Shearon Harris / H. B. Robinson License Amendment Request to Support the Transition to Duke Non-LOCA Analysis Methods

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Duke/NRC Pre-submittal Meeting
August 3, 2017

Objective

- Brief the NRC on the proposed submittal and review schedule
- Obtain feedback on schedule

Presentation Outline

- Methodology Report Status
- Licensing Approach
- LAR Scope
  - Power Distribution TS Changes
  - Shutdown Margin TS Changes (Harris Only)
  - Relocation of TS Parameters to the COLR
  - COPERNIC
  - BOC MTC TS Revision (Robinson Only)
- Conclusion

Methodology Report Status

	MNS/CNS	ONS	Proposed RNP/HNP	Submittal Date
Physics Codes / Models	DPC-NE-1005 CASMO-4/SIMULATE-3	DPC-NE-1006 CASMO-4/SIMULATE-3	DPC-NE-1008 CASMO-5/SIMULATE-3	August 19, 2015 Approved May 18, 2017
Physics Applications Power Distribution Monitoring	DPC-NE-2011	NFS-1001 DPC-NE-1002	DPC-NE-2011 revision	February 3, 2016++ Resubmitted May 4, 2016 Approved May 18, 2017
Physics Applications Reload Design	DPC-NF-2010	NFS-1001 DPC-NE-1002	DPC-NF-2010 revision	February 3, 2016++ Resubmitted May 4, 2016 Approved May 18, 2017
NSSS Codes / Models	DPC-NE-3000 RETRAN-02	DPC-NE-3000 RETRAN-3D	DPC-NE-3008 RETRAN-3D	November 19, 2015 RAI Response: Nov. 10, 2016
Subchannel T/H Methods	DPC-NE-3000 DPC-NE-2004 VIPRE-01	DPC-NE-3000 DPC-NE-2003 VIPRE-01	DPC-NE-3008 DPC-NE-2005 VIPRE-01	November 19, 2015 RAI Response: Nov. 10, 2016
SCD Methodology	DPC-NE-2005	DPC-NE-2005	DPC-NE-2005 revision	March 5, 2015 Approved March 8, 2016
Transient Analysis	DPC-NE-3001 DPC-NE-3002 SIMULATE-3K (REA)	DPC-NE-3005 SIMULATE-3K (REA)	DPC-NE-3009 SIMULATE-3K (REA)	October 3, 2016
Fuel Performance	DPC-NE-2008 (TACO-3) DPC-NE-2009 (PAD 4.0)	DPC-NE-2008 (TACO-3 and GDTACO)	N/A - TS changes only COPERNIC-2	August/September 2017

++ Withdrawn April 7, 2016

Licensing Approach

- Extend previously NRC-approved McGuire/Catawba and fuel vendor methodologies to Harris and Robinson
- Power distribution TS changes are based on those implemented at McGuire and Catawba
- SDM TS change is based on TSTF-248
- TS parameters relocated are consistent with those relocated for McGuire and Catawba
- Adopt COPERNIC fuel rod performance methodology (approved for Oconee)

Licensing Approach cont'd

- BOC MTC TS Change implemented to improve analysis margins at 50% rated thermal power
- UFSAR Changes
  - Implemented via 10 CFR 50.59 following methodology report approval coincident with first in-house reload

Schedule

- Support the reload licensing analysis for Harris Unit 1 Cycle 23 and Robinson Unit 2 Cycle 33
  - H1EOC22 (10/19)
  - R2EOC33 (9/20)
- Reload Analyses Start:
  - HNP (Spring 2018)
  - RNP (Early 2019)
- NRC approval requested for (December 2018)
- Implementation prior to the startup of H1C23 and R2C34

