# Refurbishing – A Cost Effective Option for Long Term Operation of Research Reactors

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In recent times it has been observed that the life time of research reactors can be significantly extended through implementation of appropriate refurbishing actions. This is feasible since the initially proclaimed design life of such facilities in most cases, is an arbitrary number. This aspect is applicable to research reactors, nuclear power plants and many nuclear fuel cycle facilities.

In India extensive refurbishing of the 40 MWt research reactor CIRUS was done during 1997 – 2002. Cirus is a vertical tank type reactor using natural uranium as fuel, light water as coolant, heavy water as moderator and graphite as reflector and became operational in 1960. Detailed ageing assessment of its systems, structures and components was done during 1992-1997 after the reactor had been in operation for about 30 years. The assessment included inspections, operating experience review, review of the Safety Analysis Report, seismic re-evaluation of structures and assessment of stored energy in the graphite reflector. A refurbishing plan was then drawn-up and preparatory work undertaken that included development of procedures, procurement of replacement items etc. The reactor was then shutdown, core unloaded and reactor systems were prepared for preservation during refurbishing. Extensive refurbishing was then carried out and the reactor brought back into operation successfully. During refurbishing, a low temperature vacuum evaporation based desalination unit was also coupled to the reactor to serve as demonstration of using waste heat from a research reactor for sea water desalination.

The scope of refurbishing of Cirus got considerably expanded as a result of identification of additional jobs during further inspections undertaken after reactor shut-down and core unloading. Consequently the refurbishing took about 5 years against the initially planned period of about 3 years. Inspite of this, the facility could be refurbished at a cost which is less than 10% of the cost of building a replacement reactor of similar capabilities. After refurbishment, the reactor is expected to operate with enhanced safety for a period of 20 years or even more. It can therefore be stated that refurbishing, based on Cirus experience, is a cost-effective option for long term operation of a research reactor facility.

# REFURBISHING – A COST EFFECTIVE OPTION FOR LONG TERM OPERATION OF RESEARCH REACTORS –

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- RR Life Extension Feasible Through Refurbishing
- Initial Proclaimed Design Life – an Arbitrary Number

- Example of CIRUS Ref. In India
  - 40 MWt, Nat. U. fuelled, $H_2O$ cooled, $D_2O$ moderated, graphite reflected vertical tank type reactor
  - In operation since 1960
  - Availability started declining after 1990
  - Detailed ageing studies done.

## CIRUS Ageing Stuides ; 1992-1997

- Detailed Inspection of SSCs
- Optg. Exp. Review
- Review of SAR
- Seismic Re-evaluation of Structures
- Assessment of Stored Energy in Reflector

## Refurbishing Plan and Preparatory Work

- Development of Procedures and Special Tools
- Procurement of Replacement Items
- Identification of Work Execution Agencies
- PERT Network
- QA Plan
- Regulatory Review

## CIRUS Refurbishing : 1997 – 2002

- Reactor S/D and core unloading
- Further Inspections – Considerable Expansion in Scope of work
- Preservation of Systems during Extended Outage
- Implementation of Ref. Actions
- Systems Commissioning and Testing
- Core loading and Restart
- Integration of a Low Temp. Vac. Evap. Desalination Unit

## Conclusion

- Refurb. Took 5 Yrs. (Planned 3 Yrs.)
- Cost ; Less than 10% of Replacement Reactor
- Reactor Expected to operate for 20 Yrs. Or even more
- Refurbishing is a Cost Effective Option