Department of Energy
Washington, D.C. 20545

Docket No. 50-537
HQ:S:82:105

50-537

OCT 15 1982

Mr. Paul S. Check, Director
CRBR Program Office
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Check:

SUMMARY OF HCDA ENERGETICS MEETING HELD ON SEPTEMBER 21, 1982

The meeting agenda, attendance list, and viewgraphs distributed at the subject meeting are enclosed as Enclosures 1, 2, and 3, respectively. The formal presentations and general discussion focused on clarification of technical issues associated with the CRBRP/PO response to formal NRC questions. Presentations were made by both the NRC and CRBRP consultants. As a result of the meeting, the Project will undertake the actions listed in Enclosure 4.

Sincerely,

John R. Longenecker

John R. Longenecker
Acting Director, Office of the
Clinch River Breeder Reactor
Plant Project
Office of Nuclear Energy

Enclosures

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AGENDA

CRBRP/NRC HCDA Energetics Meeting

September 21, 1982

Argonne National Laboratory
Building 207
Conference Room DA-126

1. Introductory remarks, *(NRC/CRBRP, 15 min)*.

2. TOP energetics potential (pin internal fuel motion, sweepout, incoherence), *(CRBRP, 15 min - NRC, 15 min)*.

3. LOF-d-TOP potential (sodium void worth and other uncertainties), *(CRBRP, 30 min - NRC, 30 min)*.

4. Plenum fission gas compaction (energetics potential, clad relocation, initiating power phase histories), *(CRBRP, 30 min - NRC, 15 min)*.

LUNCH

5. Fuel removal and energetics potential in connection with meltout/annular pool phase, *(CRBRP, 60 min - NRC, 60 min)*.

6. Role of structures in energetic termination, *(CRBRP, 15 min - NRC, 30 min)*.

7. Concluding remarks, *(CRBRP, 30 min - NRC, 30 min)*.

CRBRP/NRC HCDA Energetics Meeting

September 21, 1982

Hans Fauske	FAI (312-323-8750)
C.L. Allen	CRBRP-NRC (301-492-9626)
Mike Epstein	FAI (213-901-$\overset{78}{7064}$)
Ray Booth	CRBRPO (615-574-6373)
Dennis Switick	Gen. Elec 408-738-7125
PAUL BOEHNERT	NRC-ACRS 202/634-3267
Charles Bell	LANL 505/667/7322
W. R. BOHL	LANL 505-667-2395
P.K. Mast	SNL 505-844-0364
T Theofanous	Purdue 317-494-5757
Jim Cahalan	ANL/RAS FTS-972-4682
D. WEBER	ANL/RAS FTS-972-4701
HERBERT HENRYSON	ANL/AP FTS-972-4857
ALAN WALTAR	WHC FTS-444-5257
Hartmut Wider	ANL/RAS FTS-972-4690
Richard Grolmes	FAI (312-323-8750)
L. Wilhelm Deitrich	ANL/RAS FTS 972-4571
STEPHEN ADDITON	WECCO 301-654-3591
[illegible]	ANL/RAS FTS 972-4837

[illegible]

ENCLOSURE 3

CRBRP HCDA ENERGETICS MEETING

INITIATING PHASE ASSESSMENTS

PRESENTED BY

DAVID P. WEBER

SEPTEMBER 21, 1982

ARGONNE NATIONAL LABORATORY
ARGONNE, ILLINOIS 60439

CRBRP HCDA ENERGETICS MEETING
INITIATING PHASE ASSESSMENT

- TOP ENERGETICS POTENTIAL
- LOF'D'TOP POTENTIAL
- PLENUM FISSION GAS COMPACTION

ASSESSMENT OF WHOLE CORE IMPLICATIONS OF MIDPLANE PIN FAILURES IN SLOW RAMP TOP IN HETEROGENEOUS CORE CRBRP WITH SAS/PLUTO2

- EOC-4 10¢/SEC SCENARIO
    - FAILURE MELT FRACTION, CAVITY PRESSURE, AND PARTICLE SIZE CHOSEN TO SIMULATE W2 EXPERIMENT
    - ALL FUEL PINS ASSUMED TO FAIL COHERENTLY
    - LEAD CHANNEL FAILURE (6) LEADS TO LOW PEAK POWER (4.5 P_0) AND LIMITED POSITIVE REACTIVITY (10¢)
    - LIMITED PLUTO-2 PREDICTED SWEEPOUT LEADS TO MORE RAPID POWER RECOVERY THAN EOC-4 TOP CASE 2 (GEFR 523)
    - SUBSEQUENT DRIVER ASSEMBLY FAILURES AT LOW REACTIVITY STATE IMPLY SUB-PROMPT CRITICAL EXCURSION AND SUBCRITICALITY (PEAK POWER = 5.7 P_0)
- EOC-3 10¢/SEC SCENARIO
    - EOC-3 CHANNEL POWER FACTORS USED WITH EXISTING EOC-4 DATA
    - SECONDARY ASSEMBLY FAILURES (CH. 11 AND 7) DELAYED IN TIME (66 AND 82 MSEC) PREVENT SUPERPOSITION OF POSITIVE FUEL FEEDBACKS
    - SIGNIFICANT NEGATIVE FUEL REACTIVITY FROM LEAD CHANNELS WITHIN 300 MSEC (~ 4$)

PLUTO2 APPLICATIONS TO IN-PILE TESTS

- PRE-TEST AND POST-TEST ANALYSES OF TREAT TESTS E8, H6, AND L8 WITH PLUTO AND PLUTO2

- TREAT TEST E8
  - $3/SEC TOP FFTF SIMULATION
  - LOW PUMP PRESSURE AND INITIAL SODIUM VELOCITY
  - FAILURE LOCATION ABOVE MID-PLANE
  - CONSIDERABLE EARLY SWEEPOUT WITH EXPERIMENTAL RESULTS FASTER AND LARGER THAN PLUTO CALCULATIONS

- TREAT TEST H6
  - 50¢/SEC TOP FFTF SIMULATION
  - PROTOTYPIC PRESSURE DROP AND INITIAL SODIUM VELOCITY
  - SEVERAL EVENTS SEPARATED BY MORE THAN 100 MSEC
  - CALCULATION AND HODOSCOPE SHOW SIGNIFICANT EARLY SWEEPOUT (10G WITHIN 30 MSEC AND 28G WITH 90 MSEC)

- TREAT TEST L8
  - LOF'D'TOP SIMULATION FOR CRBRP HOMOGENEOUS CORE
  - DEGRADED POTENTIAL FOR FUEL SWEEPOUT
  - FUEL MOTION REACTIVITY NEGATIVE 20 MSEC AFTER ROD FAILURE
  - CALCULATED SWEEPOUT LAGGED MEASUREMENTS

Dave Wade, ©
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CRBRP HCDA ENERGETICS MEETING
INITIATING PHASE ASSESSMENT

- TOP ENERGETICS POTENTIAL
- LOF'D'TOP POTENTIAL
- PLENUM FISSION GAS COMPACTION

VOID WORTH UNCERTAINTY IMPLICATIONS ON LOF'D'TOP POTENTIAL

- SAS3D MODELING ASSUMPTIONS
    - BEST ESTIMATE SODIUM VOID REACTIVITY WORTHS PROVIDED BY ANL/AP
    - SODIUM VOID WORTH UNCERTAINTIES BASED ON ANL/AP ZPPR EXPERIMENTAL RESULTS AND ANALYTICAL METHODS AND DATA BASE USED IN CRITICAL EXPERIMENTS
    - FUEL MOTION ASSUMPTIONS IN SLUMPY BASED ON RECENT ANL/RAS L6/L7 ANALYSIS
- KEY MODELING POINTS
    - MAXIMUM POSITIVE COOLANT VOIDING REACTIVITY PLUS TWICE UNCERTAINTY RESULTS IN $2.19 VOIDING REACTIVITY
    - EXPERIMENTALLY CONSISTENT FUEL MOTION MODELING PLAYS IMPORTANT ROLE IN ANY LOF'D'TOP ASSESSMENT

