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Projekt Schneller Brüter

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by

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Abstract

This comparative study of a hypothetical ramp accident for the fresh SNR-300 Mark 1 and Mark 1A cores shows the influence of the different core design parameters on the energy stored in the fuel at the end of the disassembly phase. Calculations are performed with the CARMEN/ KADIS code system and differences are carefully analysed and documented. The larger fuel inventory, the flatter power distribution and worth curves together with the more positive sodium void reactivity are mainly responsible for the more energetic excursion in the Mark 1A core disruptive accident.

Analyse eines schweren, hypothetischen Leistungsstörfalls für den Mark 1 und den Mark 1A Kern des SNR-300

Zusammenfassung

Die vorliegende Studie vergleicht die Energiefreisetzungen eines hypothetischen, schweren Leistungsstörfalls mit einer 5 $/sec Einleitungsrampe für den Mark 1 und den Mark 1A Kern des SNR-300. Mit dem CARMEN/ KADIS Code-System werden die Unfallverläufe simuliert und die wesentlichen Entwurfsparameter, die die Energiefreisetzung beeinflussen, analysiert. Die größere Brennstoffmasse, die flachere Leistungsverteilung und die flacheren Wertkurven sowie die höhere Natriumvoidreaktivität sind die Hauptursachen für die Erhöhung der Energiefreisetzung beim Mark 1A core.

REMARK

The results of the ramp accident analysis for the SNR-300 Mark 1 and Mark 1A reactor cores reflect the status of the analysis at the beginning of 1974. Since that time more refined methods have been applied to analyze these ramp accidents; especially a more consistent treatment of the fuel coolant interaction in the predisassembly and disassembly phases of the accident has considerably decreased the absolute values of the energy releases for both SNR-300 reactor cores. The comparative accident analysis for the two reactor cores and the influence of the various design parameters as presented here are still valid with respect to the tendencies indicated and they are of sufficient interest to warrant publication.

TABLE OF CONTENTS

1. Introduction

Two hypothetical whole core disruptive accidents are considered for the licensing procedures of the SNR-300-reactor:

1. Flow coastdown due to primary pump failure with simultaneous failure of the primary and secondary shutdown systems
2. An unlimited reactivity insertion rate (e.g. 5 $/sec) with simultaneous failure of the primary and secondary shutdown systems.

Since the first accident calculations were performed for the SNR-300-Mark 1 core /1/ in 1971-72, a new reference core was designed, the Mark-1A. This core has a larger fuel inventory, a flatter power density distribution, and a more positive sodium void reactivity effect. Consequently, the licensing procedure needed a comparative safety study between both cases for some representative accidents. The present report gives a comparison for the 5 $/s reactivity accident of the fresh Mark 1 and Mark 1A cores. This initiating event was shown to give a higher energy release than the flow coastdown for the Mark 1 core /1/ and this is the reason that it is chosen for the comparison.

The accidental sequence consists of two phases: the predisassembly- and the disassembly-phase, which are calculated by the two coupled computer codes CARMEN2 and KADIS. In section 2 the two cores Mark 1 and Mark 1A are described and the most important differences of both cores are explained. In section 3 the calculational methods are briefly discussed and some remarks about details of the accident analysis are made. In section 4 the results of the pre-disassembly- and disassembly-calculations are presented. Particular attention is paid to the energy release and the amount of energy in the molten fuel at the end of the disassembly phase. A short sensitivity study is also presented for the main parameters, which are modified in accordance with the transition from Mark 1 to Mark 1A. Finally, section 5 gives some conclusions.

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2. Models and input data

2.1 The Mark-1 core

The Mark-1 reactor core has two zones of different enrichment. There are 73 fuel elements with 22.3 % Pu in the inner zone, and 78 fuel elements with 32.2 % Pu in the outer zone. Each element contains 169 fuel rods. The core height for operating conditions is 96.24 cm.

The radial blanket is formed by 228 blanket elements. The thickness of the upper and lower axial blankets is 40 cm each.

The safety and the control systems of the reactor consist of two independent scram systems, composed of 6 shut down rods in the inner core zone, and of 12 control rods at the interface between both zones.

The cross-section of the core is given in fig. 1; the two dimensional R-Z models used in the calculations are shown in fig. 2 and 3. These geometrical models are similar to the models used for the SAS-VENUS calculations performed at the A.N.L. /1/.

For the predisassembly phase, the CARMEN calculations are done with 6 annular channels for the inner core zone, and 3 annular channels for the outer core zone. Each channel is represented by a typical fuel pin, its cladding, the associated coolant and the structural material. Axially, each channel is divided into 4 nodes in the upper axial blanket, 10 nodes in the core, and 3 nodes in the lower axial blanket (fig. 2).

For the calculation of reactivity coefficients used in the KADIS code, there are 3 regions for the inner zone and 3 regions for the outer zone (fig. 3); the subassembly ring located at the transition from one zone to the other is composed of fuel elements of both zones; this ring and the following ring of the outer zone are divided axially into two regions, in order to distinguish the regions containing control rods (in the upper part of the core) and those containing followers (in the lower part). The hydrodynamic mesh used in KADIS is identical with the CARMEN mesh shown in fig. 2.

2.2 The Mark-1A core

The Mark-1A core is also divided into two zones of different enrichment; the first zone (inner core) contains 115 fuel elements (with 24.9 % Pu), the second zone (outer zone) contains 90 fuel elements (with 35.9 % Pu). There are 166 fuel rods and 3 tie rods in each fuel element. These numbers reflect that the Mark-1A core (equivalent radius of 90.27 cm) is larger than the Mark-1 core (equivalent radius of 78.95 cm), but the radial blanket is smaller: only 96 elements (equivalent thickness of 18 cm) instead of 228 elements (equivalent thickness of 42 cm) in the Mark-1 design.

Under operating conditions, the core height is 96.42 cm; the thickness of the upper and lower axial blankets is respectively 40.20 cm and 40.13 cm.

Three control rods in the inner core zone and 6 ones at the interface between core zones compose the primary shut down system. The secondary system is formed by 3 safety rods in the inner zone. In this core model "diluents" are not taken into account.

The cross-section of the Mark-1A core is given in fig. 4; the geometrical models with the two dimensional R-Z representations are shown in fig. 5 and 6.

For the predisassembly calculations performed by the CARMEN-2 code 7 annular channels are used for the inner zone and 2 annular channels for the outer zone. Axially, each channel is divided into 10 nodes in the core and into 3 nodes in each axial blanket (fig. 5).

The reactivity coefficients used in the KADIS code are calculated by dividing the Mark 1A core into regions as follows: the inner zone is divided into 8 regions, and only 1 region represents the outer zone (fig. 6). As in the Mark-1 model, rings are divided axially into 2 regions in order to bring a distinction between the zones containing absorbing materials and those containing rod followers. The hydrodynamic mesh used in KADIS is identical with the CARMEN mesh shown in fig. 5.

2.3 Input data and differences between Mark-1 and Mark-1A cores

A summary of the input data and of the differences between Mark-1 and Mark-1A is given on table I. The most important differences are:

The Mark-1A core has

- a higher fuel inventory
- a flatter radial power distribution
- a lower power per pin
- a higher sodium reactivity
- a slightly less negative Doppler coefficient.

In fig. 7 one can see the radial power distribution of both cores; the figure shows also a flatter Mark-1 power distribution, which is similar to the Mark-1A distribution, i.e. which gives for both core zones the same values of radial power shape factor; the latter power distribution is used for the sensitivity calculations (see later § 4.2).

The sodium channel voiding pattern as a function of time, which is used in the predisassembly phase is assumed to be the same for both cores; it is obtained from calculations of fuel-coolant interaction performed at the A.N.L. /1/, and it is displayed in fig. 8.

For the Mark-1, the values and the local distribution of the Doppler coefficient and of the sodium reactivity are those used in previous calculations at the A.N.L. /1/.

For the Mark-1A core, these values were obtained by perturbation calculations, which were performed by Interatom. It must be mentioned that there is a distinction between sodium density reactivity and sodium void reactivity, i.e. between reactivity variations due to density changes with temperature increase and reactivity variations due to the sodium voiding after initiation of fuel coolant interactions.

A detailed list of the input data set for the Mark-1 and Mark-1A CARMEN calculations is given in appendix 1.

In the disassembly phase, the total material reactivity worth curves are used to calculate the nuclear feedback caused by material motion. The data for the Mark-1 core are taken from the ANL calculations /1/ . The reactivity worth curves for the Mark-1A core have been calculated at the INR /2/.

A list of reactivity coefficients for the Mark-1 and Mark-1A KADIS calculations is given in appendix 2.

3. Calculation methods

3.1 Short description of the computational methods

The predisassembly phase of the accident, i.e. the dynamic behaviour of the fast reactor core from steady state initial conditions till the core disassembly start, is calculated by the multichannel CARMEN2 code of BELGONUCLEAIRE - Brussels. The code consists of coupled modules describing point neutron kinetics, thermodynamics of cylindrical fuel elements with temperature dependent properties, sodium boiling and ejection processes in the channels, space dependent reactivity feedbacks etc. The core channel voiding scheme can also be specified by input data; in this way the result of a fuel-coolant interaction is simulated.

A detailed description of the code and the calculation methods is given in /3/ with a comparison between CARMEN2 results and SAS2A (ANL) results for the same 5 $/s accident of the SNR 300 Mark 1 core; the agreement is quite satisfactory. The code CARMEN2 is operational on the IBM 370/168 computer of the Karlsruhe Nuclear Center.

The CARMEN2 code uses a pin failure criterion based on fuel temperature and fraction of molten fuel. The switch-over from the predisassembly to the disassembly phase takes place when the average temperature in the hottest fuel pellet exceeds a prespecified threshold temperature. The data transfer between the CARMEN2 and the KADIS code is accomplished by a magnetic tape created by CARMEN2, which contains the image of the input data cards as required by KADIS.

The disassembly phase is calculated by the GfK-code KADIS /4/. This code describes the process of pressure build up and material motion during a prompt critical excursion by solving the Navier-Stokes hydrodynamic equations for a compressible fluid. The fission energy heats up the fuel adiabatically, heat transfer to sodium can be described by an FCI module. Reactivity feedbacks due to Doppler broadening and material motion can be accounted for. This motion feedback leads finally to a shut down of the reactor. The major results of the code are the amount of molten fuel, the energy deposited in the molten fuel masses and the temperature distributions at the end of the excursion. Other results are the power-, pressure-, velocity-, density- and temperature-distributions as functions of time. The kinetic energy, as described by velocity and density distributions, can also be obtained from the calculations.

3.2 Discussion of some assumptions and models used for accident analysis

The comparative study was mainly performed in 1973. The first step was to reproduce the results obtained with the SAS2A/VENUS codes for the Mark 1 core in 1971 /1/, so that the same geometrical model and a similar way of calculation as in those previous calculations were used for the 5 $/s transient overpower accident of the SNR 300 core.

The chosen pin failure criterion is: 45 % of the fuel is molten for a length of 10 cm around the hottest point. The interaction between molten fuel and liquid coolant after pin failure is precalculated in a separate code using the Cho and Wright model /1,page 78/ and the obtained channel voiding pattern as a function of time is introduced by input data into the predisassembly calculation. The same pattern is used for all core channels after failure initiation for Mark 1 as well as for Mark 1A. It must be noticed that the real voiding starts 4 milliseconds after pin failure.

The threshold temperature for switch-over from the pre-disassembly- to the disassembly-phase, i.e. the average temperature of the hottest pellet, is 3250°C.

Several small improvements of the models were accomplished before the final comparison of the Mark 1 and Mark 1A cores was performed. They concern mainly the fuel initial density, the residual fraction of sodium in the channel voided region, the molten fuel fraction evaluation, and the "effective" fuel temperature transferred from the CARMEN2 to the KADIS code. (This "effective" temperature is calculated directly from the fuel energy content at the time of data transfer).

During the disassembly phase of the accident, an option allows to take into account a pressure increase due to local fuel coolant interactions (FCI) according to the Cho and Wright model. The FCI can be initiated in each KADIS mesh cell. The initialization criterion is a threshold fuel temperature (3100 K). A fraction of the fuel equal to the volumetric fraction of sodium vapor (compared to the total volume of sodium) is assumed not to participate in the heat transfer process.

The comparative results for both cores, which are discussed in the next section, were obtained with the last version of the code chain CARMEN2/KADIS in March 74. Some sentivity calculations were performed with earlier versions of the codes; consequently some slight differences appear for the reference cases.

4. Results

4.1 Detailed analysis

The table II provides the main final results of the pre-disassembly and disassembly phases for both cores. It is shown that with the same conservative assumptions relative to the accident evolution, the energy stored in the molten fuel at the end of the disassembly in Mark 1A is increased by a factor 2.10 or 2.62 in comparison with Mark 1, respectively without and with taking into account the fuel-coolant interaction during disassembly.

The figures 9, 10 and 11 show for both cases the time evolution of

- the core power in relative units
- the positive reactivity ramp, i.e. the time derivative of the sum of all the reactivity components, except the negative Doppler feedback
- the reactivity components (inserted ramp, Doppler, sodium density, sodium void and total).

The time points of pin failure for each channel are given, for both cores, in table III.

The power evolutions are very similar until the first pin failure occurs. As the steady state conditions of Mark 1A correspond to lower fuel temperatures, the first failure comes later, but after this initiation, the power increases faster in Mark 1A due to the more coherent failure of the pins and the following voiding process in the annular core channels (see the table of pin failure times). The more coherent voiding process is caused by the flatter power distribution and the higher maximum positive void reactivity of the Mark 1A core. At the start of disassembly, the power is about 2.8 times higher in Mark 1A than in Mark 1. One can see on the figure of the positive reactivity ramps, a delay between the pin failure initiation and the corresponding reactivity increase which is due to the four milliseconds delay between pin failure and start of channel voiding (see section 3.2). The ramp increases almost stepwise for each new channel voiding. Before the first pin failure, the ramp is about the inserted ramp (5 \$/s) for both cores; at the start of disassembly the ramp is 57.8 \$/s for Mark 1 and 92.4 \$/s for Mark 1A. Another important difference at the start of disassembly is the total reactivity: 1.091 \$ for Mark 1 and 1.157 \$ for Mark 1A.

Figure 12 gives the axial profiles of the central fuel temperatures in the central channel of the cores and in the outer channel of the first radial core zone, at steady state and at the start of disassembly. The lower steady state temperatures for Mark 1A explain the longer duration of the predisassembly phase, since the failure criteria correspond to the same temperature for both cores. At the start of disassembly, the profiles in the central channel are very similar due to the identity of the switch-over criterion. On the other hand, there is more molten fuel in the Mark 1A core as can be deduced from the profile in the outer channel of the first enrichment zone.

In Fig. 13 the power histories during the disassembly phase have been plotted for the Mark 1 and the Mark 1A cores respectively. The differences in time and maximal values are remarkably high. The larger energy content together with a higher reactivity input at the beginning of disassembly leads to an earlier shut down of the power excursion in the Mark 1A core. When using the FCI module the quick and high pressure build up of the FCI leads to an earlier disassembly compared to the cores where only the (one and two phase) fuel pressure gradients were used as a driving force for disassembly. The following FCI parameters were applied in using the Cho-Wright model: fuel particle radius 150 μ, mixing time constant 3 msec. Fig. 14 shows the corresponding energy releases and fig. 15 the net reactivities. In fig. 16 the reactivity components for the different cases are plotted. The inserted ("programmed") reactivity ramps are quite different for Mark 1 and Mark 1A corresponding to the different void reactivities of the two cores.

4.2 Parametric sensitivity study from Mark 1 to Mark 1A

The results of a sensitivity study with respect to the different design parameters of both cores are summarized on table IV. Some more detailed results are given in table V.

The flatter radial power distribution of the Mark 1A core is responsible for a big increase of the energy stored in the molten fuel: a Mark 1 case calculated with a radial power distribution similar to the Mark 1A distribution (i.e. with the same power shape factor in both core zones, see fig. 7) produces a 35 % higher value for the energy stored in the molten fuel. This is mainly due to the fact that, with a flatter power distribution, the voiding process occurs more coherently, which gives a bigger positive sodium void range, when disassembly occurs; in addition, the steady state fuel temperature in the central channel is smaller and the duration of the predisassembly phase is larger.

The energy increase due to the change of the sodium reactivity distribution is also very remarkable: 27 %. As mentioned in § 2.3, there is a difference, for the Mark 1A design, between sodium void and sodium density reactivity; the shape of both reactivity distributions is the same, but the total positive reactivity value is higher for the density reactivity.

The influence of the material worth curves used in the disassembly phase was also considered. For these sensitivity studies the worth curves have been divided by 3. We observe a rather weak influence on the energy stored in the molten fuel. The increase in the energy deposited in molten fuel being only 12 %. This is related to the high energy input into the core before efficient disassembly starts.

The influences of the lower power per pin and of the changes of Doppler coefficients are very small.

The lower power per pin (see table IV) delays strongly the time of disassembly, but the data transferred to the KADIS calculation (ramp, reactivity, power) are quite the same as in the base case. The difference due to the change of Doppler coefficients is derived from sensitivity studies performed during another parametric study /5/; in fact, the energy stored in the molten fuel is very sensitive to the Doppler, but the total value of Doppler for Mark 1 and Mark 1A are quite the same (Mark 1 Doppler is slightly (< 5 %) more negative).

The sum of all the considered contributions is also given in table IV. This value can only be considered as a very rough estimate for the total effect of going from the Mark 1 to the Mark 1A core. Nevertheless, the value of 113 % is not far from the difference between the energy stored in the molten fuel of Mark 1 and Mark 1A, as calculated for the two different cores without fuel coolant interaction in the disassembly phase, i.e. 110 % (see § 4.1 and table II).

5. Conclusions

- The accident analysis described in this report was obtained by recent computing tools (the CARMEN2 and KADIS codes) using conservative assumptions in view of comparisons with previous results for the SNR-300-Mark 1 core. The data for the new Mark 1A core design were still preliminary with respect to some important parameters such as power and reactivity worth distributions, but the objective was to provide first results of the energy release during a transient overpower accident for the new Mark 1A design.

- The energy stored in the molten fuel at the end of the disassembly phase for a 5 $/sec ramp accident is considerably higher (by more than a factor two) for the Mark 1A core if compared with the results for the Mark 1 core.

- A sensitivity study with respect to the different design parameters of the two cores has provided a reasonable understanding of the (quantitative) influence of the various design parameter changes on the energy stored in the molten fuel at the end of the disassembly phase. The increase of the energy stored in the molten fuel at the end of the disassembly phase for the Mark 1A core is mainly due to the flatter power distribution, the higher void reactivities, the flatter worth curves, and the larger fuel inventory.

6. Tables and Figures

Table I

Main differences between SNR-300 Mark-1 and Mark-1A data and parameters

Parameter	Mark 1	Mark-1A	(Mk1A/Mk1)-1
Core power (MW) (without radial blanket)	705	731	(+3.6 %)
Average power per pin (kW)	27.6	21.4	(-23 %)
Core radius (cm)	78.95	90.27	
Fuel inventory (kg)	4875	6411	(+31.5 %)
Number of pins	25519	34030	(+33 %)
Radial power shape factor	1.368	1.205	(-12 %)
Axial power shape factor (channel 1)	1.201	1.277	(+6 %)
Maximum specific power (W/g)	219	160	(-27 %)
Coolant flow rate in channel 1 (g/s)	147.5	102.5	(-30 %)
Maximum positive sodium void reactivity (Δk/k)	0.0106	0.0136	(+28 %)
Doppler reactivity coefficient (Δk/k/ΔT/T) (without radial blanket)	$-4.2 \; 10^{-3}$	$-4.1 \; 10^{-3}$	(-3 %)

Table II

CARMEN/KADIS results

5 $/s ramp accident, base cases

Core	Mark-1		Mark-1A	
Pre-disassembly phase				
Duration (ms)	330.6		350.5	
Final ramp rate ($/s)	57.8		92.4	
Final reactivity excess ($)	1.091		1.157	
Final power (10^6MW)	0.6261		1.770	
Final energy stored in the fuel (MJ)	3522		5881	
Final effective max.temp. (K)	3480		3530	
Disassembly phase	no FCI	with FCI	no FCI	with FCI
Maximum power (10^6MW)	0.993	1.03	2.80	2.83
Duration (ms)	4.03	2.48	2.88	2.02
Energy produced during the disassembly phase (MJ)	2660	1890	4820	4170
Energy deposited in the molten fuel (MJ)	2538	1613	5327	4225
Mass of molten fuel (kg)	3899	3333	5876	5710
Aver. temp. of molten fuel (K)	3887	3505	4472	4091
Maximum fuel temperature (K)	5415	4577	6491	5707
Max. rad. velocity (m/s)	14.18	64.96	59.44	45.21
Max. ax. velocity (m/s)	16.22	100.59	63.88	74.76
Max. rad.displacement (cm)	1.9	1.3	4.3	1.8
Max. ax. displacement (cm)	1.3	2.7	4.9	2.6

Table III

Moment of pin failure for each channel

Mark-1			Mark-1A		
Time (sec)	Channel	Core zone	Time (sec)	Channel	Core zone
0.3170	1	inner	0.3412	1	inner
0.3186	2	inner	0.3421	2	inner
0.3240	3	inner	0.3421	3	inner
0.3240	7	outer	0.3448	4	inner
0.3279	4	inner	0.3482	8	outer
0.3298	8	outer	0.3488	5	inner
0.3299	5	inner	0.3495	6	inner
0.3306	start of	disassembly	0.3500	7	inner
0.3312	6	inner	0.3505	start of	disassembly
0.3315	9	outer	0.3507	9	outer

Table IV

Parameter changes from Mark 1 to Mark 1A

Change	Energy of molten fuel (MJ)		Difference (%)
	base	modif.	
Flatter radial power distrib.	2676	3618	+ 35
Lower power per pin (-20 %)	2676	2826	+ 6
Na void and density distributions (+ 28 % and + 55 %, flatter distrib.)	2676	3406	+ 27
Flatter worth curves (factor 1/3)	2676	3006	+ 12
Doppler (< 5 %)	2676	2740	+ 2
Increase of fuel mass (+ 31 %)	no meaningful calculation possible.		estimate: + 31
Total			+ 113

Table V

Detailed results of the sensitivity study concerning the parametric changes from Mark-1 to Mark-1A

Change	-	Flatter radial power distribution	Lower power per pin	Higher sodium reactivity	Flatter worth curves
Predisassembly phase					
Duration (ms)	329.8	340.3	358.3	321.9	329.8
Final ramp rate ($/s)	58.2	58.7	57.2	80.8	58.2
Final reactivity excess ($)	1.087	1.127	1.095	1.141	1.087
Final power (10^6MW)	0.6356	1.174	0.7342	0.9390	0.6356
Final energy stored in the fuel (MJ)	3784	4404	4232	3837	3784
Final maximum fuel temperature (K)	3536	3530	3531	3536	3536
Disassembly phase					
Maximum power (10^6MW)	1.31	1.94	1.39	2.35	1.34
Duration (ms)	3.84	2.87	3.57	2.79	4.37
Energy produced during the disassembly phase (MJ)	3260	3690	3260	4010	3630
Energy deposited in the molten fuel (MJ)	2676	3618	2826	3406	3006
Mass of molten fuel (kg)	4324	4781	4442	4684	4506
Average temperature of molten fuel (K)	3814	4129	3854	4062	3925
Maximum fuel temperature (K)	5823	6220	5848	6422	6105