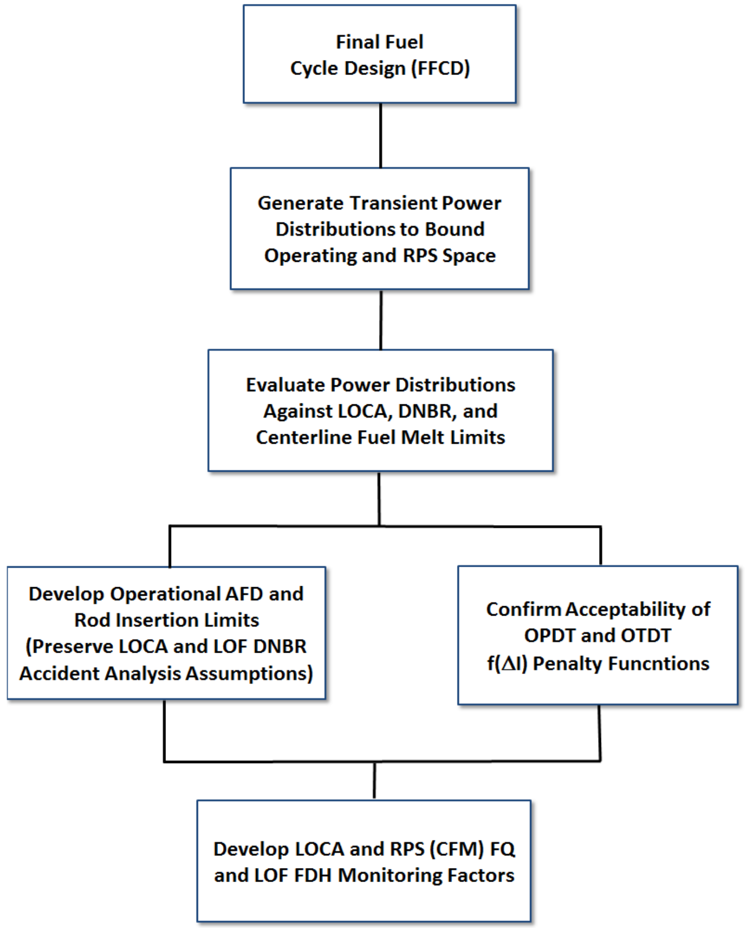
Power Distribution TS Changes

- Required to implement the power distribution surveillance methodology described in DPC-NE-2011-P-A
- McGuire and Catawba specifications used as a template
- Affected Specifications
  - TS 3.2.1 (TS 3.2.2) Heat Flux Hot Channel Factor - FQ
  - TS 3.2.2 (TS 3.2.3) Nuclear Enthalpy Rise Hot Channel Factor – $F\Delta H$
  - TS 3.2.3 (TS 3.2.1) Axial Flux Difference (AFD)
  - TS 3.2.4 (TS 3.2.4) Quadrant Power Tilt Ratio (QPTR)

DPC-NE-2011-P Overview

- Develops Axial Flux Difference (AFD) and Rod Insertion limits (RILs) to preserve the initial condition power peaking assumptions for LOCA and LOF DNB
- Confirms the acceptability of the f(ΔI) portion of the OTDT and OPDT trip functions for over-power Condition II transients
  - OPDT and OTDT trip functions protect against centerline fuel melt and DNB.
- Develops core Monitoring Factors for Tech Spec FQ and FΔH power distribution surveillances

