

OSART Good Practices

MAINTENANCE

Maintenance Facilities and Equipment

Temelin 1/2, Czech Republic

Mission Date; 12 Feb.-1 Mar., 2001

The plant has established for its operating phase a method to monitor and analyse electrical disturbances and equipment performance. The operating organisation arranged to leave in service the start-up commissioning electrical monitoring system (MOSAD-4) to provide continuous on-line monitoring capabilities as a way to record important event information for assessment of electrical disturbances. The capability for electrical system monitoring consists of inputs from 112 analogue and 3264 binary signals of Unit 1 Temelin. An external time standard source for correct time marking of the events and flexibility in setting sample rates set for both analog and digital inputs are features of the system. This allows for the analysis of electrical related events to be explained as the large number of binary signals and correct time makes it possible to determine the sequence of events and make determinations that the equipment is performing correctly.

Since the system is capable of high speed sensing and analysing electrical parameters during transient conditions, it is being used to monitor most of the electrical tests performed at the plant. The range of testing being monitored is from relatively simple activities like motor

starts, to very complex tests such as the loss of offsite power and start of the 5 diesel generators with simultaneous back-up energization of all 6 kV switchgears. The plant is now recording routine tests performed during operations, for example the diesel load sequence test or back-up energizing of a switchgear, to analyze and compare the results with previous or other similar tests as a method for detecting deficiencies.

Data from the monitoring activities is saved in the computer and subsequently stored on CD media for subsequent use.

Zaporozhe, Ukraine

Mission Date; 6-23 Sept, 2004

Before the job starts, a briefing is performed. The briefing covers all aspects of the job and is normally performed by the supervisor/foreman in charge of the job. All participant, briefer and briefed have to sign off in the work permit that the briefing has been done. The way ZNPP perform documented briefing prior start of maintenance works could be seen as a good practice.

Kashiwazaki 3/6, Japan

Mission Date; 1-18 Nov, 2004

Foreign material exclusion has been taken into account when planning the work and controlling the work sites.

Foreign material exclusion activities are proactively planned and built into the work orders. List for tools accessing the containment and software for tools accessing the pressure

suppression chamber and turbine work site has been established. Safety cords in the tools are being used in critical work sites to prevent them falling. The amount of material accessing the containment and pressure suppression chamber is reduced. Reactor pool is covered with concrete slabs and pool for steam dryer with steel covers during operation. The fences around the pools in the reactor hall were covered with coloured plastic during outage.

Penly, France

Mission Date; 29 Nov.-16 Dec., 2004

The team recognized the stowage of field installed hoisting equipment as a good practice. This practice consists of placing lifting equipment located near safety-related equipment in

a

secure state to protect against damage to seismically qualified equipment. An ingenious, award winning hook has been developed to assist with this practice.

The main actions carried out consisted of:

- Hoists located above safety-related equipment were removed.
- The slack from the chain on the hoist carrier was coiled around a metal hook so as to prevent the chain from swinging free and the carrier from moving.
- Safety stops were installed on the booms.
- Safe stationing positions were identified on the beams for all handling equipment at risk (hoist carriers, cranes, etc).

A set of actions easy to implement and which prove the compliance of lifting equipment with the nuclear safety reference for 1300 MW series (topic "external hazards of natural origin - earthquakes").

Ignalina, Lithuania

Mission Date; 5-21 June, 2006

The plant implemented a policy and wide programme to support usage of new equipment facilities/tools/stands and training mock-ups for mechanical maintenance. The main objectives are preparing and performing maintenance activities and implementing ALARA programme and practices.

There is a plant policy to enhance facilities/mock-ups for all mechanical maintenance workshops:

- a) new equipment facilities/tools/stands:
 - machine-tools in most workshops;
 - hydraulic/pneumatic facilities;
 - welding automats;
 - new plasma-cutting facilities;
 - full scope-test stand of Main Circulation Pump;
- b) training mock-ups:
 - mock-up for main circuits 300 mm tubes welding;
 - removable insulation mock-up;
 - cutting/welding/reinstallation full scope mock-up of fuel reactor tube-channels.