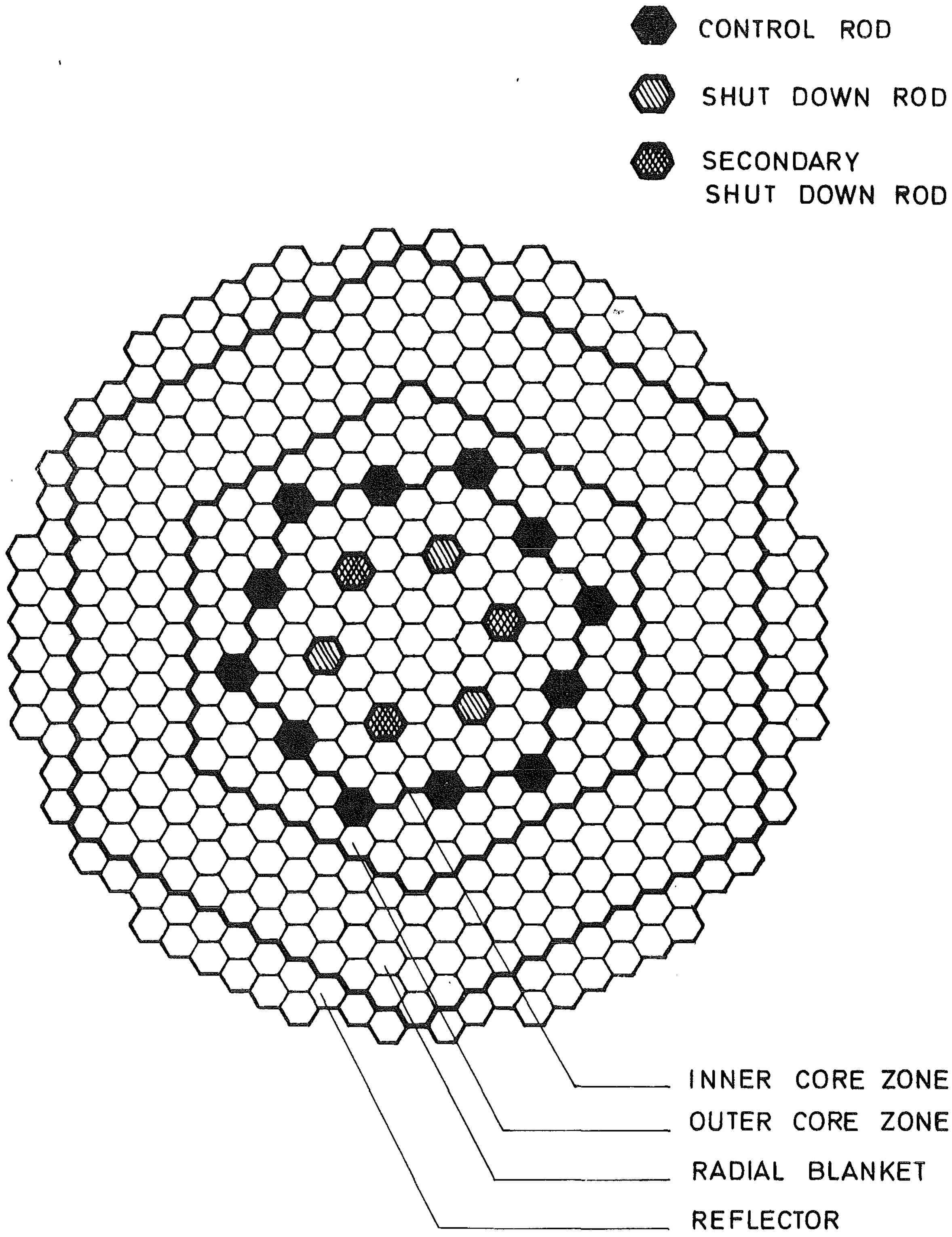
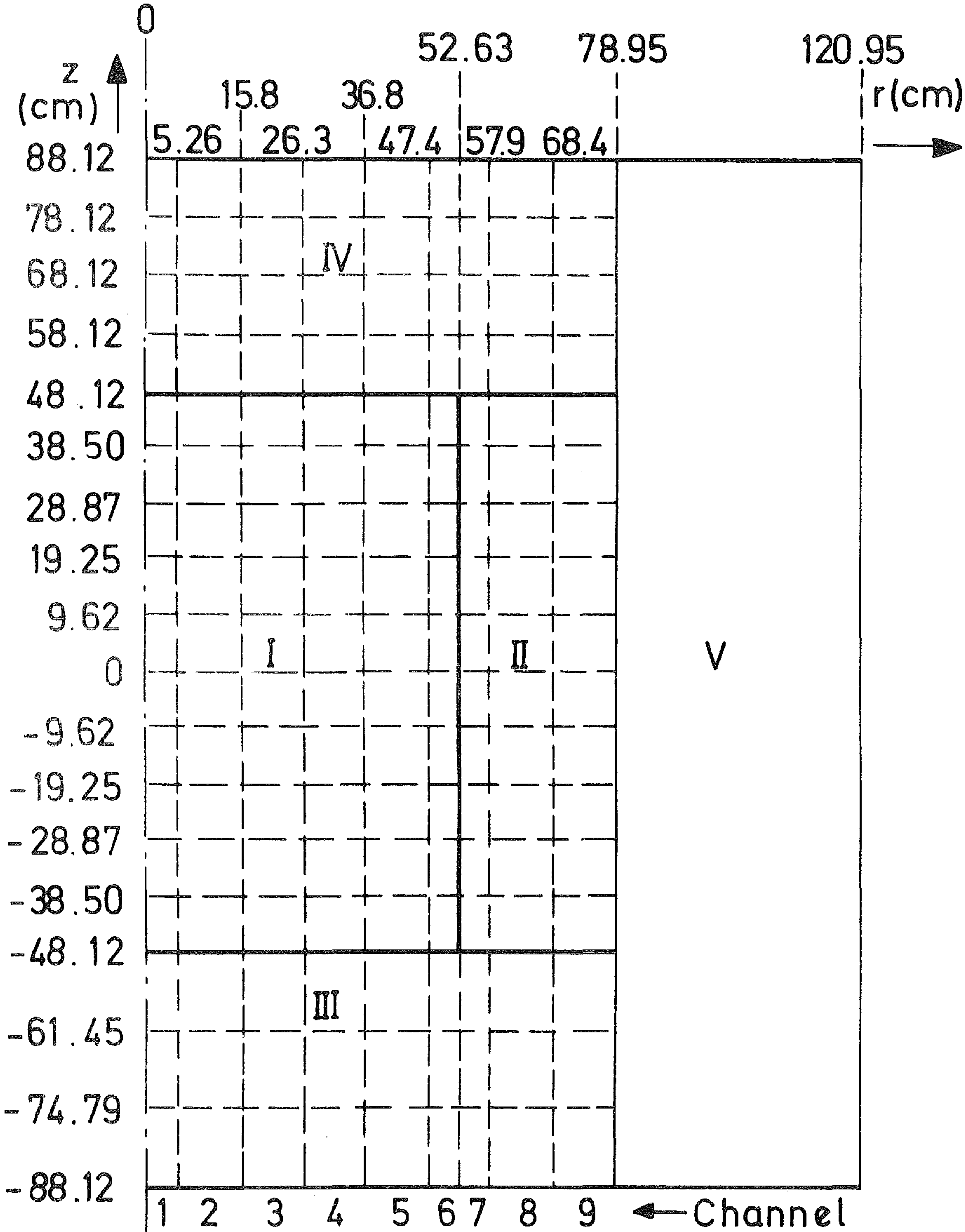


FIG. 1: SNR -300 MARK - 1 CORE



I Inner core zone
II Outer core zone
III Lower axial blanket
IV Upper axial blanket
V Radial blanket.

FIG. 2: SNR 300 MARK 1 CORE GEOMETRICAL MODEL FOR THE CARMEN 2 CODE

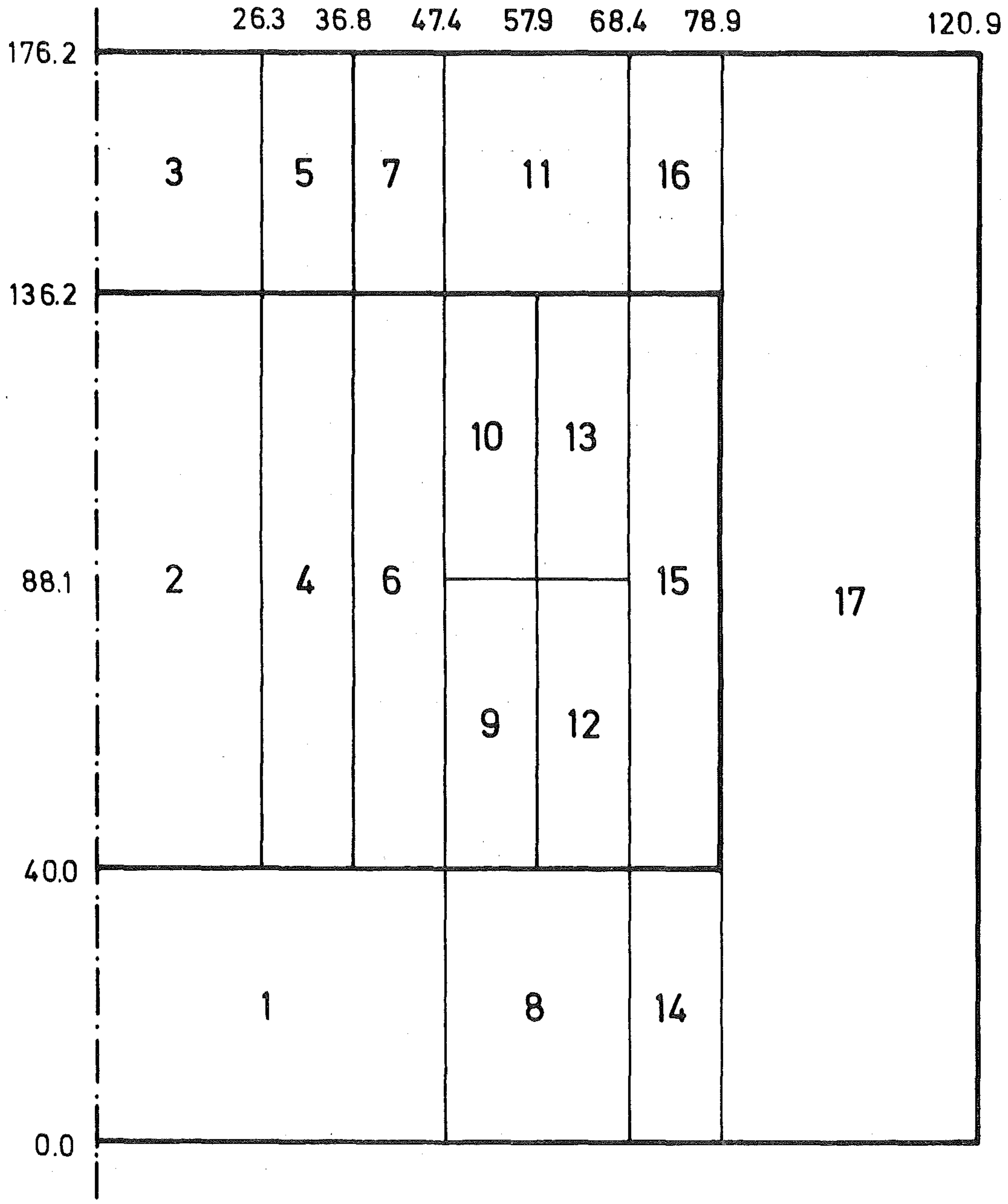


FIG. 3: MARK I-REGIONS FOR THE CALCULATION OF THE REACTIVITY-COEFFICIENTS USED BY KADIS (DOPPLER COEFFICIENTS AND TOTAL MATERIAL WORTH CURVES)

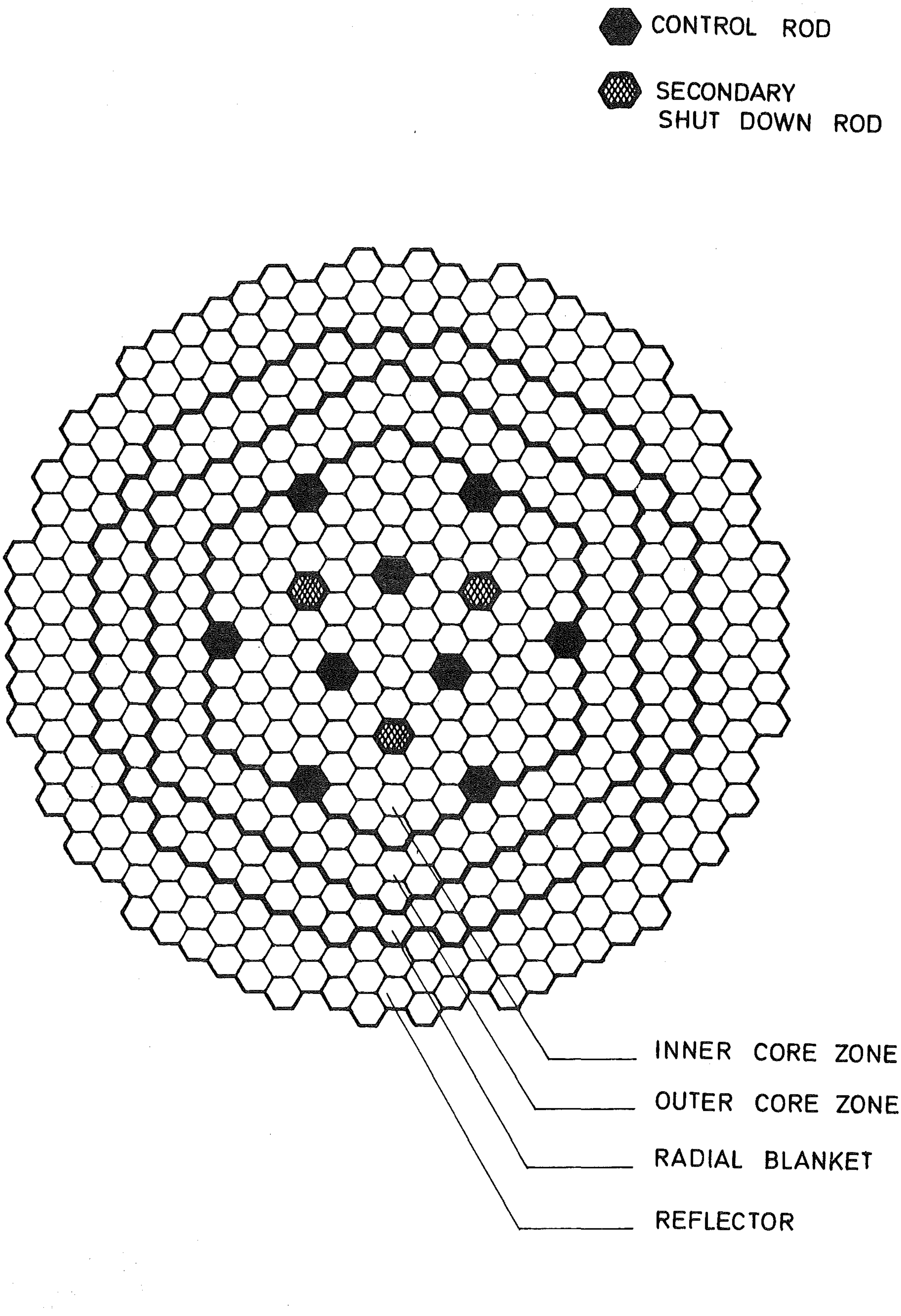


FIG.4: SNR-300 MARK-1A CORE

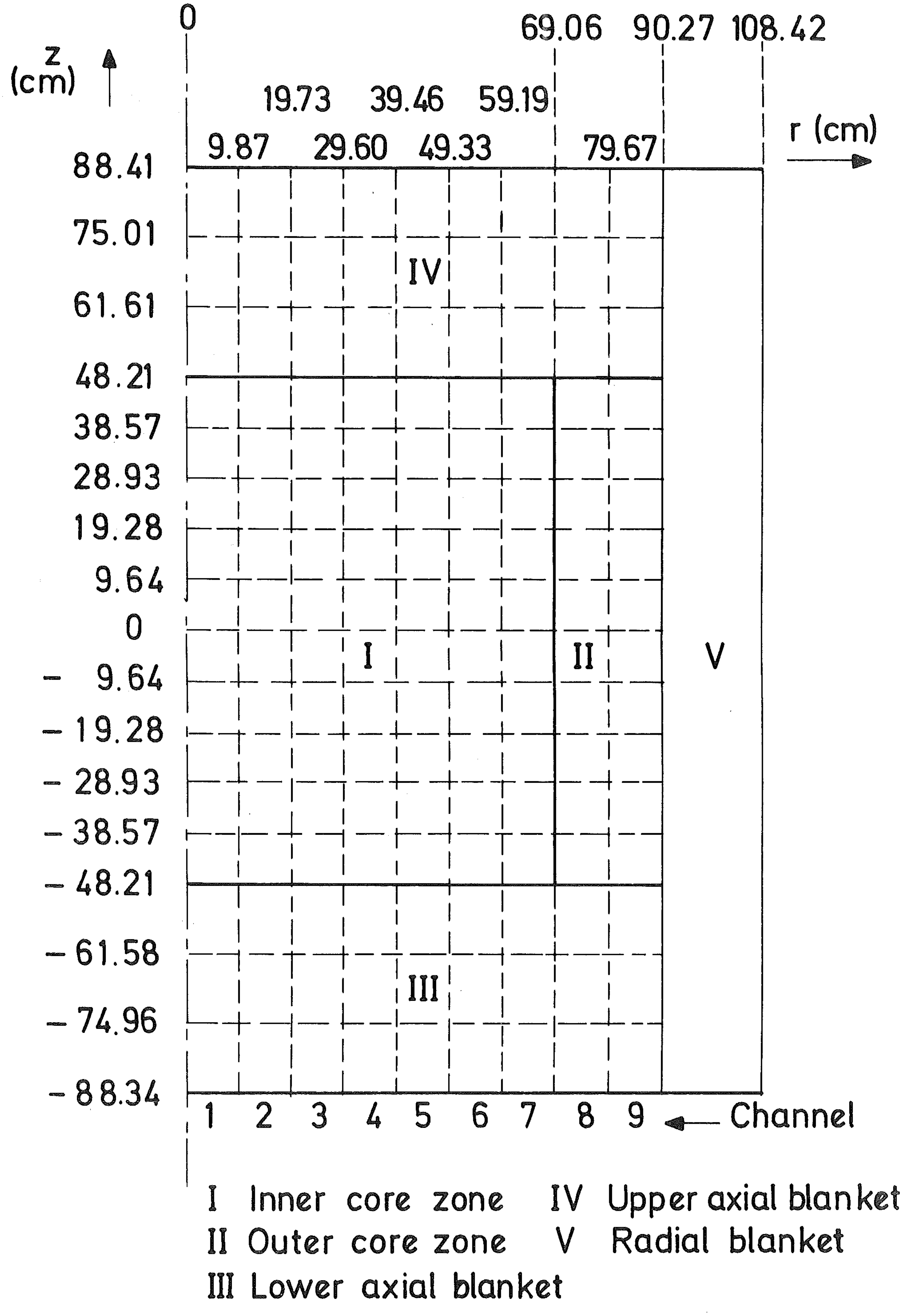


FIG. 5: SNR 300 MARK 1A CORE GEOMETRICAL MODEL FOR THE CARMEN 2 CODE

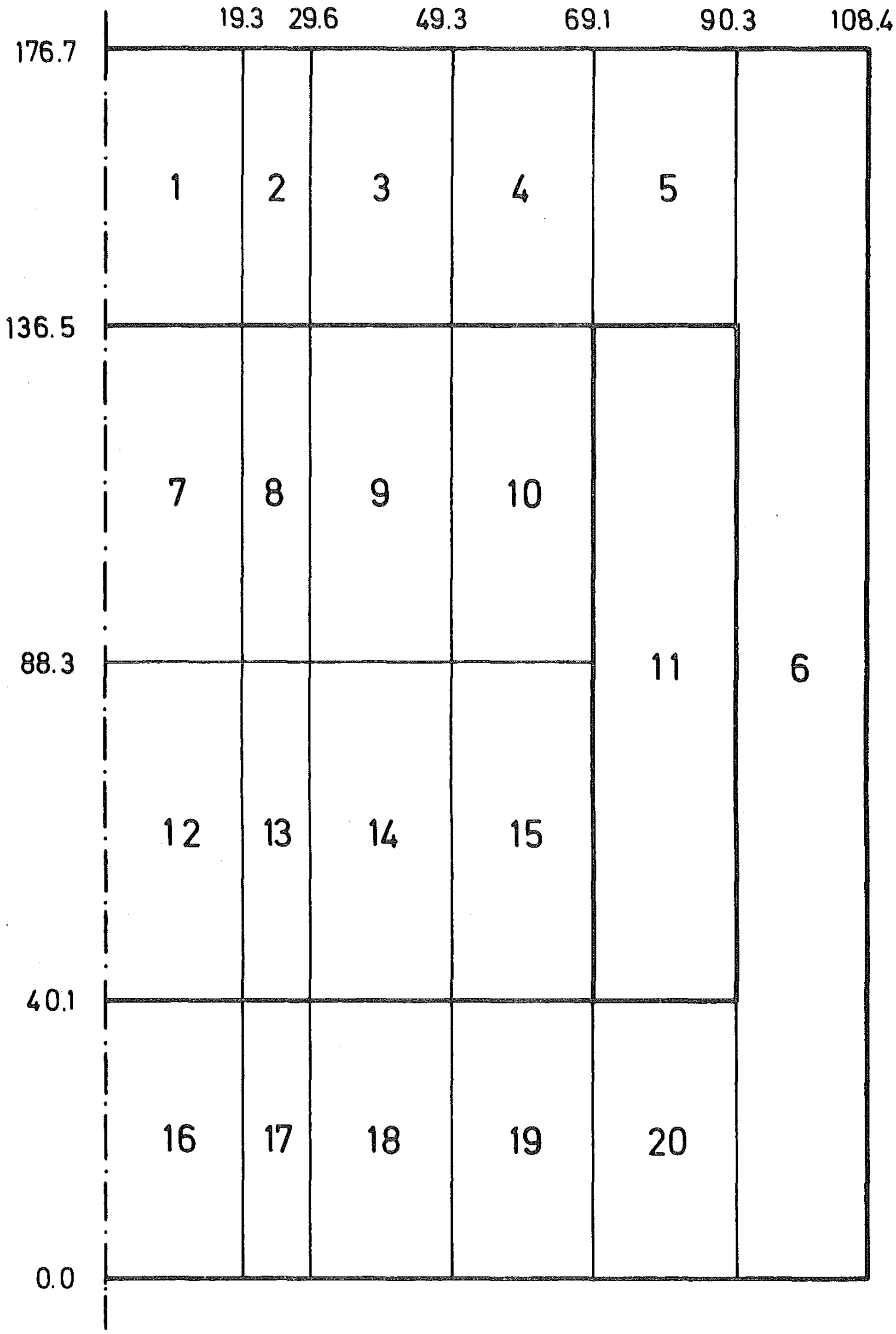


FIG. 6: MARK1A-REGIONS FOR THE CALCULATION OF THE REACTIVITY COEFFICIENTS USED BY KADIS (DOPPLER COEFFICIENTS AND TOTAL MATERIAL WORTH CURVES)

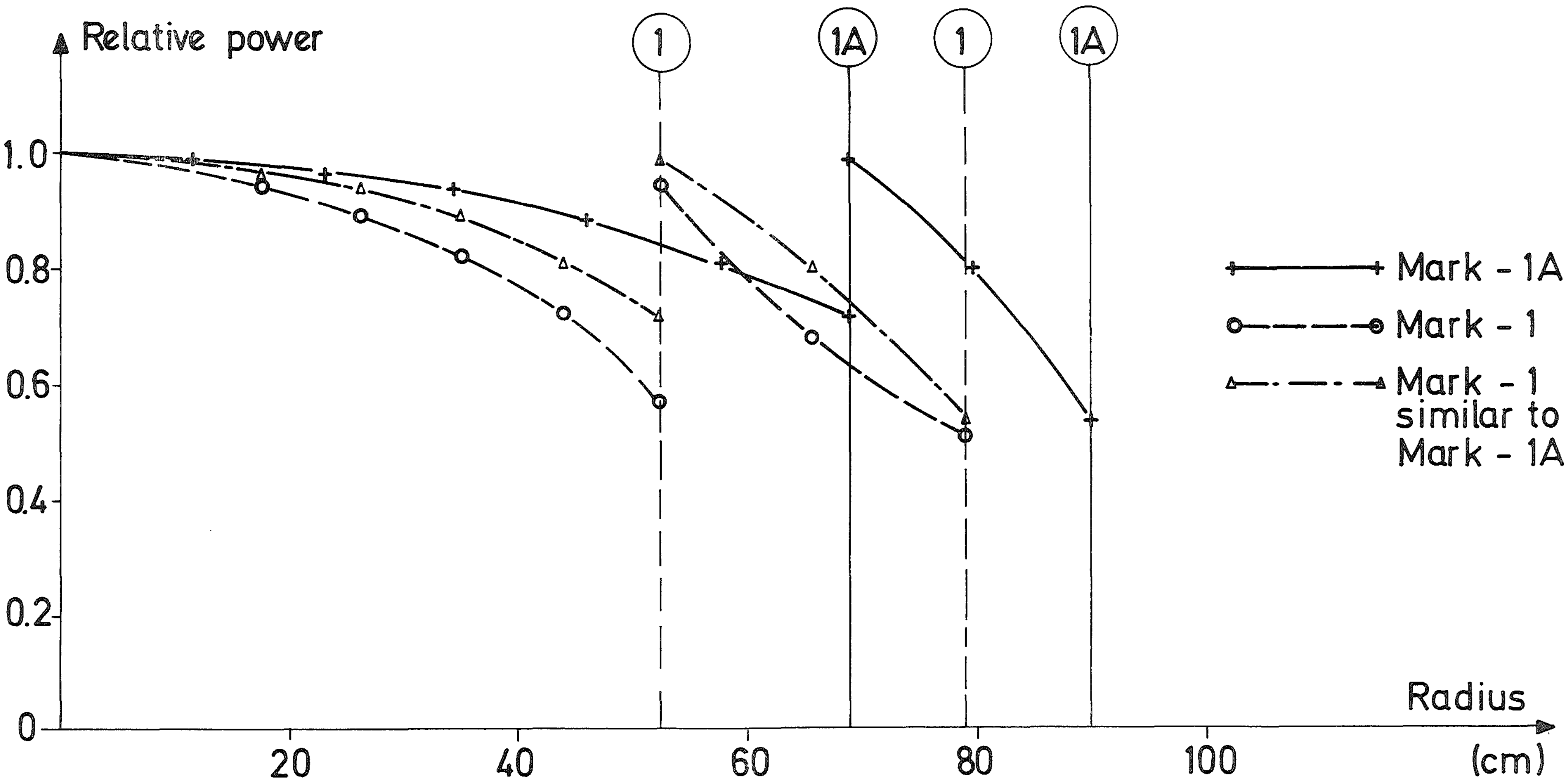


FIG. 7: RADIAL POWER DISTRIBUTION IN THE CORE

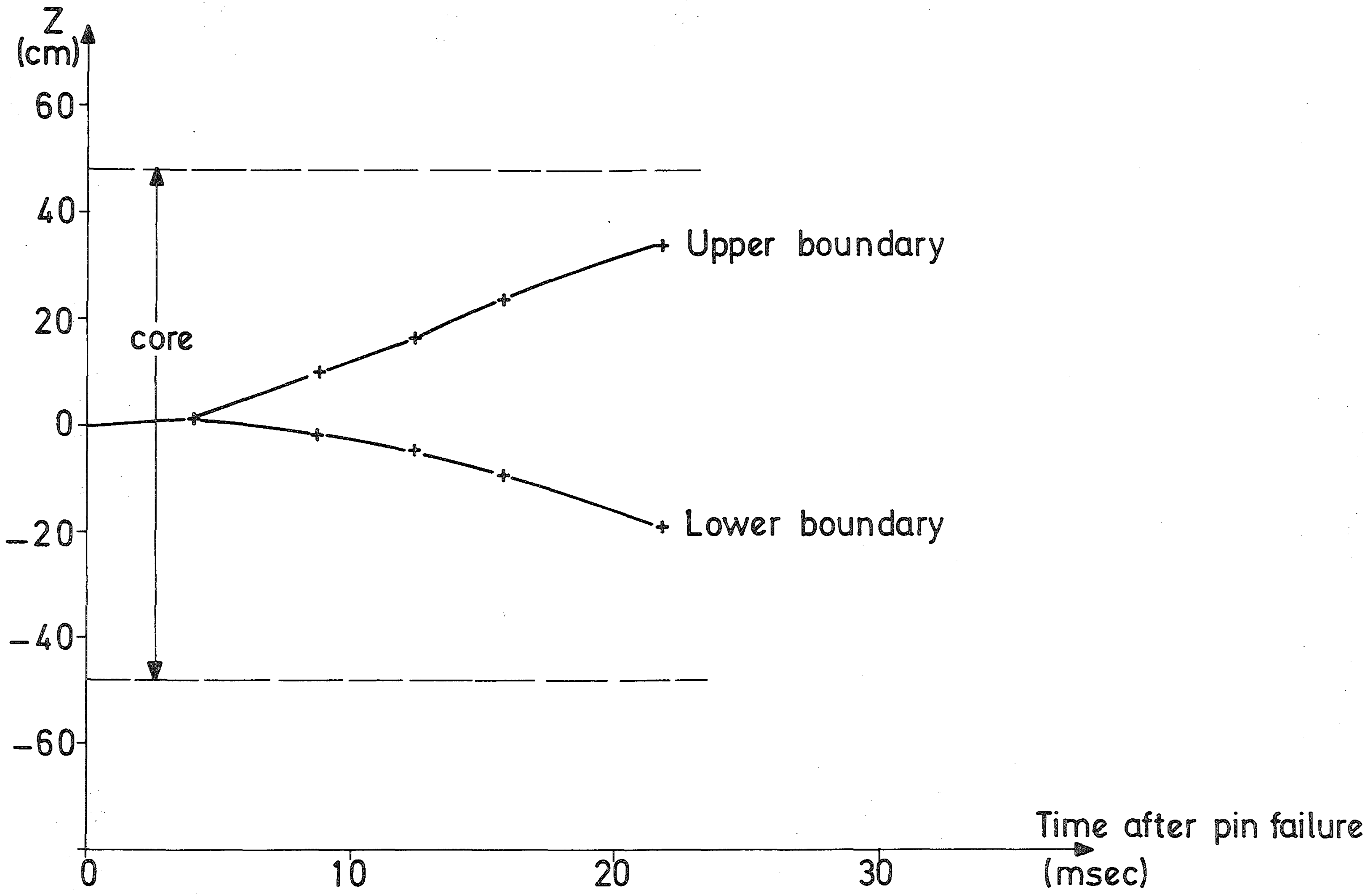


FIG. 8: SODIUM VOIDING PATTERN DUE TO FUEL-COOLANT INTERACTION
(In each channel)

