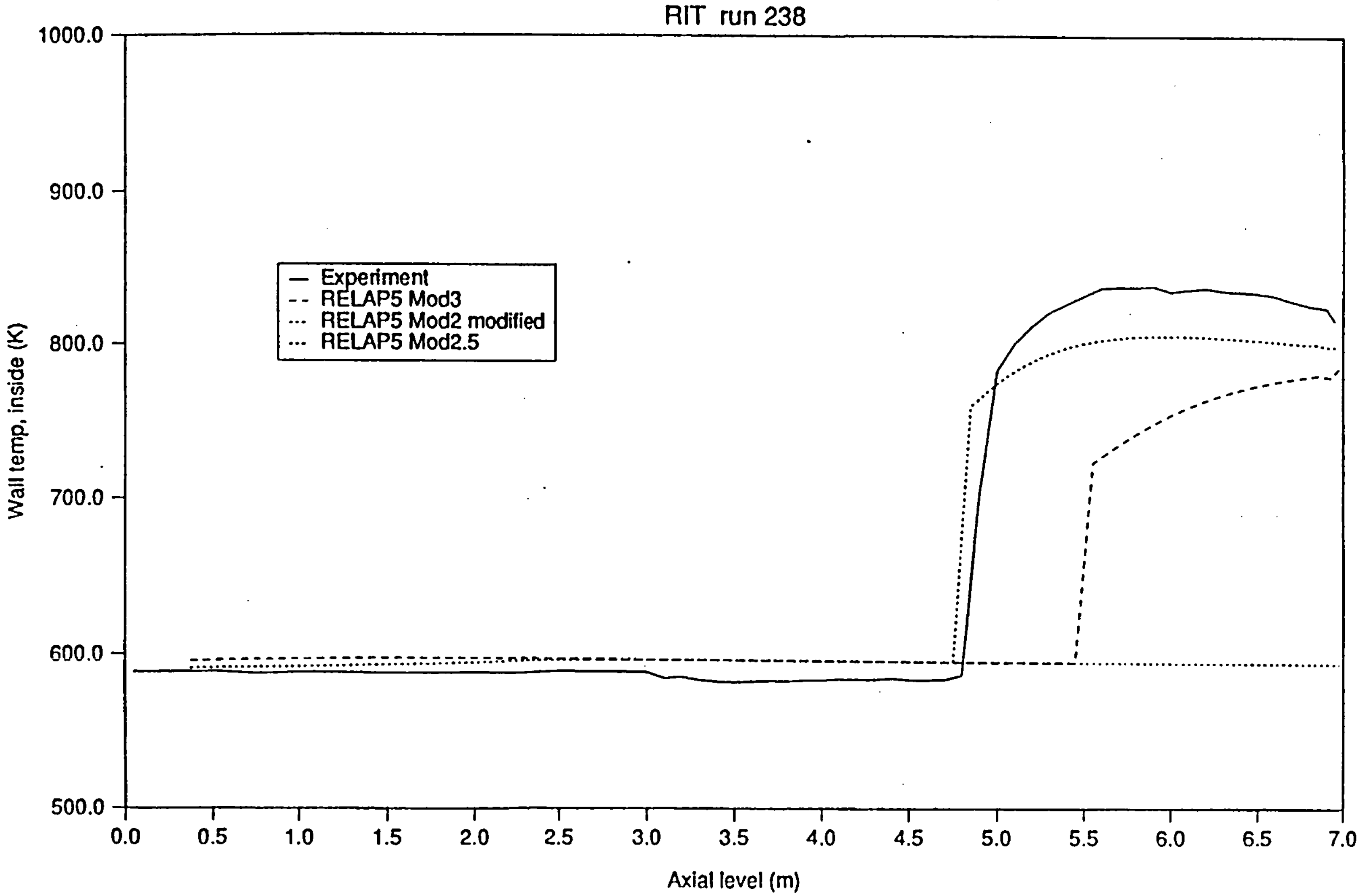
Inner wall temperatures for run 221
p=10.01 MPa, G=1973.8 kg per sqm-s
delta-t=10.1 K, heat flux=665 kW per sqm



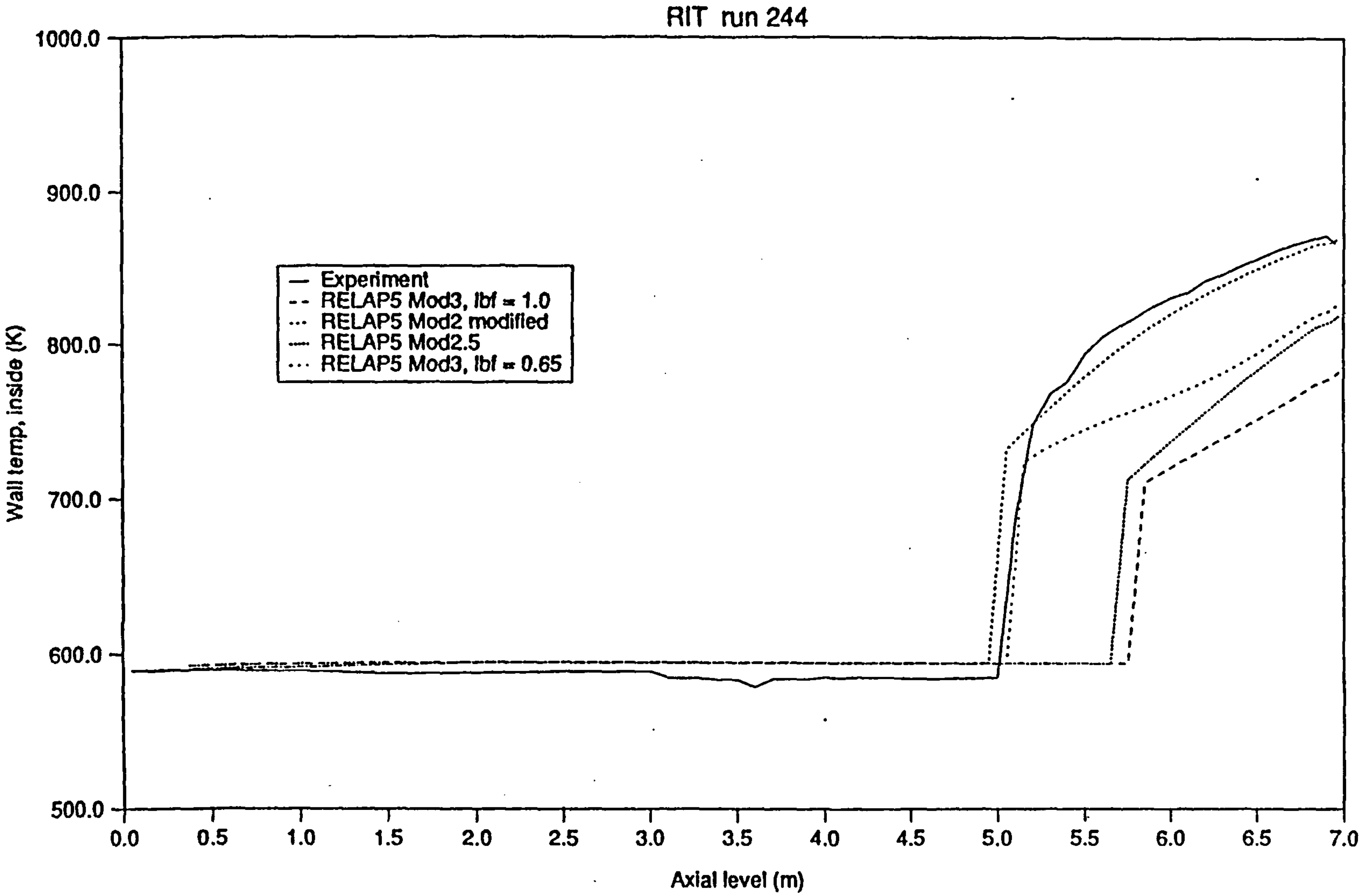
Inner wall temperatures for run224
p=10.02 MPa, G=1990.3 kg per sqm-s
delta-t=10.8 K, heat flux=860 kW per sqm



