TERA

Westinghouse Electric Corporation
Water Reactor Divisions

Nuclear Technology Division
Box 355
Pittsburgh Pennsylvania 15230

July 30, 1980
NS-TMA-2285

Mr. James R. Miller, Chief
Special Projects Branch
Division of Project Management
U. S. Nuclear Regulatory Commission
Phillips Building
7920 Norfolk Avenue
Bethesda, Maryland 20014

Dear Mr. Miller:

Enclosed are:

(1) Forty (40) copies of the responses to the questions forwarded in Reference 1 (Proprietary).

(2) Twenty (20) copies of the responses to the questions forwarded in Reference 1 (Non-Proprietary).

Also enclosed are:

(1) One (1) copy of Application for Withholding, AW-76-42 (Non-Proprietary).

(2) One (1) copy of Affidavit (Non-Proprietary).

This submittal provides the balance of the additional information requested by the NRC in Reference 1 on the Westinghouse Electric Corporation topical report WCAP-9226 (Proprietary) and WCAP-9227 (Non-Proprietary), "Reactor Core Response to Excessive Secondary Steam Releases." Reference 2 provides the responses to the remaining questions.

This submittal contains proprietary information of Westinghouse Electric Corporation. In conformance with the requirements of 10CFR Section 2.790, as amended, of the Commission's regulations, we are enclosing with this submittal an application for withholding from public disclosure and an affidavit. The affidavit sets forth the basis on which the information may be withheld from public disclosure by the Commission.

THIS DOCUMENT CONTAINS
POOR QUALITY PAGES

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Correspondence with respect to the affidavit or application for withholding should reference AW-80-45, and should be addressed to R. A. Wiesemann, Manager, Regulatory & Legislative Affairs, Westinghouse Electric Corporation, P. O. Box 355, Pittsburgh, Pennsylvania 15230.

Very truly yours,

T. M. Anderson, Manager
Nuclear Safety Department

/bek
Enclosures

References:

(1) Letter from John F. Stolz to T. M. Anderson dated September 26, 1978. Subject: "Review of WCAP-9226"

(2) Letter NS-TMA-2080, T. M. Anderson to John F. Stolz, dated May 7, 1979, WCAP-9226 Round 1 Question Responses.

cc: T. P. Speis
B. J. Youngblood
J. Guttmann

Westinghouse Electric Corporation
Water Reactor Divisions

Nuclear Technology Division
Box 355
Pittsburgh Pennsylvania 15230

July 30, 1980
AW-80-45

Mr. James R. Miller, Chief
Special Projects Branch
Division of Project Management
U. S. Nuclear Regulatory Commission
Phillips Building
7920 Norfolk Avenue
Bethesda, Maryland 20014

APPLICATION FOR WITHHOLDING PROPRIETARY INFORMATION FROM PUBLIC DISCLOSURE

SUBJECT: Responses to Questions on WCAP-9226, "Reactor Core Response to Excessive Secondary Steam Releases"

REF: Westinghouse Letter No. NS-TMA-2285, Anderson to Miller, dated July 30, 1980

Dear Mr. Miller:

The proprietary material transmitted by the referenced letter supplements the proprietary material previously submitted by Westinghouse concerning reactor core response to excessive secondary steam releases. Further, the affidavit submitted to justify the material previously submitted, AW-76-42, is equally applicable to this material.

Accordingly, withholding the subject information from public disclosure is requested in accordance with the previously submitted affidavit and application for withholding, AW-76-42, dated September 29, 1976, a copy of which is attached.

Correspondence with respect to this application for withholding or the accompanying affidavit should reference AW-80-45, and should be addressed to the undersigned.

Very truly yours,

Robert A. Wiesemann

Robert A. Wiesemann, Manager
Regulatory & Legislative Affairs

/bek
Attachment

cc: E. C. Shomaker, Esq.
Office of the Executive Legal Director, NRC

Westinghouse Electric Corporation Power Systems

Box 355
Pittsburgh Pennsylvania 15230

September 29, 1976
AW-76-42

Mr. John F. Stolz, Chief
Light Water Reactors Project
Division of Project Management
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
7920 Norfolk Avenue
Bethesda, Maryland 20014

APPLICATION FOR WITHHOLDING PROPRIETARY
INFORMATION FROM PUBLIC DISCLOSURE

SUBJECT: WCAP-8822, "Mass and Energy Releases Following a Steam Line Rupture" (Proprietary)

REF: Westinghouse Letter No. NS-CE-1220 Eicheldinger to Stolz Dated September 29, 1976

Dear Mr. Stolz:

This application for withholding is submitted by Westinghouse Electric Corporation ("Westinghouse") pursuant to the provisions of paragraph (b)(1) of Section 2.790 of the Commission's regulations. Withholding from public disclosure is requested with respect to the subject information which is further identified in the affidavit accompanying this application.

The undersigned has reviewed the information sought to be withheld and is authorized to apply for its withholding on behalf of Westinghouse, WRD, notification of which was sent to the Secretary of the Commission on April 19, 1976.

The affidavit accompanying this application sets forth the basis on which the information may be withheld from public disclosure by the Commission and addresses with specificity the considerations listed in paragraph (b)(4) of Section 2.790 of the Commission's regulations.

Accordingly it is respectfully requested that the subject information which is proprietary to Westinghouse and which is further identified in the affidavit be withheld from public disclosure in accordance with 10 CFR Section 2.790 of the Commission's regulations.

Correspondence with respect to this application for withholding or the accompanying affidavit should reference AW-76-42 and should be addressed to the undersigned.

Very truly yours,

Robert A. Wiesemann

Robert A. Wiesemann, Manager
Licensing Programs

/smh

Enclosure

cc: J. W. Maynard, Esq.
Office of the Executive Legal Director, NRC

AW-76-42

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

ss

COUNTY OF ALLEGHENY:

Before me, the undersigned authority, personally appeared Robert A. Wiesemann, who, being by me duly sworn according to law, deposes and says that he is authorized to execute this Affidavit on behalf of Westinghouse Electric Corporation ("Westinghouse") and that the averments of fact set forth in this Affidavit are true and correct to the best of his knowledge, information, and belief:

Robert A. Wiesemann

Robert A. Wiesemann, Manager
Licensing Programs

Sworn to and subscribed
before me this 30 day
of September 1976.

Rebecca A. Spence

Notary Public

NOTARIAL SEAL
REBECCA A. SPENCE, Notary Public
Pittsburgh, Allegheny County
My Commission Expires March 15, 1978

(1) I am Manager, Licensing Programs, in the Pressurized Water Reactor Systems Division, of Westinghouse Electric Corporation and as such, I have been specifically delegated the function of reviewing the proprietary information sought to be withheld from public disclosure in connection with nuclear power plant licensing or rule-making proceedings, and am authorized to apply for its withholding on behalf of the Westinghouse Water Reactor Divisions.

(2) I am making this Affidavit in conformance with the provisions of 10 CFR Section 2.790 of the Commission's regulations and in conjunction with the Westinghouse application for withholding accompanying this Affidavit.

(3) I have personal knowledge of the criteria and procedures utilized by Westinghouse Nuclear Energy Systems in designating information as a trade secret, privileged or as confidential commercial or financial information.

(4) Pursuant to the provisions of paragraph (b)(4) of Section 2.790 of the Commission's regulations, the following is furnished for consideration by the Commission in determining whether the information sought to be withheld from public disclosure should be withheld.

(i) The information sought to be withheld from public disclosure is owned and has been held in confidence by W[illegible]inghouse.

(ii) The information is of a type customarily held in confidence by Westinghouse and not customarily disclosed to the public. Westinghouse has a rational basis for determining the types of information customarily held in confidence by it and, in that connection, utilizes a system to determine when and whether to hold certain types of information in confidence. The application of that system and the substance of that system constitutes Westinghouse policy and provides the rational basis required.

Under that system, information is held in confidence if it falls in one or more of several types, the release of which might result in the loss of an existing or potential competitive advantage, as follows:

(a) The information reveals the distinguishing aspects of a process (or component, structure, tool, method, etc.) where prevention of its use by any of Westinghouse's competitors without license from Westinghouse constitutes a competitive economic advantage over other companies.

(b) It consists of supporting data, including test data, relative to a process (or component, structure, tool, method, etc.), the application of which data secures a competitive economic advantage, e.g., by optimization or improved marketability.

(c) Its use by a competitor would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing a similar product.

(d) It reveals cost or price information, production capacities, budget levels, or commercial strategies of Westinghouse, its customers or suppliers.

(e) It reveals aspects of past, present, or future Westinghouse or customer funded development plans and programs of potential commercial value to Westinghouse.

(f) It contains patentable ideas, for which patent protection may be desirable.

(g) It is not the property of Westinghouse, but must be treated as proprietary by Westinghouse according to agreements with the owner.

There are sound policy reasons behind the Westinghouse system which include the following:

(a) The use of such information by Westinghouse gives Westinghouse a competitive advantage over its competitors. It is, therefore, withheld from disclosure to protect the Westinghouse competitive position.

(iii) The information is being transmitted to the Commission in confidence and, under the provisions of 10 CFR Section 2.790, it is to be received in confidence by the Commission.

(iv) The information is not available in public sources to the best of our knowledge and belief.

(v) The proprietary information sought to be withheld in this submittal is that which is appropriately marked in WCAP-8822, "Mass and Energy Releases Following a Steam Line Rupture," (Proprietary), being transmitted by Westinghouse Letter No. NS-CE-1220, Eicheldinger to Stolz, dated September 29, 1976. This report is being submitted pursuant to the NRC's Topical Report Program for generic review by the Regulatory Staff and is expected to be referenced in several license applications.

This information enables Westinghouse to:

(a) Justify the design basis for emergency systems.

(b) Assist its customers to obtain licenses.

(c) Optimize long-term cooling design.

Further, this information has substantial commercial value as follows:

(a) Westinghouse sells the use of the information to its customers for purposes of meeting NRC requirements for licensing documentation.

(b) Westinghouse uses the information to perform and justify analyses which are sold to customers.

Public disclosure of this information is likely to cause substantial harm to the competitive position of Westinghouse because it would enable others to use the information to meet NRC requirements for licensing documentation without purchasing the right to use the information.

The development of this information is the result of many years of Westinghouse effort and the expenditure of a considerable sum of money.

In order for competitors of Westinghouse to duplicate this information, similar engineering programs would have to be performed and a significant manpower effort, having the requisite talent and experience, would have to be expended for data analyses and code development.

Further the deponent sayeth not.

WCAP-9226 "REACTOR CORE RESPONSE TO EXCESSIVE SECONDARY STEAM RELEASES"
RESPONSE TO FIRST ROUND QUESTIONS - STATUS SUMMARY

Question	Response in:
212.1	NS-TMA-2285
212.2	NS-TMA-2285
212.3	NS-TMA-2080
212.4	NS-TMA-2080
212.5	NS-TMA-2080
212.6	NS-TMA-2080
212.7	NS-TMA-2080
212.8	NS-TMA-2080
212.9	NS-TMA-2285
212.10	NS-TMA-2285
212.11	NS-TMA-2080
212.12	NS-TMA-2285
222.1	NS-TMA-2285
222.2	NS-TMA-2285
222.3	NS-TMA-2080
222.4	NS-TMA-2080
222.5	NS-TMA-2080
222.6	NS-TMA-2285
222.7	NS-TMA-2080
222.8	NS-TMA-2285
222.9	NS-TMA-2080
222.10	NS-TMA-2080
222.11	NS-TMA-2285
222.12	NS-TMA-2080
222.13	NS-TMA-2285
222.14	NS-TMA-2285
222.15	NS-TMA-2080
231.1	NS-TMA-2080
232.1	NS-TMA-2285
232.2	NS-TMA-2080
232.3	NS-TMA-2080
232.4	NS-TMA-2285
232.5	NS-TMA-2285
232.6	NS-TMA-2285

Q) 212.1 Provide in tabular form a list of NSS features (3-loop, UHI, etc.) covered by the analyses presented in WCAP-9226 so that applicants referencing this report can show, by comparison, its applicability to their plant designs.

A) 212.1

Because the main purpose of WCAP-9226 (WCAP-9227) is to show the sensitivity of the steamline break to a variety of plant feature variations, initial conditions, operating modes and break sizes, the applicability of the report is very extensive. The relevant NSSS features which define applicability, are listed below:

No. of Reactor Coolant Loops	3 or 4
Fuel type	any
Steamline break protection system	WCAP-9226, Figure 1.2-1 System 1 or System 2
Safety Injection System	WCAP-9226, Figure 1.2.2
Protection System Features	Overpower and DNB protection trips steamline break protection (see above)
Steam generator model	Any model with or without integral steam flow restrictor
Upper head injection	3 loop - not applicable 4 loop - with or without UHI

The absence of any of these features does not necessarily render the report unapplicable. Exceptions will be evaluated on a case-by-case basis on individual plants at the time Westinghouse performs the FSAR analysis.

There are many implicit plant characteristics inherent to the information above, e.g. all 3 loop plants have the same pressurizer volume. These details are implicitly considered in arriving at the criteria above.

The WCAP provides, for plants which may reference it, the basis for the FSAR case assumptions. This case is presented in a plant specific analysis for each applicants' FSAR. The report is written specifically to address the licensing guidelines of Regulatory Guide 1.70, Rev. 2.

Q) 212.2 Provide in tabular form a list of interface requirements by components and systems outside Westinghouse scope of supply which must be met by referencing applicants to satisfy the assumptions in WCAP-9226. For example, WCAP-9226 assumes that systems which control the operation of power-operated steam relief and stam dump valves are designed so that a single failure will not cause simultaneous opening of all valves.

A) 212.2

Because WCAP-9226 restricts itself exclusively to the reactor core response for steamline rupture accidents, very few Balance of Plant (BOP) systems are of relevance to the results. When the NSSS meets the criteria given in the response to Question 212.1, no BOP systems or signals are needed to either trip the reactor or actuate any engineered safeguards systems.

The analysis has been performed assuming that the plant is designed and constructed according to the requirements given to the Architect Engineers. The requirements which are of significance to the steamline break accident are summarized below:

Main Steam Line Valves

- A valving arrangement is required which will function to shut off flow from either the forward or reverse directions in the steam line from each steam generator within five (5) seconds after receipt of a steam line isolation signal. This is to prevent uncontrolled blowdown from more than one steam generator.

- These valves are to be located outside the containment building as close to the containment as practical and downstream of the steam generator safety and relief valves.

- For any break, in any location, no more than one steam generator would blowdown through the break event if one of the isolation valves fails to close. In addition all steam generators are assumed to blowdown until steamline isolation is completed.

- For breaks downstream of the isolation valves, closure of all valves would completely terminate the blowdown.

Main Feedwater Isolation

- Redundant isolation of main feedwater lines:

  In addition to the normal control action which will close the feedwater control valves, a safety injection signal will rapidly close all feedwater control valves and backup feedwater isolation valves, trip the main feedwater pumps, and close the feedwater pump discharge valves.

- The feedwater control valve and backup feedwater isolation valve must close in five seconds during emergency conditions, i.e., feedwater isolation.

Other Main Steam System Valves

- The valves upstream and downstream of the main steam isolation valves, i.e., steam generator safety, relief, and steam dump valves, shall be sized such that the maximum capacity of any single valve does not exceed 1,050,000 lb/hr steam at 1300 psia. This is necessary to meet criteria for the accidental depressurization of the main steam system.

- Multiple failure of these valves cannot be postulated as the result of any single failure. This guarantees that the most limiting single failure is minimum boric acid injection capability. Assuming a single failure of a valve upstream of the main steam isolation valves is less severe than assuming a failure in the ECCS which would impair delivery of boron from the Boron Injection Tank. Any single failure that causes a failure of the main steam isolation valves shall not cause a failure of valves downsteam of the main steam isolation valves.

- The control of the power operated relief valve must be independent and designed such that no single failure can cause opening of greater than 1 (one) power operated relief valve.

Other

- Instrument air is only required for normal operation of the air-operated valves.

- The Low Steamline Pressure Signal is lead-lag compensated. The transfer function for the lead-lag compensation is represented in Laplace Transform form as $P_o(s) = \frac{\tau_1 s + 1}{\tau_1 s + 1} P_i(s)$ is the measured steamline pressure and $P_o(s)^2$ = output from the compensation. The purpose of the lead-lag compensation is to decrease the time required to attain an acutation signal by sensing the rate of pressure change as well as the actual steam pressure and thus result in an output pressure signal which is lower than the actual steam pressure. Actuation occurs when $P_o(s)$ reaches the low steamline pressure setpoint.

  Westinghouse will provide to the balance of plant designer with the low steamline pressure lead/lag compensation time constants (τ_1 and τ_2) for the steamline break protection system.

- A failure of any main steam line or malfunction of a valve installed therein or any consequential damage must not:

  1. Initiate a loss of coolant accident,
  2. Render inoperable any safeguard service,
  3. Impair the containment building,

4. Reduce flow capability for the auxiliary feedwater system below minimum required, nor permit feedwater addition at a rate greater than the maximum auxiliary feedwater capacity for more than ten seconds after the occurrence.

5. Result in uncontrolled flow from more than one steam generator, or

6. Break lines in other loops which by themselves cause a Reactor Coolant System cooldown of 100°F/hr or greater.

- The residual steam load due to steam since in the main steam system downstream of the MSIVs shall not exceed the equivalent flow from the largest safety, relief or steam dump valve, failed fully open.

Q) 212.9 WCAP-9226 should provide time-dependent graphs of the following parameters for the limiting case at hot shutdown and the limiting case at full power (in addition to those provided)

(1) steam generator pressure

(2) steam generator level

(3) steam generator UA used in analysis

(4) break discharge flow

(5) steam generator fluid temperature

(6) fuel and cladding temperatures

(7) steamline feedwater flow rates

(8) pressurizer water level

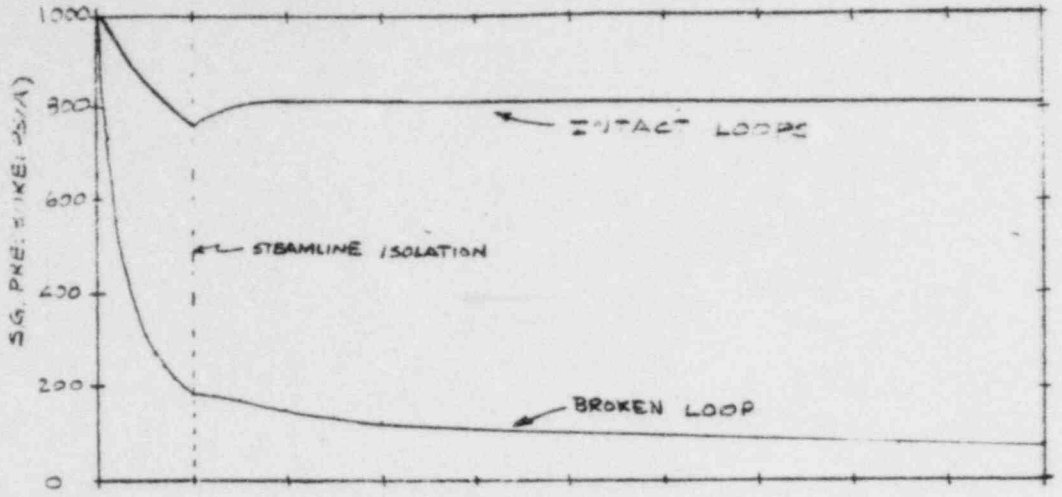
(9) reactor power

All graphs must be scaled and labeled to permit evaluation.