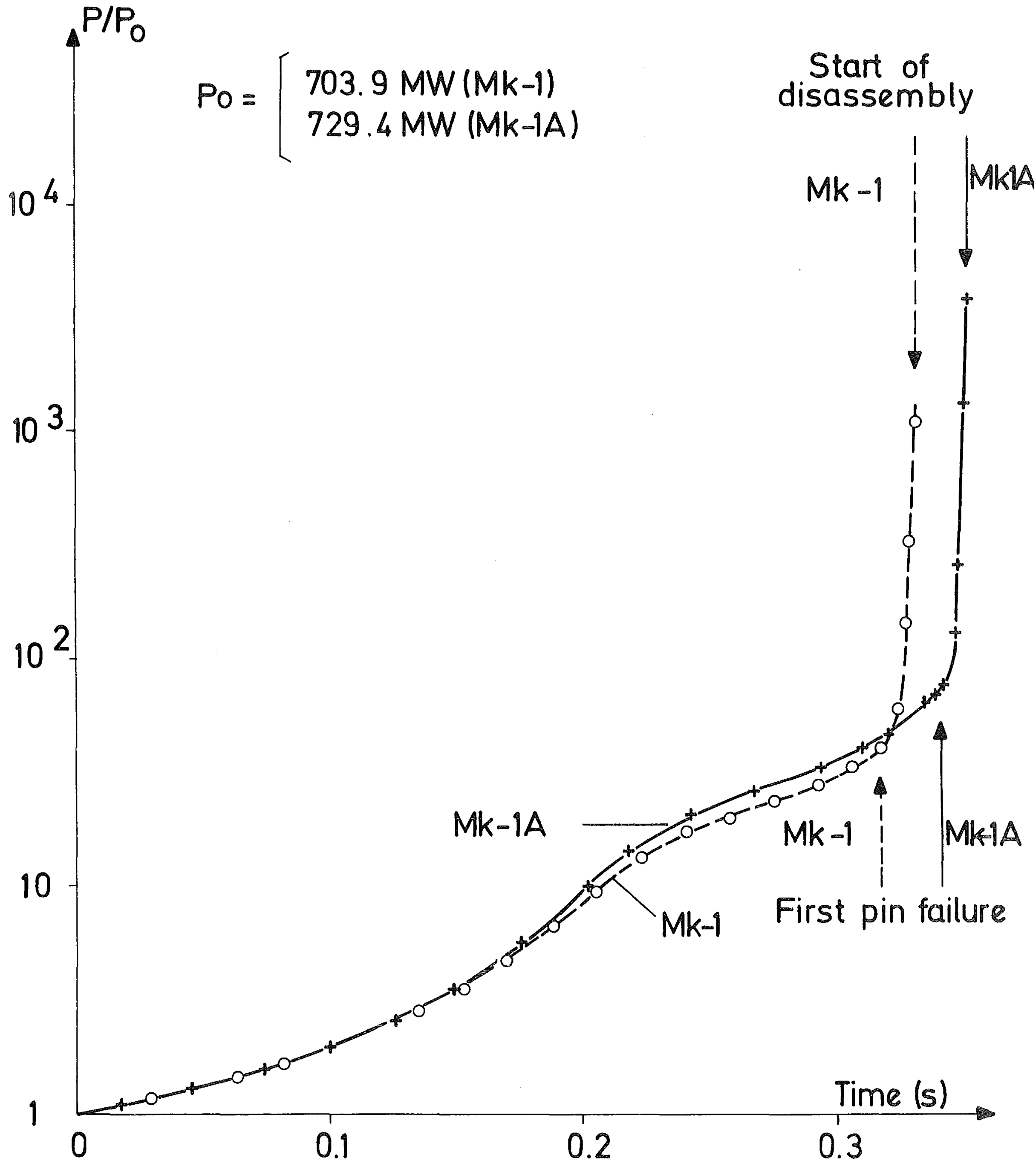


FIG. 9: NORMALIZED POWER VERSUS TIME
(5 $/s ramp accident)

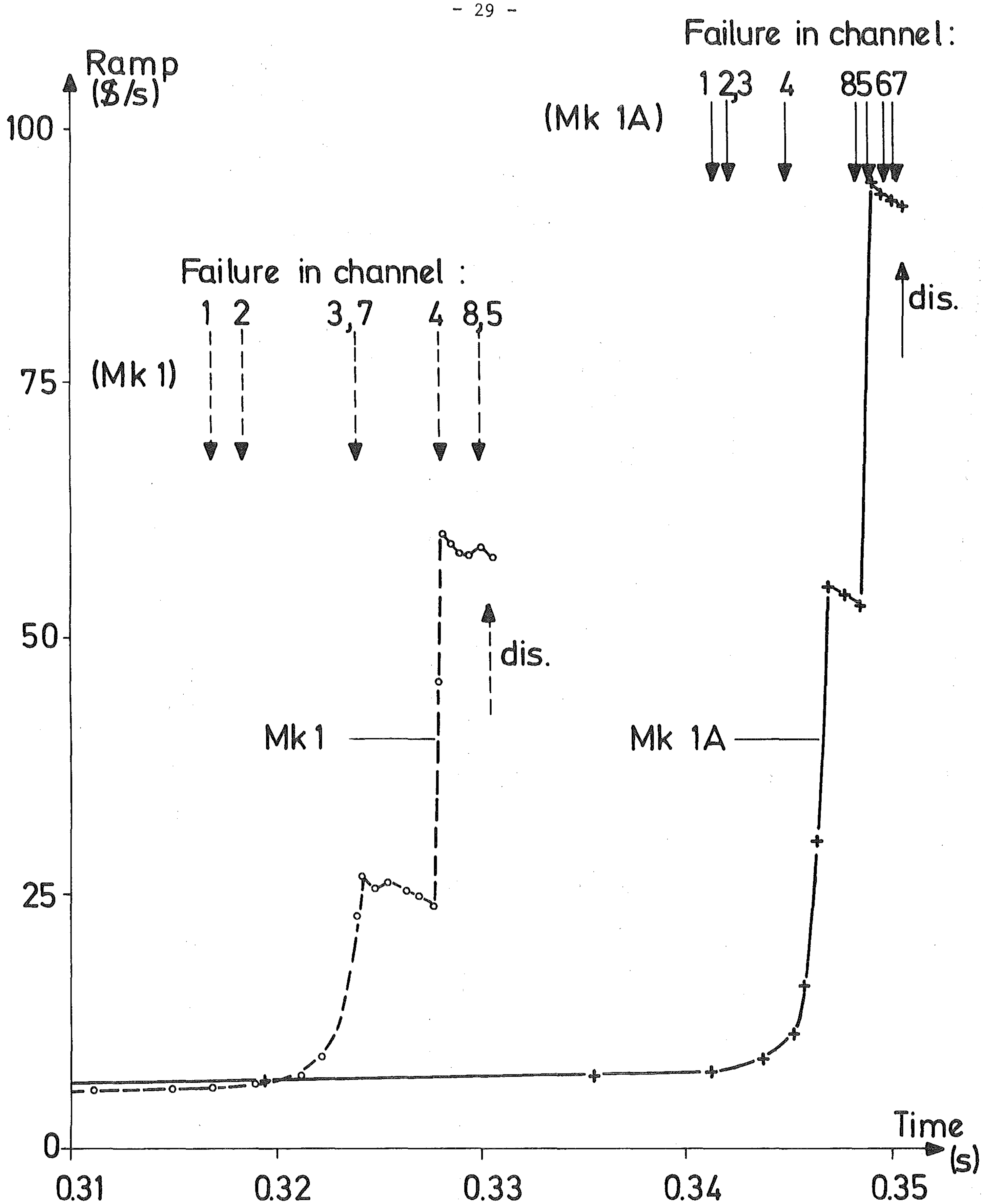


FIG. 10: POSITIVE REACTIVITY RAMP VERSUS TIME.
(5$/s ramp accident)

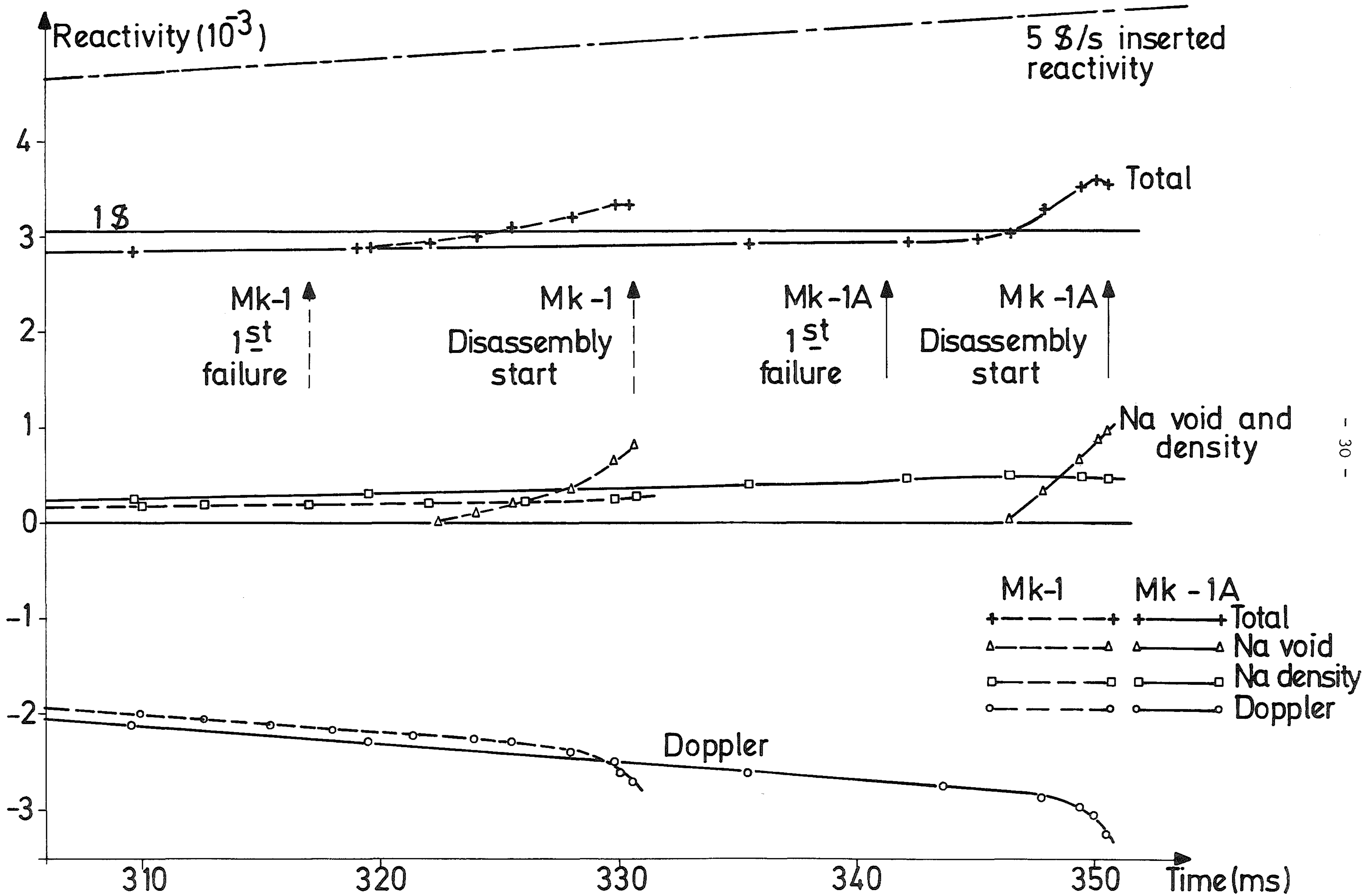


FIG. 11: REACTIVITY VERSUS TIME (5 $/s ramp accident)

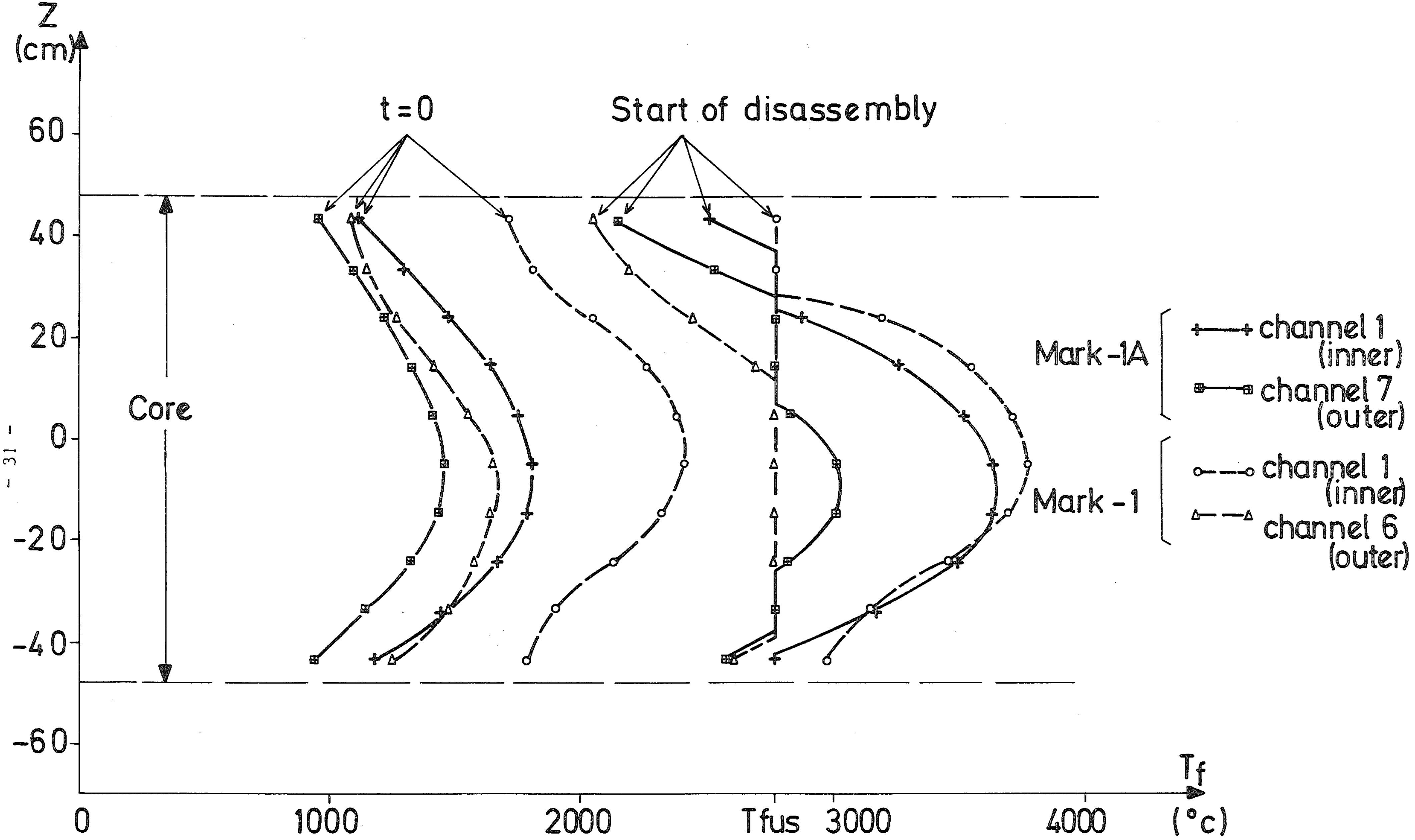


FIG. 12: FUEL CENTRAL TEMPERATURE AXIAL PROFILES IN THE FIRST RADIAL CORE ZONE (5$/s ramp accident)