VOID WORTH UNCERTAINTY IMPLICATIONS ON LOF'D'TOP POTENTIAL

- SAS3D WHOLE CORE RESULTS
    - COOLANT BOILING IN ALL DRIVER ASSEMBLIES BEFORE LEAD CHANNEL (CH. 6) FUEL MOTION
    - COMPLETE CORE VOIDING IN DRIVER ASSEMBLY CHANNELS 2,4,6,7,9,10 AND 11 AT TIME OF CHANNEL 6 FUEL MOTION
    - PARTIAL VOIDING IN CHANNELS 12, 13, 14 AND 15
    - POWER LEVEL IS LOW (~ 10 P_0) AND FAILURE CONDITIONS ARE FAR FROM BEING MET IN LOW POWER CHANNELS.
    - COOLANT BOILING IN INTERNAL BLANKETS TAKES PLACE AFTER FUEL DISRUPTION AND GROSS DISPERSAL IN CHANNELS 6, 2, 4 AND 7
- CONCLUSION
    - EVEN USING CONSERVATIVE ESTIMATES OF THE UNCERTAINTIES IN COOLANT VOIDING REACTIVITY, NO THRESHOLD FOR LOF'D'TOP EVENTS WAS FOUND WHEN EXPERIMENTALLY VERIFIED FUEL MOTION BEHAVIOUR WAS EMPLOYED

[illegible] [illegible] ③

CRBRP HCDA ENERGETICS MEETING
INITIATING PHASE ASSESSMENT

- TOP ENERGETICS POTENTIAL
- LOF'D'TOP POTENTIAL
- PLENUM FISSION GAS COMPACTION

POTENTIAL FOR AUTOCATALYSIS DUE TO PLENUM FISSION GAS INDUCED FUEL COMPACTION

- INITIAL ASSESSMENT (BASED ON GEFR-523 EOC-4 LOF BASE CASE 1A) SHOWED COMPLETE BLOWDOWN IN EARLY ASSEMBLIES BUT POTENTIAL FOR COMPACTION IN LATER ASSEMBLIES
- AUTOCATALYTIC BEHAVIOR WAS AFFECTED BY CONSERVATIVE MODELING OF EARLY FUEL MOTION
- TREAT LOF TESTS, ESPECIALLY L6 AND L7, WERE IDENTIFIED AS THE MOST RELEVANT DATABASE AND EXTENSIVE SAS3D/SLUMPY ANALYSES WERE PERFORMED
- FISSION GAS AVAILABILITY AND DISTRIBUTION WERE DETERMINED WITH FRAS3 CODE
- WHOLE CORE ANALYSES WERE PERFORMED WITH EXPERIMENTALLY CONSISTENT FUEL DISPERSAL MODELING, LEADING TO ELIMINATION OF CONCERN FOR PLENUM GAS COMPACTION

FISSION GAS MODELING WITH FRAS3

- TECHNICAL APPROACH
  - VALIDATION OF FRAS3 MODELING BY COMPARISON OF PREDICTED AND MEASURED GAS RELEASES IN FGR TESTS WHICH MOST CLOSELY REPRESENT CRBR CONDITIONS
  - PREDICTIONS OF THE FRACTION OF THE INITIAL FISSION GAS CONCENTRATIONS RETAINED AT TIME OF FUEL MOTION IN L6 AND L7 TESTS FOR USE IN SAS3D/SLUMPY
  - PREDICTIONS OF GAS CONCENTRATIONS FOR EOC-4 LEAD CHANNEL 6 WITH LOF GEFR-523 BEST ESTIMATE THERMAL HISTORY
- CONCLUSIONS ON GAS RETENTION

	PERCENT RETAINED IN GRAINS	PERCENT RETAINED ON GRAIN BOUNDARIES
L6	24	9.5
L7	64	4.7
CH 6	54	4.7

SAS3D/SLUMPY ANALYSIS OF L6 AND L7 TREAT TESTS

- TECHNICAL APPROACH
  - PROCEDURE FOLLOWED FOR HEAT BALANCE AND TEST SIMULATIONS
  - STEADY-STATE SIMULATION OF IRRADIATION HISTORY
  - 20-SECOND TRANSIENT TO SET INITIAL THERMAL-HYDRAULIC CONDITION
  - TEST TRANSIENT
- SAS3D INPUT
  - FISSION GAS PARAMETERS BASED ON FRAS3 ANALYSIS
  - FRACTION OF GRAVITY SET TO 0.2
  - VERY LITTLE COUPLING BETWEEN COOLANT VAPOR STREAM, AND FUEL MOTION (QSODOM = 0.02)
  - EFFECTIVE FUEL VISCOSITY ENHANCED TO ACCOUNT FOR PRESENCE OF PARTIALLY SOLID FUEL (VISFU = 10000)
  - FUEL MOTION INITIATED ON 50% FUEL MELT FRACTION
- TEST RESULTS
  - SATISFACTORY SIMULATION OF BOTH L6 AND L7 TESTS

WHOLE CORE ANALYSIS AND PLENUM GAS COMPACTION ASSESSMENT

- WHOLE CORE POWER AND REACTIVITY RESULTS
    - LEAD CHANNEL REACTIVITY STAYS POSITIVE FOR 146 MSEC, WITH PEAK POWER OF 4.7 P_0
    - REACTOR DRIVEN SUBCRITICAL ON LEAD CHANNEL FUEL MOTION BY 406 MSEC
    - ASSESSMENTS PERFORMED ON SUBSEQUENT FAILURES AND TIMING
- POTENTIAL FOR COMPACTION OF FUEL
    - PIPFLO MODELING IN SAS3D AND 1400°C CLADDING TEMPERATURE FAILURE CONDITION USED
    - TIME CONSTANT FOR BLOWDOWN CALCULATED TO BE LESS THAN 250 MSEC
    - ALL DRIVER CHANNELS HAVE SEVERAL TIME CONSTANTS TO BLOWDOWN PRIOR TO FUEL MOTION INITIATION
- CONCLUSION
    - AUTOCATALYSIS BY PLENUM GAS COMPACTION OF PINS IS HIGHLY UNLIKELY

Hern Henryson
②

SODIUM VOID WORTH

ALTERNATIVE METHODOLOGIES

- USE STATE-OF-THE-ART METHODS AND CROSS SECTION DATA FOR CALCULATIONS. DETERMINE UNCERTAINTIES FROM "KNOWLEDGE" OF UNCERTAINTIES IN METHODS/DATA.

- USE INTEGRAL DATA BASE TO DERIVE AN "EXPERIMENTAL" VALUE. UNCERTAINTIES FALL OUT OF ANALYSIS

BIAS FACTOR METHOD

- SINGLE BIAS FACTOR

$$P = \alpha C$$

- TWO FACTORS (LEAKAGE AND NON-LEAKAGE)

$$P = \beta N + \gamma L$$

$$\mathrm{MIN} \sum_{I} \left(\frac{P_I - E_I}{\sigma_I}\right)^2$$

COMPUTATIONAL MODEL

- ENDF/B-IV Data
- MC^2-2/SDX Processing to 20 Energy Groups
- Three-Dimensional Diffusion Theory
- Correct for Streaming Using Benoist Directional Diffusion Coefficients
- Exact Perturbation Theory

Ratios of Calculated to Measured Reactivities for Sodium Voiding

Cases	C/E Before Biasing	% Standard Deviation After Biasing[a]
CRBR-EMC[b] BOC-1, positive part of core	0.98	10
CRBR-EMC EOC-4, positive part of core	1.23	6
101 mixed zones	1.08	12
Axial blankets without control rods	0.91	1
Axial blankets with control rods	1.23	2
Core zones with negative reactivity signals	1.02	9

[a] Separate bias factors applied to positive and negative components of reactivity. For any subset, the average C/E is 1.0 after biasing.

[b] Engineering mockup critical experiments for sodium-void reactivity in CRBR; reactor geometry and composition closely matched.

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Bias Factors and Uncertainties
for Sodium-void Reactivity in CRBR

Zone	Bias Factor[a]		Calculational Uncertainty,[b] %	
	BOC-1	EOC-4	BOC-1	EOC-4
Central core	1.0	0.82	10	6 ✓
External core	1.0	1.0	10	10
Axial blankets	1.0	1.0	20	20
Internal blankets	1.0	1.0	20	20

[a] to be multiplied times the calculated value.

[b] to be added in quadrature with uncertainties from other sources.

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[a] to be multiplied times the calculated value.

[b] to be added in quadrature with uncertainties from other sources.

Additional Uncertainties
in CRBR Sodium-void Reactivity

Source	Uncertainty[a], % of Total Reactivity	
	BOC-1	EOC-4
Fuel pins instead of plates	0	0
Sequence of voiding	3.5	3.5
Temperature distribution	2.5	2.5
Fission products	0	3.0

[a] To be added in quadrature with the values of "experimental" uncertainty.

