November 4, 1986

MEMORANDUM FOR: Ashok C. Thadani, Director
PWR Project Directorate #8
Division of PWR Licensing-B

FROM: Patrick M. Sears, Project Manager
PWR Project Directorate #8
Division of PWR Licensing-B

SUBJECT: SUMMARY OF MEETING HELD ON OCTOBER 22, 1986 CONCERNING MAINE YANKEE LARGE BREAK LOCA ANALYSIS AXIAL POWER SHAPE

The meeting was held in Bethesda, Maryland. Those who attended are listed in Enclosure 1.

Maine Yankee described in more detail information previously given the staff in a telecon on September 2, 1986, and a meeting with the staff held September 9, 1986 regarding the incorrect axial power distribution used in Maine Yankee's Large LOCA Analysis.

Maine Yankee provided the staff with the following information and plan of action:

1. Selection of Core Axial Power Shapes (Enclosure 2)
2. Selection of Modified Injection delta P (Enclosure 3)
3. Revision to YAEC Steam Cooling Model (Enclosure 4)
4. Cycle 10 Analysis (Phase I) (Enclosure 5)
5. Cycle 10 Analysis (Phase II) (Enclosure 5)

Regarding Phase I, Maine Yankee proposed a submittal of axial power shapes and injection delta P for staff review November 3, 1986, and expressed hopefulness for staff response (SE) by December 3, 1986. The staff will follow up with Maine Yankee as to the ability of the staff to provide a SE by December 3, 1986. This date is based on a Cycle 10 restart in April 1987.

Regarding Phase II, Maine Yankee proposed a meeting with the staff in mid-December to present a revised steam cooling model and receive staff comment. Following this meeting, Maine Yankee would submit the model change February 1, 1987 and receive the SE from the NRC (Maine Yankee's proposed target date) May 1, 1987. This date was desired to eliminate late cycle operating restrictions imposed by current LOCA analyses and axial shape limitations.

Maine Yankee also discussed submittal of a proposed change to the Technical Specifications which would allow removal of certain cycle specific parameters in exchange for references to methodology. The staff was unable to be encouraging about the prospects for approval of such a submittal.

Original signed by

Patrick M. Sears, Project Manager
PWR Project Directorate #8
Division of PWR Licensing-B

Enclosures: As Stated

cc w/enclosures: See next page

PBD#8	PBD#8	PBD#8	PBD#8	RSB:PWR-B
PKreutzer	RPerfetti;cf	PSears	AThadani	CThomas
11/3/86	11/4/86	11/4/86	11/4/86	11/4/86

DMB016

MEETING SUMMARY DISTRIBUTION LIST 50-312
PWR PROJECT DIRECTORATE #8

Docket File
NRC PDR
L PDR
PBD#8 Rdg
PKreutzer
OELD
EJordan
BGrimes
ACRS-10
NRC Participants
RPerfetti
RCJones
NLauben
DFieno
AThadani
PSears

Enclosure 1

LIST OF ATTENDEES
MEETING HELD ON OCTOBER 22, 1986
MAINE YANKEE ATOMIC POWER COMPANY

NAME	ORGANIZATION
Renee M. Perfetti	NRC/PWR-B, PBD-8
Robert C. Jones	NRC/PWR-B, RSB
Norm Lauben	NRC/PWR-B, RSB
Cecil Thomas	NRC/PWR-B, RSB
Daniel Fieno	NRC/PWR-B, RSB
Ashok Thadani	NRC/PWR-B, PBD-8
George M. Solan	Yankee Atomic - Reactor Physics
Stephen P. Schultz	Yankee Atomic - LOCA
Stephen D. Evans	Maine Yankee
Keith B. Spinney	Yankee Atomic - Reactor Physics
Peter L. Anderson	Yankee Atomic, Project Manager for MY
Ausaf Husain	Yankee Atomic Electric Company, LOCA Group Manager
Jamal Ghaw	Yankee Atomic Electric Company, LOCA Group Manager
Howard F. Jones, Jr.	Maine Yankee Atomic Power Company
Ross Jensen	Yankee Atomic Electric Company

Enclosure 2

MAINE YANKEE

AXIAL SHAPES FOR LOCA ANALYSIS EVALUATION

OVERVIEW

TYPICAL AXIAL POWER SHAPES

- O NOMINAL FULL POWER SHAPES
- O XENON OSCILLATION SHAPES

LIMITS ON AXIAL POWER SHAPES DUE TO LCO'S

- O SYMMETRIC OFFSET LIMITS
- O RADIAL PEAKING LIMITS
- O LOCA LIMITS

CLASSES OF AXIAL POWER SHAPES

- O CLASS 1 - HIGH POWER UP TO PEAK LOCATION
- O CLASS 2 - HIGH POWER FROM PEAK TO PCT LOCATION

MATHEMATICALLY-DEFINED AXIAL SHAPES

- O INCENTIVES
- O ASSUMPTIONS
- O TYPES OF AXIAL SHAPES
- O COMPARISON TO POSSIBLE AREA OF PEAK POWER SHAPES

MAINE YANKEE

TYPICAL AXIAL POWER SHAPES

LOW-LEAKAGE RELOAD CORES

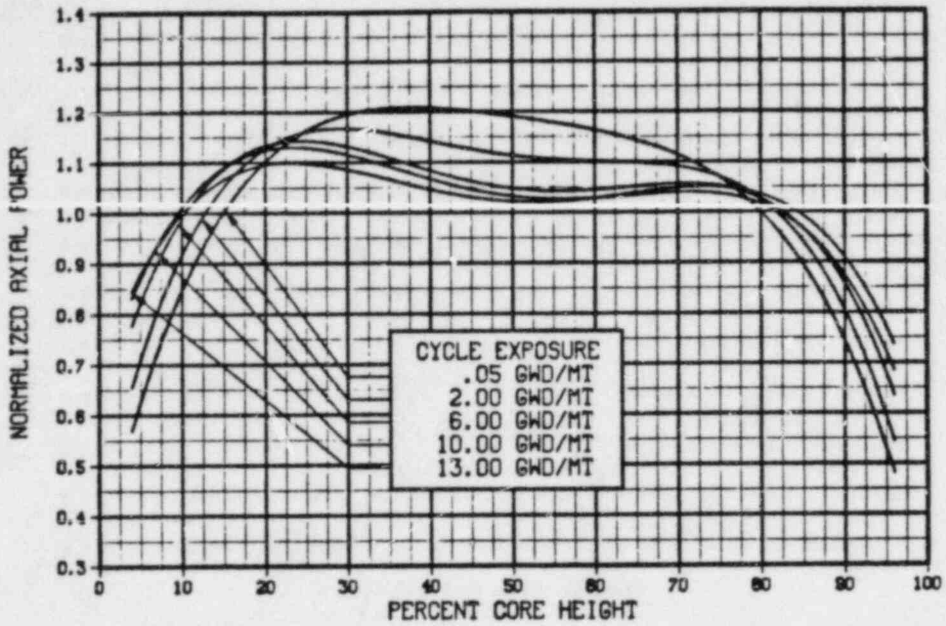
NOMINAL FULL-POWER SHAPES

- O ALL NEAR-LIMITING ASSEMBLIES ARE FRESH
- O FRESH ASSEMBLIES START WITH FLATTENED COSINE SHAPES
  - BOTTOM-PEAKED IN LOW BURNUP REGIONS
  - SYMMETRIC IN MEDIUM BURNUP REGIONS
  - TOP-PEAKED IN HIGH BURNUP REGIONS
- O FRESH ASSEMBLIES BURN TO
  - FLATTENED BOTTOM-PEAKED SHAPES
  - MILDLY DOUBLE-HUMPED BOTTOM-PEAKED SHAPES
- O RELATIVE POWER AT HIGHER AXIAL ELEVATIONS INCREASES WITH CYCLE BURNUP

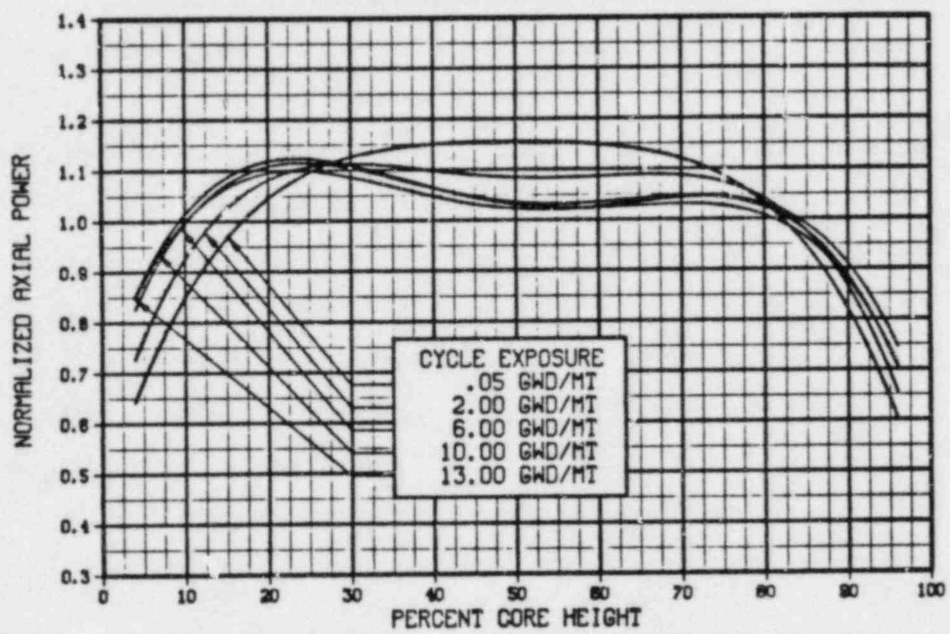
XENON OSCILLATION CASES

- O AXIAL XENON OSCILLATION CASES ARE GENERATED FOR SYMMETRIC OFFSET DEPENDENT RPS SETPOINTS
- O THESE CASES PRODUCE THE HIGHEST AXIAL PEAKINGS

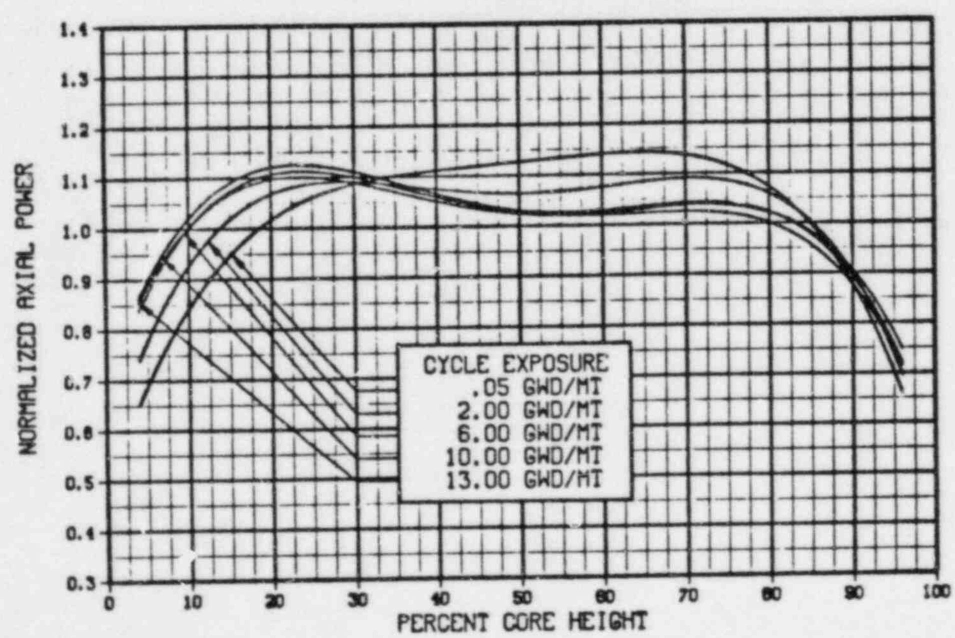
MY CYCLE 10 NORMALIZED AXIAL POWER VS. % CORE HEIGHT
HFP, ARO EQUILIBRIUM CONDITIONS