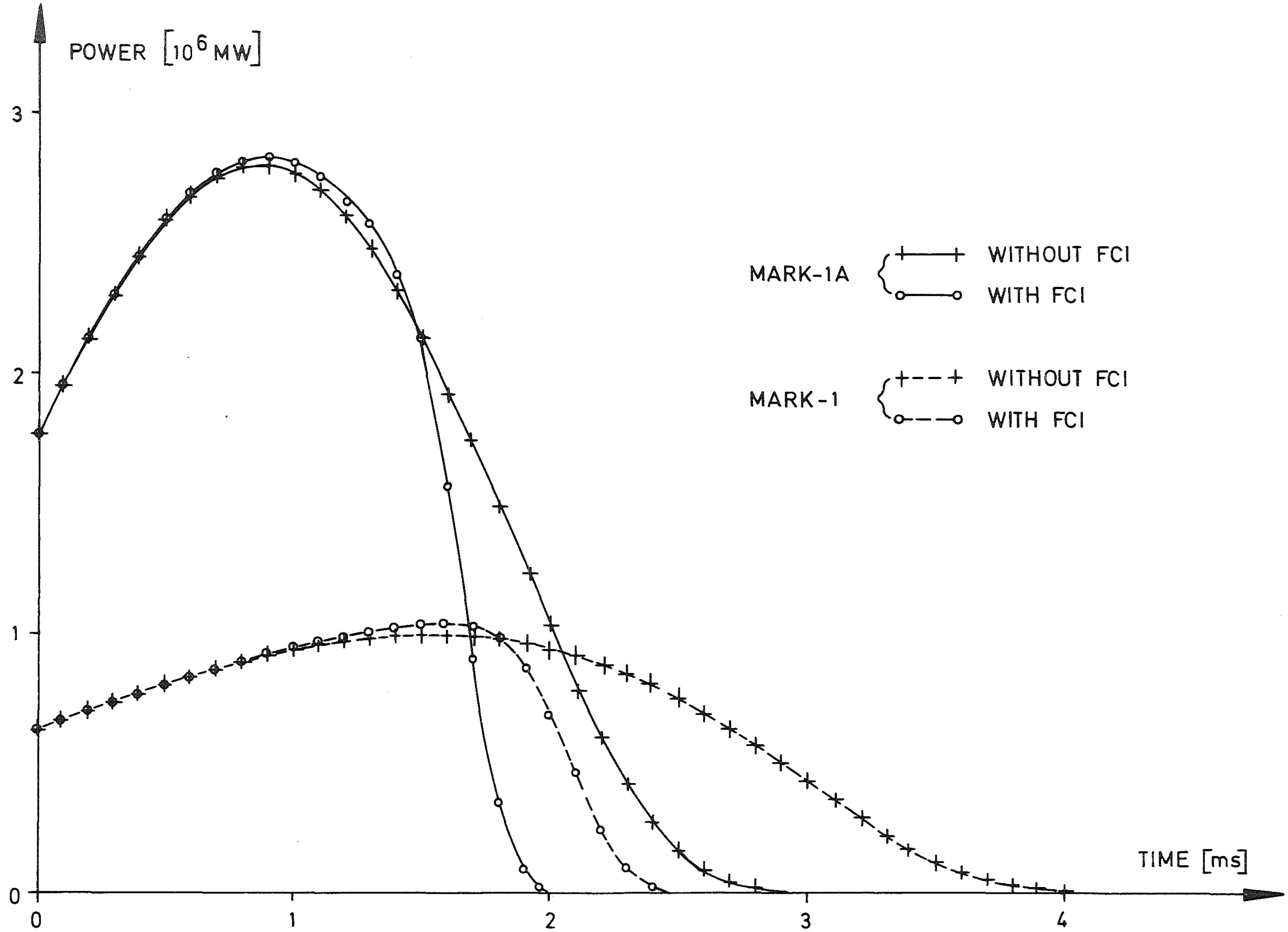


FIG. 13: POWER VERSUS TIME DURING THE DISASSEMBLY PHASE

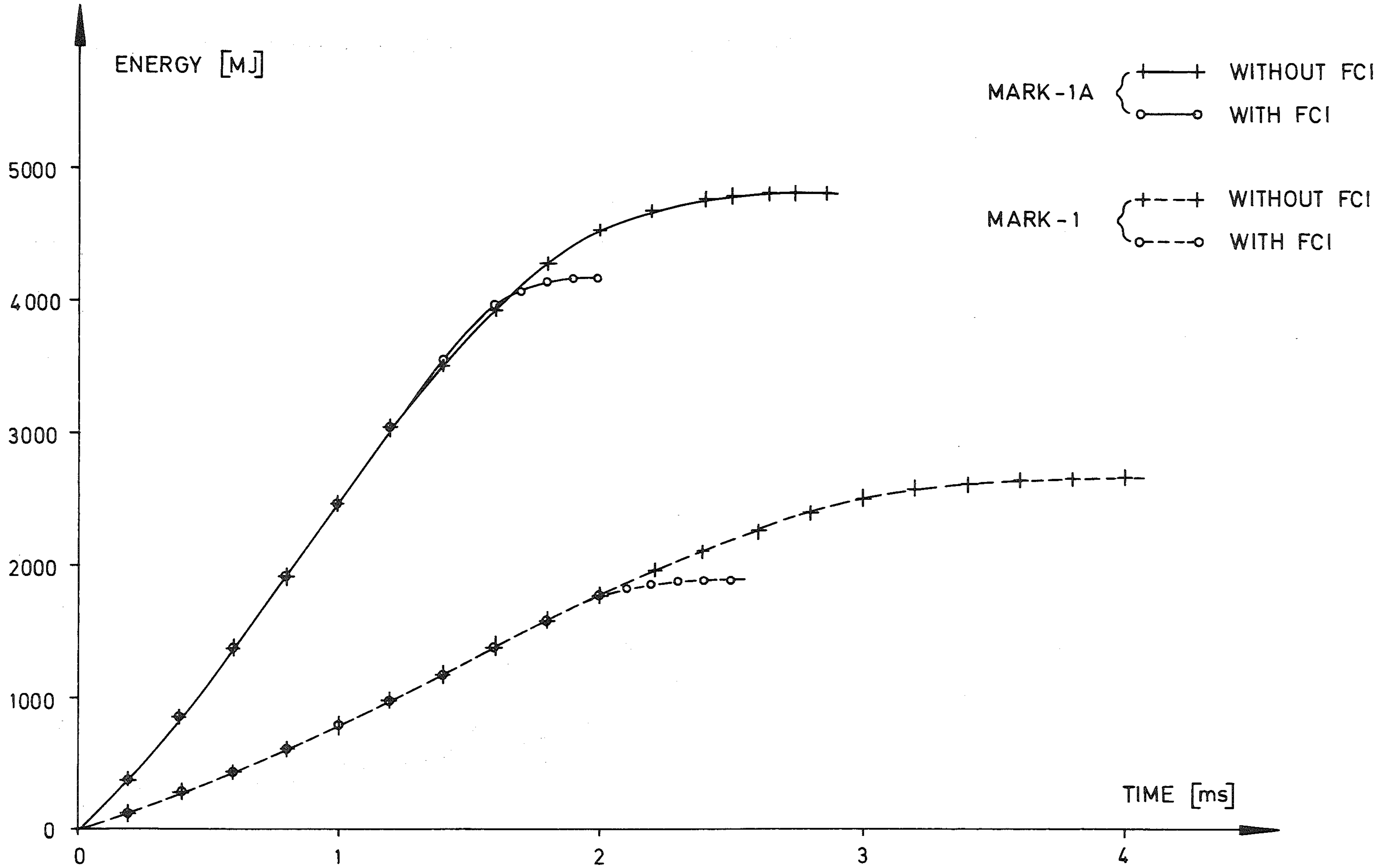


FIG.14: ENERGY RELEASE DURING THE DISASSEMBLY PHASE

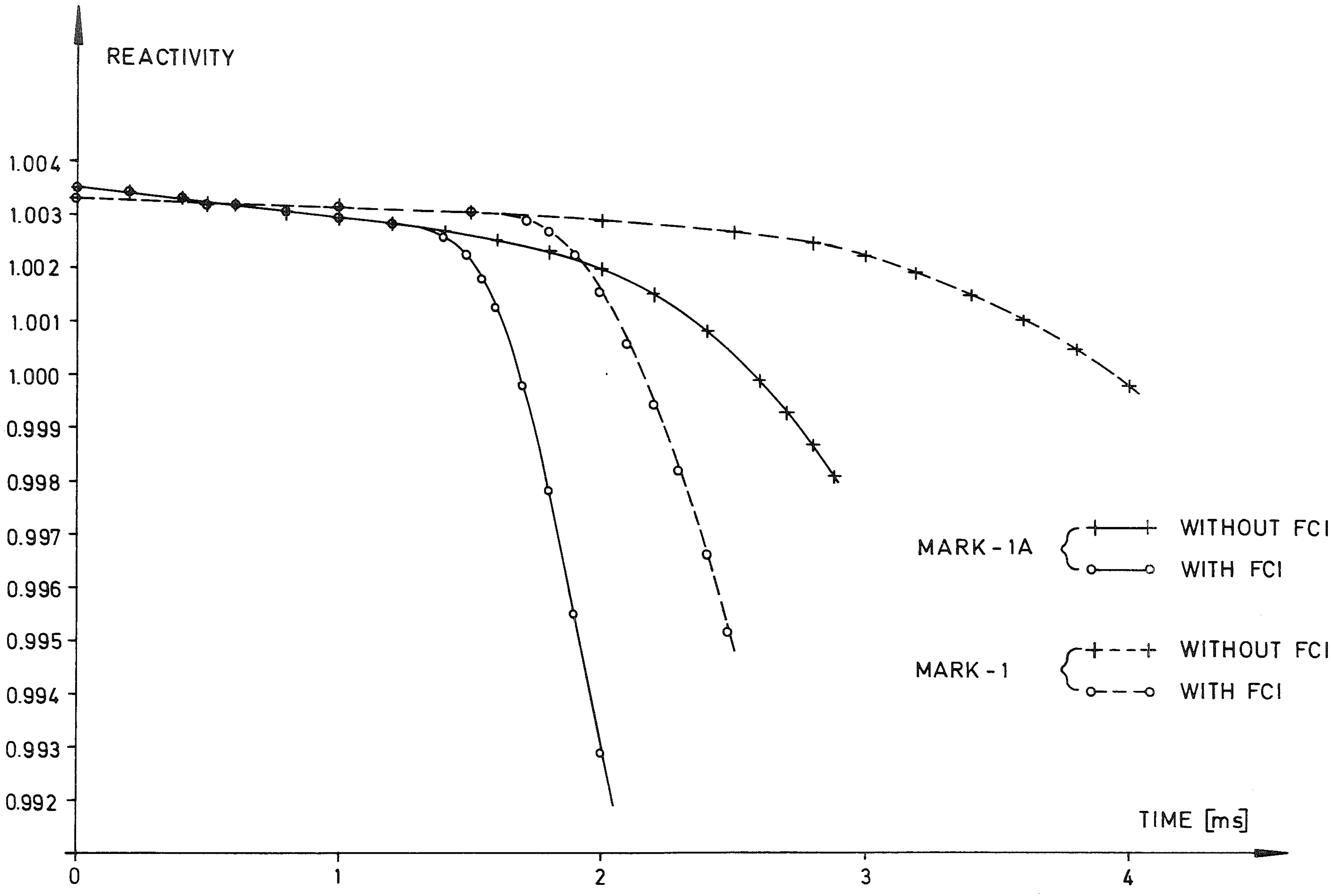


FIG. 15 : REACTIVITY VERSUS TIME DURING THE DISASSEMBLY PHASE

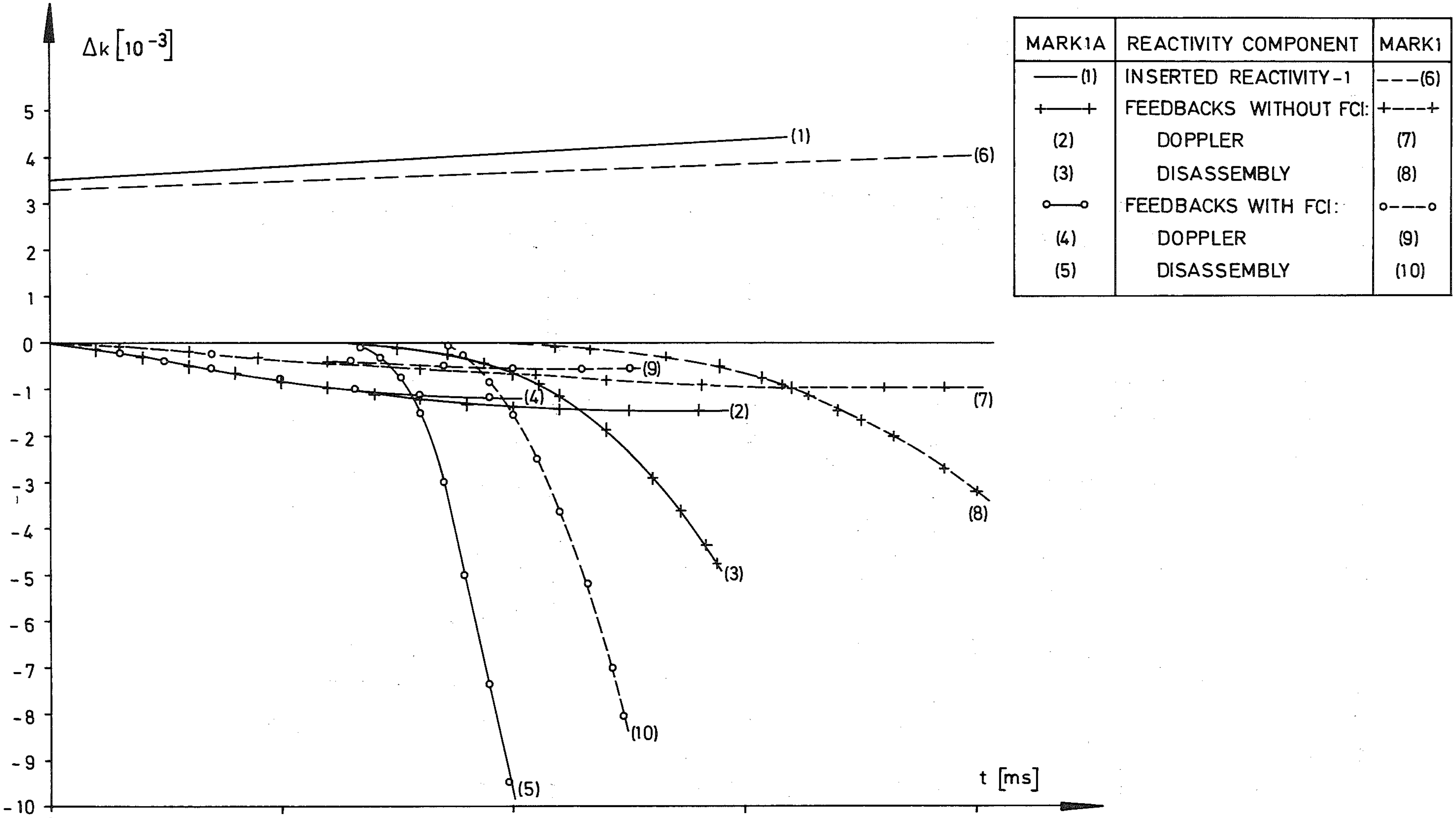


FIG. 16: REACTIVITY COMPONENTS VERSUS TIME DURING THE DISASSEMBLY PHASE

7. Appendices: Detailed data of the Mark-1 and Mark-1A cores

7.1 Input data for the CARMEN calculations

a. General data

	Mark 1	Mark 1A
Core length	96.24	96.42
Upper axial blanket thickness (cm)	40.0	40.20
Lower axial blanket thickness (cm)	40.0	40.13
Radial blanket thickness (cm)	42.0	18.0
Core inner zone radius (cm)	52.63	69.06
Core outer radius (cm)	78.95	90.27
Fuel pin number in core inner zone	13351	19090
Fuel pin number in core outer zone	12168	14940
Fuel pellet radius (cm)	0.255	0.2545
Cladding thickness (cm)	0.038	0.038
Fuel - cladding initial width (cm)	0.007	0.0075
Pitch size (cm)	0.79	0.79
Coolant cross-section associated to a fuel pin (cm^2)	0.2577	0.2577
Fuel pin number per subassembly	169	166
Inner radius of the simulated wrapper tube (cm)	5.392	5.494
Outer radius of this wrapper tube (cm)	5.672	5.774
Core + axial blanket nominal power (Mcal/sec)	168.4	174.5
Reactor inlet coolant temperature (^oC)	377	377
Average coolant temperature increase through the reactor (^oC)	200	200
Coolant pressure at the upper liquid level (bar)	1.53	1.53
Total coolant flow rate through the core (kg/sec)	2786	2887
Fuel-clad gap heat transfer coefficient (cal/sec . cm^2 . ^oC)	0.359	0.359

Material volume fractions per channel for Mark 1 core:

Channel	Fuel	Coolant	Steel
1	0.32	0.478	0.202
2	0.32	0.478	0.202
3	0.32	0.478	0.202
4	0.214	0.599	0.187
5	0.32	0.478	0.202
6(**)	0.256	0.469/0.550	0.275/0.194
7(**)	0.256	0.469/0.550	0.275/0.194
8(**)	0.267	0.471/0.538	0.262/0.195
9	0.32	0.478	0.202

Material volume fractions per channel for Mark 1A core:

Channel	Fuel	Coolant	Steel
1	0.307	0.493	0.20
2	0.307	0.493	0.20
3(**)	0.2361	0.4815/0.5768	0.2824/0.1871
4	0.2557	0.5537	0.1906
5	0.307	0.493	0.20
6	0.307	0.493	0.20
7(**)	0.2528	0.4842/0.5572	0.2630/0.1900
8	0.307	0.493	0.20
9	0.307	0.493	0.20

(**) For coolant and steel, the first value corresponds to the upper half of the core with inserted control rods, the second one to the lower half.

b. Neutron kinetic data

		Mark 1	Mark 1A
Prompt neutron lifetime (sec)		$4.678 \; 10^{-7}$	$4.470 \; 10^{-7}$
Delayed neutron total fraction		$3.038 \; 10^{-3}$	$3.035 \; 10^{-3}$
Fractions:	group 1	$7.838 \; 10^{-5}$	$7.592 \; 10^{-5}$
	group 2	$6.626 \; 10^{-4}$	$6.680 \; 10^{-4}$
	group 3	$5.828 \; 10^{-4}$	$5.644 \; 10^{-4}$
	group 4	$1.083 \; 10^{-3}$	$1.101 \; 10^{-3}$
	group 5	$4.743 \; 10^{-4}$	$4.707 \; 10^{-4}$
	group 6	$1.574 \; 10^{-4}$	$1.553 \; 10^{-4}$
Precursor decay constant (sec^{-1}):			
	group 1	0.0129	0.01296
	group 2	0.0311	0.03132
	group 3	0.134	0.1350
	group 4	0.331	0.3442
	group 5	1.26	1.371
	group 6	3.21	3.767

Relative contribution of the axial meshes to the Doppler constant for each channel (x 10^{-2}) for Mark 1 core:

Channel	1	2	3	4	5	6	7	8	9
	0.02	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.01
Upper axial blanket	0.15	0.13	0.06	0.01	0.02	0.02	0.02	0.02	0.06
	0.72	0.62	0.32	0.01	0.15	0.11	0.11	0.13	0.33
	2.66	2.43	1.60	0.66	0.96	0.63	0.63	0.77	1.61
	4.06	3.90	3.38	2.65	2.16	0.71	0.71	0.44	0.71
	5.52	5.46	5.28	4.84	3.62	1.23	1.23	0.96	2.88
	7.79	7.75	7.64	7.16	5.39	1.87	1.87	1.38	4.36
	9.91	9.09	9.85	9.39	7.26	2.67	2.67	2.03	6.10
	11.48	11.50	11.57	11.32	9.59	4.78	4.78	4.04	8.60
Core	12.16	12.22	12.43	12.59	12.76	12.67	12.67	12.15	12.46
	11.76	11.85	12.18	12.66	14.05	17.12	17.12	16.90	14.32
	10.35	10.45	10.82	11.44	13.05	16.56	16.56	16.48	13.49
	8.26	8.37	8.71	9.32	10.70	13.78	13.78	13.74	11.04
	7.09	7.19	7.48	8.13	9.31	12.24	12.24	12.17	9.18
Lower axial blanket	5.57	5.66	5.92	6.61	7.45	10.62	10.62	12.93	9.65
	1.86	1.90	2.04	2.34	2.61	3.72	3.72	4.45	3.13
	0.62	0.64	0.70	0.81	0.90	1.26	1.26	1.48	1.03

Doppler reactivity coefficient $\left(\frac{\Delta k}{k} / \frac{\Delta T}{T} \right)$ (x 10^{-3}) for Mark 1 core:

Channel	1	2	3	4	5	6	7	8	9
Sodium present	-0.0563	-0.4351	-0.8041	-0.6708	-0.9609	-0.3970	-0.1323	-0.3802	-0.3794
Sodium voided	-0.0259	-0.1983	-0.3508	-0.2752	-0.4489	-0.2010	-0.0670	-0.2112	-0.3072

Relative contribution of the axial meshes to the Doppler constant for each channel (x 10^{-2}) for Mark 1A core:

Channel	1	2	3	4	5	6	7	8	9
Upper axial blanket	0.03	0.02	0.02	0.04	0.05	0.03	0.03	0.06	0.07
	0.35	0.24	0.21	0.43	0.47	0.31	0.29	0.62	0.74
	2.08	1.50	1.22	2.29	2.53	1.83	1.75	3.39	3.87
	2.22	1.47	0.91	2.33	2.63	1.70	1.61	2.69	3.13
	3.74	2.60	1.71	3.89	4.32	2.95	2.77	4.33	5.11
	5.54	3.88	2.56	5.69	6.29	4.34	4.07	6.25	7.36
	7.64	5.44	3.57	7.71	8.46	5.92	5.54	8.31	9.61
	10.14	8.07	5.87	10.15	10.76	8.37	7.98	10.45	11.45
Core	12.71	13.02	13.51	12.98	12.81	13.37	13.48	12.40	12.42
	13.79	15.68	17.51	14.12	13.39	15.52	15.85	12.82	12.11
	12.78	14.81	16.63	12.99	12.15	14.28	14.54	11.43	10.53
	10.43	12.12	13.59	10.52	9.77	11.49	11.67	9.08	8.19
	7.72	8.89	9.83	7.58	7.09	8.36	8.55	6.70	5.72
Lower axial blanket	9.50	10.81	11.58	8.62	8.37	10.16	10.43	10.14	8.59
	1.16	1.29	1.19	0.60	0.83	1.21	1.28	1.19	0.97
	0.15	0.16	0.13	0.05	0.09	0.15	0.17	0.15	0.12

Doppler reactivity coefficient ($\frac{\Delta k}{k}$ / $\frac{\Delta T}{T}$) (x 10^{-3}) for Mark 1A core:

Channel	1	2	3	4	5	6	7	8	9
Sodium present	-0.1041	-0.2744	-0.3149	-0.5580	-0.7735	-0.6856	-0.5086	-0.5325	-0.3616
Sodium voided	-0.0460	-0.1197	-0.1343	-0.2305	-0.3318	-0.3031	-0.2340	-0.2342	-0.1692

Coolant density and coolant void reactivity effects distribution per mesh ($\Delta k/k \times 10^{-4}$) for Mark 1 core:

Channel	1	2	3	4	5	6	7	8	9
Upper axial blanket	- 0.00	- 0.02	- 0.02	- 0.01	- 0.02	- 0.01	- 0.00	- 0.01	- 0.01
	- 0.01	- 0.05	- 0.07	- 0.02	- 0.05	- 0.02	- 0.01	- 0.02	- 0.03
	- 0.03	- 0.19	- 0.33	- 0.14	- 0.29	- 0.11	- 0.04	- 0.12	- 0.18
	- 0.10	- 0.75	- 1.36	- 0.98	- 1.48	- 0.52	- 0.17	- 0.64	- 0.92
Core	- 0.15	- 1.17	- 2.09	- 2.58	- 2.50	- 0.55	- 0.18	- 0.79	- 2.32
	- 0.02	- 0.17	- 0.50	- 1.07	- 0.44	0.81	0.27	0.78	- 1.93
	0.10	0.70	0.90	0.19	1.45	2.23	0.74	2.32	- 1.96
	0.22	1.57	2.33	1.53	3.45	3.63	1.21	3.76	- 2.16
	0.30	2.23	3.50	2.67	5.07	4.18	1.39	3.91	- 3.01
	0.34	2.53	4.06	3.27	5.77	2.99	1.00	1.62	- 4.69
	0.31	2.32	3.78	3.04	5.30	2.42	0.81	0.66	- 5.57
	0.22	1.60	2.61	1.89	3.61	1.30	0.43	- 0.52	- 5.38
	0.07	0.50	0.76	0.04	0.94	- 0.37	- 0.12	- 2.15	- 5.78
	- 0.14	- 1.04	- 1.81	- 2.66	- 2.86	- 2.97	- 0.99	- 5.14	- 6.83
Lower axial blanket	- 0.11	- 0.86	- 1.43	- 2.14	- 2.27	- 2.11	- 0.70	- 3.23	- 2.91
	- 0.03	- 0.20	- 0.35	- 0.75	- 0.61	- 0.65	- 0.22	- 0.97	- 0.75
	- 0.01	- 0.08	- 0.16	- 0.38	- 0.28	- 0.29	- 0.10	- 0.39	- 0.26

Coolant density reactivity effect distribution per mesh ($\Delta k/k \times 10^{-4}$) for Mark 1A core:

Channel	1	2	3	4	5	6	7	8	9
Upper axial blanket	- 0.01	- 0.03	- 0.04	- 0.06	- 0.10	- 0.09	- 0.07	- 0.09	- 0.07
	- 0.02	- 0.05	- 0.07	- 0.14	- 0.23	- 0.23	- 0.18	- 0.31	- 0.30
	- 0.14	- 0.31	- 0.34	- 0.69	- 1.19	- 1.20	- 0.96	- 1.85	- 1.84
	- 0.15	- 0.26	- 0.22	- 0.68	- 1.31	- 1.27	- 0.86	- 2.59	- 3.49
	0.09	0.51	0.77	0.55	0.41	0.71	1.00	- 1.28	- 4.27
	0.39	1.45	1.98	2.11	2.55	3.13	3.24	0.27	- 5.06
	0.68	2.35	3.15	3.64	4.65	5.41	5.31	1.64	- 5.84
Core	0.89	2.91	3.75	4.72	6.18	6.76	6.27	2.32	- 6.58
	0.98	2.97	3.71	4.98	6.71	6.85	5.55	2.01	- 7.13
	0.90	2.59	3.14	4.40	6.00	5.74	4.33	1.03	- 7.31
	0.63	1.77	2.11	2.98	4.00	3.55	2.51	- 0.51	- 7.05
	0.21	0.59	0.71	0.95	1.10	0.57	0.12	- 2.49	- 6.45
	- 0.23	- 0.64	- 0.71	- 1.13	- 1.91	- 2.36	- 2.25	- 4.50	- 5.59
Lower axial blanket	- 0.33	- 0.90	- 1.05	- 1.61	- 2.50	- 2.77	- 2.68	- 4.01	- 3.57
	- 0.05	- 0.15	- 0.20	- 0.33	- 0.39	- 0.41	- 0.39	- 0.46	- 0.36
	- 0.04	- 0.11	- 0.12	- 0.16	- 0.23	- 0.25	- 0.20	- 0.21	- 0.13

Coolant void reactivity effect distribution per mesh ($\Delta k/k \times 10^{-5}$ per void height cm) for Mark 1A core:

Channel	1	2	3	4	5	6	7	8	9
Upper axial blanket	- 0.03	- 0.07	- 0.08	- 0.14	- 0.22	- 0.23	- 0.18	- 0.28	- 0.25
	- 0.05	- 0.13	- 0.16	- 0.28	- 0.44	- 0.46	- 0.35	- 0.57	- 0.52
	- 0.19	- 0.47	- 0.56	- 0.98	- 1.60	- 1.69	- 1.34	- 2.27	- 2.15
Core	- 0.29	- 0.67	- 0.76	- 1.27	- 2.46	- 2.64	- 1.87	- 4.17	- 5.25
	0.02	0.19	0.30	0.23	- 0.47	- 0.50	0.26	- 2.69	- 6.57
	0.31	1.21	1.58	2.08	1.96	2.07	2.77	- 1.00	- 7.94
	0.65	2.18	2.73	3.85	4.39	4.47	5.00	0.45	- 9.29
	0.90	2.82	3.44	5.05	6.16	6.06	6.04	1.12	-10.47
	1.01	3.02	3.70	5.44	6.83	6.59	5.65	0.78	-11.25
	0.93	2.66	3.25	4.77	6.05	5.59	4.24	- 0.40	-11.40
	0.59	1.67	2.01	2.94	3.63	2.95	1.98	- 2.27	-10.85
	0.09	0.24	0.31	0.42	0.13	- 0.63	- 0.90	- 4.61	- 9.77
	- 0.49	- 1.35	- 1.53	- 2.32	- 3.77	- 4.40	- 3.97	- 7.12	- 8.30
Lower axial blanket	- 0.47	- 1.32	- 1.54	- 2.32	- 3.54	- 3.84	- 3.53	- 5.03	- 4.35
	- 0.11	- 0.32	- 0.41	- 0.62	- 0.84	- 0.89	- 0.80	- 1.03	- 0.83
	- 0.08	- 0.23	- 0.26	- 0.36	- 0.56	- 0.61	- 0.53	- 0.69	- 0.55

c. Power density distributions

For Mark 1 core:

Channel	1	2	3	4	5	6	7	8	9	Radial blanket
Upper axial blanket	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00
	0.07	0.06	0.05	0.05	0.04	0.03	0.04	0.03	0.03	0.01
	0.59	0.56	0.52	0.45	0.38	0.28	0.40	0.39	0.26	0.01
	0.65	0.63	0.59	0.52	0.43	0.31	0.45	0.37	0.30	0.01
	0.77	0.75	0.69	0.62	0.52	0.38	0.55	0.43	0.37	0.02
	0.90	0.87	0.81	0.74	0.62	0.47	0.67	0.54	0.45	0.02
Core	0.97	0.95	0.89	0.81	0.69	0.54	0.78	0.63	0.52	0.02
	1.00	0.98	0.92	0.85	0.74	0.60	0.86	0.71	0.57	0.02
	0.98	0.96	0.91	0.84	0.74	0.62	0.89	0.73	0.58	0.02
	0.89	0.88	0.83	0.77	0.70	0.60	0.83	0.69	0.54	0.02
	0.79	0.78	0.74	0.69	0.62	0.58	0.75	0.62	0.49	0.02
	0.75	0.75	0.71	0.67	0.60	0.49	0.72	0.59	0.46	0.02
Lower axial blanket	0.08	0.08	0.07	0.07	0.06	0.05	0.07	0.05	0.04	0.01
	0.02	0.02	0.02	0.01	0.01	0.01	0.02	0.01	0.01	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

For Mark 1A core:

Channel	1	2	3	4	5	6	7	8	9	Radial blanket
Upper axial blanket	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00
	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01
	0.43	0.41	0.37	0.38	0.40	0.36	0.32	0.40	0.31	0.02
	0.57	0.55	0.50	0.50	0.53	0.49*	0.43	0.54	0.42	0.03
	0.70	0.68	0.62	0.62	0.65	0.60	0.53	0.66	0.51	0.04
	0.83	0.80	0.72	0.72	0.76	0.70	0.61	0.77	0.59	0.04
Core	0.93	0.90	0.83	0.82	0.85	0.78	0.69	0.85	0.65	0.05
	0.99	0.97	0.93	0.92	0.90	0.83	0.75	0.90	0.67	0.05
	1.00	0.98	0.96	0.94	0.90	0.83	0.76	0.89	0.66	0.05
	0.94	0.93	0.90	0.89	0.84	0.78	0.71	0.83	0.61	0.04
	0.83	0.81	0.79	0.78	0.74	0.68	0.61	0.71	0.52	0.04
	0.66	0.65	0.64	0.63	0.62	0.54	0.49	0.56	0.41	0.03
Lower axial blanket	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.02	0.01
	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00
	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00

d. Material properties (Mark 1 and Mark 1A)

d.1) Fuel

Initial density (g/cm^3)	9.4178
Melting point (^oC)	2767
Latent heat of melting (J/g)	280.37

Specific heat ($J/g\ ^oC$)

$$0.231 + 2.79\ 10^{-4} \times T - 3.42\ 10^{-7} \times T^2 + 1.72\ 10^{-10} \times T^3 - 2.27\ 10^{-14} \times T^4$$

Thermal conductivity ($W/cm\ ^oC$)

$$4.93\ 10^{-2} - 4.185\ 10^{-5} \times T + 1.99\ 10^{-8} \times T^2 - 2.99\ 10^{-12} \times T^3$$

d.2) Cladding

Theoretical density (g/cm^3)	7.6
Melting point (^oC)	1375
Specific heat ($J/g\ ^oC$)	0.6224
Thermal conductivity ($W/cm\ ^oC$)	0.196

d.3) Structure

Specific heat density ($J/cm^3\ ^oC$)	4.73
Thermal conductivity ($W/cm\ ^oC$)	0.196

d.4) Coolant

Specific heat ($J/g\ ^oC$)	1.265

e. Pin failure criterion

45 % molten fuel cross-section on 10 cm length around the hottest point of a channel.

7.2 Input data for the KADIS calculations

f. Doppler coefficients as used for the KADIS disassembly calculations (Mark 1 and Mark 1A)

f.1) Mark 1 - Doppler weighting factors used for the 17 KADIS regions shown in fig.3. For each region r the equation

$$\frac{1}{k} \; \frac{dk_r}{dT} = W_r \; \left(\frac{A}{T^{3/2}} + \frac{B}{T} \right)$$

is applied with A = - 0.04812 and B = - 0.00336 (T in units of Kelvin)

Region r	Weighting Factors
1	0.0559
2	0.2298
3	0.0063
4	0.1195
5	0.001
6	0.1681
7	0.0022
8	0.0308
9	0.0763
10	0.0118
11	0.0015
12	0.0541
13	0.0066
14	0.0104
15	0.0636
16	0.0015
17	0.1602

f.2) Mark 1A - Doppler coefficients used for the 20 KADIS regions shown in fig. 6. For each region r the equation

$$\frac{1}{k}\ \frac{dk_r}{dT} = \left(\frac{A_r}{T^{3/2}} + \frac{B_r}{T} \right)$$

is applied (T in units of Kelvin).