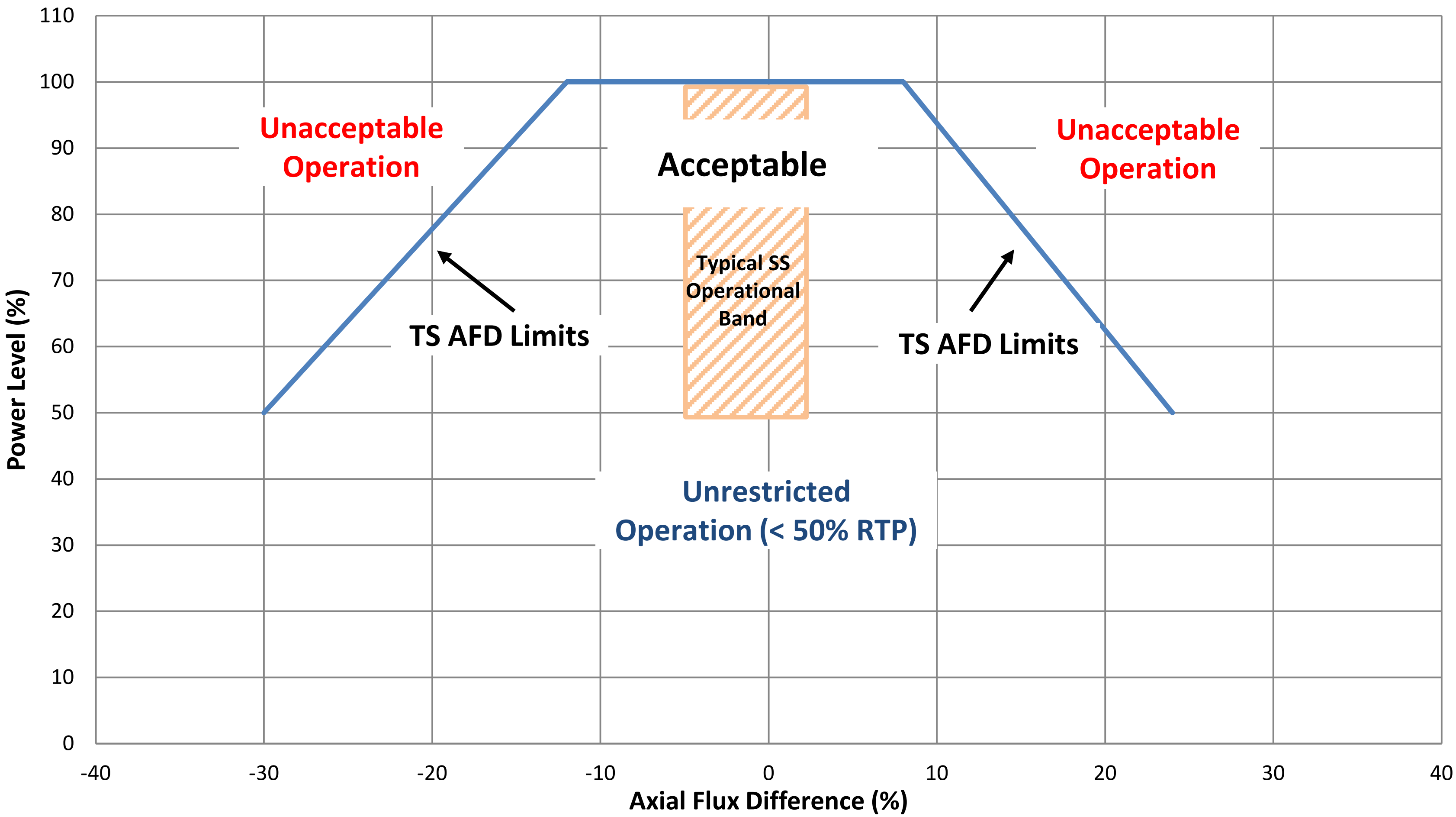
Maneuvering Analysis Process



DPC-NE-2011-PA Overview
Monitoring Factors

- Similar to the Westinghouse W(Z) factors in that they are used to quantify peaking factor margin in the transient condition at the AFD limits
- 3-D factors functionalized against burnup and power
- Account for LOCA FQ, CFM FQ and LOF DNB $F_{\Delta H}$ transient margin
- Cycle-specific
- Specified in the COLR

Typical Axial Flux Difference Limits



Heat Flux Hot Channel Factor FQ Surveillance

- Three checks are performed
  - Steady State FQ: confirmation of the current state of the core
  - Transient (or operational) FQ: Confirmation that the LOCA limits would not be exceeded under operational transient conditions
  - RPS FQ: Confirmation that CFM limits would not be exceeded in the event of an over-power Condition II transient

FQ Steady State

- $F_Q^M(x,y,z) \leq \frac{F_Q^{RTP}}{P} K(Z)$ for P > 0.5

where,

$F_Q^M(x,y,z)$ = measured F_Q

F_Q^{RTP}= the LOCA limit at rated thermal power (RTP) specified in the Core Operating Limits Report (COLR). Augmented by K(BU) if necessary.