FRESH ASSEMBLY IN LOW BURNUP REGION

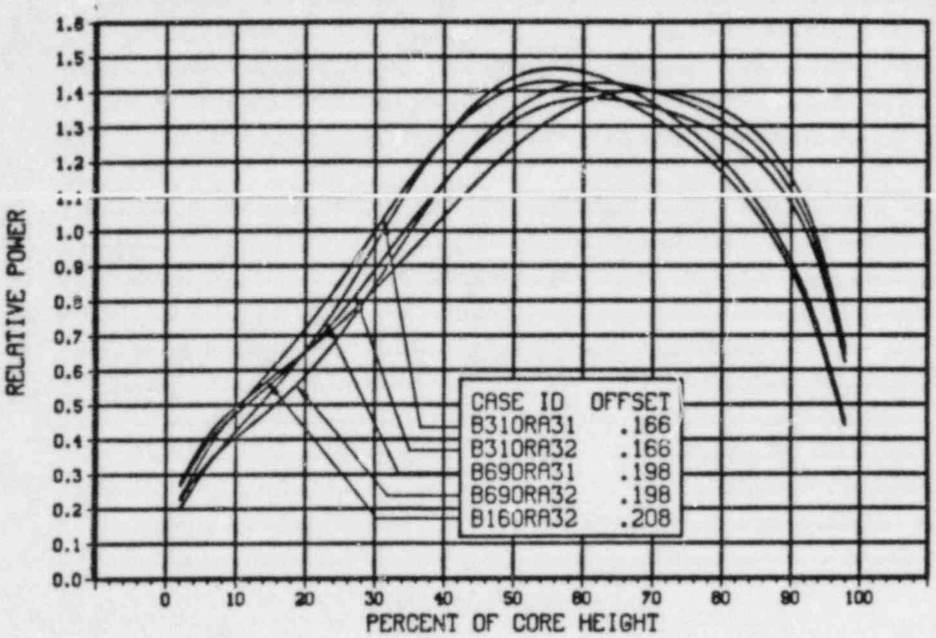


FRESH ASSEMBLY IN MEDIUM BURNUP REGION

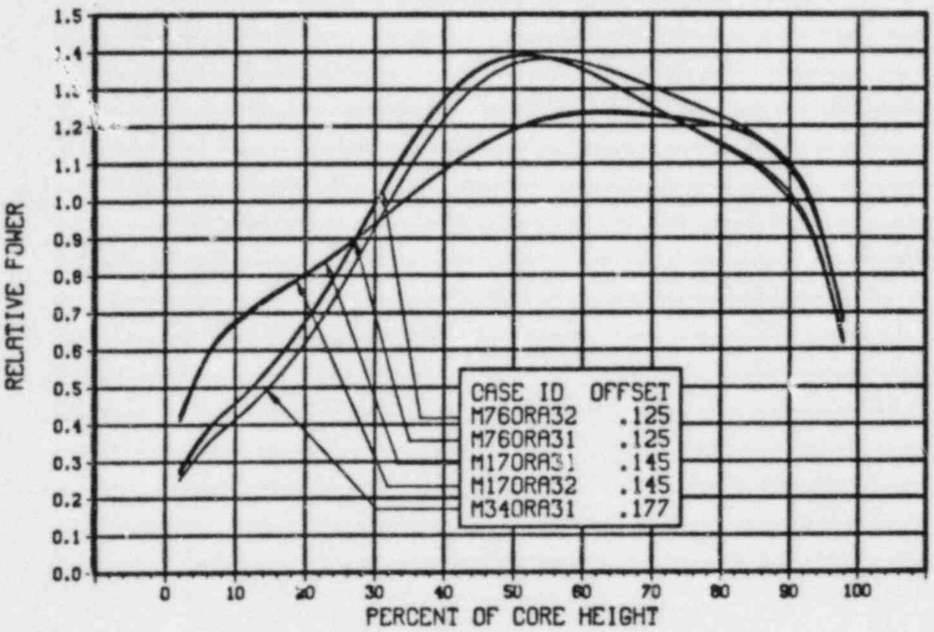


FRESH ASSEMBLY IN HIGH BURNUP REGION

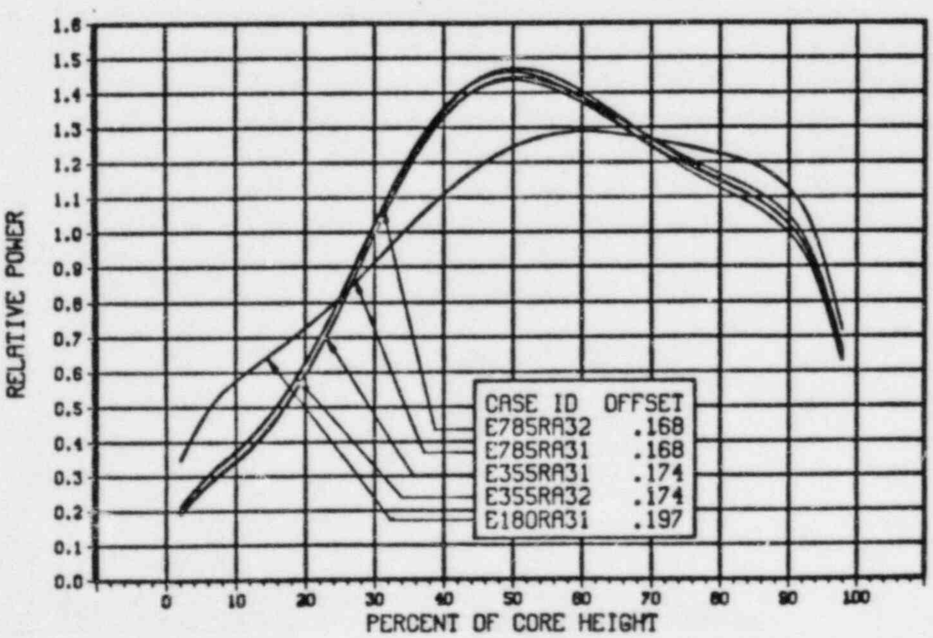
MY CYCLE 10 NORMALIZED AXIAL POWER VS. PERCENT CORE HEIGHT
XENON OSCILLATION CASES, POSITIVE SYMMETRIC OFFSET



BEGINNING OF CYCLE



MIDDLE OF CYCLE



END OF CYCLE

MAINE YANKEE

LIMITS ON AXIAL POWER SHAPES

DUE TO LIMITING CONDITIONS FOR OPERATION (LCO'S)

SYMMETRIC OFFSET LIMITS

- O SYMMETRIC OFFSET LIMITS AS A FUNCTION OF POWER ARE MONITORED BY THE EXCORE DETECTORS AND CONSTITUTE AN LCO
- O SYMMETRIC OFFSET LIMITS NEAR FULL POWER DEFINE AN ENVELOPE OF ACCEPTABLE TOP-PEAKED AXIAL POWER SHAPES VERSUS CORE HEIGHT FOR LOCA EVALUATION

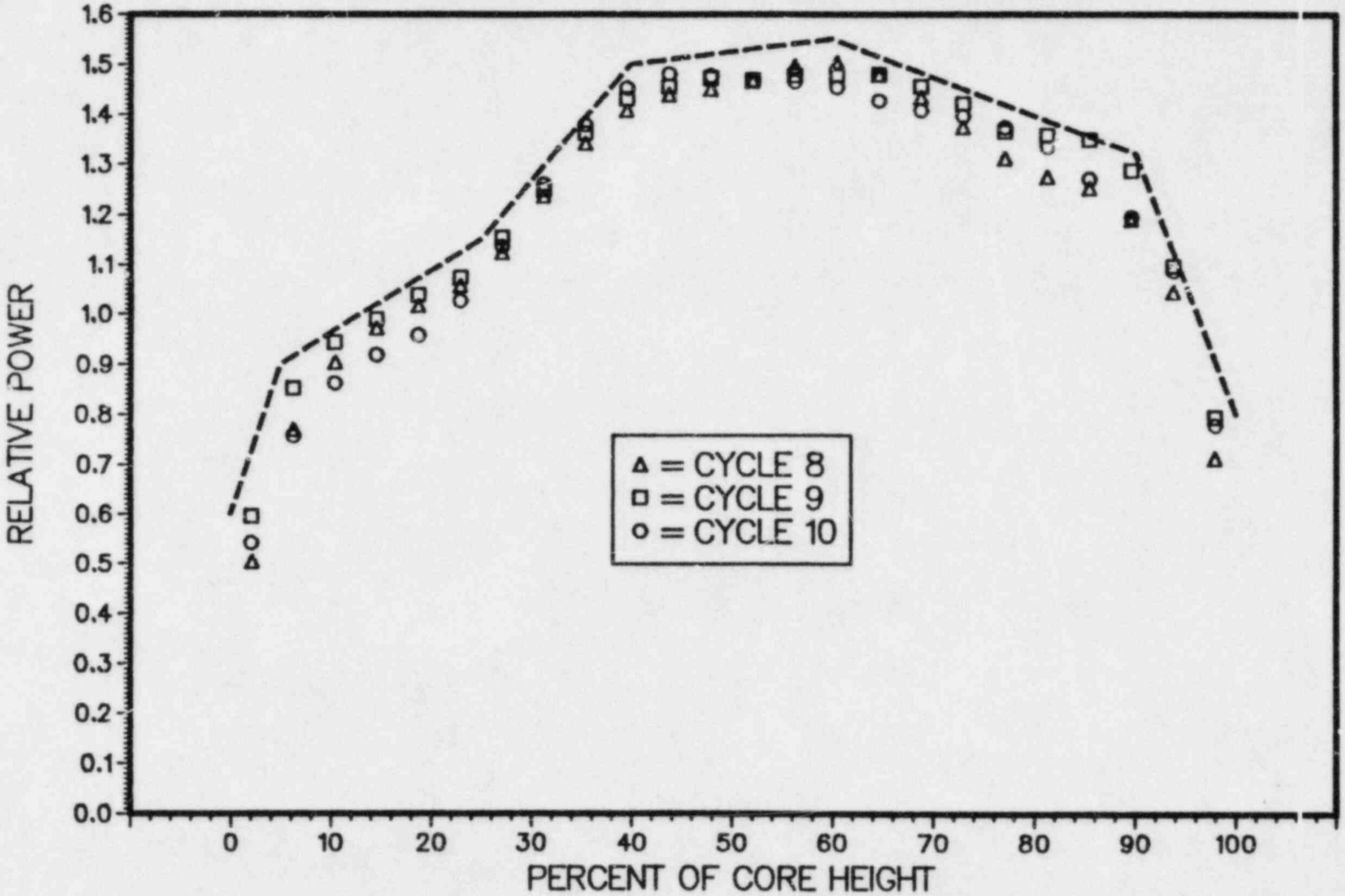
RADIAL PEAKING LIMITS

- O RADIAL PEAKING LIMITS ARE MONITORED BY THE FIXED INCORE DETECTORS AND CONSTITUTE AN LCO
- O RADIAL PEAKING LIMITS DEFINE THE MAXIMUM ALLOWABLE INTEGRATED POWER IN THE FUEL ROD
- O THE MAXIMUM RADIAL PEAKING FACTOR AND ALL UNCERTAINTIES IN TECHNICAL SPECIFICATIONS ARE APPLIED TO MAXIMIZE THE INTEGRATED POWER IN THE FUEL PIN