Region r	A_r	B_r
1	-0.4281^{-4}	-0.5978^{-5}
2	-0.4824^{-4}	-0.2976^{-5}
3	-0.1568^{-3}	-0.3377^{-4}
4	-0.2085^{-3}	-0.1859^{-4}
5	-0.2392^{-3}	-0.3070^{-4}
6	-0.3076^{-2}	-0.3573^{-3}
7	-0.5342^{-3}	-0.7591^{-4}
8	-0.4197^{-3}	-0.3533^{-4}
9	-0.2543^{-2}	-0.3530^{-3}
10	-0.2383^{-2}	-0.2112^{-3}
11	-0.8410^{-2}	-0.5474^{-3}
12	-0.2053^{-2}	-0.1850^{-3}
13	-0.1703^{-2}	-0.1809^{-3}
14	-0.6441^{-2}	-0.5894^{-3}
15	-0.6874^{-2}	-0.5848^{-3}
16	-0.2052^{-3}	-0.3727^{-4}
17	-0.1377^{-3}	-0.3551^{-4}
18	-0.5401^{-3}	-0.1036^{-3}
19	-0.6499^{-3}	-0.1152^{-3}
20	-0.5524^{-3}	-0.7559^{-4}

g. Total material worth curves used for the KADIS disassembly calculations (Mark 1 and Mark 1A)

In the following these data are listed for Mark 1 under g.1 and for Mark 1A under g.2. The geometrical configurations used to calculate these reactivity coefficients are shown in fig.3 and fig. 5 for Mark 1 and Mark 1A respectively.

```
MARK-1 CORE  /  5 $/S RAMP ACCIDENT  /       BASE CASE      / NOV.8 1973

 RADIAL DISTANCE

 0.0         5.263      15.789      26.315      36.841      47.367      52.630      57.894
68.422      78.950     120.950

 AXIAL DISTANCE

 0.000      13.333      26.667      40.000      49.624      59.248      68.872      78.496
88.120      97.744     107.370     116.990     126.620     136.240     146.240     156.240
166.240     176.240

NUMBER OF RADIAL ZONES =   10     NUMBER OF AXIAL ZONES =   17

STOP CONDITIONS ARE;
MAX. TIME  =  0.10000D 01     MAX. CYCLE =          1500     MAX. DISTORTION =  0.10000D 04
MAX. POWER =  0.10000D 25     MIN. POWER =  0.10000D 11     K-EFF-LIMIT     =  0.95000D 00


EPS1   =  0.0             EPS2   =  0.0             EPS3   =  0.10000D 00   EPS4   =  0.10000D 00
DELT   =  0.50000D-04     DELTMX =  0.50000D-04     DELTMN =  0.10000D-05   RHOCRT =  0.30000D 01

OUTPUT PARAMETERS          0    0    0    1   10    0    0

WMAX LIMITS FOR TIME STEP CONTROL    0.20000  0.04000
```

Fig.1 Mark 1 Geometrical and control input data for KADIS g.1 Mark 1 Total material worth curves for region 1

INPUT MATERIAL WORTH FOR REGION 1

```
0.21881D-08 0.21883D-08 0.21888D-08 0.21905D-08 0.21939D-08 0.22003D-08
0.22110D-08 0.22276D-08 0.22518D-08 0.22861D-08 0.23339D-08 0.22270D-08
0.20201D-08 0.18663D-08 0.17427D-08 0.16363D-08
0.24191D-08 0.24186D-08 0.24170D-08 0.24149D-08 0.24134D-08 0.24137D-08
0.24174D-08 0.24261D-08 0.24415D-08 0.24650D-08 0.24979D-08 0.23968D-08
0.22078D-08 0.20530D-08 0.19250D-08 0.18152D-08
0.24671D-08 0.24655D-08 0.24605D-08 0.24531D-08 0.24442D-08 0.24356D-08
0.24288D-08 0.24259D-08 0.24287D-08 0.24383D-08 0.24549D-08 0.24115D-08
0.22458D-08 0.21016D-08 0.19799D-08 0.18752D-08
0.25555D-08 0.25517D-08 0.25404D-08 0.25226D-08 0.24998D-08 0.24741D-08
0.24478D-08 0.24238D-08 0.24048D-08 0.23930D-08 0.23896D-08 0.24583D-08
0.23025D-08 0.21684D-08 0.20563D-08 0.19567D-08
0.27247D-08 0.27171D-08 0.26948D-08 0.26591D-08 0.26118D-08 0.25563D-08
0.24959D-08 0.24354D-08 0.23794D-08 0.23329D-08 0.22994D-08 0.25396D-08
0.23927D-08 0.22711D-08 0.21741D-08 0.20903D-08
0.30484D-08 0.30349D-08 0.29944D-08 0.29285D-08 0.28407D-08 0.27348D-08
0.26166D-08 0.24931D-08 0.23739D-08 0.22676D-08 0.21838D-08 0.26683D-08
0.25363D-08 0.24357D-08 0.23637D-08 0.23041D-08
0.36540D-08 0.36307D-08 0.35612D-08 0.34474D-08 0.32935D-08 0.31049D-08
0.28899D-08 0.26600D-08 0.24305D-08 0.22191D-08 0.20450D-08 0.28641D-08
0.27633D-08 0.27007D-08 0.26722D-08 0.26530D-08
0.47539D-08 0.47158D-08 0.46022D-08 0.44155D-08 0.41587D-08 0.38387D-08
0.34667D-08 0.30586D-08 0.26387D-08 0.22389D-08 0.19006D-08 0.31564D-08
0.31223D-08 0.31321D-08 0.31766D-08 0.32205D-08
0.66835D-08 0.66248D-08 0.64477D-08 0.61544D-08 0.57460D-08 0.52286D-08
0.46118D-08 0.39150D-08 0.31724D-08 0.24366D-08 0.17905D-08 0.35818D-08
0.36948D-08 0.38434D-08 0.40075D-08 0.41431D-08
0.99547D-08 0.98675D-08 0.96061D-08 0.91678D-08 0.85519D-08 0.77552D-08
0.67817D-08 0.56422D-08 0.43713D-08 0.30396D-08 0.18076D-08 0.41793D-08
0.46243D-08 0.50413D-08 0.53930D-08 0.56433D-08
0.15293D-07 0.15172D-07 0.14805D-07 0.14189D-07 0.13311D-07 0.12158D-07
0.10713D-07 0.89581D-08 0.68890D-08 0.45448D-08 0.21575D-08 0.49721D-08
0.61939D-08 0.71259D-08 0.77486D-08 0.80875D-08
0.23677D-07 0.23516D-07 0.23034D-07 0.22216D-07 0.21045D-07 0.19492D-07
0.17515D-07 0.15040D-07 0.11961D-07 0.81083D-08 0.33425D-08 0.58856D-08
0.90391D-08 0.10894D-07 0.11856D-07 0.12092D-07
0.35147D-07 0.34939D-07 0.34336D-07 0.33298D-07 0.31829D-07 0.29859D-07
0.27335D-07 0.24113D-07 0.19991D-07 0.14487D-07 0.66353D-08 0.66096D-08
0.13183D-07 0.16650D-07 0.18229D-07 0.18423D-07
```

R LATTICE (CM)

```
0.0         0.2631D 01 0.5262D 01 0.7894D 01 0.1053D 02 0.1316D 02 0.1579D 02 0.1842D 02 0.2105D 02 0.2368D 02
0.2631D 02 0.3684D 02 0.3947D 02 0.4210D 02 0.4473D 02 0.4737D 02
```

Z LATTICE (CM)

```
0.0         0.3333D 01 0.6666D 01 0.1000D 02 0.1333D 02 0.1667D 02 0.2000D 02 0.2333D 02 0.2667D 02 0.3000D 02
0.3333D 02 0.3667D 02 0.4000D 02
```

g.1 Mark 1 Total material worth curves for region 2

INPUT MATERIAL WORTH FOR REGION 2

0.33844D-06	0.33772D-06	0.33554D-06	0.33195D-06	0.32691D-06	0.32050D-06
0.31266D-06	0.30346D-06	0.29274D-06	0.28033D-06	0.26550D-06	
0.35818D-06	0.35741D-06	0.35512D-06	0.35134D-06	0.34607D-06	0.33935D-06
0.33125D-06	0.32179D-06	0.31109D-06	0.29928D-06	0.28662D-06	
0.38291D-06	0.38211D-06	0.37973D-06	0.37580D-06	0.37034D-06	0.36342D-06
0.35511D-06	0.34553D-06	0.33481D-06	0.32314D-06	0.31079D-06	
0.40926D-06	0.40844D-06	0.40598D-06	0.40192D-06	0.39630D-06	0.38919D-06
0.38067D-06	0.37086D-06	0.35989D-06	0.34793D-06	0.33517D-06	
0.43561D-06	0.43476D-06	0.43223D-06	0.42803D-06	0.42222D-06	0.41487D-06
0.40607D-06	0.39592D-06	0.38454D-06	0.37207D-06	0.35870D-06	
0.46031D-06	0.45943D-06	0.45681D-06	0.45247D-06	0.44647D-06	0.43886D-06
0.42974D-06	0.41919D-06	0.40734D-06	0.39431D-06	0.38030D-06	
0.48185D-06	0.48095D-06	0.47825D-06	0.47378D-06	0.46758D-06	0.45973D-06
0.45030D-06	0.43939D-06	0.42710D-06	0.41356D-06	0.39899D-06	
0.49897D-06	0.49804D-06	0.49528D-06	0.49069D-06	0.48435D-06	0.47630D-06
0.46663D-06	0.45542D-06	0.44279D-06	0.42885D-06	0.41386D-06	
0.51063D-06	0.50969D-06	0.50688D-06	0.50223D-06	0.49579D-06	0.48761D-06
0.47778D-06	0.46640D-06	0.45356D-06	0.43940D-06	0.42417D-06	
0.51608D-06	0.51514D-06	0.51231D-06	0.50764D-06	0.50116D-06	0.49295D-06
0.48307D-06	0.47164D-06	0.45876D-06	0.44454D-06	0.42929D-06	
0.51489D-06	0.51395D-06	0.51114D-06	0.50649D-06	0.50004D-06	0.49186D-06
0.48204D-06	0.47069D-06	0.45791D-06	0.44382D-06	0.42875D-06	
0.50693D-06	0.50600D-06	0.50323D-06	0.49863D-06	0.49227D-06	0.48421D-06
0.47454D-06	0.46336D-06	0.45079D-06	0.43697D-06	0.42220D-06	
0.49243D-06	0.49152D-06	0.48880D-06	0.48429D-06	0.47806D-06	0.47016D-06
0.46070D-06	0.44977D-06	0.43749D-06	0.42401D-06	0.40963D-06	
0.47194D-06	0.47105D-06	0.46840D-06	0.46400D-06	0.45794D-06	0.45024D-06
0.44103D-06	0.43039D-06	0.41845D-06	0.40535D-06	0.39136D-06	
0.44629D-06	0.44543D-06	0.44286D-06	0.43861D-06	0.43272D-06	0.42527D-06
0.41634D-06	0.40603D-06	0.39446D-06	0.38177D-06	0.36822D-06	
0.38415D-06	0.38336D-06	0.38098D-06	0.37705D-06	0.37160D-06	0.36472D-06
0.35645D-06	0.34692D-06	0.33621D-06	0.32448D-06	0.31195D-06	
0.35030D-06	0.34954D-06	0.34728D-06	0.34353D-06	0.33836D-06	0.33178D-06
0.32392D-06	0.31483D-06	0.30464D-06	0.29345D-06	0.28152D-06	
0.31641D-06	0.31570D-06	0.31356D-06	0.31003D-06	0.30514D-06	0.29895D-06
0.29150D-06	0.28290D-06	0.27324D-06	0.26267D-06	0.25140D-06	
0.28381D-06	0.28314D-06	0.28116D-06	0.27787D-06	0.27333D-06	0.26755D-06
0.26061D-06	0.25254D-06	0.24345D-06	0.23344D-06	0.22276D-06	
0.25357D-06	0.25297D-06	0.25114D-06	0.24814D-06	0.24398D-06	0.23874D-06
0.23243D-06	0.22511D-06	0.21672D-06	0.20718D-06	0.19650D-06	
0.22758D-06	0.22702D-06	0.22534D-06	0.22261D-06	0.21884D-06	0.21417D-06
0.20866D-06	0.20248D-06	0.19551D-06	0.18696D-06	0.17315D-06	

R LATTICE (CM)

0.0 0.2631D 01 0.5262D 01 0.7894D 01 0.1053D 02 0.1316D 02 0.1579D 02 0.1842D 02 0.2105D 02 0.2368D 02
0.2632D 02

Z LATTICE (CM)

0.4000D 02 0.4458D 02 0.4917D 02 0.5375D 02 0.5833D 02 0.6291D 02 0.6750D 02 0.7208D 02 0.7666D 02 0.8125D 02
0.8583D 02 0.9041D 02 0.9499D 02 0.9958D 02 0.1042D 03 0.1133D 03 0.1179D 03 0.1225D 03 0.1271D 03 0.1317D 03
0.1362D 03

g.1 Mark 1 Total material worth curves for regions 3 and 4

```
INPUT MATERIAL WORTH FOR REGION   3

0.54878D-07 0.54852D-07 0.54828D-07 0.54754D-07 0.54721D-07 0.54699D-07
0.54835D-07 0.55237D-07 0.56432D-07 0.59737D-07 0.71161D-07
0.40023D-07 0.40023D-07 0.40038D-07 0.40064D-07 0.40143D-07 0.40298D-07
0.40625D-07 0.41261D-07 0.42568D-07 0.45413D-07 0.51406D-07
0.27956D-07 0.27966D-07 0.27999D-07 0.28065D-07 0.28182D-07 0.28384D-07
0.28723D-07 0.29290D-07 0.30227D-07 0.31735D-07 0.33609D-07
0.19263D-07 0.19271D-07 0.19295D-07 0.19343D-07 0.19422D-07 0.19548D-07
0.19740D-07 0.20024D-07 0.20417D-07 0.20909D-07 0.21308D-07
0.13117D-07 0.13119D-07 0.13125D-07 0.13138D-07 0.13160D-07 0.13194D-07
0.13242D-07 0.13303D-07 0.13363D-07 0.13388D-07 0.13298D-07
0.88641D-08 0.88603D-08 0.88510D-08 0.88338D-08 0.88109D-08 0.87794D-08
0.87382D-08 0.86779D-08 0.85889D-08 0.84481D-08 0.82343D-08
0.59919D-08 0.59852D-08 0.59645D-08 0.59298D-08 0.58799D-08 0.58137D-08
0.57283D-08 0.56199D-08 0.54819D-08 0.53065D-08 0.50906D-08
0.40978D-08 0.40892D-08 0.40630D-08 0.40194D-08 0.39575D-08 0.38772D-08
0.37771D-08 0.36566D-08 0.35141D-08 0.33487D-08 0.31642D-08
0.28778D-08 0.28685D-08 0.28404D-08 0.27937D-08 0.27284D-08 0.26449D-08
0.25436D-08 0.24256D-08 0.22927D-08 0.21472D-08 0.19950D-08
0.21118D-08 0.21023D-08 0.20742D-08 0.20273D-08 0.19626D-08 0.18804D-08
0.17825D-08 0.16707D-08 0.15482D-08 0.14193D-08 0.12906D-08
0.16446D-08 0.16354D-08 0.16079D-08 0.15624D-08 0.14995D-08 0.14203D-08
0.13263D-08 0.12197D-08 0.11040D-08 0.98427D-09 0.86723D-09
0.13705D-08 0.13616D-08 0.13351D-08 0.12914D-08 0.12310D-08 0.11549D-08
0.10647D-09 0.96204D-09 0.84970D-09 0.73150D-09 0.61159D-09
0.11049D-08 0.10970D-08 0.10733D-08 0.10343D-08 0.98048D-08 0.91279D-09
0.83230D-09 0.74034D-09 0.63804D-09 0.52607D-09 0.40461D-09

            R LATTICE (CM)

 0.0        0.2631D 01 0.5262D 01 0.7894D 01 0.1053D 02 0.1316D 02 0.1579D 02 0.1842D 02 0.2105D 02 0.2368D 02
 0.2632D 02

            Z LATTICE (CM)

 0.1362D 03 0.1396D 03 0.1429D 03 0.1462D 03 0.1496D 03 0.1529D 03 0.1562D 03 0.1596D 03 0.1629D 03 0.1662D 03
 0.1696D 03 0.1729D 03 0.1762D 03

INPUT MATERIAL WORTH FOR REGION   4

0.23716D-06 0.22467D-06 0.21602D-06 0.21010D-06 0.20702D-06
0.24078D-06 0.22945D-06 0.22020D-06 0.21280D-06 0.20682D-06
0.24270D-06 0.23138D-06 0.22163D-06 0.21332D-06 0.20610D-06
0.24313D-06 0.23135D-06 0.22106D-06 0.21214D-06 0.20428D-06
0.24308D-06 0.23072D-06 0.21987D-06 0.21044D-06 0.20210D-06
0.24318D-06 0.23023D-06 0.21884D-06 0.20893D-06 0.20014D-06
0.24374D-06 0.23029D-06 0.21843D-06 0.20807D-06 0.19886D-06
0.24490D-06 0.23108D-06 0.21885D-06 0.20815D-06 0.19859D-06
0.24655D-06 0.23254D-06 0.22014D-06 0.20925D-06 0.19947D-06
0.24834D-06 0.23437D-06 0.22201D-06 0.21117D-06 0.20142D-06
0.24970D-06 0.23599D-06 0.22388D-06 0.21334D-06 0.20391D-06
0.24993D-06 0.23660D-06 0.22486D-06 0.21473D-06 0.20568D-06
0.24836D-06 0.23544D-06 0.22402D-06 0.21415D-06 0.20528D-06
0.24461D-06 0.23201D-06 0.22081D-06 0.21102D-06 0.20204D-06
0.23856D-06 0.22628D-06 0.21523D-06 0.20540D-06 0.19626D-06
0.22084D-06 0.20923D-06 0.19856D-06 0.18880D-06 0.17954D-06
0.21011D-06 0.19891D-06 0.18856D-06 0.17896D-06 0.16980D-06
0.19874D-06 0.18807D-06 0.17809D-06 0.16877D-06 0.15980D-06
0.18719D-06 0.17706D-06 0.16759D-06 0.15866D-06 0.15001D-06
0.17551D-06 0.16596D-06 0.15722D-06 0.14898D-06 0.14126D-06
0.16430D-06 0.15543D-06 0.14777D-06 0.14036D-06 0.13741D-06

            R LATTICE (CM)

 0.2632D 02 0.2894D 02 0.3157D 02 0.3421D 02 0.3684D 02

            Z LATTICE (CM)

 0.4000D 02 0.4458D 02 0.4917D 02 0.5375D 02 0.5833D 02 0.6291D 02 0.6750D 02 0.7208D 02 0.7666D 02 0.8125D 02
 0.8583D 02 0.9041D 02 0.9499D 02 0.9958D 02 0.1042D 03 0.1133D 03 0.1179D 03 0.1225D 03 0.1271D 03 0.1317D 03
 0.1362D 03
```

g.1 Mark 1 Total material worth curves for regions 5 and 6

```
INPUT MATERIAL WORTH FOR REGION   5

0.54204D-07-0.29940D-07-0.21369D-07-0.20815D-07-0.29617D-07

0.25830D-07-0.15064D-07-0.11754D-07-0.12369D-07-0.17774D-07

0.14266D-07-0.10787D-07-0.97303D-08-0.10093D-07-0.12047D-07

0.82883D-08-0.71139D-08-0.68801D-08-0.70690D-08-0.78299D-08

0.48562D-08-0.44838D-08-0.45016D-08-0.46102D-08-0.49267D-08

0.27890D-08-0.27058D-08-0.27849D-08-0.28553D-08-0.29959D-08

0.15232D-08-0.15430D-08-0.16267D-08-0.16768D-08-0.17455D-08

0.75016D-09-0.80485D-09-0.87856D-09-0.91747D-09-0.95521D-09

0.28411D-09-0.34901D-09-0.41143D-09-0.44336D-09-0.46661D-09

0.92905D-11-0.76319D-10-0.12960D-09-0.15624D-09-0.17100D-09
0.14659D-09 0.78227D-10 0.31698D-10 0.10378D-10 0.32179D-11
0.22725D-09 0.15328D-09 0.11247D-09 0.97477D-10 0.10156D-09
0.21006D-09 0.13559D-09 0.10481D-09 0.99284D-10 0.11815D-09

            R LATTICE (CM)

 0.2632D 02 0.2894D 02 0.3157D 02 0.3421D 02 0.3684D 02

            Z LATTICE (CM)

 0.1362D 03 0.1396D 03 0.1429D 03 0.1462D 03 0.1496D 03 0.1529D 03 0.1562D 03 0.1596D 03 0.1629D 03 0.1662D 03
 0.1696D 03 0.1729D 03 0.1762D 03


INPUT MATERIAL WORTH FOR REGION   6

0.23188D-06 0.22675D-06 0.21870D-06 0.20872D-06 0.19683D-06
0.24651D-06 0.23997D-06 0.23199D-06 0.22259D-06 0.21216D-06
0.26490D-06 0.25750D-06 0.24906D-06 0.23952D-06 0.22920D-06
0.28363D-06 0.27570D-06 0.26676D-06 0.25681D-06 0.24615D-06
0.30157D-06 0.29316D-06 0.28374D-06 0.27328D-06 0.26213D-06
0.31783D-06 0.30895D-06 0.29901D-06 0.28801D-06 0.27633D-06
0.33167D-06 0.32231D-06 0.31186D-06 0.30029D-06 0.28805D-06
0.34256D-06 0.33275D-06 0.32181D-06 0.30968D-06 0.29689D-06
0.35013D-06 0.34001D-06 0.32872D-06 0.31613D-06 0.30287D-06
0.35418D-06 0.34405D-06 0.33274D-06 0.32007D-06 0.30678D-06
0.35430D-06 0.34473D-06 0.33413D-06 0.32244D-06 0.31087D-06
0.34966D-06 0.34108D-06 0.33191D-06 0.32328D-06 0.31593D-06
0.33942D-06 0.33116D-06 0.32219D-06 0.31323D-06 0.30362D-06
0.32361D-06 0.31500D-06 0.30544D-06 0.29531D-06 0.28403D-06
0.30320D-06 0.29415D-06 0.28405D-06 0.27314D-06 0.26108D-06
0.25415D-06 0.24470D-06 0.23430D-06 0.22312D-06 0.21106D-06
0.22815D-06 0.21875D-06 0.20853D-06 0.19762D-06 0.18599D-06
0.20269D-06 0.19346D-06 0.18355D-06 0.17304D-06 0.16199D-06
0.17889D-06 0.16988D-06 0.16024D-06 0.15015D-06 0.13971D-06
0.15797D-06 0.14907D-06 0.13941D-06 0.12955D-06 0.11967D-06
0.14303D-06 0.13287D-06 0.12186D-06 0.11178D-06 0.10243D-06

            R LATTICE (CM)

 0.3684D 02 0.3947D 02 0.4210D 02 0.4473D 02 0.4737D 02

            Z LATTICE (CM)

 0.4000D 02 0.4458D 02 0.4917D 02 0.5375D 02 0.5833D 02 0.6291D 02 0.6750D 02 0.7208D 02 0.7666D 02 0.8125D 02
 0.8583D 02 0.9041D 02 0.9499D 02 0.9958D 02 0.1042D 03 0.1133D 03 0.1179D 03 0.1225D 03 0.1271D 03 0.1317D 03
 0.1362D 03
```

Fig. 1 Mark 1 Total material worth curves for regions 7 and 8

INPUT MATERIAL WORTH FOR REGION 7

0.62211D-07	0.45668D-07	0.38688D-07	0.34965D-07	0.32338D-07
0.37291D-07	0.30198D-07	0.26561D-07	0.24219D-07	0.22554D-07
0.21518D-07	0.19082D-07	0.17243D-C7	0.15865D-07	C.14904D-07
0.12644D-07	0.11694D-07	0.10838D-07	0.10111D-07	0.95786D-08
0.74863D-08	0.70897D-08	0.66935D-08	0.63208D-08	0.60272D-08
0.44620D-08	0.42882D-08	0.41000D-08	0.39061D-08	0.37411D-08
0.26872D-08	0.26067D-08	0.25120D-08	0.24063D-08	0.23084D-08
0.16470D-08	0.16064D-08	0.15545D-08	0.14922D-08	0.14295D-08
0.10388D-08	0.10164D-08	0.98485D-09	0.94399D-09	0.89965D-09
0.68402D-09	0.67154D-09	0.65061D-09	0.62043D-09	C.58511D-09
0.47720D-09	0.47308D-09	0.45878D-09	0.43367D-09	0.40139D-09
0.35589D-09	0.36361D-09	0.35434D-09	0.33059D-09	0.29636D-09
0.24870D-09	0.26803D-09	0.26374D-09	0.24248D-09	0.20785D-09

R LATTICE (CM)

0.3684D 02 0.3947D 02 0.4210D 02 0.4473D 02 0.4737D 02

Z LATTICE (CM)

0.1362D 03 0.1396D 03 0.1429D 03 0.1462D 03 0.1496D 03 0.1529D 03 0.1562D 03 0.1596D 03 0.1629D 03 0.1662D 03
0.1696D 03 0.1729D 03 0.1762D 03

INPUT MATERIAL WORTH FOR REGION 8

0.19706D-08	0.18980D-08	0.17979D-08	0.16797D-08	0.15487D-08	0.14089D-08
0.12644D-08	0.11203D-08	0.98429D-09			
0.23217D-08	0.22295D-08	0.21182D-08	0.19900D-08	0.18482D-08	0.16960D-08
0.15366D-08	0.13736D-08	0.12122D-08			
0.26372D-08	0.25379D-08	0.24249D-08	0.22966D-08	0.21540D-08	0.19992D-08
0.18348D-08	0.16634D-08	0.14895D-08			
0.31082D-08	0.30136D-08	0.29042D-08	0.27786D-08	0.26366D-08	0.24796D-08
0.23093D-08	0.21282D-08	0.19428D-08			
0.38130D-08	0.37324D-08	0.36342D-08	0.35168D-08	0.33795D-08	0.32223D-08
0.30463D-08	0.28534D-08	0.26522D-08			
0.48575D-08	0.48027D-08	0.47265D-08	0.46268D-08	C.45018D-08	0.43500D-08
0.41707D-08	0.39642D-08	0.37414D-08			
0.63859D-08	0.63740D-08	0.63354D-08	0.62687D-08	0.61697D-08	0.60349D-08
0.58596D-08	0.56411D-08	0.53917D-08			
0.85908D-08	0.86428D-08	0.86634D-08	0.86533D-08	C.86057D-08	0.85111D-08
0.83588D-08	0.81385D-08	0.78617D-08			
0.11727D-07	0.11864D-07	0.11970D-07	0.12050D-07	0.12095D-07	0.12084D-07
0.11994D-07	0.11802D-07	0.11513D-07			
0.16128D-07	0.16349D-07	0.16558D-07	0.16774D-07	0.16984D-07	0.17136D-07
0.17182D-07	0.17086D-07	0.16833D-07			
0.22226D-07	0.22447D-07	0.22742D-07	0.23152D-07	0.23655D-07	0.24110D-07
0.24414D-07	0.24532D-07	0.24440D-07			
0.30583D-07	0.30476D-07	0.30748D-07	0.31412D-07	0.32505D-07	0.33501D-07
0.34213D-07	0.34663D-07	0.34985D-07			
0.41625D-07	0.40743D-07	0.40749D-07	0.41560D-07	C.43476D-07	0.45362D-07
0.46685D-07	0.47426D-07	0.48109D-07			

R LATTICE (CM)

0.4737D 02 0.4999D 02 0.5262D 02 0.5526D 02 0.5789D 02 0.6052D 02 0.6315D 02 C.6578D 02 0.6842D 02

Z LATTICE (CM)

