Power Distribution Limits

Chapter 13.0

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

HRTD
Human Resources
Training & Development

Objectives

1. State the purpose of imposing power distribution limits.

2. State the limiting conditions for operation (LCOs) in the technical specifications related to power distribution.

Obj-1

Purpose

- LCOs Limit core power distribution to the initial values assumed in accident analysis.
- LCOs and LSSS are based on safety analysis so the specified acceptable fuel design limits (SAFDL's) are not exceeded as a result of anticipated operational occurrences (AOOs)

Limiting conditions for operation (LCOs)

1. Linear heat rate (LHR),
2. Total planar radial peaking factor ,
3. Total integrated radial peaking factor,
4. Axial shape index (ASI) limit,
5. Azimuthal power tilt , and
6. Departure from nucleate boiling ratio (DNBR) limits.

13.2.1 Linear Heat Rate

- ensures that in the event of a LOCA, the peak temperature of the fuel cladding will not exceed 2200° F
- requires that the linear heat rate be less than or equal to a specific value in kW/ft
- the limit curve for the LPD RPS trip which ensures that the SAFDLs are not exceeded

Figure 13-1 Allowable Peak Linear Heat Rate vs. Time in Cycle

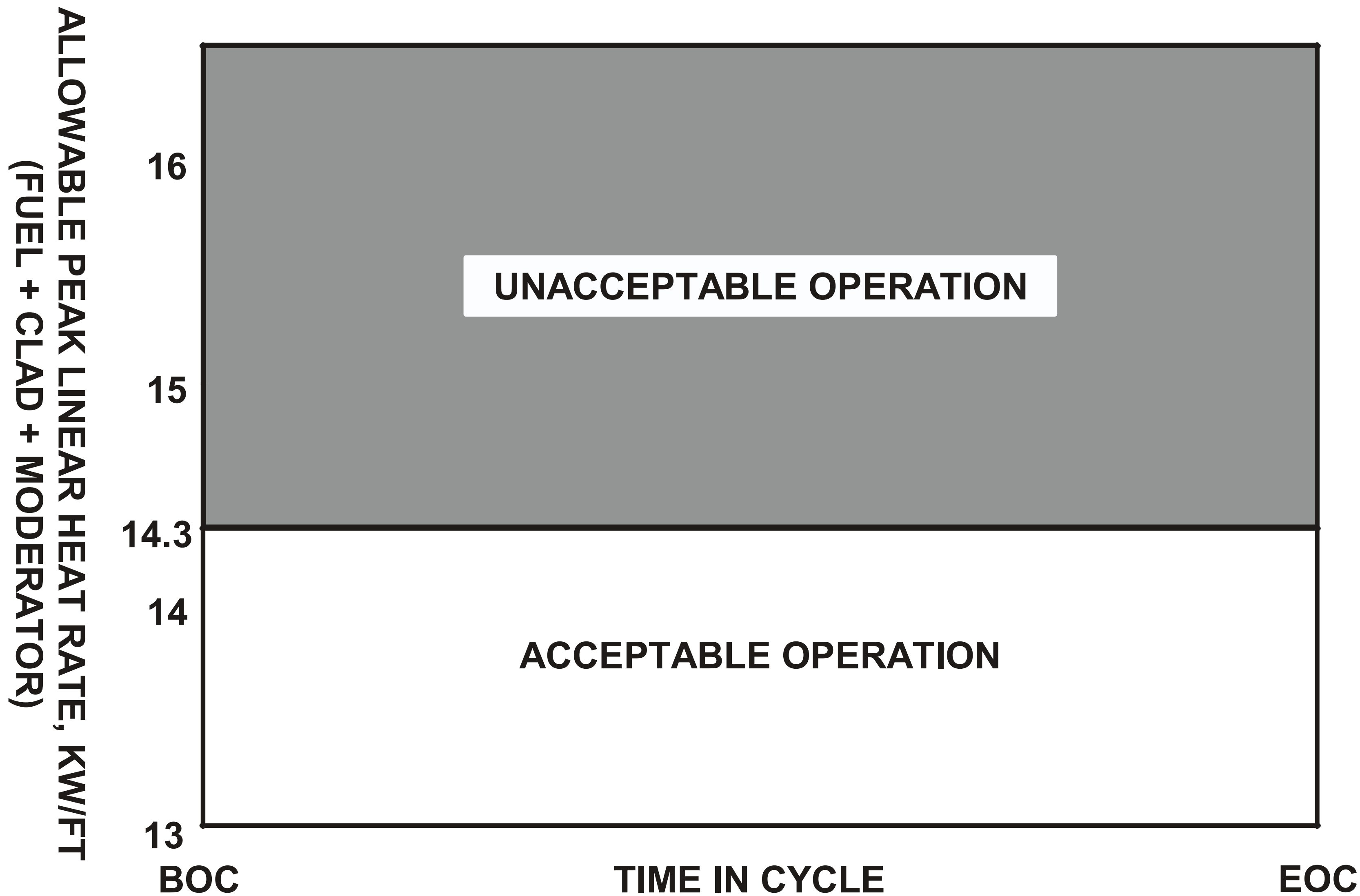


Figure 13-2 Linear Heat Rate Axial Flux Offset Control Limits

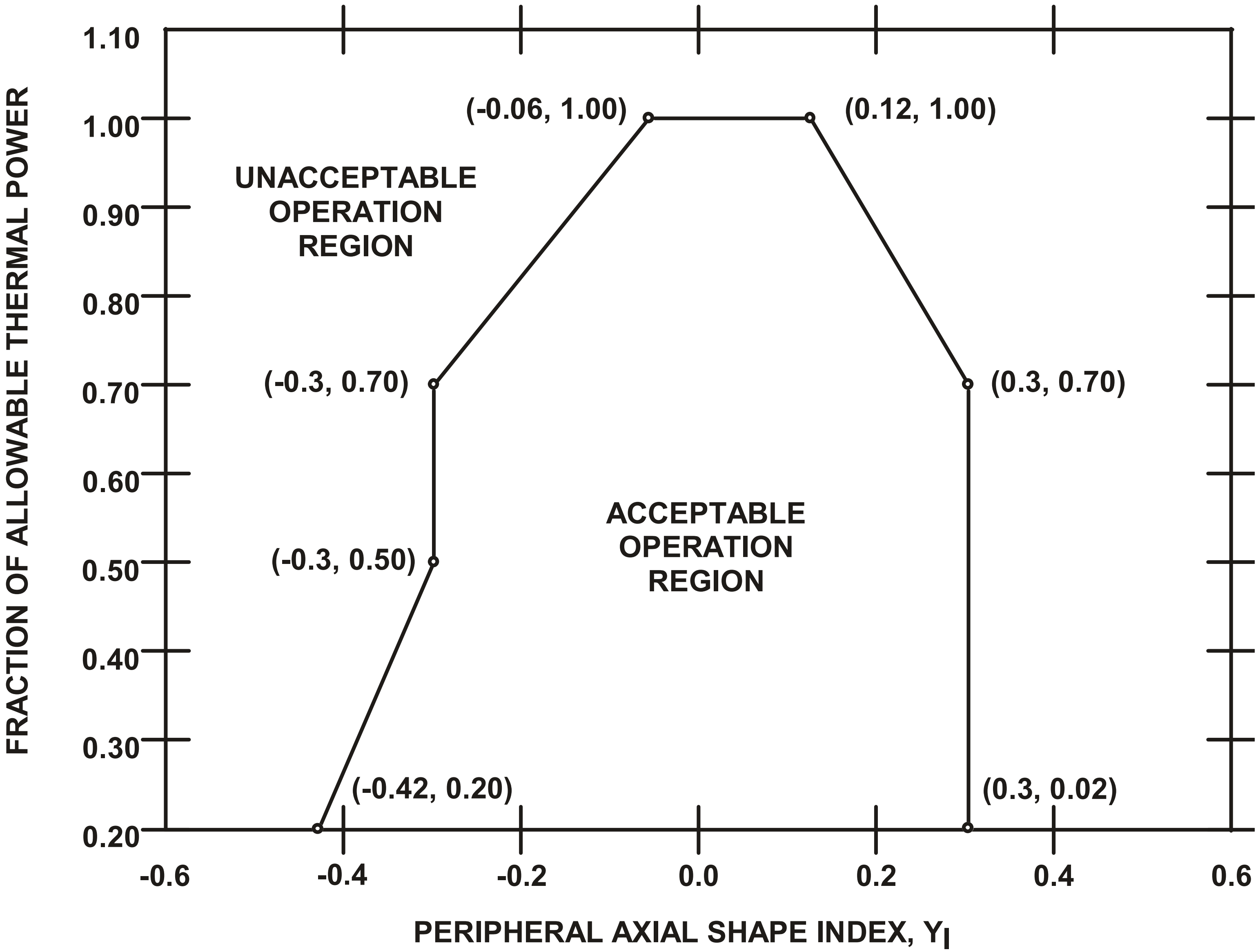
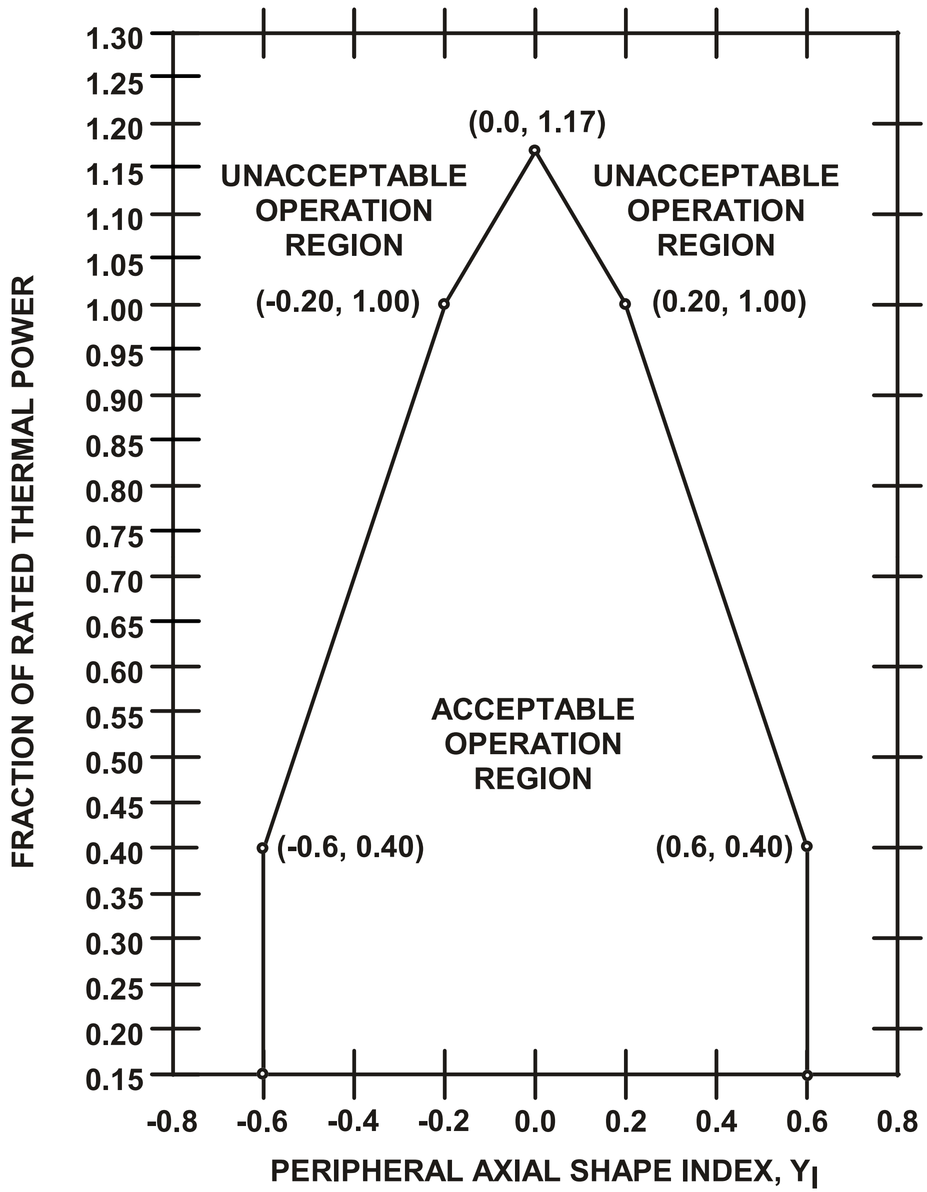


