ATTACHMENT 47

List and Status of Plant Modifications

Browns Ferry Units 1, 2 and 3 EPU Modifications

The modifications required to support Extended Power Uprate (EPU) for Browns Ferry Nuclear Power Station (BFN) Units 1, 2 and 3 have been compiled and are shown in Table 1. All EPU modifications, either completed or being prepared, are in accordance with the TVA Plant Modifications and Engineering Change Control process.

Modifications not yet completed will be implemented during the next two refueling outages for each unit, as shown in the tables. For BFN Unit 1, the scheduled refueling outages are in the Fall of 2016 (RFO-U1R11) and Fall of 2018 (RFO-U1R12). For BFN Unit 2, the scheduled refueling outages are in the Spring of 2017 (RFO-U2R19) and Spring of 2019 (RFO-U2R20). For BFN Unit 3, the scheduled refueling outages are in the Spring of 2016 (RFO-U3R17) and Spring of 2018 (RFO-U3R18).

Further evaluations may identify the need for additional modifications or obviate the need for some modifications. As such, Table 1 listings are not a formal commitment to implement the modifications exactly as described or per the proposed schedule. Additionally, various minor modifications and adjustments to plant equipment, which may be necessary, are not listed.

Table 1: BFN EPU Planned Modifications and Current Schedule

Modification	Description	Scheduled Completion
Replacement Steam Dryer	New steam dryers will be installed with increased structural design margin to accommodate EPU operation. • Replacement steam dryers are curved hood six-bank dryers analyzed for fatigue resulting from flow induced vibration and hydrodynamic loads. • Main steam line strain gages were previously installed to obtain measurements at CLTP conditions which were used to design the replacement steam dryers. • New main steam line strain gages will be installed to replace the existing strain gages which have reached end of life to obtain measurements during power ascension testing of the replacement steam dryers.	Unit 1 – Fall 2018 Unit 2 – Spring 2019 Unit 3 – Spring 2018
Main Turbine	Replace the High Pressure Turbine rotor. Incorporate GE's Advanced Design Steam Path which is designed for the increased flow associated with EPU. • Replace High Pressure Turbine diaphragms and rotor buckets. • Modify the cross around relief valves (CARVs) to permit increased set pressure. • Replace and/or recalibrate Main Steam system flow and pressure instruments.	Unit 1 – Fall 2018 Unit 2 – Spring 2019 Unit 3 – Spring 2018 Unit 1 – Complete Unit 2 – Complete Unit 3 – Complete Unit 1 – Complete Unit 2 – Complete Unit 3 – Spring 2016
Turbine Sealing Steam	Increase the size of the Steam Packing Unloader Valves (SPUVs) and associated piping to enable the turbine sealing system to accommodate EPU flow requirements. • Increase SPUVs and piping from 8-inch to 10-inch components. • Replace and rescale steam flow and steam pressure transmitters.	Unit 1 – Complete Unit 2 – Complete Unit 3 – Spring 2016
Condensate Pumps	Upgrade Condensate pumps with new impellers and motors to accommodate the increased flows that will be required for EPU operation. • Replace impellers in each pump (3 pumps per Unit). • Replace 900 HP motors with 1250 HP motors. • Add orifice plate to the Condensate Recirculation line to reduce pressure drop across the flow control valve to minimize cavitation and vibration. • Replace existing pump discharge check valves with different style check valves having lower pressure drop and better transient response. • Replace pump suction strainers with stronger mesh screen to prevent screen deformation with the increased EPU flow conditions. • Change motor protection relay settings. • Recalibrate/replace pump and motor instrumentation.	Unit 1 – Complete Unit 2 – Complete Unit 3 – Complete