0.0 0.3333D 01 0.6666D 01 0.1000D 02 0.1333D 02 0.1667D 02 0.2000D 02 0.2333D 02 0.2667D 02 0.3000D 02
0.3333D 02 0.3667D 02 0.4000D 02

```
INPUT MATERIAL WORTH FOR REGION   9

0.20022D-06 0.18925D-06 0.17932D-06 0.17025D-06 0.16288D-06
0.20563D-06 0.19487D-06 0.18475D-06 0.17515D-06 0.16637D-06
0.21201D-06 0.20138D-06 0.19105D-06 0.18101D-06 0.17128D-06
0.21825D-06 0.20757D-06 0.19702D-06 0.18660D-06 0.17635D-06
0.22439D-06 0.21356D-06 0.20278D-06 0.19205D-06 0.18145D-06
0.23043D-06 0.21938D-06 0.20838D-06 0.19738D-06 0.18650D-06
0.23633D-06 0.22504D-06 0.21379D-06 0.20254D-06 0.19143D-06
0.24202D-06 0.23048D-06 0.21807D-06 0.20749D-06 0.19616D-06
0.24746D-06 0.23564D-06 0.22388D-06 0.21216D-06 0.20063D-06
0.25733D-06 0.24493D-06 0.23264D-06 0.22043D-06 0.20846D-06
0.25258D-06 0.24048D-06 0.22846D-06 0.21650D-06 0.20475D-06
0.26166D-06 0.24895D-06 0.23608D-06 0.22390D-06 0.21169D-06
0.26552D-06 0.25250D-06 0.23962D-06 0.22686D-06 0.21440D-06
0.26891D-06 0.25555D-06 0.24235D-06 0.22928D-06 0.21654D-06
0.27182D-06 0.25809D-06 0.24455D-06 0.23114D-06 0.21807D-06
0.27427D-06 0.26016D-06 0.24624D-06 0.23244D-06 0.21900D-06
0.27632D-06 0.26181D-06 0.24747D-06 0.23322D-06 0.21932D-06
0.27809D-06 0.26316D-06 0.24835D-06 0.23356D-06 0.21910D-06
0.27980D-06 0.26444D-06 0.24909D-06 0.23360D-06 0.21840D-06
0.28187D-06 0.26608D-06 0.25003D-06 0.23361D-06 0.21740D-06
0.28528D-06 0.26916D-06 0.25186D-06 0.23400D-06 0.21636D-06
0.29351D-06 0.27450D-06 0.25417D-06 0.23426D-06 0.21491D-06

           R LATTICE (CM)

 0.4737D 02 0.4999D 02 0.5262D 02 0.5526D 02 0.5789D 02

           Z LATTICE (CM)

 0.4000D 02 0.4229D 02 0.4458D 02 0.4687D 02 0.4917D 02 0.5146D 02 0.5375D 02 0.5604D 02 0.5833D 02 0.6062D 02
 0.6291D 02 0.6521D 02 0.6750D 02 0.6979D 02 0.7208D 02 0.7437D 02 0.7666D 02 0.7895D 02 0.8125D 02 0.8354D 02
 0.8583D 02 0.8812D 02

INPUT MATERIAL WORTH FOR REGION  10


0.42984D-07-0.32179D-07-0.27649D-07-0.24899D-07-0.24394D-07


0.24800D-07-0.21725D-07-0.21698D-07-0.21467D-07-0.22178D-07


0.12247D-07-0.13221D-07-0.16029D-07-0.17647D-07-0.19395D-07


0.27615D-08-0.61587D-08-0.10777D-07-0.13712D-07-0.16277D-07
0.11366D-07 0.53091D-08-0.12812D-08-0.58105D-08-0.94655D-08
0.17041D-07 0.10230D-07 0.31165D-08-0.18854D-08-0.58849D-08
0.22132D-07 0.14795D-07 0.73331D-08 0.19998D-08-0.22583D-08
0.26778D-07 0.19066D-07 0.11397D-07 0.58311D-08 0.13931D-08
0.31045D-07 0.23098D-07 0.15317D-07 0.96001D-08 0.50301D-08
0.35017D-07 0.26908D-07 0.19091D-07 0.13283D-07 0.86290D-08
0.38718D-07 0.30523D-07 0.22726D-07 0.16872D-07 0.12154D-07
0.42160D-07 0.33932D-07 0.26200D-07 0.20329D-07 0.15578D-07
0.45342D-07 0.37136D-07 0.29504D-07 0.23646D-07 0.18892D-07
0.48291D-07 0.40134D-07 0.32623D-07 0.26814D-07 0.22071D-07
0.50995D-07 0.42909D-07 0.35551D-07 0.29809D-07 0.25098D-07
0.53439D-07 0.45444D-07 0.38256D-07 0.32604D-07 0.27955D-07
0.55607D-07 0.47715D-07 0.40709D-07 0.35176D-07 0.30632D-07
0.57497D-07 0.49695D-07 0.42872D-07 0.37496D-07 0.33124D-07
0.59100D-07 0.51330D-07 0.44677D-07 0.39494D-07 0.35438D-07
0.60751D-07 0.52918D-07 0.46393D-07 0.41425D-07 0.37825D-07

           R LATTICE (CM)

 0.4737D 02 0.4999D 02 0.5262D 02 0.5526D 02 0.5789D 02

           Z LATTICE (CM)

 0.9041D 02 0.9270D 02 0.9499D 02 0.9729D 02 0.1019D 03 0.1042D 03 0.1065D 03 0.1087D 03 0.1110D 03 0.1133D 03
 0.1156D 03 0.1179D 03 0.1202D 03 0.1225D 03 0.1248D 03 0.1271D 03 0.1294D 03 0.1317D 03 0.1340D 03 0.1362D 03
```

g. 1 Mark 1 Total material worth curves for regions 9 and 10

g.1 Mark 1 Total material worth curves for regions 11 and 12

```
INPUT MATERIAL WORTH FOR REGION  11

0.25952D-08 0.46967D-09-0.64886D-09-0.77726D-09 0.21110D-09 0.16221D-08
0.24958D-08 0.28898D-08 0.28536D-08
0.25586D-08 0.13294D-08 0.62919D-09 0.52162D-09 0.96389D-09 0.15697D-08
0.19544D-08 0.21310D-08 0.20229D-08
0.19634D-08 0.12611D-08 0.81257D-09 0.68059D-09 0.78374D-09 0.97923D-09
0.11350D-08 0.12000D-08 0.10811D-08
0.14214D-08 0.10039D-08 0.71625D-09 0.59048D-09 0.57921D-09 0.62180D-09
0.66222D-09 0.66397D-09 0.56561D-09
0.98797D-09 0.73884D-09 0.55531D-09 0.45440D-09 0.41223D-09 0.40107D-09
0.39485D-09 0.37307D-09 0.30068D-09
0.67894D-09 0.52889D-09 0.41172D-09 0.33691D-09 0.29328D-09 0.26747D-09
0.24708D-09 0.22130D-09 0.17114D-09
0.47567D-09 0.38247D-09 0.30597D-09 0.25214D-09 0.21532D-09 0.18919D-09
0.16751D-09 0.14490D-09 0.11094D-09
0.34863D-09 0.28731D-09 0.23523D-09 0.19603D-09 0.16679D-09 0.14436D-09
0.12556D-09 0.10758D-09 0.84662D-10
0.27223D-09 0.22828D-09 0.19037D-09 0.16090D-09 0.13737D-09 0.11899D-09
0.10367D-09 0.89867D-10 0.74248D-10
0.22771D-09 0.19277D-09 0.16264D-09 0.13860D-09 0.11961D-09 0.10449D-09
0.92173D-10 0.81647D-10 0.70931D-10
0.20295D-09 0.17163D-09 0.14534D-09 0.12462D-09 0.10838D-09 0.95653D-10
0.85628D-10 0.77633D-10 0.70469D-10
0.19019D-09 0.15806D-09 0.13348D-09 0.11478D-09 0.10040D-09 0.89339D-10
0.80957D-10 0.74885D-10 0.70903D-10
0.15497D-09 0.12410D-09 0.10352D-09 0.88635D-10 0.77574D-10 0.69397D-10
0.63645D-10 0.60318D-10 0.60310D-10

           R LATTICE (CM)

 0.4737D 02 0.4999D 02 0.5262D 02 0.5526D 02 0.5789D 02 0.6052D 02 0.6315D 02 0.6578D 02 0.6842D 02

           Z LATTICE (CM)

 0.1362D 03 0.1396D 03 0.1429D 03 0.1462D 03 0.1496D 03 0.1529D 03 0.1562D 03 0.1596D 03 0.1629D 03 0.1662D 03
 0.1696D 03 0.1729D 03 0.1762D 03


INPUT MATERIAL WORTH FOR REGION  12

0.20100D-06 0.19039D-06 0.17811D-06 0.16517D-06 0.15217D-06
0.21027D-06 0.19954D-06 0.18745D-06 0.17439D-06 0.16104D-06
0.22164D-06 0.21054D-06 0.19835D-06 0.18510D-06 0.17144D-06
0.23365D-06 0.22224D-06 0.20981D-06 0.19632D-06 0.18238D-06
0.24598D-06 0.23429D-06 0.22161D-06 0.20787D-06 0.19369D-06
0.25840D-06 0.24646D-06 0.23353D-06 0.21953D-06 0.20513D-06
0.27068D-06 0.25851D-06 0.24534D-06 0.23108D-06 0.21646D-06
0.28260D-06 0.27020D-06 0.25680D-06 0.24229D-06 0.22744D-06
0.29395D-06 0.28133D-06 0.26770D-06 0.25295D-06 0.23787D-06
0.30452D-06 0.29169D-06 0.27784D-06 0.26285D-06 0.24755D-06
0.31415D-06 0.30109D-06 0.28702D-06 0.27181D-06 0.25628D-06
0.32266D-06 0.30937D-06 0.29507D-06 0.27964D-06 0.26390D-06
0.32990D-06 0.31637D-06 0.30184D-06 0.28619D-06 0.27026D-06
0.33576D-06 0.32197D-06 0.30720D-06 0.29133D-06 0.27521D-06
0.34014D-06 0.32606D-06 0.31104D-06 0.29495D-06 0.27864D-06
0.34300D-06 0.32859D-06 0.31328D-06 0.29696D-06 0.28045D-06
0.34431D-06 0.32951D-06 0.31387D-06 0.29729D-06 0.28057D-06
0.34411D-06 0.32885D-06 0.31280D-06 0.29592D-06 0.27894D-06
0.34248D-06 0.32667D-06 0.31013D-06 0.29286D-06 0.27553D-06
0.33960D-06 0.32308D-06 0.30596D-06 0.28822D-06 0.27044D-06
0.33565D-06 0.31828D-06 0.30056D-06 0.28235D-06 0.26408D-06
0.32998D-06 0.31188D-06 0.29382D-06 0.27556D-06 0.25758D-06

           R LATTICE (CM)

 0.5789D 02 0.6052D 02 0.6315D 02 0.6578D 02 0.6842D 02

           Z LATTICE (CM)

 0.4000D 02 0.4229D 02 0.4458D 02 0.4687D 02 0.4917D 02 0.5146D 02 0.5375D 02 0.5604D 02 0.5833D 02 0.6062D 02
 0.6291D 02 0.6521D 02 0.6750D 02 0.6979D 02 0.7208D 02 0.7437D 02 0.7666D 02 0.7895D 02 0.8125D 02 0.8354D 02
 0.8583D 02 0.8812D 02
```

Fig. 1 Mark 1 Total material worth curves for regions 13 and 14

INPUT MATERIAL WORTH FOR REGION 13

0.12309D-06	0.12086D-06	0.11766D-06	0.11283D-06	0.10600D-06
0.11698D-06	0.11494D-06	0.11173D-06	0.10706D-06	0.10084D-06
0.11189D-06	0.10962D-06	0.10632D-06	0.10183D-06	0.96070D-07
0.10734D-06	0.10475D-06	0.10133D-06	0.96972D-07	0.91549D-07
0.99077D-07	0.95929D-07	0.92276D-07	0.88055D-07	0.83068D-07
0.95197D-07	0.91834D-07	0.88385D-07	0.83899D-07	0.79050D-07
0.91426D-07	0.87891D-07	0.84062D-07	0.79898D-07	0.75156D-07
0.87753D-07	0.84079D-07	0.80183D-07	0.76028D-07	0.71376D-07
0.84169D-07	0.80385D-07	0.76436D-07	0.72289D-07	0.67711D-07
0.80685D-07	0.76814D-07	0.72820D-07	0.68675D-07	0.64166D-07
0.77309D-07	0.73363D-07	0.69332D-07	0.65196D-07	0.60742D-07
0.74045D-07	0.70043D-07	0.65988D-07	0.61855D-07	0.57448D-07
0.70918D-07	0.66874D-07	0.62799D-07	0.58665D-07	0.54300D-07
0.67947D-07	0.63874D-07	0.59783D-07	0.55650D-07	0.51315D-07
0.65152D-07	0.61060D-07	0.56961D-07	0.52827D-07	0.48512D-07
0.62548D-07	0.58453D-07	0.54358D-07	0.50222D-07	0.45919D-07
0.60156D-07	0.56087D-07	0.52006D-07	0.47870D-07	0.43574D-07
0.58003D-07	0.54004D-07	0.49945D-07	0.45812D-07	0.41520D-07
0.56126D-07	0.52271D-07	0.48218D-07	0.44086D-07	0.39812D-07
0.54799D-07	0.51068D-07	0.46976D-07	0.42864D-07	0.38664D-07

R LATTICE (CM)

0.5789D 02 0.6052D 02 0.6315D 02 0.6578D 02 0.6842D 02

Z LATTICE (CM)

0.9041D 02 0.9270D 02 0.9499D 02 0.9729D 02 0.1019D 03 0.1042D 03 0.1065D 03 0.1087D 03 0.1110D 03 0.1133D 03
0.1156D 03 0.1179D 03 0.1202D 03 0.1225D 03 0.1248D 03 0.1271D 03 0.1294D 03 0.1317D 03 0.1340D 03 0.1362D 03

INPUT MATERIAL WORTH FOR REGION 14

0.83029D-09	0.66839D-09	0.53784D-09	0.43063D-09	0.34532D-09
0.99739D-09	0.82677D-09	0.67907D-09	0.55327D-09	0.44590D-09
0.11735D-08	0.10002D-08	0.84336D-09	0.70415D-09	0.58196D-09
0.14676D-08	0.12799D-08	0.11063D-08	0.94831D-09	0.80785D-09
0.19373D-08	0.17247D-08	0.15202D-08	0.13349D-08	0.11648D-08
0.26738D-08	0.24232D-08	0.21707D-08	0.19398D-08	0.17207D-08
0.38157D-08	0.35101D-08	0.31971D-08	0.28795D-08	0.25803D-08
0.55690D-08	0.51895D-08	0.47701D-08	0.43316D-08	0.39017D-08
0.82334D-08	0.77684D-08	0.72107D-08	0.65683D-08	0.59246D-08
0.12236D-07	0.11707D-07	0.10971D-07	0.10015D-07	0.90164D-08
0.18141D-07	0.17691D-07	0.16780D-07	0.15362D-07	0.13758D-07
0.26574D-07	0.26720D-07	0.25811D-07	0.23844D-07	0.21147D-07
0.37190D-07	0.38953D-07	0.38674D-07	0.36763D-07	0.33442D-07

R LATTICE (CM)

0.6842D 02 0.7104D 02 0.7367D 02 0.7631D 02 0.7895D 02

Z LATTICE (CM)

0.0 0.3333D 01 0.6666D 01 0.1000D 02 0.1333D 02 0.1667D 02 0.2000D 02 0.2333D 02 0.2667D 02 0.3000D 02
0.3333D 02 0.3667D 02 0.4000D 02

INPUT MATERIAL WORTH FOR REGION 15

0.16438D-06	0.14940D-06	0.13378D-06	0.11823D-06	0.10372D-06
0.18968D-06	0.17437D-06	0.15883D-06	0.14330D-06	0.12935D-06
0.21945D-06	0.20351D-06	0.18744D-06	0.17128D-06	0.15687D-06
0.24997D-06	0.23332D-06	0.21657D-06	0.19956D-06	0.18446D-06
0.27871D-06	0.26135D-06	0.24389D-06	0.22604D-06	0.21026D-06
0.30347D-06	0.28547D-06	0.26739D-06	0.24882D-06	0.23248D-06
0.32237D-06	0.30388D-06	0.28533D-06	0.26626D-06	0.24954D-06
0.33391D-06	0.31513D-06	0.29634D-06	0.27707D-06	0.26024D-06
0.33700D-06	0.31818D-06	0.29944D-06	0.28036D-06	0.26378D-06
0.33096D-06	0.31232D-06	0.29401D-06	0.27567D-06	0.25989D-06
0.31512D-06	0.29677D-06	0.27969D-06	0.26307D-06	0.24897D-06
0.28171D-06	0.26924D-06	0.25708D-06	0.24379D-06	0.23234D-06
0.24914D-06	0.24109D-06	0.23189D-06	0.22122D-06	0.21193D-06
0.22109D-06	0.21451D-06	0.20673D-06	0.19763D-06	0.18966D-06
0.19477D-06	0.18893D-06	0.18199D-06	0.17392D-06	0.16680D-06
0.14588D-06	0.14082D-06	0.13488D-06	0.12815D-06	0.12211D-06
0.12361D-06	0.11878D-06	0.11319D-06	0.10697D-06	0.10133D-06
0.10321D-06	0.98544D-07	0.93238D-07	0.87458D-07	0.82184D-07
0.85111D-07	0.80539D-07	0.75439D-07	0.40012D-07	0.65038D-07
0.69772D-07	0.65220D-07	0.60220D-07	0.55011D-07	0.50202D-07
0.57741D-07	0.53177D-07	0.48154D-07	0.42927D-07	0.37821D-07

R LATTICE (CM)

0.6842D 02 0.7104D 02 0.7367D 02 0.7631D 02 0.7895D 02

Z LATTICE (CM)

0.4000D 02 0.4458D 02 0.4917D 02 0.5375D 02 0.5833D 02 0.6291D 02 0.6750D 02 0.7208D 02 0.7666D 02 0.8125D 02
0.8583D 02 0.9041D 02 0.9499D 02 0.9958D 02 0.1042D 03 0.1133D 03 0.1179D 03 0.1225D 03 0.1271D 03 0.1317D 03
0.1362D 03

INPUT MATERIAL WORTH FOR REGION 16

0.15695D-07	0.15764D-07	0.15310D-07	0.14351D-07	0.12871D-07
0.10567D-07	0.10352D-07	0.98418D-08	0.89909D-08	0.79016D-08
0.65800D-08	0.63551D-08	0.59870D-08	0.54572D-08	0.48916D-08
0.40282D-08	0.38655D-08	0.36327D-08	0.33272D-08	0.30208D-08
0.24449D-08	0.23393D-08	0.21995D-08	0.20258D-08	0.18557D-08
0.14799D-08	0.14140D-08	0.13310D-08	0.12315D-08	0.11349D-08
0.89907D-09	0.85808D-09	0.80823D-09	0.74979D-09	0.69294D-09
0.55270D-09	0.52681D-09	0.49585D-09	0.46007D-09	0.42492D-09
0.34796D-09	0.33110D-09	0.31095D-09	0.28765D-09	0.26423D-09
0.22796D-09	0.21666D-09	0.20277D-09	0.18636D-09	0.16923D-09
0.15827D-09	0.15076D-09	0.14064D-09	0.12805D-09	0.11423D-09
0.11822D-09	0.11407D-09	0.10624D-09	0.95725D-10	0.83986D-10
0.84388D-10	0.83818D-10	0.78423D-10	0.70456D-10	0.61841D-10

R LATTICE (CM)

0.6842D 02 0.7104D 02 0.7367D 02 0.7631D 02 0.7895D 02

Z LATTICE (CM)

0.1362D 03 0.1396D 03 0.1429D 03 0.1462D 03 0.1496D 03 0.1529D 03 0.1562D 03 0.1596D 03 0.1629D 03 0.1662D 03
0.1696D 03 0.1729D 03 0.1762D 03

g.1 Mark 1 Total material worth curves for regions 15 and 16

INPUT MATERIAL WORTH FOR REGION 17

0.20650D-09	0.12938D-10	-0.69913D-11	-0.39078D-11	-0.10708D-11
0.39600D-09	0.97112D-10	0.15780D-10	0.17516D-11	0.51978D-12
0.12420D-08	0.38989D-09	0.85430D-10	0.16317D-10	0.40617D-11
0.54754D-08	0.15125D-08	0.30200D-09	0.53500D-10	0.11700D-10
0.25231D-07	0.48368D-08	0.80581D-09	0.12822D-09	0.25444D-10
0.34302D-07	0.68940D-08	0.11159D-08	0.17335D-09	0.33578D-10
0.43063D-07	0.95358D-08	0.15799D-08	0.24434D-09	0.46704D-10
0.49370D-07	0.11480D-07	0.19621D-08	0.30746D-09	0.59086D-10
0.53355D-07	0.12708D-07	0.22157D-08	0.35270D-09	0.68762D-10
0.54604D-07	0.13157D-07	0.23209D-08	0.37475D-09	0.74388D-10
0.52556D-07	0.12766D-07	0.22756D-08	0.37276D-09	0.75445D-10
0.47029D-07	0.11597D-07	0.21014D-08	0.34997D-09	0.72240D-10
0.41983D-07	0.10534D-07	0.19365D-08	0.32627D-09	0.68167D-10
0.34474D-07	0.88540D-08	0.16580D-08	0.28234D-09	0.60030D-10
0.28436D-07	0.73272D-08	0.13794D-08	0.23699D-09	0.50485D-10
0.23711D-07	0.60040D-08	0.11183D-08	0.19069D-09	0.40496D-10
0.19734D-07	0.48158D-08	0.87353D-09	0.14667D-09	0.30786D-10
0.16076D-07	0.36719D-08	0.63957D-09	0.10539D-09	0.21932D-10
0.12370D-07	0.24923D-08	0.41945D-09	0.68941D-10	0.14441D-10
0.91132D-08	0.16873D-08	0.29317D-09	0.48684D-10	0.10395D-10
0.18016D-08	0.48058D-09	0.99701D-10	0.18688D-10	0.43551D-11
0.33280D-09	0.10936D-09	0.26449D-10	0.55508D-11	0.14480D-11
0.82251D-10	0.26395D-10	0.60363D-11	0.11040D-11	0.28556D-12
0.39841D-10	0.81505D-11	0.64389D-12	-0.33191D-12	-0.15668D-12

R LATTICE (CM)

0.7895D 02 0.8945D 02 0.9997D 02 0.1105D 03 0.1210D 03

Z LATTICE (CM)

0.0 0.1000D 02 0.2000D 02 0.3000D 02 0.4000D 02 0.4458D 02 0.5146D 02 0.5833D 02 0.6521D 02 0.7208D 02
0.7895D 02 0.8583D 02 0.9041D 02 0.9729D 02 0.1042D 03 0.1110D 03 0.1179D 03 0.1248D 03 0.1317D 03 0.1362D 03
0.1462D 03 0.1562D 03 0.1662D 03 0.1762D 03

g. 1 Mark 1 Total material worth curves for region 17

Fig.2 Mark 1A Geometrical and control input data for KADIS

```
  MARK-1A CORE _ 5 $/S ACC. _ P.D.=9.4178 _ CORR. NA VOL. FR. _ 15/03/74

    RADIAL DISTANCE

  0.0         9.866      19.732      29.597      39.463      49.329      59.195      69.060
 79.667      90.273     108.420

    AXIAL DISTANCE

  0.000      13.376      26.752      40.127      49.769      59.411      69.053      78.695
 88.337      97.979     107.620     117.260     126.900     136.550     149.950     163.350
176.750

 NUMBER OF RADIAL ZONES =    10     NUMBER OF AXIAL ZONES =    16

 STOP CONDITIONS ARE;
 MAX. TIME  =  0.10000D 01     MAX. CYCLE =          1500     MAX. DISTORTION =  0.10000D 04
 MAX. POWER =  0.10000D 25     MIN. POWER =  0.10000D 11     K-EFF-LIMIT     =  0.95000D 00


 EPS1    =  0.0            EPS2   =  0.0             EPS3   =  0.10000D 00   EPS4    =  0.10000D 00
 DELT    =  0.50000D-04    DELTMX =  0.50000D-04     DELTMN =  0.10000D-05   RHOCRT  =  0.30000D 01

 OUTPUT PARAMETERS            0    0    0    1   10    1 1000

 WMAX LIMITS FOR TIME STEP CONTROL    0.20000  0.04000
```

```
INPUT MATERIAL WORTH FOR REGION   1

0.10013D-07 0.99391D-08 0.97250D-08 0.93600D-08 0.88438D-08 0.81591D-08
0.72899D-08 0.61881D-08 0.47724D-08 0.28462D-08-0.11246D-09
0.71860D-08 0.71274D-08 0.69519D-08 0.66558D-08 0.62346D-08 0.56782D-08
0.49715D-08 0.40862D-08 0.29701D-08 0.15153D-08-0.38934D-09
0.48905D-08 0.48449D-08 0.47069D-08 0.44749D-08 0.41467D-08 0.37177D-08
0.31836D-08 0.25381D-08 0.17781D-08 0.91227D-09 0.23789D-10
0.35073D-08 0.34731D-08 0.33710D-08 0.32010D-08 0.29629D-08 0.26577D-08
0.22882D-08 0.18611D-08 0.13898D-08 0.90072D-09 0.44953D-09
0.27246D-08 0.27007D-08 0.26284D-08 0.25089D-08 0.23429D-08 0.21333D-08
0.18845D-08 0.16050D-08 0.13075D-08 0.10131D-08 0.75237D-09
0.14315D-08 0.14250D-08 0.14056D-08 0.13740D-08 0.13314D-08 0.12794D-08
0.12203D-08 0.11570D-08 0.10928D-08 0.10318D-08 0.97852D-09
0.11282D-08 0.11262D-08 0.11202D-08 0.11105D-08 0.10974D-08 0.10814D-08
0.10632D-08 0.10432D-08 0.10222D-08 0.10007D-08 0.97888D-09
0.57044D-09 0.57024D-09 0.56967D-09 0.56872D-09 0.56737D-09 0.56559D-09
0.56326D-09 0.56016D-09 0.55585D-09 0.54956D-09 0.53990D-09

            R LATTICE (CM)

 0.0        0.1970D 01 0.3950D 01 0.5920D 01 0.7890D 01 0.9870D 01 0.1184D 02 0.1381D 02 0.1579D 02 0.1776D 02
 0.1973D 02

            Z LATTICE (CM)

 0.1366D 03 0.1420D 03 0.1478D 03 0.1535D 03 0.1593D 03 0.1650D 03 0.1708D 03 0.1765D 03

INPUT MATERIAL WORTH FOR REGION   2

0.90943D-08-0.13346D-07-0.14859D-07-0.14662D-07-0.12897D-07-0.88974D-08

0.72973D-08-0.91238D-08-0.98543D-08-0.97470D-08-0.89148D-08-0.72839D-08

0.49753D-08-0.56554D-08-0.59823D-08-0.59200D-08-0.55360D-08-0.49696D-08

0.30246D-08-0.33154D-08-0.34579D-08-0.34225D-08-0.32472D-08-0.30226D-08

0.15733D-08-0.17228D-08-0.17954D-08-0.17739D-08-0.16818D-08-0.15714D-08
0.38970D-09 0.36474D-09 0.35485D-09 0.36181D-09 0.38072D-09 0.40113D-09
0.90247D-09 0.88922D-09 0.88512D-09 0.88907D-09 0.89969D-09 0.91525D-09
0.56556D-09 0.55727D-09 0.55501D-09 0.55683D-09 0.56260D-09 0.57063D-09

            R LATTICE (CM)

 0.1973D 02 0.2170D 02 0.2368D 02 0.2565D 02 0.2762D 02 0.2960D 02

            Z LATTICE (CM)

 0.1366D 03 0.1420D 03 0.1478D 03 0.1535D 03 0.1593D 03 0.1650D 03 0.1708D 03 0.1765D 03
```