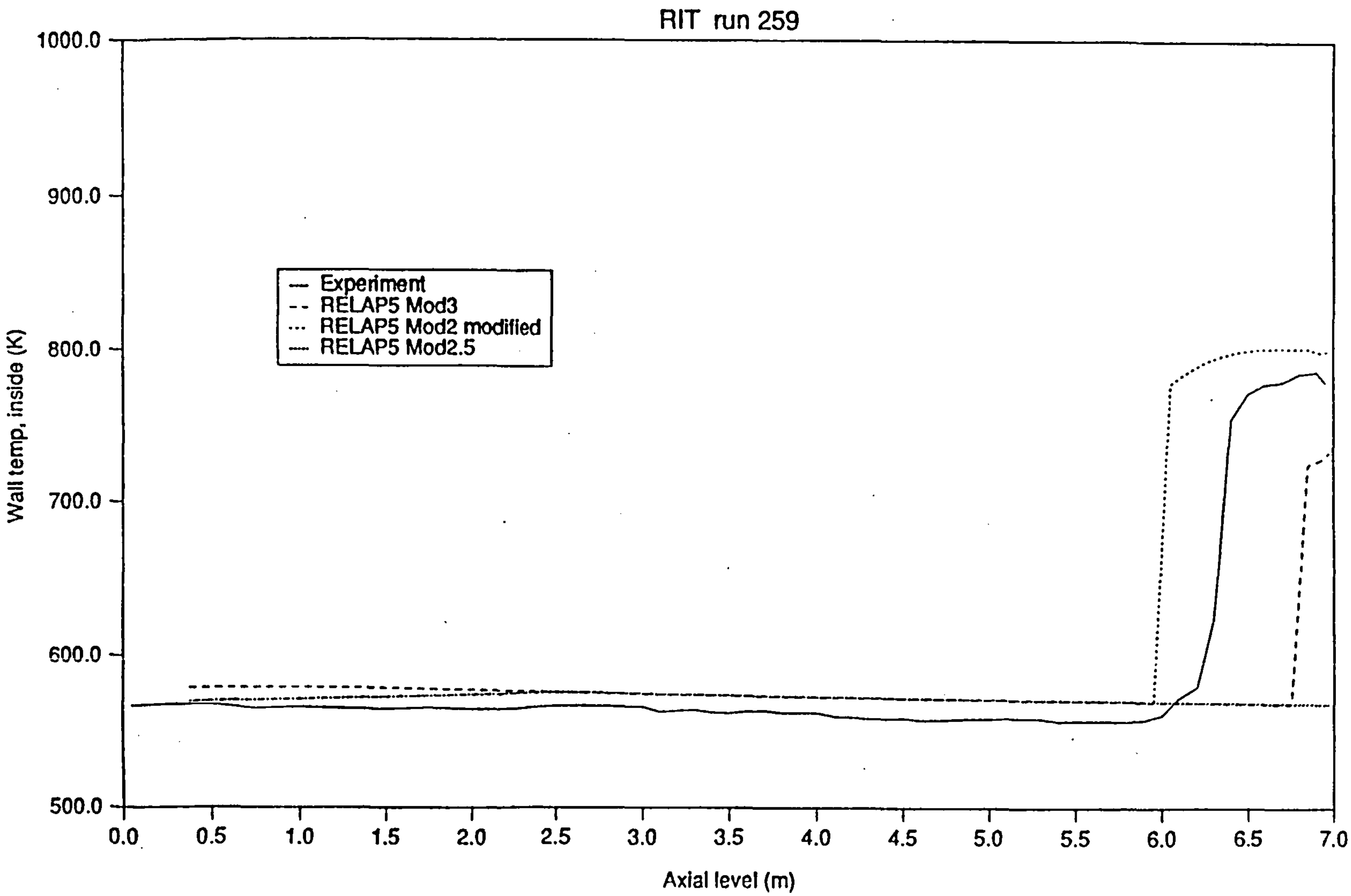
Inner wall temperatures for run 232
p=10.00 MPa, G=1499.8 kg per sqm-s
delta-t=10.4 K, heat flux=758 kW per sqm