Modification	Description	Scheduled Completion
Condensate Booster Pumps	Replace the Condensate Booster (CB) pumps and motors to increase pump capacity to accommodate the increased flows that will be required for EPU operation. • Replace CB pumps with higher capacity pumps. • Replace air-cooled 1750 HP motors with water-cooled 3000 HP motors. • Replace existing pump discharge check valves with different style check valves having lower pressure drop and better transient response. • Change motor protection relay settings. • Recalibrate/replace pump and motor instrumentation.	Unit 1 – Complete Unit 2 – Complete Unit 3 – Spring 2016
Condensate Pump and Condensate Booster Pump Area Ventilation	Provide additional cooling/ventilation in vicinity of the Condensate and Condensate Booster pumps to accommodate the increased heat load resulting from larger air-cooled Condensate Pump motors and supplement cooling requirements for the hydrogen water chemistry (HWC) main control panel. • Replace 3-position switches for operation of the Air Handling Units (AHUs) with 4-position switches that will allow parallel operation of the AHUs. • Addition of a balancing damper to the Condensate Pump motors to provide better balancing of air flow. • Addition of a branch duct and balancing damper to the HWC main control panel.	Unit 1 – Complete Unit 2 – Complete Unit 3 – Spring 2016
Feedwater Pumps and Turbines	Upgrade the Feedwater system to provide increased Feedwater flow for EPU operation. • Replace pumps with higher capacity pumps. • Replace turbine rotor, diaphragms and buckets. • Replace turbine/pump coupling. • Upgrade seal water injection subsystem. • Update Feedwater control system software for EPU conditions.	Unit 1 - Complete Unit 2 - Complete Unit 3 – Spring 2016 Unit 1 – Fall 2018 Unit 2 – Spring 2019 Unit 3 – Spring 2018
Moisture Separators	Modify the internals of the moisture separators to increase moisture removal and accommodate increased flows at EPU conditions. • Change vanes and added perforated plate on moisture separators. • Modify internal drains as needed.	Unit 1 - Complete Unit 2 - Complete Unit 3 - Complete

Modification	Description	Scheduled Completion
Feedwater Heaters	Upgrade Feedwater Heaters to support EPU operating conditions. • Re-rate the number 1, 2 and 3 Feedwater Heater shells to meet higher pressures, temperatures and flows under EPU conditions by modification of selected nozzles and replacement of shell relief valves to meet ASME code requirements. • Replace level control instrumentation on the number 1, 2 and 3 Feedwater Heaters to reduce susceptibility to flow induced turbulence (pressure transients).	Unit 1 – Complete Unit 2 – Complete Unit 3 – Spring 2016
	• Provide additional welds and bracing to the pass partition plates for Nos. 1, 2, 3, and 5 Feedwater Heaters. (Number 4 Feedwater Heaters' pass partition plates will be addressed with replacement of the tube bundle and channel head.)	Unit 1 – Complete Unit 2 – Complete Unit 3 – Spring 2016
	• Due to the increase in tube-side design pressure with the increase head capacity of the Condensate Booster pumps, replace channel head relief valves for No. 3 Feedwater Heaters with valves having higher setpoints, and install a reinforcement ring on the manways for the number 3 Feedwater Heaters.	Unit 1 – Complete Unit 2 – Complete Unit 3 – Complete
	• On each of the number 3 Feedwater Heaters, replace the upper shell and install an extraction steam inlet duct to minimize heater shell erosion and preclude tube damage from steam jet impingement.	Unit 1 – Complete Unit 2 – Spring 2017 Unit 3 – Spring 2016
	• Replace tube bundle and channel head in the number 4 Feedwater Heaters with a design less susceptible to damage from flow induced vibration.	Unit 1 – Fall 2018 Unit 2 – Spring 2019 Unit 3 – Spring 2018
Main Condenser Extraction Steam Bellows	Replace Main Condenser Extraction Steam bellows #2, #3, #4 and #5 with bellows accommodating higher design temperatures and pressures for EPU.	Unit 1 – Complete Unit 2 – Complete Unit 3 – Complete
Condensate Demineralizers	Install a 10th condensate demineralizer (and associated valves and controls) on each unit to accommodate the increased condensate flow associated with EPU operation.	Unit 1 - Complete Unit 2 - Complete Unit 3 - Complete
Steam Packing Exhauster Bypass	Increase the capacity of the steam packing exhauster bypass line to accommodate increased flow under EPU conditions. • Install larger piping and flow control valve.	Unit 1 - Complete Unit 2 - Complete Unit 3 - Complete
Torus Attached Piping	Modification to reinforce an existing pad at an ECCS ring header branch connection to address higher pipe stresses associated with EPU conditions. Required only on Units 2 and 3 as sufficient stress margin exists on Unit 1.	Unit 1 – N/A Unit 2 – Complete Unit 3 – Spring 2016
Main Steam Supports	Modify one Unit 2 Main Steam pipe support due to increased loads resulting from turbine stop valve closure at EPU steam flow rates. All other existing Unit 2 Main Steam pipe supports, and all Main Steam pipe supports on Units 1 and 3, were determined to have sufficient design margin to accommodate the increased turbine stop valve closure loads.	Unit 1 – NA Unit 2 – Complete Unit 3 – NA