Size and arrangement of these maintenance facilities are appropriate for safe and efficient completion of work. Most of these maintenance facilities/mock-ups are used for maintenance training as well as for maintenance and maintenance tests to allow the improvement in the quality of works, industrial safety, skills, ALARA programme, qualification of personnel and interaction between managers and workers within

maintenance staff.

In connection with the forthcoming plant decommissioning, the team evaluates this improvement as a good decision to enhance mechanical workshops and guaranty high-level

safety requirements after Unit 2 shut down.

South Ukraine³, Ukraine

Mission Date; 9-25 Oct., 2006

Welding simulator

To train the welders in arc welding the plant equipped the Training centre with the computerized simulator named DTS-02.

The advantages of the DTS-02 simulator during welders' initial training are:

- simulation of welding with the help of low-amperage arc;
- limiting values and parameters of simulated welding (arc length, electrode displacement speed, etc.);
- saving welding materials;
- energy saving;
- no necessity to arrange "special" conditions in simulator premise,
- "WWSim" software tracks arc length, electrode angle of slope, values indication on the monitor;
- "WWSim" identifies deviation from prescribed parameters of training;
- trainees are able to see their errors on the monitor;
- after the training course the trainee makes a debriefing followed by a report;
- allows training welders in different positions, in different modes (simulates welding of different class steels).

This simulator provides an automatic assessment of trainees' performance.

Yongwang, Korea

Mission Date; 17 Apr. - 4 May, 2007

YGN 5&6 use a strong system of ownership for visual identification on maintenance of plant equipment. YGN 5&6 has developed ownership cards, with the name and picture of the responsible maintenance and contractor technicians, which are placed on the equipment being worked on.

This system of identification is designed to inspire responsibility and pride in technicians, assure the quality of maintenance being performed and improve the capability of identification of ownership on safety related equipment. The ultimate goal of the identification system is to ensure that materials are thoroughly checked for quality before maintenance begins, abide by the regulations and YGN 5&6 process and procedural requirements.

After maintenance is completed, there is a concerted effort to double check the quality of the work performed and to prevent human errors. This is accomplished by the responsible supervisor verifying that all information and corresponding joint cooperation of contractors is well coordinated and that the maintenance history and details of work performed are

complete and documented. This system of visual accountability of technician's work practices and good maintenance practices is evaluated before the next plant overhaul and maintenance teams are awarded excellence status.

This good practice has resulted in no transient operation caused from maintenance work in 2006 on YGN 5&6, and has significantly motivated maintenance and contractor personnel to take pride in their work.

Metzamor, Armenia

Mission Date; 16 May - 2 Jun., 2011

Safety upgrading implemented by own staff.

During last number of years the plant has implemented the upgrading of several important safety systems, including neutron flux measurement, radiation control and systems for early detection of emergencies. This upgrading was performed by the plant staff with the support of manufacturers and internal supporting organizations. Assembly and adjustment of novel systems was done by the plant. The upgrading was implemented on the following systems:

- Gas detection system at reactor vessel head.
- In-core temperature control systems including hard and software, sensors, uninterrupted power supply.
- Early primary leaks detection system
- Neutron flux measurement in source level (it is used in outage time during refueling and before start-up).
- Obsolete system of data acquisition and processing of neutron flux signals was replaced to meet requirements.
- Automatic regulator of the reactor power.

This unique approach was applied under the conditions of shortage of qualified manpower in the country only at the plant. The upgrading was implemented to high level of quality. Personnel involved were motivated to maintain upgrading in good condition because they were owners of the equipment. Personnel acquired deep knowledge and skills to successfully operate, maintain and repair deficiencies.

Seabrook, USA

Mission Date; 6-24 Jun., 2011

Dedicated channel test equipment and post calibrations.