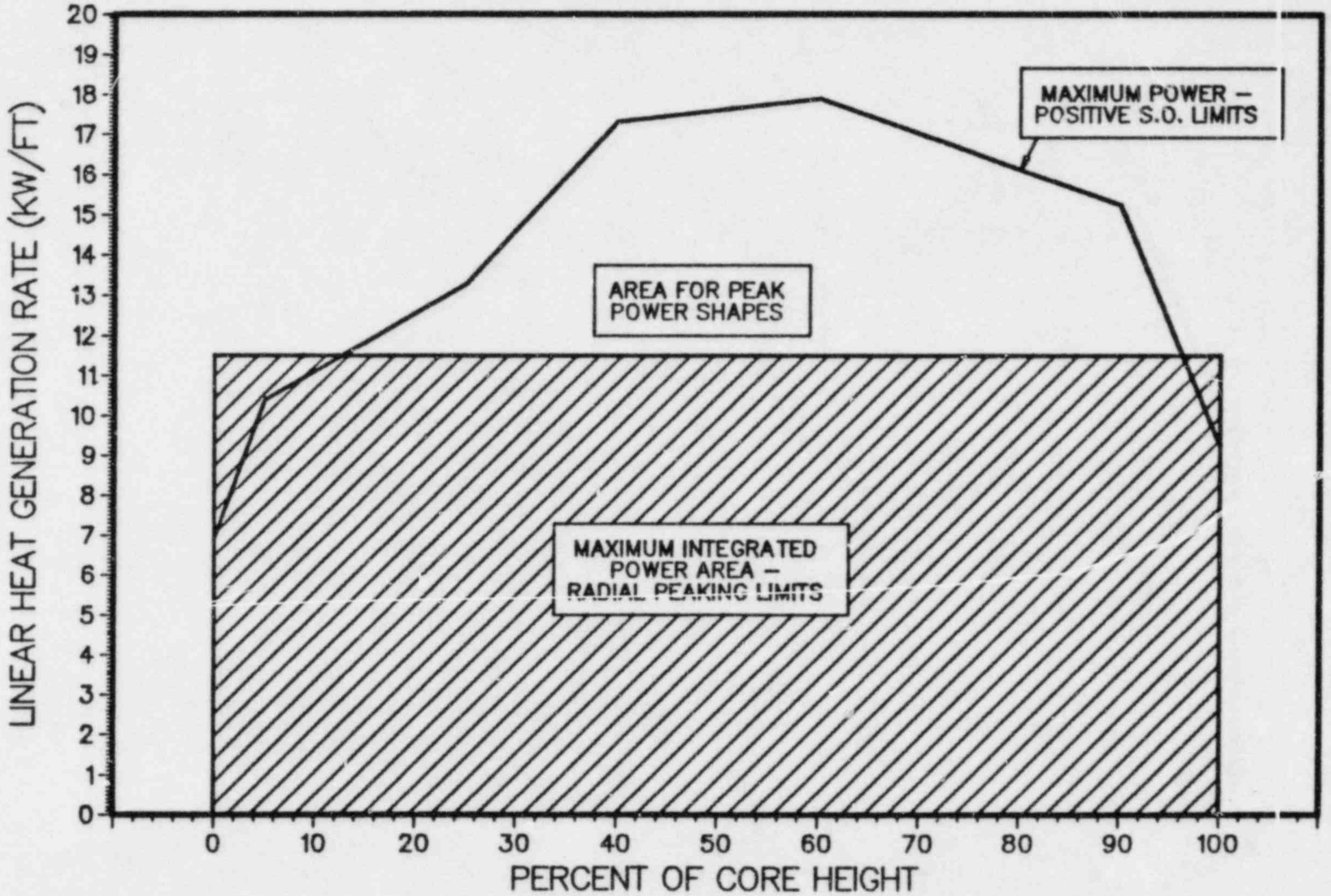
LOCA LIMITS

- O LOCA LIMITS ARE MONITORED BY THE FIXED INCORE DETECTORS AND ALARM SYSTEM AND CONSTITUTE AN LCO
- O LOCA LIMITS DEFINE THE MAXIMUM ALLOWABLE LINEAR HEAT GENERATION RATE (LHGR) AS A FUNCTION OF CORE HEIGHT
- O LOCA LIMITS AND ALLOWABLE AXIAL SHAPES ARE DETERMINED ITERATIVELY FOR A FIRST- TIME ANALYSIS

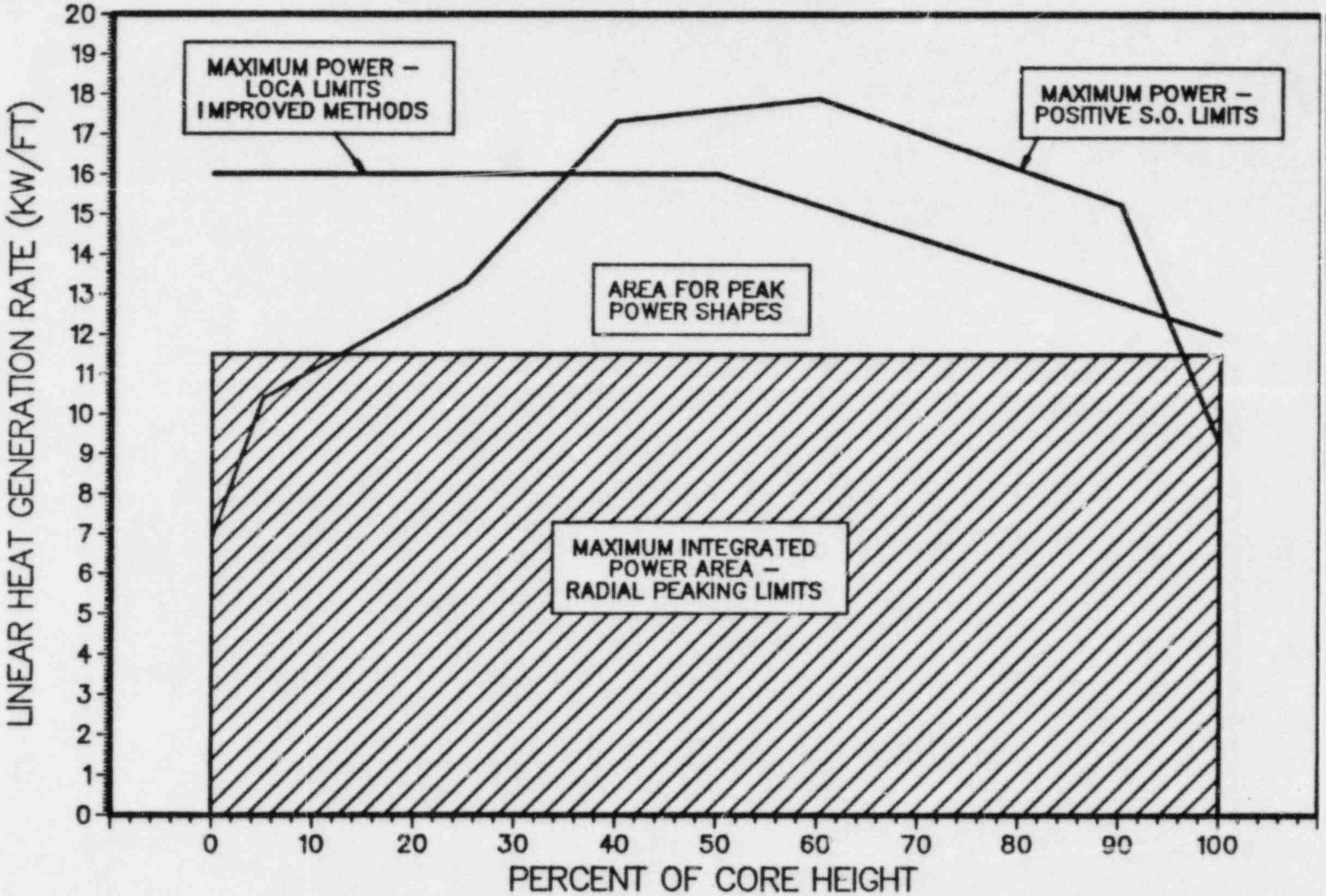
MAINE YANKEE CYCLES 8, 9, AND 10
ENVELOPE OF AXIAL POWER SHAPES FOR NEAR LIMITING ASSEMBLIES
TOP PEAKED SHAPES FROM ZERO SYMMETRIC OFFSET TO
POSITIVE SYMMETRIC OFFSET LIMITS AT FULL POWER



MAINE YANKEE CYCLE 10
AREA OF POSSIBLE PEAK POWER SHAPES
FOR EVALUATION IN LOCA



MAINE YANKEE CYCLE 10
AREA OF POSSIBLE PEAK POWER SHAPES
FOR EVALUATION IN LOCA
IMPROVED METHODS



MAINE YANKEE

CLASSES OF AXIAL POWER SHAPES

THE LOCA LHGR LIMIT IS JUSTIFIED BY EXAMINATION OF AXIAL SHAPES WITH POWER PEAKING AT SELECTED CORE ELEVATIONS

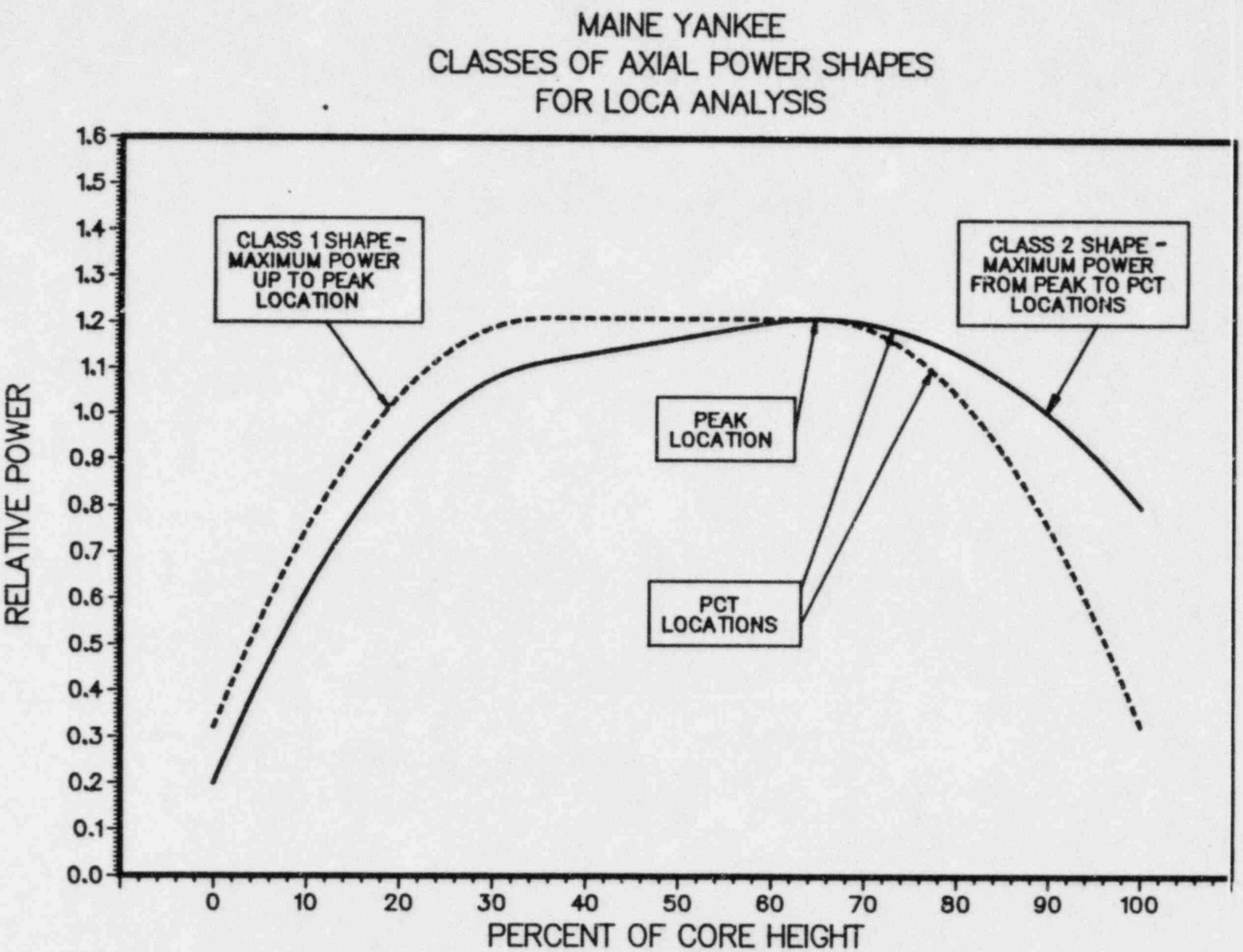
TWO CLASSES OF AXIAL SHAPES ARE EXAMINED FOR EACH ELEVATION, EACH OF WHICH MAXIMIZES A SIGNIFICANT CHARACTERISTIC