Best Estimate Sodium Void[a] Reactivity Worths ($)[b]

	BOC-1	EOC-4
Driver Assemblies		
Core	0.256	1.528
Lower Axial Blanket	-0.225	-0.160
Upper Axial Blanket	-0.177	-0.177
Total	-0.146	1.191
Internal Blanket Assemblies		
Core	1.381	1.593
Lower Axial Extension	0.008	-0.020
Upper Axial Extension	-0.007	-0.006
Total	1.382	1.567

[a] Void Flowing Sodium (81.8% driver, 72.6% Blanket)

[b] $\beta = .0032$

FUEL REMOVAL AND ENERGETICS POTENTIAL
IN CONNECTION WITH MELT-OUT/ANNULAR POOL PHASE

PRESENTED BY:

MICHAEL EPSTEIN

FAUSKE & ASSOCIATES, INC.

QUESTIONS CS760.178B5, -C6, -C7

-B5. What is the basis for maintaining continuous subcriticality in the high heat loss environment of early melt-out phase? What are the fuel losses (quantified), taking into account uncertainties in removal path geometries, driving pressures and freezing mechanisms?

-C6. What degree of subcriticality is required to prevent pool recriticality from thermal and fluid dynamics upset conditions? What is your position on the potential for small recriticalities to amplify? What is the justification for your position?

-C7. In assessing benign termination from the boiled-up pool, justify the fuel removal mechanisms and rates. In particular, assess the potential for upper pool sodium entry via rapid condensation of steel vapor pressure.

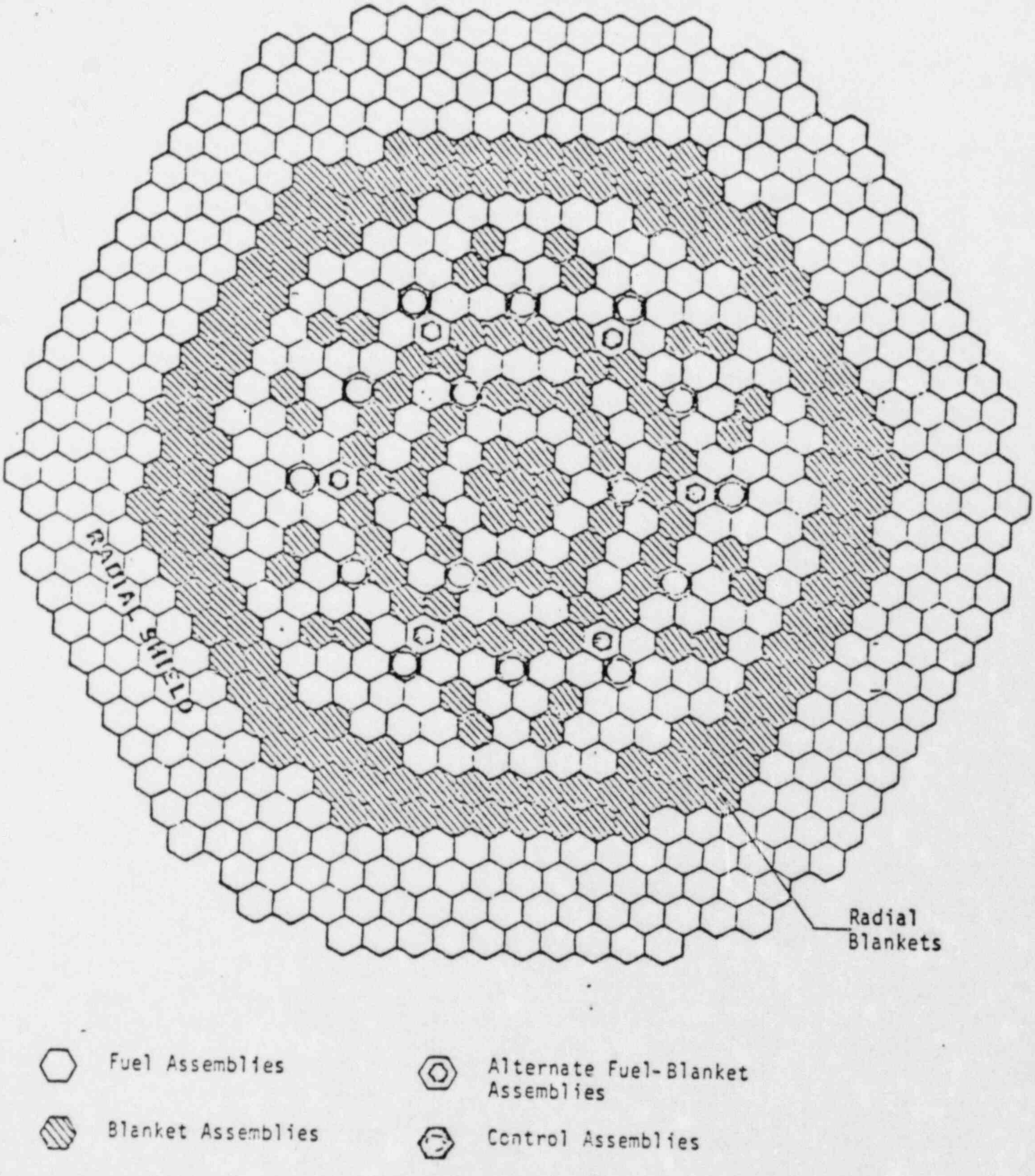
GENERIC ISSUES COVERED

1. DEFINITION OF MELT-OUT PHASE.
2. DURATION OF MELT-OUT PHASE AND SENSITIVITY TO INITIAL CONDITIONS (POWER LEVEL).
3. RECRITICALITY AND RELATED PHENOMENA.
4. FUEL FREEZING MECHANISMS AND REMOVAL PATHS.
5. FUEL REMOVAL REQUIREMENTS FOR PERMANENT SUBCRITICALITY.
6. SODIUM RE-ENTRY VIA STEEL VAPOR CONDENSATION.

POOL DEFINITIONS

1. Melt-Out/Annular Pool Phase - Merging of molten driver fuel assemblies while the inner blanket fuel assemblies remain intact.

2. Large Scale Pool - Configuration after the melting of the inner blanket assemblies.


RADIAL SHIELD
Radial Blankets
⬡ Fuel Assemblies
▨ Blanket Assemblies
Alternate Fuel-Blanket Assemblies
Control Assemblies

