Angra Unit 1 Replacement Steam Generator/Next Generation Fuel/Power Uprate Program

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Angra Unit 1

- WEC 2-Loop Downcomer Vessel Injection NPP
- Currently operating (Cycle 15) with:
  - Original WEC Model D3 SGs
  - WEC 16x16 STD fuel
  - 100% licensed NSSS power = 1882 MWt
  - 100% power Tavg = 582.7°F

Major Program Upgrades

- Areva Model 72/W/D3 RSG Design
- Transitioning to 16x16 Next Generation Fuel (NGF)
- Uprated Power of 106.3% (2000 MWt NSSS)
- Tavg range from 575°F to 585°F

Major Reasons

- SG Tube Degradation Issues
  - Plant currently operating at 83% power
- Fuel Optimization
  - 16STD is +25 year old non-optimized design
- Enhanced output (MWe) from plant
- Operational Flexibility

Feasible?

- AREVA RSG
  - Design already implemented at Krsko
- 16NGF
  - INB-KNFC-W Design (started late 1990)
    - Design Package submitted to CNEN
  - Already implemented at Kori Unit 1

Feasible?

- Uprating
  - Ideal uprate delivers more MWe with:
    - No plant modifications
    - Min/No Capital Costs
    - No increase in operations
    - No increase in maintenance costs
  - Licensing environment allows implementation
    - 118 power uprates approved world-wide
    - WEC successful gaining approval for all uprates completed (83)

Feasible?

- Uprating - Terminology
  - 3 Types of Power Uprates:
- *Measurement Uncertainty Recapture (MUR) Uprates*
  - *< 2%*
  - *Achieved by* implementing enhanced techniques for calculating reactor power.
  - Use state-of-the-art feedwater flow measurement devices to reduce the degree of uncertainty associated with feedwater flow measurement thereby providing for a more accurate calculation of power.

Feasible?

- *Stretch Power Uprate* (SPU)
  - 2% ≤ X ≤ 7%
  - Within the design capacity of the plant.
  - Usually involve changes to instrumentation setpoints but do not involve major plant modifications.
- *Extended Power Uprate* (EPU)
  - > 7%
  - Require significant modifications to major BOP equipment such as the high pressure turbines, condensate pumps and motors, main generators, and/or transformers.

Feasible?

- Uprating Feasibility Study Performed (2001):
  - Stretch Power Uprate (6.3%) can be achieved with only minor plant modifications
    - High and Low Press Turbine
  - Used Krsko uprating program as benchmark

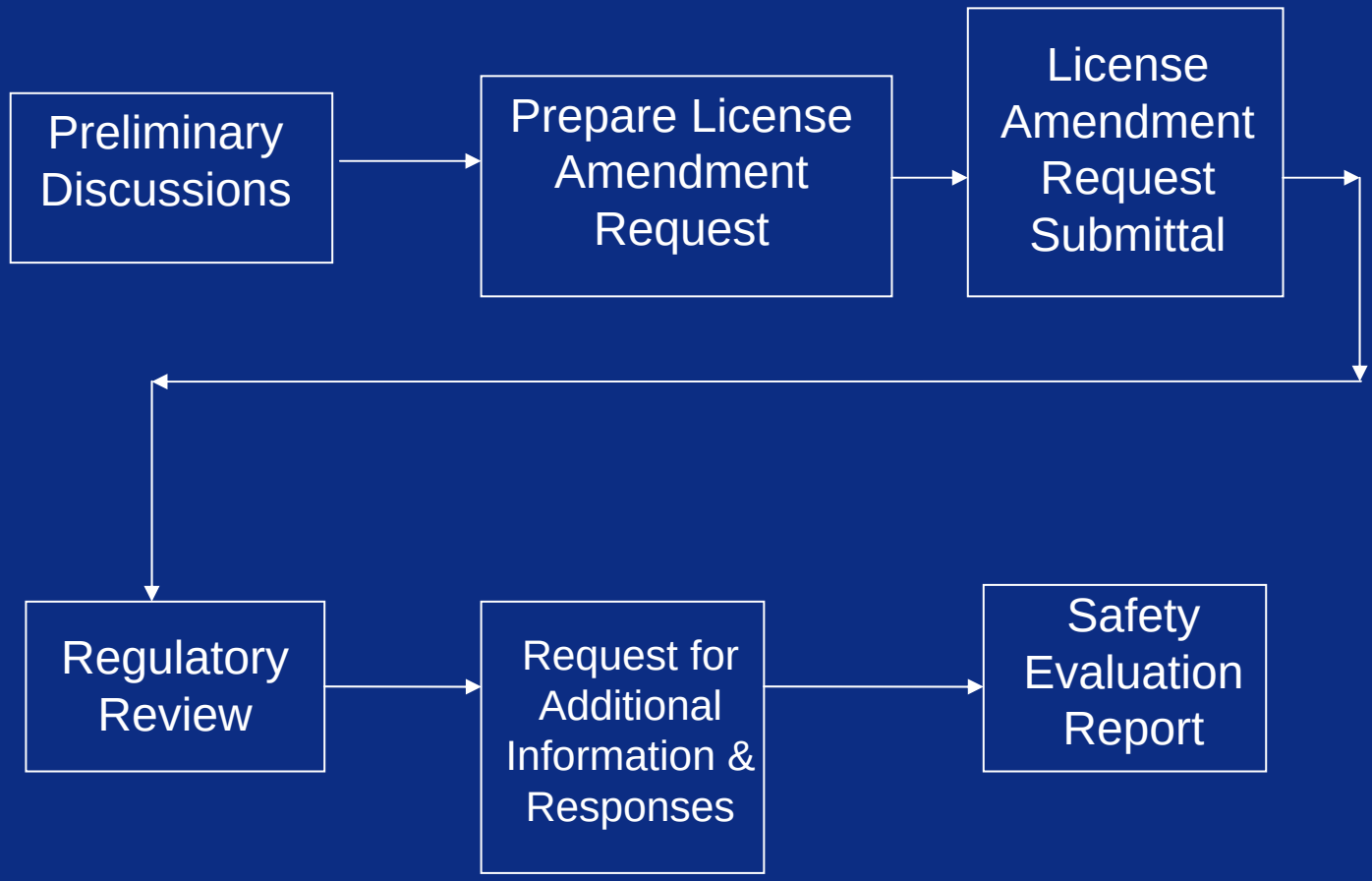
CONCLUSION: PROGRAM IS FEASIBLE!