CLASS 1 - HIGH POWER UP TO PEAK POWER LOCATION

THESE SHAPES MAXIMIZE THE INTERGATED POWER AND ENTHALPY RISE UP TO THE PEAK POWER LOCATION. FLATTENED, SYMMETRIC AXIAL SHAPES CHARACTERIZE THIS CLASS OF SHAPES

CLASS 2 - HIGH POWER FROM PEAK POWER TO PEAK CLAD TEMPERATURE (PCT) LOCATIONS

THE PCT LOCATION IS HIGHER IN THE CORE THAN THE PEAK POWER LOCATION. MAINTAINING HIGH POWER FROM THE PEAK POWER TO PCT LOCATIONS IS ACHIEVED THROUGH FLATTENED, TOP-PEAKED AXIAL SHAPES WITH MAXIMUM POWER AT THE TOP OF THE CORE


MAINE YANKEE
CLASSES OF AXIAL POWER SHAPES
FOR LOCA ANALYSIS
CLASS 1 SHAPE - MAXIMUM POWER UP TO PEAK LOCATION
CLASS 2 SHAPE - MAXIMUM POWER FROM PEAK TO PCT LOCATIONS
PEAK LOCATION
PCT LOCATIONS
RELATIVE POWER
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
10
20
30
40
50
60
70
80
90
100
PERCENT OF CORE HEIGHT

MAINE YANKEE

INCENTIVES FOR

MATHEMATICALLY- DEFINED AXIAL SHAPES

- O SINCE THE MAXIMUM RADIAL PEAKING FACTOR IS USED IN THE LOCA ANALYSIS, THE AXIAL PEAKING FACTOR IS THE ONLY FREE VARIABLE FOR ITERATION TO ALLOWABLE LHGR

- O FAMILIES OF SHAPES MUST BE GENERATED WITH AXIAL PEAKING FACTORS IN THE RANGE OF ALLOWABLE LHGR'S FOR EACH PARTICULAR CORE HEIGHT

- O TYPES OF SHAPES MUST BE GENERATED WHICH ARE POTENTIALLY MOST LIMITING. THIS IS ACCOMPLISHED BY APROACHING ONE OF MORE OF THE FOLLOWING LIMITS

  - POSITIVE SYMMETRIC OFFSET ENVELOPE
  - MAXIMUM/MINIMUM POWER AT TOP OF CORE
  - MAXIMUM/MINIMUM POWER AT BOTTOM OF CORE
  - LOCA LHGR LIMIT VERSUS CORE HEIGHT (ITERATIVELY)

- O ALL SHAPES MUST BE REALISTIC IN COMPARISON TO NORMAL AND XENON OSCILLATION AXIAL SHAPES

MAINE YANKEE

ASSUMPTIONS FOR

MATHEMATICALLY-DEFINED AXIAL SHAPES

- O ALL SHAPES CONSIST OF A COMBINATION OF PARABOLAS AND STRAIGHT LINE SEGMENTS
- O ALL SHAPES ARE NORMALIZED TO THE MAXIMUM INTEGRATED RADIAL POWER INCLUDING UNCERTAINTIES
- O ALL SHAPES ARE MATHEMATICALLY WELL-BEHAVED (I.E., CONTINUOUS WITH CONTINUOUS DERIVATIVES)
- O ALL SHAPES ARE CHARACTERIZED AS CLASS 1 OR CLASS 2 SHAPES TO ACHIEVE THE PARTICULAR OBJECTIVE WITHIN ACCEPTABLE LIMITS

MAINE YANKEE

TYPES OF

MATHEMATICALLY DEFINED AXIAL SHAPES

FLATTENED SYMMETRIC

- O FLAT STRAIGHT LINE AND TWO PARABOLAS
- O PEAK LOCATIONS FROM 50 TO 85% OF CORE HEIGHT
- O TOP/BOTTOM OF CORE POWERS NOT VARIABLE, BUT DETERMINED BY NORMALIZATION

FLATTENED TOP-PEAKED

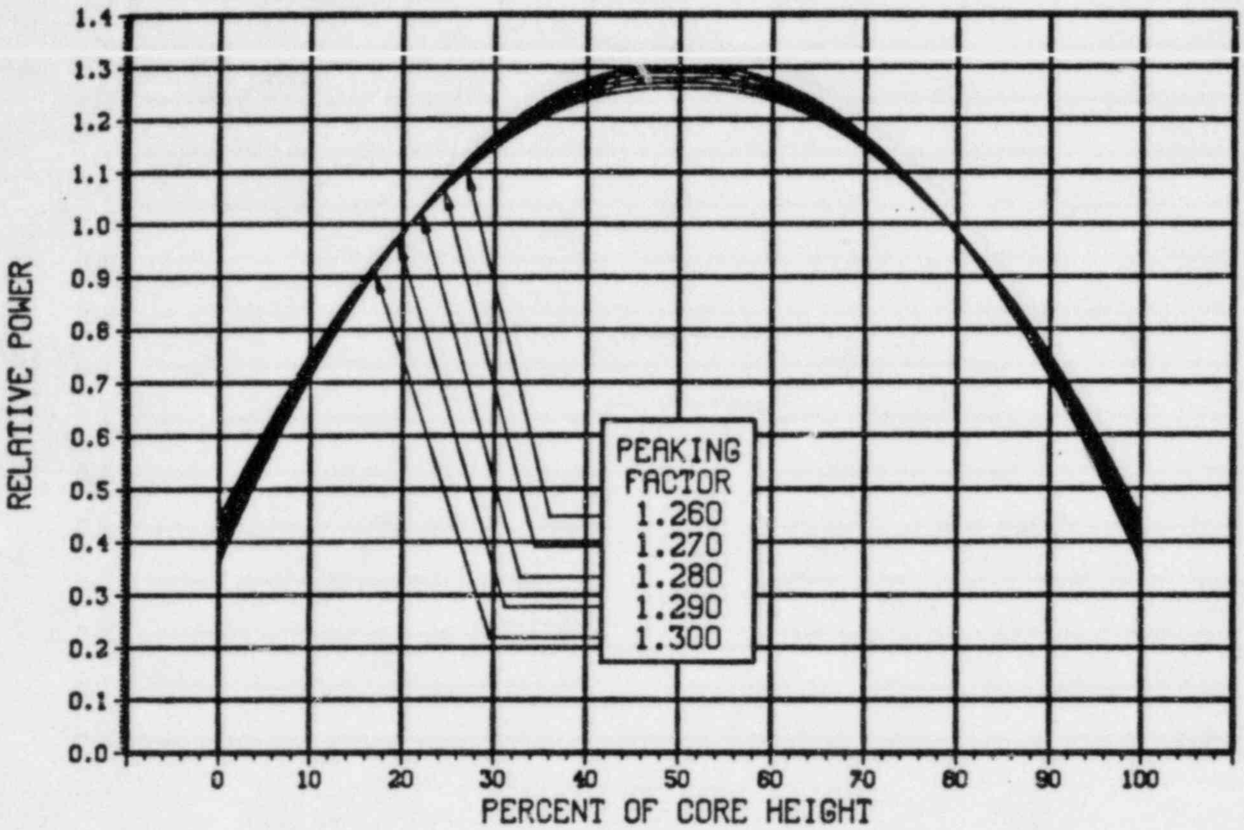
- O SLOPED STRAIGHT LINE AND TWO PARABOLAS
- O PEAK LOCATIONS FROM 50 TO 85% OF CORE HEIGHT
- O TOP/BOTTOM OF CORE POWERS VARIABLE AND SET BY CLASS OF AXIAL SHAPE DESIRED

DOUBLE-HUMPED SYMMETRIC

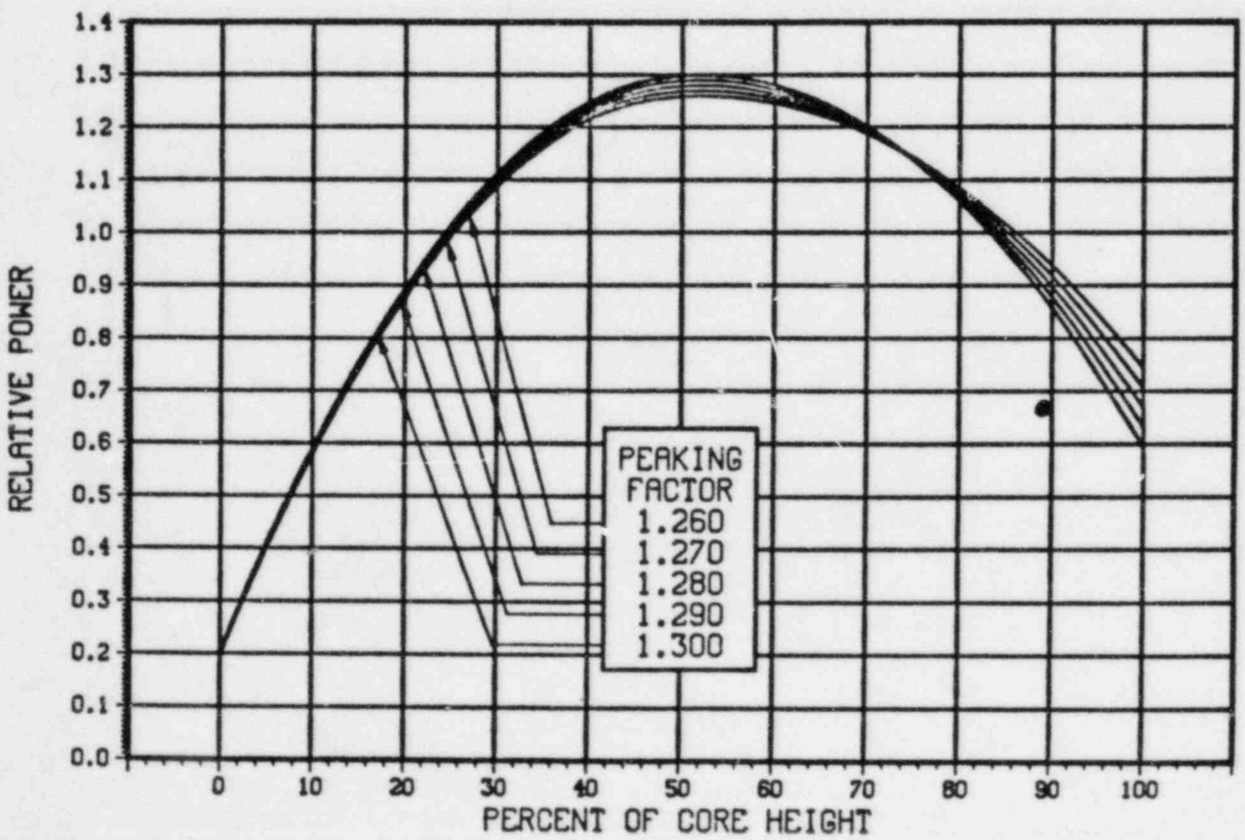
- O THREE PARABOLAS
- O PEAK LOCATIONS FROM 70 TO 85% OF CORE HEIGHT
- O TOP/BOTTOM OF CORE POWERS EQUAL BUT VARIABLE AND SET BY CLASS OF AXIAL SHAPE DESIRED

