UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

JUN 12 1979

MEMORANDUM FOR: Zoltan R. Rosztoczy, Chief, Analysis Branch, DSS

THRU: L.E. Phillips, Section Leader, Reactor Analysis Section, Analysis Branch, DSS LEP

FROM: Wayne Hodges, Reactor Analysis Section, Analysis Branch, DSS

SUBJECT: SUMMARY OF MEETING WITH GENERAL ELECTRIC

A meeting was held with General Electric on May 24, 1979, to discuss implications of Two Loop Apparatus (TLTA) results on the GE ECCS evaluation model. Further discussions were held on model deficiencies, other than those suggested by TLTA, which are being evaluated by GE and by the staff. Enclosure 1 to this letter is a summary of the meeting. Slides presented by GE are included as Enclosure 2. Enclosure 3 is a list of meeting attendees.

Wayne Hodges

Wayne Hodges
Reactor Analysis Section
Analysis Branch
Division of Systems Safety

cc: w/enclosures
Meeting Attendees
Joe Ferris
ACRS
PDR
MHB Tech. Assoc.

(87)

7907240443

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Enclosure 1

Summary of May 24, 1979 Meeting With General Electric

Reference 1 compared tests 6007, no ECCS and test 6405, low ECCS flow, from the blowdown heat transfer program. Contrary to intuition, the pressure transient with ECCS flow was slower than for no ECCS flow. In October, 1978, GE was requested to explain why the test with ECC injection had a slower pressure transient than a similar test with no ECC injection. GE proposed two possibilities: 1) increased vapor generation in the bundle due to water storage in the bundle, 2) lower volumetric break flow because of a higher liquid fraction for the case with ECC injection. Of the two possibilities, the higher vapor generation seemed more likely.

The prospect of higher vapor generation than anticipated in the simulated fuel bundle implies that the vapor generation in the SAFE and REFLOOD codes may be non-conservative. The staff and GE held several discussions and meetings on the subject and in February, 1979, a letter was sent to GE (2) requesting details of comparisons of evaluation model calculations with test data.

After extensive evaluation of the test data, GE concluded that the slower depressurization observed with ECCS injection was due primarily to the difference in break flow. In fact, the vapor flow rate exiting the upper plenum of TLTA was less for the ECCS injection test than for the test with no ECCS injection.

Based on this new interpretation of the TLTA data, GE concluded that the information requested in reference [illegible] no longer needed. As an alternative, GE proposed to submit a comparison of the peak cladding temperature as calculated by the evaluation model and as measured in the test for two

TLTA tests (average power, average ECCS flow and average power, no ECCS flow). The GE argument is that this comparison shows significant conservatism in the overall calculation (approximately 1000°F) and thus no detailed evaluation of submodels within the evaluation model is required.

GE complained that new ECCS inputs to the NRC always create crises; even when the overall model is adequately conservative. They urged the use of creative judgement on minor issues and suggested that we pull together to solve real problems.

The staff acknowledged the GE viewpoint and expressed a degree of sympathy with it. However, the staff is compelled to satisfy 10 CFR 50.46 and its Appendix K.

The differences between the GE and NRC positions can be summarized as follows: GE feels that they have demonstrated overall conservatism in their evaluation model. They, therefore, believe that submodels within their model could be non-conservative without violating 10 CFR 50.46 or Appendix K. The staff disagrees with GE in this particular application; submodels not specifically addressed in Appendix K but which may substantially affect the peak cladding temperature should be either best estimate or conservati... The fact that the evaluation model predicted conservative results for a single, one-dimensional test does not substantiate that the same degree of conservatism exists in a reactor calculation.

In assessing the TLTA data, GE uses qualitative argument to reach four basic conclusions: 1) slower depressurization results from higher liquid break flow-less vapor from core region with ECC; 2) vaporization data base is applicable after approximately 40 seconds-negligible reactor effect; 3) high heat transfer is applicable to both average and peak cladding temperature. The staff agrees that this qualitative assessment is probably correct. However, quantitative information is needed to support the qualitative argrment. The information requested in reference 2 and additional information to substantiate the arguments concerning break flow and vapor bundle flow are needed. New heat transfer data would be required to obtain credit for the increased heat transfer in the CHASTE code.

GE also discussed staff concerns on model deficiencies referred to as the Leibnitz rule approximation, and h = 4. In the Leibnitz approximation, GE used absolute rather than relative steam velocity in calculating with a moving boundary in SAFE and REFLOOD. GE has performed studies on representative plant types to demonstrate that the maximum increase in cladding temperature due to the Leibnitz rule approximation in SAFE is +10°F. In July, 1979, GE will submit analysis results and bounding case argument to show that the combined effect in SAFE and REFLOOD will be less than +20°F. Based on preliminary results, GE was confident that they could demonstrate an effect of less than +20°F.

GE presented an analysis which showed that use of an increased heat transfer coefficient in SAFE (h = 12 rather than h = 4) results in a decrease in peak cladding temperature. However, the manner in which the heat transfer transition from nucleate boiling to the h = 4 regime was performed is not clearly conservative. Therefore, the conservatism of the heat transfer transition in SAFE should be justified.

Action Items

Several action items resulted from the meeting. They are:

1. GE is to supply a written narrative to accompany the slides presented at the meeting. A date for submittal of the narrative has not been negotiated yet.

2. GE should strengthen the evidence that the steam seperator ΔP is a positive indication that the core region contributed less steam with ECC and that the slower depressurization was controlled by increased liquid break flow.

3. GE should quantify and explain the scaling principle for TLTA. Existing documentation may be used for this purpose.

4. A more detailed description of the tests and facility for the vaporization tests is needed to show that there are no significant differences when compared to the test program associated with the present data. GE committed to supply the comparison but no date was discussed.

5. GE must either justify that not including CCFL at the bottom (side entry orifice) is conservative or put it into their model. Some information has been supplied by GE in previous submittals but review of that information after the meeting shows it to be incomplete. No date for submittal of the information was discussed.

6. GE was requested to discuss the conditions required for water to accumulate at the grid spacers.

7. The conservatism of the heat transfer transition in SAFE should be justified.

References

1. G.W. Burnette, Thirty-Fourth Monthly Report, "BWR Blowdown/Emergency Core Cooling Program, August 1978," Sept. 11, 1978.

2. Letter to Dr. Glenn G. Sherwood, from Roger J. Mattson, February 9, 1979.

ENCLOSURE 2

GENERAL ELECTRIC
AGENDA

ECCS MODEL ISSUES - EXECUTIVE OVERVIEW

- INTRODUCTION — G.G. SHERWOOD
- DISCUSSION OF TECHNICAL ISSUES — G.E. DIX
    - TLTA
    - LEIBNITZ RULE
- ECCS PROGRAM COMMENTS — H.H. KLEPFER
- SUMMARY — G.G. SHERWOOD

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BACKGROUND ON ECCS MODELS

- PROBLEMS:
  1. NEW ECCS INPUTS TO NRC SEEM ALWAYS TO CREATE CRISES
  2. ECCS MODEL IMPROVEMENTS NEVER SEEM TO GET APPROVED

- EXAMPLES OF CRISES
  - ECCS INPUT ERRORS ~ NOV. 76
    (DELAYED TWO HEARINGS)
  - TLTA, LEIBNITZ, HEAT TRANSFER ~ FEB. 79
    (DELAYED BLACK FOX HEARING FINDINGS)
    (CAUSES LICENSING BOARD CONFUSION)

- LAWYERS TELL US STAFF HAS AUTHORITY FOR BALANCED JUDGEMENT
  - NRC MUST INTERPET 10CFR50.46

- PERSPECTIVE
  - 20^{o} INCREASE IN CALCULATED PCT WITH 1000^{o} MARGIN PRESENTS MAJOR CONCERN TO STAFF
  - THIS THINKING APPEARS OUT OF FOCUS

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LOCA EVALUATION MODELS

COMMISSIONERS

OVERALL THE LOCA MODEL MUST BE ADEQUATELY CONSERVATIVE

APPARENT NRC POLICY

IT MUST BE SHOWN THAT ALL OF THE SUBELEMENTS OF THE MODEL ARE CONSERVATIVE REGARDLESS OF THE OVERALL DEMONSTRATED LOCA MODEL CONSERVATISM

GE VIEW

COMMISSIONERS DO NOT REQUIRE SUBELEMENT CONSERVATISM OR THEY WOULD HAVE SO STATED

- APPENDIX K DOES NOT REQUIRE EACH SUBELEMENT TO BE CONSERVATIVE
- FINAL ENVIRONMENTAL STATEMENT RECOGNIZES SELECTIVE CONSERVATISMS
- JUDGEMENT ON CONSERVATISM SHOULD BE MEASURED AGAINST 10CFR50.46 CRITERIA (CALCULATED PCT)

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SUMMARY

- GE BELIEVES 10CFR50.46/APP K REQUIRES OVERALL LOCA MODELS ONLY BE "ADEQUATELY CONSERVATIVE" THROUGH PCT - NOT NECESSARILY ALL SUBELEMENTS
- BALANCED JUDGEMENT NEEDED FOR EVALUATION OF NEW INFORMATION
  - TESTS GIVE GOOD AND BAD NEWS
  - CAN'T IGNORE MODEL IMPROVEMENTS
- EXTENSIVE EFFORT SPENT ON SEVERAL MINOR VARIATIONS WHERE 1000°F MARGIN DEMONSTRATED
- LET'S LEARN FROM THIS EXPERIENCE ON ECCS CRISES
- LET'S USE SOME CREATIVE JUDGEMENT ON MINOR ISSUES AND PULL TOGETHER TO SOLVE REAL PROBLEMS
  - SIGNIFICANT MODEL CHANGES FOR SAFETY
  - LONG RANGE ECCS IMPROVEMENTS
  - DAY-TO-DAY APPENDIX K "CONFORMANCE" REQUIREMENTS

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TECHNICAL ISSUES

TLTA BACKGROUND

TLTA/ECC CONCERNS

RECENT DATA INTERPRETATIONS/IMPLICATIONS

TLTA/EM COMPARISON

LEIBNITZ RULE ISSUE

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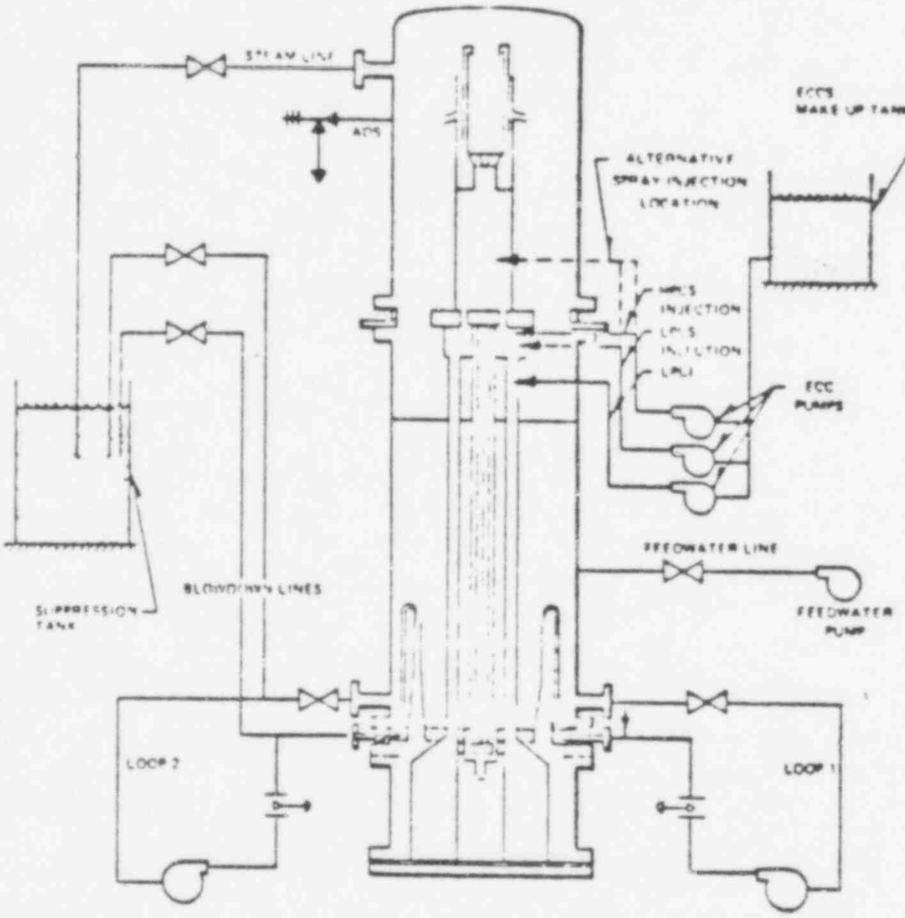
TWO LOOP TEST APPARATUS (TLTA-5) WITH EMERGENCY CORE COOLING SYSTEMS



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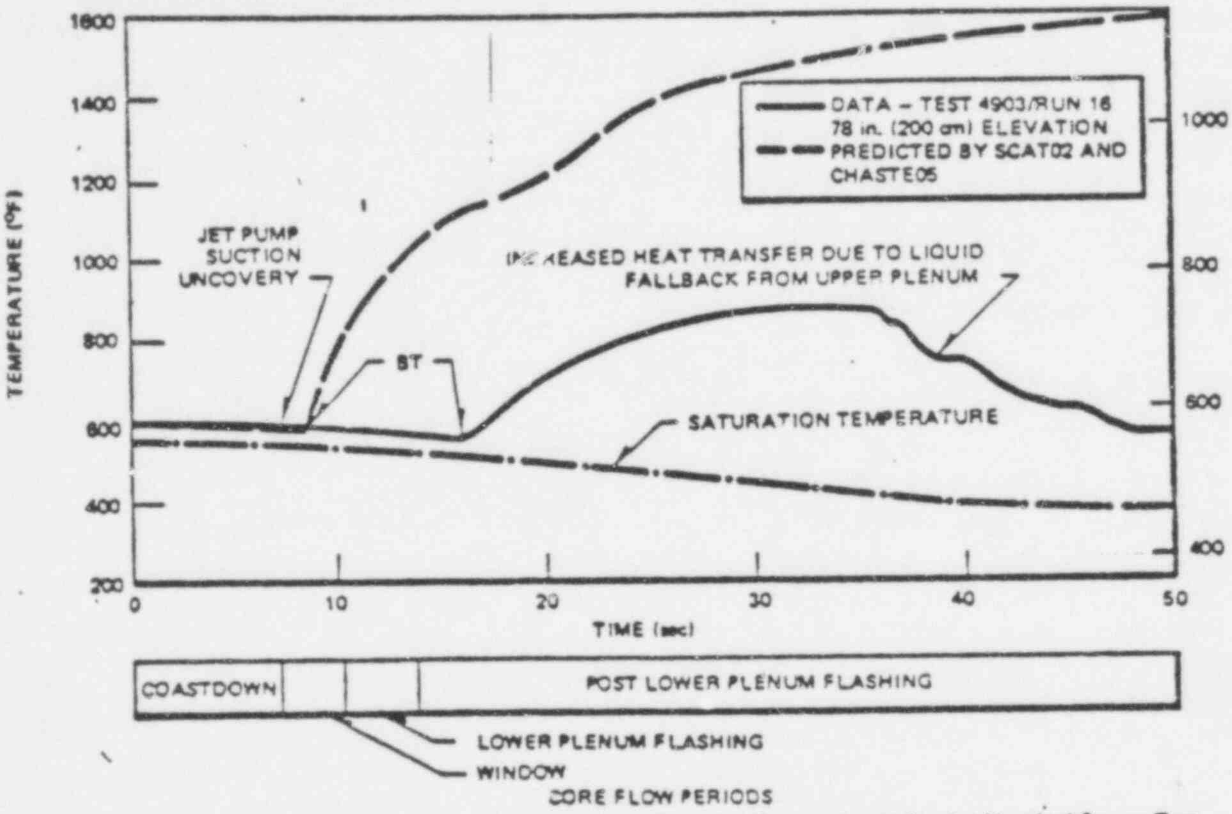

Figure 4-4. Comparison of High Power Rod Peak Cladding Temperatures for the Nominal-Power Test

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PRELIMINARY INTERPRETATION OF TLTA/ECC TEST

(WINTER 1978)

BASIS

- DEPRESSURIZATION TRANSIENT CHANGED
  - HEAT TRANSFER
  - BREAK FLOW
- PCT DECREASED WITH ECCS
- INCOMPLETE DATA EVALUATION
- SIMPLE BOUNDING ANALYSES

PRELIMINARY CONCLUSIONS

- DEPRESSURIZATION RATE SLOWER WITH ECCS
- APPARENT HIGH LIQUID DENSITY IN BUNDLE WITH ECCS
- IMPROVED BUNDLE HEAT TRANSFER WITH ECCS
- PCT DECREASED WITH ECCS

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NRC STAFF CONCERNS WITH PRELIMINARY CONCLUSIONS

I. DEPRESSURIZATION CHANGE COULD RESULT FROM HIGHER BUNDLE VAPORIZATION

II. VAPORIZATION DATA BASE POSSIBLY INAPPROPRIATE

- HIGHER LIQUID CONCENTRATION IN CORE

III. HIGH HEAT TRANSFER POSSIBLY NOT APPLICABLE FOR PEAK BUNDLES

- ADVERSE BWR PARALLEL CHANNEL EFFECTS

IV. HEAT TRANSFER IN SYSTEM CODES (AVERAGE BUNDLE) TOO LOW

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GE INTERPRETATION OF PRELIMINARY CONCLUSIONS

- NET EFFECT VERY FAVORABLE
  - HEAT TRANSFER DOMINATES
  - LOWER PCT WITH ECCS
- FURTHER DETAILED DATA EVALUATION NECESSARY
- APPROPRIATE TO EVALUATE NRC STAFF CONCERNS
- APPROPRIATE TO DEMONSTRATE EM CONSERVATISM FOR TLTA

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RECENT DATA IMPLICATIONS TO NRC STAFF CONCERNS

I. DEPRESSURIZATION RESULTS FROM HIGHER LIQUID BREAK FLOW

- LESS VAPOR FROM CORE REGION WITH ECC

II. VAPORIZATION DATA BASE APPLICABLE AFTER ~40 SECONDS

- NEGLIGIBLE REACTOR EFFECT

III. HIGH HEAT TRANSFER APPLICABLE TO PEAK BUNDLES

- NO DRIVING POTENTIAL (ΔP) DIFFERENCES

IV. INCREASED HEAT TRANSFER IN SYSTEM CODES REDUCES PCT

- LOWER PCT WITHOUT PEAK BUNDLE CREDIT
- MUCH LOWER PCT WITH REALISTIC PEAK BUNDLE CREDIT

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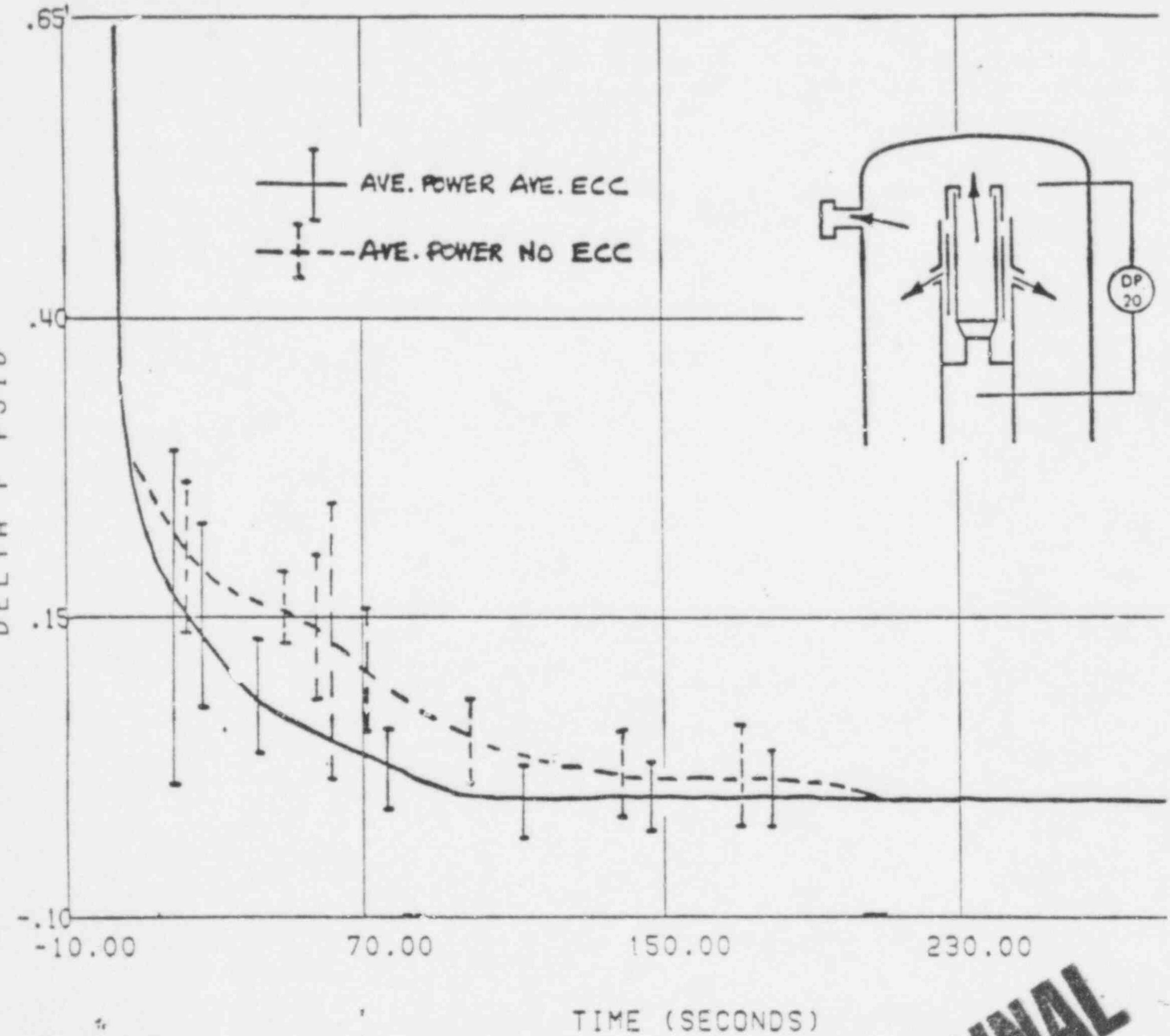
PRESSURE DROP ACROSS STEAM SEPARATOR FOR
AVERAGE POWER TESTS