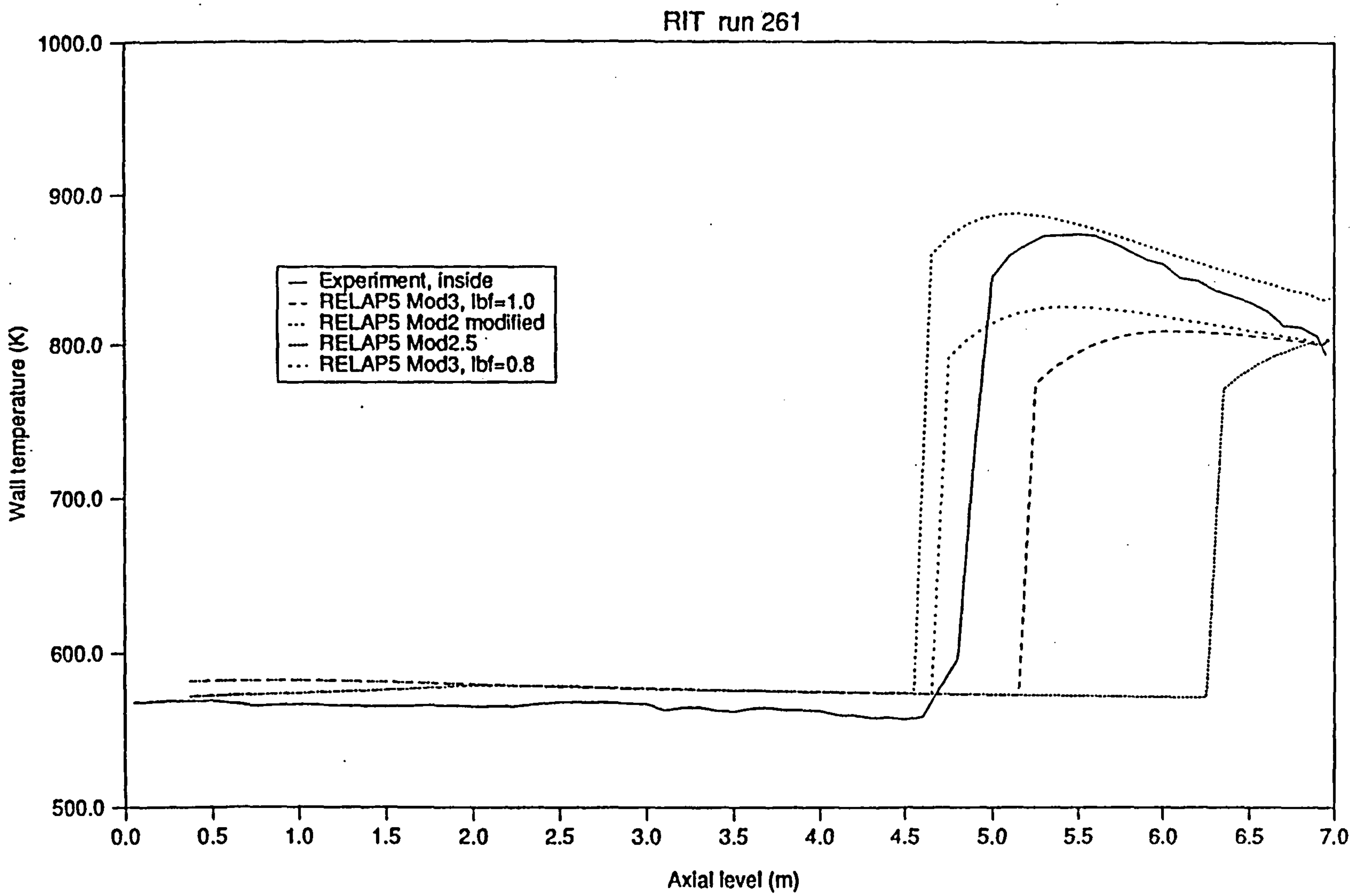
Inner wall temperatures for run 238
p=10.01 MPa, G=997.3 kg per sqm-s
delta-t=12.0 K, heat flux=556 kW per sqm



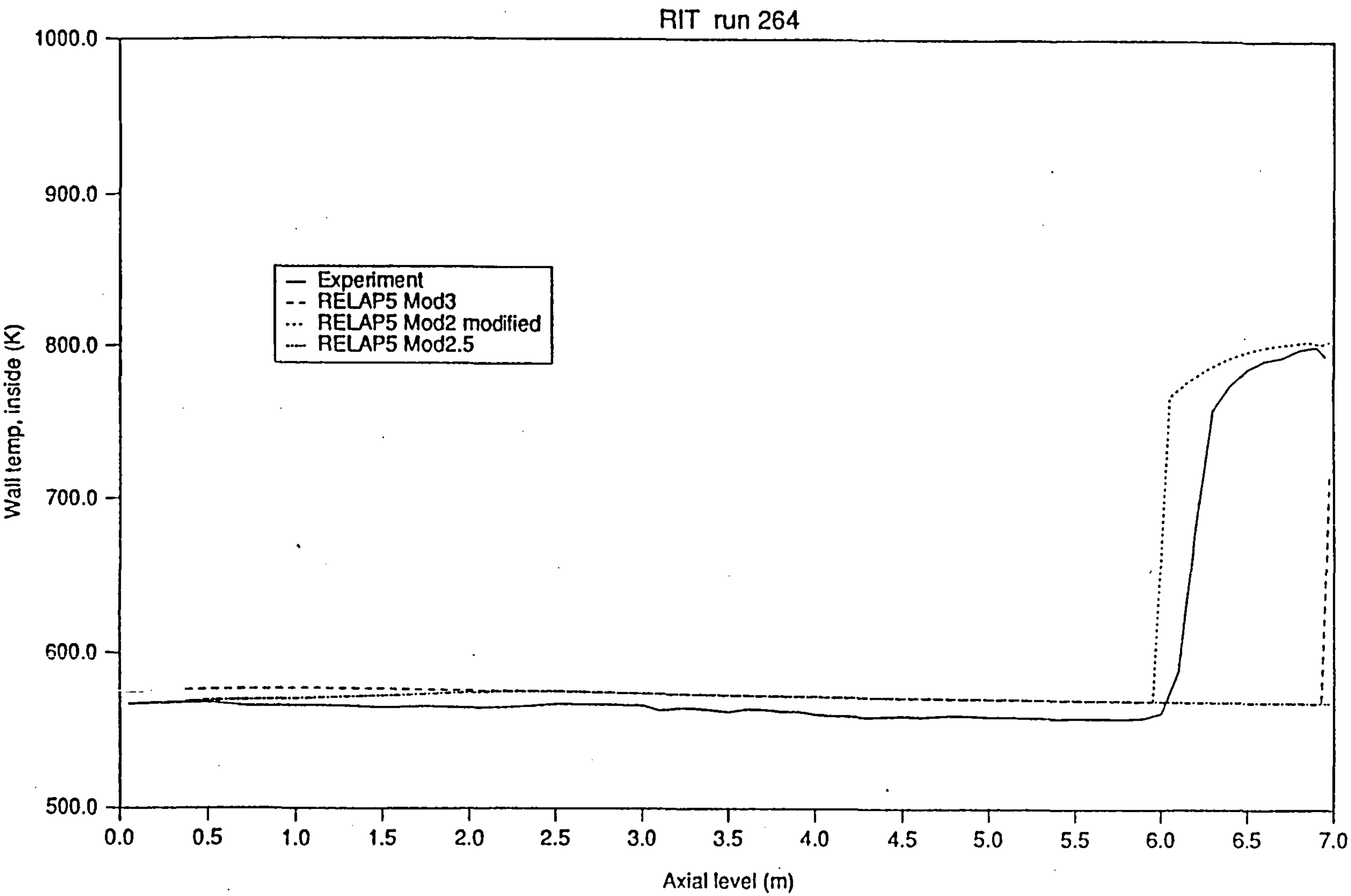
Inner wall temperatures for run 244
p=99.8 MPa, G=502.0 kg per sqm-s
delta-t=11.0 K, heat flux=405 kW per sqm