NORMALIZED AXIAL POWER SHAPES FOR LOCA ANALYSIS
PEAK AT 52.08 PERCENT OF CORE HEIGHT

CLASS 1 TYPE: FLATTENED SYMMETRIC

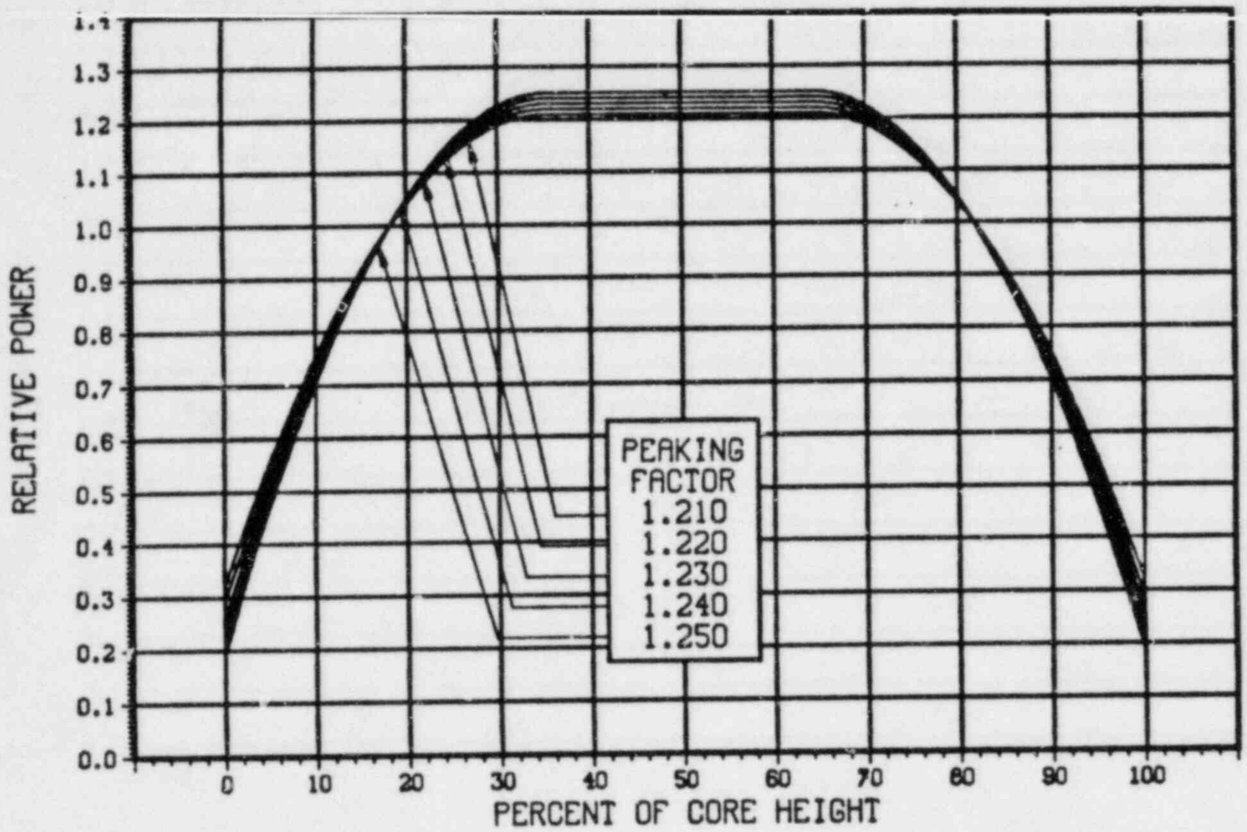


CLASS 2 TYPE: FLATTENED TOP-PEAKED, HIGH POWER AFTER PEAK

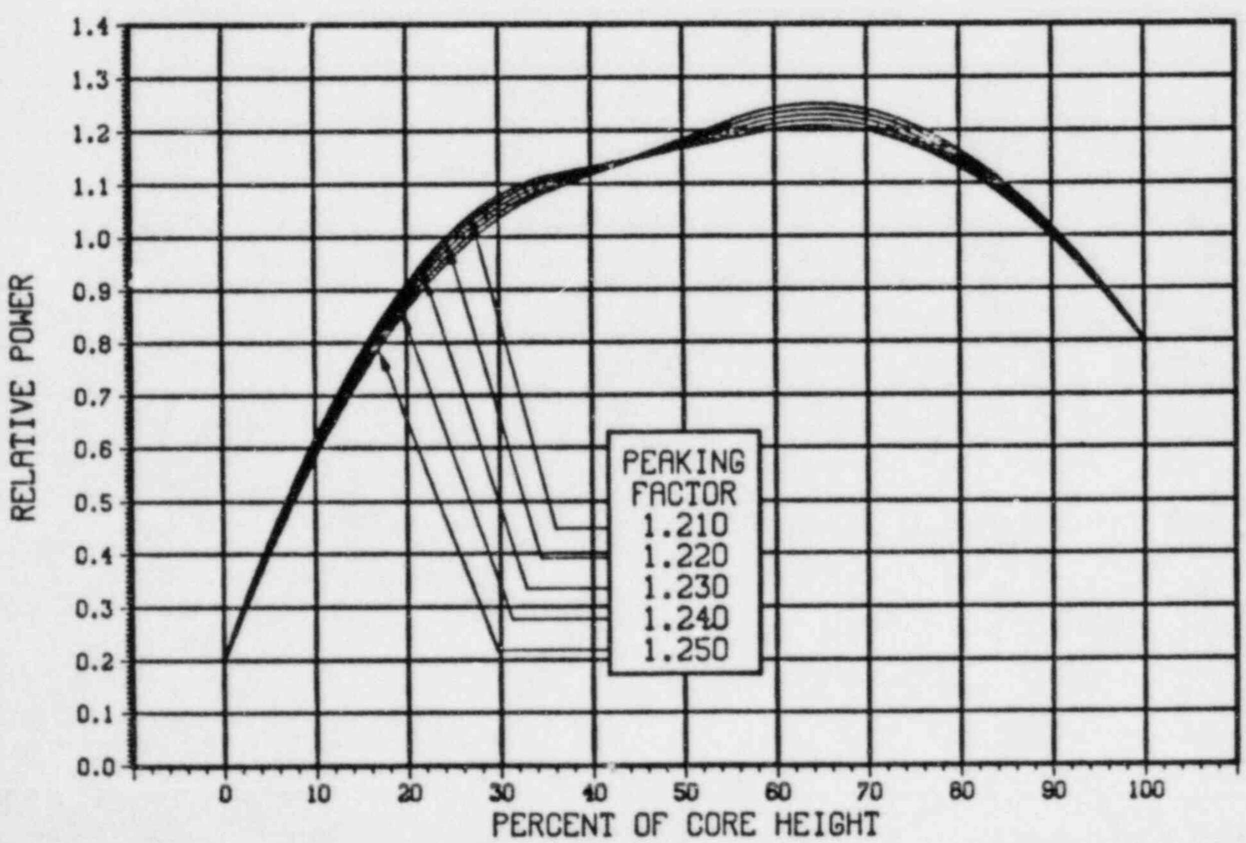


NORMALIZED AXIAL POWER SHAPES FOR LOCA ANALYSIS
PEAK AT 64.58 PERCENT OF CORE HEIGHT

CLASS 1 TYPE: FLATTENED SYMMETRIC

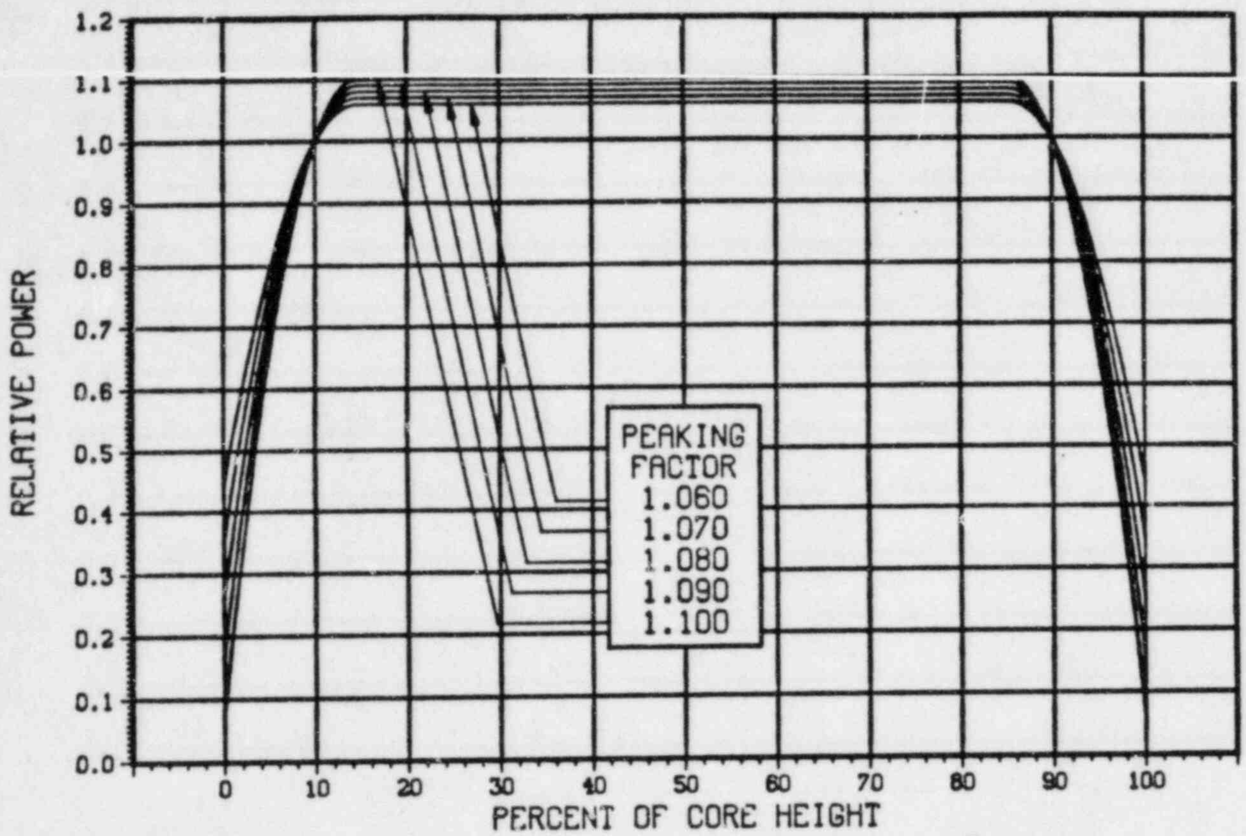


CLASS 2 TYPE: FLATTENED TOP-PEAKED, HIGH POWER AFTER PEAK

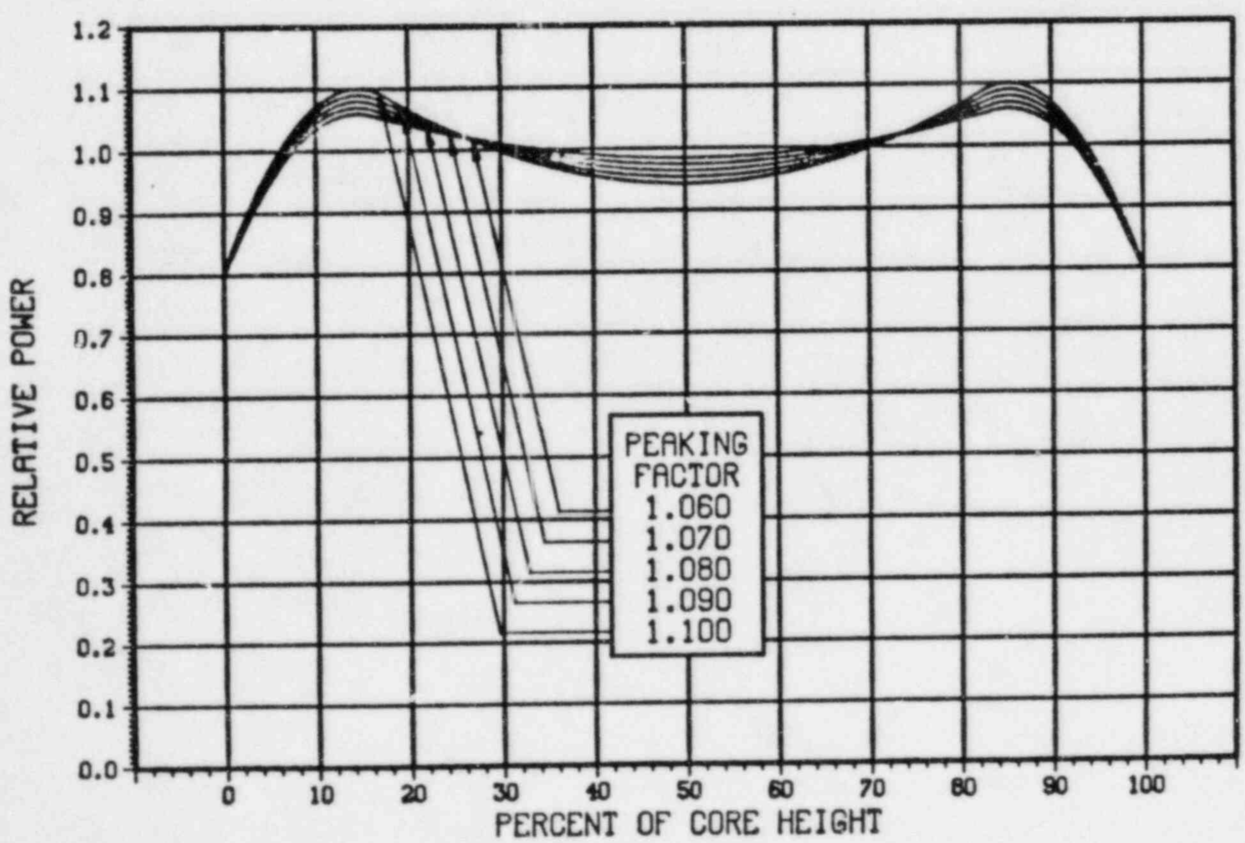


NORMALIZED AXIAL POWER SHAPES FOR LOCA ANALYSIS
MAXIMUM HEIGHT OF PEAK AT 85.42 PERCENT CORE HEIGHT

CLASS 1 TYPE: FLATTENED SYMMETRIC



CLASS 2 TYPE: DOUBLE-HUMPED SYMMETRIC, HIGH POWER AFTER PEAK