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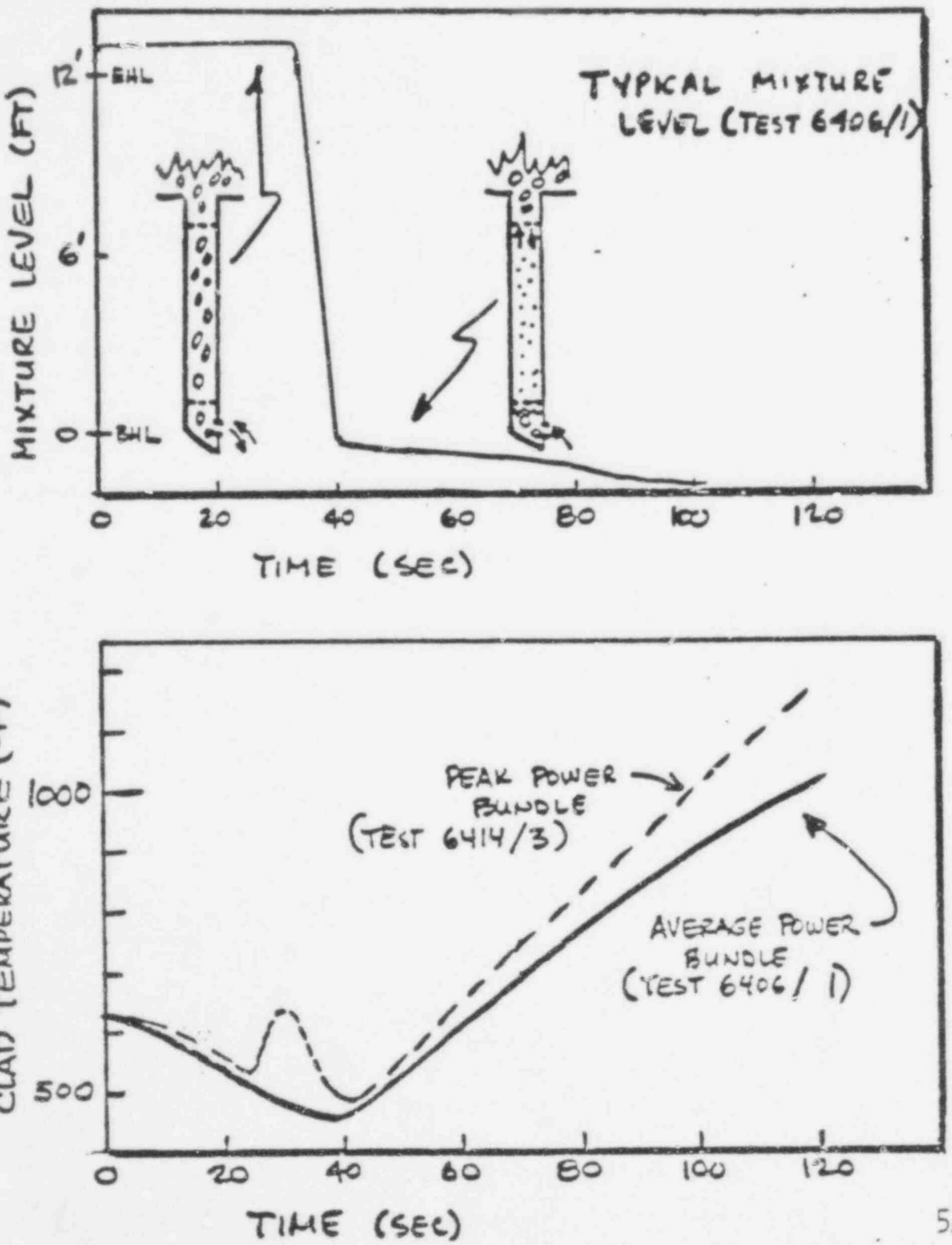
TLTA PHENOMENA INTERPRETATION



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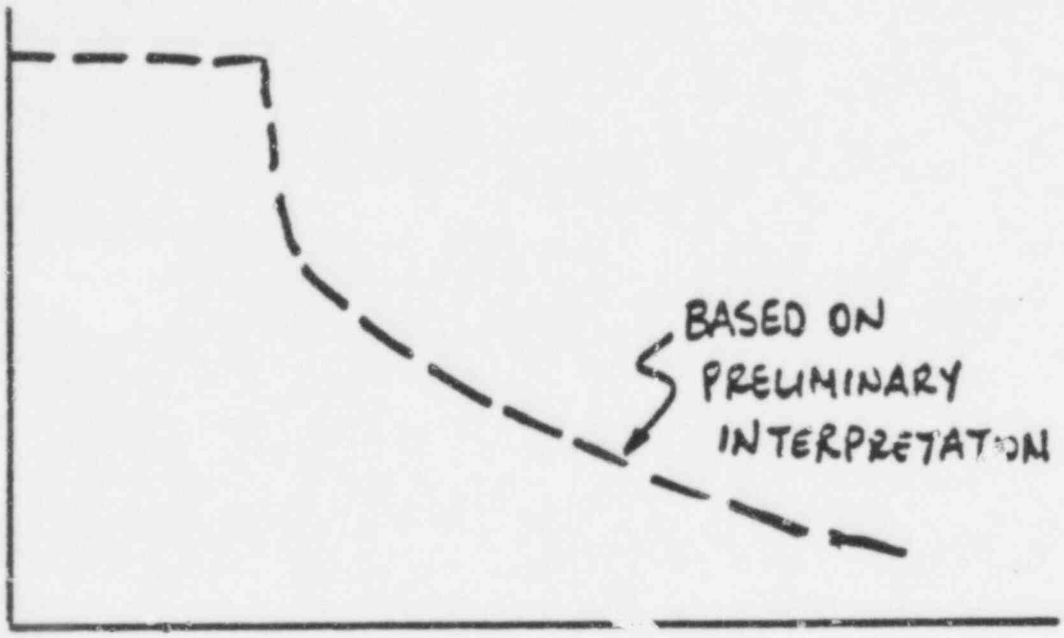

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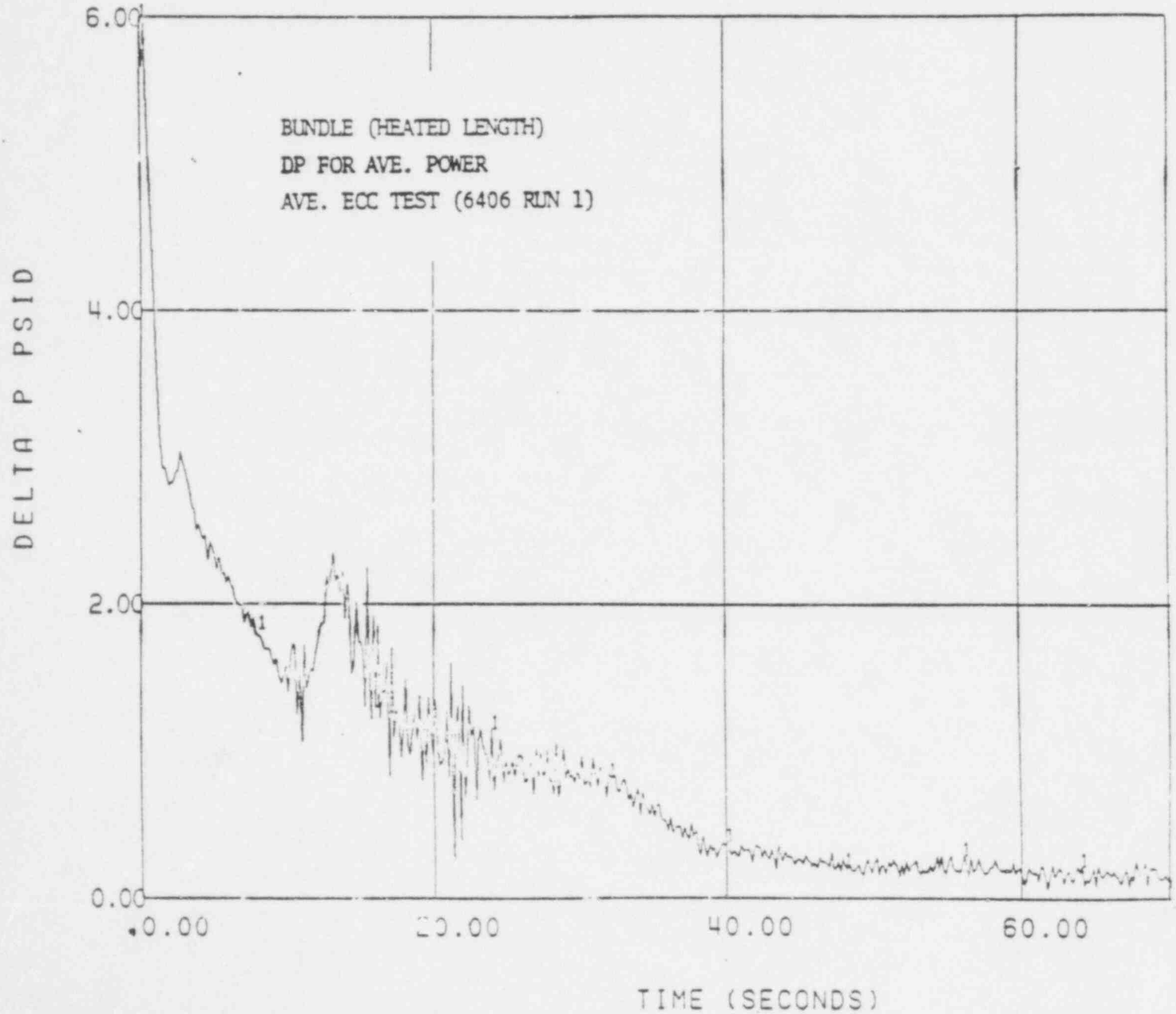

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BUNDLE DIFFERENTIAL PRESSURE FOR AVERAGE POWER,
NO ECC TEST (6406 RUN 3)

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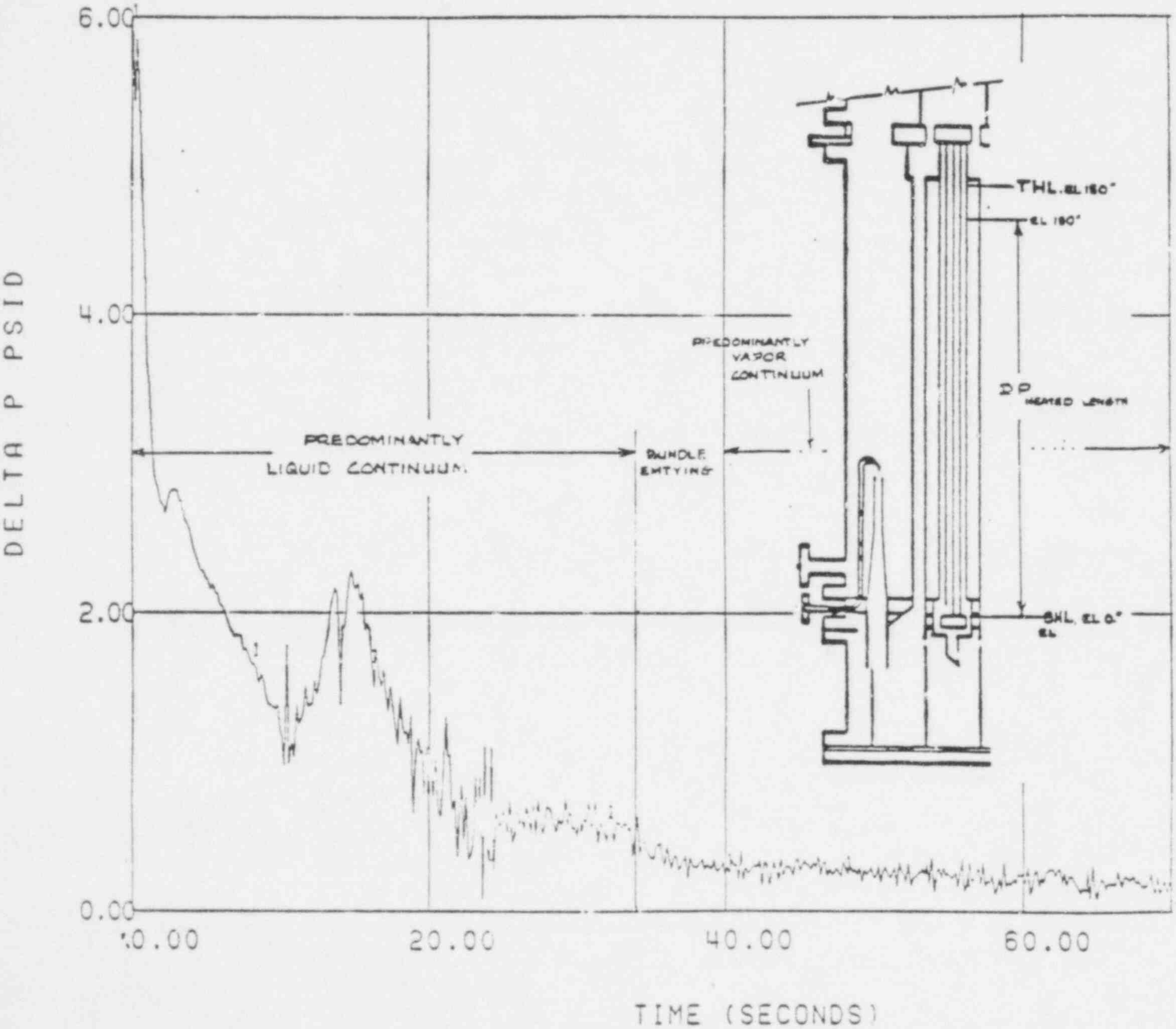

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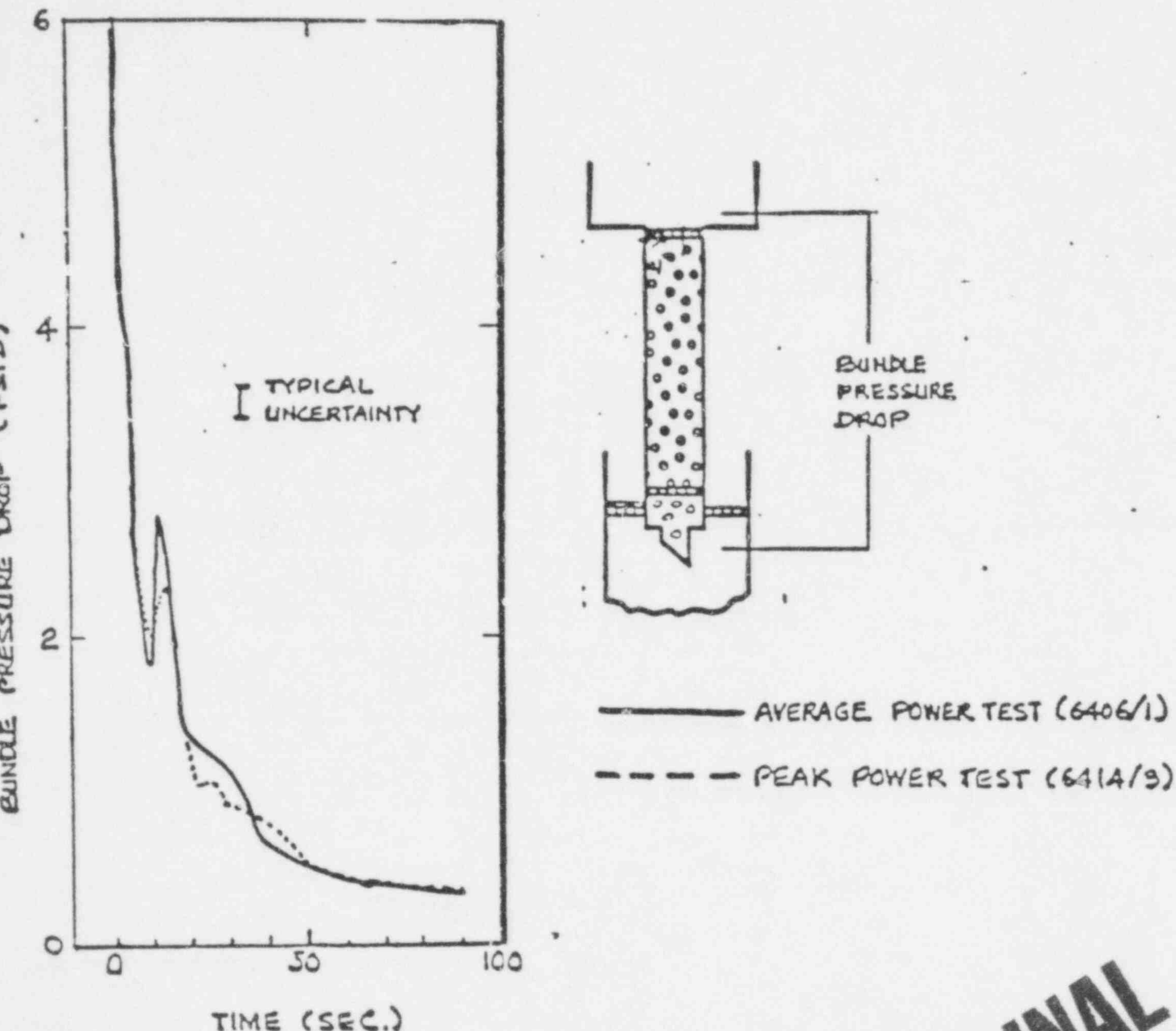
FIG.(3). COMPARISON OF BUNDLE INLET/OUTLET PRESSURE DROPS



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SYSTEM CODE HIGH HEAT TRANSFER

SAMPLE REACTOR CALCULATION RESULTS

- MOST SENSITIVE PLANT
- SYSTEM EFFECT ONLY (SAFE/REFLOOD)
  - AVERAGE BUNDLE TLTA HEAT TRANSFER
  - 95°F PCT DECREASE
- REALISTIC EFFECT (SAFE/REFLOOD & CHASTE)
  - ALL BUNDLE HEAT TRANSFER
  - 335°F PCT DECREASE

ACTIONS REQUESTED

- ADDITIONAL SAMPLE CALCULATIONS

  PLANT SPECIFIC

  BREAK SIZES

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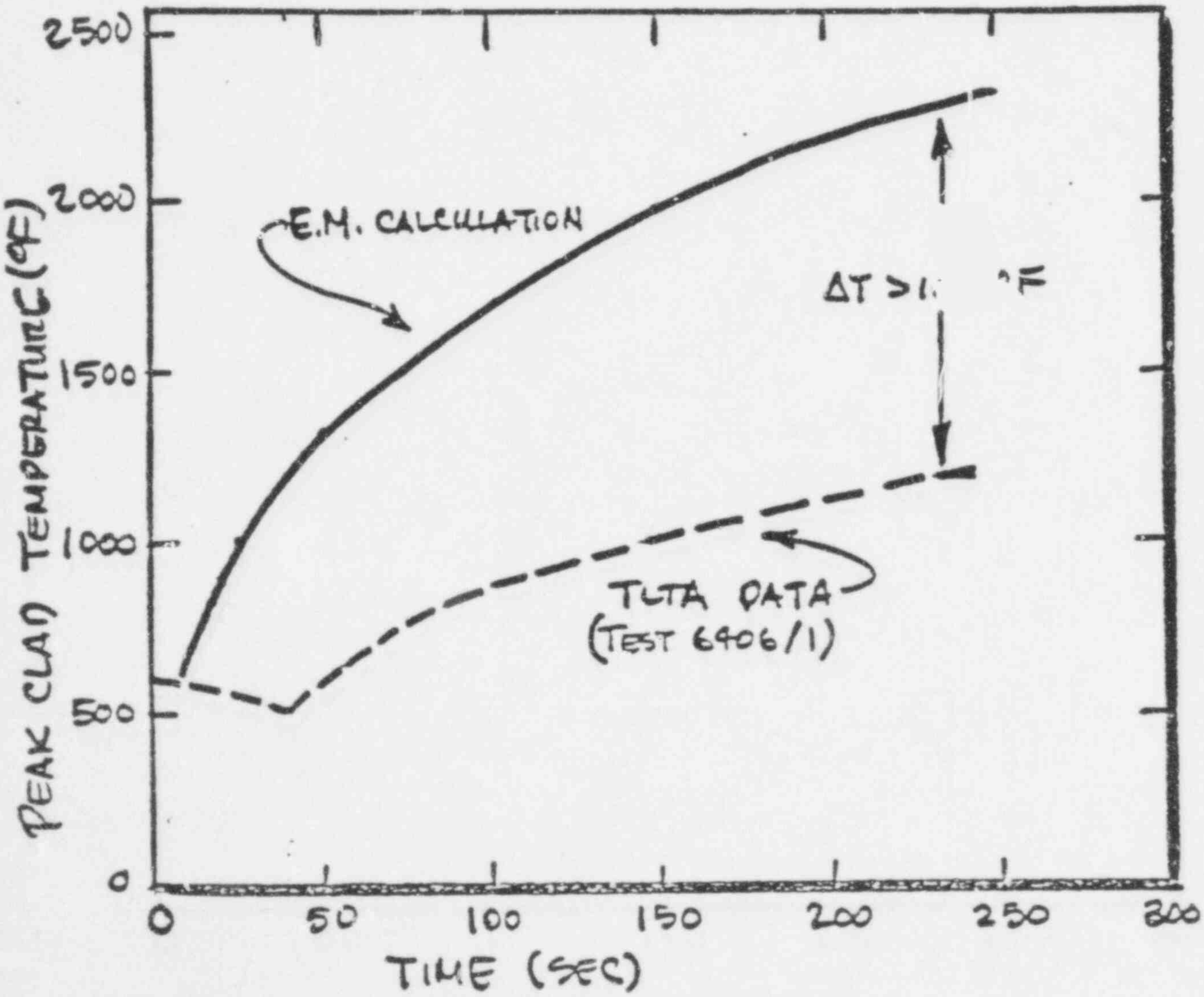
TLTA / EM COMPARISON