K(BU) = normalized F_Q as a function of burnup

P = relative thermal power

K(Z) = normalized F_Q as a function of core height

P = 0.5 for all powers $\leq$ 50% RTP

FQ Operational Surveillance

- $F_Q^M(x,y,z) \leq F_Q^D(x,y,z) * M_Q(x,y,z)$

where,

$F_Q^M(x,y,z)$ = measured F_Q

$F_Q^D(x,y,z)$ = design F_Q

$M_Q(x,y,z)$= LOCA margin available at core location x,y,z

Centerline Fuel Melt Surveillance

- $F_Q^M(x, y, z) \leq F_Q^D(x, y, z) * M_C(x, y, z)$

where,

$F_Q^M(x, y, z)$ = measured F_Q

$F_Q^D(x, y, z)$ = design F_Q

$M_C(x, y, z)$= CFM margin available at core location x,y,z

Measured FQ Exceeding Op Surveillance Limit

- With FQ exceeding its Operational limit:
  - Reduce the operational AFD limits and/or core power
  - When AFD adjustments alone are insufficient to recapture the desired margin, reduce the core power level
    - This is a change from the MNS/CNS specifications
    - Compensatory actions address concerns raised in NSAL 09-05
  - Power level adjustments are accompanied with RPS trip setpoint adjustments to maintain appropriate margin to the trip limit

Measured FQ Exceeding RPS Surveillance Limit

- With FQ exceeding its RPS limit:
  - Reduce the OPDT $f_2(\Delta I)$ breakpoints
  - Alternate options include:
    - Reducing the OTDT trip setpoint (K_1)
    - Reducing the OTDT $f_1(\Delta I)$ breakpoints
  - Alternate options may be required for Harris prior to installation of the $f_2(\Delta I)$ trip reset function

Nuclear Enthalpy Rise Hot Channel Factor - FΔH

- Two checks are performed
  - Steady State FΔH: confirmation of the current state of the core
  - Transient (or operational) FΔH: Confirmation that the LOF DNBR limits would not be exceeded under operational transient conditions

F∆H Steady State

- $F_{\Delta H}^{M}(x, y) \leq MARP(x, y) * \left[1.0 + \frac{1}{RRH} * (1.0 - P)\right]$

where,

$F_{\Delta H}^{M}(x, y)$ = Measured value of $F_{\Delta H}$

P = relative thermal power

RRH = the thermal power reduction required to compensate for each 1% that the measured radial peak exceeds its limit

MARP(x,y) = Maximum Allowed Radial Peak for the limiting DNB transient. Function of axial peak and elevation z.

$F\Delta H$ Operational Surveillance

- $F_{\Delta H}^{M}(x, y) * UMR \leq [F_{\Delta H}^{D}(x, y) * M_{\Delta H}(x, y)]$