MAINE YANKEE

MATHEMATICALLY-DEFINED AXIAL SHAPES

COMPARED TO POSSIBLE AREA OF PEAK POWER SHAPES

IMPROVED LOCA METHODS WITH STEAM COOLING (ESTIMATED LOCA LHGR LIMITS)

CLASS 1- HIGH POWER UP TO PEAK POWER LOCATION

FLATTENED, SYMMETRIC AXIAL SHAPES TEND TO PROVIDE FOR MAXIMUM UTILIZATION OF POSSIBLE AREA BELOW PEAK LOCATION

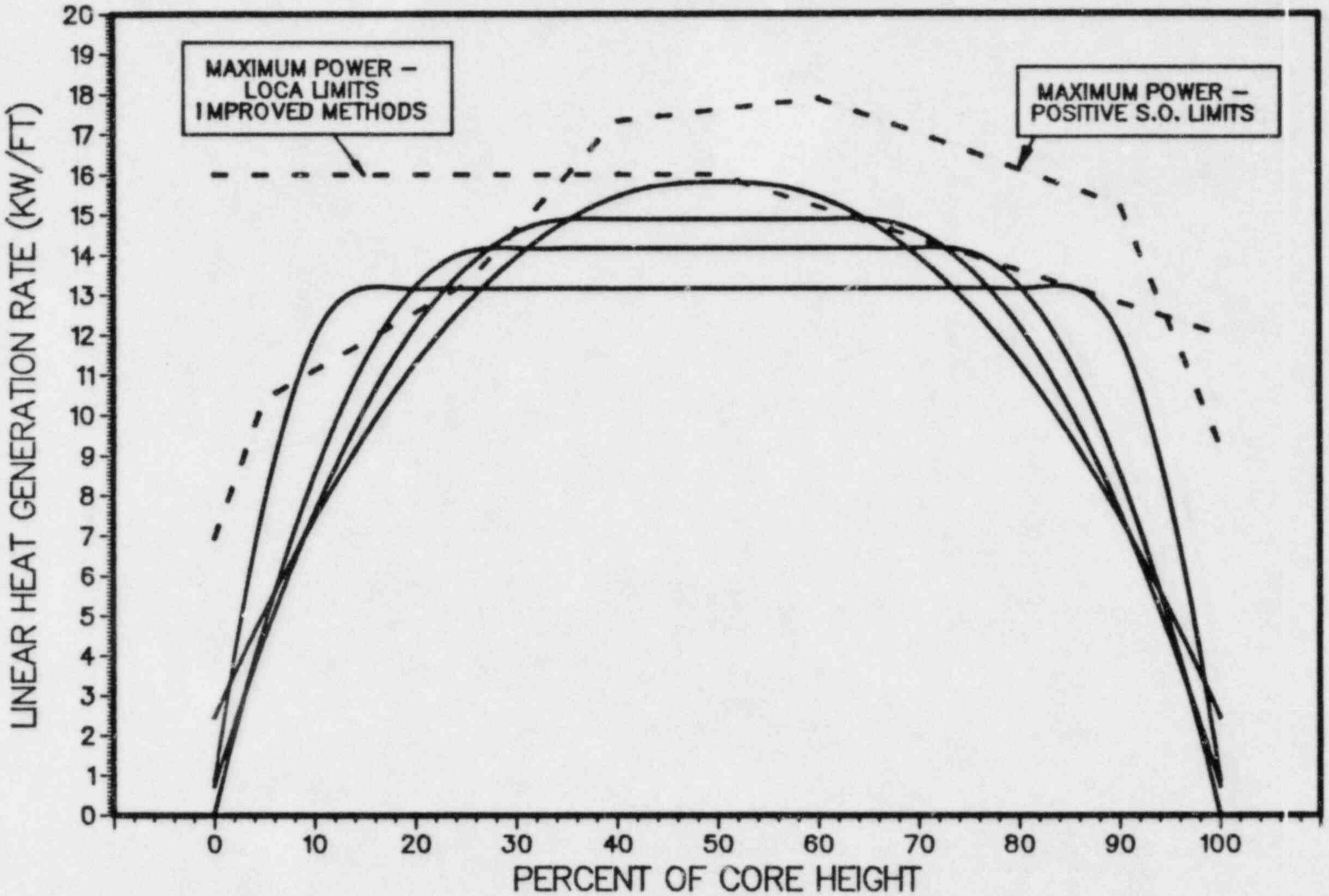
CLASS 2- HIGH POWER FROM PEAK POWER TO PCT LOCATIONS

FLATTENED, TOP-PEAKED AXIAL SHAPES WITH MAXIMUM TOP OF CORE POWER AND MINIMUM BOTTOM OF CORE POWER RESULTS IN PCT LOCATION POWERS GREATER THAN THE PRESUMED LOCA LHGR LIMIT LINE

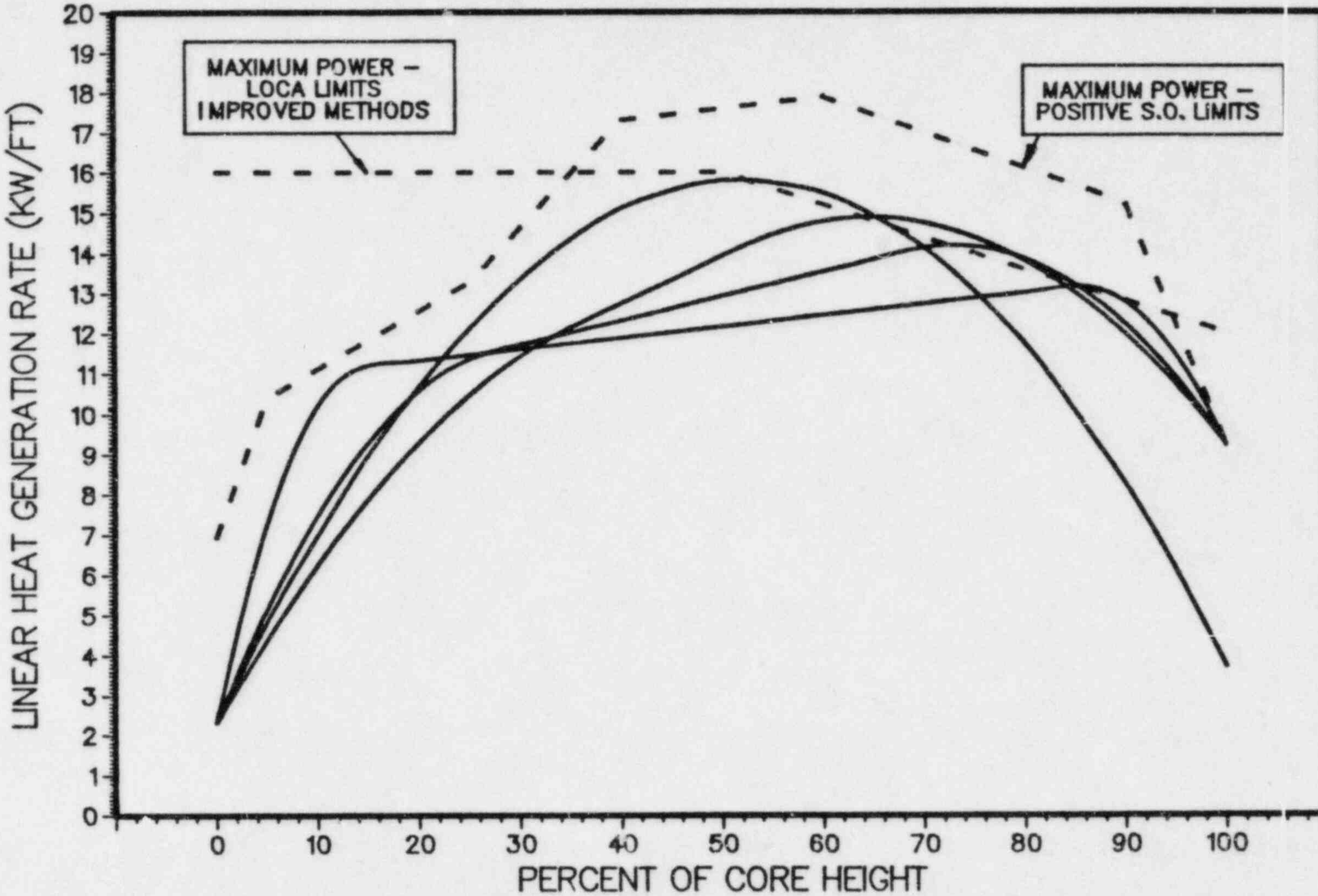
CURRENT LOCA METHODS WITH INJECTION DELTA P (ESTIMATED LOCA LHGR LIMITS)