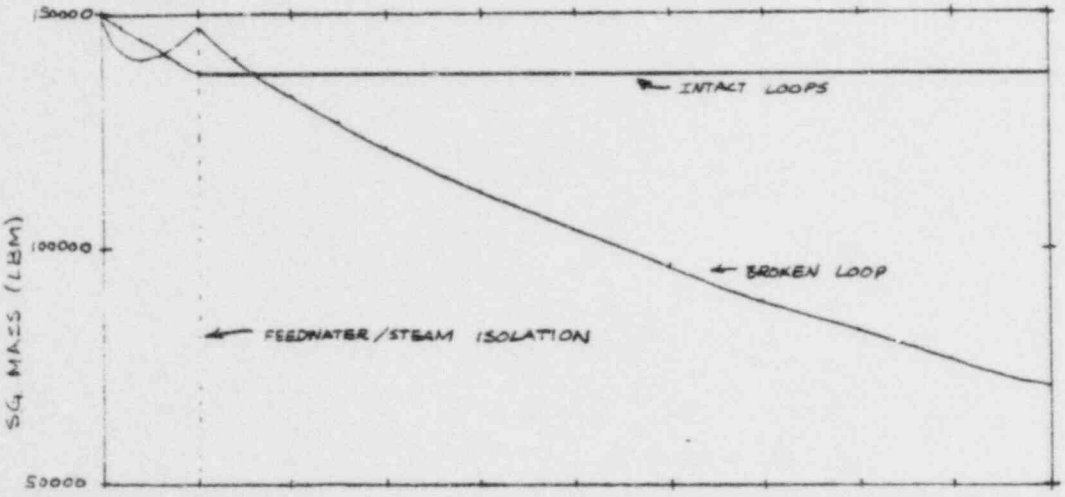
A) 212.9

The additional graphs requested for the hot shutdown case are provided. Because the DNB design basis is met for the limiting case and because coolant temperatures are much less than nominal, fuel and cladding temperature can be inferred from the graph of average coolant temperature. The steam generator is modelled as a saturated mixture, hence the steam temperature can be inferred from the steam pressure graph, which is provided.

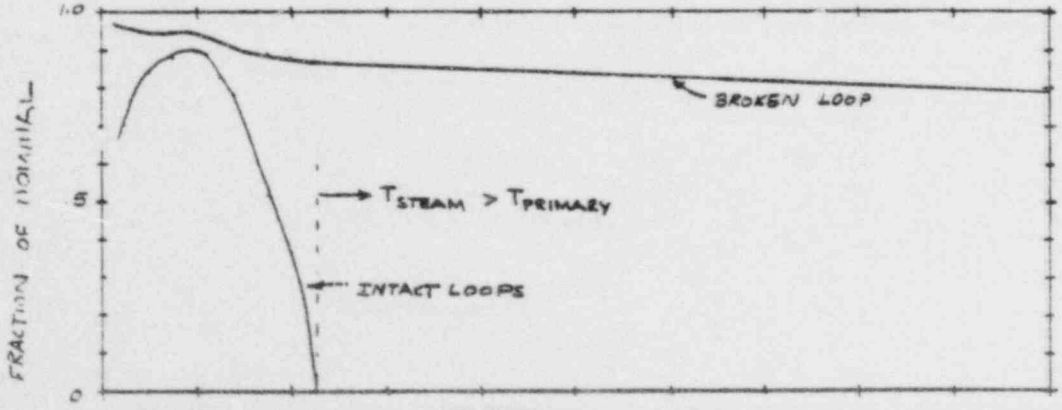
For the limiting breaks at full power the only graphs that are not provided are the steam generator level, steam generator UA and fuel/cladding temperature. The fuel and cladding temperature can be easily inferred from coolant temperature since the DNB design basis is met. The additional steam generator graph would only show that the level is above the top of the tubes and there is full UA prior to trip.



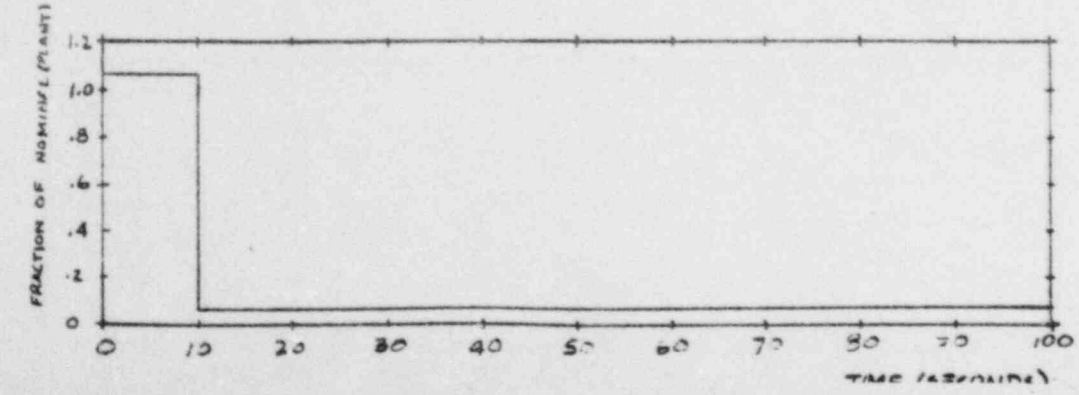
STEAM GENERATOR PRESSURE VS. TIME



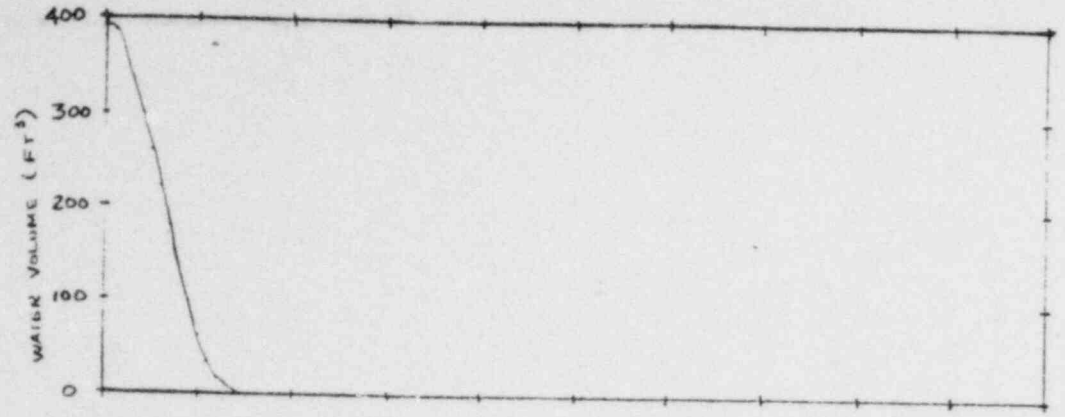
STEAM GENERATOR MASS VS TIME



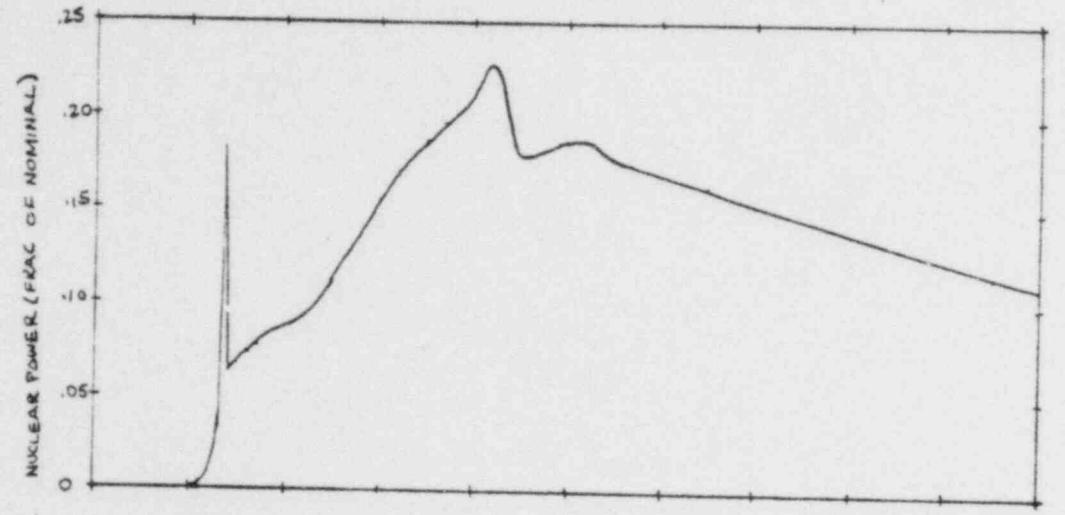
STEAM GENERATOR UA VS TIME



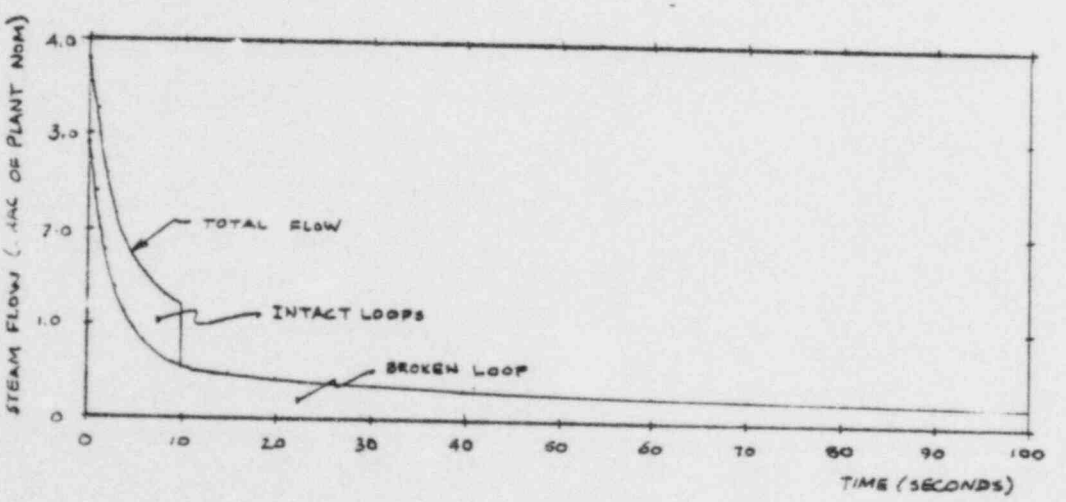
STEAM GENERATOR FEEDWATER FLOW VS TIME



PRESSURIZER WATER VOLUME VS TIME



NUCLEAR POWER VS TIME



STEAM FLOW (BREAK) VS. TIME

Q) 212.10 Provide a summary table of all events analyzed giving limiting values of pertinent variables to permit comparison and evaluation.

A) 212.10

The following table shows the requested information. The DNB value given for each case is shown as a ratio to the reference case value.

CASE	RELATIVE MINIMUM DNBR
1) Reference case 312 plant	[(a,c)
2) as 1) with full safeguards	
3) as 2) with a steam generator relief valve failed	
4) as 1) with extra 20% allowance on low steamline pressure setpoint	
5) as 1) with pressurizer on faulted loop	
6) as 1) different feed flow assumption Figure 3.1-11 through 3.1-14	
7) as 1) with extra 10% in moderator density coefficient	
8) as 1) with less 10% in moderator density coefficient	
9) as 1) with extra 10% in boron coefficient	
10) as 1) with less 10% in boron coefficient	
11) as 1) with extra 10% in power coefficient	
12) as 1) with less 10% in power coefficient	
13) as 1) with extra 10% in RCS flow rate	
14) as 1) with non-dry break flow	
15) 412 plant	
16) 412 plant with UHI	
17) as 1) with upper head initial at T_{hot}	
18) as 1) with pre-heat steam generator	
19) as 1) with one loop initially out of service	
20) as 1) with 1.3 ft^2 split break	

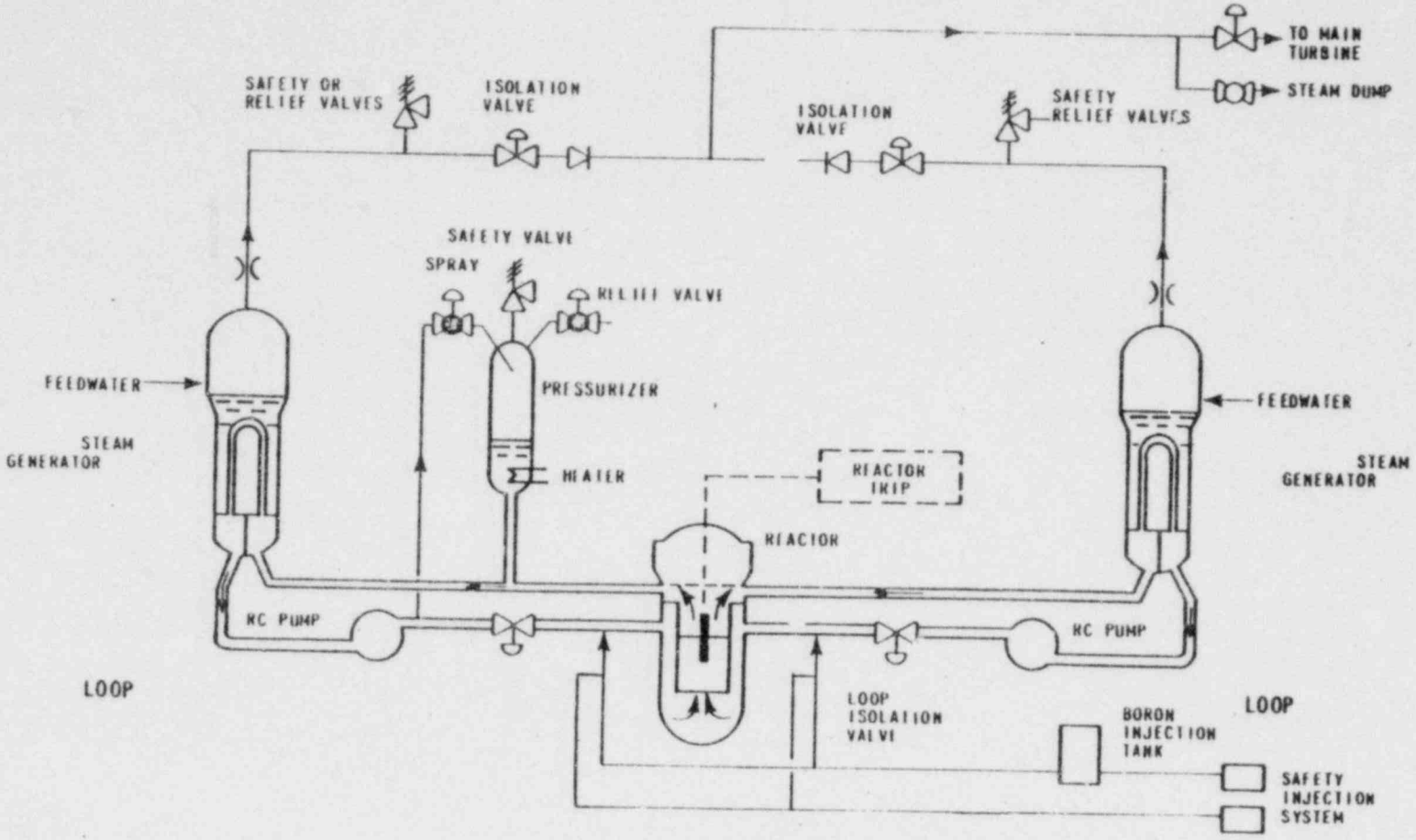
Q) 222.1 Provide a detailed flow diagram for the primary and secondary systems identifying all the components considered in the steam line break accident analysis.

A) 222.1

A flow diagram is attached, showing the relevant components and systems considered in the steamline break analysis. Specifically these include:

- Reactor Coolant Piping (multi-loop)
- Steam Generators
- Reactor Vessel
- Reactor Coolant Pump
- Steam flow - to turbine
  - to break
- Feedwater flow - main feedwater
  - auxiliary feedwater
- Plant Control Systems
  - CVCS
  - pressurizer pressure control
  - automatic control rod control
  - turbine bypass (steam dump)
  - steam generator relief valves
- Plant Protection and Engineered Safeguards Features
  - Reactor trip
  - Turbine trip
  - Safety injection system
  - Auxiliary feedwater system
  - Primary (pressurizer) safety valves
  - Secondary safety valves
  - Steamline and feedwater isolation

The assumptions governing the status of these systems are described in WCAP-9226 via parameter sensitivity studies, analyses of single failures and evaluations.



Pressurized Water Reactor Schematic Diagram

Q) 222.2 Provide a nodalization diagram used in the systems code calculations identifying what each node represents for all the codes used in this analysis.

A) 222.2

The noding in the LOFTRAN computer program is fixed, and is described in the references provided in the response to Question 212.6. The user may specify the number of nodes in the reactor core, hot leg, steam generator primary tubes, and cold leg. For WCAP-9226, the number of nodes assumed for each of these system volumes are as follows:

hot leg	4 (per loop)
steam generator tubes (primary)	10 (per loop)
cold leg	4 (per loop)
core, axial	10 (per sector)

Q) 222.6 Provide a detailed description of the model describing how boron is injected from the safety injection system into the core.

How many nodes are used in the model between the point of injection in the primary system and the core? Describe how boron transport from the point of injection in the primary system to the center of the core was calculated for cases with and without loss of offsite power.

A) 222.6

Detailed descriptions of the noding, equations and system diagrams utilized in the LOFTRAN systems computer program have been submitted to the NRC in the referenced memos.

A slug flow model is used in the cold leg for boron transport, the SI connections being simulated at the reactor coolant pump discharge. In the WCAP-9226 calculations, two cold leg nodes (per RCS loop) are simulated between the SI connections and the reactor vessel inlet nozzle. Boron mixing is simulated in the reactor vessel inlet plenum and slug flow is again assumed through the core. The effect of reactor coolant flow on the boron transport is inherently included in the slug and mixing models, in conjunction with the RCS volumes in the cold leg, reactor vessel inlet plenum and the core.

A similar model is used in the MARVEL program.

References

1) Letter NS-TMA-1802, T. M. Anderson (W) to J. F. Stolz (USNRC), May 26, 1978, "Supplemental Information on WCAP-7907".

2) Letter NS-TMA-1824, T. M. Anderson (W) to J. F. Stolz (USNRC), June 16, 1978, "Supplemental Information on WCAP-7907".

Q) 222.8 Provide the reference which was used to normalize the calculated flow rates to measured vessel flow mixing tests. If the reference is an internal memo, provide copy of this reference.

A) 222.8

Data obtained from the Indian Point 1/7 scale reactor vessel model tests was used for the selection of the "design mixing" values used for the analyses in WCAP-9226. In response to NRC questions on WCAP-7909 the applicable data was given and how the data is used. Equivalent assumptions are made in the steambreak claculations performed using the LOFTRAN code. The test data indicates that significantly more mixing occurs than is assumed in steam line break reference case calculation. Figures 3.1-35 to 3.1-37 show that the data used for the reference case is conservative.

Reference: Letter C. Eicheldinger (W) to J. F. Stolz (USNRC) NS-CE-77-1585 "Additional Information for WCAP-7909"

Q) 222.11 A recent CE paper entitled "Design Analysis Using Coupled Neutronic and Thermal Hydraulic Models" by S. G. Wagner et. al. was presented at the Topical Meeting on Advances in Reactor Physics in Gatlenburg, Tennessee (April, 1978). This paper presented an evaluation of steam line break analyses using a 3-dimensional coupled thermal-hydraulic neutronic code. Compare the results of this paper with the results of WCAP-9226. For example, the paper shows the cross flow in fuel bundles (open channels) inserts additional reactivity. Since WCAP-9226 assumed closed fuel channels instead of open fuel channels, discuss how this effect was considered in WCAP-9226.

A) 222.11

Westinghouse recognizes the existence of cross flow phenomena during steamline break conditions and has considered their effect on the results of the analysis. We have concluded that:

1. For steamline break with offsite power available (full reactor coolant flow), the closed channel model is very accurate.

2. Using DNBR as a basis (rather than reactivity, as the CE paper does), the conclusion stated in WCAP-9226 Section 3.1.1.14 concerning the steamline break without offsite power available, i.e., low RCS flow, can be substantiated with an open channel model, where the effects of cross flow is considered.

The use of closed channel calculations for the more limiting full flow cases will continue to be the basis for Westinghouse licensing calculations.

Q) 212.12 The results of a steamline rupture with one loop out of service is provided for the no load condition only. Discuss the consequences of steam line break with one loop out of service at the permissable operating power as well as for no load conditions.

A) 212.12

The specific analysis of a spectrum of steamline breaks with a reactor coolant loop out of service is not included in WCAP-9226 for the following reasons:

1) For extremely small breaks, no reactor trip is expected to occur, due to margin to the overpower and DNB protection trips. This is the same effect as seen in the parametric plots of break size in WCAP-9226 figure 3.2-23.

2) For intermediate size breaks (not large enough to actuate the secondary side SI signals) reactor trip on overpower or DNB protection trips are expected to occur, just as the cases with all loops operating. Because the setpoints for these protection systems during operation with one loop out of service are derived using the same basis as those for all loops operating, the adequacy of these trips to protect the core is implied.