TIME SCALE OF THE MELT-OUT/ANNULAR

POOL PHASE: BASIS

1. POWER LEVEL BOUNDED BY 50% OF NOMINAL TO PRECLUDE RECRITICALITY ON AN ASSEMBLY SCALE.

2. ADIABATIC HEATUP OF INNER BLANKET FUEL ASSEMBLIES:

	EOC-4	BOC-1
TIME =	46 SEC	150 SEC

3. MOLTEN DRIVER FUEL ENTERS INNER BLANKET FUEL ASSEMBLIES:

	EOC-4	BOC-1
TIME =	35 SEC	46 SEC

4. CHOICE OF THE POWER LEVEL IS NOT IMPORTANT SO LONG AS LARGE RAMP RATE RECRITICALITIES CAN BE PRECLUDED.

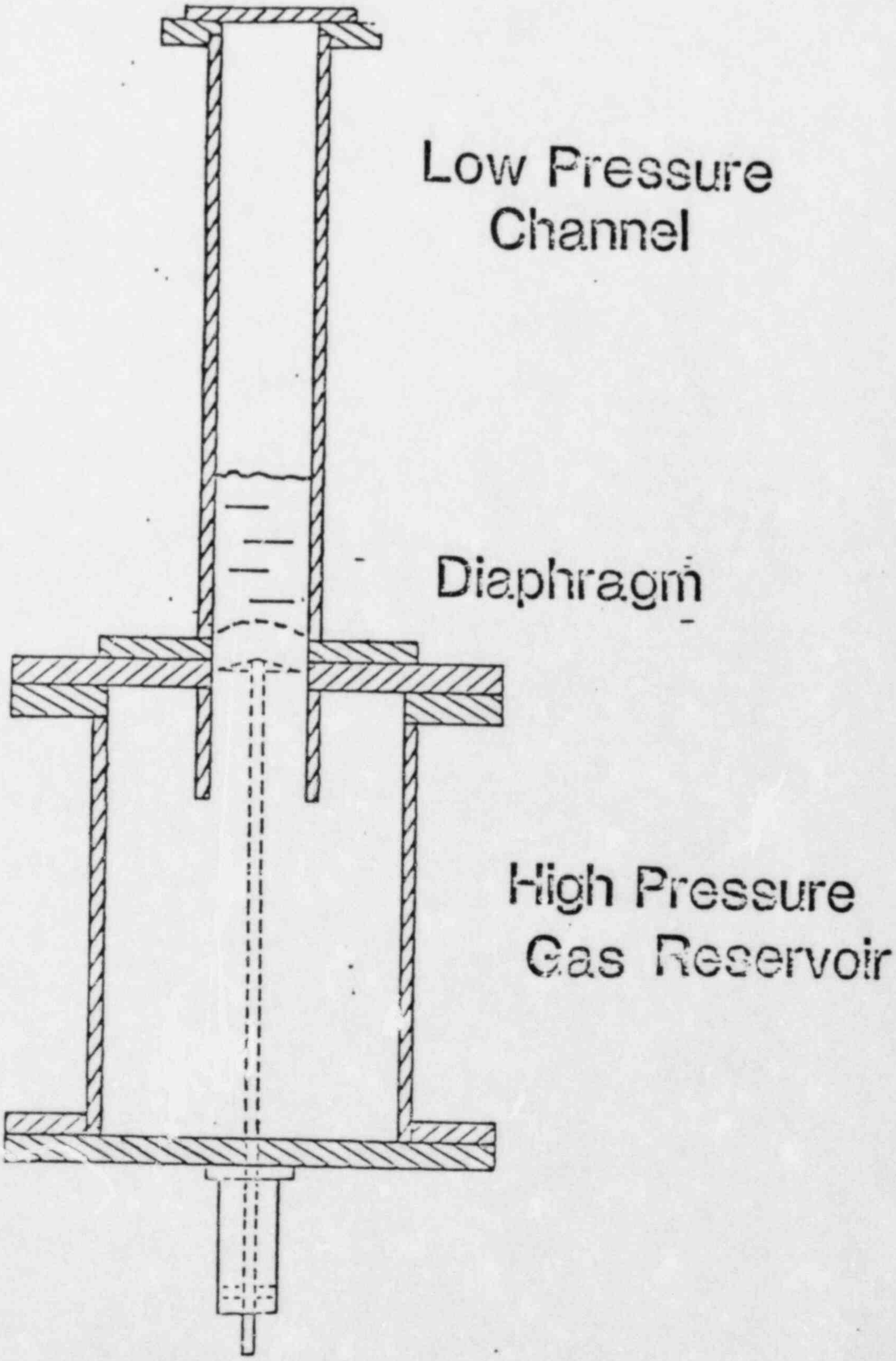
NEUTRONIC EVENTS DURING THE MELT-OUT/ANNULAR POOL PHASE

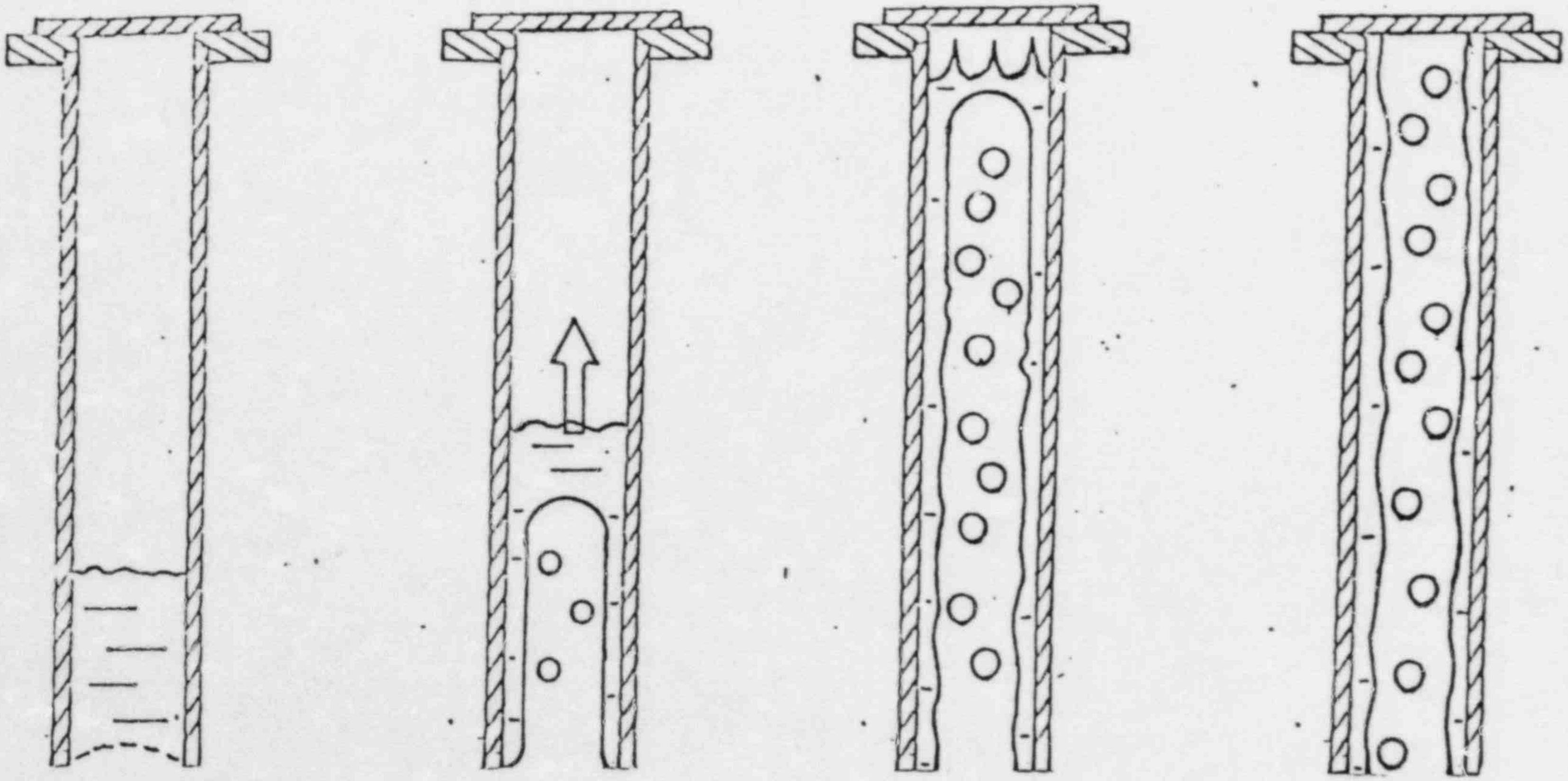
1. IF RECRITICALITIES SHOULD OCCUR THEY ARE MILD AND DO NOT AMPLIFY.
2. ASSEMBLY WALL/FUEL MIXING IS MINIMAL DUE TO FUEL CRUSTING AND MELT LAYER STABILITY.
3. MECHANISM(S) FOR SODIUM RE-ENTRY HAS NOT BEEN IDENTIFIED.