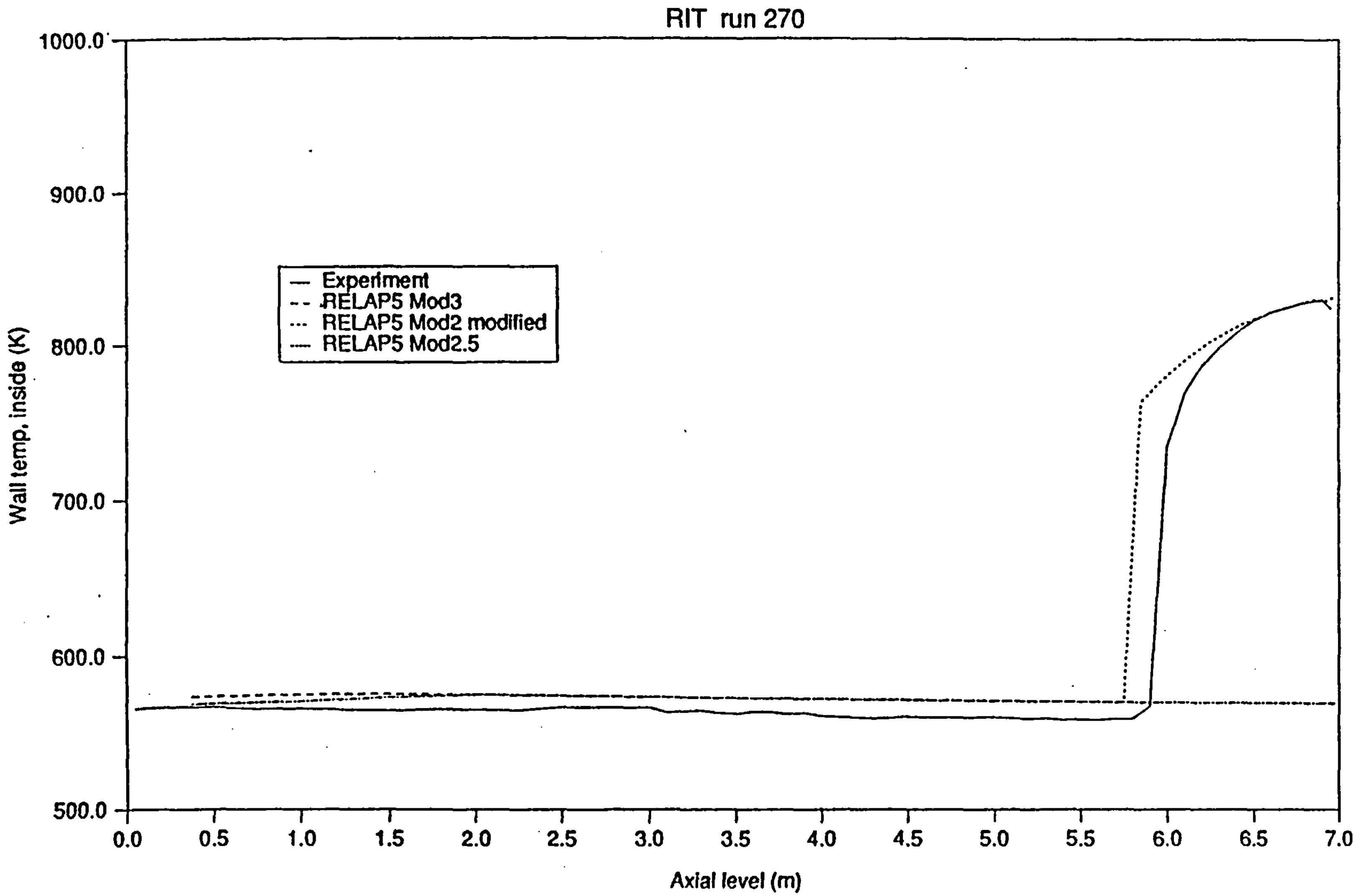
Inner wall temperatures for run 259
p=6.99 MPa, G=1989.3 kg per sqm-s
delta-t=9.9 K, heat flux=870 kW per sqm



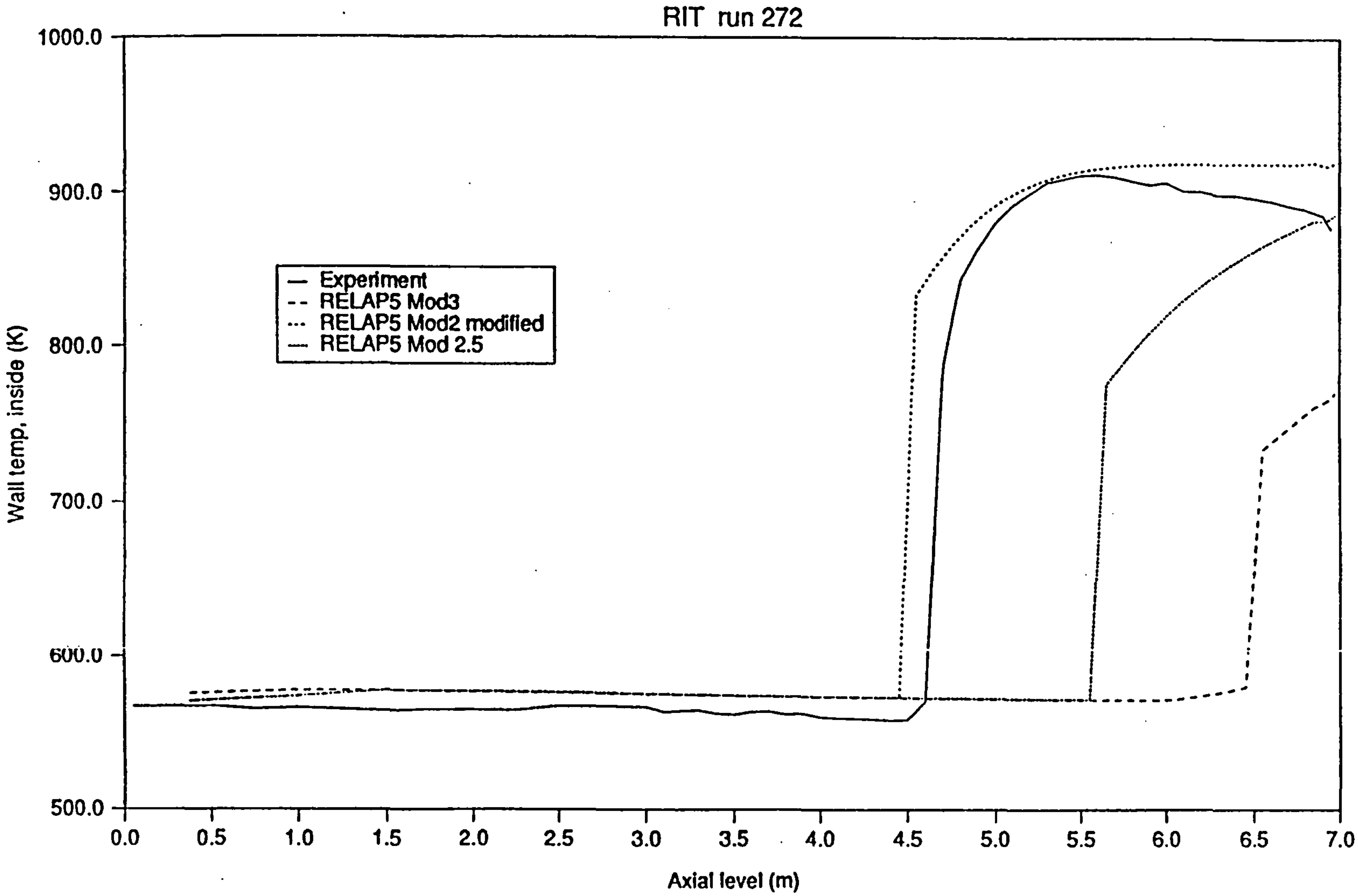
Inner wall temperatures for run 261
p=7.02 MPa, G=1998.2 kg per sqm-s
delta-t=10.6 K, heat flux=1053 kW per sqm