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CURRENT TLTA STATUS

IMPROVED DATA EVALUATION

- SLOWER DEPRESSURIZATION NOT CAUSED BY BUNDLE VAPORIZATION
- VAPORIZATION DATA BASE REPRESENTATIVE AFTER 40 SECONDS
- SIMILAR RESPONSE FOR PEAK AND AVERAGE BUNDLES
- NO BWR PARALLEL CHANNEL INTERACTION POTENTIAL
- HIGH HEAT TRANSFER EFFECTS DOMINATE
- NET RESULTS VERY FAVORABLE

PLANNED TLTA EFFORTS

- DETAILED EVALUATIONS CONTINUING
- IMPROVED CODE ANALYSES EFFORTS
- MEASUREMENT IMPROVEMENTS
- ADDITIONAL TESTS
- IMPROVED FACILITY AWAITING NRC APPROVAL

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L E I B N I T Z R U L E

BACKGROUND

- BOUNDING MODELS INCLUDE VARIOUS APPROXIMATIONS

  DOCUMENT NEDO 10329

- APPROXIMATION CHALLENGED AS NOT MATHEMATICALLY RIGOROUS

- NRC STAFF CONCERN THAT THIS IS A LARGE EFFECT

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LEIBNITZ

(CONTINUED)

RESULTS/STATUS

- NET EFFECT IS TO ACCELERATE LEVEL MOVEMENTS
- SAMPLE CALCULATIONS BEING MADE WITH FULL LEIBNITZ RULE
- EFFECT ON PCT FOUND TO BE SMALL $< \pm 10°F$

ACTION/STATUS

- SAFE CODE CALCULATION VERIFICATION IN PROGRESS
- REFLOOD CODE BEING ASSESSED
- EXPECT TOTAL EFFECT TO BE $< \pm 20°F$

CONCLUSION

- SECOND ORDER EFFECTS
- ORIGINAL APPROXIMATION VALID

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ECCS PROGRAM COMMENTS

- RECENT TLTA DATA INTERPRETATION FAVORABLE
- VAPORIZATION CORRELATION IS APPROPRIATE
- NRC TECHNICAL CONCERNS BEING RESOLVED FAVORABLY
- LARGE MARGINS BEING CONFIRMED - TLTA/EM
- MARJOR RESOURCE COMMITMENT ALREADY EXPENDED
- MAJOR RESOURCE COMMITMENT REQUIRED TO CLOSE CURRENT STAFF REQUESTS
- STAFF REQUESTS CONTINUE
- GE SHOULD CONCENTRATE FUTURE RESOURCES ON MORE IMPORTANT BEST ESTIMATE WORK

HHK
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AGENDA - TECHNICAL PRESENTATION

INTRODUCTION	A. J. LEVINE
LATEST TLTA INTERPRETATIONS	G. E. DIX
TLTA/EM COMPARISON RESULTS	A. S. RAO
REACTOR IMPLICATIONS LEIBNITZ RULE HIGH HEAT TRANSFER	A. S. RAO
STATUS OF DEVELOPMENT OF IMPROVED LOCA CODES	G. E. DIX
SUMMARY AND CONCLUSIONS	A. J. LEVINE

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TLTA/IMPROVED LOCA MODEL

PURPOSE OF MEETING

- DESCRIBE ADDITIONAL INTERPRETATIONS RESULTING FROM EVALUATION OF TLTA DATA
- PROVIDE PRELIMINARY RESULTS OF THE TLTA/EM COMPARISON
- DESCRIBE WHAT GE IS DOING AND HAS DONE IN AN ATTEMPT TO OBTAIN AN IMPROVED LOCA MODEL
- OBTAIN UPDATE ON REVIEW SCHEDULE OF GE MODEL SUBMITTALS
- DISCUSS THE GE TLTA DRAFT PROPOSAL LETTER

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TLTA MATRIX

NRC REQUESTS	GE PLANS
"SEPARATE EFFECTS"	"OVERALL RESULTS"
3 COMPARISONS (TLTA TESTS) AVG. ECCS, AVG. POWER LOW ECCS, AVG. POWER LOW ECCS, HIGH POWER	1 COMPARISON AVG. ECCS, AVG. POWER* *ALREADY COMMITTED FOR 6/79 WORK IN PROCESS, WILL COMMIT TO EVALUATE NEED FOR ADDITION COMPARISONS AFTER 6/79
7 SEPARATE PHENOMENA TEMP, PRESSURE, BUNDLE MASS/LEVEL LOWER PLENUM MASS/LEVEL, BREAK FLOW, CORE INLET FLOW, BUNDLE STEAM FLOW (IN/OUT)	1 SYSTEM PHENOMENA - PCT (6007, 6406)
4 SENSITIVITY STUDIES STEAM GENERATION, BUNDLE WATER HOLDUP (SAFE & REFLOOD)	BOUNDING APPROXIMATION CALCULATIONS

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S U M M A R Y

- GE's TLTA PROPOSAL APPROPRIATE BASED ON NEW INFORMATION
  - GE TO COMPLETE VERIFICATION OF PRELIMINARY RESULTS
  - TASK COMPLETION - JUNE '79
  - GE WILLING TO CONSIDER ADDITIONAL COMPARISONS AT THAT TIME IF APPROPRIATE
- GE's COMMITMENT TO LOCA MODEL IMPROVEMENT CONTINUES TO BE SUBSTANTIAL
  - CONSIDERABLE EFFORT ON ZEUS & THRST
- GE BELIEVES BEST ESTIMATE MODEL IS JUSTIFIED
  - JOINT EPRI/NRC/GE PROPOSAL

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TLTA DATA INTERPRETATION

TECHNICAL DETAILS

- TEST DESCRIPTION SUMMARY
- SYSTEM FLUID LEVEL
  - CONDITIONS IN BUNDLE
  - COMPARISON WITH VAPORIZATION DATA BASE
- ECC EFFECTS ON DEPRESSURIZATION
  - BUNDLE VAPORIZATION
  - BREAK FLOW CONDITIONS

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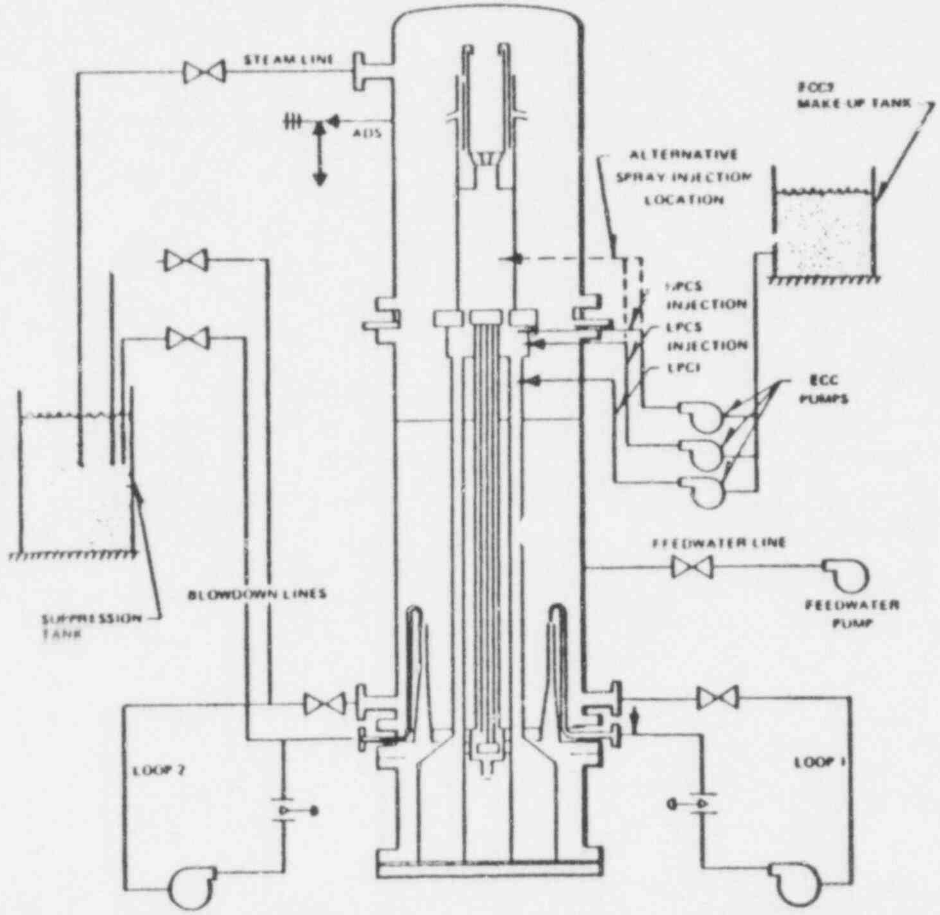
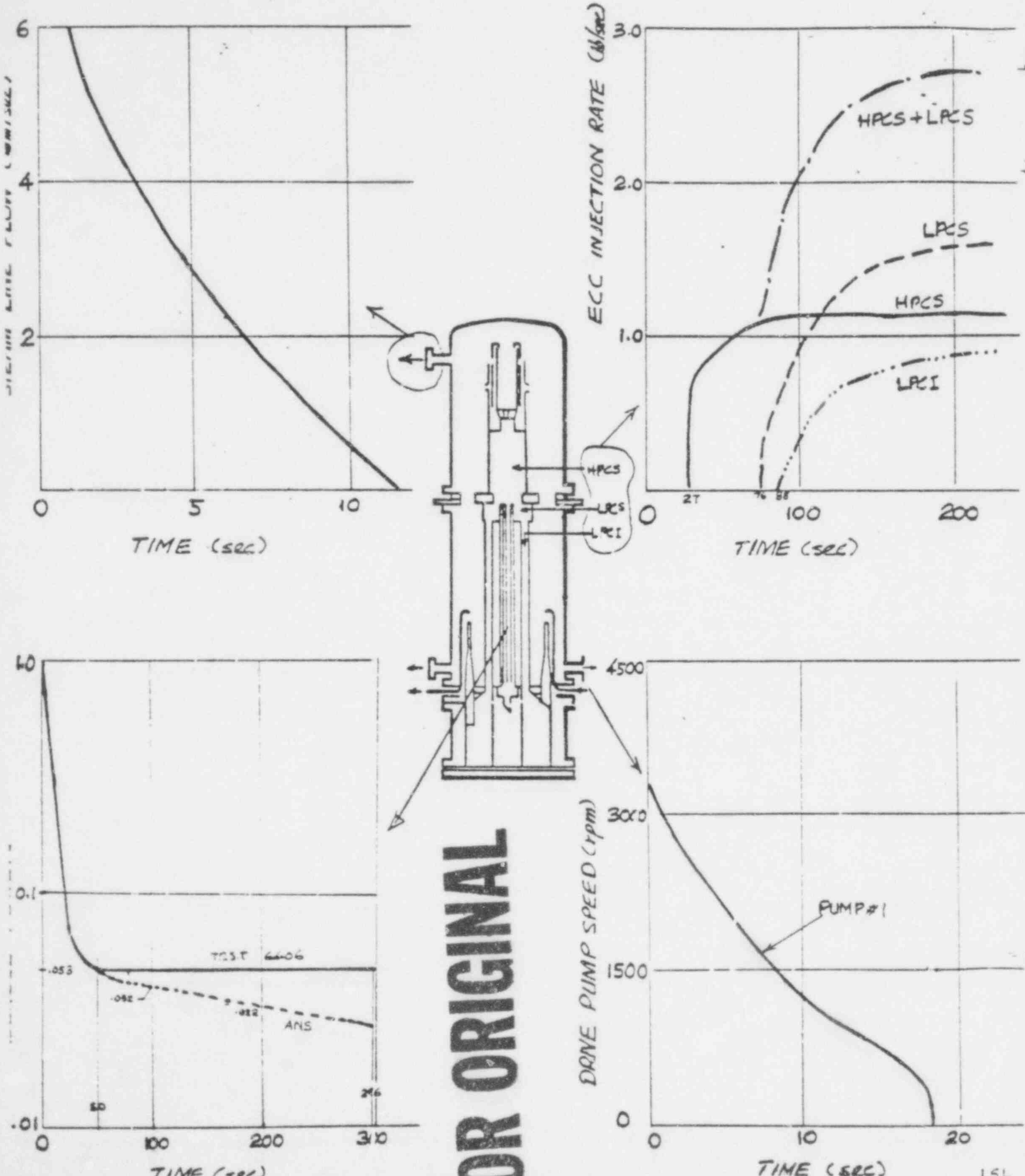
TWO LOOP TEST APPARATUS (TLTA-5) WITH EMERGENCY CORE COOLING SYSTEMS



REFERENCE TEST (AVE. POWER, AVE ECC) B.C.

6406 RUN 1



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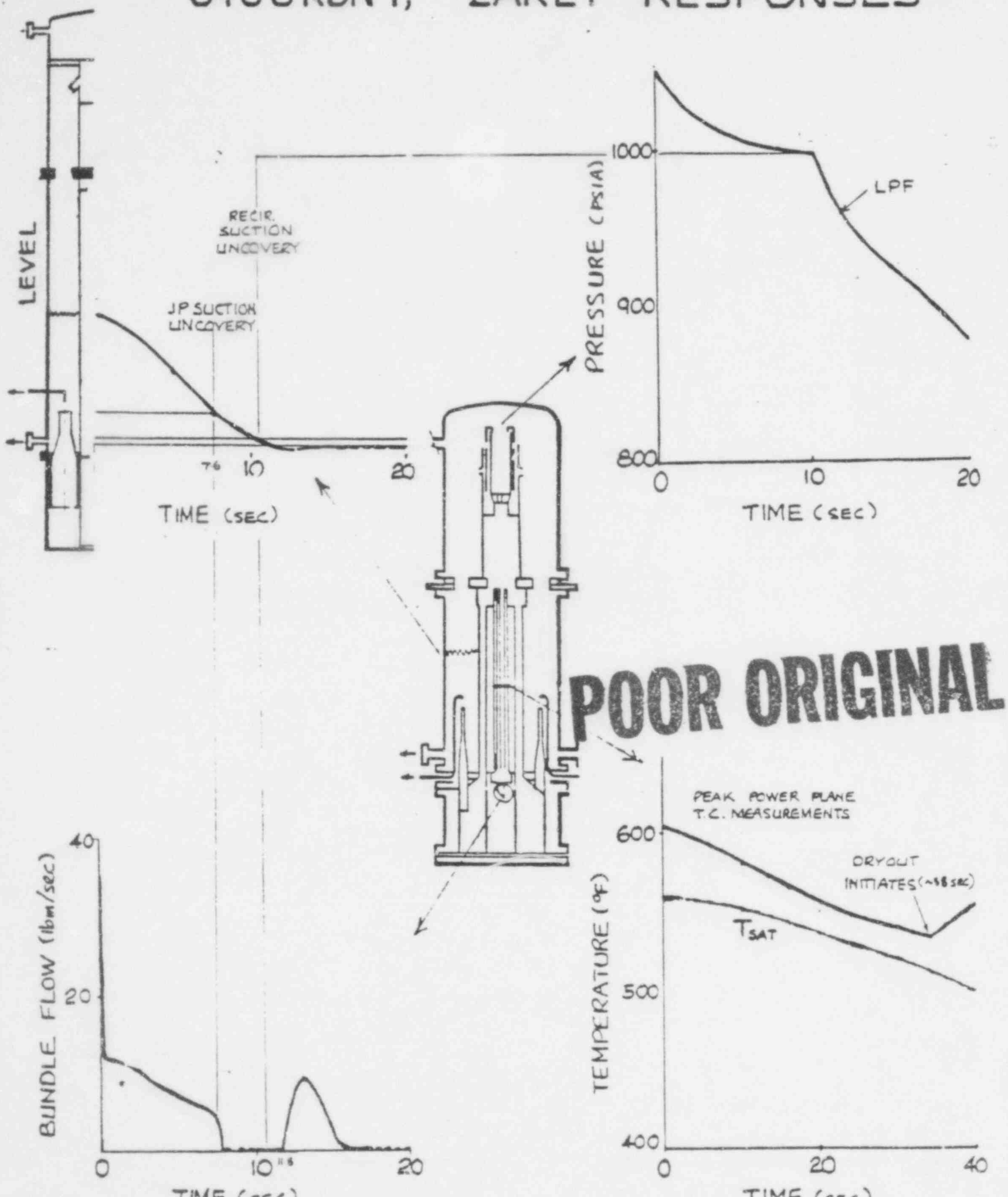
6406 RUN 1, EARLY RESPONSES



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SYSTEM FLUID LEVELS

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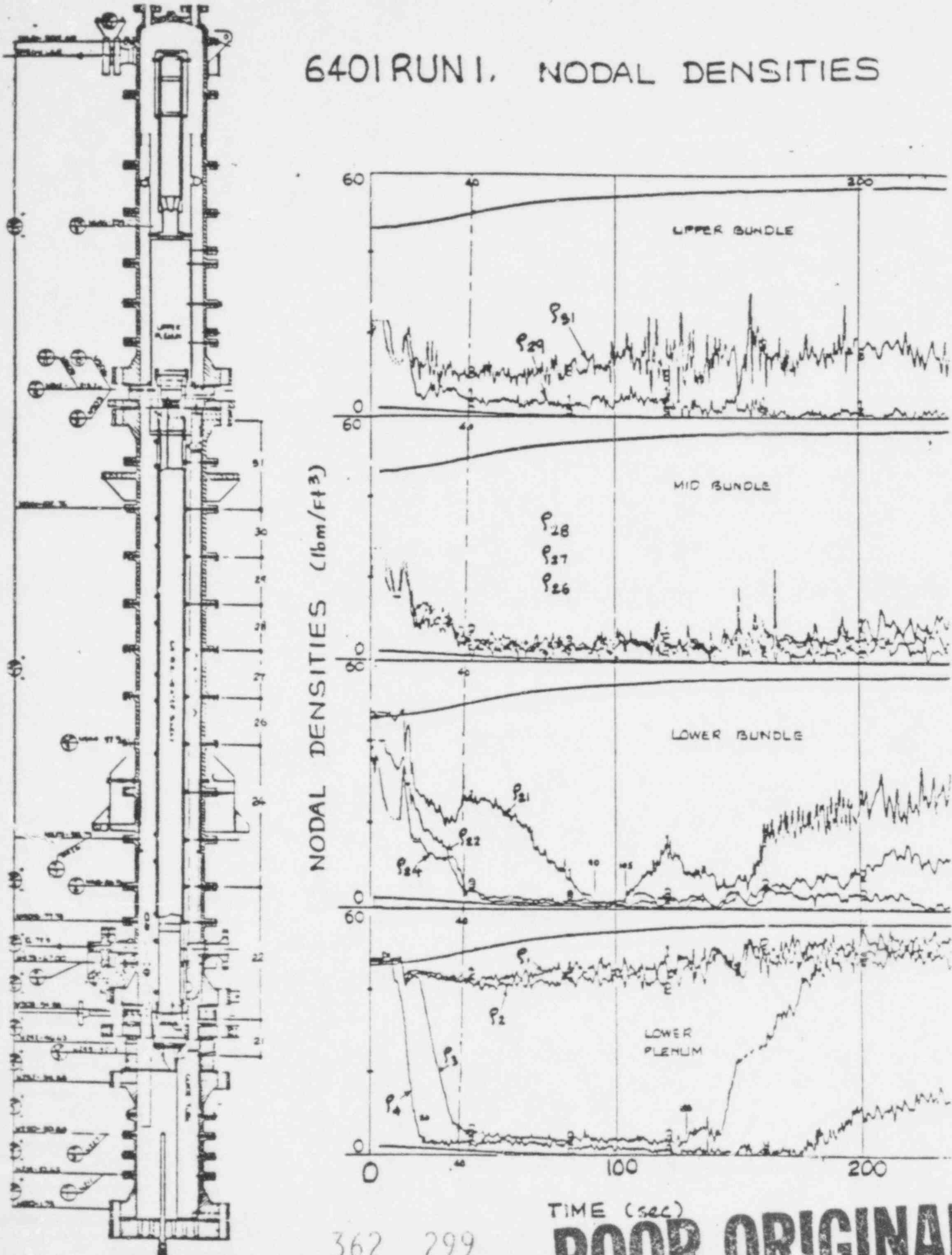
6401 RUN 1. NODAL DENSITIES
NODAL DENSITIES (lbm/ft3)
UPPER BUNDLE
MID BUNDLE
LOWER BUNDLE
LOWER PLENUM
ρ31
ρ29
ρ28
ρ27
ρ26
ρ21
ρ22
ρ24
ρ1
ρ2
ρ3
ρ4
60
0
40
100
200
TIME (sec)