CURRENT LOCA METHODS LIMITS ARE PROJECTED TO BE SUFFICIENTLY RESTRICTIVE SO THAT FLATTENED, SYMMETRIC SHAPES FULFILL THE REQUIREMENTS OF BOTH CLASS 1 AND CLASS 2 AXIAL SHAPES

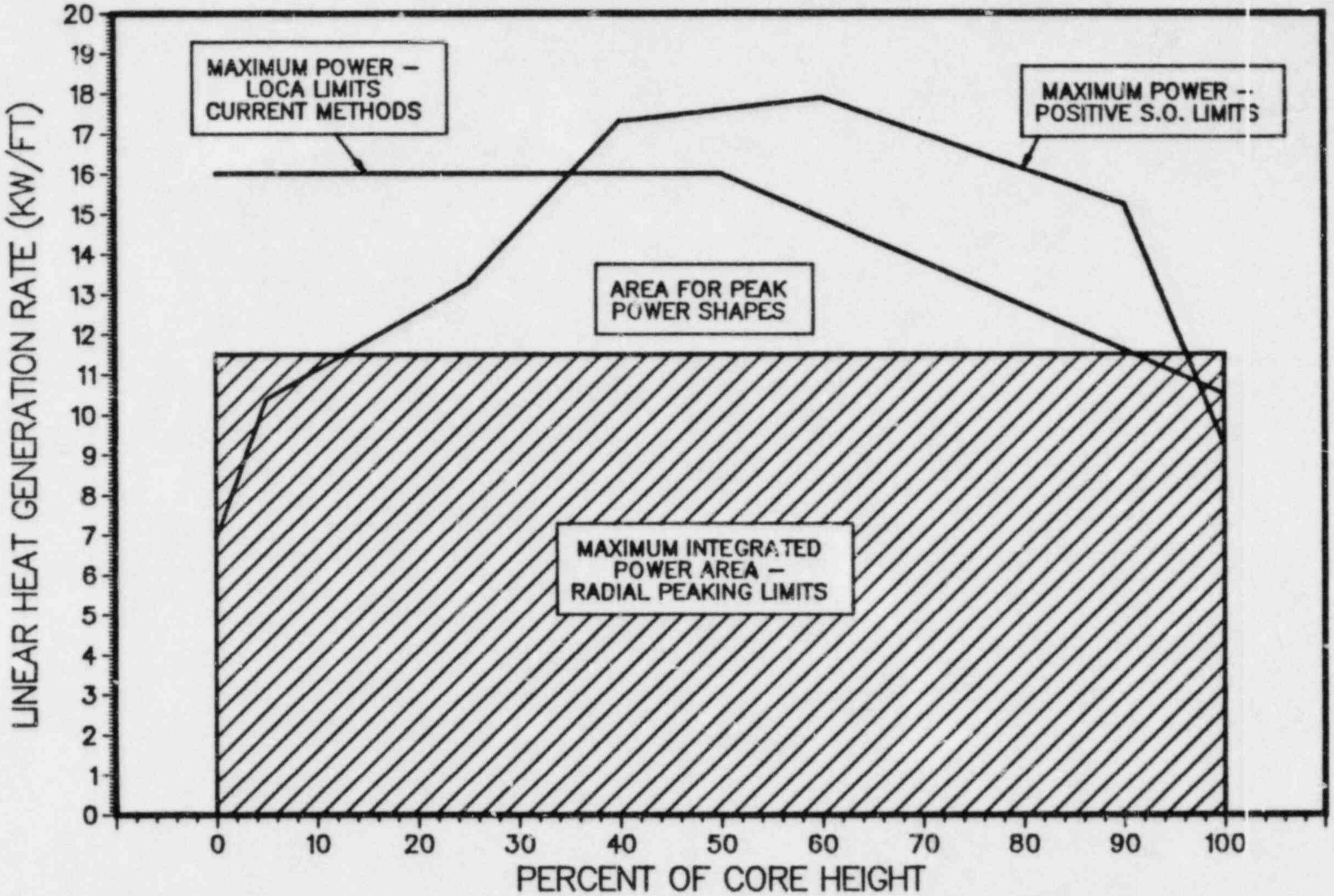
MAINE YANKEE CYCLE 10
AREA OF POSSIBLE PEAK POWER SHAPES COMPARED TO
FLAT, SYMMETRIC POWER SHAPES



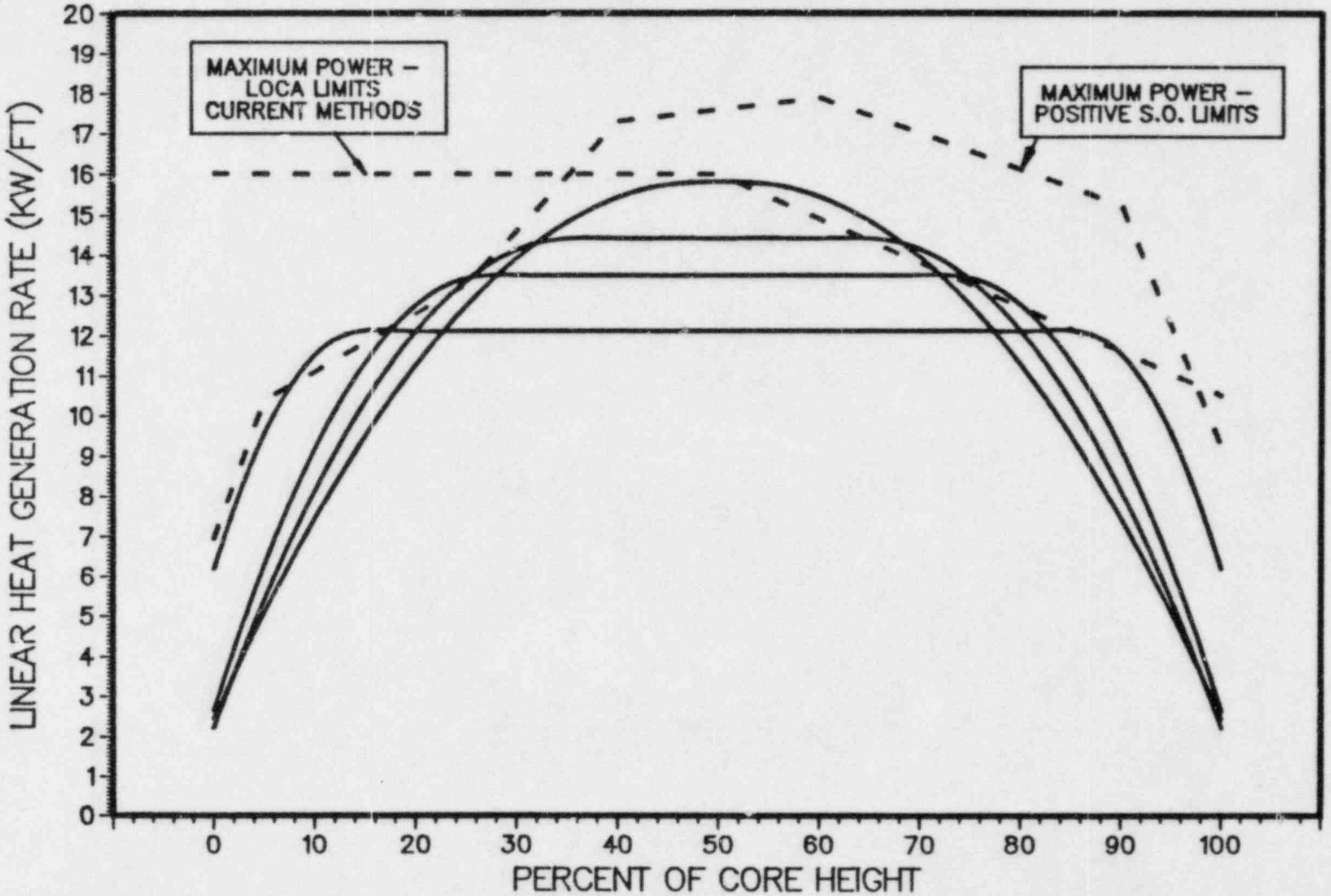
MAINE YANKEE CYCLE 10
AREA OF POSSIBLE PEAK POWER SHAPES COMPARED TO FLAT,TOP–PEAKED POWER SHAPES WITH HIGH POWER AFTER PEAK