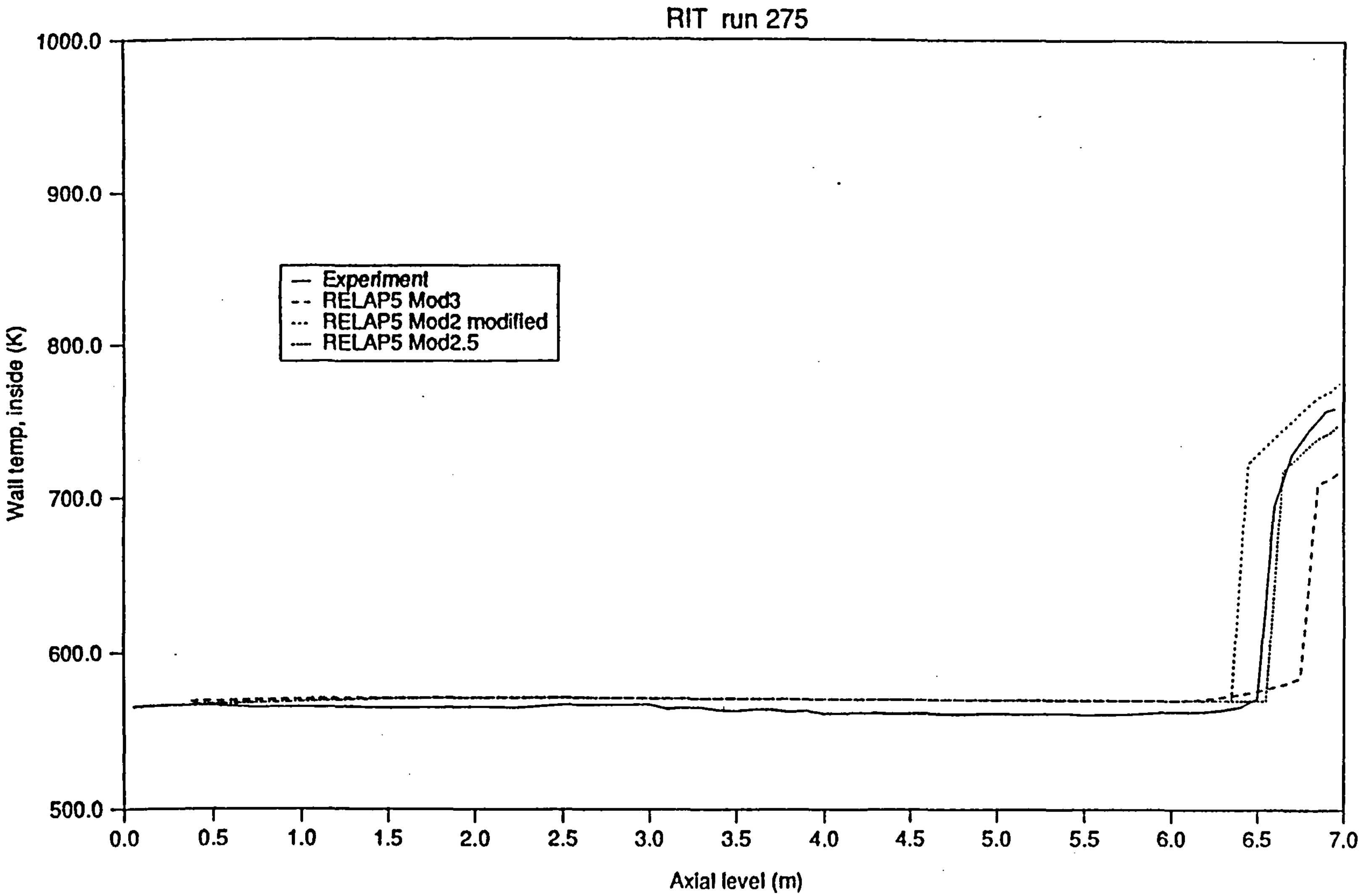
Inner wall temperatures for run 264
p=6.99 MPa, G=1500.2 kg per sqm-s
delta-t=11.0 K, heat flux=766 kW per sqm