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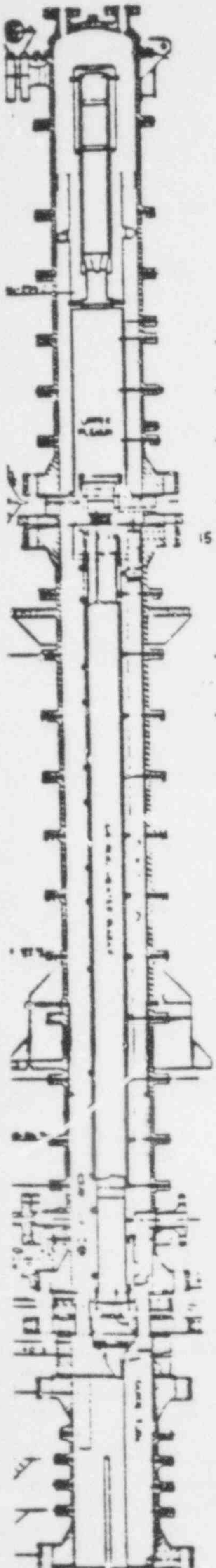
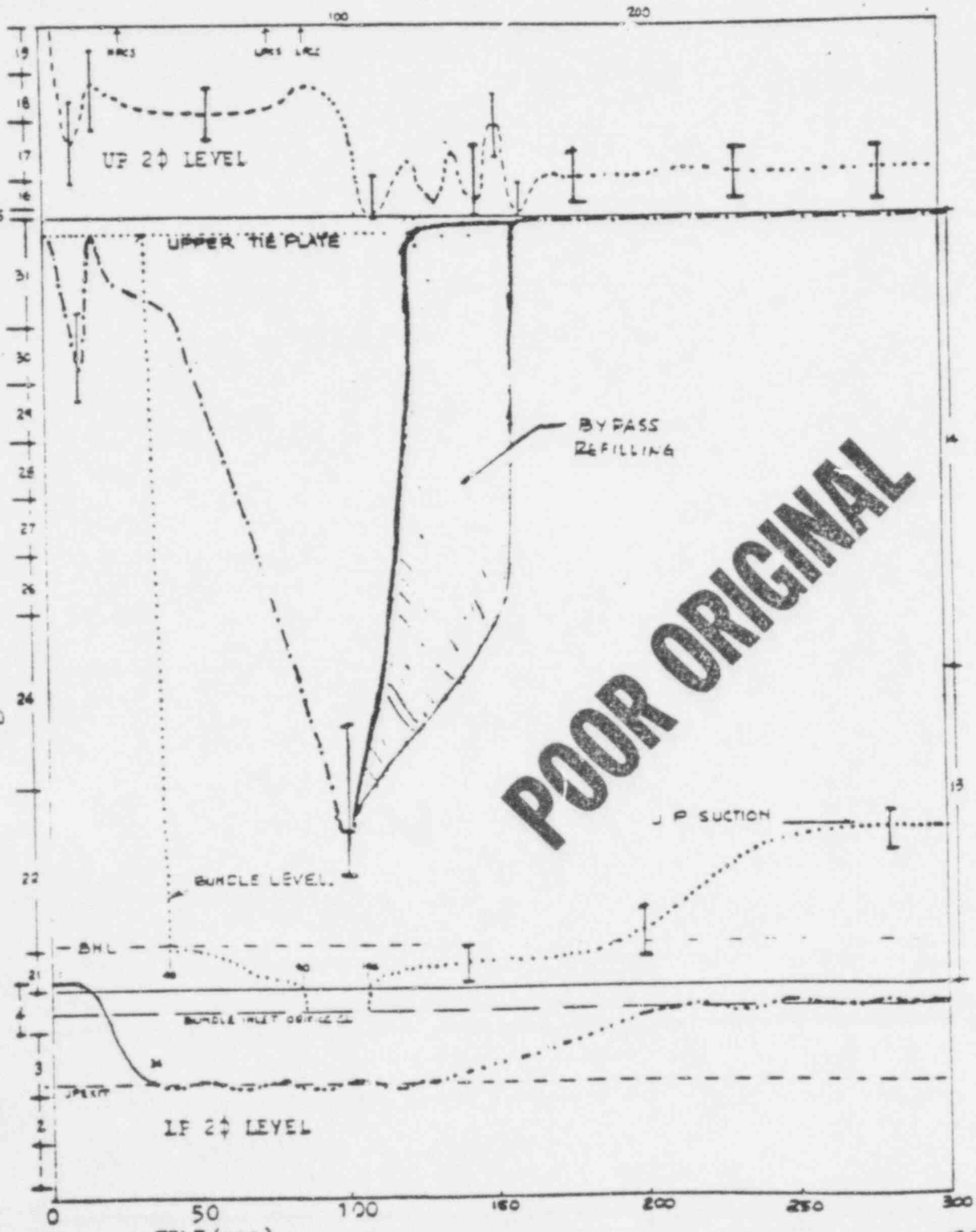
6406 RUN 1 TWO-PHASE LEVELS

SHOW TLTA REFILLING





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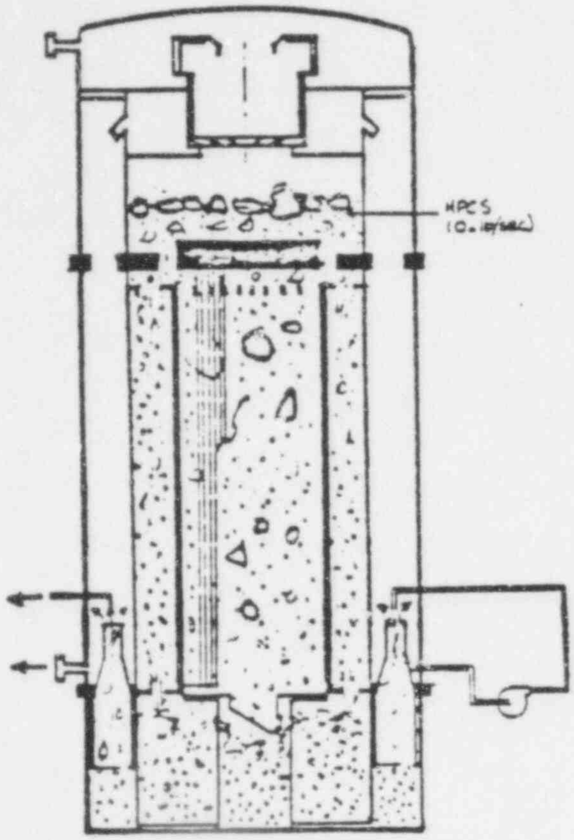
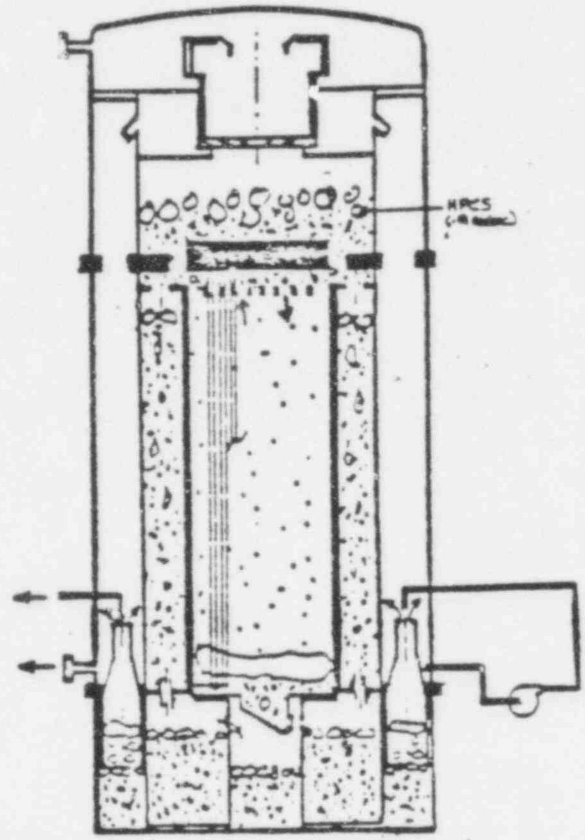
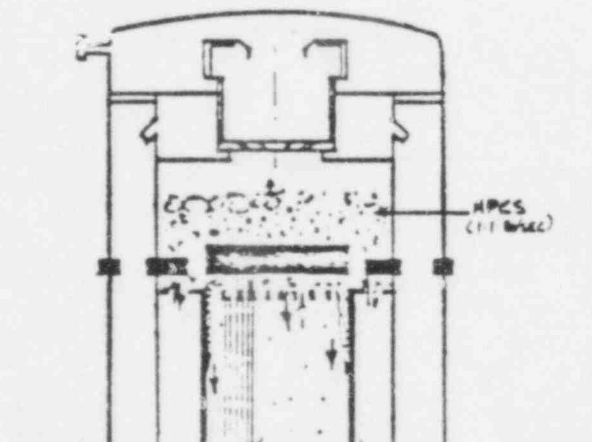


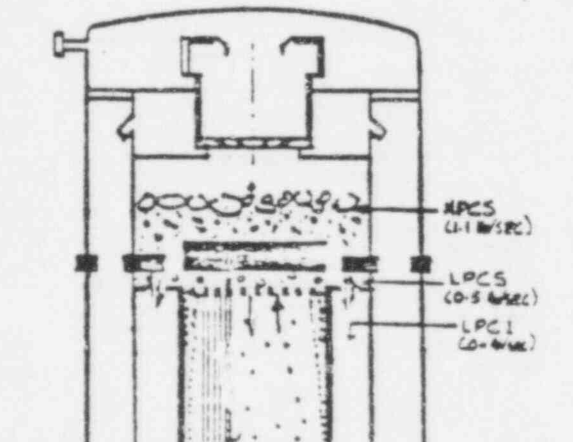
a, 6406/1 HPCS FLOW INCEPTION
(27 SEC)



b, 6406/1 JET PUMP EXIT EXPOSURE
(~ 40 SEC)



c, 6406/1 P DIFFERENCE DISCERNIBLE
(~ 64 SEC)



d, 6406/1 LPCS AND LPCI INJECTING
(~90 SEC)

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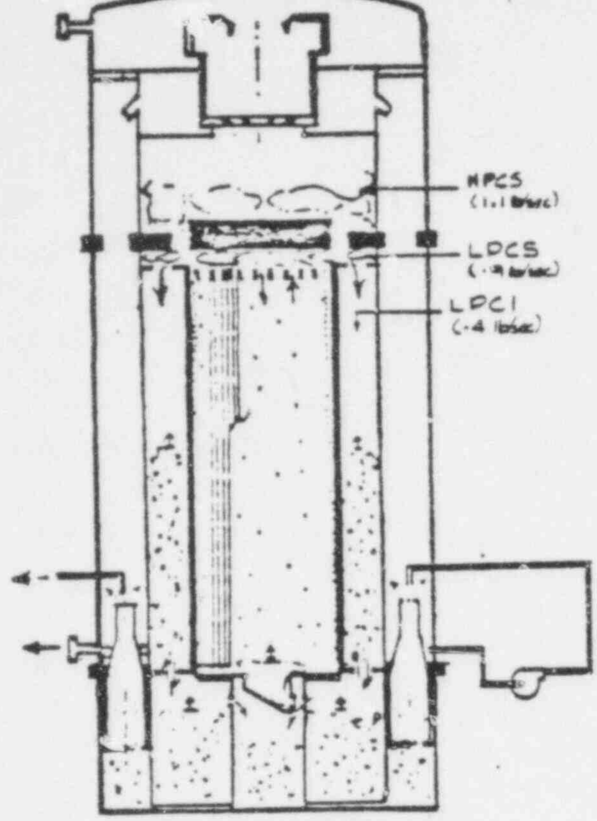
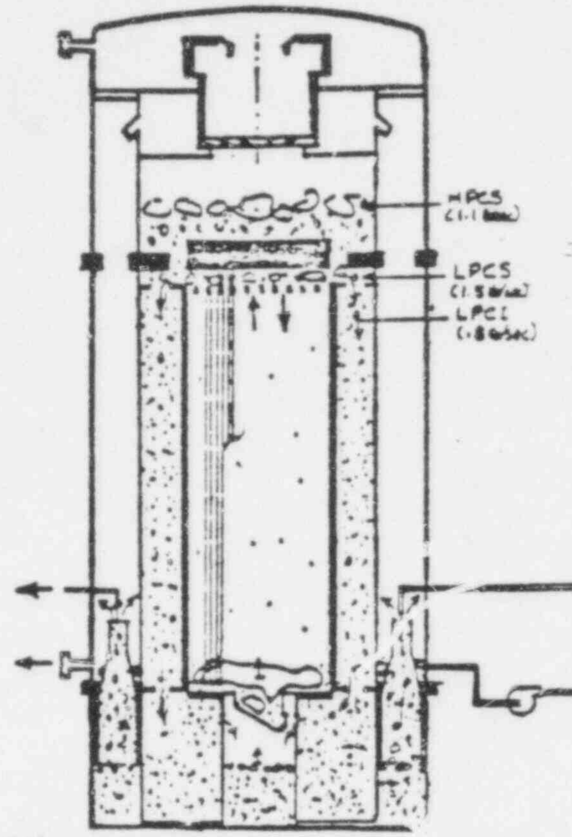
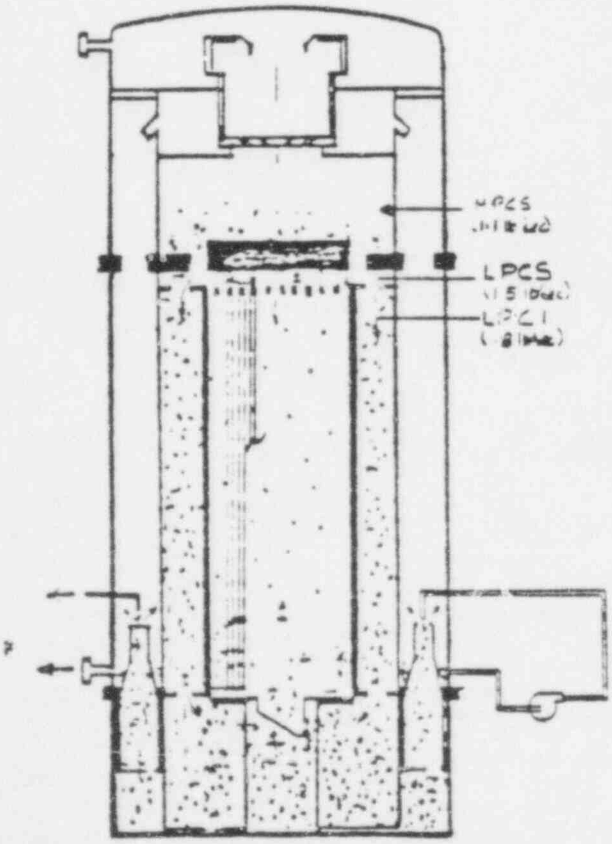


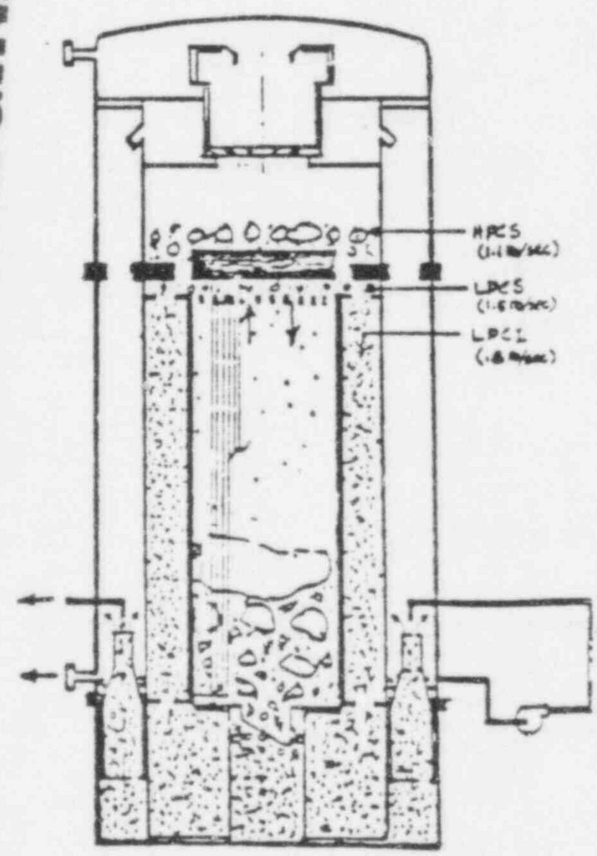
e, 6406/1 CCFL BREAKS DOWN AT BYPASS
(~ 105 SEC)



f. 6406/1 JET PUMP REFILLED WI... LIQUID
(~ 150 SEC)



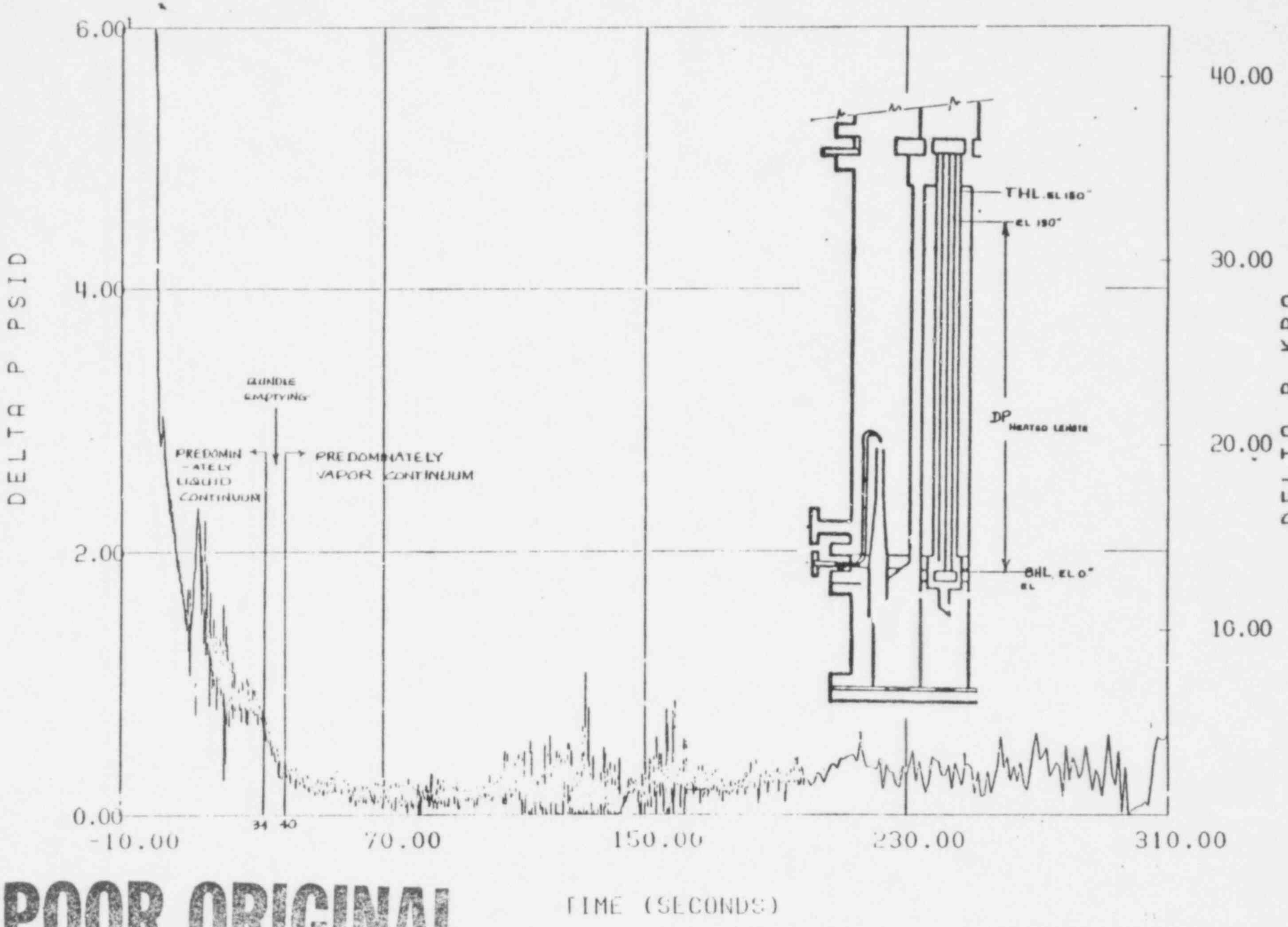
g. 6406/1 SYSTEM FILLING
(~ 160 SEC)



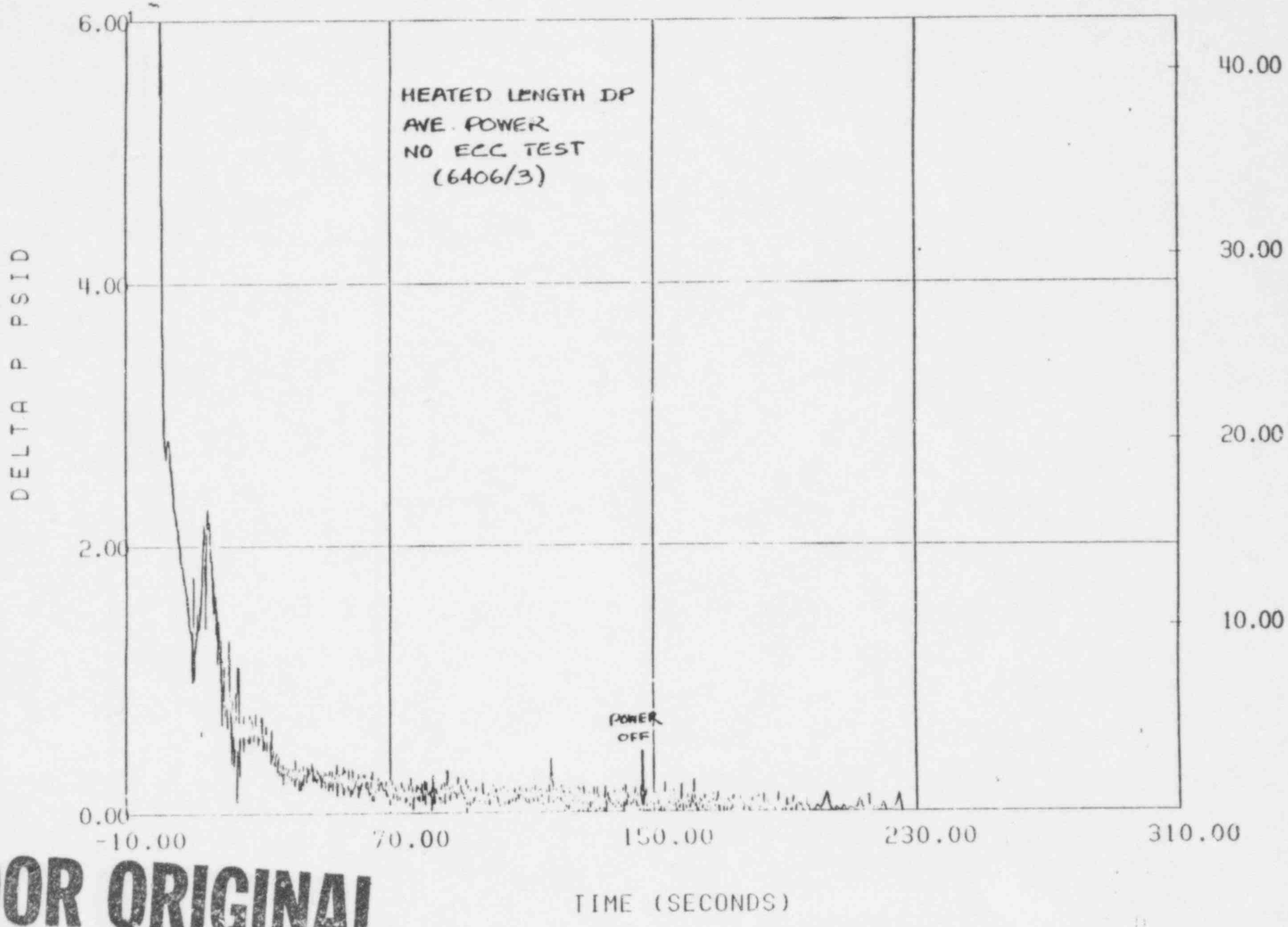
h. 6406/1 TLTA REFILLED
(~200 – 300 SEC)