3) For large breaks, the steamline signals actuate the reactor trip (SI) before the effects of the cooldown reach the core. This is due to the large loop transit time in comparison to the short protection system response time. This trip respone is sensitive to break size per loop so that operating with one loop out of service will not affect the sensitivity of this trip.

For the reasons above, only the cases from no load are presented in WCAP-9226. The results show that operation with one reactor coolant loop out of service is acceptable.

Consideration of plant specific setpoints and Technical Specification changes to properly specify other conditions of operation with one loop out of service will be addressed by each licensee's application for a license provision to permit this mode of operation.

Q) 222.13 Provide the points where calculations were performed in Figure 3.1-34. In addition, provide the following:

a. Curve showing peak core average power as a function of initial steam generator mass.

b. Time dependent axial and radial peaking factors as a function of initial steam generator mass inventory.

c. Integral and differential steam flow.

A) 222.13

Calculations were performed at initial (per steam generator) mass inventories of 75,000, 100,000, 120,000, 180,000 and 200,000 lbm in addition to the reference case of 150,000. Because all of the calculations conservatively assume dry steam blowdown and no credit for reduction of primary to secondary UA as the tube uncovers, there is little sensitivity to the parameters mentioned in the question. The table below summarizes the magnitude of the variations in the key parameters.

S/G Mass lbm	Peak Power Frac. of Nom.	Time of Peak Power (sec)
75,000	.25	43
100,000	.24	43
120,000	.24	43
150,000	.22	43
180,000	.21	43
200,000	.20	43

Q) 222.14 Discuss how upper head injection is treated in the analyses and show how its momentum is considered in the upper plenum where it mixes with the reactor coolant system flow. Discuss how UHI affects response in the pressurizer because of cooler water entering the pressurizer causing a vapor collapse which would induce a rapid surge of flow into the pressurizer. Discuss how these effects would influence core flow. Quantify the conclusions for UHI-equipped plants.

A) 222.14

Upper head injection is simulated in both the LOFTRAN and MARVEL as an accumulator which empties into the upper head volume. The momentum effects are not modeled.

The phenomenon where cool water enters the pressurizer and causes vapor collapse is not simulated explicitly. The practice of connecting the surge line to the side of the hot leg on a horizontal piping run assures that some warm water stands in the surge line, minimizing the described effect.

The results of steamline break analyses for plants with and without upper head injection are quantified in the response to Question 212.10, which is contained in this transmittal.

Q) 232.1 Describe in more detail how space dependent reactivity coefficients (moderator, Doppler, and boron) were developed and applied in the steamline break analysis. Provide curves showing the variation of the individual reactivity components (moderator, boron, scram worth, safety injection, and power coefficients) with time during the transient.

A) 232.1

The moderator, boron, and doppler coefficients are computed with a 2-D, full-core, neutron-diffusion nuclear model. The coefficients are computed with the most reactive control rod stuck out of the core and all other rods fully inserted. Therefore, the neutron flux distribution used in calculating the coefficients is representative of that which is present during the transient. The moderator coefficient is calculated over the range from HZP to coldest steamline break conditions. The return-to-power coefficient (typically referred to as the doppler coefficient) is calculated at a constant volume-average moderator density at several power levels. Since this coefficient is computed with a stuck control rod, the power distribution is tilted toward the stuck rod and because of power effects, the moderator density in the vicinity of the stuck rod is lower than the core average moderator density. Thus, the coefficient is a combination of moderator feedback effects, and doppler temperature effects with the doppler feedback term dominating. The boron coefficient is computed at several moderator densities using the same calculational model as was used for the moderator and return to power coefficients.

These coefficients are used in the transient code to compute integrated reactivity effects. The moderator coefficient is used as a function of moderator density, and the reactivity insertion due to the moderator density change is obtained by integrating the coefficient from HZP to the Steamline Break statepoint. The integral of the Return-to-Power coefficient gives the reactivity change due to the core returning critical. This coefficient is given as a function of core relative power and only adds negative reactivity when the core is critical. The boron coefficient is used to give the negative reactivity insertion as boron is added to the core.

The reactivity balance is discussed in both the LOFTRAN and MARVEL WCAP's. These codes do not have as output variables the individual components of reactivity. The individual components of reactivity can be constructed from the information provided in WCAP-9226.

Q) 232.4 Provide power coefficient curves similar to Figure 3-1-4 that show the difference in values between the stuck rod and no stuck rod coefficient.

A) 232.4

The no stuck rod power coefficient will vary somewhat from plant to plant but in each case the bounding values are presented in each plant FSAR Chapter 15.

Q) 232.5 Provide representative radial and axial power distributions during the transient.

A) 232.5

Attachment 1 is a copy of a request for information pertaining to the Westinghouse steamline break generic analyses performed for WCAP-9226 "Reactor Core Response to Excessive Secondary Steam Releases". Westinghouse considers the attached request as a clarification of WCAP-9226 Round 1 question 232.5 which reads: Provide representative radial and axial power distributions during the transient. The response is provided in Attachment 2, and is identical to the material informally supplied in August, 1979 to S. Salah and R. P. Denise.

ATTACHMENT 1

T.o.: Bob Steitler Westinghouse NES

WESTINGHOUSE PROPRIETARY [illegible] 2

From: S. Salah NRC AB/DSS

Subject: Input data for steam line break analysis (Typ. 3 Lp W Plants)

For following steam line break cases

1. EOL from HZP with offsite power (DEB)
2. EOL from HZP without offsite power (DEB)
3. EOL from full power (DEB)
4. EOL from HZP small break ($0.24\ ft^2$)
5. BOL from full power (DEB)

described in WCAP 9227, provide input data for typical Westinghoose 3 loop plants. Data should consist of 4 to 5 state points (different time during accident), which will be used in our code to calcolate DNBR. Data requested are as follows for each case:

a. Core average power level
b. radial and axial power distribution for each fuel bundle.
c. core inlet flow rate distribution
d. core inlet coolant temperature
e. system pressure
f. Core geometery with stuck rod location

ATTACHMENT 2

TABLE 1

Reference Plant Description

Core:	
number of assemblies	157
rod array	17 x 17
rod O.D.	0.374
grids	8
active fuel length (in.)	144
number of control rods	48
Number of loops	3
Steam Generator	51 series
NSSS Power (@ 100%)	2785 MWt
Reactor Power	2775 MWt
Thermal Design Flow	92800 gpm/loop
Reactor Coolant Pressure	2250 psia

4.6 ft^2 Double Ended Rupture

EOL - HZP

With Offsite Power

TABLE 2

Pertinent State Point Data
EOL - HZP
Offsite Power Available

CASE NO.	TIME (SEC)	FLOW (FRAC)	POWER (FRAC)	PRESSURE (PSIA)	H_A	H_B	H_C	H_D	H_E	H_F
F-1	30	1.0	.15	899.7	368.3	382.0	395.8	433.3	462.2	487.0
F-2	35	1.0	.18	876.4	360.8	374.6	388.6	426.3	455.0	480.4
F-3	40	1.0	.21	855.2	355.4	369.5	383.3	421.3	450.8	476.6
F-4	44	1.0	.22	839.7	351.8	365.7	379.5	417.2	446.2	470.9
F-5	50	1.0	.19	814.3	347.9	361.7	375.5	413.0	441.9	466.5

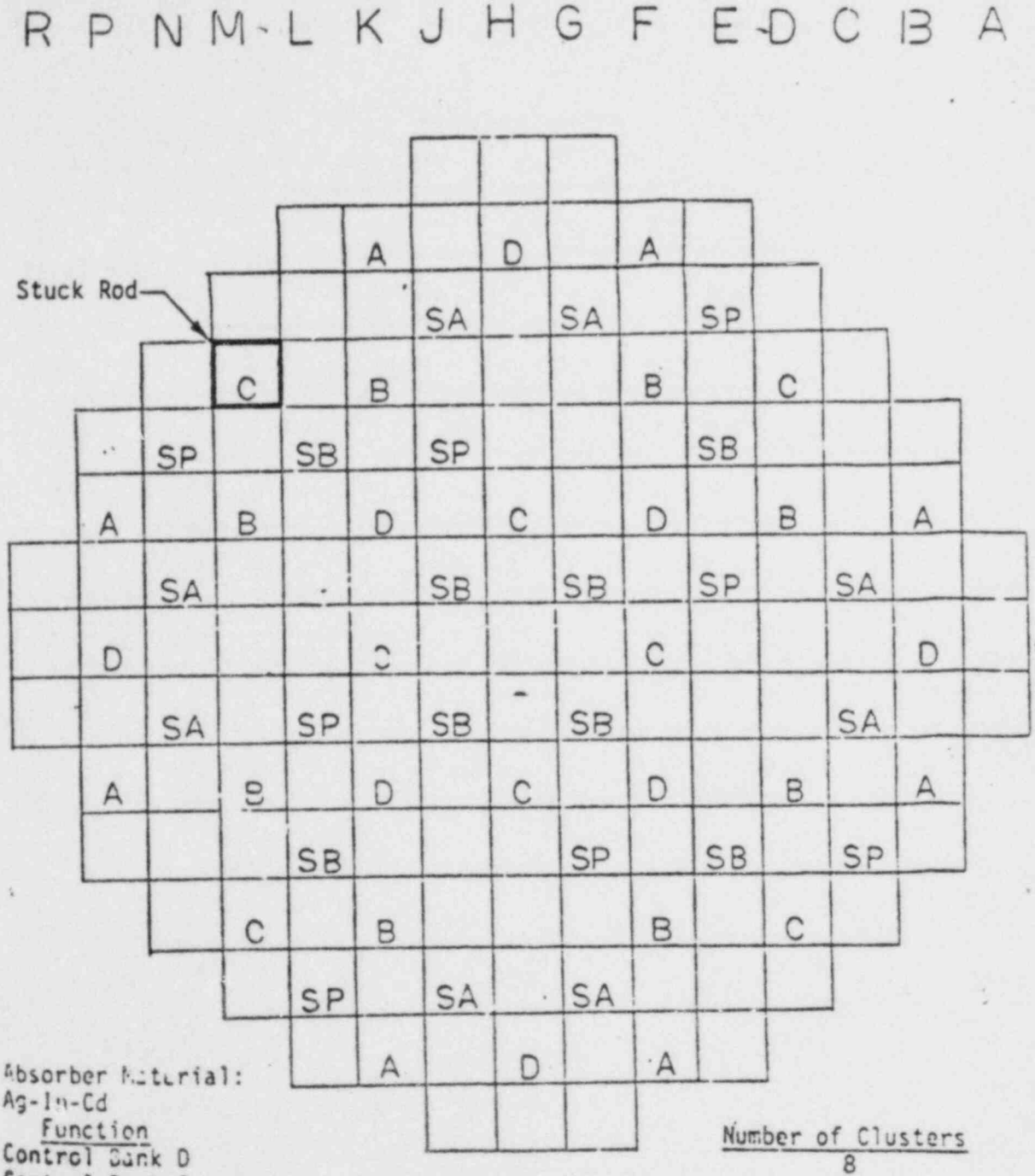


Figure 1

Core Geometry With Stuck Rod Location

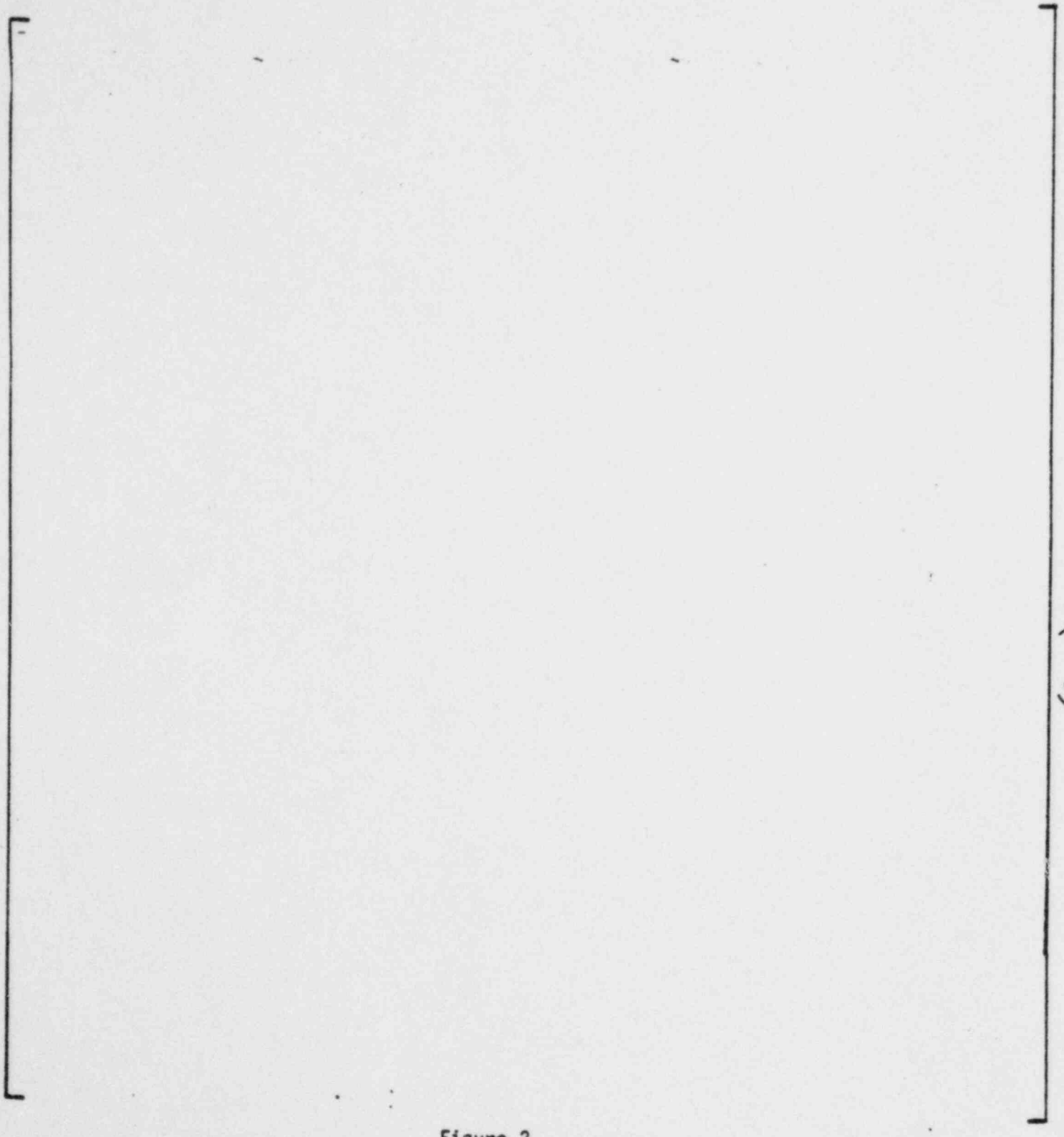


Figure 2

Regions for Core Inlet Enthalpy Distribution

TABLE 6

AXIAL MESH DESCRIPTION

ROW	DELTA Z	
1	9.167074	
2	9.167074	
3	9.167074	
4	9.167074	
5	13.750611	
6	18.334148	
7	28.417930	
8	28.417930	
9	28.417930	FUEL
10	28.417930	RODS
11	28.417930	
12	28.417930	
13	28.417930	
14	28.417920	
15	28.417930	
16	28.417930	
17	18.334148	
18	13.750611	
19	9.167074	
20	9.167074	
21	9.167074	
22	9.167074	

CASE F-1 (119)

W/POWER 30.0 SEC

ASSEMBLY AVERAGE POWERS FOR THE WHOLE CORE.

PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
4	1															
4	2															
4	3															
4	4															
4	5															
4	6															
4	7															
4	8															
4	9															
4	10															
4	11															
4	12															
4	13															
4	14															
4	15															
4	ROW AV.															

CASE F-1 (2/9)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
5	1															
5	2															
5	3															
5	4															
5	5															
5	6															
5	7															
5	8															
5	9															
5	10															
5	11															
5	12															
5	13															
5	14															
5	15															
5	ROW AVG															

(A, C)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
6	1															
6	2															
6	3															
6	4															
6	5															
6	6															
6	7															
6	8															
6	9															
6	10															
6	11															
6	12															
6	13															
6	14															
6	15															
6	ROW AVG															

(A, C)

CASE F-1 (2/9)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
7	1															
7	2															
7	3															
7	4															
7	5															
7	6															
7	7															
7	8															
7	9															
7	10															
7	11															
7	12															
7	13															
7	14															
7	15															
7	ROW AVG															5

(A,C)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
8	1															
8	2															
8	3															
8	4															
8	5															
8	6															
8	7															
8	8															
8	9															
8	10															
8	11															
8	12															
8	13															
8	14															
8	15															
8	ROW AVG															5

(A,C)

CASE F-1 (4|9)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
9	1															
9	2															
9	3															
9	4															
9	5															
9	6															
9	7															
9	8															
9	9															
9	10															
9	11															
9	12															
9	13															
9	14															
9	15															
9	ROW AVG															

(A,C)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
10	1															
10	2															
10	3															
10	4															
10	5															
10	6															
10	7															
10	8															
10	9															
10	10															
10	11															
10	12															
10	13															
10	14															
10	15															
10	ROW AVG.															

(A,C)

CASE F-1 (6/9)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
13	1															
13	2															
13	3															
13	4															
13	5															
13	6															
13	7															
13	8															
13	9															
13	10															
13	11															
13	12															
13	13															
13	14															
13	15															
13	ROW AVG															

(A, C)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
14	1															
14	2															
14	3															
14	4															
14	5															
14	6															
14	7															
14	8															
14	9															
14	10															
14	11															
14	12															
14	13															
14	14															
14	15															
14	ROW AVG															

(A, C)

CASE F-1 (5/9)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
11	1															
11	2															
11	3															
11	4															
11	5															
11	6															
11	7															
11	8															
11	9															
11	10															
11	11															
11	12															
11	13															
11	14															
11	15															
11	ROW AVG															

(A.C)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
12	1															
12	2															
12	3															
12	4															
12	5															
12	6															
12	7															
12	8															
12	9															
12	10															
12	11															
12	12															
12	13															
12	14															
12	15															
12	ROW AVG															

(A.C)

CASE F-1 (7/9)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
15	1															
15	2															
15	3															
15	4															
15	5															
15	6															
15	7															
15	8															
15	9															
15	10															
15	11															
15	12															
15	13															
15	14															
15	15															
15	ROW AVG															

(A,C)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	1															
16	2															
16	3															
16	4															
16	5															
16	6															
16	7															
16	8															
16	9															
16	10															
16	11															
16	12															
16	13															
16	14															
16	15															
16	ROW AVG															

(A,C)

CASE F-1 (9|9)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
19	1															
19	2															
19	3															
19	4															
19	5															
19	6															
19	7															
19	8															
19	9															
19	10															
19	11															
19	12															
19	13															
19	14															
19	15															
19	ROW AVG															

(A, C)

CASE F-2 (119)

W/ POWER 35.C

ASSEMBLY AVERAGE POWERS FOR THE MIDDLE CORE.

PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															

(A,C)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
4	1															
4	2															
4	3															
4	4															
4	5															
4	6															
4	7															
4	8															
4	9															
4	10															
4	11															
4	12															
4	13															
4	14															
4	15															
4	ROW AVG.															

