

OSART Good Practices

OPERATIONS

Operations Facilities and Operator Aids

Mühleberg, Switzerland

Mission Date; 6-23 November, 2000

The PVS (Process Visualization System) is a visually sophisticated computer system which enables shift personnel to follow plant status easily. The PVS consists of 3 parts: PVS, SPDS (Safety Parameter Display System) and Trend View System. The quality of the displays as well as the human factors input from operations make this system unique. Visualization is on large screens situated above the relevant control panels in the control room providing an overview of status and important data without having to look at individual instruments. There are three of these screens which are of LCD technology and 100 x 75 cm in size. PVS has access to 2700 process data points which can be presented digitally or trended. Many images can be displayed simultaneously as thumbnails. The system is also very helpful in providing an overview of normal, abnormal and emergency conditions.

SPDS provides presentation of important operational data for operational and abnormal conditions. The Trend View System can present trends of up to 24 hours of all of the 2700 process data points. The SPDS is also provided in real time display in both the plant specific simulator and the SUSAN building control room.

Operations personnel, including shift staff actively participated in the design of these systems. This resulted in greater acceptance of the system by the shift personnel. In addition, the quality of the drawings and presentation of charts and values is excellent and easy to understand. These systems are also easy to operate.

Plant Control Center.

Considering the fact that plant shift supervisor controls the operation of several units it seemed to be necessary to establish a center where the unit's main parameters, the national grid connection can be monitored and the appropriate communication is available for the plant control. The plant control center (PCC) is a workplace for plant shift supervisor, dispatcher and plant chief electric. They are provided with dispatch phone system allowing a direct phone contact with operational personnel of all units in conference mode.

The present role and functions of the PCC in normal operation condition are:

- The PCC shall monitor the operation of units, and some common systems like electric and cooling water systems, heating and other auxiliary systems and the fire alarm systems.
- Two-way communication with National Dispatch Center
- Coordinating the work of shift operation personnel monitoring the units and the related process systems.
- Handling of installed emergency preparedness communication devices and completion of tests with specified frequency.

In case of an accident, PCC is the center from where control the process parameters and operational condition at the location of emergency situation is performed to provide conditions of accident prevention including required notifications and information preparation.

PCC information system is constructed from modular elements suitable for displaying analogue and dual-state signals. Information to the scheme board is supplied by microprocessor data acquisition system from the units, 400/120 kv substation and water intake plant. PCC computer system includes two vax type microcomputers and the relevant peripheral devices. The system shall process data received from the units and the dosimetry system.

In case of any potential accident on the plant the personnel will be immediately alerted and informed by the computerized (computer controlled) acoustic safety alarm and information system in accordance with the emergency preparedness plan (including activation of civil defense sirens and public alarm). The pannon-courier of pannon gsm system is used for a fast, easy-to-handle and at the same time reliable alarm system by sending short textual messages (SMS) by cell (mobile) phones, by monitoring the messages sent, and by processing the reception of the messages.

Dukovany 1/4, Czech Republic

Mission Date; 5-22 November, 2001

Effective operator aids have been provided for Control Room staff to enhance their capability to monitor and respond to changes in plant condition. In addition, good human factors methods were used to develop Safety system surveillance test sheets that are colour-coded to clearly designate which work groups are responsible for the execution of each test section. The unique features of these operator aids are as follows:

A computer based alarm response program has been developed that is simple to use and readily accepted by operations staff. It is a graphical replica of each annunciator panel in the control room. The operator simply selects the panel, then clicks on the corresponding alarm window on the computer, and the alarm response procedure is then immediately visible on the screen. A backup paper copy is also maintained in the control room.

Each section of the Safety system surveillance test procedures is highlighted in a different colour code according to which work group is responsible to execute that section. For example, the steps for Field Operators are highlighted in red, Instrumentation & Control are highlighted in yellow, Electrical in green and Control Room operators are purple.

The computer based alarm response program allows rapid access to control room alarms and the colour-coded surveillance test procedures reduce the risk of human errors. Both of these operator aids can result in an overall increase in operational safety.

Sta. M. Garona, Spain

Mission Date; 18 Feb.-2 Mar., 2002

Field operators take field data with hand held computers in which the trending of the parameters taken over the last six days is available. This helps the field operator to enhance surveillance of plant equipment.

Field data are taken with hand-held computers, which have the data from the last six daily walk-downs. For each parameter there are maximum, minimum and variation limits, which warn the operator when surpassed. In this situation the evolution of the parameter over the last 6 days can be immediately observed either graphically or in data. The comments from previous walk-downs can also be seen.

Therefore this tool enables the personnel, who perform the walk-downs, to obtain important information about the evolution of the parameter, to help in decision-making and to anticipate responses in order to prevent the degradation of equipment or inadmissible parameter values.

This improves surveillance of equipment performance and contributes to an increase in plant operational safety.

