MODULE 6

SPECIALIST REQUIREMENTS IN MAINTENANCE FOR NPP

MODULE 6 OBJECTIVE

- To aquire an understanding of some of the specialist requirements.
- To appreciate where specialist services may be readily available and where the owner has to set up training provisions.
- To understand the broad scope of activities involved in running an NPP.

TOPICS FOR REVIEW

- Normal industrial hazards
- Additional hazards
- Constraints for maintenance work
- Special analytical tools
- Special automatic tools
- Environmental qualifications

TOPICS FOR REVIEW

- Special protective clothing
- Special work practices - rehearsals
- Information management technology
- Major inspection programs

NORMAL INDUSTRIAL HAZARDS

- Heat
- High pressure
- Electricity
- Chemicals
- Heights
- Motion

ADDITIONAL HAZARDS

- Radiation
  - fixed
  - loose
  - gaseous

ADDITIONAL HAZARDS

What does radiation mean to maintenance staff?

Straight forward jobs become complicated. All aspects of doing work in the 'radiation island' must take into account the various sources of ie. Gamma, Neutron, Alpha, and whether it is Fixed (eg. inherently bonded in the metals), Loose (eg. deposited on the surfaces), Gaseous (eg. in the atmosphere within a system).

Each type of condition requires a different way of coping with the hazard and (this is all in addition to doing whatever work may be required to be done). Care and assessment is required to minimize provisions to contain any loose contamination and prevent it from being spread around.

- Where there is a possibility of breathing in any radioactive elements, provisions must be made to wear respirators or plastic suits.
- Where machining has to be done special features must be provided to eliminate the spread of contamination by building tents or other confining provisions.
- The staff must be vigilant for changes to the radiation fields as the job progresses particularly when it spans several days or weeks.
- Preventing contamination and decontaminating tools and equipment require a significant amount of work. Also extensive facilities must be provided for this purpose.

CONSTRAINTS FOR MAINTENANCE WORK

- Reactor requires CONSTANT COOLING (7 % of power remains when reactor is first shut down).
- Elaborate provisions have to be made to allow work to proceed on special safety systems.
- Direct access to equipment is often not possible.

CONSTRAINTS FOR MAINTENANCE WORK

A. REACTOR COOLING REQUIREMENTS:

1. At any time when maintenance has to be done on a reactor coolant system, reliable backup heat sinks must ALWAYS be available. This usually complicates the planning or work as the heat sinks may only be adequate several days after a shut down. A recall time may also be imposed. All this when the outage time is already minimized.

2. The fact that the reactor requires such reliable and multiple heat sinks results in extensive and complicated systems, with extensive testing requirements.

B. PROVISIONS FOR WORKING ON SPECIAL SAFETY SYSTEMS:

1. In order to do maintenance on a special safety system (SDS I, SDS II, ECC or containment) these have each been designed with 3 channels and sufficient redundancy to work on them without any 'impairment' to the system.

2. Where the whole system has to be made unavailable the reactor may be cooled down and left for several days, the moderator may be placed in 'shut down guarantee' condition.

3. The design has grouped systems such that at no time are all 'lines of defense' disabled. Maintenance activities must be worked around each of the constraints.

4. Special attention must be paid when systems are 'opened' for inspection inside containment, such that they are not opened at remote location and cause a breach of containment.

C. DIRECT ACCESS:

1. In many instances maintenance and repairs have to be done on equipment with unusually high radiation fields. This requires creativity in the approach to the job to initially reduce these fields . The alternatives are:
Time - Wait for field to decay.

Shielding - Apply temporary shielding.
Distance - Use remote or extended tools.

2. Usually a combination of all 3 are applied. These situations usually result in the fabrication of special tools and facilities; the use of 'robots' and in some cases small submarines.

3. The process is time consuming and costly.

4. In some instances full size models are built and rehearsals carried out for the planned work activities.

SPECIAL ANALYTICAL TOOLS

- Radiation monitoring - To constantly monitor fields; type and strength
- Vibration analysis - Rotating equipment, piping and structures.
- Radiography - Weld inspections, position of internal components.
- Ultrasonic detection - Assessment of material flaws.
- Eddy current detection - Assessment of

SPECIAL ANALYTICAL TOOLS

- Laser displacement analysis - Assess location / position of components.
- Acoustic analysis - Assess unusual 'rattling'.
- Impression imagery - assess wear on material.
- Time domain refractometery - Find faults in electric cables.
- Thermography - Look at temperatures;

SPECIAL AUTOMATED TOOLS

- Non-Intrusive downcounter flow measurement - Monitoring SG performance (good diagrams pg 40).
- Portable digital electronic radiography
  - Instant digital images
  - Larger range than film
  - Compensates for background radiation
  - Non intrusive valve inspection

SPECIAL AUTOMATIC TOOLS

- Air operated valve diagnostic tool - Use; calibration and degradation checking.
- Motor operated valve diagnostic tools - Ensure correct set up and operation of MOV's.
- Fuel channel removal and installation tools - Fuel channel replacement.

SPECIAL AUTOMATIC TOOLS

- Fuel channel scrapper tool - To remove slivers of the dry and wet F/C inside bore for metallurgical checks.
- Plugging SG tube tool - Automated system to replace manual plug and seal weld.
- Noise (electrical) analysis technique - To evaluate the vibration levels of reactor In-core components eg. Pressure tube and calandria tube.