(A,C)

CASE F-2 (319)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
7	1															
7	2															
7	3															
7	4															
7	5															
7	6															
7	7															
7	8															
7	9															
7	10															
7	11															
7	12															
7	13															
7	14															
7	15															
7	ROW AV															

(A, C)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
8	1															
8	2															
8	3															
8	4															
8	5															
8	6															
8	7															
8	8															
8	9															
8	10															
8	11															
8	12															
8	13															
8	14															
8	15															
8	ROW AVG															

(A, C)

CASE F-2 (4/9)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
9	1															
9	2															
9	3															
9	4															
9	5															
9	6															
9	7															
9	8															
9	9															
9	10															
9	11															
9	12															
9	13															
9	14															
9	15															
9	ROW AV															

(A,<)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
10	1															
10	2															
10	3															
10	4															
10	5															
10	6															
10	7															
10	8															
10	9															
10	10															
10	11															
10	12															
10	13															
10	14															
10	15															
10	ROW AV															

(A,<)

CASE F-2 (2/9)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
5	1															
5	2															
5	3															
5	4															
5	5															
5	6															
5	7															
5	8															
5	9															
5	10															
5	11															
5	12															
5	13															
5	14															
5	15															
5	ROW AVG															

(A,C)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
6	1															
6	2															
6	3															
6	4															
6	5															
6	6															
6	7															
6	8															
6	9															
6	10															
6	11															
6	12															
6	13															
6	14															
6	15															
6	ROW AVG															

(A,C)

CASE F-2 5/9

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
11	1															
11	2															
11	3															
11	4															
11	5															
11	6															
11	7															
11	8															
11	9															
11	10															
11	11															
11	12															
11	13															
11	14															
11	15															
11	ROW AVG															

(A, C)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
12	1															
12	2															
12	3															
12	4															
12	5															
12	6															
12	7															
12	8															
12	9															
12	10															
12	11															
12	12															
12	13															
12	14															
12	15															
12	ROW AVG															

(A, C)

CASE F-2 5/9

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
11	1															
11	2															
11	3															
11	4															
11	5															
11	6															
11	7															
11	8															
11	9															
11	10															
11	11															
11	12															
11	13															
11	14															
11	15															
11	ROW AVG															

(A, C)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
12	1															
12	2															
12	3															
12	4															
12	5															
12	6															
12	7															
12	8															
12	9															
12	10															
12	11															
12	12															
12	13															
12	14															
12	15															
12	ROW AVG															

(A, C)

CASE F-2 (779)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
15	1															
15	2															
15	3															
15	4															
15	5															
15	6															
15	7															
15	8															
15	9															
15	10															
15	11															
15	12															
15	13															
15	14															
15	15															
15	ROW AVG.															

(A,C)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	1															
16	2															
16	3															
16	4															
16	5															
16	6															
16	7															
16	8															
16	9															
16	10															
16	11															
16	12															
16	13															
16	14															
16	15															
16	ROW AVG															

(A,C)

CASE F-2 (8/9)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
17	1															
17	2															
17	3															
17	4															
17	5															
17	6															
17	7															
17	8															
17	9															
17	10															
17	11															
17	12															
17	13															
17	14															
17	15															
17	ROW AVG.															

(A,C)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
18	1															
18	2															
18	3															
18	4															
18	5															
18	6															
18	7															
18	8															
18	9															
18	10															
18	11															
18	12															
18	13															
18	14															
18	15															
18	ROW AVG.															

(A,C)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
19	1															
19	2															
19	3															
19	4															
19	5															
19	6															
19	7															
19	8															
19	9															
19	10															
19	11															
19	12															
19	13															
19	14															
19	15															
19	ROW AVG															

(A,C)

CASE F-3 (119)

W/ POW[illegible] 40.0 sec

ASSEMBLY AVERAGE POWERS FOR THE WHOLE CORE.

PLANE	COL 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1															
2															
3															
4															
5															
6															
7	1														
8	1														
9															
10															
11															
12															
13															
14															
15															

(A,C)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
9	1															
9	2															
9	3															
9	4															
9	5															
9	6															
9	7															
9	8															
9	9															
9	10															
9	11															
9	12															
9	13															
9	14															
9	15															
9	ROW AVG.															

(A,C)

CASE F-3 (2/9)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
5	1															
5	2															
5	3															
5	4															
5	5															
5	6															
5	7															
5	8															
5	9															
5	10															
5	11															
5	12															
5	13															
5	14															
5	15															
5	ROW AVG															

(A, C)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
6	1															
6	2															
6	3															
6	4															
6	5															
6	6															
6	7															
6	8															
6	9															
6	10															
6	11															
6	12															
6	13															
6	14															
6	15															
6	ROW AVG															

(A, C)

CASE F-3 (3/9)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
7	1															
7	2															
7	3															
7	4															
7	5															
7	6															
7	7															
7	8															
7	9															
7	10															
7	11															
7	12															
7	13															
7	14															
7	15															
7	ROW AVG															

(A,C)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
8	1															
8	2															
8	3															
8	4															
8	5															
8	6															
8	7															
8	8															
8	9															
8	10															
8	11															
8	12															
8	13															
8	14															
8	15															
8	ROW AVG															

(A,C)

CASE F-3 (A19)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
9	1															
9	2															
9	3															
9	4															
9	5															
9	6															
9	7															
9	8															
9	9															
9	10															
9	11															
9	12															
9	13															
9	14															
9	15															
9	ROW AVG															

(A,C)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
10	1															
10	2															
10	3															
10	4															
10	5															
10	6															
10	7															
10	8															
10	9															
10	10															
10	11															
10	12															
10	13															
10	14															
10	15															
10	ROW AVG															

(A,C)

CASE F-3 (519)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
11	1															
11	2															
11	3															
11	4															
11	5															
11	6															
11	7															
11	8															
11	9															
11	10															
11	11															
11	12															
11	13															
11	14															
11	15															
11	ROW AVG															

(A, <)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
12	1															
12	2															
12	3															
12	4															
12	5															
12	6															
12	7															
12	8															
12	9															
12	10															
12	11															
12	12															
12	13															
12	14															
12	15															
12	ROW AVG															

(A, <)

CASE F-3 (6/9)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
13	1															
13	2															
13	3															
13	4															
13	5															
13	6															
13	7															
13	8															
13	9															
13	10															
13	11															
13	12															
13	13															
13	14															
13	15															
13	ROW AVG															

(A, C)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
14	1															
14	2															
14	3															
14	4															
14	5															
14	6															
14	7															
14	8															
14	9															
14	10															
14	11															
14	12															
14	13															
14	14															
14	15															
14	ROW AVG															

(A, C)

CASE F-3 (7/9)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
15	1															
15	2															
15	3															
15	4															
15	5															
15	6															
15	7															
15	8															
15	9															
15	10															
15	11															
15	12															
15	13															
15	14															
15	15															
15	ROW AVG															

(A, <)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	1															
16	2															
16	3															
16	4															
16	5															
16	6															
16	7															
16	8															
16	9															
16	10															
16	11															
16	12															
16	13															
16	14															
16	15															
16	ROW AVG															

(A, <)

A

CASE F-3 (8/9)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
17	1															
17	2															
17	3															
17	4															
17	5															
17	6															
17	7															
17	8															
17	9															
17	10															
17	11															
17	12															
17	13															
17	14															
17	15															
17	ROW AVG															

(A, C)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
18	1															
18	2															
18	3															
18	4															
18	5															
18	6															
18	7															
18	8															
18	9															
18	10															
18	11															
18	12															
18	13															
18	14															
18	15															
18	ROW AVG															

(A, C)

A

(a.a)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
19	1															
19	2															
19	3															
19	4															
19	5															
19	6															
19	7															
19	8															
19	9															
19	10															
19	11															
19	12															
19	13															
19	14															
19	15															
19	ROW AVG.															

(A.4)

CASE F-4 (119)

W/ POWER 44.1 EFPD

ASSEMBLY AVERAGE POWERS FOR THE WHOLE CORE.

PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															

(A, C)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
4	1															
4	2															
4	3															
4	4															
4	5															
4	6															
4	7															
4	8															
4	9															
4	10															
4	11															
4	12															
4	13															
4	14															
4	15															
4	ROW AVG															

(A, C)

CASE F-4 (2/9)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
5	1															
5	2															
5	3															
5	4															
5	5															
5	6															
5	7															
5	8															
5	9															
5	10															
5	11															
5	12															
5	13															
5	14															
5	15															
5	ROW AV															

(A.C)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
6	1															
6	2															
6	3															
6	4															
6	5															
6	6															
6	7															
6	8															
6	9															
6	10															
6	11															
6	12															
6	13															
6	14															
6	15															
6	ROW AVG															

(A.C)

CASE F-4 (3/9)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
7	1															
7	2															
7	3															
7	4															
7	5															
7	6															
7	7															
7	8															
7	9															
7	10															
7	11															
7	12															
7	13															
7	14															
7	15															
7	ROW AVG															

(A,C)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
8	1															
8	2															
8	3															
8	4															
8	5															
8	6															
8	7															
8	8															
8	9															
8	10															
8	11															
8	12															
8	13															
8	14															
8	15															
8	ROW AVG															

(A,C)

CASE F-4 (4|9)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
9	1															
9	2															
9	3															
9	4															
9	5															
9	6															
9	7															
9	8															
9	9															
9	10															
9	11															
9	12															
9	13															
9	14															
9	15															
9	ROW AV															

(A,C)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
10	1															
10	2															
10	3															
10	4															
10	5															
10	6															
10	7															
10	8															
10	9															
10	10															
10	11															
10	12															
10	13															
10	14															
10	15															
10	ROW AVG.															

(A,C)

CASE F-4 (E/a)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
11	1															
11	2															
11	3															
11	4															
11	5															
11	6															
11	7															
11	8															
11	9															
11	10															
11	11															
11	12															
11	13															
11	14															
11	15															
11	ROW AVG															

(A, C)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
12	1															
12	2															
12	3															
12	4															
12	5															
12	6															
12	7															
12	8															
12	9															
12	10															
12	11															
12	12															
12	13															
12	14															
12	15															
12	ROW AVG															

(A, C)

CASE F-4 (7/9)

ROW PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
15	1														
15	2														
15	3														
15	4														
15	5														
15	6														
15	7														
15	8														
15	9														
15	10														
15	11														
15	12														
15	13														
15	14														
15	15														
15	ROW AVG.														

(A, <)

ROW PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	1														
16	2														
16	3														
16	4														
16	5														
16	6														
16	7														
16	8														
16	9														
16	10														
16	11														
16	12														
16	13														
16	14														
16	15														
16	ROW AVG.														

(A, <)

CASE F-4 (8/9)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
17	1															
17	2															
17	3															
17	4															
17	5															
17	6															
17	7															
17	8															
17	9															
17	10															
17	11															
17	12															
17	13															
17	14															
17	15															
17	ROW AVG.															

(A,C)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
18	1															
18	2															
18	3															
18	4															
18	5															
18	6															
18	7															
18	8															
18	9															
18	10															
18	11															
18	12															
18	13															
18	14															
18	15															
18	ROW AVG.															

(A,C)

CASE F-4 (9/9)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
19	1															
19	2															
19	3															
19	4															
19	5															
19	6															
19	7															
19	8															
19	9															
19	10															
19	11															
19	12															
19	13															
19	14															
19	15															
19	ROW AVG.															

(A, C)

CASE F-5 (1/9)

INJ/POWER 50.0 SEC.

ASSEMBLY AVERAGE POWERS FOR THE WHOLE CORE.

PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															

(A, C)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
4	1															
4	2															
4	3															
4	4															
4	5															
4	6															
4	7															
4	8															
4	9															
4	10															
4	11															
4	12															
4	13															
4	14															
4	15															
4	ROW AVG															

(A, C)

CASE F-5 (2/9)

ROW	PLANE	COL. 1
7	1	
7	2	
7	3	
7	4	
7	5	
7	6	
7	7	
7	8	
7	9	
7	10	
7	11	
7	12	
7	13	
7	14	
7	15	
7 ROW AVG.		

		COL. 1	2	3	4	5	6	7	8	9	10	11	12	13
5	1													
5	2													
5	3													
5	4													
5	5													
5	6													
5	7													
5	8													
5	9													
5	10													
5	11													
5	12													
5	13													
5	14													
5	15													
5 ROW AVG														

ROW	PLANE	COL. 1
8	1	
8	2	
8	3	
8	4	
8	5	
8	6	
8	7	
8	8	
8	9	
8	10	
8	11	
8	12	
8	13	
8	14	
8	15	
8 ROW AVG		

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13
6	1													
6	2													
6	3													
6	4													
6	5													
6	6													
6	7													
6	8													
6	9													
6	10													
6	11													
6	12													
6	13													
6	14													
6	15													
6 ROW AVG														

CASE F-E (5/a)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
11	1															
11	2															
11	3															
11	4															
11	5															
11	6															
11	7															
11	8															
11	9															
11	10															
11	11															
11	12															
11	13															
11	14															
11	15															
11	ROW AVG															

(A.C)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
12	1															
12	2															
12	3															
12	4															
12	5															
12	6															
12	7															
12	8															
12	9															
12	10															
12	11															
12	12															
12	13															
12	14															
12	15															
12	ROW AVG.															

(A.C)

CASE F-5 (2/9)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
13	1															
13	2															
13	3															
13	4															
13	5															
13	6															
13	7															
13	8															
13	9															
13	10															
13	11															
13	12															
13	13															
13	14															
13	15															
13	ROW AVG															

(A, C)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
14	1															
14	2															
14	3															
14	4															
14	5															
14	6															
14	7															
14	8															
14	9															
14	10															
14	11															
14	12															
14	13															
14	14															
14	15															
14	ROW AVG															

(A, C)

CASE F-5 (7/9)

		2	3	4	5	6									
15	1														
15	2														
15	3														
15	4														
15	5														
15	6														
15	7														
15	8														
15	9														
15	10														
15	11														
15	12														
15	13														
15	14														
15	15														
15	ROW AVG														

(A,C)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	1															
16	2															
16	3															
16	4															
16	5															
16	6															
16	7															
16	8															
16	9															
16	10															
16	11															
16	12															
16	13															
16	14															
16	15															
16	ROW AVG															

(A,C)

A

CASE T-5 (819)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
17	1															
17	2															
17	3															
17	4															
17	5															
17	6															
17	7															
17	8															
17	9															
17	10															
17	11															
17	12															
17	13															
17	14															
17	15															
17	ROW AVG.															

(A, C)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
18	1															
18	2															
18	3															
18	4															
18	5															
18	6															
18	7															
18	8															
18	9															
18	10															
18	11															
18	12															
18	13															
18	14															
18	15															
18	ROW AVG.															

(A, C)

CASE F-5 (9/9)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
19	1															
19	2															
19	3															
19	4															
19	5															
19	6															
19	7															
19	8															
19	9															
19	10															
19	11															
19	12															
19	13															
19	14															
19	15															
19	ROW AV.															

(A, C)

5

4.6 ft^2 Double Ended Rupture

EOL - HZP

Without Offsite Power

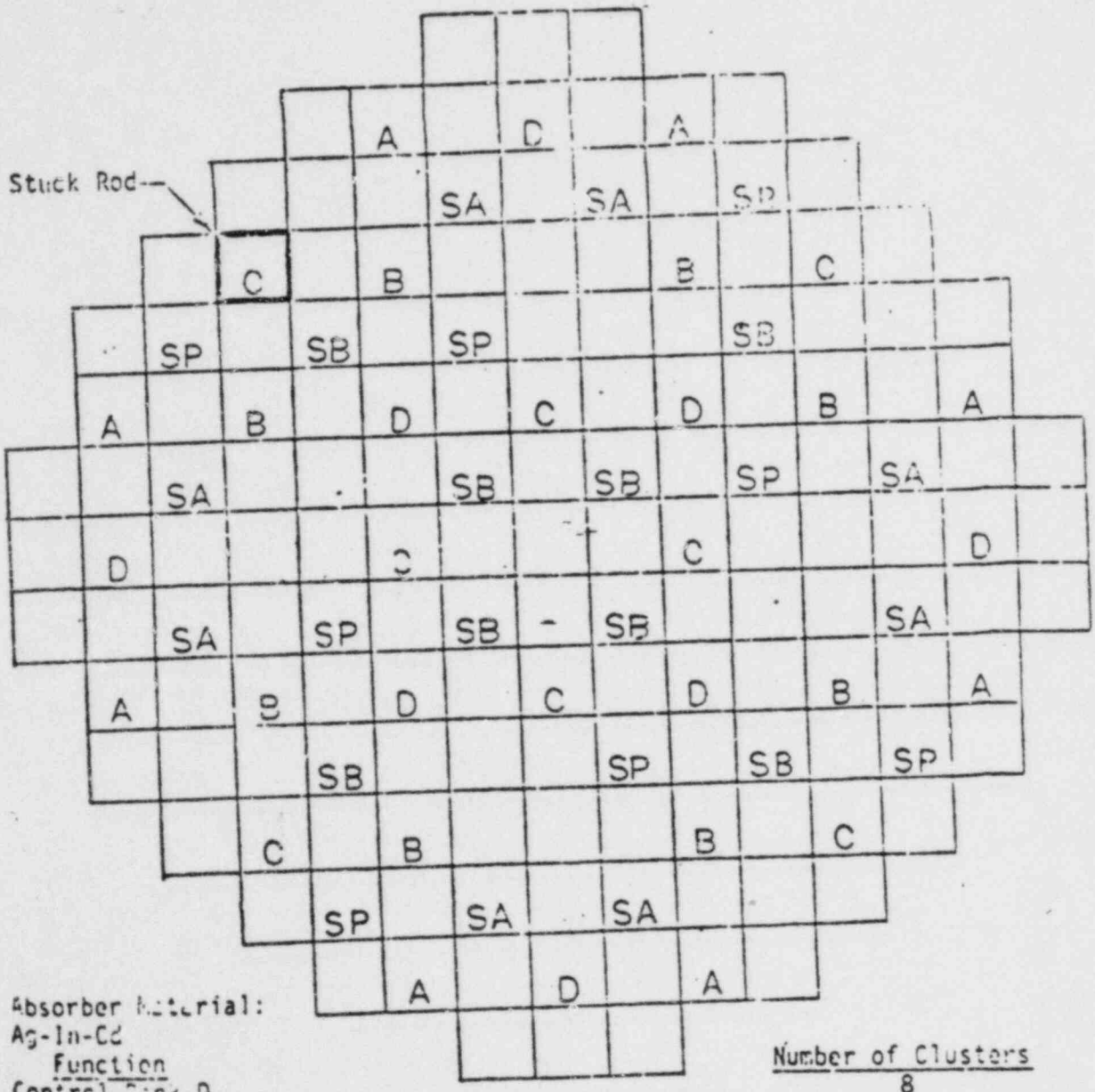


Figure 1

Core Geometry With Stuck Rod Location

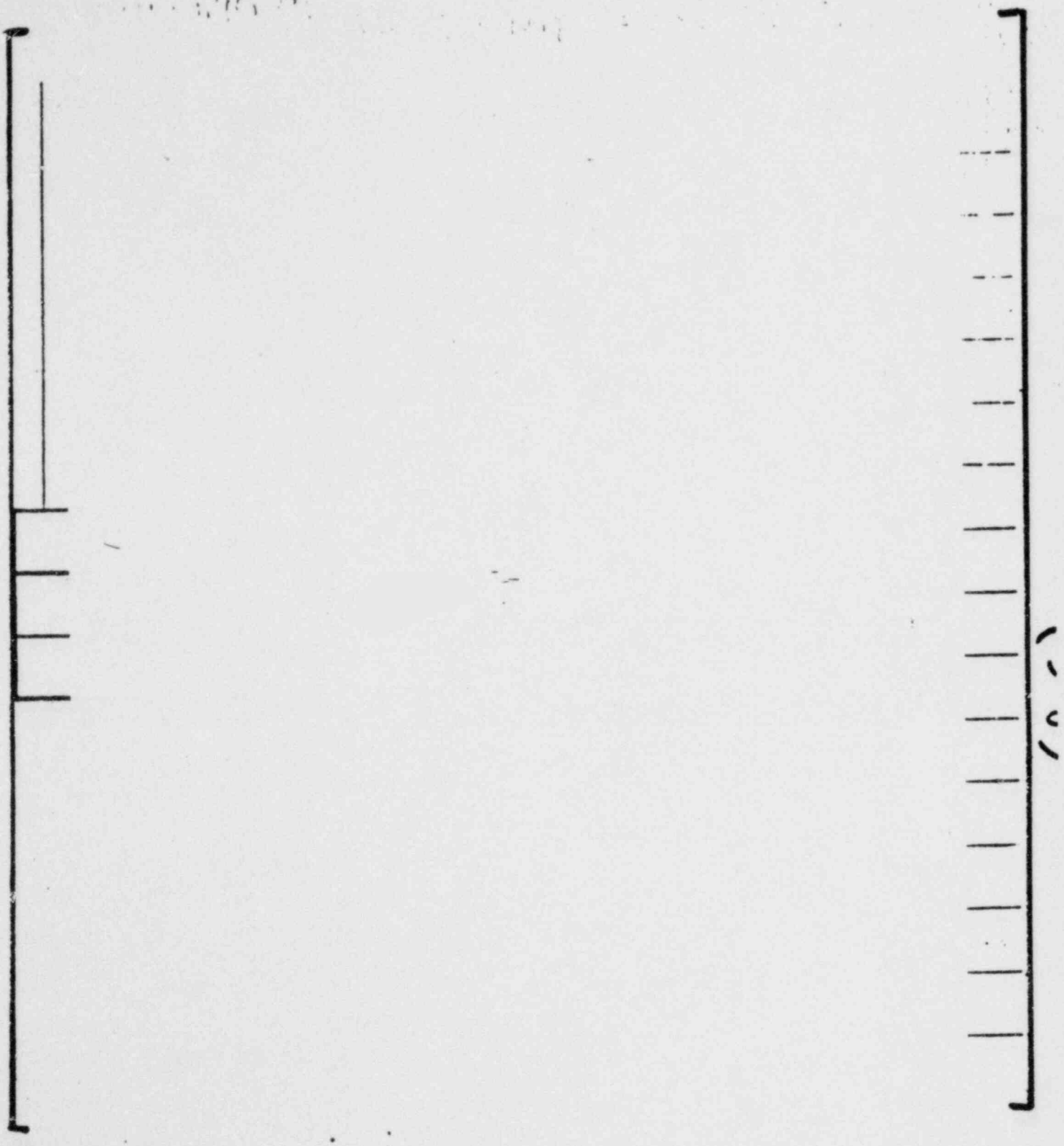


Figure 2

Regions for Core Inlet Enthalpy Distribution

TABLE 6

AXIAL MESH DESCRIPTION

ROW	DELTA Z	
1	9.167074	
2	9.167074	
3	9.167074	
4	9.167074	
5	13.750611	
6	18.334148	
7	28.417930	
8	28.417930	
9	28.417930	FUEL
10	28.417930	RODS
11	28.417930	
12	28.417930	
13	28.417930	
14	28.417930	
15	28.417930	
16	28.417930	
17	18.334148	
18	13.750611	
19	9.167074	
20	9.167074	
21	9.167074	
22	9.167074	

TABLE 3
Pertinent State Point Data
EOL - HZP
With Loss of Offsite Power

CASE NO.	TIME (SEC)	FLOW (FRAC)	POWER (FRAC)	PRESSURE (PSIA)	H_A	H_B	H_C	H_D	H_E	H_F
L-1	40.5	.25	.068	923.7	342.5	360.2	378.1	426.9	464.9	497.6
L-2	45.5	.23	.070	927.9	333.1	351.6	370.4	418.3	461.3	495.6
L-3	50.5	.21	.070	923.1	324.2	343.3	362.7	412.0	456.3	491.7
L-4	60.5	.18	.063	914.4	308.7	328.6	348.7	399.8	445.6	482.2
L-5	67.5	.17	.050	908.7	299.7	320.1	340.6	393.1	440.1	477.6

CASE L-1 (1/9)

LU/C POWER 40.0 KW

ASSEMBLY AVERAGE POWERS FOR THE WHOLE CORE.

PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															

(A,C)

KW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
4	1															
4	2															
4	3															
4	4															
4	5															
4	6															
4	7															
4	8															
4	9															
4	10															
4	11															
4	12															
4	13															
4	14															
4	15															
4	ROW AVG.															

(A,C)

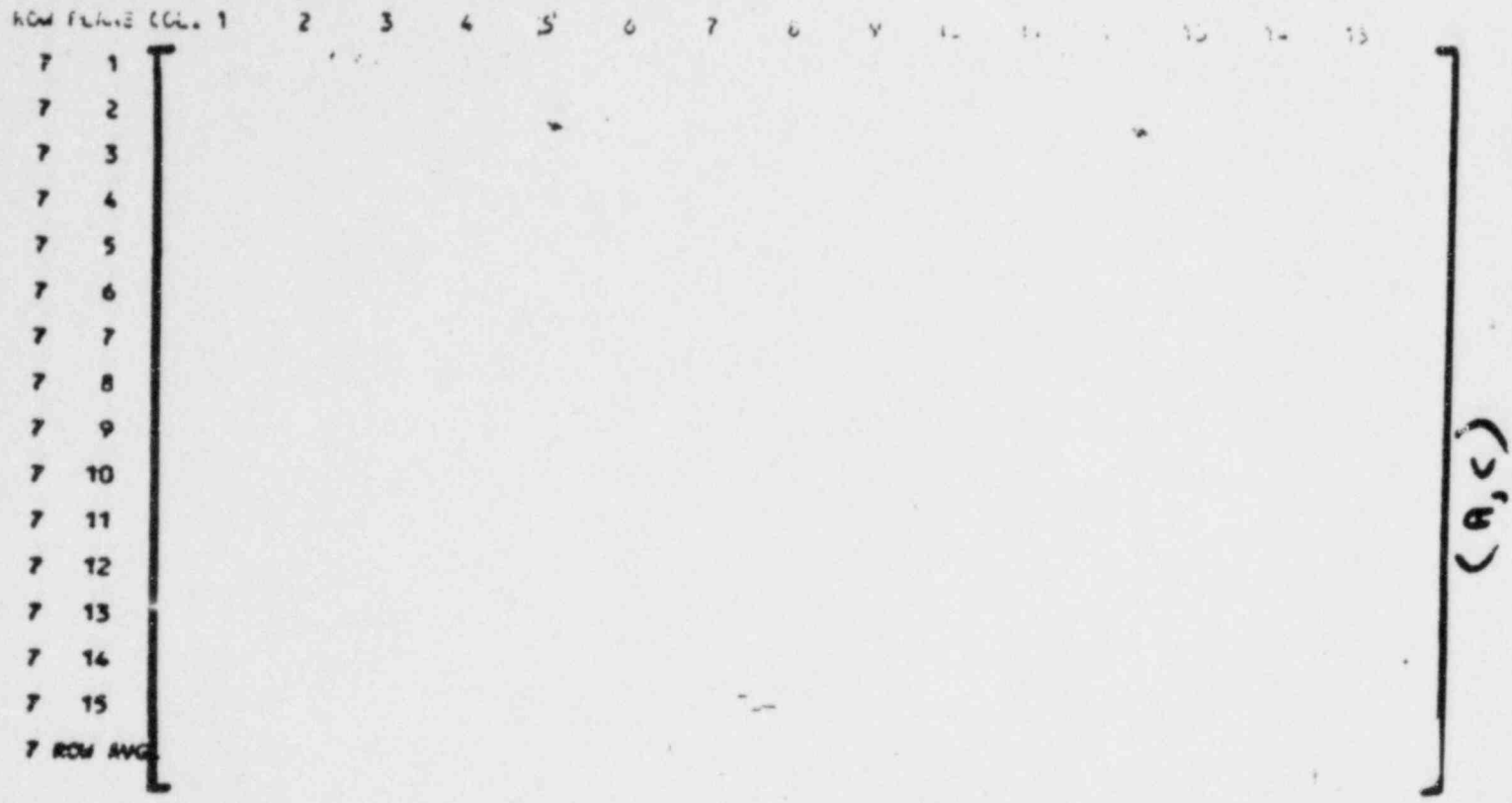
CASE 4 (2/a)

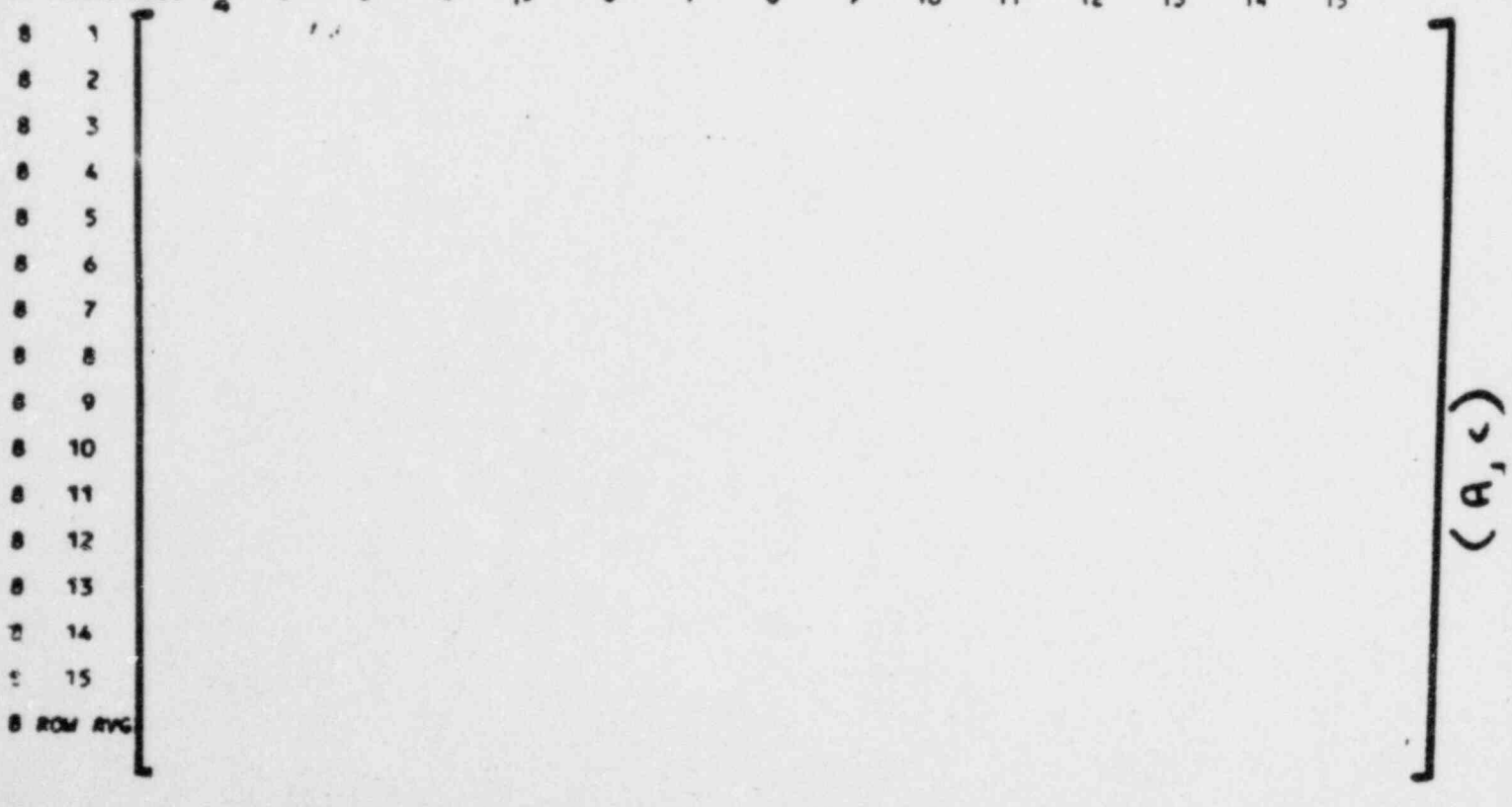
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
ROW AVG.															

(A, c)

PLANE COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
ROW AVG.															

(A, c)


ROW PLANE COL. 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
7 1
7 2
7 3
7 4
7 5
7 6
7 7
7 8
7 9
7 10
7 11
7 12
7 13
7 14
7 15
7 ROW AVG
(A,C)


ROW PLANE COL. 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
8 1
8 2
8 3
8 4
8 5
8 6
8 7
8 8
8 9
8 10
8 11
8 12
8 13
8 14
8 15
8 ROW AVG
(A,C)

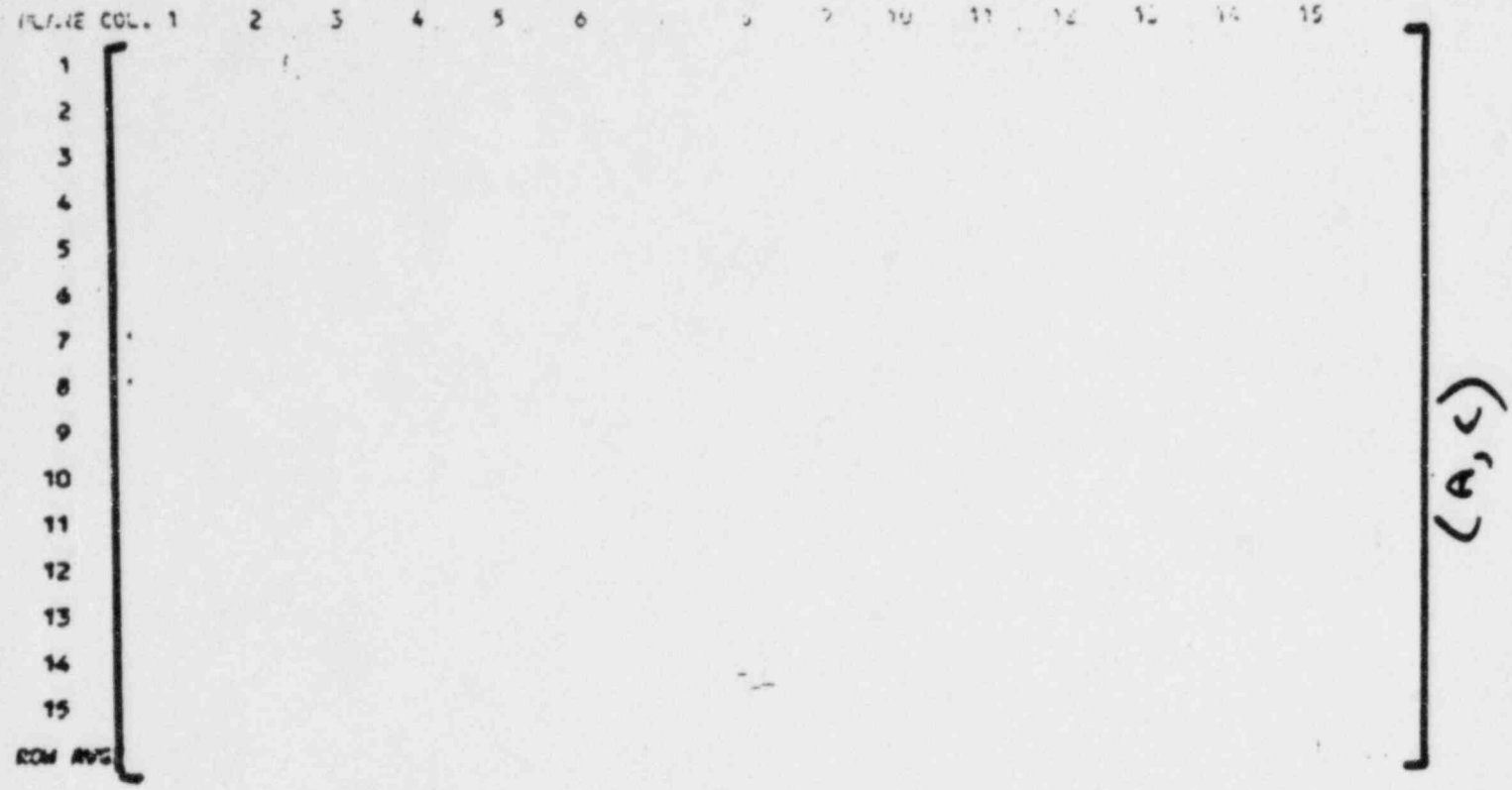
CASE 1-1 (A19)

PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
ROW AVG															

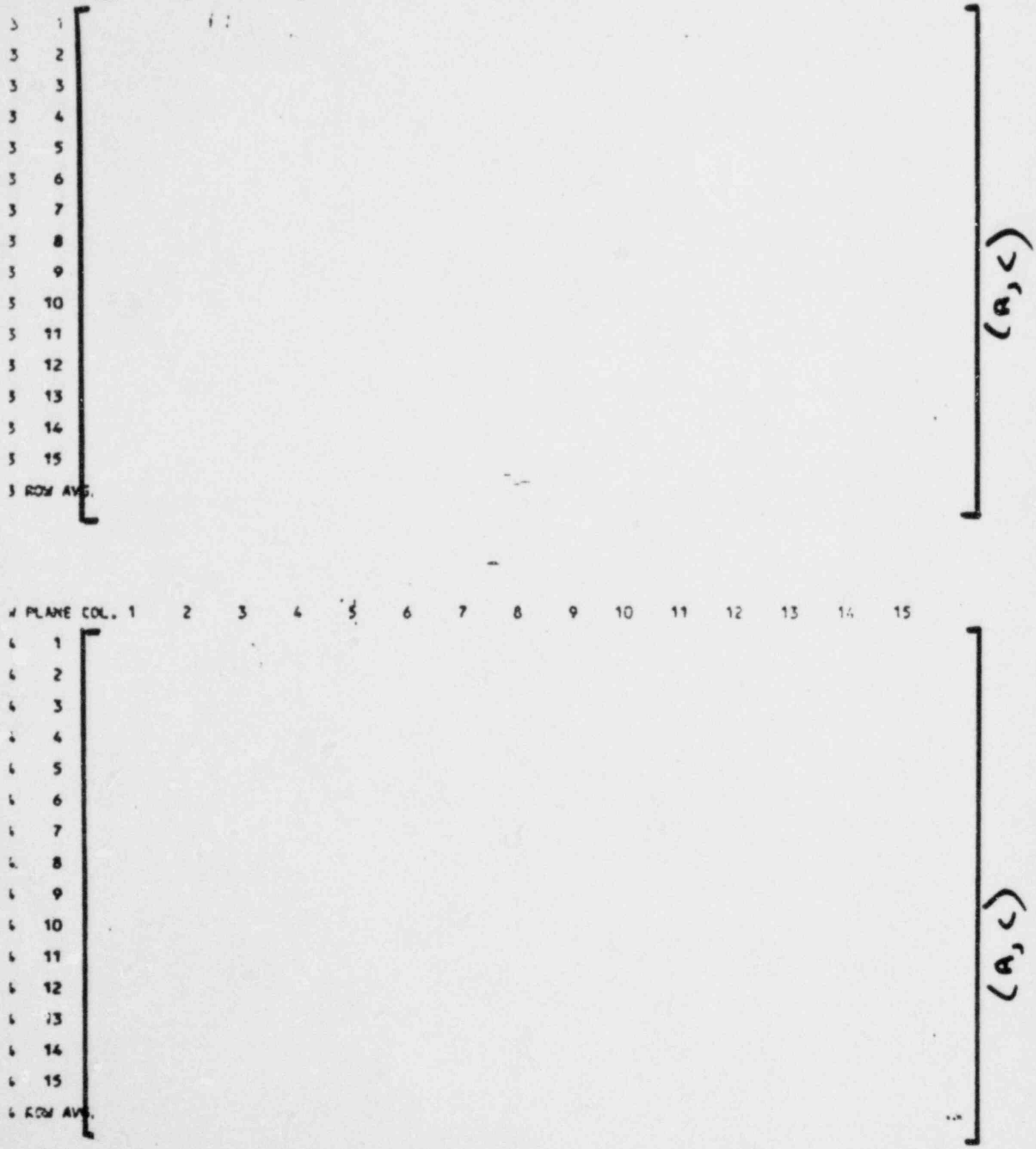
(A, C)

PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
ROW AVG															

(A, C)


PLANE COL. 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
ROW AVG
(A, C)


PLANE COL. 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
ROW AVG
(A, C)


3 PLANE COL. 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
3 1
3 2
3 3
3 4
3 5
3 6
3 7
3 8
3 9
3 10
3 11
3 12
3 13
3 14
3 15
3 ROW AVG.
(A,C)
4 PLANE COL. 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
4 1
4 2
4 3
4 4
4 5
4 6
4 7
4 8
4 9
4 10
4 11
4 12
4 13
4 14
4 15
4 ROW AVG.
(A,C)