FLOW REGIME AND RECRITICALITY CONSIDERATIONS DURING THE MELT-OUT/ANNULAR POOL PHASE

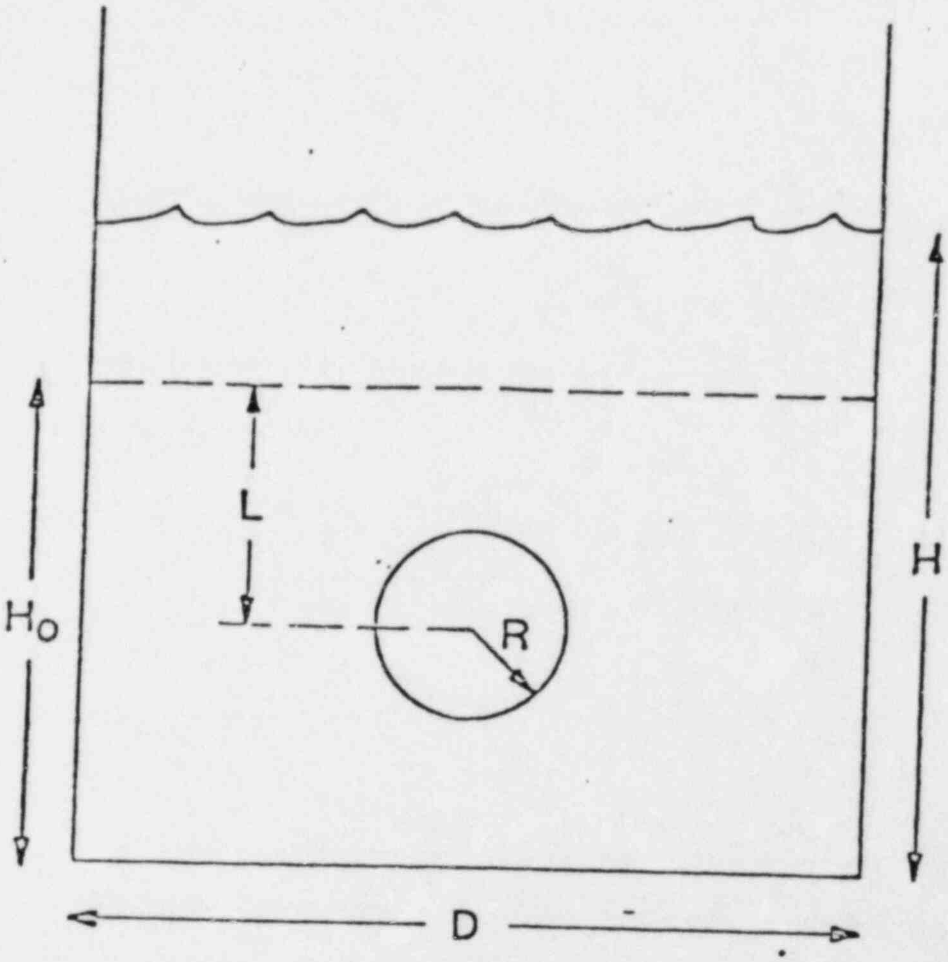
- EXPERIMENT
- ANALYTICAL CONSIDERATIONS

Liquid Slug Instability Experiment





EXPERIMENTAL OBSERVATION



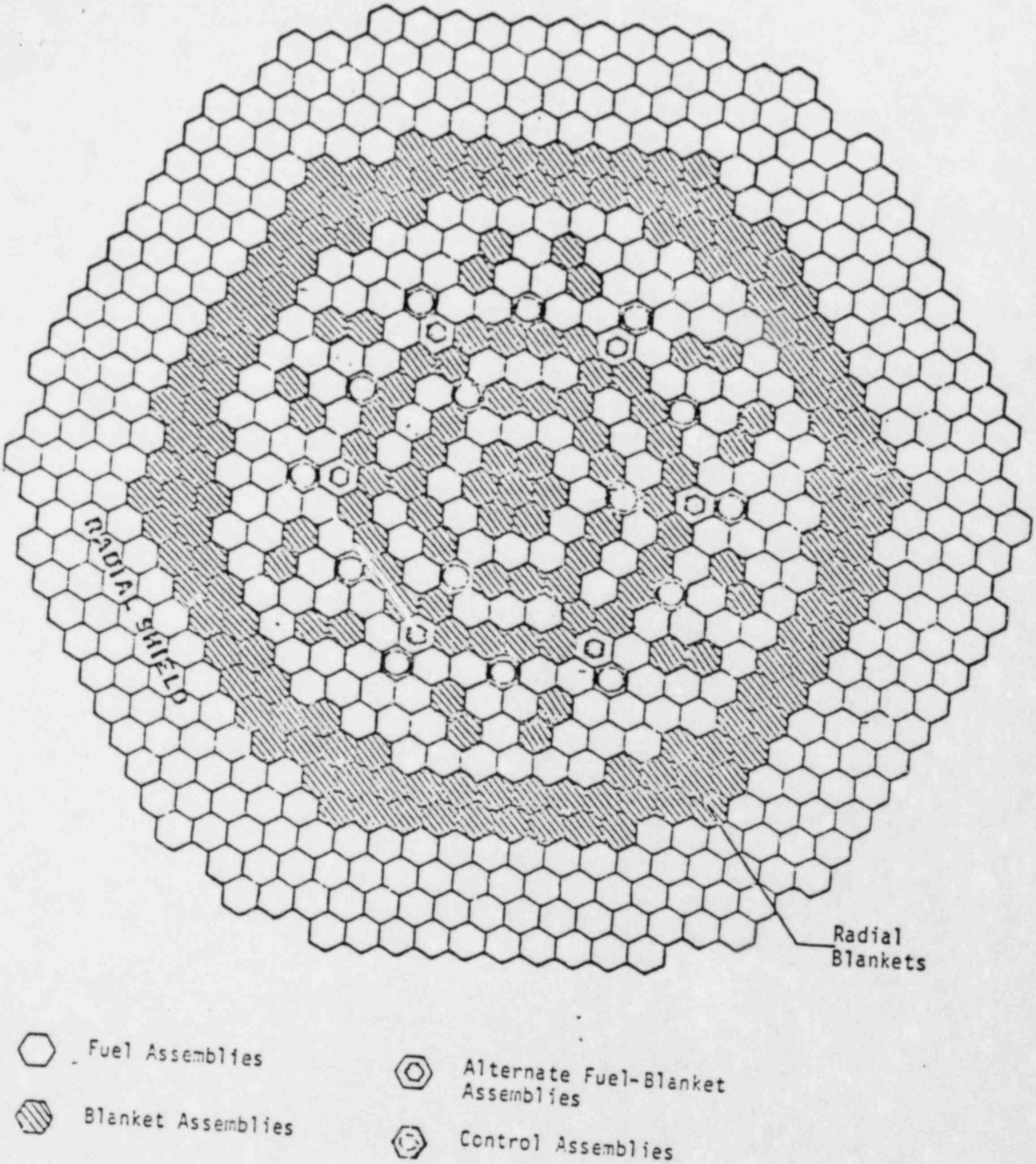
$$R > \frac{D^2}{16L}$$

ANALYTICAL CONSIDERATIONS; 1D vs. 3D

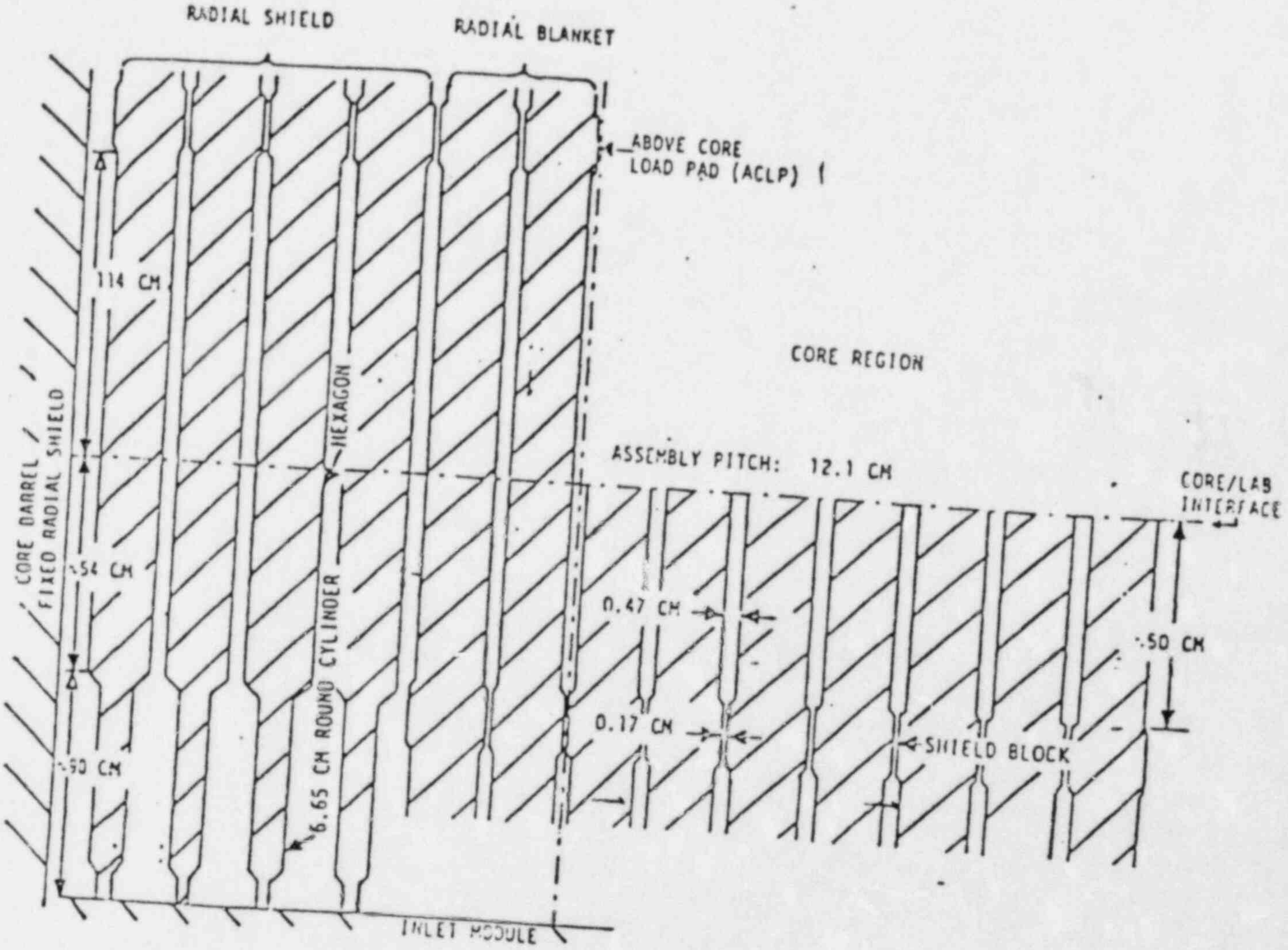
TERMINATION OF MELT-OUT/ANNULAR POOL PHASE

1. FUEL REMOVAL PATHS ARE AVAILABLE.