Modification	Description	Scheduled Completion
Reactor Recirculation Pumps & Motors	Upgrade the reactor recirculation system for EPU core flow operating conditions. • Perform analyses/evaluations to increase the design ratings for the recirculation pumps and motors. • Upgrade the Variable Frequency Drive (VFD) control system. • Perform pump and motor instrumentation upgrades - jet pump head, RCW flow, motor winding temperatures, VFD protective relay settings. • Revise Upper Power Runback setting for EPU conditions.	Unit 1 - Complete Unit 2 - Complete Unit 3 - Complete Unit 1 – Fall 2018 Unit 2 – Spring 2019 Unit 3 – Spring 2018
Jet Pump Sensing Line Clamps	Install jet pump sensing line clamps to reduce pipe vibration under EPU conditions.	Unit 1 - Complete Unit 2 - Complete Unit 3 - Complete
Main Generator System	Uprate main generator to 1330 MVA (Unit 1) / 1332 MVA (Units 2 & 3). • Install rewound stator to support higher generator output capacity. • Replace/modify stator water cooling (SWC) instruments and change SWC flow, pressure, DP and temperature settings to support increased stator water cooling requirements.	Unit 1 - Complete Unit 2 - Spring 2019 Unit 3 - Complete
Main Generator Hydrogen Pressure	Increase generator hydrogen pressure from 65 psig to 75 psig to support EPU operation. • Change pressure regulating valve settings and pressure alarm setting. • Replace pressure switches as needed for new operating range. • Change generator field over-excitation relay settings. • Eliminate hydrogen flow integrator to mitigate hydrogen leakage.	Unit 1 – Fall 2018 Unit 2 – Spring 2019 Unit 3 – Spring 2018
Isophase Bus Duct Cooling	Modify isophase bus duct cooling system to remove increased bus duct heat under EPU conditions. • Replace cooling fans and motors. • Replace cooling coils.	Unit 1 - Complete Unit 2 - Complete Unit 3 - Complete
Main Bank Transformers	Upgrade main bank transformers to account for the higher power output from the main generators at EPU conditions. • Replace three 500 MVA transformers per unit. • Replace one Units 1 and 2 500 MVA spare transformer. • Install new dedicated Unit 3 500 MVA spare transformer.	Unit 1 - Complete Unit 2 - Complete Unit 3 - Installation complete, post-modification testing of the Unit 3 Spare Transformer pending
Vibration Monitoring	Install mounting brackets/supports and temporary instrumentation for vibration monitoring during EPU power ascension in accordance with Attachment 45 (Flow Induced Vibration Analysis and Monitoring Program).	Unit 1 – Fall 2018 Unit 2 – Spring 2019 Unit 3 – Spring 2018

Modification	Description	Scheduled Completion
Main Steam Isolation Valves (MSIV)	Modify MSIVs to support steam flow increase at EPU conditions. • Install longer stroke actuators to move the poppet further out of the flow stream. This modification reduced valve pressure drop to accommodate EPU conditions. • Perform additional modifications to improve performance of the MSIVs including new bonnets, nose guided poppets (trimmed profile), and larger diameter valve stems.	Unit 1 – Complete Unit 2 – Complete Unit 3 – Complete
Electro-Hydraulic Control (EHC) Software	Revise EHC software to address changes in plant parameters required to support EPU. • Electrical Overspeed set point, Intermediate Pressure, Power Load Unbalance, Turbine First Stage Pressure, and Megawatt (MW) Control	Unit 1 – Complete Unit 2 – Complete Unit 3 – Complete
Technical Specification Instrument Respan	Technical Specification Instrument respan and setpoint changes for EPU • Turbine 1st stage pressure scram bypass permissive setpoint change • Main steam line high flow isolation channel respan • APRM flow biased and setdown instrument respan and setpoint change	Unit 1 - Fall 2018 Unit 2 - Spring 2019 Unit 3 - Spring 2018
Balance of Plant Instrument Respan	Respan balance of plant (BOP) instruments for EPU. • Update hydrogen water chemistry programmable logic controller (PLC) software for control of hydrogen and oxygen injection at EPU. • Replace and respan hydrogen water chemistry flow instruments. • Replace and respan extraction steam pressure instruments. • Replace and respan feedwater heater pressure and level instruments. • Recalibrate setpoints for reactor feedwater low suction and steam jet air ejector stage I/II/III low pressure switches. • Respan high pressure turbine exhaust intermediate pressure. • Replace and respan offgas condenser cooling water temperature instruments.	Unit 1 - Complete Unit 2 - Complete Unit 3 - Spring 2016