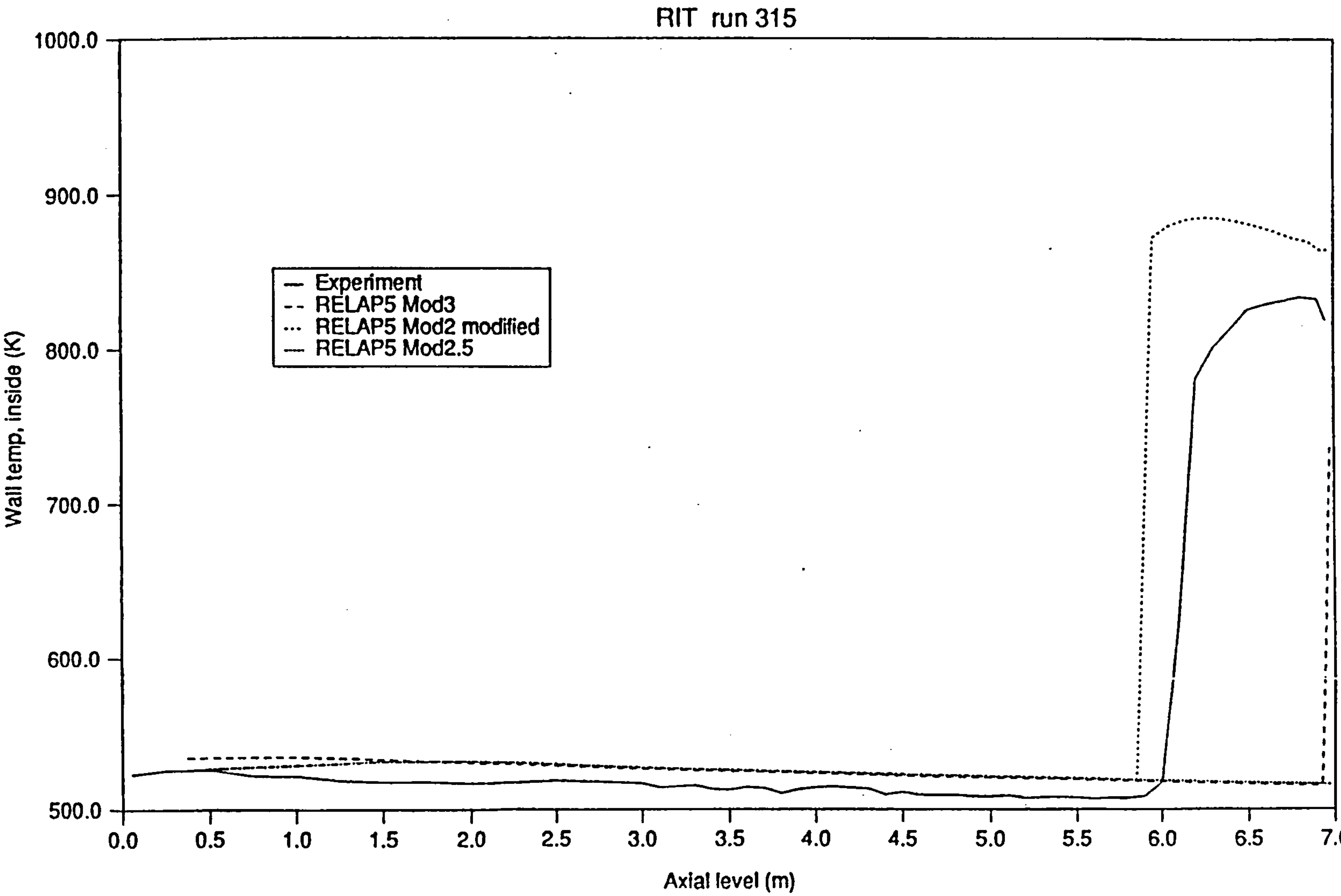
Inner wall temperatures for run 270
p=7.02 MPa, G=996.5 kg per sqm-s
delta-t=12.0 K, heat flux=660 kW per sqm



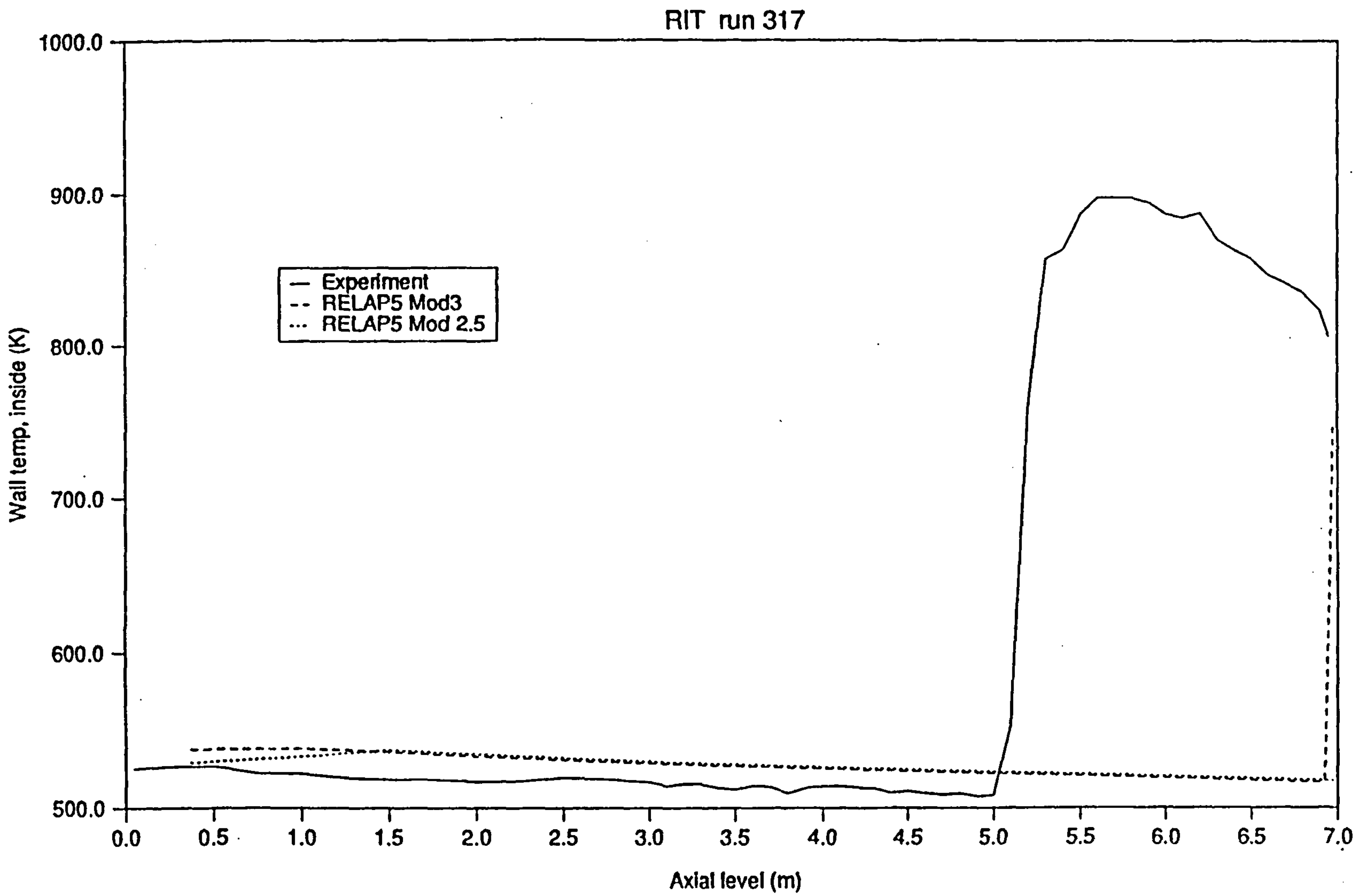
Inner wall temperatures for run 272
p=7.02 MPa, G=999.6 kg per sqm-s
delta-t=11.7 K, heat flux=815 kW per sqm