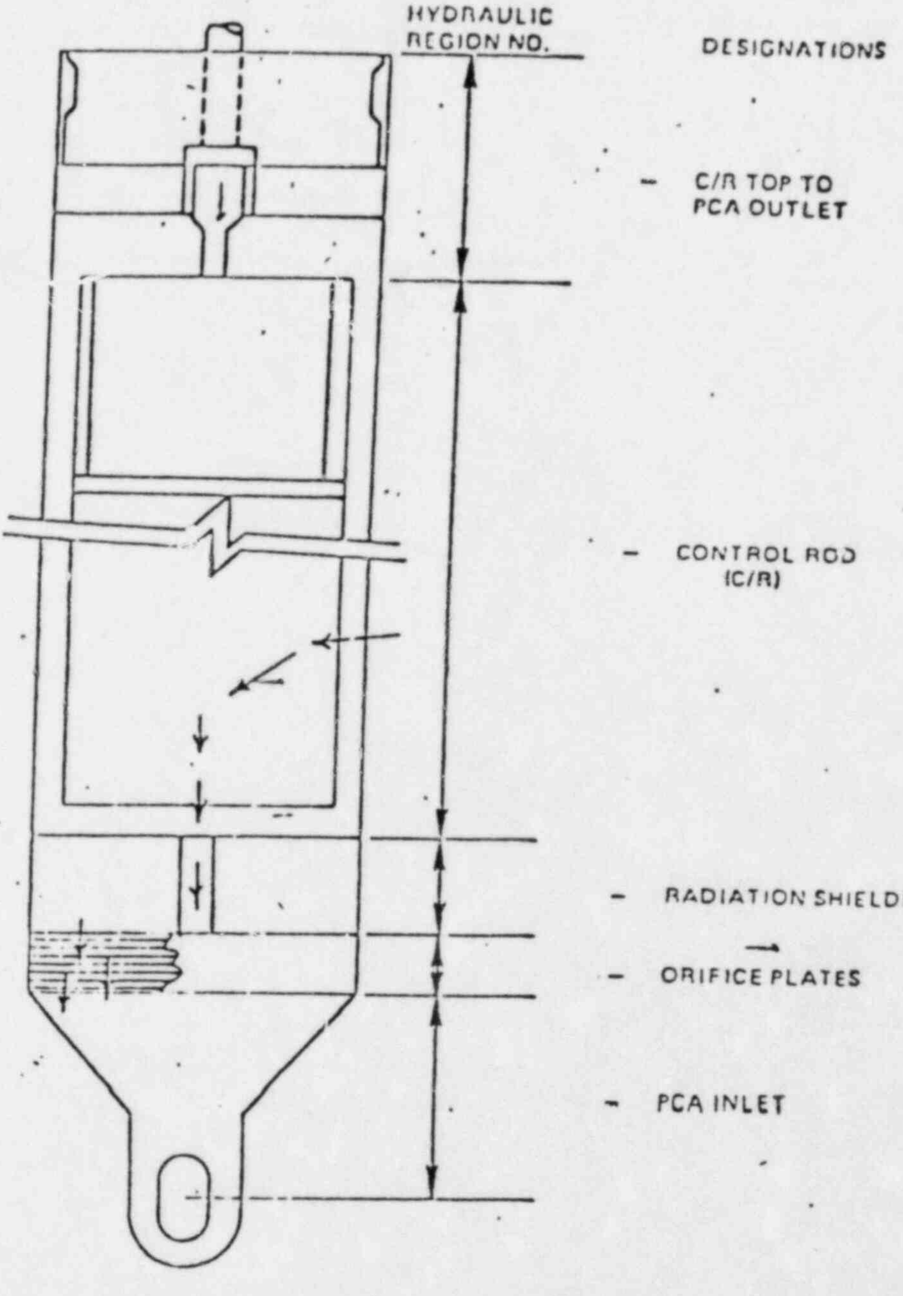
2. FUEL REMOVAL IS SUFFICIENT TO ASSURE PERMANENT SUB-CRITICALITY EVEN WHEN ASSESSED WITH CONSERVATIVE MODELS.



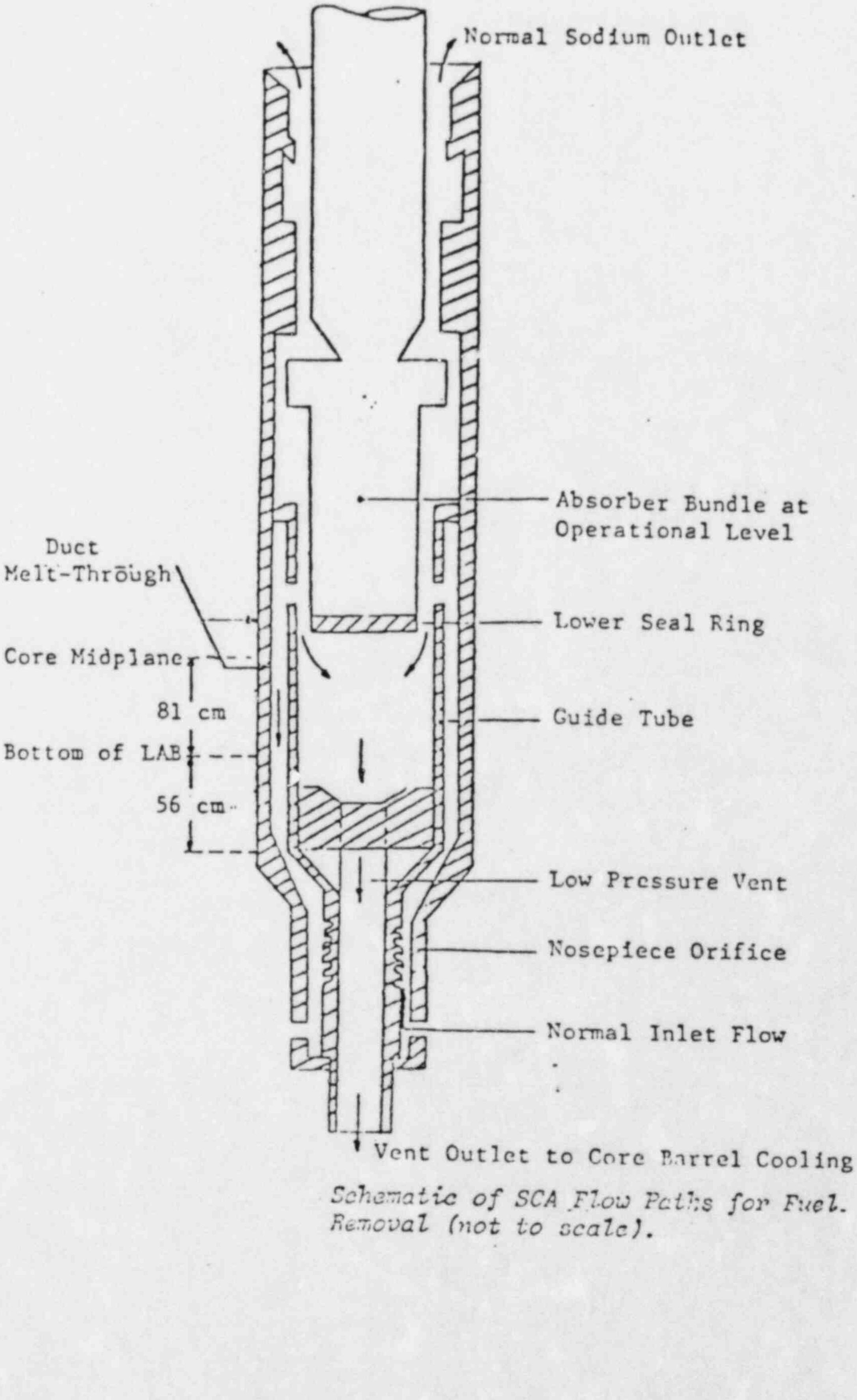
CRBRP Heterogeneous Core



Sketch Showing the Interstitial Gaps Outside and Below the Core Region.



Schematic of Primary Control Assembly.
⟶ Indicates Fuel Melt Path.



Schematic of SCA Flow Paths for Fuel Removal (not to scale).

