

Karachi Nuclear Power Complex

Beyond Design Life Operation of KANUPP (Safety Upgrades & Ageing Management)

By:

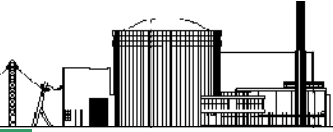
Syed Rafat Ali

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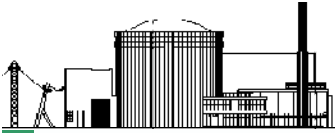
International Seminar on "Nuclear Safety and Security Challenges of the 21st Century",

21-23 April, 2011 Islamabad, Pakistan



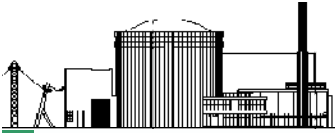
OUTLINE OF PRESENTATION

- ❑ General Plant Description
- ❑ Background
- ❑ Regulatory Requirements for PLEX
- ❑ Re-licensing Workplan
- ❑ Re-licensing Outage-1 (RLO-1) for PLEX
- ❑ Re-licensing Outage-2 (RLO-2) for PLEX
- ❑ Timeline History of Re-licensing
- ❑ Pending Operating License Conditions for PLEX
- ❑ Principal SSCs for PLEX - AMP
- ❑ Conclusion



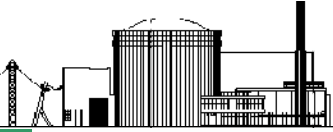
GENERAL PLANT DESCRIPTION

<input type="checkbox"/> Reactor Type	PHWR (CANDU)
<input type="checkbox"/> Commercial Operation	1972
<input type="checkbox"/> Rated Thermal Power	433 MW _{th}
<input type="checkbox"/> Gross Electrical Power	137 MWe
<input type="checkbox"/> Coolant	Heavy Water (D ₂ O)
<input type="checkbox"/> Moderator	Heavy Water (D ₂ O)
<input type="checkbox"/> Calandria	Stainless Steel
<input type="checkbox"/> Pressure Tube	Zr-2.5% Nb Alloy
<input type="checkbox"/> Refueling Sequence	On-Power



BACKGROUND

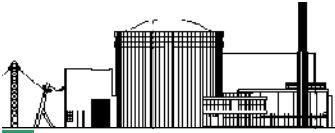
- ❑ In early nineties PAEC decided to extend operational life of KANUPP.
- ❑ Invited various international missions for review of potential issues related to safe operation and ultimate life extension.
- ❑ During 30 years operation, plant was operated mostly below 100 MWe, equivalent to nearly 11 Effective Full Power Years (EFPYs). This is an obvious indicator of remaining useful life of the plant.
- ❑ As a result of expert missions many safety up-gradation programs were initiated to improve plant safety, combat ageing / degradation of SSCs and to extend plant operation beyond design life of 30 years.