In order to prevent a meter that potentially could have a flaw from causing the loss of function of safety related redundant trains or channels, a good practice was identified in the area of control of measuring and test equipment (M&TE) in combining the use of dedicated

channel test equipment and the post calibration of M&TE as follows:

- The use of dedicated channel test equipment: Dedicated Channel Equipment involves the

use of specific instruments on specific trains or channels. The station has four safety related channels, the tags are colour coded red, white, blue, yellow. The station has four redundant sets of calibration equipment that are marked with the matching colour of the channels that they calibrate. This practice prevents a single piece of M&TE from causing

a

loss of functions on any more than one channel.

- Post calibrations: Post calibrating M&TE when major work is performed provides assurance

that the safety related equipment just calibrated is still in tolerance, so that any suspect readings can be evaluated immediately to ensure full operability and technical specification compliance.

Rajasthan, India

Mission Date; 29 Oct. -15 Nov.,

To avoid inadvertent contact with live electrical circuits, a pocket voltage detector was provided to all Electrical Maintenance section staff.

In Electrical Maintenance section, it is used by all departmental workers. These are small detectors with following features:

- Small Torch with white LED light.
- It detects the presence of voltages from 90V to 600VAC.
- LED light color changes from white to blue dependent on distance from source.
- (approximately 8 inch) and it changes to red light, closer to voltage source.

This helps the workers to avoid inadvertent contact with live components.



Figure 10.

Rajasthan, India

Mission Date; 29 Oct. -15 Nov.,

In order to reduce tritium uptake station developed a textile tailor made parachute balloon to seal off heat exchangers (HX) opening for drainage purpose and internal flushing of the 3211 HX moderator heat exchanger with non-tritiated D2O is performed before access.

In PHWR type of reactors, tritium uptake is of major concern. Sometimes, due to increase in

area Derived Air Concentration (DAC), activities must be halted and this may increase equipment downtime, resource depletion and subsequently defeating the ALARA principles.

On many occasions, during maintenance of heat exchangers (HX), spillage of D2O was reported which was a contributor to internal dose consumption by mechanical maintenance personnel.

During maintenance activities carried out on D2O heat exchangers, various activities related

to tube plugging and In Service Inspection by eddy current testing, it is necessary to drain D2O completely from the crevices of heat exchanger (HX). For this purpose, whenever a heat exchanger is opened, evaporation of D2O causes increase in Derive Air concentration (DAC) of that area. During D2O HX draining and collection practices, a small gap is created in-between the HX flange and cover and subsequently tailor made parachute balloon is inserted over the HX opening. The parachute balloon has one drain valve and a vent valve. The Heat exchanger is shifted backwards, later tilted up from the other end and residual tritiated D2O was collected from the drain point of the parachute bag. The bag is progressively drained into a drum using vacuum.

This technique is successful in draining of D2O heat exchangers like Shut Down HX, Regenerative Heat Exchanger, etc. This practice emulates ALARA principles by achieving reduction in internal dose. From dose data trend analysis, it is obvious that percentage of internal dose consumption for Mechanical Maintenance personal has been reduced from around 60 % in year 2009 to less than 30 % in year 2012.

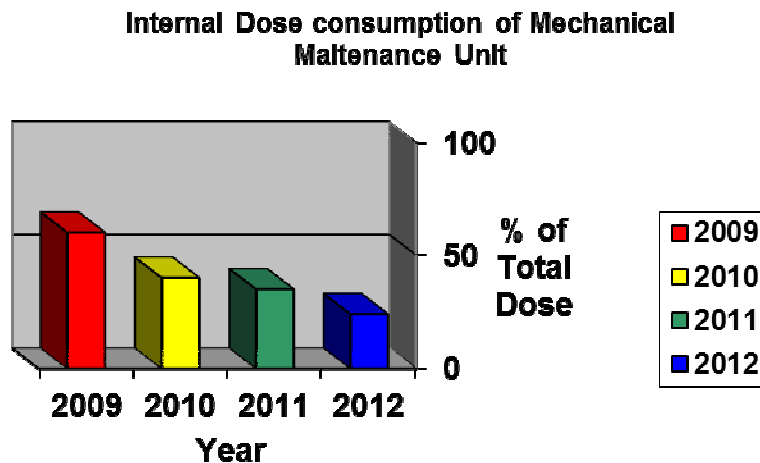


Figure 6.