Workscope

- ELETRONUCLEAR, INB and WEC performed analytical work to address the NSSS areas
  - Systems
  - Components
  - Safety Analyses
  - Fuel Analyses
- Results/Conclusions published in licensing documentation supporting ELETRONUCLEAR LAR submittal to CNEN

  LAR = License Amendment Request

Typical Major Programs Licensing Process



NSSS Systems Analyses

- All Acceptance Criteria were met
- WEC Addressed following systems:
  - NSSS Fluid and Auxiliary Systems
  - NSSS Control Systems
  - NSSS/BOP Interface System requirements

NSSS Systems Analyses

- Plant Operation Changes Supported
  - Revised the pressurizer water level program
  - New Tavg control program
  - New SG level control program
  - Load rejection steam dump controller setpoints
  - Feedwater/Condensate Pump Configuration
  - RHR Cooldown

NSSS Components Analyses

- All Acceptance Criteria were met
  - ASME Stress/fatigue usage limits
- WEC Addressed following components:
  - Reactor Vessel Structural and Integrity
  - Reactor Vessel Internals
  - Control Rod Drive Mechanisms
  - Reactor Coolant Pumps/Motors
  - Pressurizer
  - NSSS Auxiliary Equipment

NSSS Components Analyses

- ELETRONUCLEAR Addressed the Reactor Coolant Loop Piping/Supports

- Plant Operation Changes Supported
  - Reduced number of SG Snubbers

NSSS Safety Analyses

- Performed by WEC with support from ELETRONUCLEAR
- All Chapter 6 and 15 events reanalyzed with the latest US NRC approved methodology and computer codes. This includes:
  - Best-Estimate LBLOCA ASTRUM Evaluation Model (EM)
  - Appendix K SBLOCA NOTRUMP EM
  - Non-LOCA RETRAN EM
  - Radiological Doses with updated Alternate Source Term methodology (RG 1.183)
  - LOCA Containment GOTHIC Model

NSSS Safety Analyses

- All Acceptance Criteria were met
- Plant Operations Changes Supported
  - Revised OTDT/OPDT Reactor Trip (RT) setpoints
  - Decreased High Prz Pressure RT setpoint/delay
  - Increased Low Prz Pressure RT and SI setpoints
  - Revised SG Level RT setpoints
  - Decreased Max Containment Pressure Tech Spec limit
- Hot leg switchover time (from cold leg to hot leg recirc following LBLOCA) requirement reduced from 12 to 4 hours

NSSS Fuel Analyses

- All Acceptance Criteria were met
- All Chapter 4 fuel areas were reanalyzed with the latest US NRC approved methodology and computer codes.
- ETN, INB and WEC performed the fuel analyses:
  - Fuel Core Design (INB / ETN)
  - Fuel Thermal Hydraulics (INB / ETN)
  - Fuel Rod Design (INB)
  - Fuel Grid Crush (WEC)
  - Fuel Holddown Spring (INB)

Conclusions

- The Angra RSG/NGF/Uprating Program involves
  - AREVA RSGs for Cycle 16
  - Transitioning to 16NGF for Cycle 16
  - 6.3% Uprating for Cycle 19
- ELETRONUCLEAR, INB and WEC performed analytical work to address affected NSSS areas
- Approach/Methodology used consistent with those used by WEC for many other RSGs/fuel transition/power uprates around the world

Conclusions

- All NSSS areas potentially affected by RSG/NGF/Power Uprate were determined to satisfy applicable acceptance criteria with limited amount of plant operation changes
- ELETRONUCLEAR, INB and WEC generated licensing documentation to support the ELETRONUCLEAR LAR submittal to CNEN
- CNEN review still underway.