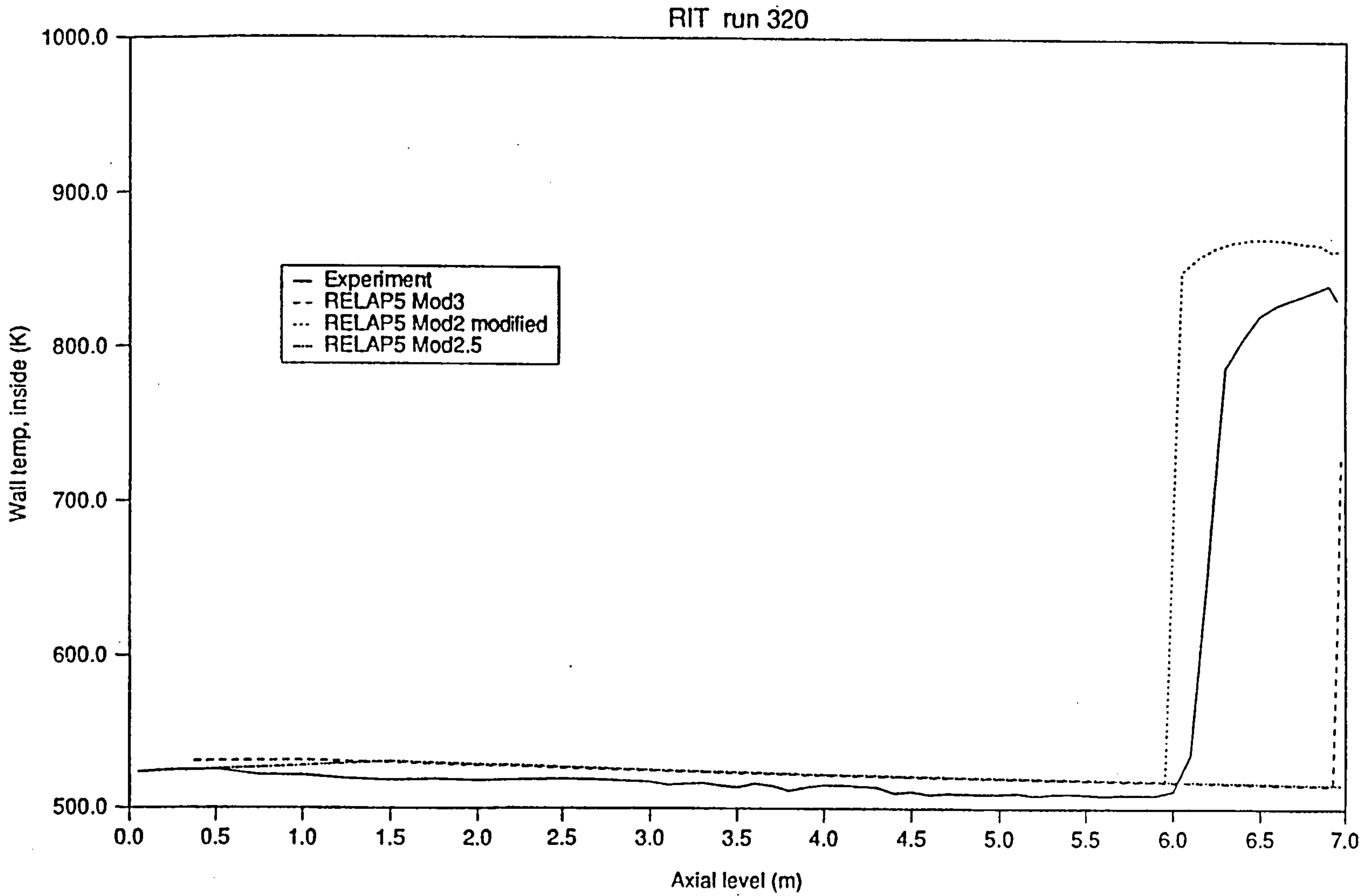
Inner wall temperatures for run 275
p=7.01 MPa, G=500.9 kg per sqm-s
delta-t=11.7 K, heat flux=410 kW per sqm



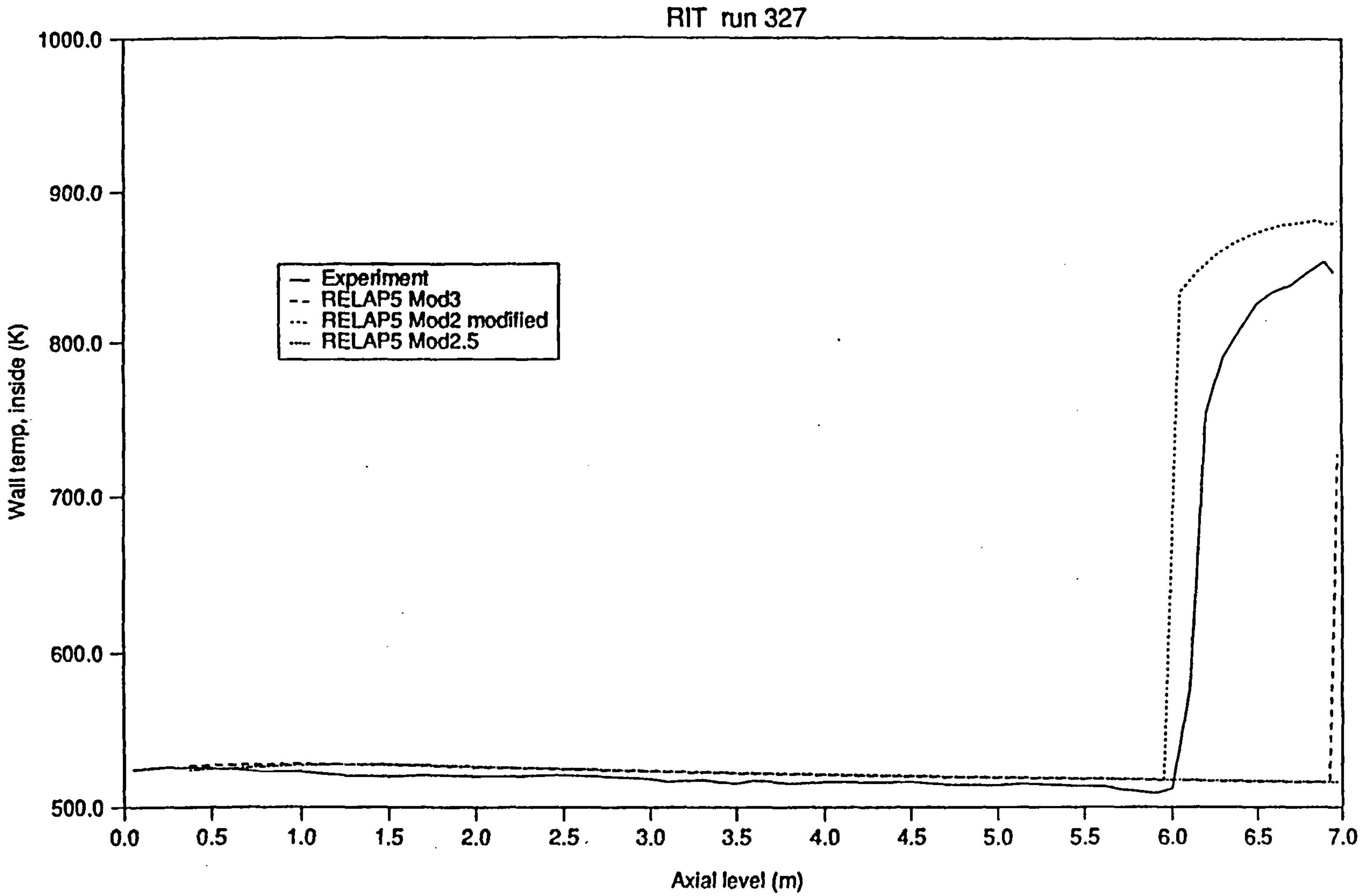
Inner wall temperatures for run 315
p=3.01 MPa, G=1986.3 kg per sqm-s
delta-t=9.2 K, heat flux=873 kW per sqm