Before work is performed at moderator HX an internal flushing with non-tritiated D2O is performed.

For moderator heat exchanger flushing, during bi-ennial outage period about 2 tons of non-tritiated heavy water is kept available. The "D2O addition station" is established inside the reactor building and all equipment required to carry out the operation is available. An established procedure (OTO No 21, rev.0, May 11, 2010) exists for the operation.

The experience shows that the air concentration of tritium at the work place is reduced from more than 1000 DAC to 10-50 DAC which substantially lowers the probability for uptake during the work. Ventilation with air does not give the same result since some hold-up water will always exist as the tritium activity of this water is of the order of 700 GBq per liter.

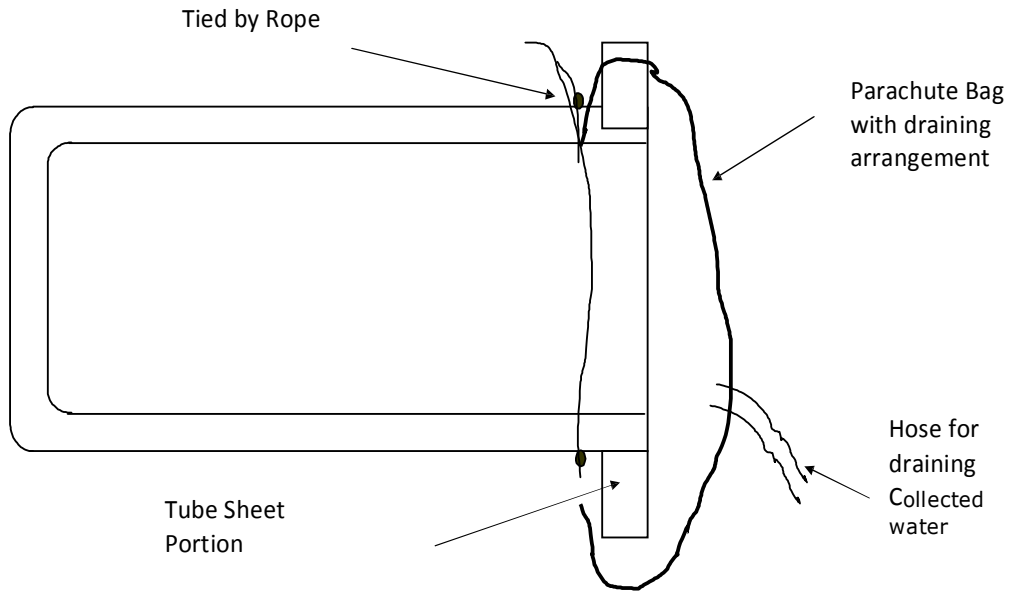


Figure 7. Schematic Sketch of HX and parachute balloon



Figure 8. Folded Parachute Bag



Figure9. Use of parachute bag in Heat Exchanger draining.

Rajasthan, India

Mission Date; 29 Oct. -15 Nov.,

Use of testing facilities and mock-ups.

The station focuses on a philosophy “Do it right The First Time”. To achieve this, various test facilities and mock-ups are developed for enhancing the skill and competency of the maintenance personnel as well as improvement of system performance. It also validates spares before installation at actual location. The test facilities are extensively used for qualifying procedures and tools, training of the personnel etc. With electronic systems test

facilities, it is possible to check electronic components of the systems for their health, fault identification and rectification, power supply tuning, etc. These test facilities contribute in reduction of down time, collective dose consumption, optimization of spare inventory and improve quality of work.