REQUIREMENTS FOR PERMANENT SUBCRITICALITY

REACTIVITY LEVELS FOR VARIOUS DISRUPTED CORE CONFIGURATIONS AT BOC-1

Case	Description of Core Configuration	Reactivity ($)
1	43% of total fuel inventory removed from the core. The remaining fuel in the annular regions is homogenized in the core and fully compacted with IB and CR assemblies intact.	-1.4
2	Same as Case 1 except that only 33% of total fuel inventory is removed.	+10.2
3	Same as 2 except fuel boils up with a linear/uniform void fraction.	-67-37
4	41% of total inventory removed from core. The remaining fuel, the IB and CR (except B_4C) assemblies are homogenized and fully compact.	-10.5

		% Driver Fuel Inventory			
	Location	Upper Axial Blanket and Radial Blanket	Interassembly Gaps	Control Rod Assemblies	Power Level and Time Interval Between Melt-Out/Annular Pool Phase and Homogeneous Pool Phase**
BOC-1	Early* Fuel Removal	< 10% Based on Limited Opening in Clad Bkg.	> 40% Rate of Removal is Fuel Melt Limited	≈ 10%	≈ 150 sec
	Later* Fuel Removal	≈ 20% No fuel Penetration into UAB - RB only	15% Based on BFM and BOC Gaps	> 40%	Time Interval Reduced by 1/4 Due to Driver Fuel Penetration into Bkt. Assembly ≈ 35 sec
EOC-4	Early* Fuel Removal	> 25% Based on Exp. Data Limited Clad Bkg.	> 40% Rate of Removal is Fuel Melt Limited	0%	≈ 46 sec
	Later* Fuel Removal	> 40% Based on BFM in UAB (25%) Plus (20%) into RB	> 10% Based on BFM and EOC Gaps	> 30%	Time Interval Reduced by 1/2 Due to Driver Fuel Penetration into Bkt. Assembly ≈ 23 sec

---

*Relative to the annular pool phase time interval.

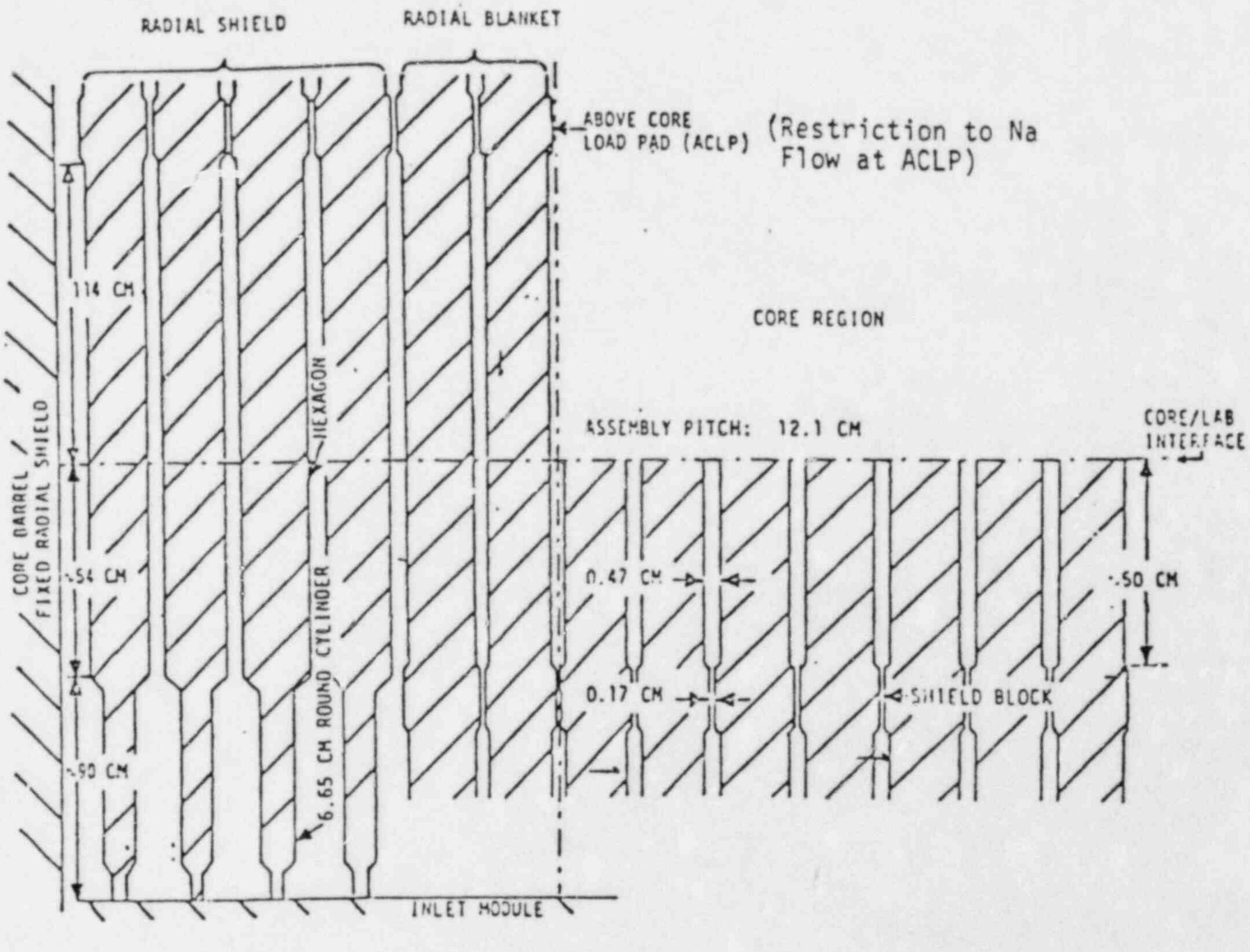
**Defined by loss of inner blanket fuel assemblies structural integrity.

POTENTIAL FOR LOSS OF FUEL INVENTORY PRIOR TO MELT-OUT OF INNER BLANKET ASSEMBLIES

EFFECT OF SODIUM IMPEDANCE ON FUEL PENETRATION INTO GAPS

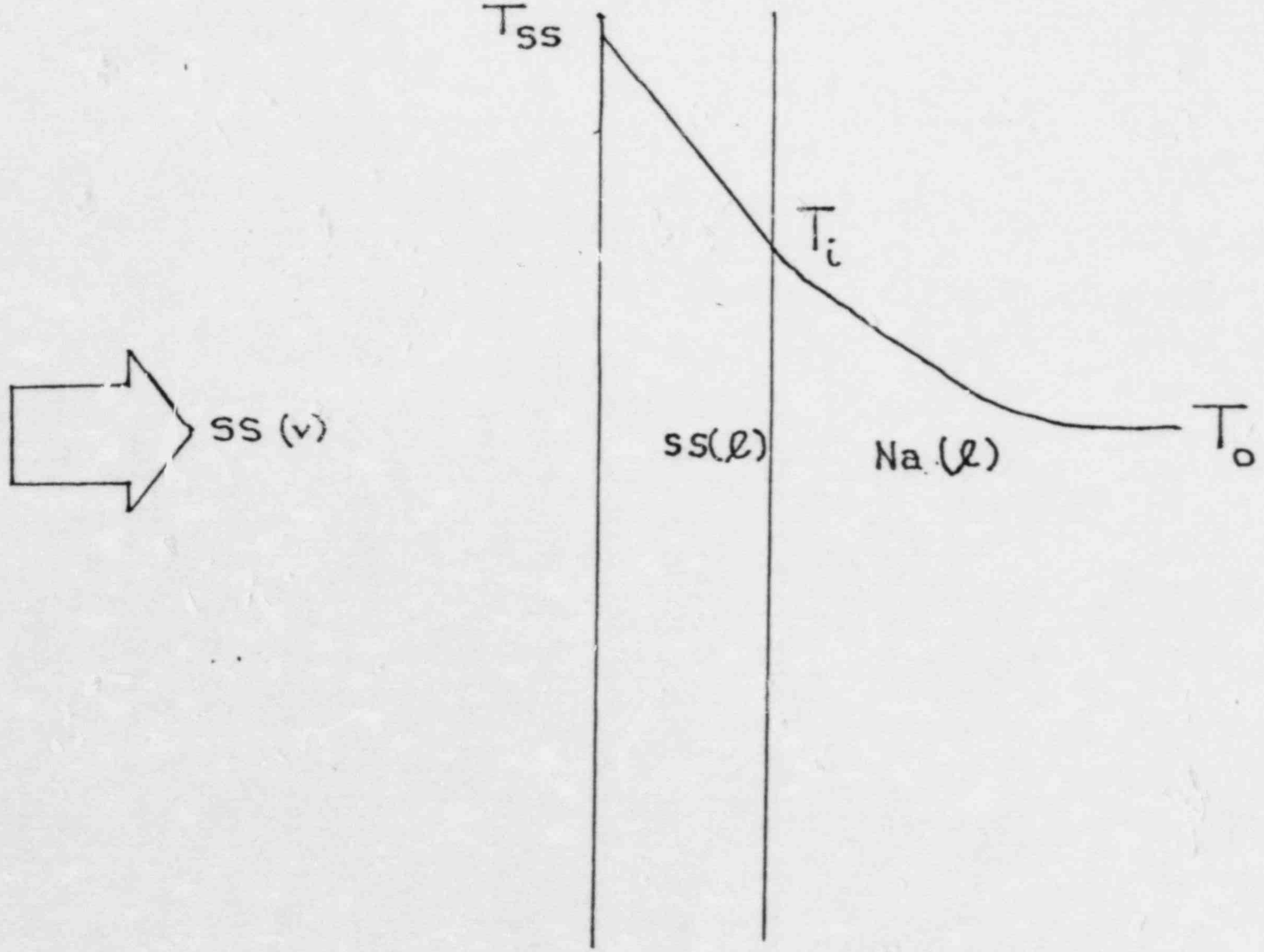
1. CONDUCTION MODEL: PENETRATION LENGTH IS REDUCED BY AT MOST 40%. THIS REDUCTION DOES NOT ALTER THE FUEL REMOVAL INVENTORY.