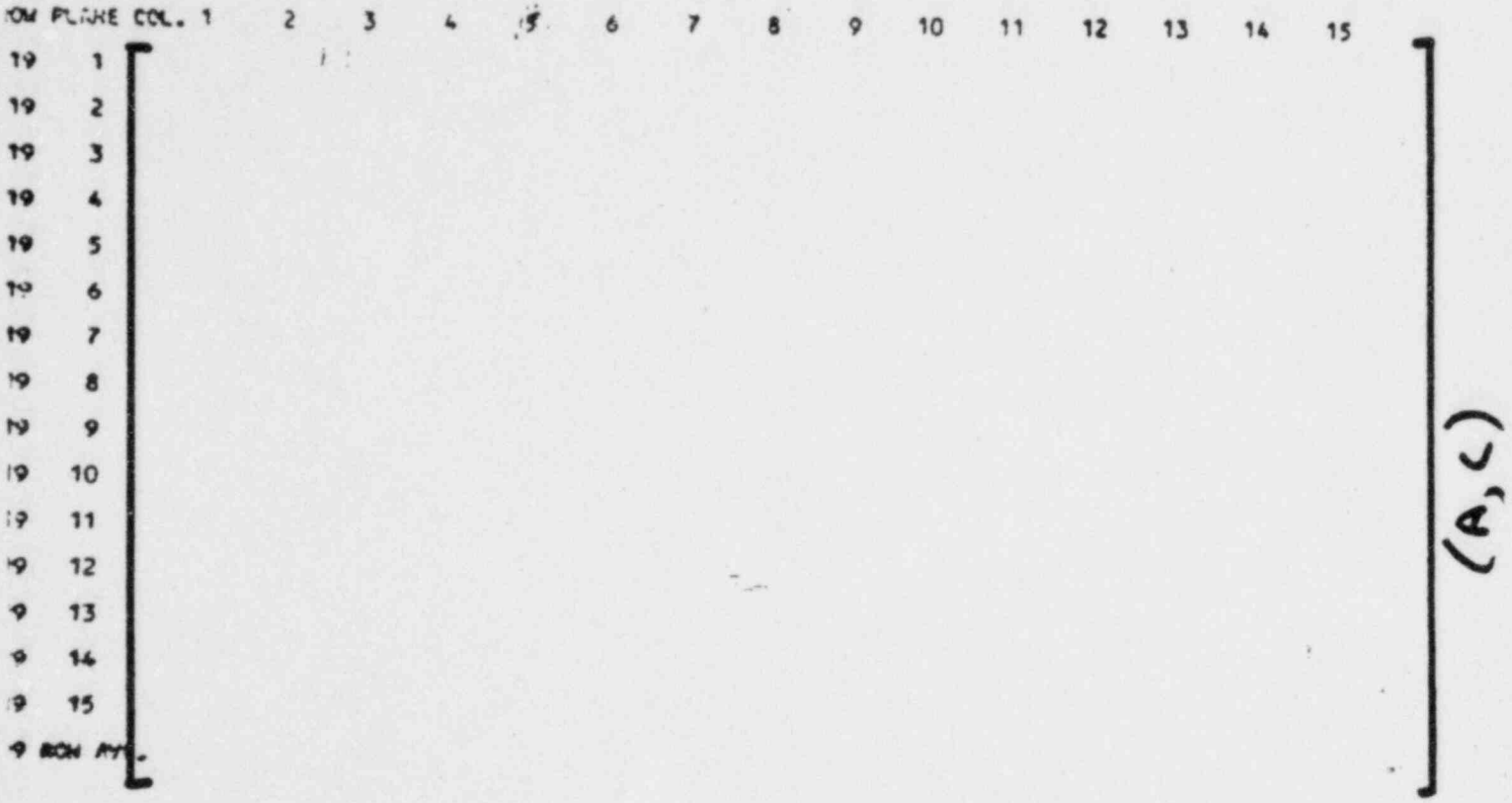
CASE L-1 (8/9)

		COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
17	1															
17	2															
17	3															
17	4															
17	5															
17	6															
17	7															
17	8															
17	9															
17	10															
17	11															
17	12															
17	13															
17	14															
17	15															
17	ROW AVG.															

(A, C)

	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
18	1															
18	2															
18	3															
18	4															
18	5															
18	6															
18	7															
18	8															
18	9															
18	10															
18	11															
18	12															
18	13															
18	14															
18	15															
18	ROW AVG.															

(A, <)


ROW PLANE COL. 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
19 1
19 2
19 3
19 4
19 5
19 6
19 7
19 8
19 9
19 10
19 11
19 12
19 13
19 14
19 15
19 ROW AVG.
(A, C)

CASE L-2 (1/9)

W/O POWER 45.5 FT.

ASSEMBLY AVERAGE POWERS FOR THE WHOLE CORE.

PLANE \ COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															

(A,C)

PLANE \ COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															

(A,C)

CASE L-2 (2/9)

PLANE COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
PLANE ROW															
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
ROW AVG.															

PLANE COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
PLANE COL.															
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
ROW AVG.															

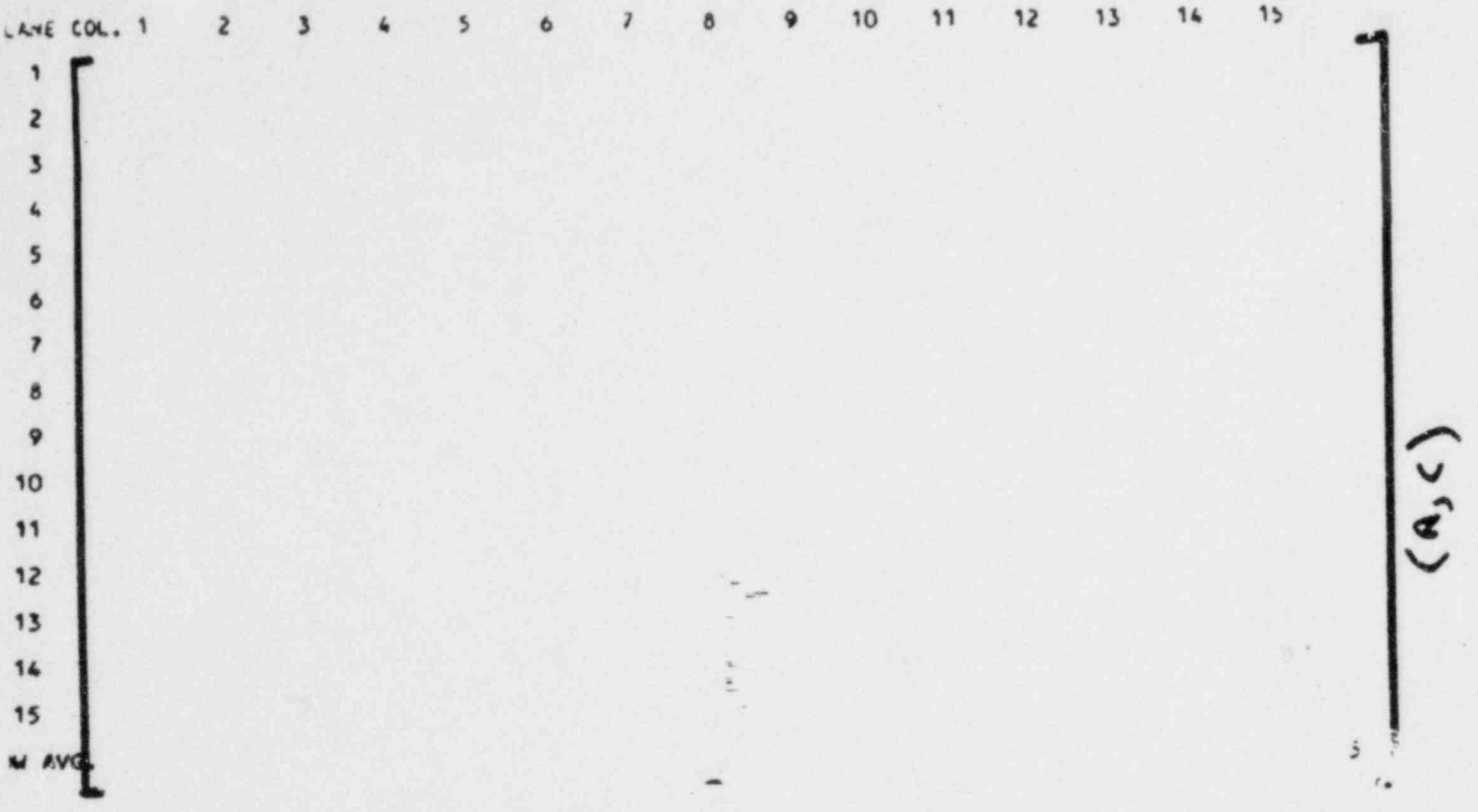
ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
9	1															
9	2															
9	3															
9	4															
9	5															
9	6															
9	7															
9	8															
9	9															
9	10															
9	11															
9	12															
9	13															
9	14															
9	15															
9	ROW AVG.															

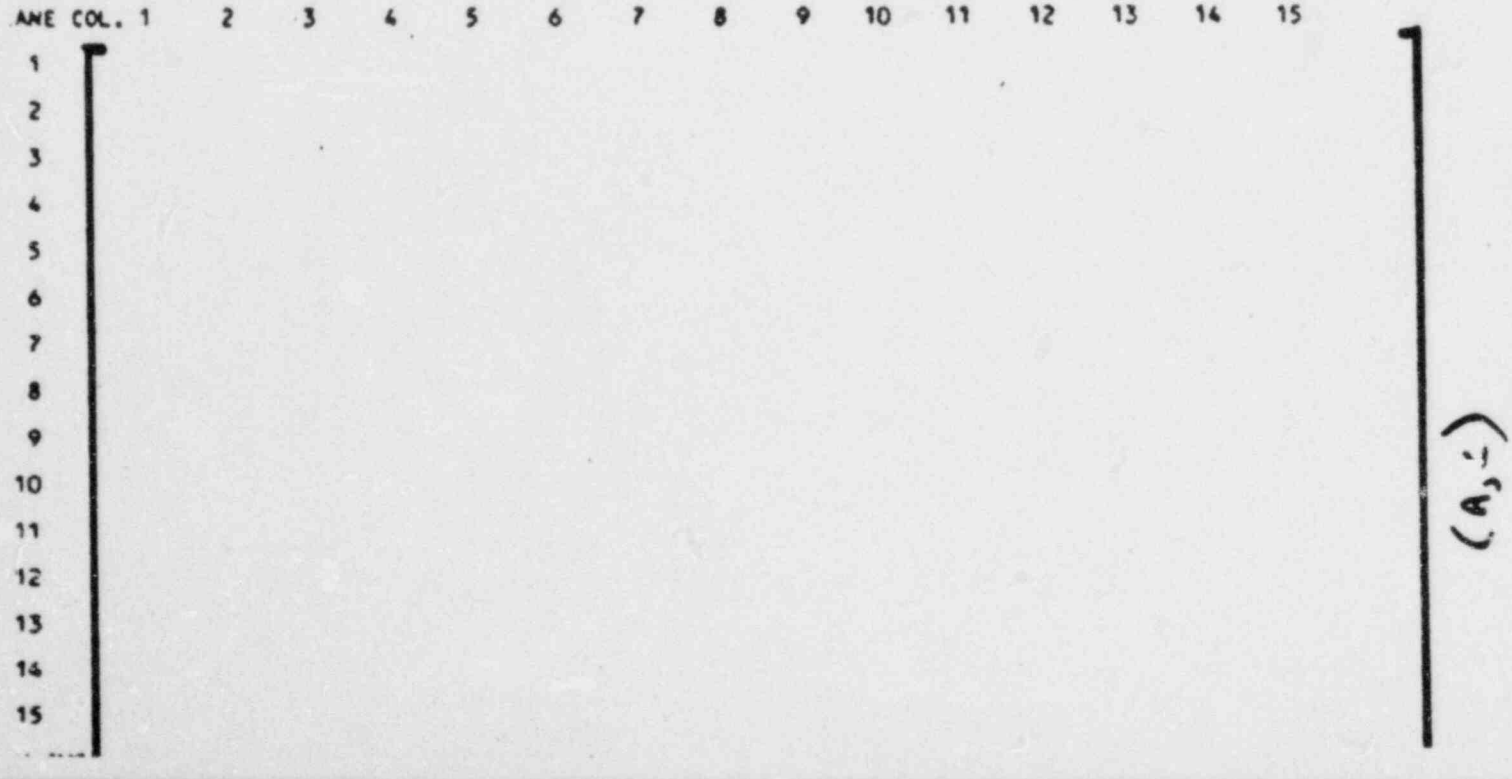
(A,1)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
10	1															
10	2															
10	3															
10	4															
10	5															
10	6															
10	7															
10	8															
10	9															
10	10															
10	11															
10	12															
10	13															
10	14															
10	15															
10	ROW AVG.															

(A,1)

CASE L-2 (5/9)


LANE COL. 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
M AVG
(A,C)


ANE COL. 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
(A,i)

CASE L-2 (6/9)


PLANE COL. 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
ROW AVG
(A,C)


PLANE COL. 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
1
2
3
4
5
6
7
8
9
10
11
12
13
14
ROW AVG
(A,C)


PLANE COL. 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
(A, c)


PLANE COL. 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
(A, c)

CASE L-2 (3/9)

N PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
17	1														
17	2														
17	3														
17	4														
17	5														
17	6														
17	7														
17	8														
17	9														
17	10														
17	11														
17	12														
17	13														
17	14														
17	15														
17	ROW AVG.														

(A, C)

N PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
8	1														
8	2														
8	3														
8	4														
8	5														
8	6														
8	7														
8	8														
8	9														
8	10														
8	11														
8	12														
8	13														
8	14														
8	15														
8	ROW AVG.														

(A, C)

CASE 1-2 (9/1)

ZW	PLANE	COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
19	1																
19	2																
19	3																
19	4																
19	5																
19	6																
19	7																
19	8																
19	9																
19	10																
19	11																
19	12																
19	13																
19	14																
19	15																
19	ROW AVG																

(A, C)

CASE L-3 (119)

W/O [illegible]

ASSEMBLY AVERAGE POWERS FOR THE WHOLE CORE.

PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															

(A.C)

ON PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
4	1														
4	2														
4	3														
4	4														
4	5														
4	6														
4	7														
4	8														
4	9														
4	10														
4	11														
4	12														
4	13														
4	14														
4	15														
4	ROW AVG														

(A.C)

CASE L-3 (2/9)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
5	1															
5	2															
5	3															
5	4															
5	5															
5	6															
5	7															
5	8															
5	9															
5	10															
5	11															
5	12															
5	13															
5	14															
5	15															
5	ROW AVG															

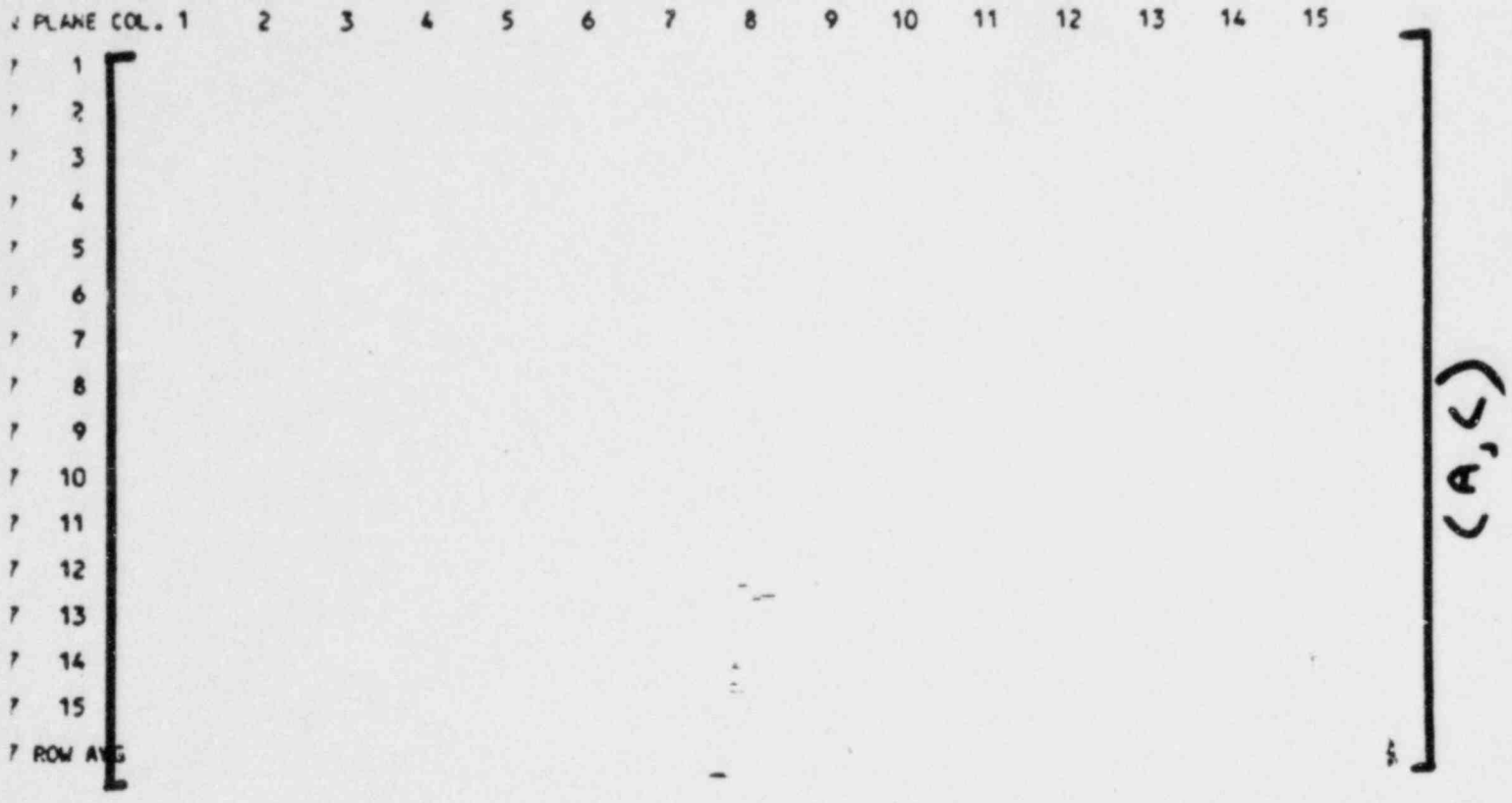
(a.c)

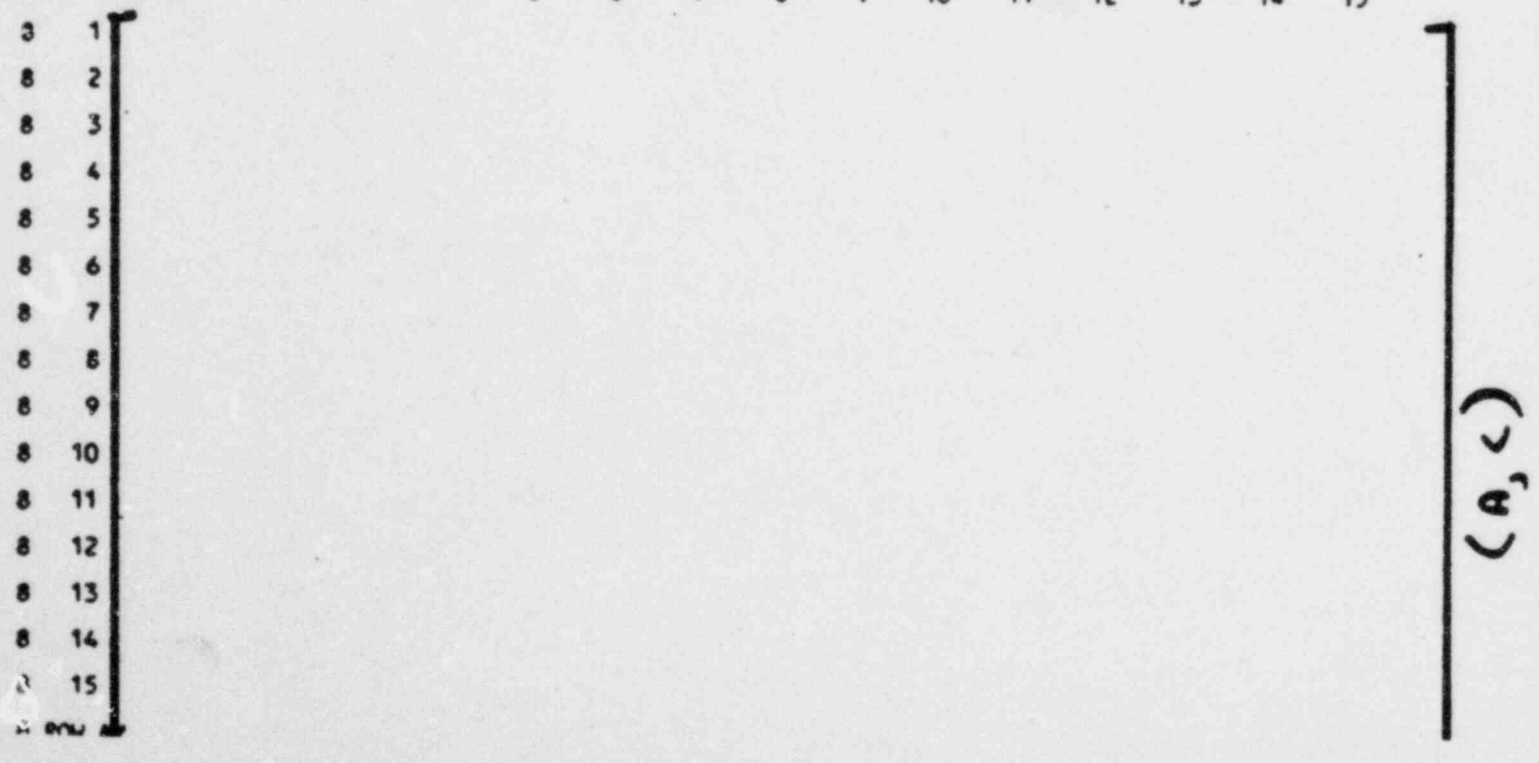
19

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
6	1															
6	2															
6	3															
6	4															
6	5															
6	6															
6	7															
6	8															
6	9															
6	10															
6	11															
6	12															
6	13															
6	14															
6	15															
6	ROW AVG															

(a.c)

CASE L-3 (3/9)


PLANE COL. 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
ROW AVG
(A,<)


PLANE COL. 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
(A,<)

CASE L-3 (4/9)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
9	1															
9	2															
9	3															
9	4															
9	5															
9	6															
9	7															
	8															
9	9															
9	10															
9	11															
9	12															
9	13															
9	14															
9	15															
9	ROW AVG															

(A, C)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
)	1															
)	2															
)	3															
)	4															
)	5															
)	6															
)	7															
)	8															
)	9															
)	10															
)	11															
)	12															
)	13															
)	14															
)	15															
)	ROW AVG															

(A, C)

CONT 1-3 (7/a)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
11	1															
11	2															
11	3															
11	4															
11	5															
11	6															
11	7															
11	8															
11	9															
11	10															
11	11															
11	12															
11	13															
11	14															
11	15															
11	ROW AVG															

(a c)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
12	1															
12	2															
12	3															
12	4															
12	5															
12	6															
12	7															
12	8															
12	9															
12	10															
12	11															
12	12															
12	13															
12	14															
12	15															
12	ROW AVG															

(a c)

CASE L-3 (619)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
13	1															
13	2															
13	3															
13	4															
13	5															
13	6															
13	7															
13	8															
13	9															
13	10															
13	11															
13	12															
13	13															
13	14															
13	15															
13	ROW AVG															

(A.C.)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
14	1															
14	2															
14	3															
14	4															
14	5															
14	6															
14	7															
14	8															
14	9															
14	10															
14	11															
14	12															
14	13															
14	14															
14	15															

(A.C.)