MAINE YANKEE CYCLE 10
AREA OF POSSIBLE PEAK POWER SHAPES
FOR EVALUATION IN LOCA
CURRENT METHODS



MAINE YANKEE CYCLE 10
AREA OF POSSIBLE PEAK POWER SHAPES COMPARED TO
FLAT, SYMMETRIC POWER SHAPES

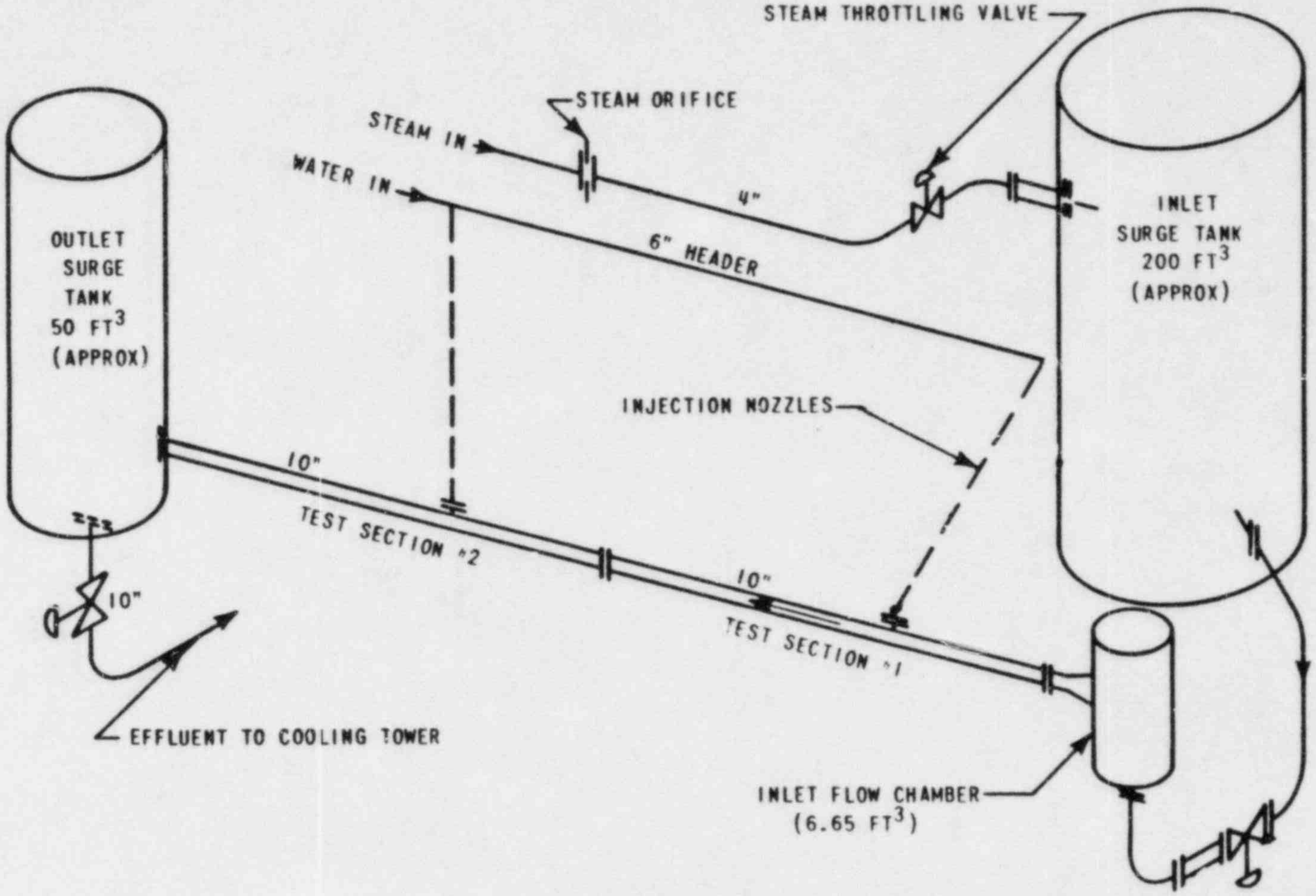


- YAEC LOCA MODEL USED FOR MAINE YANKEE SINCE 1979

- LOST MARGIN DUE TO AXIAL POWER SHAPE ISSUE

- TO GAIN BACK SOME OF THE LOST MARGIN A MODEL IMPROVEMENT IS SUGGESTED

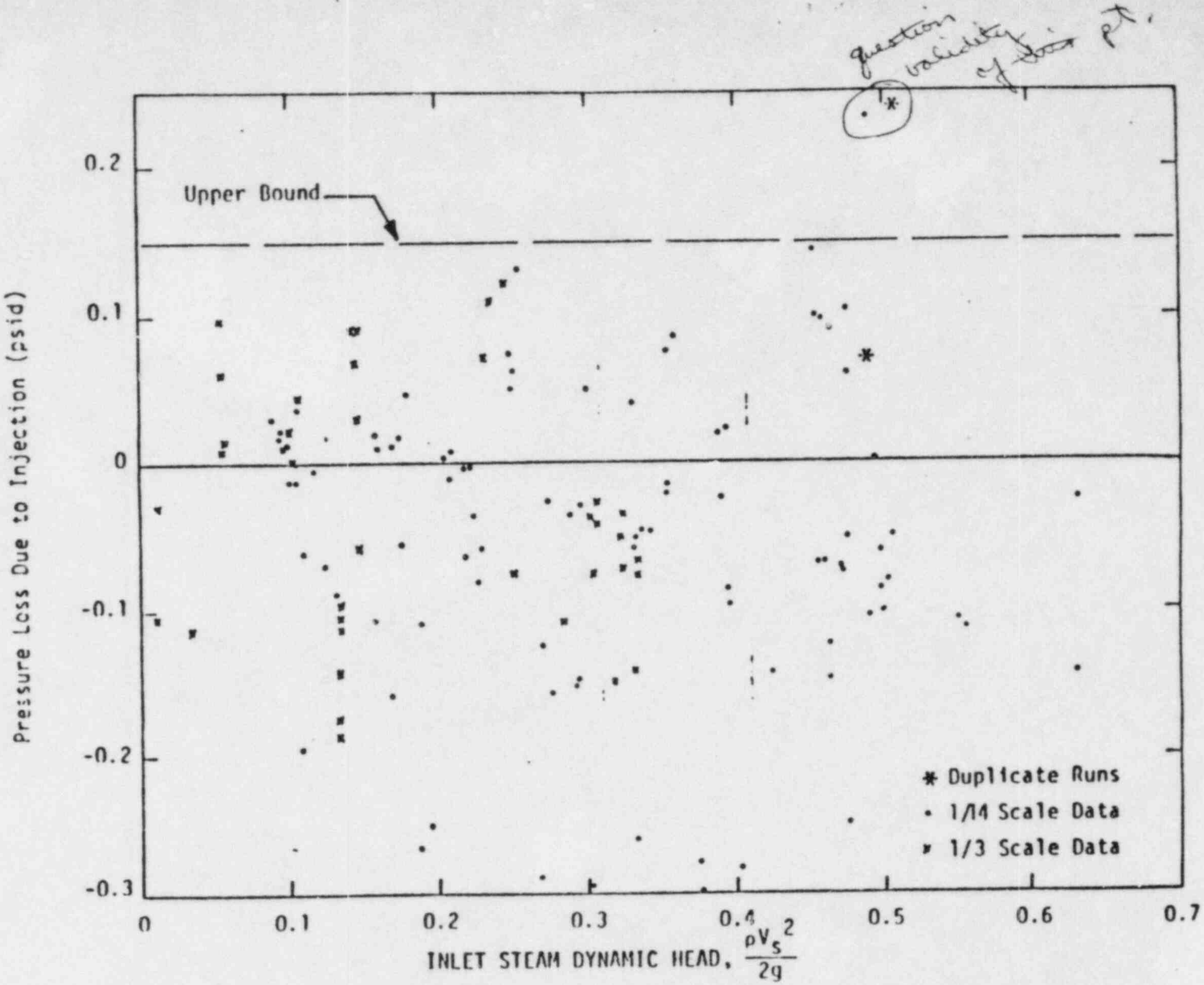
    - IMPLEMENT A MORE REALISTIC VALUE OF INJECTION ΔP IN THE REFLOOD MODEL



Steam/Water Mixing Test Hardware

TEST PARAMETER AND THEIR RANGES

PARAMETER	1/14 SCALE TEST RANGE	1/3 SCALE TEST RANGE	MAINE YANKEE
COLD LEG PRESSURE (PSIA)	20,40,60	22,50	37
INJECTION WATER VELOCITY (FT/SEC) PUMPED INJEC.	4, 8, 12	1 - 16	12.87
INJECTION ANGLE	90,45	90,45	90
STEAM TEMPERATURE (^{O}F)	350,550	SAT,500	530
INJECTION WATER TEMP.	80,120,150	80,120,150	110



Pressure Loss Due to Pumped Safety Injection

Enclosure 4

PRESENTATION OF PROPOSED REVISION TO YAEC STEAM COOLING MODEL

- INTRODUCTION
- REVIEW EXISTING MODEL
- NEW MODEL OBJECTIVES
- NEW MODEL DESCRIPTION
- PLANNED JUSTIFICATION FOR NEW MODEL

CURRENT YAEC STEAM COOLING MODEL

-FLOW DIVERSION DUE TO BLOCKAGE

USES A COMBINATION OF EXXON WREM-I AND WREM-II DEPENDENT UPON PERCENT OF BLOCKAGE.

-HEAT TRANSFER

AN EQUIVALENT STEAM FLOW IS DEFINED SUCH THAT THE HEAT TRANSFER COEFFICIENT(H) CALCULATED USING DITTUS-BOELTER EXACTLY MATCHES THE FLECHT CORRELATION AT THE NODE IMMEDIATELY BELOW THE BLOCKAGE PLANE

-FLUID ENERGY EQUATION

G=CRF*GIN*FZ

WHERE FZ IS DEFINED TO ASSURE CONSERVATIVE RESULT THROUGH AND ABOVE THE BLOCKAGE PLANE

NEW MODEL OBJECTIVES

-REMOVE EXCESSIVE CONSERVATISMS PRESENT IN EXISTING MODEL

-UTILIZE INFORMATION FROM FLECHT-SEASET IN DEVELOPING AND JUSTIFYING NEW MODEL

-SATISFY THE INTENT OF APPENDIX K BY COMPUTING THE EFFECT OF THE BLOCKAGE UPON THE FLOW AND HEAT TRANSFER

-ASSURE THAT THE STEAM COOLING MODEL IS ALWAYS CONSERVATIVE COMPARED TO THE FLECHT CORRELATION

MODEL DESCRIPTION

ASSUMPTIONS

-COOLANT FLOW IS SATURATED STEAM
-COOLANT TEMPERATURE IS CONSTANT AT TSAT
-DOMINANT HEAT TRANSFER IS PER FLECHT CORRELATION
-CHANGE IN HEAT TRANSFER COEFFICIENT DUE TO FLOW DIVERSION MUST BE CALCULATED
-HEAT TRANSFER ENHANCEMENT DUE TO SINGLE PHASE TURBULENCE WILL BE CALCULATED
-HEAT TRANSFER ENHANCEMENT DUE TO DROPLET BREAKUP WILL BE NEGLECTED

FLOW DIVERISION DUE TO BLOCKAGE

-EXISTING MODEL WILL BE USED TO OBTAIN GB/G

HEAT TRANSFER

H=HFLECHT * FB * FT
FB=(GB/G)**0.8 (D/DB)**0.2
FT=TURBULENCE ENHANCEMENT FACTOR CALCULATED USING MODEL FROM FLECHT-SEASET
FB*FT < 1.0

MODEL JUSTIFICATION

THE MODEL WILL BE DEMONSTRATED TO BE CONSERVATIVE WITH RESPECT TO ASSUMING HEAT TRANSFER FROM THE FLECHT CORRELATION

COMPARISONS TO RESULTS FROM THE EXISTING MODEL WILL ALSO BE PROVIDED

CYCLE 10 ANALYSIS (PHASE I)

- CURRENT METHOD WITH FOLLOWING CHANGES WILL BE UTILIZED
  - o ΔP PENALTY OF 0.15 PSID

- BREAK SPECTRUM SENSITIVITY WILL BE PERFORMED
  - o CYCLE 5 RESULTS WILL BE USED FOR THE BLOW-DOWN PERIOD
  - o MODIFIED REFLOOD MODEL WILL BE USED FOR THE REFLOOD PERIOD.
  - o WORST BREAK SIZE WILL BE IDENTIFIED
- BOUNDARY CONDITIONS FOR WORST BREAK SIZE WILL BE USED TO GENERATE LHGR FOR VARIOUS POWER SHAPES

- RESULTS WILL BE SUBMITTED WITH THE CPAR 90 DAYS BEFORE CORE STARTUP

AH/ OCT. 22, 1985

CYCLE 10 ANALYSIS (PHASE II)

- CYCLE 10 ANALYSIS WILL BE REDONE WITH A REVISED STEAM COOLING MODEL

- MODEL CHANGE SUBMITTED TO NRC	2/1/87
- SER FROM NRC	5/1/87
- SUBMITTAL OF ANALYSIS SCOPE SIMILAR TO (PHASE I)	10/1/87
- SER ON SUBMITTAL	12/1/87

AH/ OCT. 22, 1986