362 302

BUNDLE DIFFERENTIAL PRESSURE FOR AVE. POWER AVE. ECC TEST (6406/1)



362 303



POOR ORIGINAL

362 304

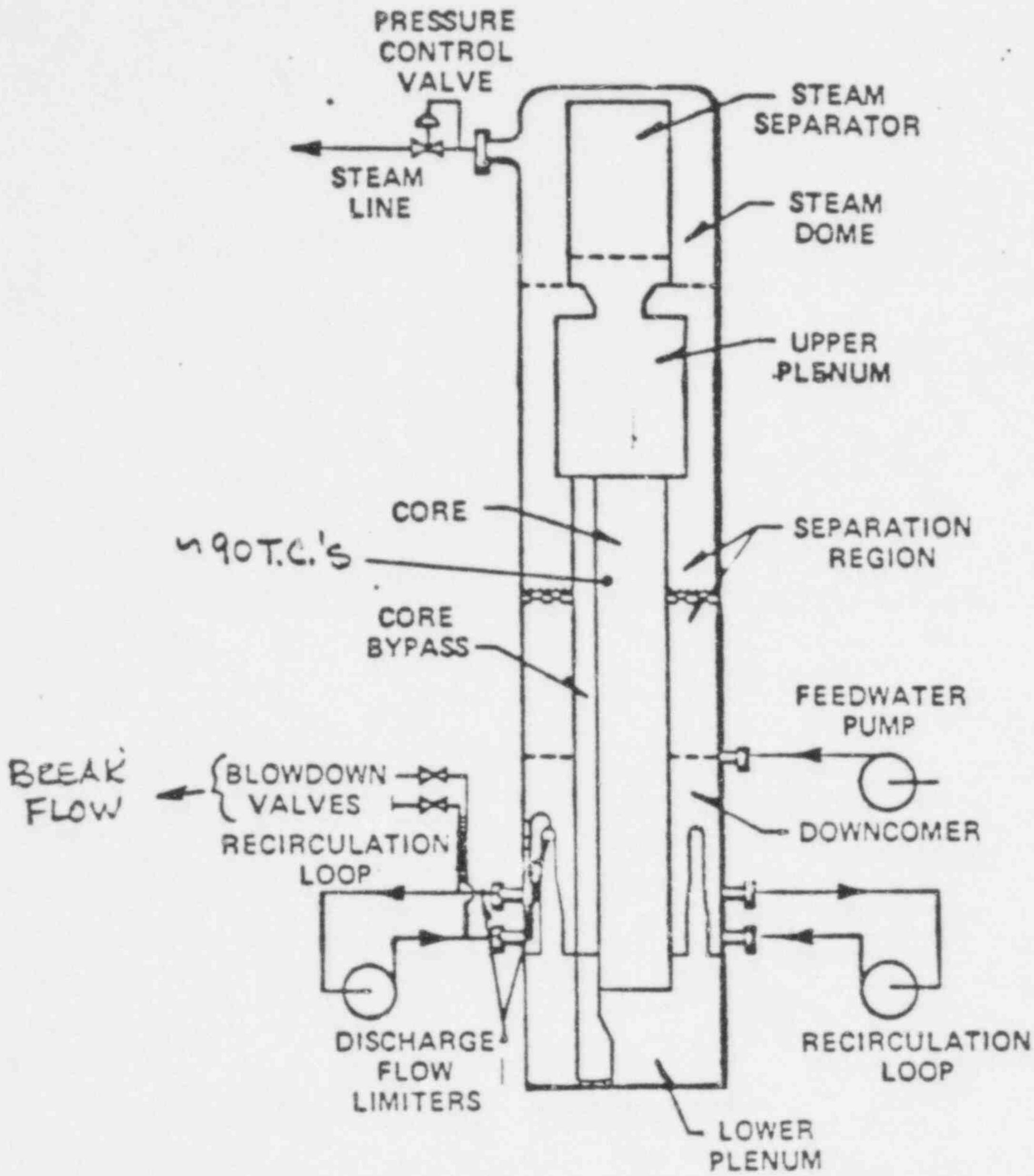
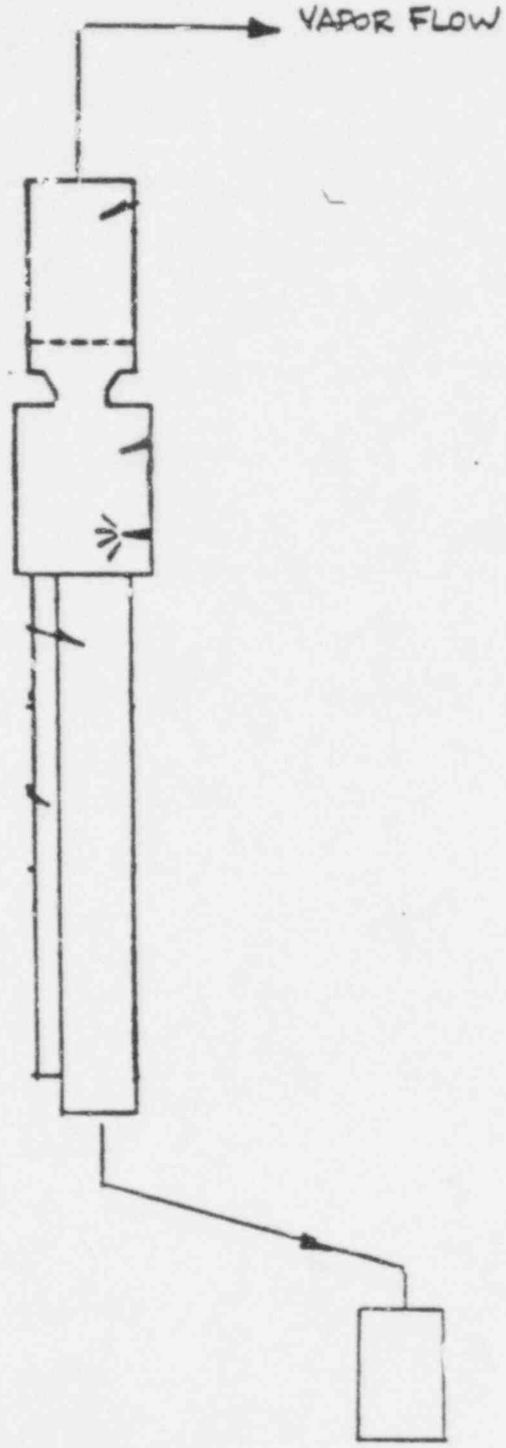


FIGURE 2. TWO-LOOP TEST APPARATUS

POOR ORIGINAL

GED
5/24/79

362 305



VAPORIZATION TESTS

BUNDLE VAPORIZATION CONCLUSIONS

- HIGHER BUNDLE VAPORIZATION BEFORE JET PUMP UNCOVERY
  - 40 SEC IN TLTA
  - 30 TO 45 SEC FOR REACTOR

- VAPORIZATION DATA BASE ENTIRELY REPRESENTATIVE SUBSEQUENTLY
  - BUNDLE AND SYSTEM CONDITIONS MATCHED
  - CORRELATION CONSERVATISMS APPLICABLE

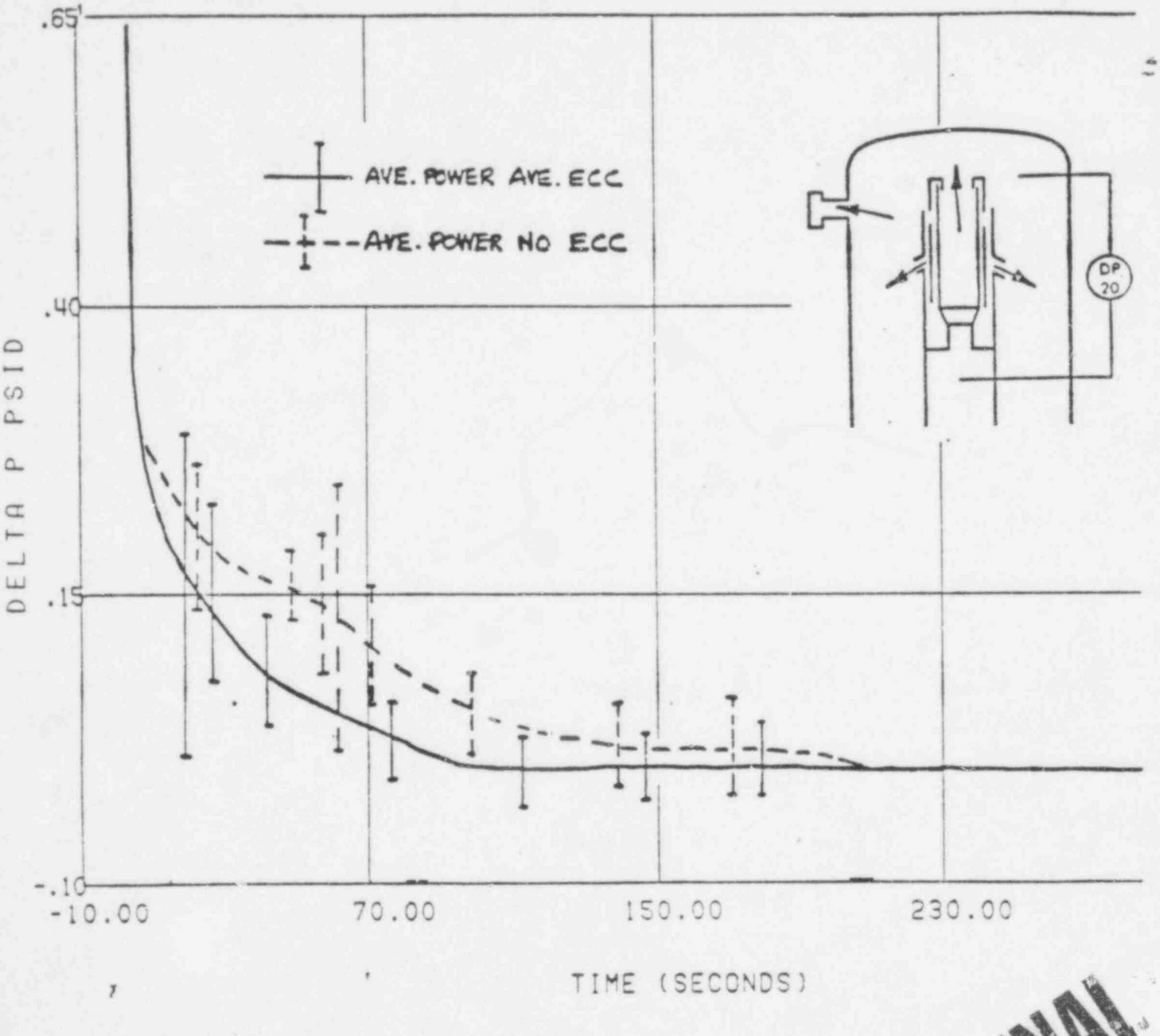
GED
5/24/79

ECC EFFECTS ON DEPRESSURIZATION

GED
5/24/79

362 308

PRESSURE DROP ACROSS STEAM SEPARATOR FOR
AVERAGE POWER TESTS

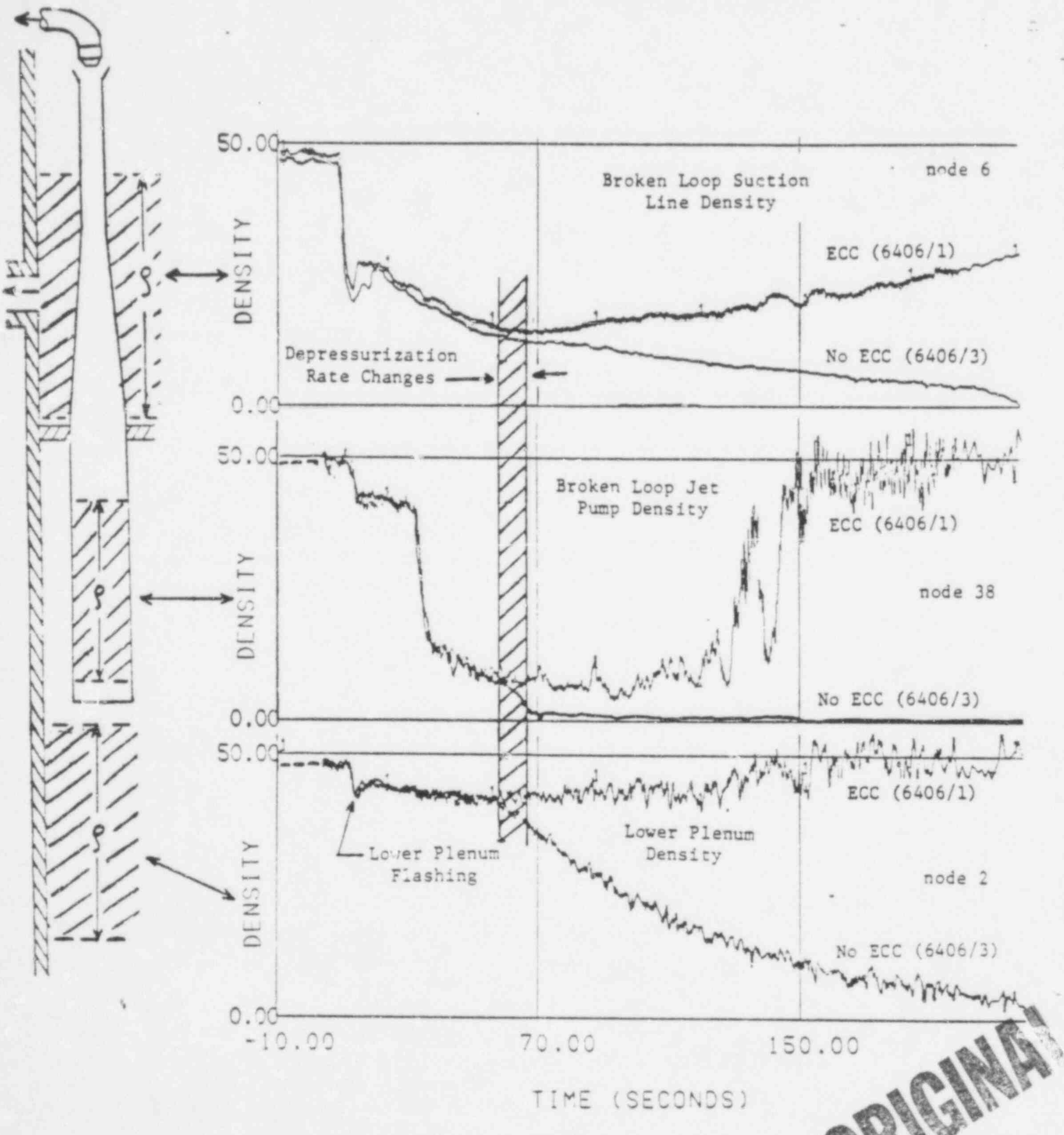


POOR ORIGINAL

362 309

GED
5/79

BREAK FLOW DENSITY COMPARISON



362 310

ECC DEPRESSURIZATION CONCLUSIONS

- CORE REGION CONTRIBUTED LESS STEAM WITH ECC
- PRESSURE VESSEL REWET MAY HAVE INCREASED STEAM FLOW
- SLOWER DEPRESSURIZATION CONTROLLED BY INCREASED LIQUID BREAK FLOW

GED
5/24/79

(5)

TLTA/EM COMPARISON RESULTS

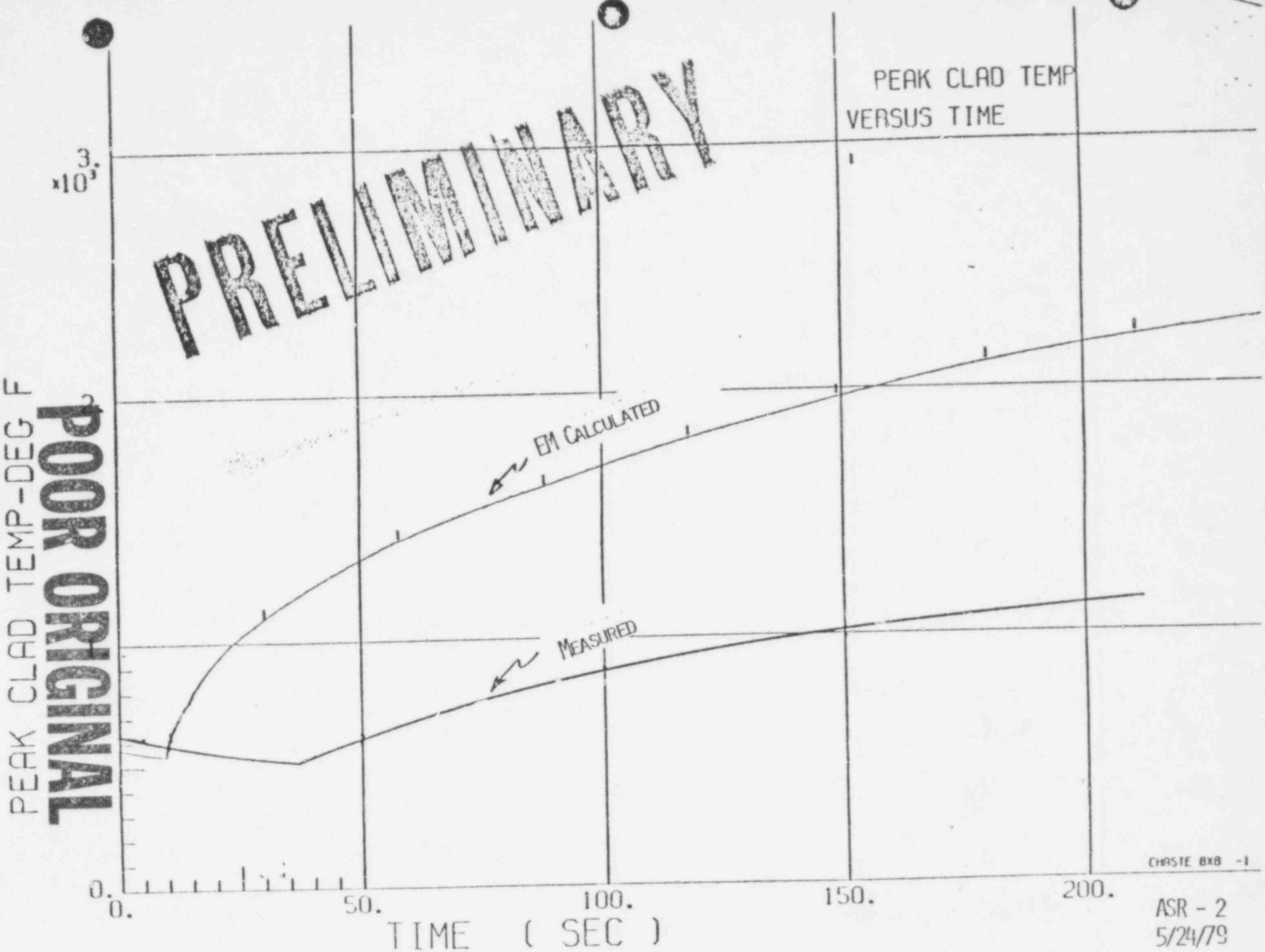
- PURPOSE: DEMONSTRATE CONSERVATISM IN EM CALCULATION OF PCT

- BACKGROUND
  - PREVIOUS CALCULATION SHOWED 1000F CONSERVATISM
    - 7 X 7 FUEL
    - BLOWDOWN PHASE ONLY
    - HOT AND AVERAGE BUNDLES
  - CURRENT CALCULATION
    - 8 X 8 FUEL
    - BLOWDOWN AND ECC PHASES
    - AVERAGE BUNDLE ONLY
  - CODES USED
    - LAMB/SCAT FOR BLOWDOWN PHASE
    - SAFE/REFLOOD FOR ENTIRE TRANSIENT
    - CHASTE FOR PCT CALCULATION
  - ASSUMPTIONS
    - MEASURED POWER AND DIMENSIONS
    - STANDARD APPENDIX K ANALYSIS ASSUMPTIONS