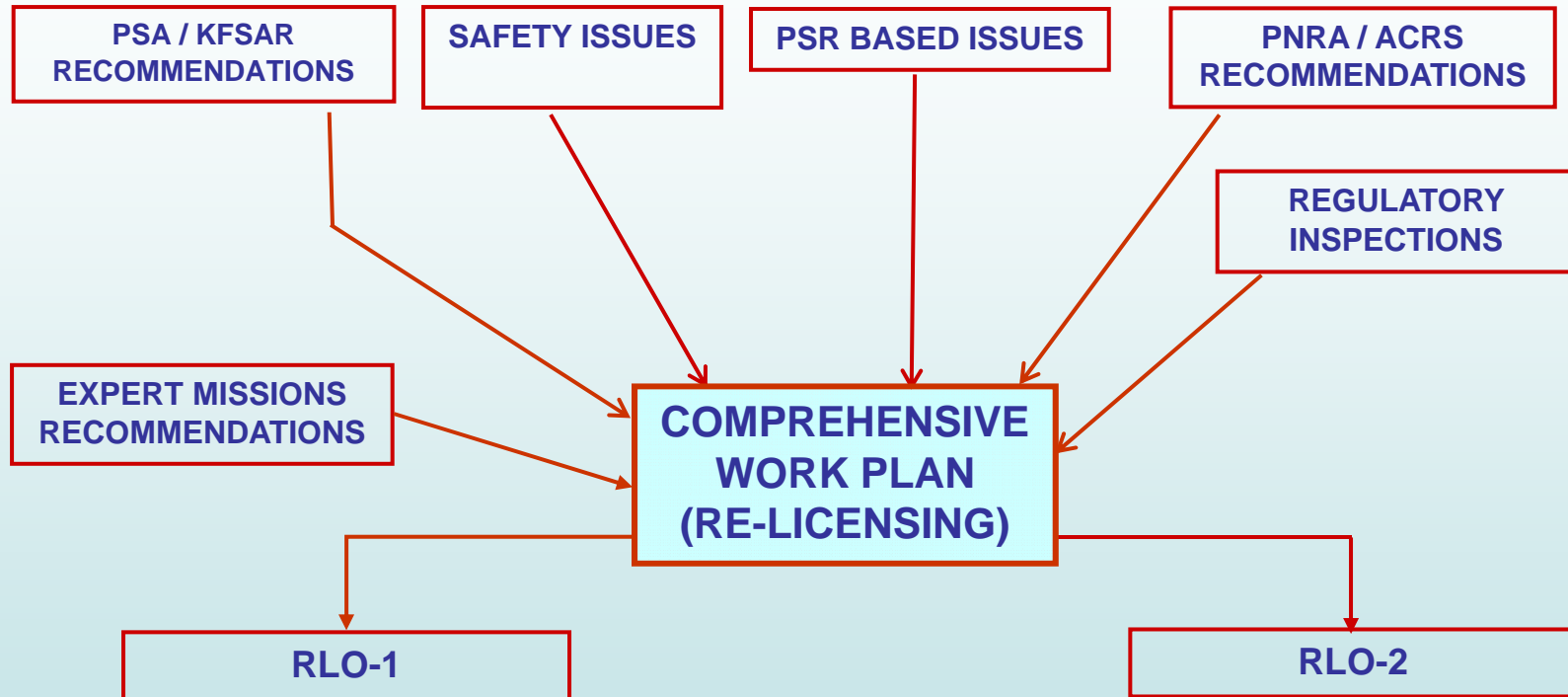
REGULATORY REQUIREMENTS FOR LIFE EXTENSION

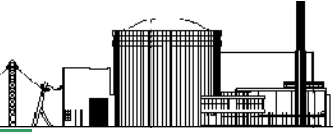
- ❑ Periodic Safety Review (PSR)
- ❑ Safety Upgrades (17 +7 safety issues)
- ❑ Revised Final Safety Analysis Report (KFSAR)
- ❑ Probabilistic Safety Analysis Report (Level-1 Plus)
- ❑ Decommissioning program
- ❑ An Evaluation of the Potential Impact on the Environment

WORK PLAN WAS DEVELOPED FOR IMPLEMENTATION IN TWO PHASES



RE-LICENSING WORK PLAN



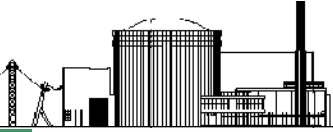


RE-LICENSING OUTAGE-1 (RLO-1) FOR LIFE EXTENSION

MAJOR SAFETY UPGRADES

- ❑ INSTALLATION OF EMERGENCY D2O ADDITION FACILITY FOR SMALL LOCA HANDLING
- ❑ AUTOMATIC BOILER CRASH COOL DOWN (ABCC) LOGIC
- ❑ PROTECTION OF ACTIVE DRAINAGE SUMP FROM DEBRIS ACCUMULATION
- ❑ REPLACEMENT OF ACTIVITY MONITORING SYSTEM
- ❑ BATTERY BANK REPLACEMENT
- ❑ SEISMIC FIXES
- ❑ QUALIFICATION OF EQUIPMENT
- ❑ AUTOMATION OF EMERGENCY FEED WATER SYSTEM (SECONDARY HEAT SINK) TO IMPROVE CORE DAMAGE FREQUENCY (CDF)
- ❑ CONTROL ROOM HABITABILITY FOR MAIN STEAM LINE BREAK (MSLB)
- ❑ IMPROVE EMERGENCY / STANDBY POWER AT PLANT (DE-DG3)
- ❑ CRITICAL PARAMETER DISPLAY & EMERGENCY SHUTDOWN PANEL