2. BULK FREEZING MODEL: NO EFFECT ON PENETRATION LENGTH.

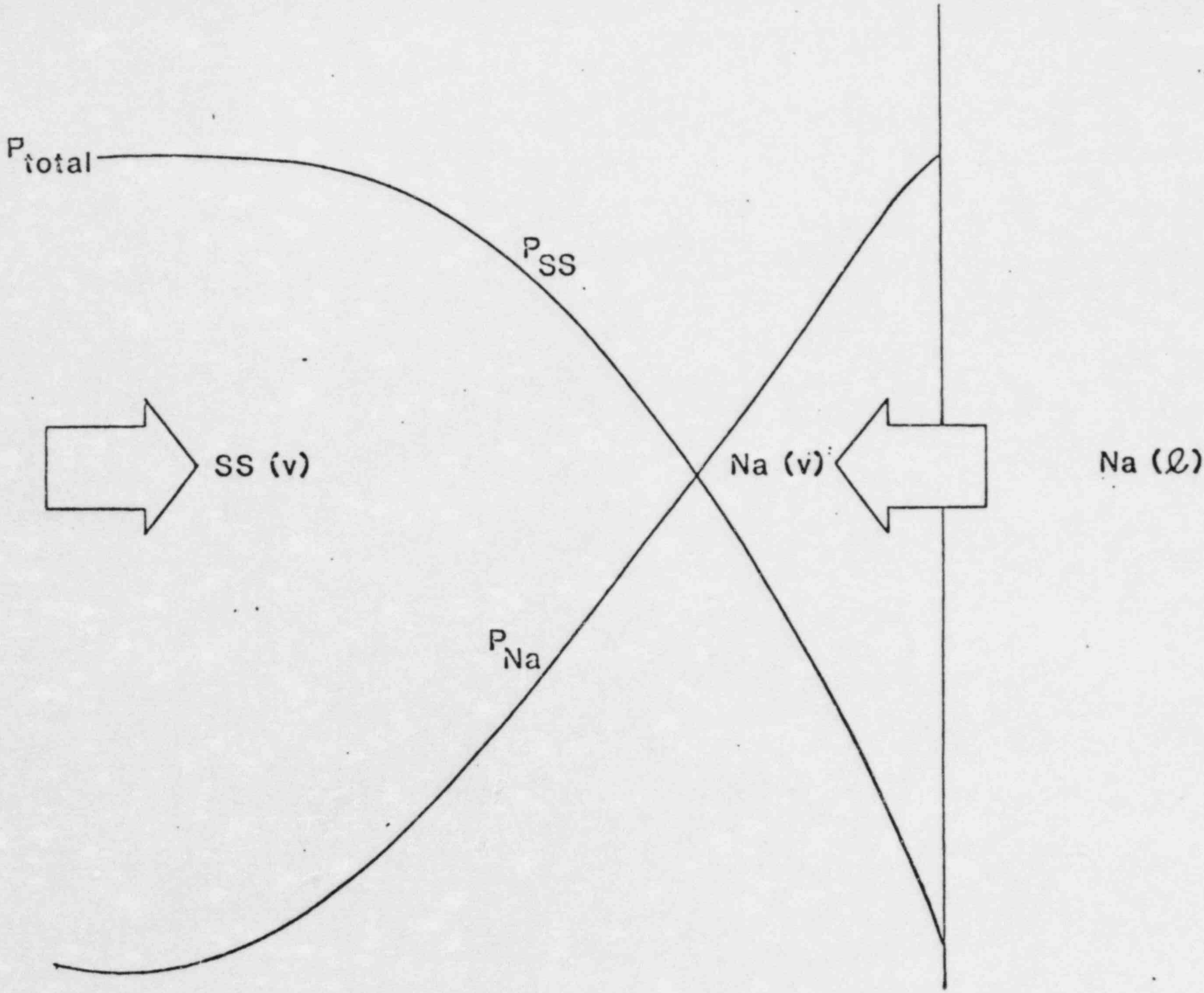


Sketch Showing the Interstitial Gaps Outside and Below the Core Region.

CONSIDERATION OF POOL SODIUM ENTRY VIA
RAPID CONDENSATION OF STEEL VAPOR PRESSURE



T_{ss}
T_i
T_o
SS (v)
ss(ℓ)
Na (ℓ)


P_{total}
P_{SS}
P_{Na}
SS (v)
Na (v)
Na (ℓ)

SUMMARY RESPONSE TO QUESTIONS

1. Once molten fuel becomes available on an assembly basis, mild recriticality events may be possible but they are limited in amplitude and do not amplify.

2. Multiple paths for fuel removal are available on a short time scale, relative to the melt-out of internal blanket assemblies. Correspondingly, fuel removal is not overly sensitive to fuel penetration model assumptions and fuel escape impedances.

3. There is always time for sufficient fuel removal, i.e. about 40% of the driver fuel, to achieve permanent subcriticality prior to loss of the annular inner blanket barrier.

4. The accident sequence will terminate benignly without the development of a homogeneous large scale <u>confined</u> pool phase as defined in (Ref. QCS760.178B5-1).

5. Sodium re-entry via steel vapor condensation can be ruled out on the basis of excessive sodium vaporization when liquid sodium comes into contact with steel vapor.

ROLE OF STRUCTURES DURING ENERGETIC TERMINATION

- INTERNAL STRUCTURES ACT TO ABSORB, PARTITION AND REDUCE THE LEVEL OF CORE EXPANSION FORCES ON THE PHTS BOUNDARY.
- THE UIS PLAYS AN IMPORTANT MITIGATING ROLE VIA BOTH HYDRODYNAMIC AND HEAT TRANSFER PROCESSES
- FINITE ELEMENT ANALYSIS INDICATES THAT A FORCE OF 6.5 MILLION LBF IS REQUIRED TO BUCKLE THE UIS SUPPORT COLUMNS, AND THEREBY REDUCE ITS MITIGATING ROLE.
- THE MAJOR UNCERTAINTY IN THE ABOVE ANALYSIS OF UIS COLUMN BUCKLING IS IN THE YIELD STRESS; -20 TO +100%.
- INTRAASSEMBLY BLOCKAGES IN UCS ARE STRONG RELATIVE TO EXPECTED CORE PRESSURES, WITH THE BLOCKAGE TEMPERATURE THE CONTROLLING FACTOR.
- OVERALL EFFECT OF STRUCTURES IS TO REDUCE THE PHTS LOADS BELOW THOSE CALCULATED VIA AN ISENTROPIC CORE EXPANSION PROCESS.

ENCLOSURE 4

ACTION ITEMS FOLLOWING THE SEPTEMBER 21, 1982 CRBRP/NRC HCDA ENERGETICS MEETING HELD AT ARGONNE NATIONAL LABORATORY

The following action items will be completed and submitted to NRC within two months.

1. Provide concise statement on TOP initiating ramp rates.
2. Provide EOC-3 neutronics data (data type transmitted to ANL will suffice).
3. Provide results of SAS sensitivity evaluation of best parameters for L6 and 17 in-pile tests.
4. Provide SAS 3D input deck with SLUMPY parameters used in response to QCS.760.
5. Recalculate plenum fission gas effects for EOC-4 with new sodium void worth.
6. Provide SAS 3D corrections made to complete item 5.
7. Provide TREAT test R-8 fuel pin data.
8. Provide analysis supporting fuel freezing upon entry to inner blanket assemblies.
9. Provide results of the GAP tests being performed at ANL when available.