CONCLUSION: PRELIMINARY CALCULATION SHOWS EM CONSERVATIVELY CALCULATES PCT BY 1000F

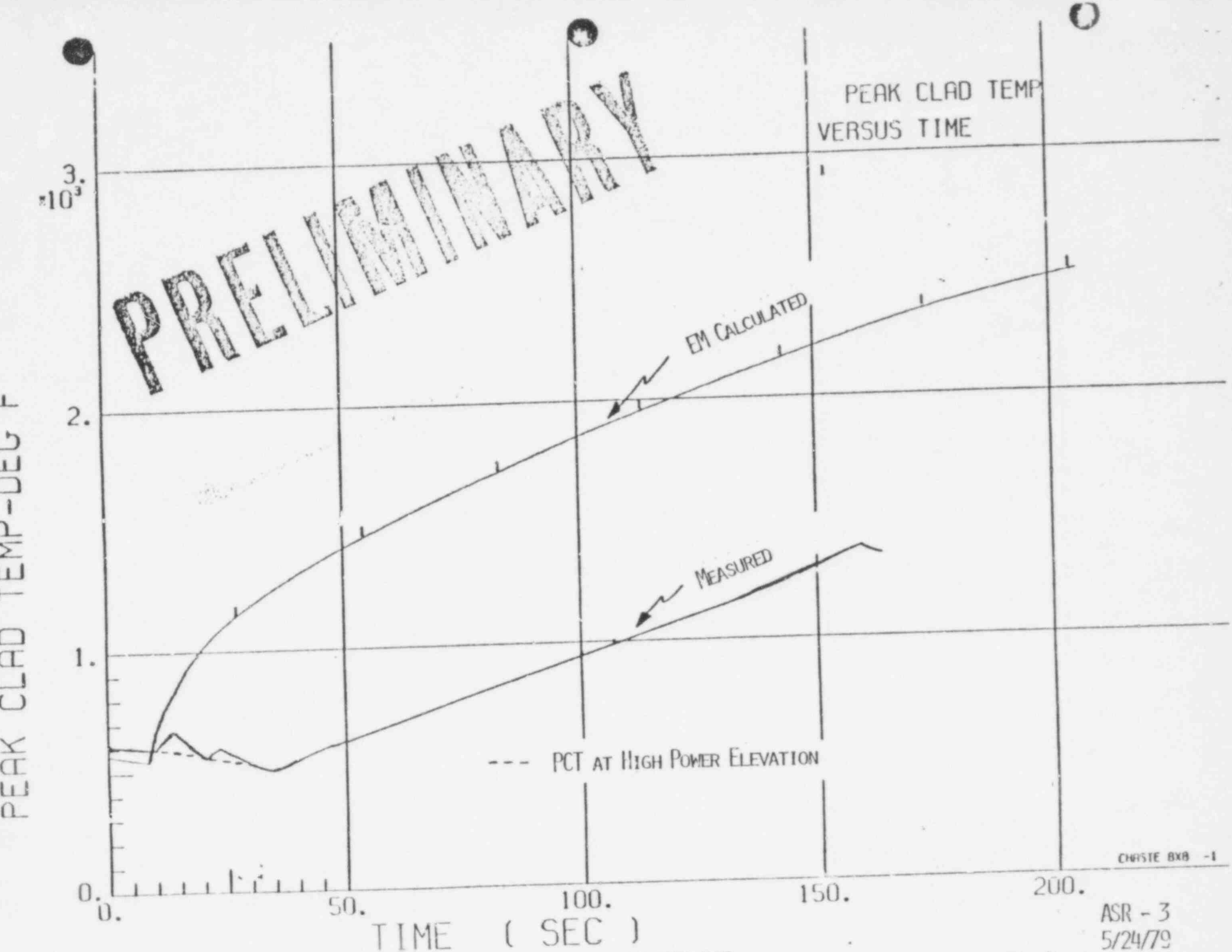
ASR - 1
5/24/79

362 312



ASR - 2
5/24/79

FIGURE 1 TEST WITH ECC MEASURED AND EM CALCULATED PCT



ASR - 3
5/24/79

FIGURE 1 TEST W/O ECC MEASURED AND EM CALCULATED PCT

POOR ORIGINAL

362 314

SUMMARY AND CONCLUSION

- CURRENT CALCULATION CONFIRMS PREVIOUS CONCLUSIONS ABOUT CONSERVATISM OF PCT CALCULATION USING EM

- MAJOR AREAS OF CONSERVATISM
  - BLOWDOWN HEAT TRANSFER - NUCLEATE BOILING TILL UNCOVERY (DELAYED)
  - HIGHER ECC PHASE HEAT TRANSFER

- OVERALL LARGE CONSERVATISM OF EM OVERSHADOWS ANY UNCERTAINTIES ABOUT SUB-MODELS

ASR - 4
5/24/79

REACTOR IMPLICATIONS

- LEIBNITZ RULE
  - PREVIOUSLY DOCUMENTED
  - SMALL PCT SENSITIVITY

- HIGH HEAT TRANSFER
  - SEPARATE EFFECTS
    - LOWER PCT
  - CONSISTENT APPLICATION
    - EVEN LOWER PCT

CONCLUSION: CURRENT CODES NEED NOT BE CHANGED

ASR - 5
5/24/79

LEIBNITZ RULE

- CURRENT APPROXIMATION
  - STEAM VELOCITY LEAVING NODE BASED ON BUBBLE RISE VELOCITY AND BULK VELOCITY ONLY
  - LIQUID CALCULATIONS ARE EXACT

- EXACT CALCULATION
  - STEAM VELOCITY SHOULD INCLUDE INTERFACE VELOCITY
  - ONLY SIGNIFICANT WHEN LEVEL CHANGES ARE VERY RAPID (~10 SECS OUT OF 200 SECS)

- REPRESENTATIVE PLANT STUDIES SHOW SMALL SENSITIVITY TO CHANGES IN SAFE
  - STUDY DONE USING SAFE (EXACT)/REFLOOD (APPROX.)
  - SAME CONCLUSION EXPECTED FOR SAFE/REFLOOD (EXACT)

CONCLUSION: CURRENT APPROXIMATION IS JUSTIFIED

ASR - 6
3/24/79

CHOICE OF PLANTS

- TWO IMPORTANT PARAMETERS
  - UNCOVERY TIME AND RATE
  - PRESSURE AND DEPRESSURIZATION RATE
    - CCFL
    - FLASHING

UNCOVERY TIME AND RATE	CASE
- FAST (BIG BREAK)	B,E
- MEDIUM (MID-SIZE BREAK	C,D
- SLOW (SMALL BREAK)	F
- AFTER ECC INITIATION	A

PRESSURE/DEPRESSURIZATION RATE	
- HIGH SENSITIVITY	A,C,D
- MODERATE	B
- MINOR	E
- SMALL BREAK (MINOR)	F

- CHOICE OF PLANTS COVERS ALL CLASS OF PLANTS AND EXPECTED RESULTS

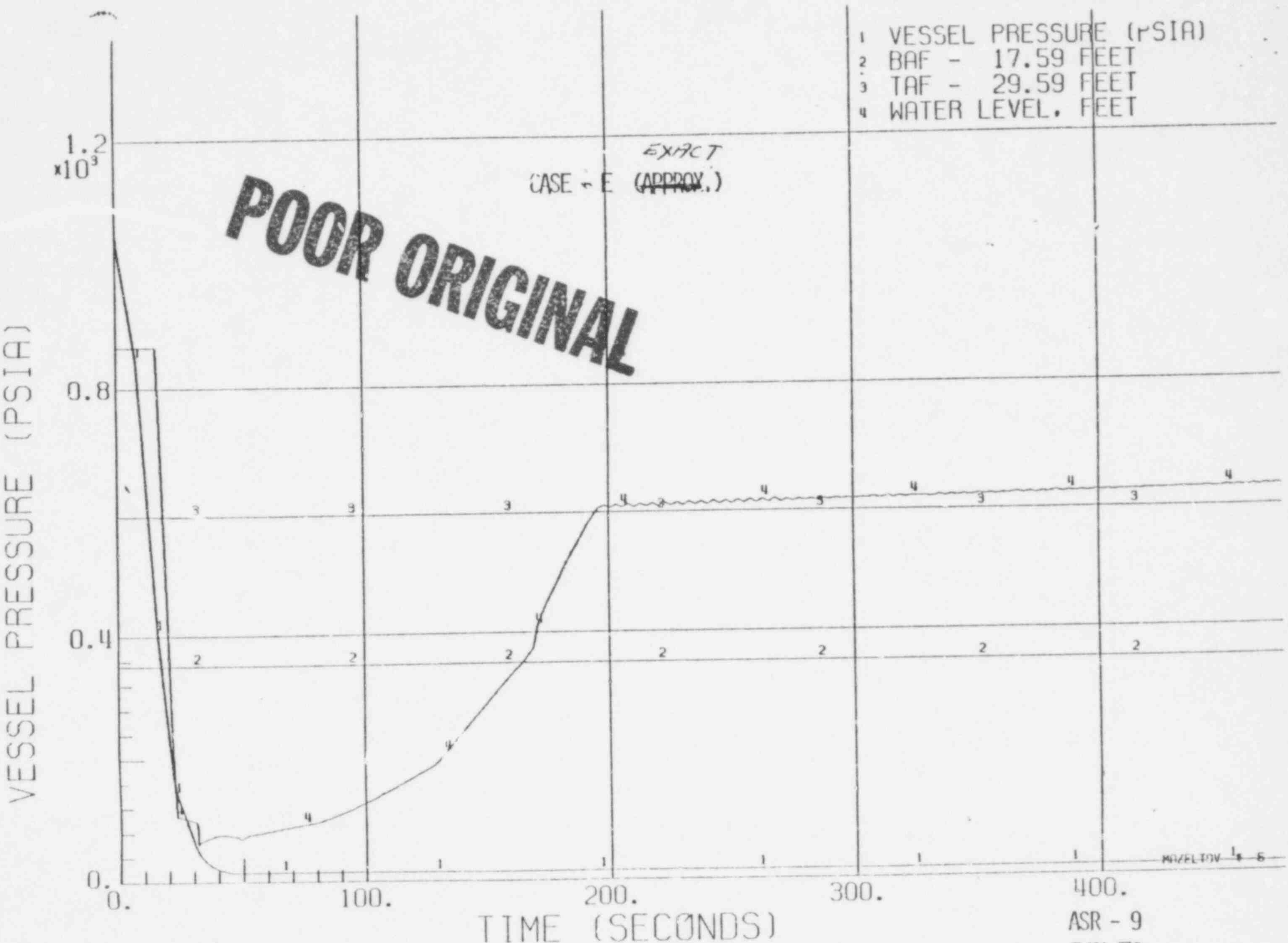
ASR - 7
5/24/79

RESULTS OF CALCULATIONS

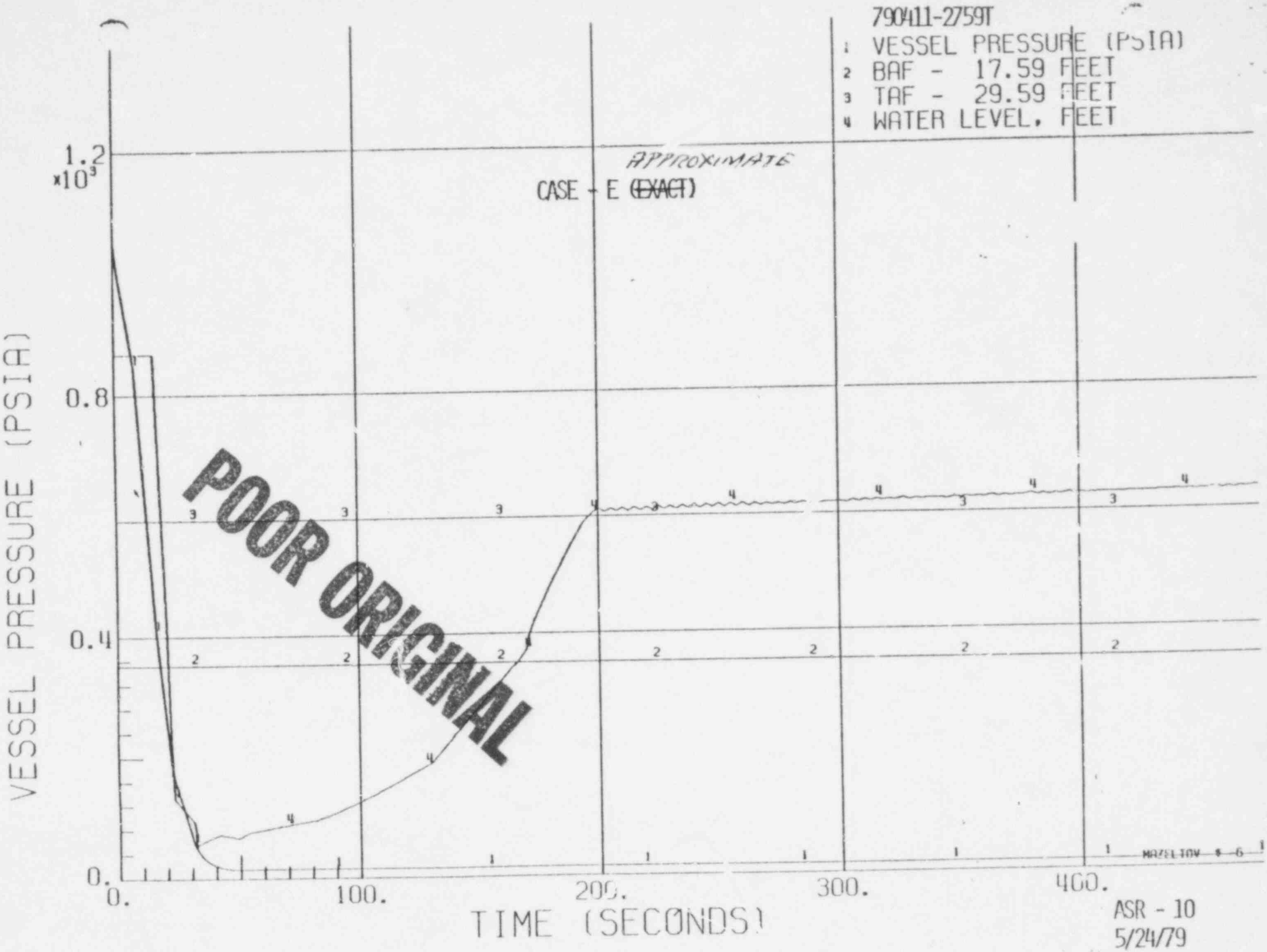
	PLANT/BREAK	REDUCTION IN UNCOVERY TIME	REDUCTION IN REFLOOD TIME	Δ PCT
A	TYPICAL BWR/6	0.6	10.	-40
B	LPCI MOD 251 BWR/4 SUCT DBA	2.5	1.8	+5
C	LPCI MOD 218 BWR/4 DSCG DBA	3.0	5.7	-10
D	LPCI MOD 218 BWR/4 LIMITING DSCG	3.4	7.6	-10
E	TYPICAL BWR/3	2.0	0.8	+5
F	TYPICAL SMALL BREAK BWR/3	0.4	0	+2

- NO SIGNIFICANT CHANGE IN MAJOR PARAMETERS
  - PRESSURE
  - LEVEL
- SMALL PCT SENSITIVITY

790414-6406T



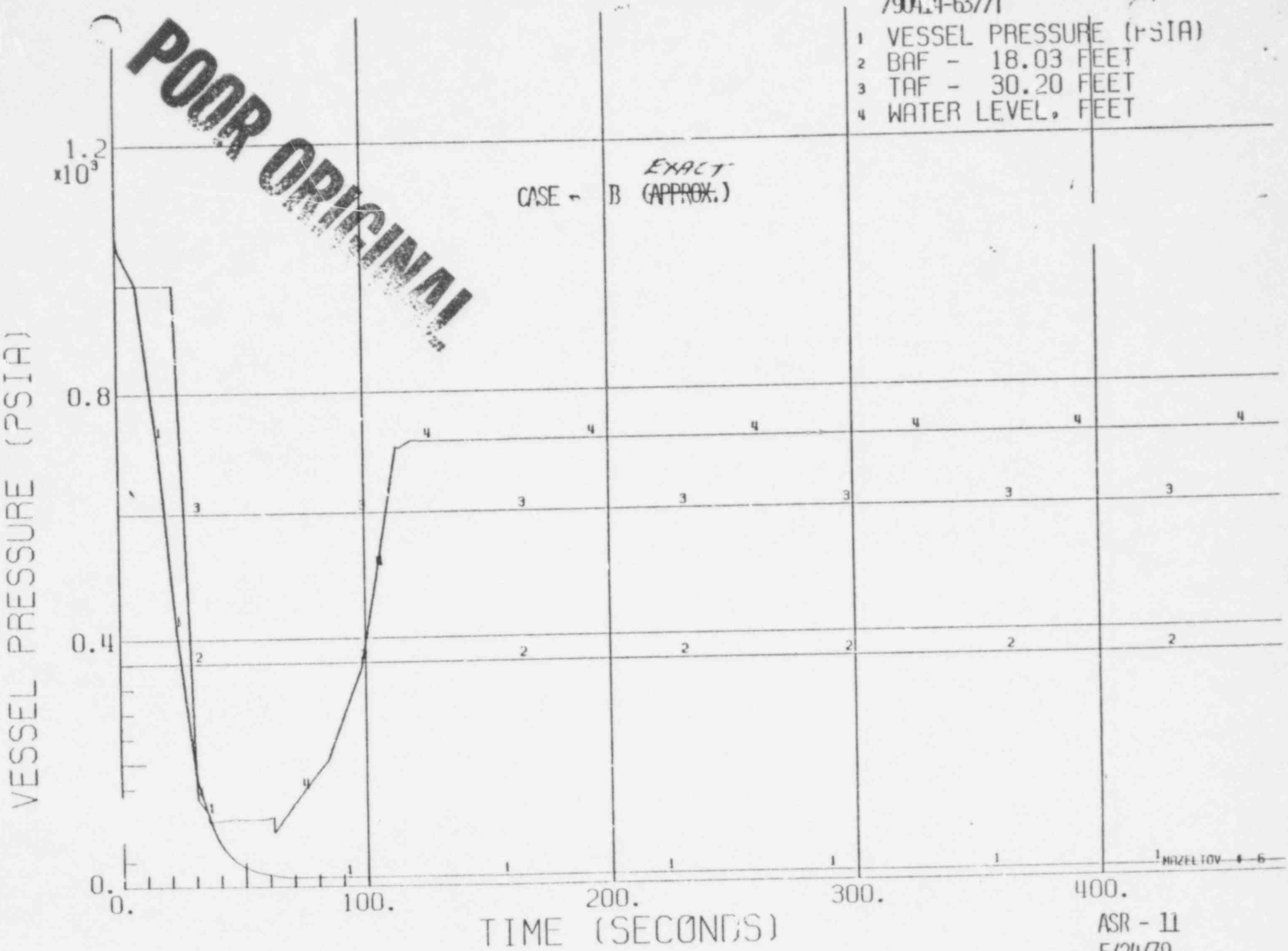
ASR - 9
5/24/79



790411-2759T
1 VESSEL PRESSURE (PSIA)
2 BAF - 17.59 FEET
3 TAF - 29.59 FEET
4 WATER LEVEL, FEET
APPROXIMATE
CASE - E (EXACT)
1.2
x10³
0.8
0.4
0.
VESSEL PRESSURE (PSIA)
0.
100.
200.
300.
400.
TIME (SECONDS)
POOR ORIGINAL
ASR - 10
5/24/79

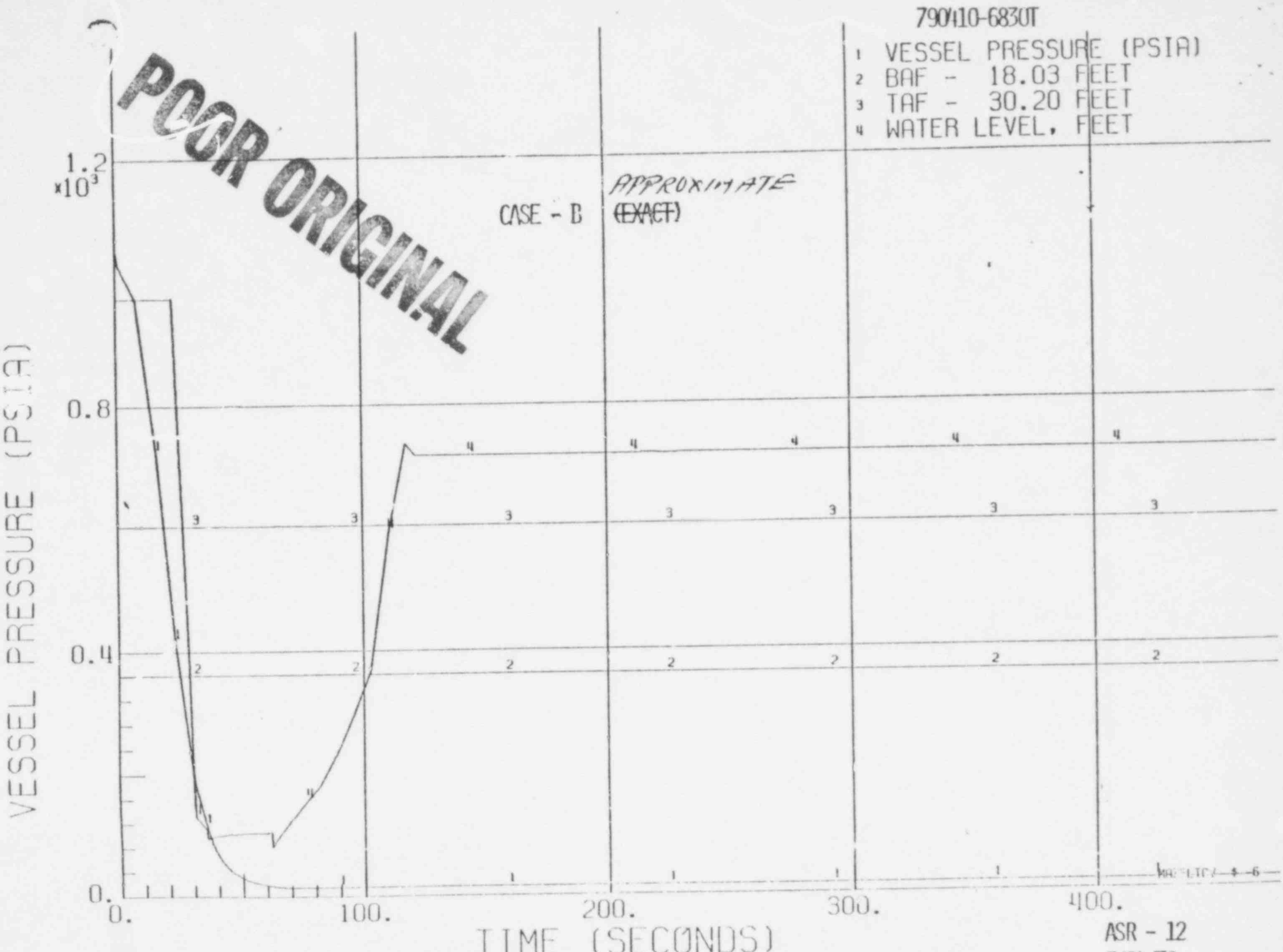
362 321

790414-6377T



362 322

ASR - 11
5/24/79



790410-6830T
1 VESSEL PRESSURE (PSIA)
2 BAF - 18.03 FEET
3 TAF - 30.20 FEET
4 WATER LEVEL, FEET
APPROXIMATE
CASE - B (EXACT)
POOR ORIGINAL
VESSEL PRESSURE (PSIA)
1.2 x10³
0.8
0.4
0.
TIME (SECONDS)
0.
100.
200.
300.
400.