Figure 13-3 Axial Power Distribution - High Trip Setpoint Peripheral Axial Shape Index vs. Fraction of Rated Thermal Power



13.2.2 Total Planar Radial Peaking Factor

- the maximum ratio of the peak to average power density of the individual fuel rods in any of the unrodded horizontal planes, excluding tilt
- limit F^T_{xy} ensures that the assumptions used in the analysis for establishing the LHR limit and local power density (LPD) LSSS remain valid during operations at various allowed CEA insertion limits
- ensure that a fuel cladding temperature of 2200°F is not exceeding during a LOCA and the SAFDLs for DNB and kW/ft are not exceeded

13.2.3 Total Integrated Radial Peaking Factor

- the ratio of the peak pin power to the average pin power in an unrodded core
- ensure that the assumptions used in the analysis in establishing the DNB margin LCO, and the thermal margin low pressure (TMLP) LSSS setpoint remain valid during operation at various allowable CEA group insertion limits

13.2.4 Azimuthal Power Tilt

- maximum difference between power generated in any core quadrant (upper or lower) and the average power of all quadrants in that half (upper or lower) of the core divided by the average power of all quadrants in that half (upper or lower) of the core.
- ensure that the assumptions used in the analysis for establishing the LHR limit and the LPD LSSS remain valid during operations at various allowed CEA insertion limits
- assumptions used in the analysis in establishing the DNB margin LCO, and the TMLP LSSS setpoint also remain valid during operation at various allowable CEA group insertion limits

13.2.5 DNB Parameters

- cold leg temperature,
- pressurizer pressure,
- RCS flow and
- ASI

13.3 Monitoring of Power Distribution Limits

- If CEAs are aligned to within the technical specification limits, and
- regulating CEAs are positioned in accordance with the power dependent insertion limits, then
- the radial and axial core flux shapes should fall within the analyzed bounds of safety analysis, also;
- total power should be less than or equal to the licensed power limit

13.4 Xenon Redistribution

core xenon distribution is proportional to the radial and axial flux shapes

1. A dropped CEA,
2. A misaligned CEA,
3. A turbine run back with the reactor regulating system in automatic and
4. Power maneuvering with the CEAs.

13.5 Limiting Transients/Accidents

1. Loss of forced reactor coolant flow - there must be at least a 95% probability at a 95% confidence level that the hot fuel rod in the core does not experience DNB,

2. During a double ended rupture of a cold leg, the peak cladding temperature must not exceed the 10CFR50.46 limit of 2200°F and

3. During an ejected CEA accident, the fission energy input to the fuel must not exceed 280 cal/gm.

The End