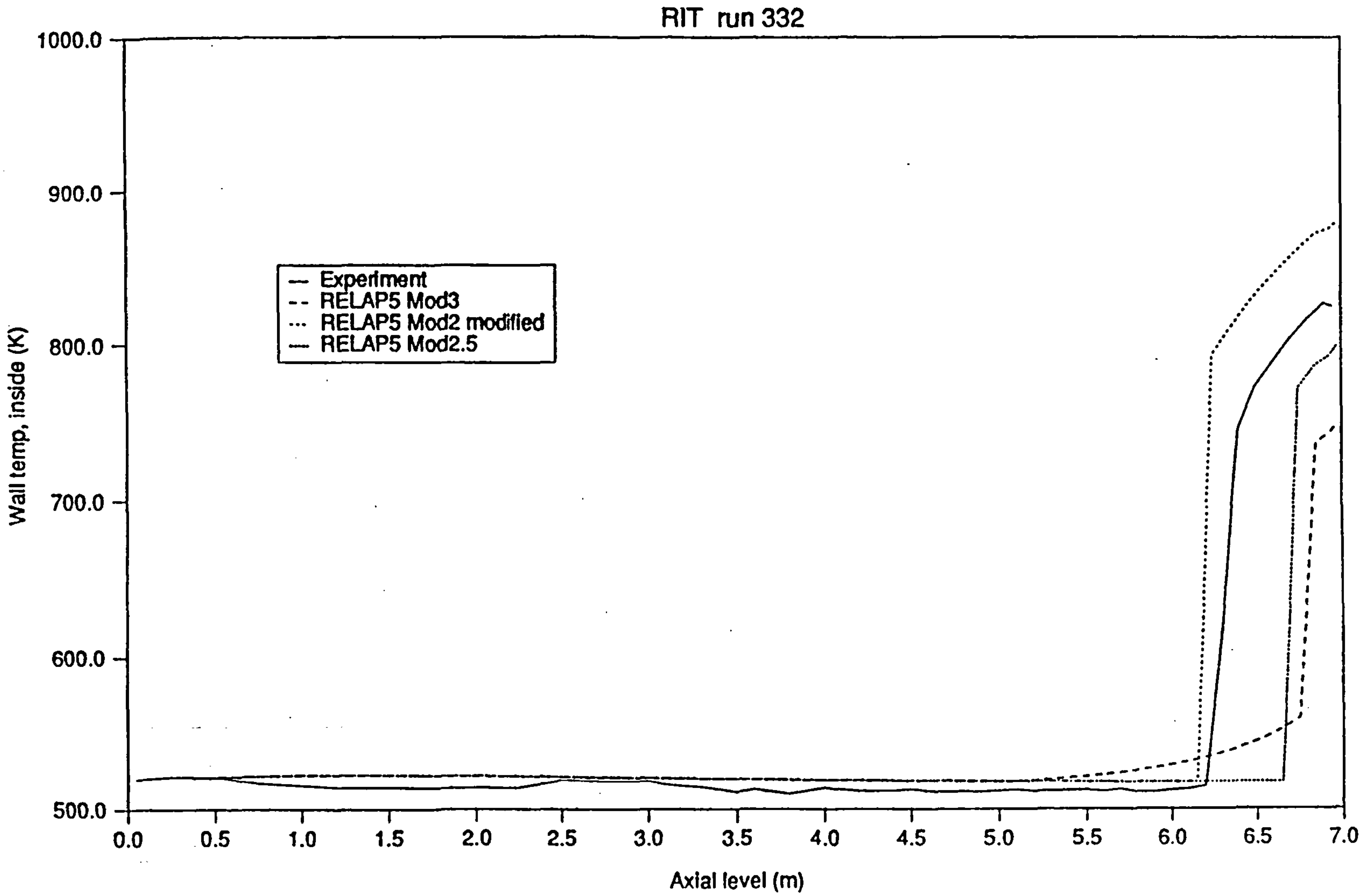
Inner wall temperatures for run 317
p=3.03 MPa, G=1987.3 kg per sqm-s
delta-t=10.2 K, heat flux=1058 kW per sqm



Inner wall temperatures for run 320
p=2.99 MPa, G=1499.3 kg per sqm-s
delta-t=9.2 K, heat flux=769 kW per sqm



Inner wall temperatures for run 327
p=3.00 MPa, G=1005.6 kg per sqm-s
delta-t=9.9 K, heat flux=667 kW per sqm



Inner wall temperatures for run 332
p=3.00 MPa, G=496.4 kg per sqm-s
delta-t=9.3 K, heat flux=464 kW per sqm

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10. SUPPLEMENTARY NOTES

11. ABSTRACT (200 words or less)

Assessment of RELAP5/MOD2 has been made against various experimental data, among other data from twenty-five post-dryout experiments conducted at the Royal Institute of Technology (RIT) in Stockholm. As the MOD3 version of RELAP5 has now been released, incorporating a different method of calculating critical heat flux compared to RELAP5/MOD2, it seemed justified to make another assessment against the same RIT-data.

The results show that the axial dryout position is generally better predicted by the MOD3 than by the MOD2 version. The prediction is, however, still nonconservative, i.e. the calculated dryout position falls in most cases downstream the actual measured point. While the pre-dryout heat transfer seems to be equal for MOD2 and MOD3, both versions giving slightly higher wall temperatures than the experiments, there is a considerable difference in the post-dryout heat transfer. The results of the RIT data comparison indicate that MOD3 underpredicts the post-dryout heat transfer. The results of the RIT data comparison indicate that MOD3 underpredicts the post-dryout wall temperatures remarkably while MOD2 gave reasonable agreement. In this respect RELAP5/MOD3 shows no improvement over RELAP5/MOD2.

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

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RELAP5/MOD3
Twenty-Five Post-Dryout
Royal Institute Technology

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