ASR - 12
5/24/79

SUMMARY AND CONCLUSIONS

- APPROXIMATION AS DOCUMENTED IS APPROPRIATE
- EFFECT OF CHANGES IN SAFE IS SMALL
- REFLOOD CHANGES EXPECTED TO BE SMALL

CONCLUSION:	CURRENT CODES NEED NOT BE CHANGED

ASR - 13
5/24/79

EFFECT OF HIGHER HEAT TRANSFER IN EM

- CONSISTENT APPLICATION
  - HIGHER HEAT TRANSFER IN SAFE/REFLOOD
    - AFFECTS VAPORIZATION AND PRESSURE
  - HIGHER HEAT TRANSFER IN CHASTE
    - AFFECTS STORED ENERGY/DECAY HEAT REMOVAL
    - NUCLEATE BOILING OBSERVED IN TLTA
    - LOWER BOUND CORRELATION SUBMITTED TO NRC
- SEPARATE EFFECTS
  - SAFE/REFLOOD CHANGES LOWER PCT
  - CHASTE EFFECT BIGGER THAN SAFE (300 vs 95F)
- CONCLUSION
  - EVALUATION MODEL TREATMENT OF HEAT TRANSFER IS OVERLY CONSERVATIVE

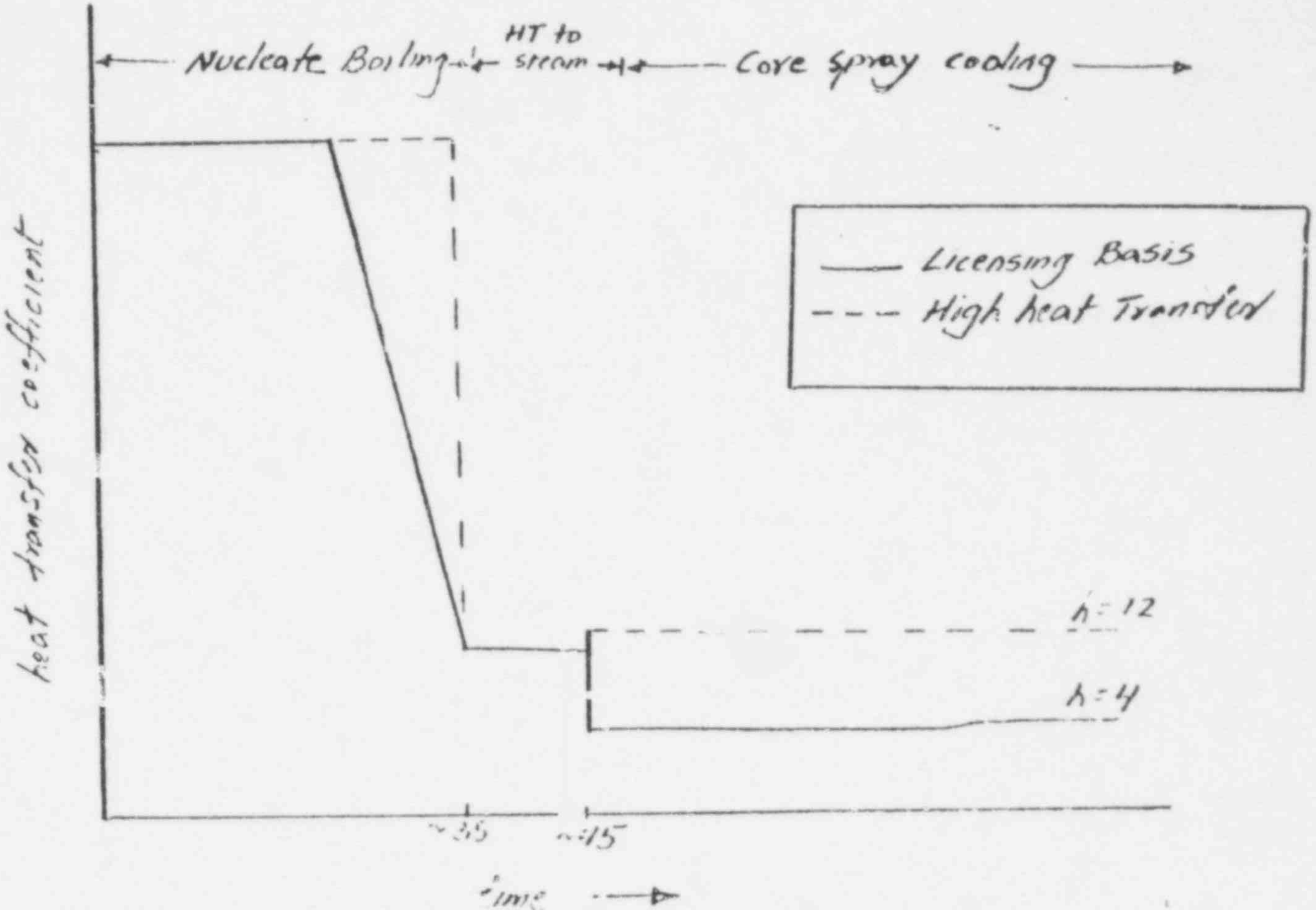
ASR - 14
5/24/79

SAMPLE CALCULATION

- PLANT SELECTED (218 BWR/4)
  - LARGEST SENSITIVITY TO VAPORIZATION AND PRESSURE
  - LIMITING BREAK - 86% DBA
- CONSISTENT APPLICATION
  - PCT DECREASES BY 335F
- SEPARATE EFFECTS
  - SYSTEM CODE (SAFE/REFLOOD) CHANGES ONLY
    - PCT DECREASES BY 95F
  - HIGH POWER BUNDLE (CHASTE)
    - PCT DECREASES ~ 300F
- CONCLUSION: THIS CALCULATION CONFIRMS EXPECTED SENSITIVITY TO HIGHER HEAT TRANSFER

ASR - 15
5/24/79

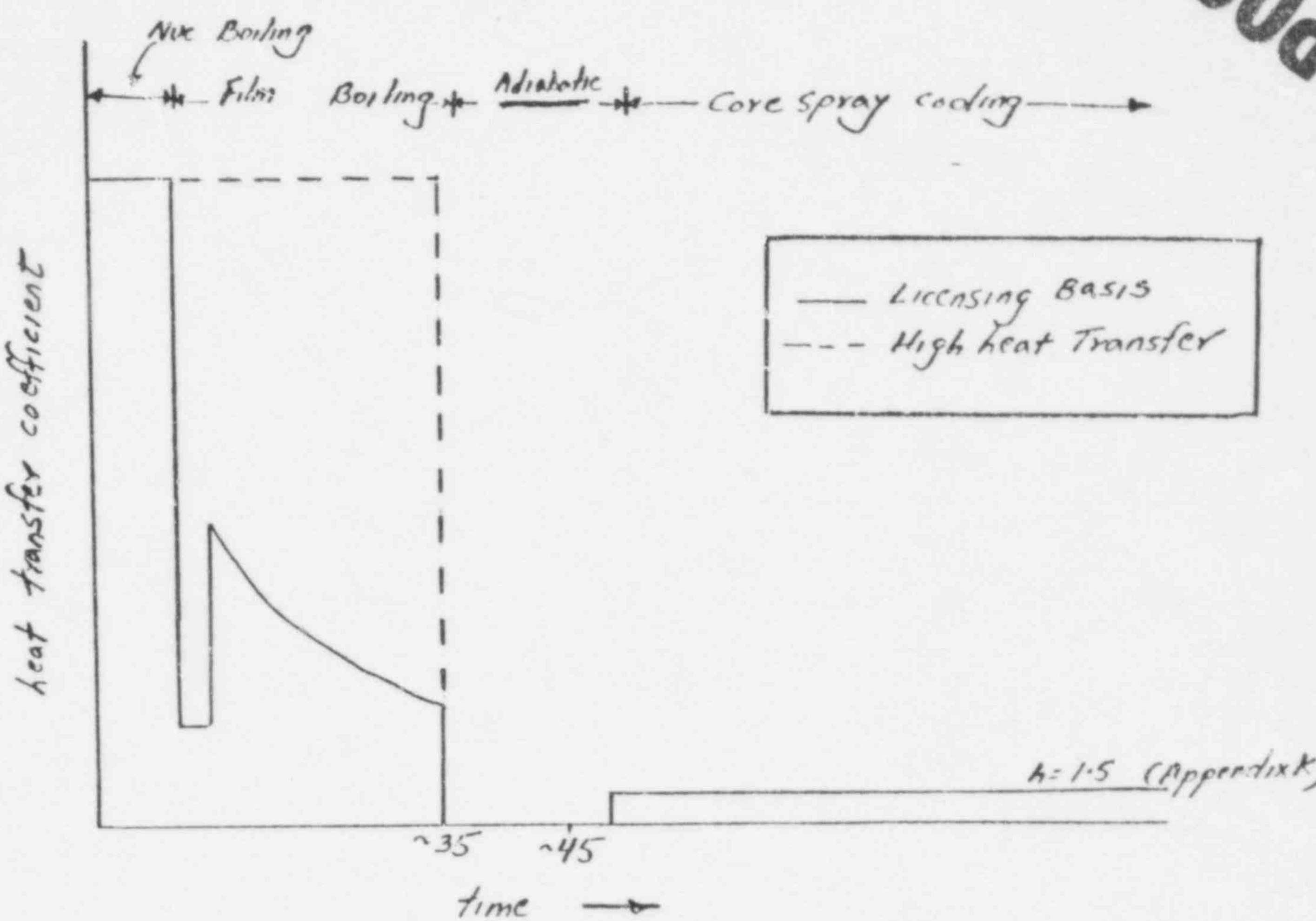
AVERAGE BUNDLE



ASR - 17
5/24/79

362 327

HOT BUNDLE



Heat Transfer in CHASTE calculations

ASR - 18
5/24/79

362 328

SUMMARY AND CONCLUSIONS

- CONSISTENT APPLICATION RESULTS IN CONSIDERABLY LOWER PCT
- EVEN SEPARATE EFFECT STUDIES SHOW LOWER PCT
- CURRENT EM CODES NEED NOT BE CHANGED

ASR - 19
5/24/79

EFFECTS OF HIGH HEAT TRANSFER ON PRESSURE

- POSSIBLE DELAY IN ECC INJECTION
  - EFFECT OF HARDWARE DELAY TIMES
- MORE INVENTORY REMAINING AFTER BLOWDOWN
- MORE LIQUID DOWNFLOW AT CCFL RESTRICTIONS
- LONGER PERIOD OF LOWER PLENUM FLASHING

NET EFFECT: - MOST PLANTS PCT IS LOWER FOR HIGHER PRESSURE

- FOR OTHER PLANTS PCT SENSITIVITY ± 50F

5/24/79

6

G.E. LOCA MODEL DEVELOPMENT

- EVALUATION MODEL HISTORY
- STATUS OF IMPROVED MODELS
- CURRENT DIRECTION

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EVALUATION MODELS

- PRE 1974
  - SAFE
  - LAMB
  - SCAT
  - CHASTE
- 1974 - REFLOOD
  - ADDRESS CCFL AT TOP OF CORE/BYPASS
- MODEL IMPROVEMENT SUBMITTALS
  - 1977: CHASTO5 (GREY BODY FACTORS/CONDUCTION)
    PARTIALLY DRILLED CORE ANALYSIS
  - 1978: GESTR/CHASTO6
    MODIFIED BROMLEY
    LEAKAGE FLOWS/REFLD06
    CCFL CORRELATION
    NUCLEAR MODELS
    } UNDER REVIEW

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IMPROVED MODELS

- **SYSTEM CODE (ZEUS)**
  - Begun 1975
  - Completed for Blowdown Phase
  - Technical Problems/Limitations
  - ZEUS Upgrade Proposed Under NRC/EPRI/GE Program
  - Discontinued in 1978 in Favor of Best Estimate Model (TRAC)

- **HOT CHANNEL CODE (THRST)**
  - Completed 1978
  - Candidate for EM Submittal

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THRST01

HOT CHANNEL CALCULATION

- FEATURES
  - DRIFT FLUX HYDRAULICS
  - COUNTER CURRENT FLOW AND CCFL
  - LEVEL TRACKING
  - MULTIPLE ROD GROUPS
  - TRANSIENT GAP CONDUCTANCE
  - STEAM COOLING

- FUTURE IMPROVEMENTS
  - TRANSITION BOILING MODEL
  - IMPROVED REWET CRITERION
  - MECHANISTIC CORE SPRAY HEAT TRANSFER

REALISTIC SYSTEM CODE NECESSARY FOR BEST APPLICATION

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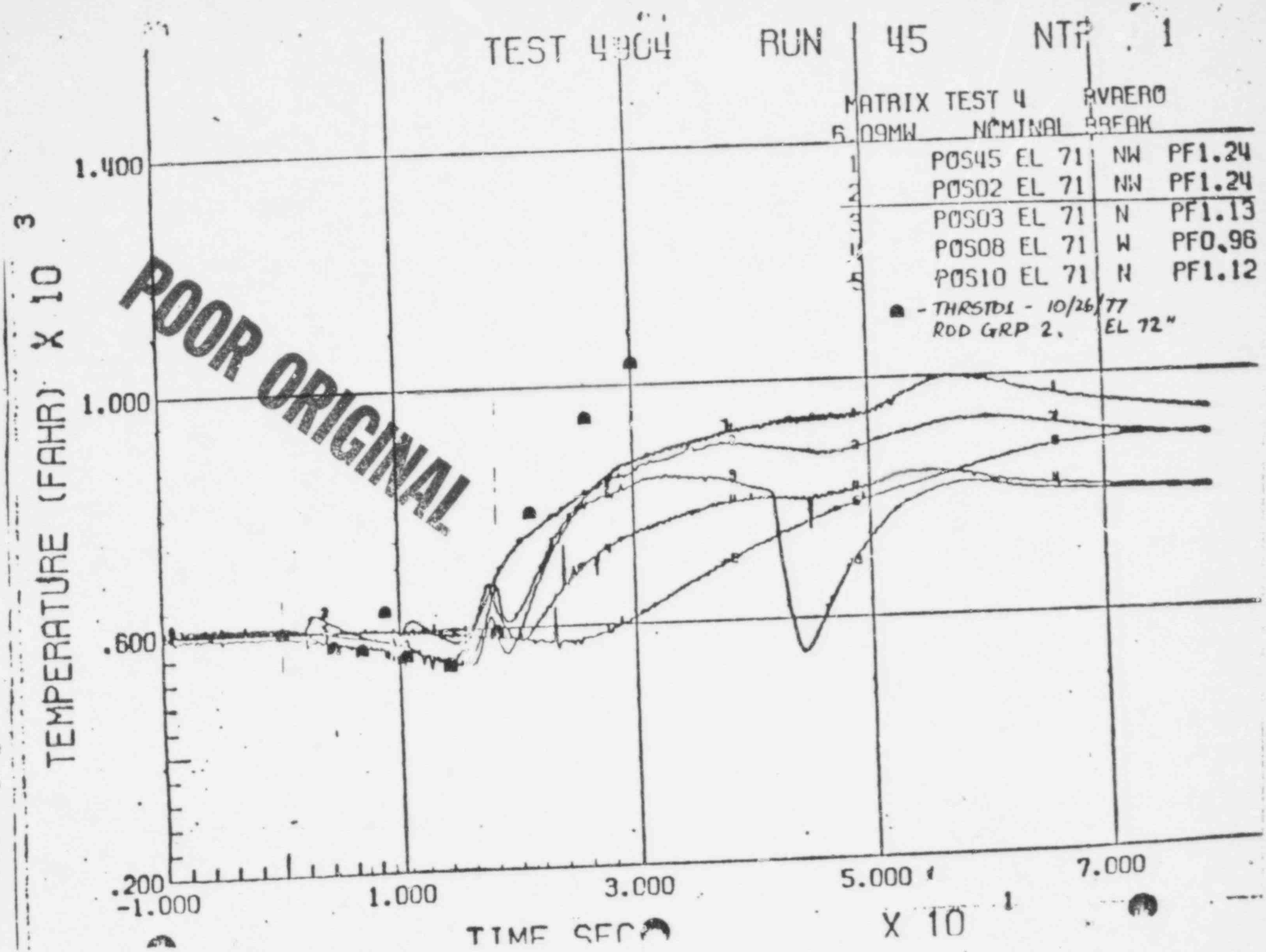
TEST 4904 RUN 45 NTP . 1
MATRIX TEST 4 AVAERO
6.09MW NOMINAL BREAK
1 POS45 EL 71 NW PF1.24
2 POS02 EL 71 NW PF1.24
3 POS03 EL 71 N PF1.13
4 POS08 EL 71 W PF0.96
5 POS10 EL 71 N PF1.12
● - THRSTD1 - 10/26/77
ROD GRP 2. EL 72"
1.400
1.000
.600
.200
-1.000
1.000
3.000
5.000
7.000
X 10
TIME SEC
TEMPERATURE (FAHR) X 10 3
POOR ORIGINAL

362 335

ZEUS01

SYSTEM HYDRAULICS MODEL

- VESSEL IS DIVIDED INTO 21 NODAL REGIONS.
- EACH REGION IS SUBDIVIDED TO MODEL THE AXIAL VOID FRACTION DISTRIBUTION.
- THE SUB-NODE HYDRAULICS INCORPORATE THE ZUBER-FINDLAY DRIFT FLUX FORMULATION FOR LIQUID/VAPOR SLIP FLOW.
- SUBSTANTIAL IMPROVEMENT IN PREDICTED SYSTEM FLUID INVENTORIES RELATIVE TO SAFE/REFLOOD - VERIFIED BY DIRECT COMPARISON TO TLTA DATA.

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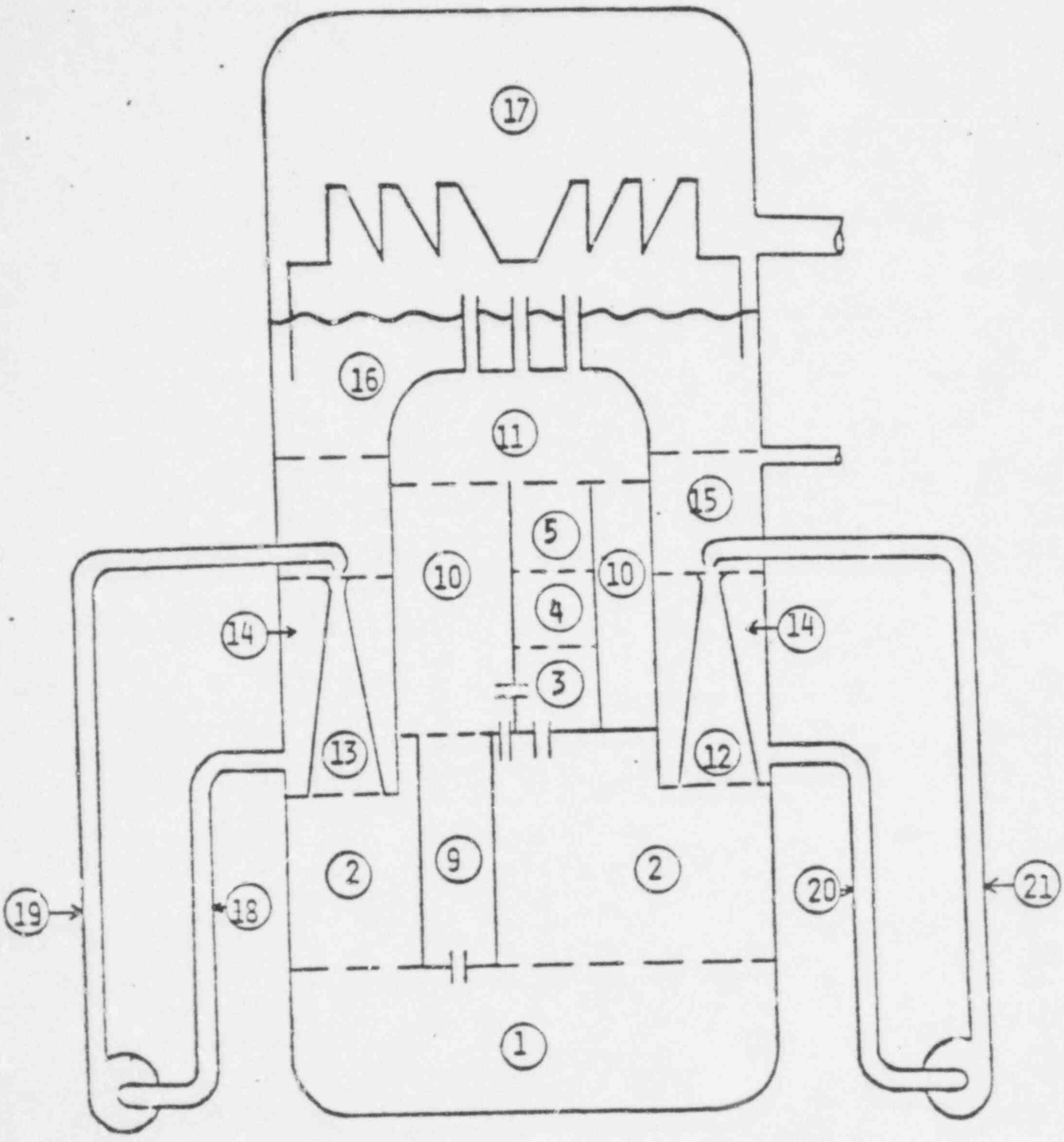
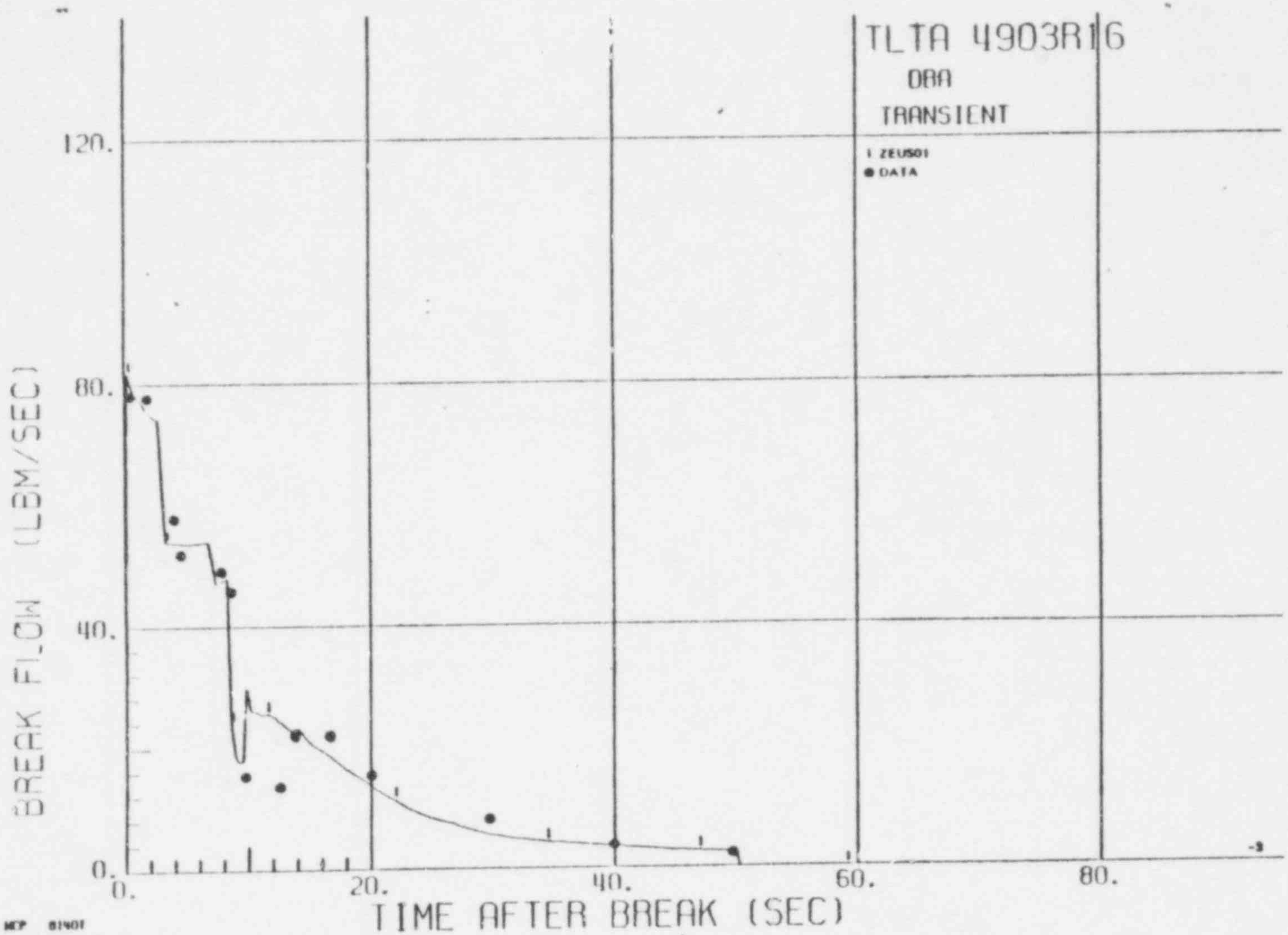
ZEUS HYDRAULIC NODING