Modification	Description	Scheduled Completion
Condenser Instrumentation	Upgrade condenser instrumentation for improved reliability and performance monitoring under EPU conditions. • Replace/relocate condenser A/B/C hotwell pressure transmitters to improve inputs to the integrated computer system (ICS). • Add condenser circulating water (CCW) inlet/outlet temperature inputs to the integrated computer system (ICS). • Respan condenser A/B/C CCW outlet flow channels and add to ICS. • Revise reactor feed pump turbine (RFPT) trip to two out of three logic. • Modify Steam jet air ejector (SJAE) to remove the trip on low condenser vacuum and eliminate auto-start of standby SJAE. • Install nine new condenser vacuum pressure transmitters per unit (3 on each condenser) and provide signals to electro-hydraulic control (EHC) system. • Move condenser A/B/C low vacuum alarm, low vacuum turbine trip and low vacuum bypass trip functions to EHC logic (previously performed by pressure switches). • Perform hardware and software changes to EHC system to support new alarm and trip functions.	Unit 1 - Complete Unit 2 - Complete Unit 3 - Complete Unit 1 - Fall 2018 Unit 2 - Spring 2019 Unit 3 - Spring 2018
Steam Jet Air Ejector (SJAE) Pressure switches	Revise setpoints for SJAE condensate pressure switches to prevent inadvertent SJAE isolation.	Unit 1 - Complete Unit 2 - Complete Unit 3 - Spring 2016
Main Steam Acoustic Vibration Suppressors	Install Acoustic Vibration Suppressors (AVS) inside the Main Steam 6" diameter blind flanged branch lines to reduce acoustic loading on the steam dryer.	Unit 1 - Complete Unit 2 - Complete Unit 3 - Complete
Standby Liquid Control (SLC) System	The shutdown capability of the SLC system is being increased to support the Containment Accident Pressure Credit Elimination during an ATWS event as discussed in PUSAR Section 2.8.4.5.3 (Attachment 6) by increasing the Boron-10 enrichment.	Unit 1 – Fall 2018 Unit 2 – Spring 2019 Unit 3 – Spring 2018
Emergency High Pressure Make-up Pump	As part of the transition to National Fire Protection Association Standard (NFPA) 805, BFN is installing a non-safety related emergency high pressure pump in each unit to provide make-up from the Condensate Storage Tank to the Reactor Pressure Vessel. This modification is not required for EPU operation but is addressed in PUSAR Section 2.6.5.2 (Attachment 6), Containment Accident Pressure (CAP) Elimination. Although not needed for CAP Credit Elimination, use of the make-up pump will provide additional NPSH margin during the Fire Event.	Unit 1 – Fall 2016 Unit 2 – Spring 2017 Unit 3 – Spring 2018

Modification	Description	Scheduled Completion
Hardened Wetwell Vent	In response to EA-13-109, “Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions,” the Hardened Wetwell Vent (HWWV) will be modified to provide individual vent lines for each BFN unit. As discussed in PUSAR Section 2.6.1.4 (Attachment 6), the existing HWWV capacity would be reduced to 0.88% of rated thermal power under EPU conditions. However, with the implementation of this modification in response to EA-13-109, the capacity of the HWWV will be restored to 1% of EPU thermal power.	Unit 1 – Fall 2016 Unit 2 – Spring 2017 Unit 3 – Spring 2018