g.2 Mark 1A Total material worth curves for regions 1 and 2

```
INPUT MATERIAL WORTH FOR REGION   3

0.36865D-08 0.60496D-08 0.72587D-08 0.80444D-08 0.85435D-08 0.88019D-08
0.88161D-08 0.85297D-08 0.76813D-08
0.27197D-08 0.43373D-08 0.53411D-08 0.59861D-08 0.63900D-08 0.65905D-08
0.65905D-08 0.63545D-08 0.58271D-08
0.24119D-08 0.31831D-08 0.38293D-08 0.43000D-08 0.46077D-08 0.47641D-08
0.47769D-08 0.46530D-08 0.44447D-08
0.22238D-08 0.26122D-08 0.29904D-08 0.32959D-08 0.35079D-08 0.36222D-08
0.36454D-08 0.35927D-08 0.35088D-08
0.20404D-08 0.22671D-08 0.25007D-08 0.26980D-08 0.28383D-08 0.29149D-08
0.29324D-08 0.29034D-08 0.28575D-08
0.14183D-08 0.14685D-08 0.15183D-08 0.15605D-08 0.15893D-08 0.16023D-08
0.15998D-08 0.15848D-08 0.15626D-08
0.11182D-08 0.11428D-08 0.11606D-08 0.11704D-08 0.11712D-08 0.11628D-08
0.11457D-08 0.11209D-08 0.10904D-08
0.57157D-09 0.58141D-09 0.58555D-09 0.58475D-09 0.57948D-09 0.57009D-09
0.55697D-09 0.54068D-09 0.52210D-09

             R LATTICE (CM)

 0.2960D 02 0.3206D 02 0.3453D 02 0.3700D 02 0.3946D 02 0.4193D 02 0.4440D 02 0.4686D 02 0.4933D 02

             Z LATTICE (CM)

 0.1366D 03 0.1420D 03 0.1478D 03 0.1535D 03 0.1593D 03 0.1650D 03 0.1708D 03 0.1765D 03

INPUT MATERIAL WORTH FOR REGION   4


0.16577D-09-0.17376D-08-0.22952D-08-0.22783D-08-0.18705D-08-0.10951D-08
0.11462D-09 0.19738D-08 0.50265D-08


0.17725D-09-0.84614D-09-0.10903D-08-0.10253D-08-0.68977D-09-0.84611D-10
0.82615D-09 0.21276D-08 0.39306D-08
0.28976D-10-0.18935D-09-0.27221D-09-0.18314D-09 0.86612D-10 0.54238D-09
0.11925D-08 0.20379D-08 0.29929D-08
0.35741D-09 0.28981D-09 0.28113D-09 0.37044D-09 0.57198D-09 0.88968D-09
0.13184D-08 0.18377D-08 0.23709D-08
0.66886D-09 0.64309D-09 0.65124D-09 0.71945D-09 0.85788D-09 0.10671D-08
0.13401D-08 0.16573D-08 0.19690D-08
0.91761D-09 0.90241D-09 0.89503D-09 0.89995D-09 0.91764D-09 0.94677D-09
0.98401D-09 0.10242D-08 0.10574D-08
0.93963D-09 0.90962D-09 0.88234D-09 0.85821D-09 0.83680D-09 0.81738D-09
0.79898D-09 0.78056D-09 0.76062D-09
0.50693D-09 0.48700D-09 0.46683D-09 0.44675D-09 0.42673D-09 0.40673D-09
0.38685D-09 0.36742D-09 0.34910D-09

             R LATTICE (CM)

 0.4933D 02 0.5180D 02 0.5426D 02 0.5673D 02 0.5919D 02 0.6166D 02 0.6413D 02 0.6659D 02 0.6906D 02

             Z LATTICE (CM)

 0.1366D 03 0.1420D 03 0.1478D 03 0.1535D 03 0.1593D 03 0.1650D 03 0.1708D 03 0.1765D 03
```

g.2 Mark 1A Total material worth curves for regions 3 and 4

8.2 Mark 1A Total material worth curves for regions 5 and 6

```
INPUT MATERIAL WORTH FOR REGION   5

0.89802D-08 0.12260D-07 0.14244D-07 0.15476D-07 0.16162D-07 0.16408D-07
0.16267D-07 0.15767D-07 0.14891D-07 0.13513D-07
0.68988D-08 0.87800D-08 0.10019D-07 0.10817D-07 0.11249D-07 0.11360D-07
0.11175D-07 0.10699D-07 0.98896D-08 0.88148D-08
0.51213D-08 0.60839D-08 0.68174D-08 0.73132D-08 0.75724D-08 0.76063D-08
0.74266D-08 0.70399D-08 0.64502D-08 0.57856D-08
0.38390D-08 0.43625D-08 0.47731D-08 0.50493D-08 0.51766D-08 0.51554D-08
0.49923D-08 0.46991D-08 0.42935D-08 0.38659D-08
0.29436D-08 0.32392D-08 0.34638D-08 0.36021D-08 0.36434D-08 0.35869D-08
0.34389D-08 0.32107D-08 0.29202D-08 0.26229D-08
0.13066D-08 0.13336D-08 0.13419D-08 0.13295D-08 0.12948D-08 0.12384D-08
0.11627D-08 0.10718D-08 0.97050D-09 0.87000D-09
0.79916D-09 0.77685D-09 0.74684D-09 0.70955D-09 0.66550D-09 0.61570D-09
0.56160D-09 0.50504D-09 0.44802D-09 0.39376D-09
0.34371D-09 0.32509D-09 0.30408D-09 0.28168D-09 0.25849D-09 0.23503D-09
0.21187D-09 0.18975D-09 0.16986D-09 0.15368D-09

             R LATTICE (CM)

 0.6906D 02 0.7142D 02 0.7377D 02 0.7613D 02 0.7849D 02 0.8084D 02 0.8320D 02 0.8556D 02 0.8792D 02 0.9027D 02

             Z LATTICE (CM)

 0.1366D 03 0.1420D 03 0.1478D 03 0.1535D 03 0.1593D 03 0.1650D 03 0.1708D 03 0.1765D 03

INPUT MATERIAL WORTH FOR REGION   6

0.42279D-09 0.30994D-09 0.21890D-09 0.15429D-09 0.10892D-09 0.75296D-10
0.65906D-09 0.45218D-09 0.29291D-09 0.17627D-09 0.94275D-10 0.36968D-10
0.22205D-08 0.13957D-08 0.79469D-09 0.36906D-09 0.86198D-10-0.11390D-09
0.16326D-07 0.87187D-08 0.44053D-08 0.19839D-08 0.65018D-09-0.26268D-09
0.24544D-07 0.13772D-07 0.69585D-08 0.31704D-08 0.11197D-08-0.33974D-09
0.28524D-07 0.16406D-07 0.85586D-08 0.40095D-08 0.14612D-08-0.47150D-09
0.30819D-07 0.17796D-07 0.93509D-08 0.43911D-08 0.15941D-08-0.63901D-09
0.32056D-07 0.18500D-07 0.97151D-08 0.45421D-08 0.16119D-08-0.80065D-09
0.32785D-07 0.18881D-07 0.98795D-08 0.45769D-08 0.15675D-08-0.97370D-09
0.32997D-07 0.18947D-07 0.98631D-08 0.45132D-08 0.14743D-08-0.11468D-08
0.32678D-07 0.18700D-07 0.96789D-08 0.43673D-08 0.13486D-08-0.12999D-08
0.31850D-07 0.18164D-07 0.93516D-08 0.41595D-08 0.12064D-08-0.14203D-08
0.30585D-07 0.17387D-07 0.89113D-08 0.39109D-08 0.10623D-08-0.14974D-08
0.28985D-07 0.16435D-07 0.83975D-08 0.36433D-08 0.92976D-09-0.15255D-08
0.27650D-07 0.15655D-07 0.79886D-08 0.34438D-08 0.84442D-09-0.15130D-08
0.24881D-07 0.14068D-07 0.71813D-08 0.30792D-08 0.72347D-09-0.14055D-08
0.22232D-07 0.12584D-07 0.64517D-08 0.27840D-08 0.67112D-09-0.12058D-08
0.19810D-07 0.11254D-07 0.58119D-08 0.25488D-08 0.66670D-09-0.95180D-09
0.17559D-07 0.10018D-07 0.52084D-08 0.23256D-08 0.66757D-09-0.68924D-09
0.15080D-07 0.86004D-08 0.44546D-08 0.20026D-08 0.61460D-09-0.43833D-09
0.12093D-07 0.66037D-08 0.32629D-08 0.14250D-08 0.42937D-09-0.25463D-09
0.63208D-08 0.33004D-08 0.17024D-08 0.74914D-09 0.20289D-09-0.16069D-09
0.22273D-08 0.13524D-08 0.74995D-09 0.33673D-09 0.73963D-10-0.10424D-09
0.46006D-09 0.30895D-09 0.19043D-09 0.10173D-09 0.39014D-10-0.49359D-11
0.12736D-09 0.98843D-10 0.74297D-10 0.55628D-10 0.41558D-10 0.30616D-10

             R LATTICE (CM)

 0.9027D 02 0.9390D 02 0.9753D 02 0.1012D 03 0.1048D 03 0.1084D 03

             Z LATTICE (CM)

 0.0         0.1338D 02 0.2675D 02 0.4013D 02 0.4494D 02 0.4975D 02 0.5456D 02 0.5938D 02 0.6419D 02 0.6900D 02
 0.7381D 02 0.7863D 02 0.8344D 02 0.8825D 02 0.9168D 02 0.9855D 02 0.1054D 03 0.1123D 03 0.1191D 03 0.1260D 03
 0.1329D 03 0.1420D 03 0.1535D 03 0.1650D 03 0.1765D 03
```

g.2 Mark 1A Total material worth curves for region 7

```
INPUT MATERIAL WORTH FOR REGION   7

0.26764D-06 0.26746D-06 0.26691D-06 0.26602D-06 0.26482D-06 0.26337D-06
0.26180D-06 0.26031D-06 0.25929D-06 0.25966D-06 0.26333D-06
0.25778D-06 0.25759D-06 0.25701D-06 0.25606D-06 0.25478D-06 0.25323D-06
0.25151D-06 0.24982D-06 0.24855D-06 0.24855D-06 0.24959D-06
0.24583D-06 0.24562D-06 0.24498D-06 0.24392D-06 0.24247D-06 0.24064D-06
0.23848D-06 0.23605D-06 0.23344D-06 0.23072D-06 0.22687D-06
0.23231D-06 0.23207D-06 0.23136D-06 0.23019D-06 0.22855D-06 0.22643D-06
0.22383D-06 0.22073D-06 0.21709D-06 0.21279D-06 0.20707D-06
0.21777D-06 0.21752D-06 0.21676D-06 0.21550D-06 0.21372D-06 0.21141D-06
0.20854D-06 0.20505D-06 0.20090D-06 0.19593D-06 0.18961D-06
0.20274D-06 0.20248D-06 0.20170D-06 0.20040D-06 0.19857D-06 0.19618D-06
0.19320D-06 0.18960D-06 0.18529D-06 0.18019D-06 0.17386D-06
0.18767D-06 0.18742D-06 0.18665D-06 0.18535D-06 0.18353D-06 0.18116D-06
0.17821D-06 0.17466D-06 0.17044D-06 0.16548D-06 0.15943D-06
0.17286D-06 0.17261D-06 0.17186D-06 0.17061D-06 0.16885D-06 0.16656D-06
0.16373D-06 0.16034D-06 0.15633D-06 0.15166D-06 0.14601D-06
0.15852D-06 0.15828D-06 0.15757D-06 0.15638D-06 0.15471D-06 0.15256D-06
0.14990D-06 0.14673D-06 0.14300D-06 0.13867D-06 0.13348D-06
0.14484D-06 0.14461D-06 0.14394D-06 0.14284D-06 0.14128D-06 0.13927D-06
0.13681D-06 0.13388D-06 0.13045D-06 0.12650D-06 0.12179D-06
0.13195D-06 0.13175D-06 0.13113D-06 0.13010D-06 0.12865D-06 0.12680D-06
0.12453D-06 0.12185D-06 0.11873D-06 0.11516D-06 0.11094D-06
0.11717D-06 0.11698D-06 0.11641D-06 0.11547D-06 0.11416D-06 0.11249D-06
0.11045D-06 0.10806D-06 0.10532D-06 0.10221D-06 0.98568D-07
0.10407D-06 0.10390D-06 0.10338D-06 0.10252D-06 0.10132D-06 0.99793D-07
0.97945D-07 0.95792D-07 0.93353D-07 0.90645D-07 0.87541D-07
0.92878D-07 0.92719D-07 0.92240D-07 0.91445D-07 0.90334D-07 0.88912D-07
0.87186D-07 0.85170D-07 0.82895D-07 0.80428D-07 0.77731D-07
0.84174D-07 0.84026D-07 0.83575D-07 0.82824D-07 0.81763D-07 0.80394D-07
0.78701D-07 0.76686D-07 0.74359D-07 0.71805D-07 0.69182D-07

             R LATTICE (CM)

 0.0         0.1970D 01 0.3950D 01 0.5920D 01 0.7890D 01 0.9870D 01 0.1184D 02 0.1381D 02 0.1579D 02 0.1776D 02
 0.1973D 02

             Z LATTICE (CM)

 0.8834D 02 0.9168D 02 0.9511D 02 0.9855D 02 0.1020D 03 0.1054D 03 0.1088D 03 0.1123D 03 0.1157D 03 0.1191D 03
 0.1226D 03 0.1260D 03 0.1294D 03 0.1329D 03 0.1363D 03
```

g.2 Mark 1A Total material worth curves for region 8

```
INPUT MATERIAL WORTH FOR REGION   8

0.34485D-06-0.31476D-06-0.30356D-06-0.30617D-06-0.32239D-06-0.35627D-06

0.27287D-06-0.25813D-06-0.25373D-06-0.25557D-06-0.26425D-06-0.28508D-06

0.23289D-06-0.22706D-06-0.22614D-06-0.22735D-06-0.23171D-06-0.24397D-06

0.20369D-06-0.20113D-06-0.20143D-06-0.20230D-06-0.20484D-06-0.21350D-06

0.17894D-06-0.17782D-06-0.17857D-06-0.17923D-06-0.18088D-06-0.18760D-06

0.15638D-06-0.15596D-06-0.15685D-06-0.15737D-06-0.15854D-06-0.16401D-06

0.13517D-06-0.13514D-06-0.13605D-06-0.13648D-06-0.13734D-06-0.14192D-06

0.11497D-06-0.11515D-06-0.11605D-06-0.11640D-06-0.11705D-06-0.12091D-06

0.95700D-07-0.96016D-07-0.96869D-07-0.97166D-07-0.97652D-07-0.10092D-06

0.77413D-07-0.77812D-07-0.78615D-07-0.78867D-07-0.79228D-07-0.81987D-07

0.60215D-07-0.60661D-07-0.61414D-07-0.61630D-07-0.61893D-07-0.64218D-07

0.40457D-07-0.40906D-07-0.41590D-07-0.41777D-07-0.41948D-07-0.43840D-07

0.22958D-07-0.23353D-07-0.23970D-07-0.24141D-07-0.24258D-07-0.25830D-07

0.82011D-08-0.85082D-08-0.90636D-08-0.92401D-08-0.93405D-08-0.10687D-07
0.37268D-08 0.36829D-08 0.32953D-08 0.30705D-08 0.27659D-08 0.14023D-08

                R LATTICE (CM)

 0.1973D 02 0.2170D 02 0.2368D 02 0.2565D 02 0.2762D 02 0.2960D 02

                Z LATTICE (CM)

 0.8834D 02 0.9168D 02 0.9511D 02 0.9855D 02 0.1020D 03 0.1054D 03 0.1088D 03 0.1123D 03 0.1157D 03 0.1191D 03
 0.1226D 03 0.1260D 03 0.1294D 03 0.1329D 03 0.1363D 03
```

Fig.2 Mark 1A Total material worth curves for region 9

INPUT MATERIAL WORTH FOR REGION 9

```
0.22560D-06 0.21613D-06 0.21166D-06 0.20907D-06 0.20700D-06 0.20497D-06
0.20288D-06 0.20099D-06 0.20007D-06
0.21617D-06 0.20820D-06 0.20341D-06 0.20100D-06 0.19923D-06 0.19753D-06
0.19580D-06 0.19434D-06 0.19318D-06
0.19977D-06 0.19604D-06 0.19290D-06 0.19117D-06 0.18981D-06 0.18835D-06
0.18667D-06 0.18480D-06 0.18240D-06
0.18484D-06 0.18323D-06 0.18144D-06 0.18038D-06 0.17939D-06 0.17812D-06
0.17643D-06 0.17425D-06 0.17127D-06
0.17117D-06 0.17071D-06 0.16979D-06 0.16923D-06 0.16853D-06 0.16741D-06
0.16573D-06 0.16341D-06 0.16020D-06
0.15846D-06 0.15865D-06 0.15828D-06 0.15806D-06 0.15756D-06 0.15656D-06
0.15494D-06 0.15260D-06 0.14936D-06
0.14655D-06 0.14712D-06 0.14709D-06 0.14708D-06 0.14673D-06 0.14584D-06
0.14429D-06 0.14201D-06 0.13885D-06
0.13530D-06 0.13608D-06 0.13627D-06 0.13640D-06 0.13615D-06 0.13535D-06
0.13390D-06 0.13173D-06 0.12872D-06
0.12466D-06 0.12556D-06 0.12589D-06 0.12611D-06 0.12594D-06 0.12521D-06
0.12386D-06 0.12182D-06 0.11900D-06
0.11462D-06 0.11558D-06 0.11600D-06 0.11627D-06 0.11615D-06 0.11550D-06
0.11425D-06 0.11236D-06 0.10974D-06
0.10521D-06 0.10618D-06 0.10665D-06 0.10696D-06 0.10689D-06 0.10630D-06
0.10515D-06 0.10340D-06 0.10100D-06
0.94365D-07 0.95317D-07 0.95830D-07 0.96173D-07 0.96138D-07 0.95622D-07
0.94580D-07 0.93006D-07 0.90855D-07
0.84557D-07 0.85484D-07 0.86052D-07 0.86444D-07 0.86451D-07 0.85984D-07
0.85023D-07 0.83587D-07 0.81659D-07
0.75615D-07 0.76656D-07 0.77408D-07 0.77911D-07 0.77971D-07 0.77526D-07
0.76582D-07 0.75193D-07 0.73404D-07
0.67647D-07 0.69196D-07 0.70405D-07 0.71112D-07 0.71239D-07 0.70787D-07
0.69790D-07 0.68307D-07 0.66486D-07
```

R LATTICE (CM)

```
0.2960D 02 0.3206D 02 0.3453D 02 0.3700D 02 0.3946D 02 0.4193D 02 0.4440D 02 0.4686D 02 0.4933D 02
```

Z LATTICE (CM)

```
0.8834D 02 0.9168D 02 0.9511D 02 0.9855D 02 0.1020D 03 0.1054D 03 0.1088D 03 0.1123D 03 0.1157D 03 0.1191D 03
0.1226D 03 0.1260D 03 0.1294D 03 0.1329D 03 0.1363D 03
```

g.2 Mark 1A Total material worth curves for region 10

INPUT MATERIAL WORTH FOR REGION 10

```
0.18951D-07-0.92338D-08-0.42896D-08-0.19512D-08-0.13295D-08-0.20294D-08

0.40352D-08-0.76489D-08-0.13561D-07

0.37153D-08 0.74431D-09 0.24417D-08 0.31210D-08 0.29063D-08 0.18827D-08
0.35072D-10-0.27907D-08-0.72225D-08
0.45741D-08 0.59106D-08 0.57659D-08 0.54039D-08 0.46871D-08 0.35881D-08
0.20775D-08 0.13353D-09-0.27827D-08
0.98893D-08 0.98024D-08 0.87177D-08 0.77501D-08 0.67418D-08 0.56270D-08
0.43759D-08 0.29695D-08 0.84918D-09
0.13797D-07 0.12993D-07 0.11458D-07 0.10178D-07 0.90229D-08 0.79267D-08
0.68497D-08 0.57649D-08 0.41136D-08
0.17022D-07 0.15851D-07 0.14109D-07 0.12695D-07 0.11486D-07 0.10420D-07
0.94700D-08 0.85827D-08 0.72318D-08
0.19892D-07 0.18542D-07 0.16743D-07 0.15287D-07 0.14078D-07 0.13059D-07
0.12195D-07 0.11440D-07 0.10286D-07
0.22572D-07 0.21148D-07 0.19368D-07 0.17928D-07 0.16750D-07 0.15781D-07
0.14982D-07 0.14314D-07 0.13308D-07
0.25120D-07 0.23687D-07 0.21965D-07 0.20573D-07 0.19443D-07 0.18525D-07
0.17781D-07 0.17169D-07 0.16265D-07
0.27538D-07 0.26135D-07 0.24493D-07 0.23168D-07 0.22094D-07 0.21227D-07
0.20530D-07 0.19958D-07 0.19123D-07
0.29800D-07 0.28458D-07 0.26915D-07 0.25664D-07 0.24650D-07 0.23834D-07
0.23178D-07 0.22633D-07 0.21847D-07
0.32377D-07 0.31125D-07 0.29704D-07 0.28546D-07 0.27607D-07 0.26853D-07
0.26247D-07 0.25736D-07 0.24991D-07
0.34583D-07 0.33428D-07 0.32116D-07 0.31036D-07 0.30162D-07 0.29468D-07
0.28917D-07 0.28452D-07 0.27753D-07
0.36335D-07 0.35246D-07 0.34004D-07 0.32969D-07 0.32130D-07 0.31472D-07
0.30973D-07 0.30587D-07 0.30037D-07
0.38193D-07 0.37155D-07 0.35970D-07 0.34940D-07 0.34097D-07 0.33446D-07
0.32993D-07 0.32717D-07 0.32438D-07
```

R LATTICE (CM)

```
0.4933D 02 0.5180D 02 0.5426D 02 0.5673D 02 0.5919D 02 0.6166D 02 0.6413D 02 0.6659D 02 0.6906D 02
```

Z LATTICE (CM)

```
0.8834D 02 0.9168D 02 0.9511D 02 0.9855D 02 0.1020D 03 0.1054D 03 0.1088D 03 0.1123D 03 0.1157D 03 0.1191D 03
0.1226D 03 0.1260D 03 0.1294D 03 0.1329D 03 0.1363D 03
```

g.2 Mark 1A Total material worth curves for region 11

```
INPUT MATERIAL WORTH FOR REGION  11

0.16561D-06 0.15992D-06 0.15232D-06 0.14346D-06 0.13375D-06 0.12349D-06
0.11301D-06 0.10262D-06 0.92704D-07 0.83851D-07
0.19751D-06 0.19134D-06 0.18382D-06 0.17492D-06 0.16493D-06 0.15416D-06
0.14292D-06 0.13155D-06 0.12036D-06 0.11034D-06
0.23549D-06 0.22893D-06 0.22096D-06 0.21154D-06 0.20092D-06 0.18937D-06
0.17722D-06 0.16480D-06 0.15243D-06 0.14145D-06
0.26562D-06 0.25888D-06 0.25062D-06 0.24080D-06 0.22967D-06 0.21752D-06
0.20465D-06 0.19141D-06 0.17814D-06 0.16641D-06
0.28651D-06 0.27967D-06 0.27125D-06 0.26119D-06 0.24975D-06 0.23722D-06
0.22390D-06 0.21012D-06 0.19626D-06 0.18406D-06
0.30347D-06 0.29660D-06 0.28811D-06 0.27792D-06 0.26629D-06 0.25350D-06
0.23987D-06 0.22573D-06 0.21145D-06 0.19893D-06
0.31574D-06 0.30891D-06 0.30042D-06 0.29023D-06 0.27856D-06 0.26570D-06
0.25195D-06 0.23765D-06 0.22315D-06 0.21050D-06
0.32205D-06 0.31532D-06 0.30695D-06 0.29691D-06 0.28541D-06 0.27269D-06
0.25907D-06 0.24486D-06 0.23041D-06 0.21783D-06
0.32195D-06 0.31535D-06 0.30724D-06 0.29755D-06 0.28645D-06 0.27415D-06
0.26093D-06 0.24708D-06 0.23294D-06 0.22068D-06
0.31535D-06 0.30883D-06 0.30112D-06 0.29206D-06 0.28167D-06 0.27008D-06
0.25755D-06 0.24433D-06 0.23076D-06 0.21903D-06
0.30185D-06 0.29556D-06 0.28884D-06 0.28087D-06 0.27154D-06 0.26097D-06
0.24936D-06 0.23700D-06 0.22421D-06 0.21318D-06
0.26998D-06 0.26706D-06 0.26249D-06 0.25642D-06 0.24885D-06 0.23992D-06
0.22986D-06 0.21896D-06 0.20756D-06 0.19771D-06
0.23694D-06 0.23529D-06 0.23191D-06 0.22704D-06 0.22073D-06 0.21312D-06
0.20443D-06 0.19491D-06 0.18488D-06 0.17619D-06
0.20323D-06 0.20209D-06 0.19935D-06 0.19524D-06 0.18984D-06 0.18326D-06
0.17571D-06 0.16741D-06 0.15864D-06 0.15099D-06
0.16977D-06 0.16885D-06 0.16650D-06 0.16294D-06 0.15822D-06 0.15248D-06
0.14589D-06 0.13865D-06 0.13102D-06 0.12429D-06
0.13799D-06 0.13714D-06 0.13505D-06 0.13189D-06 0.12772D-06 0.12266D-06
0.11687D-06 0.11055D-06 0.10392D-06 0.98006D-07
0.10303D-06 0.10220D-06 0.10034D-06 0.97541D-07 0.93869D-07 0.89444D-07
0.84429D-07 0.79020D-07 0.73423D-07 0.68349D-07
0.76550D-07 0.76077D-07 0.74434D-07 0.71792D-07 0.68325D-07 0.64212D-07
0.59642D-07 0.54823D-07 0.50027D-07 0.45700D-07

            R LATTICE (CM)

 0.6906D 02 0.7142D 02 0.7377D 02 0.7613D 02 0.7849D 02 0.8084D 02 0.8320D 02 0.8556D 02 0.8792D 02 0.9027D 02

            Z LATTICE (CM)

 0.4013D 02 0.4494D 02 0.4975D 02 0.5456D 02 0.5938D 02 0.6419D 02 0.6900D 02 0.7381D 02 0.7863D 02 0.8344D 02
 0.8825D 02 0.9511D 02 0.1020D 03 0.1088D 03 0.1157D 03 0.1226D 03 0.1294D 03 0.1363D 03
```