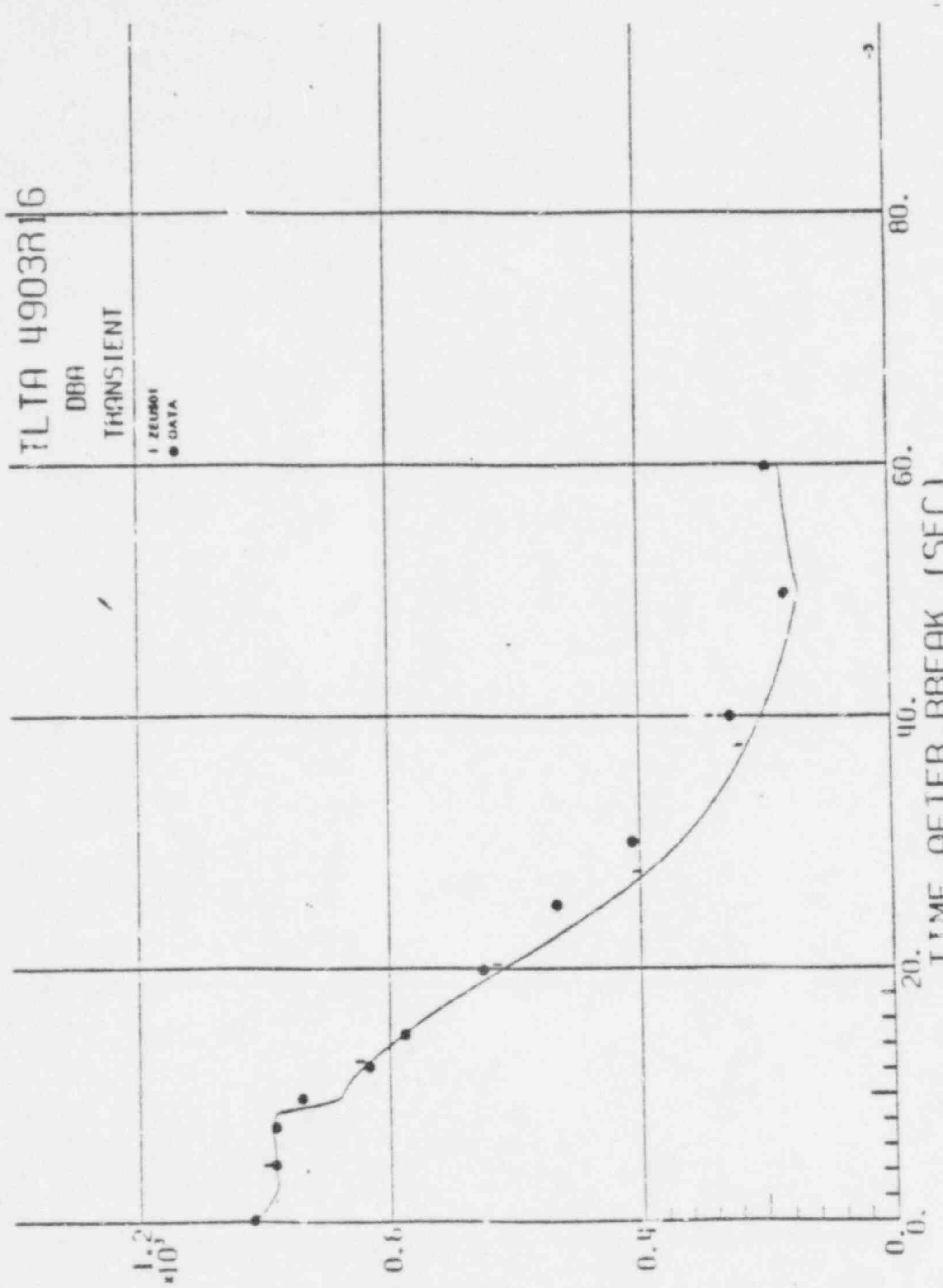
CED
5/24/79

362 337



362 338

GED
5/24/79



POOR ORIGINAL

362 339

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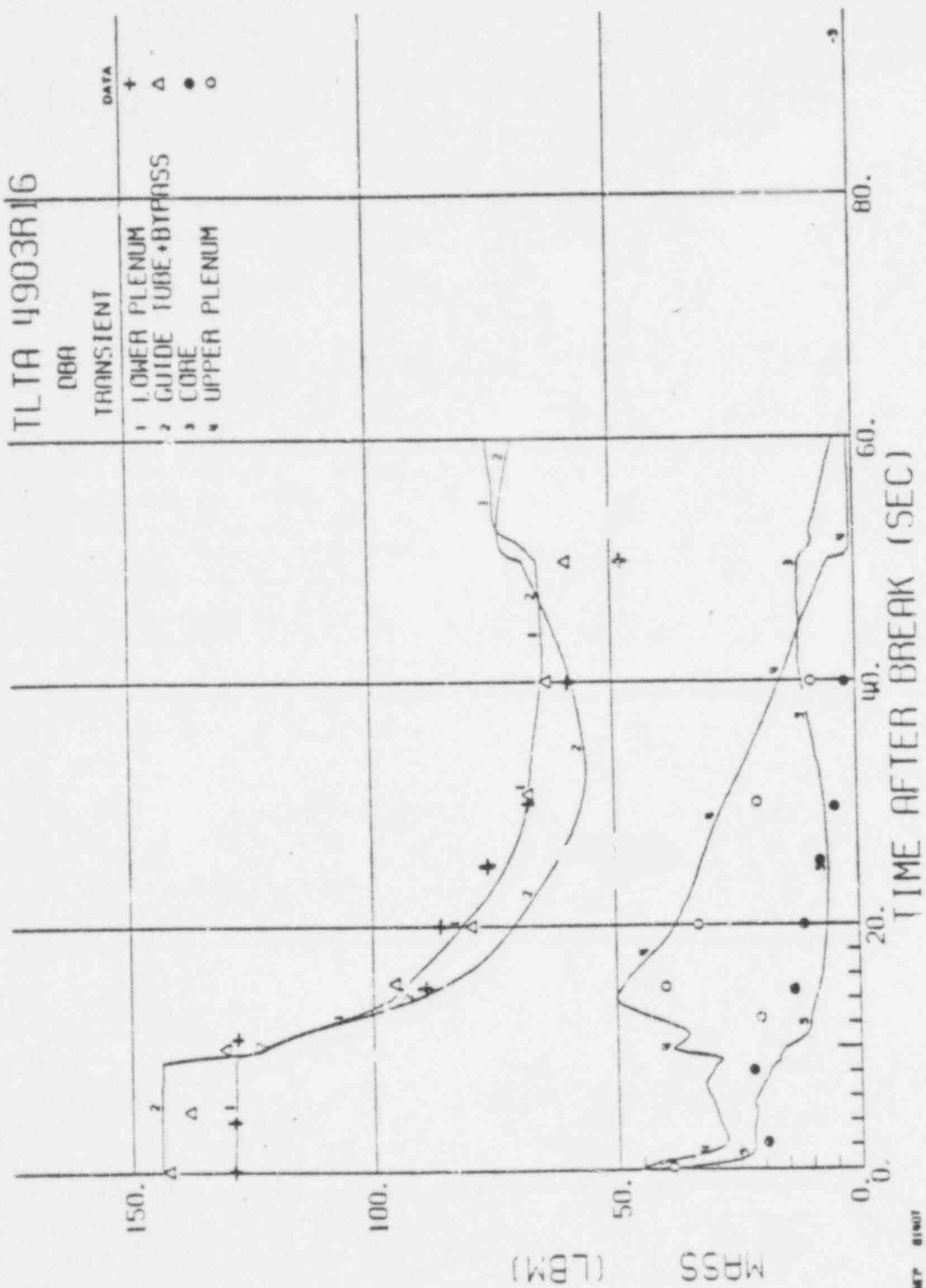
5/24/79



POOR ORIGINAL

GED
5/24/79

362 340

ZEUS

TECHNICAL LIMITATIONS

- SINGLE PRESSURE
- ONE DIMENSIONAL APPROACH
- THERMAL EQUILIBRIUM

UNCERTAINTIES

- LOW PRESSURE NUMERICAL OSCILLATIONS

FURTHER WORK

- MULTIPLE BUNDLES
- PROGRAMMING IMPROVEMENT

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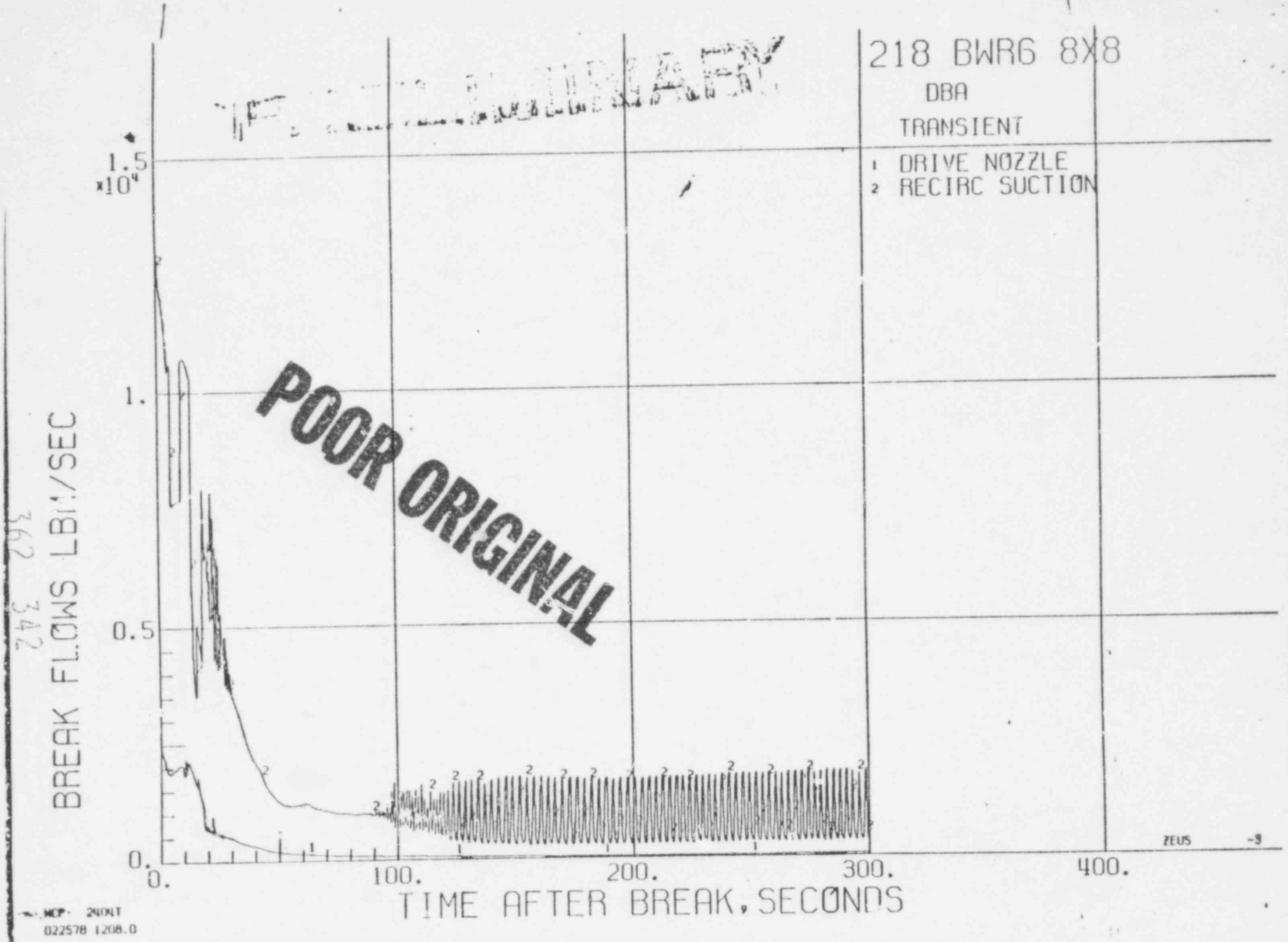
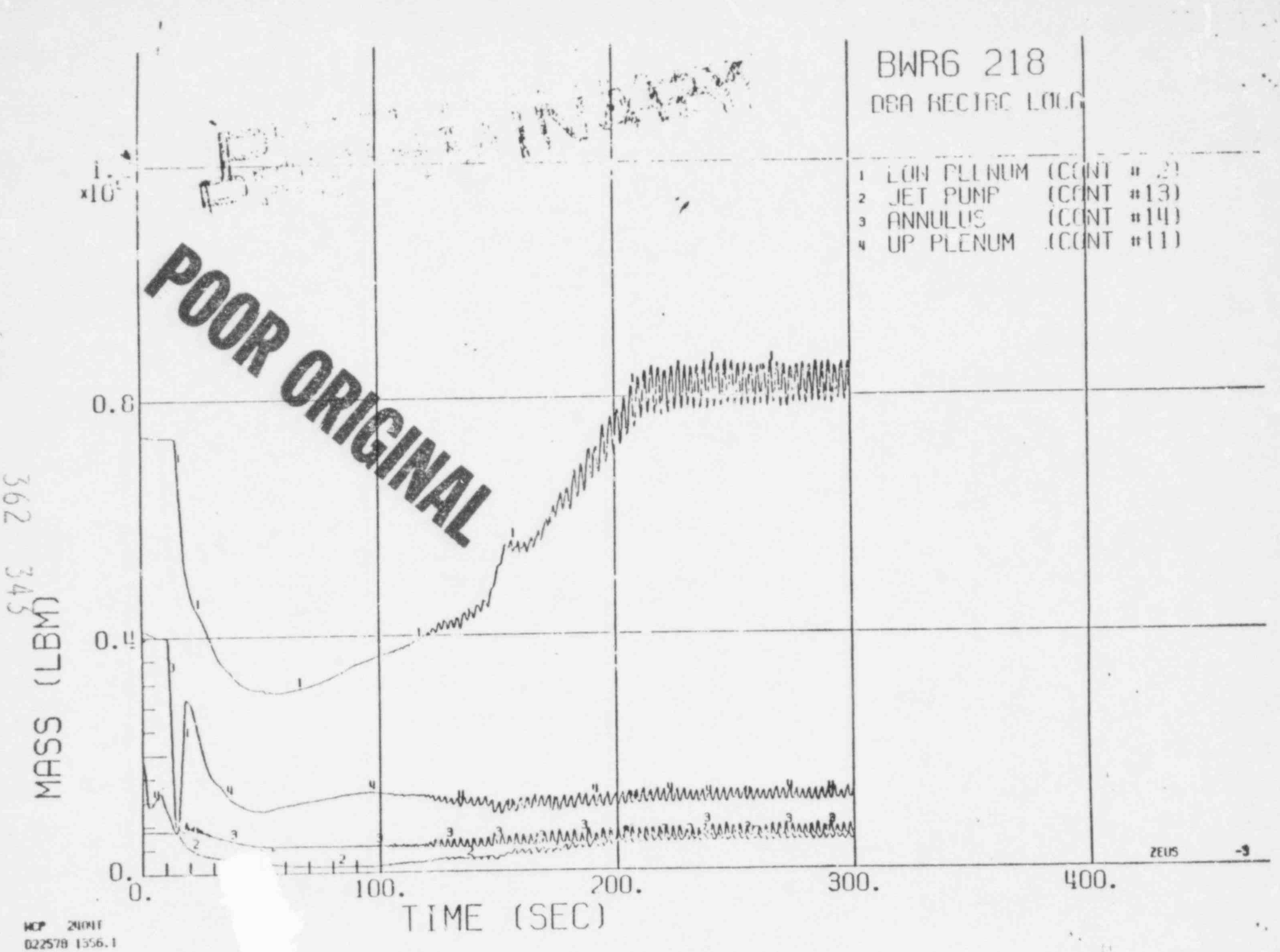

PRELIMINARY
218 BWR6 8X8
DBA
TRANSIENT
1 DRIVE NOZZLE
2 RECIRC SUCTION
1.5
x10⁴
1.
0.5
0.
BREAK FLOWS LBM/SEC
0.
100.
200.
300.
400.
TIME AFTER BREAK, SECONDS
ZEUS
POOR ORIGINAL
022578 1208.0

362 342


BWR6 218
DBA RECIRC LOCA
1 LOW PLENUM (CONT # 2)
2 JET PUMP (CONT #13)
3 ANNULUS (CONT #14)
4 UP PLENUM (CONT #11)
MASS (LBM)
1. x10
0.8
0.4
0.
0.
100.
200.
300.
400.
TIME (SEC)
ZEUS
-3
POOR ORIGINAL
HCP 2WNT
022578 1556.1

362 345

REASONS FOR DISCONTINUING 'ZEUS'

- TECHNICAL LIMITATIONS
  - Not 'Best Estimate' Model

- UNCERTAINTIES IN CODE PERFORMANCE
  - Major Model Additions Required

- DECISION TO SUPPORT NRC EFFORT ON BEST ESTIMATE MODEL
  - Address All 'What If's '
  - Quantify Real Margins

GED
5/24/79

CURRENT DIRECTION

- BEST ESTIMATE ANALYSIS
- COMMITMENT MADE TO TRAC/BWR
  (AWAITING COMMITMENT FROM EPRI/NRC-RSR)
- INCENTIVE FOR: A) MARGIN QUANTIFICATION
  B) DESIGN IMPROVEMENTS
- STATUS
  - TRAC-P1/P1A OBTAINED
  - WORK INITIATED ON RESTRUCTURING, DATA PREDICTION, MODEL IMPROVEMENTS, TEST SET UP
  - ADVANCED HOT CHANNEL HEAT TRANSFER MODEL DEVELOPMENT UNDER WAY

GED
5/24/79

SUMMARY

- CURRENT EM SIMPLE AND CONSERVATIVE
- EFFORT ON INTERMEDIATE IMPROVED MODEL DIVERTED TO BEST ESTIMATE MODELS
- G.E. COMMITMENT TO PURSUE CO-OPERATIVE BEST ESTIMATE LOCA MODELS

GED
5/24/79

ENCLOSURE 3

ATTENDANCE LIST FOR MAY 24, 1979 MEETING WITH GE

NAME	ORGANIZATION
WAYNE HODGES	NRC/DSS
LARRY PHILLIPS	NRC/DSS
ROY WOODS	NRC/DOR
F. Schroeder	NRC/DSS
Z. R. Rosztoczy	NRC/DSS
L D DAVIS	NRC OELD
G.E. DIX	GE
A. S. Rao	GE
R.H. Buchholz	GE
L. S. GIFFORD	GE
George Edgar	MC&B
Ed. Firestone	GE
Joseph Gallo	IL&B
VAUGHN L. CONRAD	Public Service Co of Oklahoma
WILLIAM D. BECKNER	NRC/RSR
WARREN C LYON	NRC/RSR
VERN ROONEY	NRC/DOR
P.S. CHECK	DOR
JOE SCINTO	OELD
Calvin W. Moon	NRC/DPM
[illegible]	NRC/DPM
A. J. LEVINE	GE
H H Klepfer	G.E.
VIC STELLO*	NRC/DOR
ROGER MATTSON*	NRC/DSS

* PART TIME

POOR ORIGINAL

362 347