CASE L-?. (7/9)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
15	1															
15	2															
15	3															
15	4															
15	5															
15	6															
15	7															
15	8															
15	9															
15	10															
15	11															
15	12															
15	13															
15	14															
15	15															
15	ROW AVG.															

(A, C)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	1															
16	2															
16	3															
16	4															
16	5															
16	6															
16	7															
16	8															
16	9															
16	10															
16	11															
16	12															
16	13															
16	14															
16	15															
16	ROW AVG.															

(A, C)

CASE L-3 (8/9)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
17	1															
17	2															
17	3															
17	4															
17	5															
17	6															
17	7															
17	8															
17	9															
17	10															
17	11															
17	12															
17	13															
17	14															
17	15															
17	ROW AVG.															

(A.C)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
18	1															
18	2															
18	3															
18	4															
18	5															
18	6															
18	7															
18	8															
18	9															
18	10															
18	11															
18	12															
18	13															
18	14															
18	15															
18	ROW AVG.															

(A.C)

CASE L-3 (9/9)

W	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
9	1															
9	2															
9	3															
9	4															
9	5															
9	6															
9	7															
9	8															
9	9															
9	10															
9	11															
9	12															
9	13															
9	14															
9	15															
9	ROW AVG															

(A,C)

CASE L-4 (1/9)

ASSEMBLY AVERAGE POWERS FOR THE WHOLE CORE.

PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															

(A,C)

PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
ROW AVG															

(A,C)

CASE L-4 (2/9)

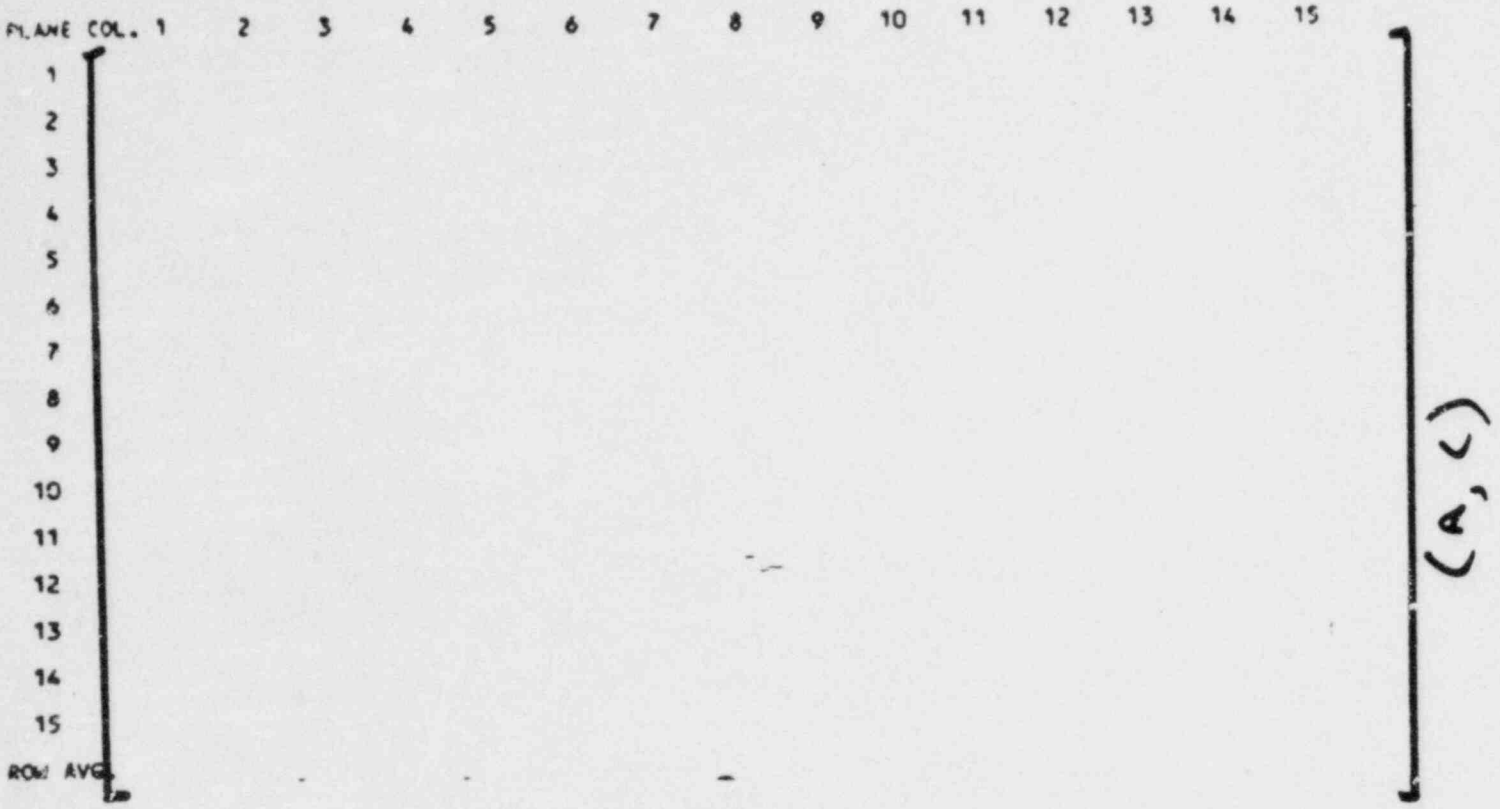
ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
5	1															
5	2															
5	3															
5	4															
5	5															
5	6															
5	7															
5	8															
5	9															
5	10															
5	11															
5	12															
5	13															
5	14															
5	15															
5	ROW AVG															

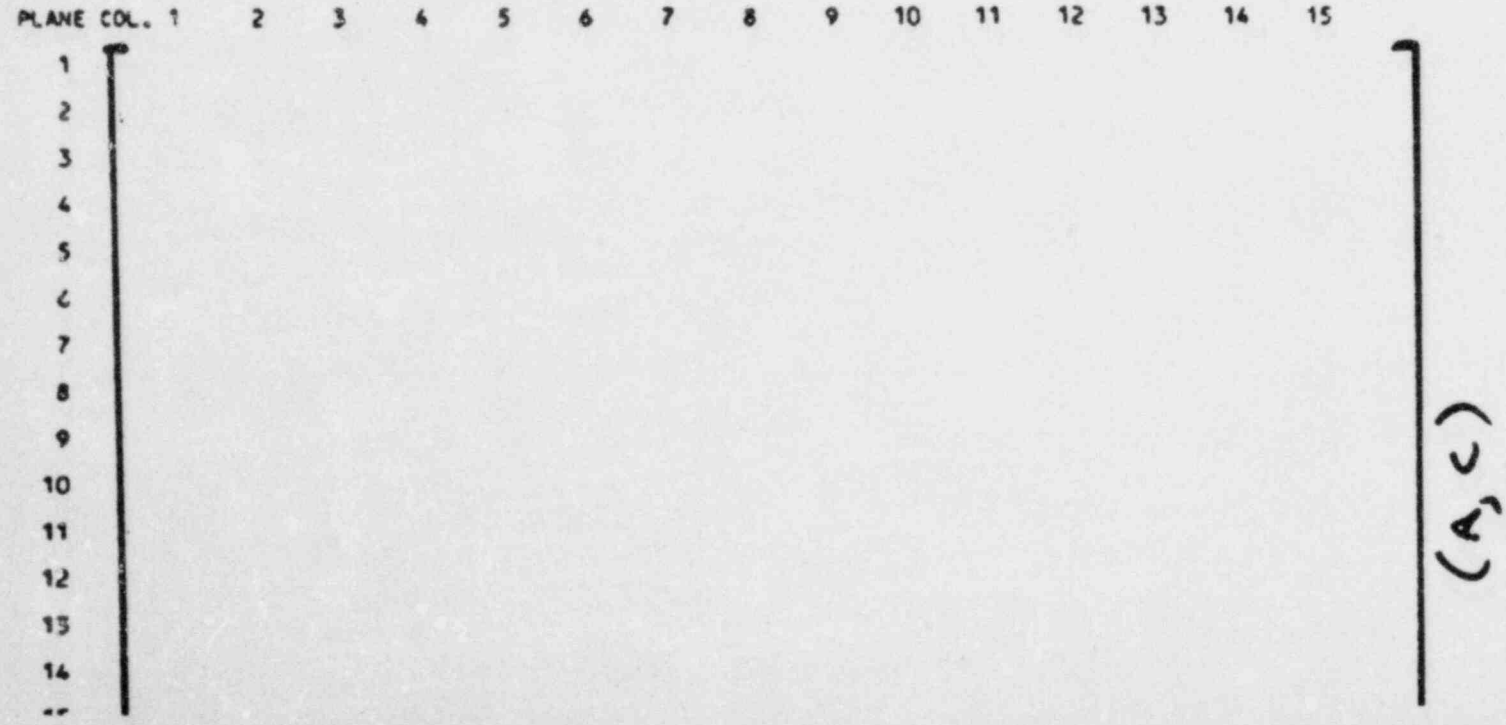
(A.C)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
6	1															
6	2															
6	3															
6	4															
6	5															
6	6															
6	7															
6	8															
6	9															
6	10															
6	11															
6	12															
6	13															
6	14															
6	15															
6	ROW AVG.															

(A.C)

CASE L-4 (2/9)


PLANE COL. 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
ROW AVG
(A, C)


PLANE COL. 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
1
2
3
4
5
6
7
8
9
10
11
12
13
14
(A, C)

CASE 1-4 (4/9)

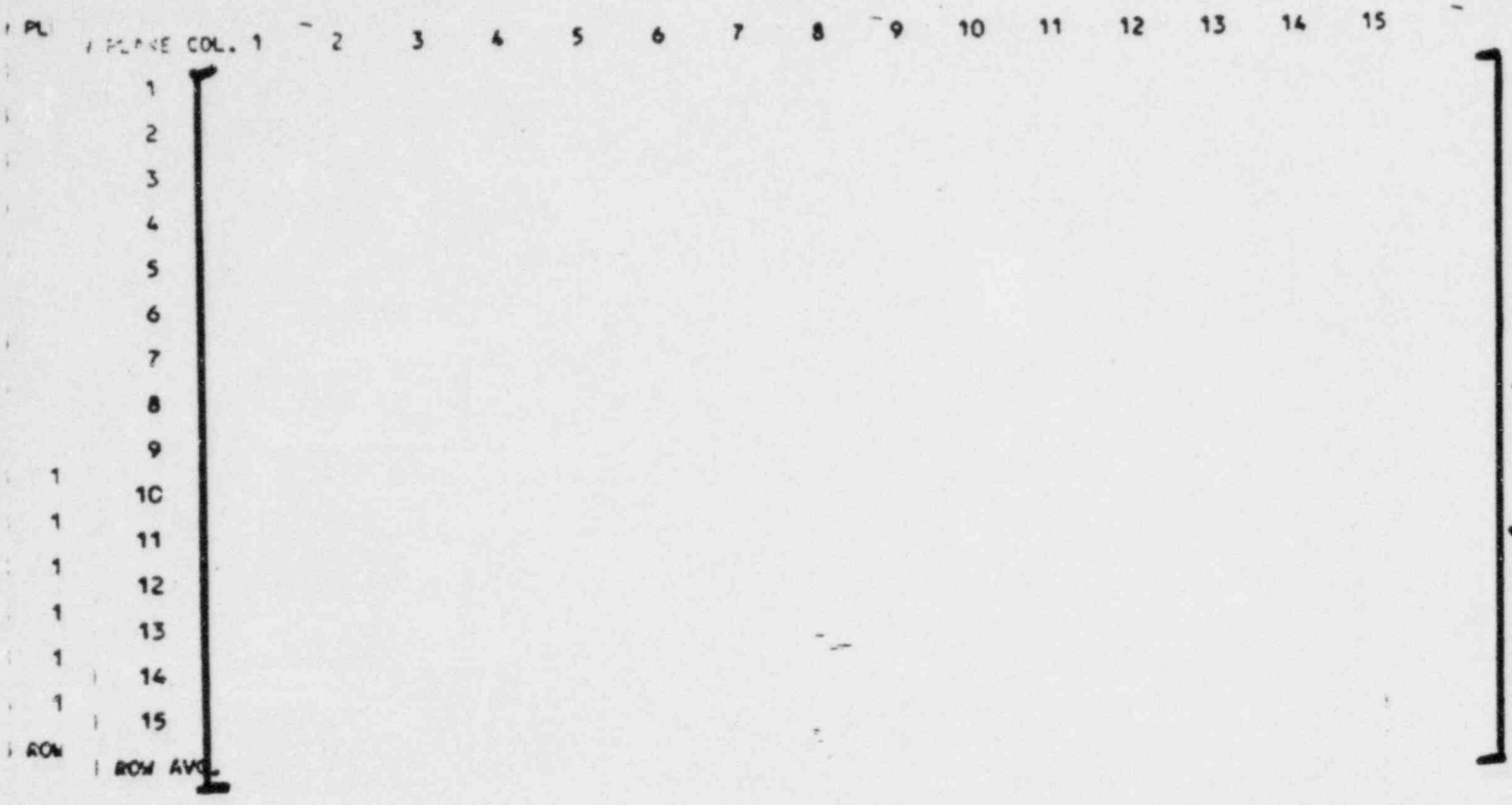
PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
ROW AVG															

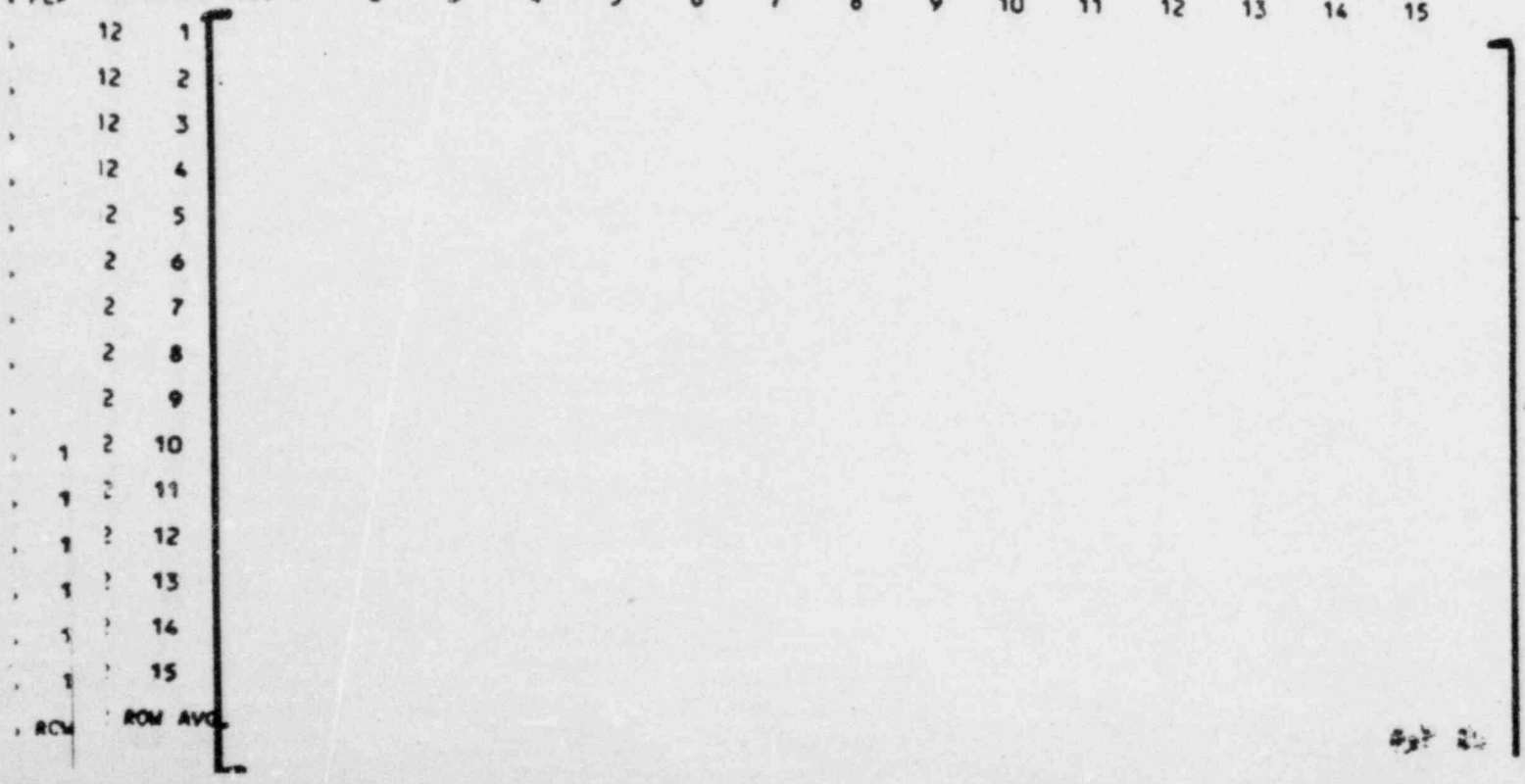
(A, C)

PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
ROW AVG															

(A, C)

CASE L-


PLANE COL. 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
1
2
3
4
5
6
7
8
9
1 10
1 11
1 12
1 13
1 14
1 15
ROW AVG.
(A.S)


OW PLANE COL. 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
12 1
12 2
12 3
12 4
2 5
2 6
2 7
2 8
2 9
1 2 10
1 2 11
1 2 12
1 2 13
1 2 14
1 2 15
ROW AVG.
(A.S)

CASE L-4 (7/9)

PLANE COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
ROW AVG.															