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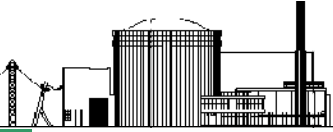


RE-LICENSING OUTAGE-1 (RLO-1) FOR LIFE EXTENSION

AGEING MANAGEMENT TASKS

- FUEL CHANNEL INTEGRITY ASSESSMENT (FCIA)
- FEEDER PIPES ASSESSMENT
- STEAM GENERATOR CONDITION ASSESSMENT
- OVERHAULING OF VALVES (MOV's, SOV's)
- CABLE ASSESSMENT
- CIVIL STRUCTURES ASSESSMENT

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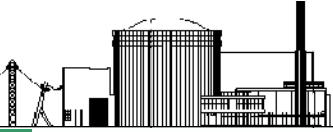


RE-LICENSING OUTAGE-1 (RLO-1) FOR LIFE EXTENSION

C&I REPLACEMENT

- ❑ REPLACEMENT OF REGULATING COMPUTERS
- ❑ REPLACEMENT OF 15 CONTROL LOOPS
- ❑ REPLACEMENT OF 27 MEASUREMENT LOOPS

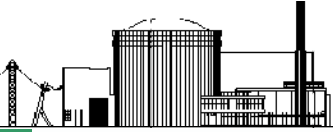
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RE-LICENSING OUTAGE-1 (RLO-1) FOR LIFE EXTENSION

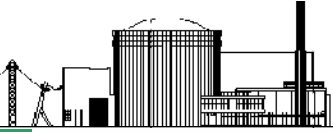
OTHER MAJOR ACTIVITIES

- FIRE PREVENTION AND CONTROL
- REMOVAL OF BOOSTER FUEL (8 BOOSTER RODS)
- CONDENSER PARTIAL RE-TUBING (1826 TUBES OF WEST SIDE)
- REPLACEMENT OF MAIN CHILLER
- REPLACEMENT OF MAIN AIR COMPRESSOR
- OVERHAULING OF NUCLEAR AND CONVENTIONAL VALVES / ACTUATORS
- OVERHAULING OF NUCLEAR AND CONVENTIONAL PUMPS AND MOTORS
- STEAM GENERATOR CLEANING (PHT SIDE)
- REPAIR OF SEA WATER INTAKE STRUCTURE
- REPLACEMENT OF RADIATORS OF MAIN TRANSFORMER
- REPLACEMENT OF CR120 RELAYS
- COMMISSIONING OF N16 CHANNEL A



RE-LICENSING OUTAGE-2 (RLO-2) FOR LIFE EXTENSION

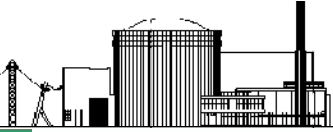
- ❑ FOR HIGH POWER OPERATION OF THE PLANT, PNRA ASKED FOR COMPLETION OF SAFETY UPGRADES WHICH INVOLVED PROCUREMENT OF QUALIFIED EQUIPMENT FROM ABROAD.
- ❑ AFTER ARRANGEMENT OF REQUIRED MATERIAL & EQUIPMENT AND COMPLETION OF ENGINEERING, PLANT WAS SHUTDOWN ON DEC. 12, 2005 TO COMPLETE REMAINING RE-LICENSING REQUIREMENTS.



MAJOR SAFETY UPGRADES COMPLETED FOR LIFE EXTENSION

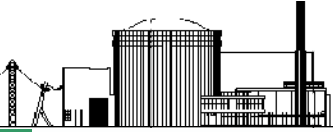
- ❑ FORCED EMERGENCY INJECTION SYSTEM (FIJW)
- ❑ REDUNDANT EMERGENCY INJECTION SYSTEM (RIJW)
- ❑ QUALIFIED MOTORS (MH-PUMPS 03 No, AD-PUMPS 02 No)
- ❑ CONTROL ROOM HABITABILITY
- ❑ LOCA RELATED JOBS (EST, CPH-FR-MVs)
- ❑ FIRE PREVENTION / CONTROL (CABLE GALLERIES, MEZZANINE FLOOR)
- ❑ FIRE DOORS
- ❑ FUEL CHANNEL INSPECTIONS / SCRAPE SAMPLING
- ❑ STEAM GENERATORS INSPECTION (VISUAL EXAMINATION OF SG # 1, 2 & 4, CONSTRICTION MONITORING OF ALL SG's, NDE OF SG#2, ECT OF 15% TUBES OF SG# 1 AND 2)