INPUT MATERIAL WORTH FOR REGION 12

```
0.20863D-06 0.20848D-06 0.20801D-06 0.20725D-06 0.20617D-06 0.20480D-06
0.20311D-06 0.20113D-06 0.19884D-06 0.19629D-06 0.19350D-06
0.21501D-06 0.21485D-06 0.21440D-06 0.21364D-06 0.21258D-06 0.21122D-06
0.20957D-06 0.20764D-06 0.20546D-06 0.20304D-06 0.20043D-06
0.22448D-06 0.22432D-06 0.22386D-06 0.22309D-06 0.22202D-06 0.22065D-06
0.21900D-06 0.21708D-06 0.21491D-06 0.21252D-06 0.20994D-06
0.23426D-06 0.23410D-06 0.23363D-06 0.23285D-06 0.23177D-06 0.23039D-06
0.22872D-06 0.22678D-06 0.22459D-06 0.22217D-06 0.21954D-06
0.24396D-06 0.24380D-06 0.24332D-06 0.24252D-06 0.24142D-06 0.24001D-06
0.23831D-06 0.23633D-06 0.23408D-06 0.23159D-06 0.22887D-06
0.25319D-06 0.25303D-06 0.25254D-06 0.25171D-06 0.25058D-06 0.24913D-06
0.24738D-06 0.24534D-06 0.24303D-06 0.24046D-06 0.23765D-06
0.25878D-06 0.25861D-06 0.25811D-06 0.25727D-06 0.25611D-06 0.25463D-06
0.25285D-06 0.25077D-06 0.24841D-06 0.24579D-06 0.24291D-06
0.26395D-06 0.26378D-06 0.26326D-06 0.26241D-06 0.26122D-06 0.25971D-06
0.25789D-06 0.25577D-06 0.25335D-06 0.25068D-06 0.24775D-06
0.26864D-06 0.26846D-06 0.26793D-06 0.26705D-06 0.26584D-06 0.26429D-06
0.26242D-06 0.26025D-06 0.25779D-06 0.25506D-06 0.25208D-06
0.27276D-06 0.27257D-06 0.27204D-06 0.27114D-06 0.26989D-06 0.26831D-06
0.26640D-06 0.26418D-06 0.26167D-06 0.25889D-06 0.25586D-06
0.27628D-06 0.27609D-06 0.27554D-06 0.27461D-06 0.27334D-06 0.27172D-06
0.26977D-06 0.26750D-06 0.26494D-06 0.26212D-06 0.25904D-06
0.27921D-06 0.27903D-06 0.27845D-06 0.27751D-06 0.27620D-06 0.27454D-06
0.27254D-06 0.27023D-06 0.26762D-06 0.26475D-06 0.26164D-06
0.28142D-06 0.28123D-06 0.28065D-06 0.27968D-06 0.27834D-06 0.27664D-06
0.27461D-06 0.27225D-06 0.26960D-06 0.26668D-06 0.26353D-06
0.28286D-06 0.28267D-06 0.28207D-06 0.28109D-06 0.27973D-06 0.27800D-06
0.27594D-06 0.27354D-06 0.27085D-06 0.26790D-06 0.26473D-06
0.28351D-06 0.28330D-06 0.28271D-06 0.28171D-06 0.28034D-06 0.27860D-06
0.27652D-06 0.27410D-06 0.27140D-06 0.26843D-06 0.26526D-06
0.28330D-06 0.28310D-06 0.28250D-06 0.28151D-06 0.28014D-06 0.27841D-06
0.27633D-06 0.27393D-06 0.27125D-06 0.26832D-06 0.26520D-06
0.28220D-06 0.28200D-06 0.28140D-06 0.28043D-06 0.27908D-06 0.27738D-06
0.27535D-06 0.27303D-06 0.27044D-06 0.26763D-06 0.26466D-06
0.28014D-06 0.27994D-06 0.27936D-06 0.27841D-06 0.27710D-06 0.27547D-06
0.27353D-06 0.27135D-06 0.26898D-06 0.26646D-06 0.26391D-06
0.27705D-06 0.27686D-06 0.27630D-06 0.27537D-06 0.27412D-06 0.27256D-06
0.27077D-06 0.26881D-06 0.26681D-06 0.26488D-06 0.26338D-06
0.27289D-06 0.27271D-06 0.27216D-06 0.27126D-06 0.27005D-06 0.26857D-06
0.26692D-06 0.26523D-06 0.26373D-06 0.26285D-06 0.26410D-06
0.26764D-06 0.26746D-06 0.26691D-06 0.26602D-06 0.26482D-06 0.26337D-06
0.26180D-06 0.26031D-06 0.25929D-06 0.25966D-06 0.26333D-06
```

R LATTICE (CM)

```
0.0         0.1970D 01 0.3950D 01 0.5920D 01 0.7890D 01 0.9870D 01 0.1184D 02 0.1381D 02 0.1579D 02 0.1776D 02
0.1973D 02
```

Z LATTICE (CM)

```
0.4013D 02 0.4253D 02 0.4494D 02 0.4735D 02 0.4975D 02 0.5216D 02 0.5456D 02 0.5697D 02 0.5938D 02 0.6178D 02
0.6419D 02 0.6659D 02 0.6900D 02 0.7141D 02 0.7381D 02 0.7622D 02 0.7863D 02 0.8103D 02 0.8344D 02 0.8584D 02
0.8825D 02
```

Fig.2 Mark 1A Total material worth curves for region 12

8.2 Mark 1A Total material worth curves for region 13

INPUT MATERIAL WORTH FOR REGION 13

0.17123D-06	0.16859D-06	0.16673D-06	0.16561D-06	0.16522D-06	0.16572D-06
0.17158D-06	0.16915D-06	0.16729D-06	0.16593D-06	0.16506D-06	0.16464D-06
0.17334D-06	0.17102D-06	0.16910D-06	0.16757D-06	0.16637D-06	0.16543D-06
0.17457D-06	0.17220D-06	0.17020D-06	0.16854D-06	0.16715D-06	0.16599D-06
0.17537D-06	0.17292D-06	0.17084D-06	0.16909D-06	0.16762D-06	0.16636D-06
0.17585D-06	0.17332D-06	0.17118D-06	0.16937D-06	0.16786D-06	0.16657D-06
0.17601D-06	0.17343D-06	0.17126D-06	0.16944D-06	0.16791D-06	0.16662D-06
0.17607D-06	0.17346D-06	0.17125D-06	0.16942D-06	0.16789D-06	0.16661D-06
0.17604D-06	0.17339D-06	0.17117D-06	0.16933D-06	0.16780D-06	0.16653D-06
0.17592D-06	0.17325D-06	0.17100D-06	0.16916D-06	0.16765D-06	0.16639D-06
0.17574D-06	0.17303D-06	0.17078D-06	0.16894D-06	0.16744D-06	0.16621D-06
0.17549D-06	0.17276D-06	0.17049D-06	0.16865D-06	0.16716D-06	0.16595D-06
0.17519D-06	0.17244D-06	0.17015D-06	0.16831D-06	0.16683D-06	0.16564D-06
0.17487D-06	0.17209D-06	0.16979D-06	0.16794D-06	0.16646D-06	0.16528D-06
0.17458D-06	0.17178D-06	0.16947D-06	0.16759D-06	0.16609D-06	0.16489D-06
0.17437D-06	0.17159D-06	0.16927D-06	0.16735D-06	0.16579D-06	0.16452D-06
0.17439D-06	0.17171D-06	0.16940D-06	0.16741D-06	0.16570D-06	0.16425D-06
0.17489D-06	0.17248D-06	0.17027D-06	0.16817D-06	0.16614D-06	0.16428D-06
0.17633D-06	0.17468D-06	0.17280D-06	0.17053D-06	0.16789D-06	0.16503D-06
0.17977D-06	0.18031D-06	0.17896D-06	0.17657D-06	0.17306D-06	0.16767D-06
0.18889D-06	0.18997D-06	0.18830D-06	0.18597D-06	0.18267D-06	0.17644D-06

R LATTICE (CM)

0.1973D 02 0.2170D 02 0.2368D 02 0.2565D 02 0.2762D 02 0.2960D 02

Z LATTICE (CM)

0.4013D 02 0.4253D 02 0.4494D 02 0.4735D 02 0.4975D 02 0.5216D 02 0.5456D 02 0.5697D 02 0.5938D 02 0.6178D 02
0.6419D 02 0.6659D 02 0.6900D 02 0.7141D 02 0.7381D 02 0.7622D 02 0.7863D 02 0.8103D 02 0.8344D 02 0.8584D 02
0.8825D 02

Fig.2 Mark 1A Total material worth curves for region 14

INPUT MATERIAL WORTH FOR REGION 14

```
0.18139D-06 0.18124D-06 0.17969D-06 0.17730D-06 0.17428D-06 0.17072D-06
0.16662D-06 0.16193D-06 0.15646D-06
0.18475D-06 0.18406D-06 0.18246D-06 0.18014D-06 0.17722D-06 0.17378D-06
0.16984D-06 0.16540D-06 0.16042D-06
0.19071D-06 0.18938D-06 0.18755D-06 0.18518D-06 0.18231D-06 0.17897D-06
0.17520D-06 0.17105D-06 0.16655D-06
0.19685D-06 0.19526D-06 0.19327D-06 0.19085D-06 0.18799D-06 0.18474D-06
0.18110D-06 0.17713D-06 0.17287D-06
0.20290D-06 0.20121D-06 0.19915D-06 0.19670D-06 0.19386D-06 0.19065D-06
0.18710D-06 0.18322D-06 0.17908D-06
0.20863D-06 0.20692D-06 0.20484D-06 0.20239D-06 0.19957D-06 0.19639D-06
0.19288D-06 0.18906D-06 0.18496D-06
0.21208D-06 0.21037D-06 0.20830D-06 0.20586D-06 0.20306D-06 0.19989D-06
0.19640D-06 0.19260D-06 0.18851D-06
0.21526D-06 0.21356D-06 0.21151D-06 0.20909D-06 0.20630D-06 0.20315D-06
0.19967D-06 0.19587D-06 0.19179D-06
0.21811D-06 0.21644D-06 0.21441D-06 0.21201D-06 0.20924D-06 0.20612D-06
0.20264D-06 0.19885D-06 0.19476D-06
0.22059D-06 0.21895D-06 0.21695D-06 0.21459D-06 0.21184D-06 0.20874D-06
0.20527D-06 0.20147D-06 0.19737D-06
0.22266D-06 0.22107D-06 0.21911D-06 0.21678D-06 0.21407D-06 0.21097D-06
0.20752D-06 0.20371D-06 0.19960D-06
0.22434D-06 0.22279D-06 0.22088D-06 0.21859D-06 0.21591D-06 0.21285D-06
0.20940D-06 0.20559D-06 0.20146D-06
0.22553D-06 0.22402D-06 0.22216D-06 0.21992D-06 0.21729D-06 0.21426D-06
0.21083D-06 0.20701D-06 0.20286D-06
0.22624D-06 0.22476D-06 0.22295D-06 0.22076D-06 0.21818D-06 0.21519D-06
0.21177D-06 0.20797D-06 0.20381D-06
0.22645D-06 0.22500D-06 0.22321D-06 0.22108D-06 0.21856D-06 0.21562D-06
0.21224D-06 0.20845D-06 0.20430D-06
0.22624D-06 0.22472D-06 0.22294D-06 0.22085D-06 0.21839D-06 0.21552D-06
0.21221D-06 0.20846D-06 0.20434D-06
0.22566D-06 0.22396D-06 0.22210D-06 0.22002D-06 0.21762D-06 0.21484D-06
0.21164D-06 0.20799D-06 0.20398D-06
0.22495D-06 0.22274D-06 0.22067D-06 0.21854D-06 0.21620D-06 0.21355D-06
0.21051D-06 0.20705D-06 0.20327D-06
0.22453D-06 0.22109D-06 0.21853D-06 0.21629D-06 0.21402D-06 0.21155D-06
0.20876D-06 0.20563D-06 0.20236D-06
0.22548D-06 0.21898D-06 0.21560D-06 0.21318D-06 0.21099D-06 0.20872D-06
0.20627D-06 0.20367D-06 0.20154D-06
0.22560D-06 0.21613D-06 0.21166D-06 0.20907D-06 0.20700D-06 0.20497D-06
0.20288D-06 0.20099D-06 0.20007D-06
```

R LATTICE (CM)

```
0.2960D 02 0.3206D 02 0.3453D 02 0.3700D 02 0.3946D 02 0.4193D 02 0.4440D 02 0.4686D 02 0.4933D 02
```

Z LATTICE (CM)

```
0.4013D 02 0.4253D 02 0.4494D 02 0.4735D 02 0.4975D 02 0.5216D 02 0.5456D 02 0.5697D 02 0.5938D 02 0.6178D 02
0.6419D 02 0.6659D 02 0.6900D 02 0.7141D 02 0.7381D 02 0.7622D 02 0.7863D 02 0.8103D 02 0.8344D 02 0.8584D 02
0.8825D 02
```

INPUT MATERIAL WORTH FOR REGION 15

```
0.15332D-06 0.14733D-06 0.14216D-06 0.13735D-06 0.13273D-06 0.12824D-06
0.12393D-06 0.11998D-06 0.11677D-06
0.15665D-06 0.15154D-06 0.14671D-06 0.14206D-06 0.13750D-06 0.13301D-06
0.12858D-06 0.12421D-06 0.12004D-06
0.16202D-06 0.15742D-06 0.15281D-06 0.14824D-06 0.14368D-06 0.13912D-06
0.13453D-06 0.12988D-06 0.12516D-06
0.16753D-06 0.16314D-06 0.15866D-06 0.15413D-06 0.14954D-06 0.14491D-06
0.14019D-06 0.13535D-06 0.13040D-06
0.17293D-06 0.16863D-06 0.16420D-06 0.15967D-06 0.15506D-06 0.15036D-06
0.14555D-06 0.14061D-06 0.13557D-06
0.17802D-06 0.17375D-06 0.16933D-06 0.16480D-06 0.16016D-06 0.15541D-06
0.15055D-06 0.14556D-06 0.14048D-06
0.18109D-06 0.17681D-06 0.17239D-06 0.16785D-06 0.16319D-06 0.15842D-06
0.15354D-06 0.14854D-06 0.14346D-06
0.18391D-06 0.17962D-06 0.17520D-06 0.17064D-06 0.16596D-06 0.16117D-06
0.15628D-06 0.15128D-06 0.14620D-06
0.18645D-06 0.18215D-06 0.17771D-06 0.17313D-06 0.16844D-06 0.16364D-06
0.15873D-06 0.15373D-06 0.14867D-06
0.18868D-06 0.18436D-06 0.17989D-06 0.17530D-06 0.17058D-06 0.16577D-06
0.16085D-06 0.15586D-06 0.15082D-06
0.19058D-06 0.18623D-06 0.18173D-06 0.17710D-06 0.17237D-06 0.16753D-06
0.16262D-06 0.15763D-06 0.15261D-06
0.19216D-06 0.18777D-06 0.18323D-06 0.17857D-06 0.17380D-06 0.16895D-06
0.16402D-06 0.15904D-06 0.15404D-06
0.19333D-06 0.18890D-06 0.18433D-06 0.17961D-06 0.17480D-06 0.16992D-06
0.16498D-06 0.16000D-06 0.15501D-06
0.19411D-06 0.18963D-06 0.18500D-06 0.18024D-06 0.17537D-06 0.17044D-06
0.16547D-06 0.16049D-06 0.15551D-06
0.19449D-06 0.18997D-06 0.18528D-06 0.18045D-06 0.17551D-06 0.17051D-06
0.16549D-06 0.16048D-06 0.15550D-06
0.19450D-06 0.18993D-06 0.18519D-06 0.18027D-06 0.17524D-06 0.17014D-06
0.16504D-06 0.15997D-06 0.15495D-06
0.19415D-06 0.18957D-06 0.18478D-06 0.17976D-06 0.17460D-06 0.16937D-06
0.16414D-06 0.15897D-06 0.15387D-06
0.19352D-06 0.18898D-06 0.18415D-06 0.17901D-06 0.17369D-06 0.16829D-06
0.16287D-06 0.15751D-06 0.15224D-06
0.19275D-06 0.18836D-06 0.18348D-06 0.17818D-06 0.17266D-06 0.16704D-06
0.16137D-06 0.15572D-06 0.15010D-06
0.19217D-06 0.18818D-06 0.18312D-06 0.17752D-06 0.17173D-06 0.16587D-06
0.15995D-06 0.15390D-06 0.14756D-06
0.19286D-06 0.18855D-06 0.18275D-06 0.17668D-06 0.17060D-06 0.16455D-06
0.15844D-06 0.15208D-06 0.14498D-06
```

R LATTICE (CM)

```
0.4933D 02 0.5180D 02 0.5426D 02 0.5673D 02 0.5919D 02 0.6166D 02 0.6413D 02 0.6659D 02 0.6906D 02
```

Z LATTICE (CM)

```
0.4013D 02 0.4253D 02 0.4494D 02 0.4735D 02 0.4975D 02 0.5216D 02 0.5456D 02 0.5697D 02 0.5938D 02 0.6178D 02
0.6419D 02 0.6659D 02 0.6900D 02 0.7141D 02 0.7381D 02 0.7622D 02 0.7863D 02 0.8103D 02 0.8344D 02 0.8584D 02
0.8825D 02
```

g.2 Mark 1A Total material worth curves for region 15

8.2 Mark 1A Total material worth curves for regions 16 and 17

INPUT MATERIAL WORTH FOR REGION 16

```
0.30663D-08 0.30648D-08 0.30601D-08 0.30523D-08 0.30412D-08 0.30262D-08
0.30061D-08 0.29781D-08 0.29361D-08 0.28675D-08 0.27451D-08
0.38934D-08 0.38907D-08 0.38826D-08 0.38689D-08 0.38497D-08 0.38245D-08
0.37926D-08 0.37526D-08 0.37018D-08 0.36348D-08 0.35409D-08
0.38747D-08 0.38712D-08 0.38604D-08 0.38427D-08 0.38182D-08 0.37872D-08
0.37502D-08 0.37077D-08 0.36606D-08 0.36100D-08 0.35579D-08
0.38931D-08 0.38874D-08 0.38710D-08 0.38441D-08 0.38076D-08 0.37636D-08
0.37140D-08 0.36615D-08 0.36103D-08 0.35652D-08 0.35304D-08
0.41340D-08 0.41223D-08 0.40873D-08 0.40299D-08 0.39509D-08 0.38527D-08
0.37391D-08 0.36159D-08 0.34921D-08 0.33835D-08 0.33108D-08
0.53436D-08 0.53195D-08 0.52478D-08 0.51261D-08 0.49524D-08 0.47220D-08
0.44300D-08 0.40683D-08 0.36268D-08 0.30904D-08 0.24461D-08
0.64772D-08 0.64368D-08 0.63148D-08 0.61019D-08 0.57926D-08 0.53645D-08
0.47990D-08 0.40522D-08 0.30800D-08 0.17973D-08 0.81254D-10
```

R LATTICE (CM)

```
0.0        0.1970D 01 0.3950D 01 0.5920D 01 0.7890D 01 0.9870D 01 0.1184D 02 0.1381D 02 0.1579D 02 0.1776D 02
0.1973D 02
```

Z LATTICE (CM)

```
0.0        0.6690D 01 0.1338D 02 0.2006D 02 0.2675D 02 0.3344D 02 0.4013D 02
```

INPUT MATERIAL WORTH FOR REGION 17

```
0.31611D-08 0.30223D-08 0.29207D-08 0.28309D-08 0.27537D-08 0.27102D-08
0.45126D-08 0.44059D-08 0.42999D-08 0.41870D-08 0.40682D-08 0.39524D-08
0.57333D-08 0.56681D-08 0.55817D-08 0.54761D-08 0.53523D-08 0.52117D-08
0.83282D-08 0.82920D-08 0.82475D-08 0.81943D-08 0.81292D-08 0.80481D-08
0.13237D-07 0.13218D-07 0.13278D-07 0.13420D-07 0.13633D-07 0.13879D-07
0.21167D-07 0.20695D-07 0.20798D-07 0.21438D-07 0.22641D-07 0.24407D-07
0.30991D-07 0.29215D-07 0.28961D-07 0.30075D-07 0.32602D-07 0.36764D-07
```

R LATTICE (CM)

```
0.1973D 02 0.2170D 02 0.2368D 02 0.2565D 02 0.2762D 02 0.2960D 02
```

Z LATTICE (CM)

```
0.0        0.6690D 01 0.1338D 02 0.2006D 02 0.2675D 02 0.3344D 02 0.4013D 02
```

```
INPUT MATERIAL WORTH FOR REGION  18

0.23406D-08 0.22585D-08 0.21599D-08 0.20759D-08 0.20122D-08 0.19686D-08
0.19422D-08 0.19284D-08 0.19166D-08
0.27889D-08 0.26593D-08 0.25433D-08 0.24521D-08 0.23846D-08 0.23382D-08
0.23103D-08 0.22980D-08 0.22946D-08
0.20628D-08 0.19458D-08 0.18545D-08 0.17932D-08 0.17522D-08 0.17260D-08
0.17116D-08 0.17072D-08 0.17033D-08
0.26483D-09 0.29573D-09 0.31203D-09 0.34207D-09 0.36763D-09 0.38030D-09
0.37729D-09 0.35784D-09 0.29616D-09


0.39377D-08-0.33269D-08-0.28972D-08-0.25656D-08-0.23577D-08-0.22783D-08


0.23241D-08-0.24897D-08-0.28265D-08


0.13426D-07-0.10488D-07-0.86393D-08-0.74346D-08-0.67790D-08-0.66102D-08


0.69118D-08-0.77157D-08-0.92168D-08


0.36115D-07-0.28581D-07-0.23824D-07-0.20872D-07-0.19237D-07-0.18672D-07


0.19118D-07-0.20684D-07-0.23734D-07

            R LATTICE (CM)

 0.2960D 02 0.3206D 02 0.3453D 02 0.3700D 02 0.3946D 02 0.4193D 02 0.4440D 02 0.4686D 02 0.4933D 02

            Z LATTICE (CM)

 0.0        0.6690D 01 0.1338D 02 0.2006D 02 0.2675D 02 0.3344D 02 0.4013D 02

INPUT MATERIAL WORTH FOR REGION  19

0.20364D-08 0.20239D-08 0.20071D-08 0.19741D-08 0.19215D-08 0.18494D-08
0.17605D-08 0.16607D-08 0.15610D-08
0.28343D-08 0.28353D-08 0.28186D-08 0.27800D-08 0.27180D-08 0.26331D-08
0.25272D-08 0.24035D-08 0.22677D-08
0.33787D-08 0.33932D-08 0.33865D-08 0.33614D-08 0.33176D-08 0.32549D-08
0.31731D-08 0.30717D-08 0.29505D-08
0.46974D-08 0.46872D-08 0.46704D-08 0.46577D-08 0.46484D-08 0.46399D-08
0.46273D-08 0.46033D-08 0.45580D-08
0.76769D-08 0.74658D-08 0.73210D-08 0.72725D-08 0.73132D-08 0.74320D-08
0.76144D-08 0.78383D-08 0.80599D-08
0.13957D-07 0.12747D-07 0.12070D-07 0.11825D-07 0.11918D-07 0.12300D-07
0.12955D-07 0.13885D-07 0.15040D-07
0.22752D-07 0.19825D-07 0.18306D-07 0.17768D-07 0.17949D-07 0.18731D-07
0.20084D-07 0.22043D-07 0.24628D-07

            R LATTICE (CM)

 0.4933D 02 0.5180D 02 0.5426D 02 0.5673D 02 0.5919D 02 0.6166D 02 0.6413D 02 0.6659D 02 0.6906D 02

            Z LATTICE (CM)

 0.0        0.6690D 01 0.1338D 02 0.2006D 02 0.2675D 02 0.3344D 02 0.4013D 02
```

g.2 Mark 1A Total material worth curves for regions 18 and 19

INPUT MATERIAL WORTH FOR REGION 20

```
0.14771D-08 0.13687D-08 0.12465D-08 0.11215D-08 0.99821D-09 0.87896D-09
0.76580D-09 0.66128D-09 0.56982D-09 0.49797D-09
0.20680D-08 0.19256D-08 0.17725D-08 0.16144D-08 0.14550D-08 0.12972D-08
0.11437D-08 0.99722D-09 0.86078D-09 0.73918D-09
0.24938D-08 0.23640D-08 0.22233D-08 0.20719D-08 0.19113D-08 0.17437D-08
0.15725D-08 0.14011D-08 0.12332D-08 0.10763D-08
0.35253D-08 0.34646D-08 0.33753D-08 0.32536D-08 0.30977D-08 0.29090D-08
0.26922D-08 0.24541D-08 0.22035D-08 0.19640D-08
0.58627D-08 0.60665D-08 0.61793D-08 0.61893D-08 0.60879D-08 0.58754D-08
0.55588D-08 0.51508D-08 0.46690D-08 0.41879D-08
0.10763D-07 0.11990D-07 0.12801D-07 0.13262D-07 0.13394D-07 0.13215D-07
0.12744D-07 0.11986D-07 0.10930D-07 0.97179D-08
0.17393D-07 0.21259D-07 0.23996D-07 0.25781D-07 0.26759D-07 0.27045D-07
0.26730D-07 0.25875D-07 0.24518D-07 0.22827D-07

            R LATTICE (CM)

 0.6906D 02 0.7142D 02 0.7377D 02 0.7613D 02 0.7849D 02 0.8084D 02 0.8320D 02 0.8556D 02 0.8792D 02 0.9027D 02

            Z LATTICE (CM)

 0.0        0.669CD 01 0.1338D 02 0.2006D 02 0.2675D 02 0.3344D 02 0.4013D 02
```

Fig.2 Mark 1A Total material worth curves for region 20

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