Most of the test facilities are developed in house over a period of time. The following are some of the test facilities developed at the station:

- **Primary Shutdown System (PSS) drive test facility:** PSS drive test facility tests the PSS drive at various simulated operating conditions at wet station. This facility is used for testing and qualification of PSS rods drive mechanisms before installing in field after maintenance. This facility is useful in reducing man-hours and collective dose consumption.
- **Reactivity Mechanism drive test facility:** This facility is for testing of Reactivity Mechanism Drive. Also the maintenance activities to be performed on the drive can be practiced and refined on these mock ups. This facility has resulted in the reduction in the Man rem and man hour consumption for the replacement of adjuster drives in situ. The collective dose consumption for Adjustor Rod Drive Mechanism maintenance has reduced from 5000 man millirem in Year 2002 to 250 man millirem in Year 2011.
- **Low Tension Motor Test facility:** This test facility contains provisions for testing motors like Moderator Pump Motor, Active Low Pressure Pump Motor, Active High Pressure Pump Motor, Active Process Water Cooling Pump Motor. All these motors are tested after maintenance on the facility before field installation.
- **Active & Non-active valve testing facility:** A separate valve testing facility exists for active & non active valves. All relief valves are also tested in this facility.
- **Dual Processor Hot Standby (DPHS) Card Test Facility:** This is a prototype of actual system and is used for testing of all types of input, output and logic cards installed in DPHS/DCHS systems. The test facility facilitates offline diagnosis, identification of problems at component level and quick rectification of the fault.
- **Channel Temperature Monitor Card Test Facility:** This facility is used for testing of all type of Channel Temperature Monitor cards. The test facility facilitates offline diagnosis, identification of problems at component level and quick rectification of the fault.
- **Programmable Digital Comparator System Card Test Facility:** This is a prototype of actual system and is used for testing of all types cards of Programmable Digital Comparator System.
- **Dew Point Probe Calibration Facility:** This facility is used for calibration & testing of dew point probes. It is useful for training & practical exposure to dew point sensors handling and calibration.
- **Control Valve Test Facility:** This facility is used for testing of CV instrumentation and training of the personnel. In-house maintenance capacity can be developed by giving hands on training to maintenance personnel without any intervention in the main.
- **Beetle Monitoring System Test Simulator:** This facility is used for testing of all types of moisture detectors monitoring system cards. The test facility facilitates offline diagnosis, identification of problems at component level and quick rectification of the fault.
- **Ram assembly test facility:** The Ram assembly drives performance check is done using this facility. By carrying out all the functional checks at this test facility, improvement in the reliability of Ram assembly before installation in field is achieved and does not consume any dose. This has led to dose reduction of 500 millirem for each replacement and a total dose reduction of 2000millirem in a year.
- **Oil equipment test facility:** The facility is used for leak test and performance checking of various oil equipment at the desired operating pressure, after maintenance.
- **Water equipment test facility:** The facility is used for leak test and performance checking of various light water equipment at the desired operating pressure, after maintenance.
- **Separator test facility:** The facility helps in calibration of the separator assembly consisting of feelers, retractors and side stops. This facility can generate and measure the very fine movements in the assembly. It is helpful in checking that the desired feed backs

are generated at proper values.

- **MT-1 calibration facility:** The facility is used for testing and calibration of leak detector transmitter MT-1. This facility gives the volume as input to the transmitter to test over a full range of the transmitter.
- **Relay Testing Lab:** Relay testing lab has been set up for testing and calibration of all kinds of protection relays installed at the station. The Lab also has computerized program and facility for calibration of test and measuring instruments used in the section.
- **Card Testing Shop:** Electronic circuit card testing facility developed within the station houses tailor made test jigs for checking the health and settings of electronic cards as well as for trouble shooting of defective cards of plant safety related Power and Control uninterruptible power supplies(Power UPS and Control UPS), Inverters , Battery chargers, Rectifier systems and Main generator excitation system.
- **Valve Test Facility:** Motorized valve test facility has been developed at the station for testing and monitoring the performance of various types of motorized valves installed at the station before installation in field.
- **Universal Process Loop:** This facility is developed in-house for training new entrants and plan personnel for various C&I related task by simulating field like conditions.

Mini Power Station: It is a working model of conventional process in a system consisting of steam generator, turbine, condenser, hot-well, CEP, dearator, feed pump, CCW pump & NDCT to train new entrants.



DPHS Card Test Facility



Separator Test Facility



Electrical Card Testing Shop



Active Valve Test Facility



Universal Process Loop



Mini Power Station

Figure 5.