where,

$F_{\Delta H}^{M}(x, y)$ = Measured $F\Delta H$

UMR = Radial uncertainty factor

$F_{\Delta H}^{D}(x, y) =$ Design radial power, $F\Delta H$

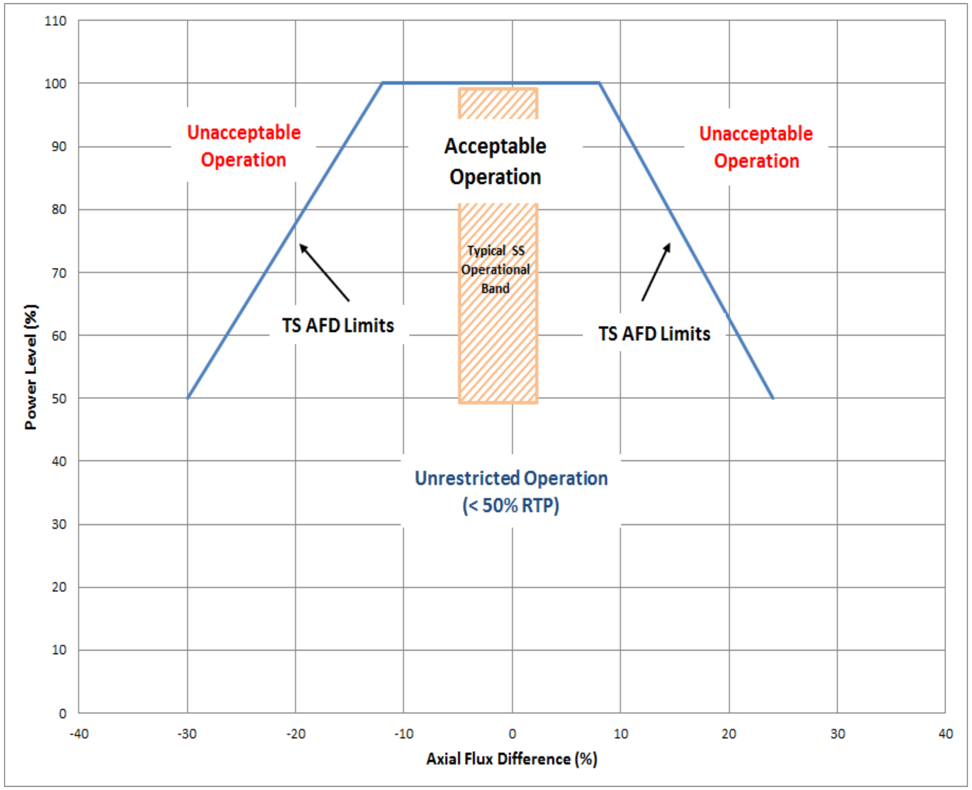
$M_{\Delta H}(x, y)$ = DNB margin remaining in location x,y in the calculated transient power distributions

Measured FΔH Exceeding Steady State or Surveillance Limit

- With FΔH exceeding its limits
  - Reduce thermal power by $\geq$ RRH for each percent FΔH exceeds its limit
  - Reduce power range and OTDT setpoints
  - Verify FΔH within limits

AFD Changes

- Replace PDC-3 methodology with the DPC-NE-2011-P-A methodology
- Replace CAOC and sliding barn limits with AFD versus power envelope



QPTR Changes

- The QPTR reference value at which a thermal power reduction is calculated is changed from 1.0 to 1.02
- Peaking factors are increased by an amount corresponding to a 2% quadrant power tilt prior to comparison against LOCA, DNB and centerline fuel melt limits

SDM Definition Change (Harris Only)

- Adopt the TSTF-248 modified definition for shutdown margin
- The change allows an exception to the highest reactivity worth stuck control rod allowance if there are two independent means of confirming that all control rods are fully inserted
- Definition change is consistent with the definition of SDM in NUREG-1431
- With any rod cluster assembly not capable of being fully inserted, the reactivity worth of the stuck control rod must be accounted for in the determination of SDM
- Soluble boron requirements to maintain SDM with and without the stuck rod assumption are controlled by plant procedures

Benefits of SDM Definition Change

- Potentially decreases the amount of boron addition required following a reactor trip or shutdown
- Reduces the amount of water and acid processing leading up to, and following a subsequent reactor startup following shutdown
- Allows commencement of a reactor cooldown earlier

Tech Spec Parameter Relocation- Harris

- Parameters relocated are consistent with those contained in the McGuire and Catawba COLRs
- MODE 1 and 2 SDM limit
  - TS 3.1.1.1 - Shutdown Margin - MODES 1 and 2
- Soluble boron requirements for the refueling water storage tank, boric acid tank or accumulators
  - TS 3.1.2.5 - Borated Water Source - Shutdown
  - TS 3.1.2.6 - Borated Water Source – Operating
  - TS 3.5.1 Emergency Core Cooling Systems, Accumulators
  - TS 3.5.4 - Emergency Core Cooling Systems, Refueling Water Storage Tank