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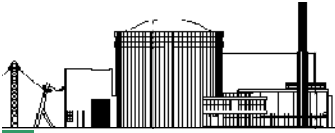
MAJOR SAFETY UPGRADES COMPLETED FOR LIFE EXTENSION

- ❑ INSPECTION FOR FEEDER THINNING / CRACKING
- ❑ EASY FIXES (SEISMIC FIXES)
- ❑ ANNULUS GAS SYSTEM MODIFICATION FOR LEAK BEFORE BREAK (LBB)
- ❑ CONTAINMENT BUILDING TESTING (11 PSIG)
- ❑ SAFETY PARAMETER DISPLAY SYSTEM (SPDS) / CRITICAL PARAMETER DISPLAY SYSTEM (CPDS)
- ❑ INSTALLATION AND RELOCATION OF 03 STRONG MOTION SEISMIC INSTRUMENTS



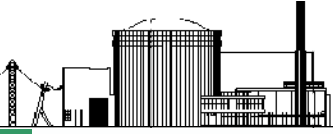
OTHER SAFETY IMPROVEMENTS FOR LIFE EXTENSION

- ❑ FIRE PSA
- ❑ REVISION OF FSAR
- ❑ REPLACEMENT OF ADDITIONAL SAFETY AND NON SAFETY C&I LOOPS (REACTOR PROTECTION = 49, SAFETY = 15, CONTROL = 22, MEASUREMENT = 27)
- ❑ SEISMIC HAZARD RE-EVALUATION



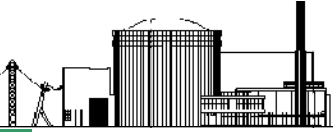
TIME LINE HISTORY OF RE-LICENSING

December 2002	Start of RLO-1
January 2004	Plant Startup and Synchronization after RLO-1 under Special License (Power Limitation to 33 % Rated Thermal Power)
August 2004	Power limitation to 45 % Rated Thermal Power
December 2005	Start of RLO-2
October 2006	Plant Startup and Synchronization after RLO-2 under Special License (Plant Operation allowed at 90 MWe)
December 2007	Operating License (Beyond Design Life) issued by PNRA up to December 2009 (Power Limitation 90 MWe)
December 2009	Operating License (Beyond Design Life) re-validated by PNRA up to December 2010 (Power Limitation 98 MWe)
Long Shutdown 2010 - 2011	Presently plant is in shutdown state due to fulfillment of remaining Operating Licensing Conditions & other major overhauling jobs and expected to re-start in May 2011



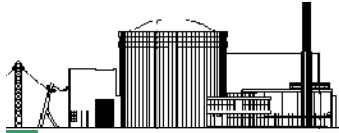
PENDING OPERATING LICENSING CONDITIONS (BEYOND DESIGN LIFE)

- Steam Generator Sludge/Water Lancing
- Fuel Channel Integrity Assessment (FCIA)
- Installation Of Critical Safety Parameter Display System (CPDS)
- Availability of Alternate Emergency Control Centre (AECC)
- Installation Of Post Accident Monitoring System (PAMS)



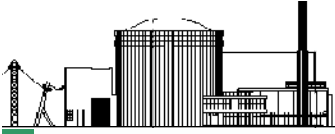
PRINCIPAL SSCs FOR PLEX – AMP

- Degradation in Steam Generator(s) Tubes
- Ageing in Reactor Fuel Channels
- Wall thinning (FAC) in Feeder pipes
- Fueling Machine
- Obsolescence of Nuclear Instrumentations (Regulation / Protection)
- Ageing of Transformers and Cables
- Refurbish / Replace Conventional Island major equipment (Condenser, HP HXs & dual phase flow pipes)



CONCLUSION

- ❑ During more than three decades of operation, KANUPP has demonstrated that its operation remained safe and not a single incident of significant release of radioactivity took place.
- ❑ After the completion of major safety up-gradation and additional work to fulfill all the regulatory requirements, plant can be operated safely for another 15 years.



KARACHI NUCLEAR POWER COMPLEX

Thank you