SPECIAL AUTOMATIC TOOLS

- Flow-accelerated corrosion - used on BOP to monitor pipe wall thinning, steam F/W.
- Spacer location and reposition tool - To verify the position of PT/CT spacers, reposition if necessary.
- Steam generator water lancing tool - To dislodge sludge build up in SG.
- Electrostatics spot testing - Assess the serviceability of aging elastomers.

SPECIAL AUTOMATIC TOOLS

- Fuel channel inspection tools - Check for axial elongation, diametrical creep, wall thinning, SAG, deuterium concentration, blisters and bearing pad fretting.
- Eddy current probes - Defect detecting and sizing in SG's.
- Ultrasonic inspections, electro sleeving SG - Repair pitted and damaged SG tubes.

SPECIAL AUTOMATIC TOOLS

- Ring thermal shield piping modification - Remote tool for very difficult job (diagram pg. 388).
- Underwater camera for fuel channel inspection - Fuel damage locator and wear checks.

ENVIRONMENTAL QUALIFICATION

- Equipment and components in a nuclear power plant must be qualified to operate successfully up to the last day of the plant operation.

ENVIRONMENTAL QUALIFICATION

- There are several environments which equipment must survive:
  - Seismic event
  - High radiation field
  - Saturated steam conditions
  - High temperatures
  - Floods
  - Water impingement

ENVIRONMENTAL QUALIFICATION

- Some must not fail during an accident / event.
- Some must withstand the event and operate correctly later.
- Extensive records must be kept to identify and control EQ components.

SPECIAL PROTECTIVE CLOTHING

- Special clothing required to be worn by staff while doing maintenance on radioactive system - is not conducive to efficient work.
- Normally wear a 'plastic suit' with plastic hood - and sometimes a double layer of outer plastics must also be worn.
- Rubber boots over safety boots; double set of plastic gloves.

SPECIAL PROTECTIVE CLOTHING

- Suit supplied with breathing air via hoses that must trail from an air distribution header.
- Underneath the plastics; cotton coveralls, socks and underwear (supplied)
- The air hose has combined wiring system to plug into the suit communication system; with ear phones and mouth piece attach to the hard-hat.

SPECIAL PROTECTIVE CLOTHING

- A spin off from the clothing requirement is a very extensive cottons and plastic laundry installation.
- A testing and repair operation for the plastic suits.
- Maintenance of an effective suit communication system.
- Distribution system to supply readily available protective clothing .

SPECIAL PROTECTIVE CLOTHING

- Decontamination process to maintain the disrobing areas free of any loose contamination.
- An allowance of time for staff to:
  - obtain required protective clothing.
  - dress up
  - undress

SPECIAL WORK PRACTICES

- While working in radioactive environments there are strict controls on the amount of dose that staff may receive over a period of time (1/4 year) and on how much they are allowed on a specific job.
- The dose allocation must be part of job planning, frequent checks are made during work performance. When / if the allocated dose is reached the job must stop and be reassessed if work is incomplete.

SPECIAL WORK PRACTICES

- High hazard work requires exhaustive review and approvals.
- Once approved NO changes are allowed - must all be done again.
- Regulatory over exposures are a very serious occurrence, with serious consequences for all concerned.
- Jobs in many cases must be rehearsed on mock ups

SPECIAL WORK PRACTICES

- Strict 'back-out' provision must be built into planned work.
- Frequent staff changes may be required to limit dose to individuals.

INFORMATION TECHNOLOGY

- Modern information technology is used extensively at NPP's.
- PC's, modems, hand held computers, and computerized tools tie into major networks.
- Large data bases are used for such things as:
  - Plant equipment data base
  - Work management system
  - Spare parts

INFORMATION TECHNOLOGY

- E.Q. Materials
- Equipment status monitoring
- Instrument calibration data lists
- Electrical and air distribution details
- Staff information
- Dose records

MAJOR INSPECTION PROGRAMS

- Fuel channel inspection
- Inservice inspection for nuclear piping
- Inservice inspection for containment
- Feedwater erosion - corrosion in service inspection (ISI).
- Steam generator and steam line ISI
- Major turbine generator inspections

MAJOR INSPECTION PROGRAMS

The various codes and standards used in the design and construction of the plant bringing with them a requirement to carryout various inspection and maintenance programs.

THE FUEL CHANNELS INSPECTION PROGRAM

This program is used by selecting various channels of various power ratings and doing a detailed examination for longitudinal creed, diametrical creep, sag, blistering wear etc.

This is to ensure that there is a good understanding of the wear and stress mechanisms and identify where various limits may be exceeded. As a result some pressure tubes may have to be changed or adjustments made to their supports.

ISI FOR NUCLEAR PIPING

Examines on a periodic base a large number of welds and keeps track of any degradation that may occur. Repair to welds or changing of piping or piping supports may result from these inspections.

ISI FOR CONTAINMENT

This is a major examination of the civil structure, with a pressure test of the containment building as part of the program. The metal tendons in the containment reinforcement are checked for stress, tension and deterioration.

The various containment elastomer seals are also checked together with all the box-up valves and associated instrumentation.

The containment ventilation system and filtering features also undergo precise testing to verify their capability.

The other inspection programs are similar; looking for deterioration and equipment to be repairs or replaced. The main effort is to maintain the system to meet the design intent and to provide a formal report to the licensing authority on each program.