(A,C)

PLANE COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
ROW AVG.															

(A,C)

CELL L-4 (3/2)

PLANE COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
ROW AVG.															

(A, C)

PLANE COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
ROW AVG.															

(A, C)

CASE L-4 (9/9)

W	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
9	1															
9	2															
9	3															
9	4															
9	5															
9	6															
9	7															
9	8															
9	9															
9	10															
9	11															
9	12															
9	13															
9	14															
9	15															
9	ROW AVG.															

(A, C)

CASE L-5 (119)

W/O POWER (17.5 ...

ASSEMBLY AVERAGE POWERS FOR THE WHOLE CORE.

PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															

(A,C)

JM	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
4	1															
4	2															
4	3															
4	4															
4	5															
4	6															
4	7															
4	8															
4	9															
4	10															
4	11															
4	12															
4	13															
4	14															
4	15															
4	ROW AVG.															

(A,C)

CASE L-E (1/9)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
5	1															
5	2															
5	3															
5	4															
5	5															
5	6															
5	7															
5	8															
5	9															
5	10															
5	11															
5	12															
5	13															
5	14															
5	15															
5	ROW AVG.															

(A, C)

ROW	PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
6	1															
6	2															
6	3															
6	4															
6	5															
6	6															
6	7															
6	8															
6	9															
6	10															
6	11															
6	12															
6	13															
6	14															
6	15															
6	ROW AVG.															

(A, C)

CASE L-5 (3/9)

PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
ROW AVG.															

(A, C)

PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
ROW AVG.															

(A, C)

CASE L-5 (H/A)

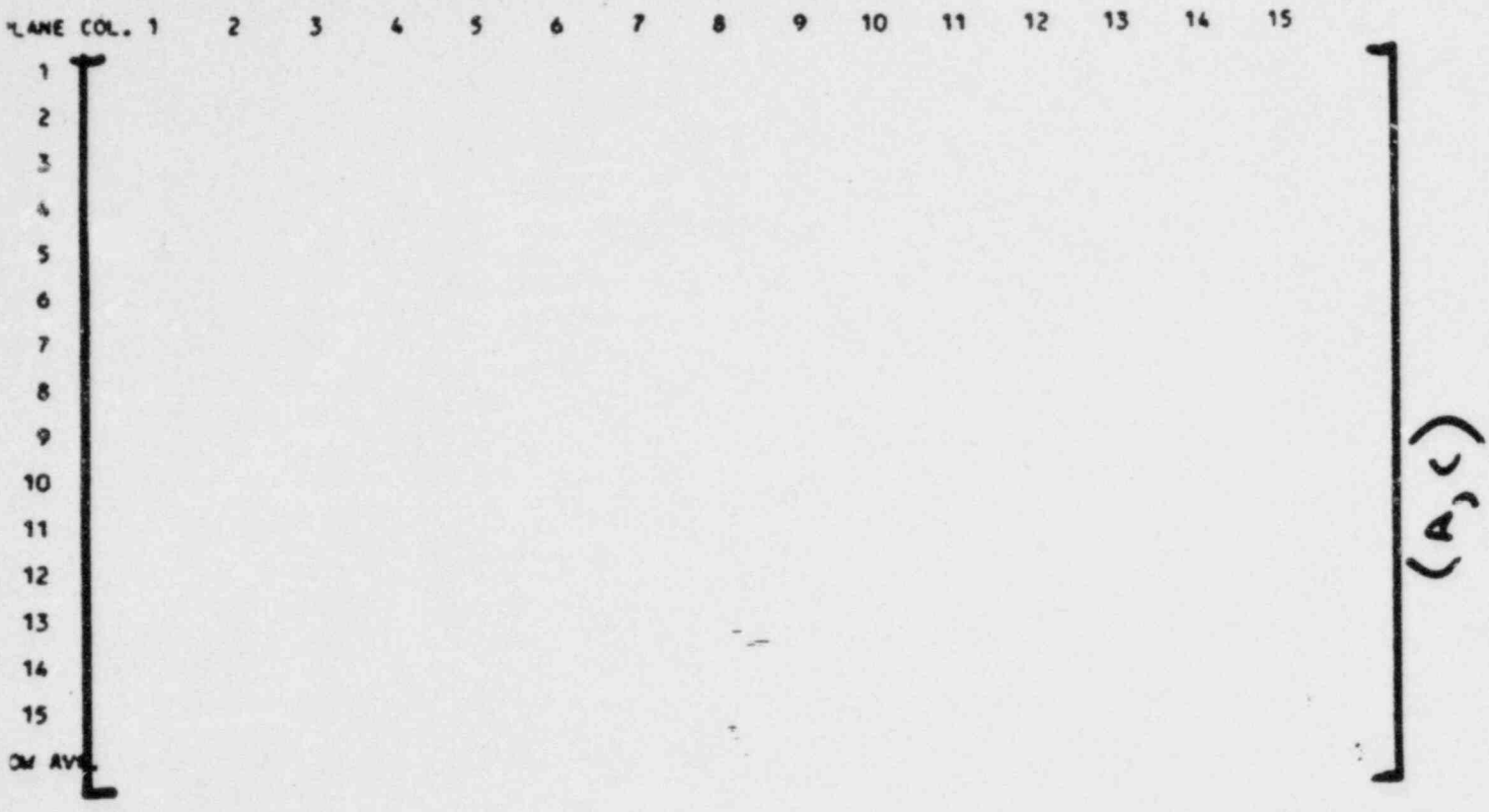
PLANE COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
ROW AVG.															

(A,C)

PLANE COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
ROW AVG.															

(A,C)

CASE L-5 (5/9)


LANE COL. 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
(A, C)


LANE COL. 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
(A, C)

W

CASE L-5 (1/2)

PLANE COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
ROW AVG															

(A, <)

PLANE COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
ROW AVG															

(A, <)

CASE L-5 (7/9)

PLANE COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
ROW AVG.															

(A,C)

PLANE COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
ROW AVG.															

(A,C)

CASE L-C (0/1)

PLANE COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
ROW AVG.															

(A, C)

PLANE COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
ROW AVG.															

(A, C)

CASE L-5 (9|9)

PLANE	COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1															
2															
3															
4															
5															
6															
7	1														
8	1														
9															
10															
11															
12															
13															
14															
15															
ROW AVG															

(A, C)

1.4 ft^2 Double Ended Rupture

EOL -HFP

TABLE 4

1.4 ft^2 (per loop) Double Ended Rupture

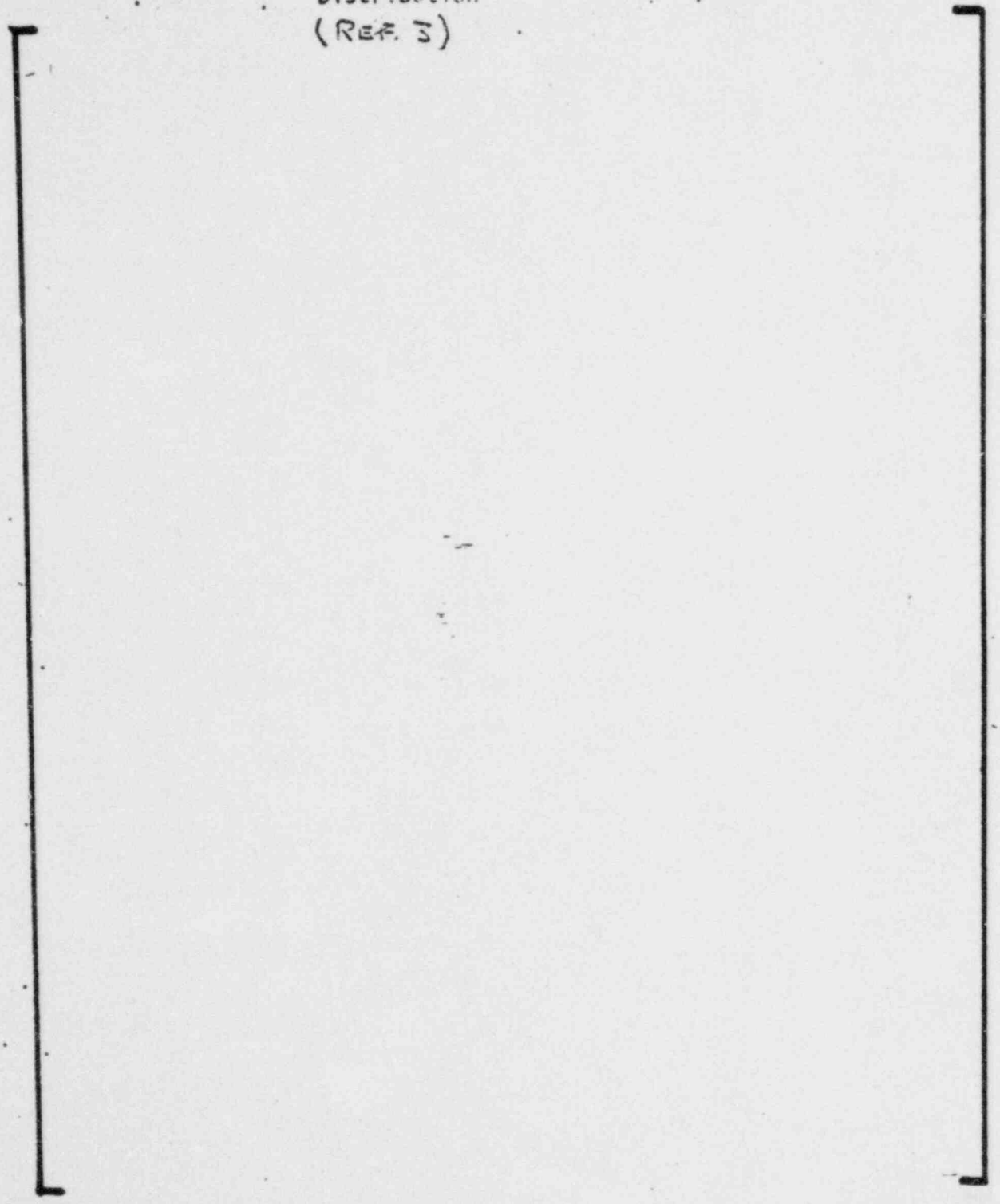
HFP - EOL

Case	Time	Flow	Power	Pressure	Hin
1	1.0	1.0	1.00	2244.	552.8
2	2.0	1.0	1.00	2233.	552.7
3	3.0	1.0	1.00	2217.	551.6
4	4.0	1.0	0.98	2195.	550.6
5	6.0	1.0	0.52	2020.	544.4

Axial and radial power distributions attached.

FIGURE 3

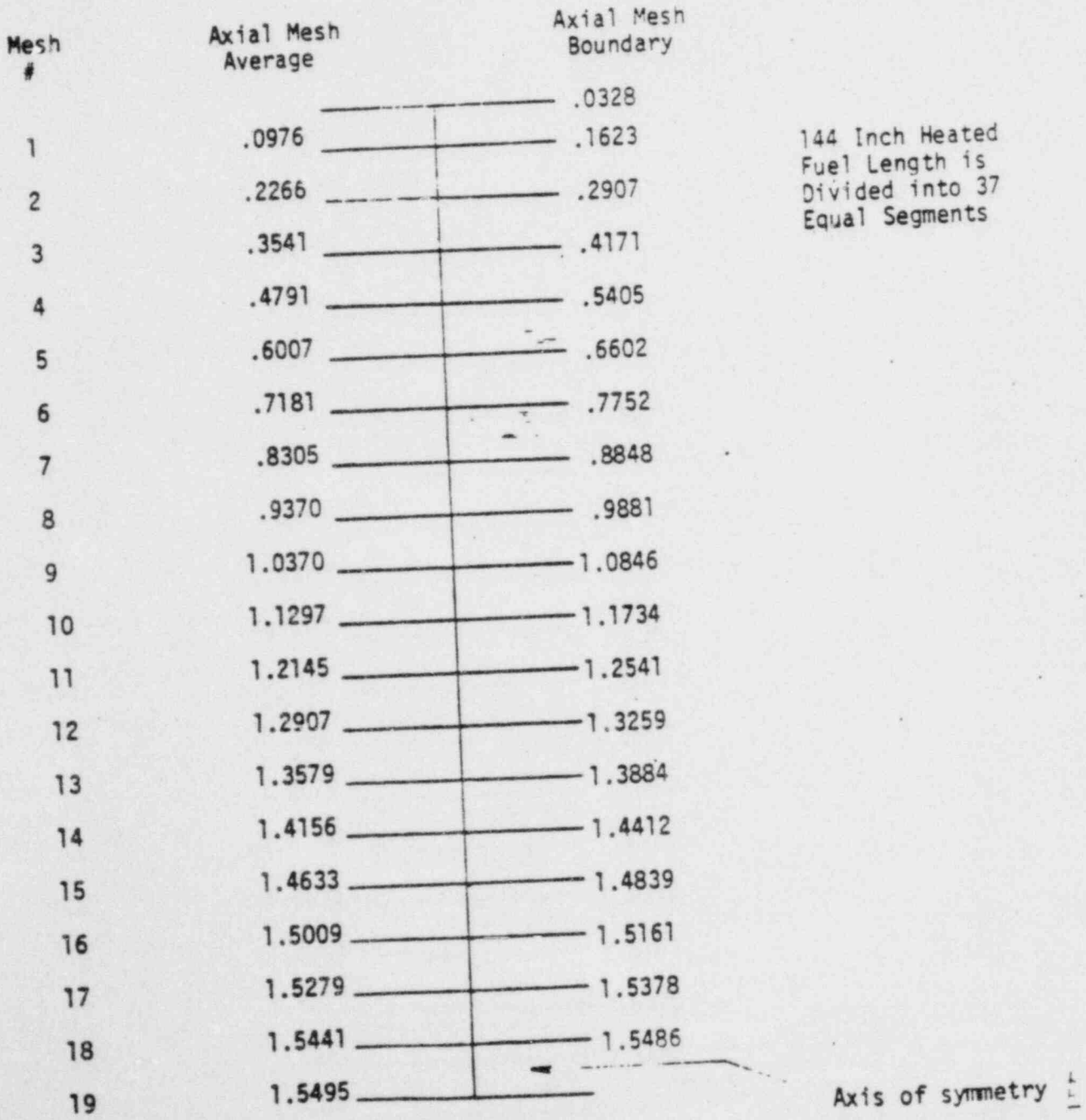
17 x 17 Three Loop Design Assemblywise Power Distribution
(REF. 3)



(A, C)

TABLE 7

AXIAL MESH DESCRIPTION AND POWER DISTRIBUTION



1.4 ft^2 Double Ended Rupture

BOP - HFP

FIGURE 3

17 x 17 Three Loop Design Assemblywise Power Distribution
(REF. 3)

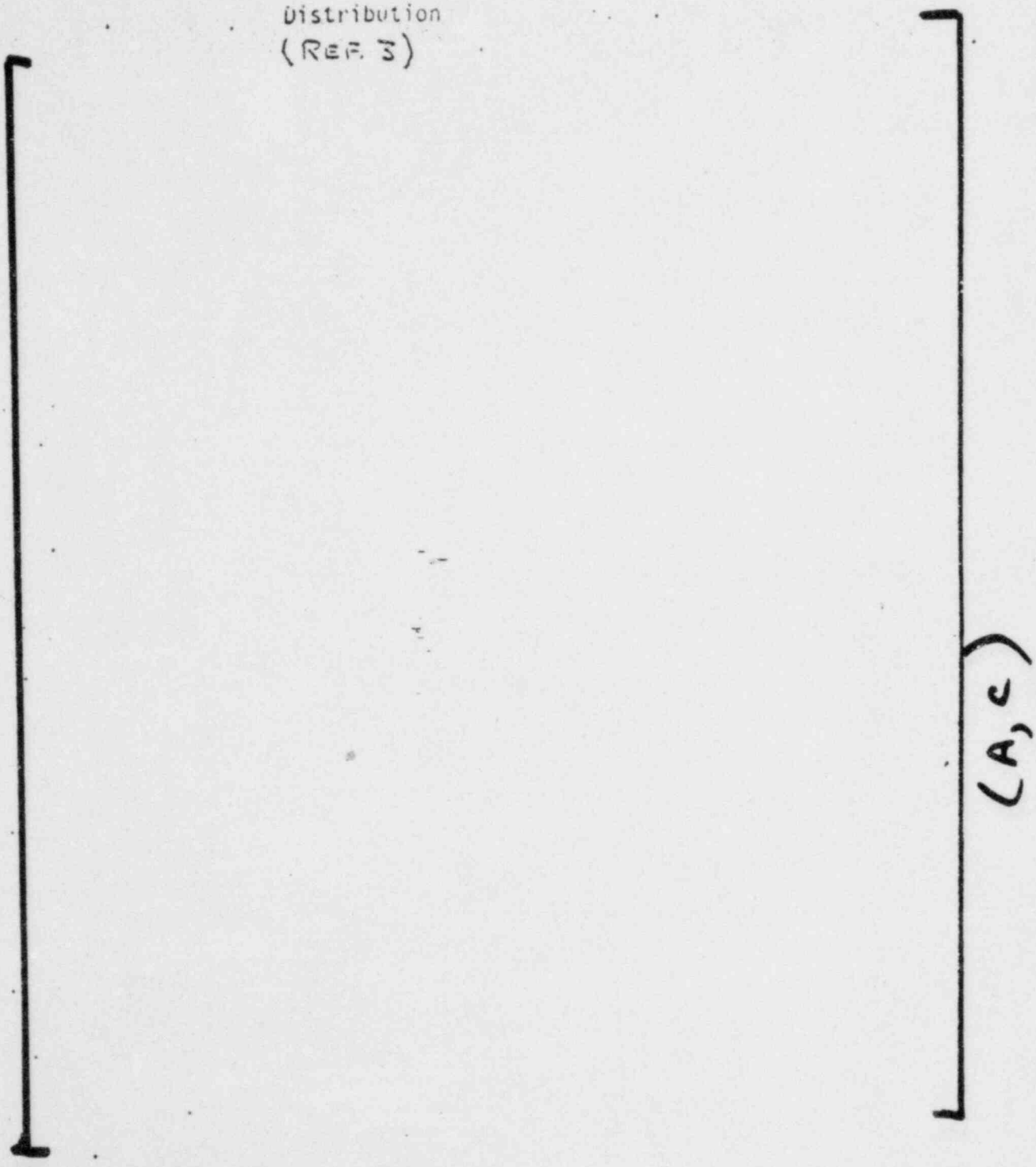


TABLE 7

AXIAL MESH DESCRIPTION AND POWER DISTRIBUTION

Mesh #	Axial Mesh Average	Axial Mesh Boundary
		.0328
1	.0976	.1623
2	.2266	.2907
3	.3541	.4171
4	.4791	.5405
5	.6007	.6602
6	.7181	.7752
7	.8305	.8848
8	.9370	.9881
9	1.0370	1.0846
10	1.1297	1.1734
11	1.2145	1.2541
12	1.2907	1.3259
13	1.3579	1.3884
14	1.4156	1.4412
15	1.4633	1.4839
16	1.5009	1.5161
17	1.5279	1.5378
18	1.5441	1.5486
19	1.5495	

144 Inch Heated Fuel Length is Divided into 37 Equal Segments

Axis of symmetry ℄

TABLE 5

1.4 ft^2 (per loop) Double Ended Rupture

HFP - BOL

Case	Time	Flow	Power	Pressure	H_{in}
1	1.0	1.0	1.00	2244.	552.8
2	2.0	1.0	1.00	2233.	552.7
3	3.0	1.0	1.00	2217.	551.6
4	4.0	1.0	0.98	2195.	550.6
5	6.0	1.0	0.52	2020.	544.4

Axial and radial power distributions attached.

Q) 232.6 Based on the variation of core average temperature during the first fifteen seconds of the transients shown in Figure 3.1-6, combined with the variation of k with core average temperature shown in Figure 3.1-3, the reactivity increase appears to be approximately half as large as that shown in Figure 3.1-6. Please explain.

A) 232.6

Figure 3.1-6 shows the variation of K_{eff} with core average temperature at constant pressure of 1000 psia. The reactivity graph in Figure 3.1-6 is the total reactivity which is calculated based on:

1. core power
2. weighted coolant density (pressure and temperature)

It would not be expected that two graphs should agree.