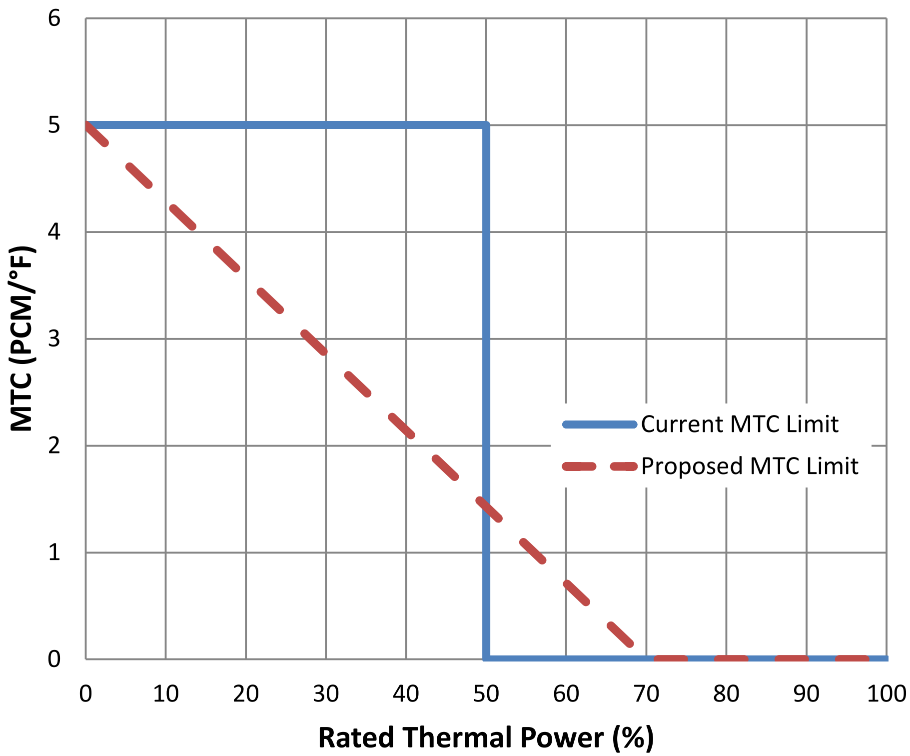
Tech Spec Parameter Relocation- Robinson

- Soluble boron requirements for the accumulators and refueling water storage tank to the COLR
  - TS 3.5.1 - Emergency Core Cooling Systems, Accumulators
  - TS 3.5.4 - Emergency Core Cooling Systems, Refueling Water Storage Tank (RWST)

COPERNIC

- Current fuel rod mechanical analyses are performed by AREVA with RODEX2
- Transition to COPERNIC is proposed to address TCD concerns
- Analysis method is described in BAW-10231P-A
- The proposed amendments would add the COPERNIC fuel performance code to TS 6.9.1.6 (Harris) and TS 5.6.5 (Robinson)
  - BAW-10231P-A to the approved COLR lists
- Self perform based on the guidance from generic letter 83-11
- COPERNIC has been approved for fuel rod mechanical analyses at Oconee (May 11, 2017)

Proposed Robinson BOC MTC TS Change



- More restrictive at power levels below 50% RTP
- Slightly less restrictive between 50% and 70% RTP
- Unchanged between 70% and 100% RTP

BOC MTC TS Change (Robinson Only)

- Current specification is restrictive at 50% RTP
- Proposed change is being pursued to increase design flexibility
- Current UFSAR analyses supports both the current and proposed MTC limits
- Future Duke analyses will be performed at the proposed limits

Conclusion

- Changes made to support Duke reload analysis methodology
- Fleet consistency was a priority
- Power distribution Tech Spec revisions are based on previously approved methods (DPC-NE-2011-P-A) and specifications approved for McGuire and Catawba
- SDM TS change is based on TSTF-248 (Harris only)
- Parameters relocated to the COLR are consistent with those contained in McGuire and Catawba COLRs
- Implementation of COPERNIC is consistent with vendor guidance
- Robinson BOC MTC Tech Spec change is driven by low margins associated with core designs using in-house methods