Angra 2, Brazil

Mission Date; 12-31 October, 2002

Safety Function Determination Program (SFDP)

In addition to the plant computer information system and SPDS system the plant developed a Safety Function Determination Program that supports the operators in the Control Room in identification of plant safety status.

This program is a tool that helps the staff of the control room ensure that any loss of Safety Function is detected and that the appropriate actions are taken. In the case that two or more Limits Conditions of Operation (LCO) are not fulfilled, simultaneously, an evaluation will have to be made, to determine if there is a loss of Safety Function. Additionally, other appropriate actions must be taken as result of the inoperability of auxiliary systems.

The SFDP is capable of:

- Crossed verifications in trains, to assure that the loss of the capacity to execute Safety Function, assumed in the accident analysis, will be detected;
- Evaluate that the plant is kept in a safe condition, if there is an inoperable system or function.
- To assure that the Conclusion Time of an inoperable system is not improperly extended as resulted of the inoperability of auxiliary systems;
- Other appropriate limitations.

The SFDP identifies where there is a loss of Safety Function. If the loss of the safety function exists, it is necessary that the corresponding actions and Tec. Spec. imposed limitations are applied. The updating of the program is assured by a long term contract with the supplier of the software.

Kashiwazaki 3/6, Japan

Mission Date; 1-18 Nov, 2004

Cooperation of TEPCO in the design of unit 6, 7 MCR - man-machine interface.

The third generation type control room design, which is used in the Main Control Room of units 6 and 7, has the goals of enhancing the reliability of operation during emergencies and maximizing the efficiency and effectiveness of the operating crew. The development of the ABWR control room design has been guided by the operation experience from the previous MCR and analysis of the operator's workload as well as the progression of state of the art technologies. The features of the design MCR units 6 and 7 are that an operator shall be able to perform all of the primary monitoring and control function from a seated position. Operator's actions required following a scram should be minimized. This design was developed in the close cooperation between designer and operating organization TEPCO. Improvement of the control room design is one of key elements to promoting reliable and safe plant operation.

On 4 November 2004 when unit no. 7 automatic scram occurred due to turbine thrust bearing gap sensor activation caused by an earthquake. The team observed that operation shift responded to the situation in a calm manner and led the plant to the safe state efficiently as the third generation design intended.

Penly, France

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

Alarm Management

The alarm management system provides a comprehensive and informed overview of alarms appearing in the control room.

Displayed alarms denoting a deficiency on the plant are tracked and validated, and actions requested to deal with them are monitored. A summary chart is available in the control room, providing a clear overview of the situation. This guarantees that information is conveyed to all shift crews.

Every week, an ongoing check is performed by the shift crew. This makes it possible to ascertain that the inventory documented in the tracking binder is accurate. It is also an effective means of following up on corrective actions and formalising a comprehensive safety analysis with regard to displayed alarms. In addition, a concise alarm report is included in the Weekly Operations Review and is presented at the site senior management meeting by the shift manager.

Penly, France

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

Room Identification/Sign

The operations department is overseeing the introduction of a plant-wide sign system, designed to make access and maintenance work easier. The team recognized this as a good practice.

The plant sign system, currently being set up on units 1 and 2, meets requirements for entering the various rooms and for addressing risks associated with specific areas of the plant. Signs consist of two sections. The first section describes a floor or an area together with the respective rooms. The second section describes each room. The system is based on the following three points:

- The sign displays a simplified drawing of the room. If it describes the room, it also provides information regarding the room about to be entered (sign posted on entrance doors).
- The sign lists the main items of equipment inside the room (valves, pumps, coolers, etc.).
- The sign displays risks and protective equipment required before entering the room (sign complies with international regulations).

The system is a very easy to understand and uses visual and intuitive communication methods. They can be understood by anyone entering plant rooms (EDF staff and contractors).

These signs have provided significant added value in terms of orientation at the site. The system has also brought about improvements in terms of industrial safety: relevant risks are posted to prevent events from occurring. Lastly, in terms of shadow training, efficient signs are conducive to a quicker transfer of knowledge through a more targeted approach to rooms and equipment.

Quinshan3, China

Mission Date; 5-24 May, 2005

Communication between the operation staff by cellular mobile phones.

The plant has established very effective communication practice between the shift crew and the plant personnel based on the use of special cellular phones with lower intensity of electromagnetic interference provided by the company.

All members of the plant staff hold company cellular phones in the field and at home. Cellular phones are approved to be used in the plant and assure good way for communication within and/or out of the operation's shift. Personal Communication system via use of mobile phones supports all phases of station activities.

It is particularly beneficial to operations and maintenance allowing staff to be contacted immediately whether they are on- or off-site. Also, the system is very helpful on enhancing questioning attitude and cross checking prior to taking action. It provides convenient access to technical support.

In case of transients, the system provides a quick and effective mean to contact on-shift personnel or the shift supervisor. Hence, minimal delays are incurred when key personnel must be contacted. Similarly access to technical support for the shift supervisor is simplified and convenient.

Additionally, the use of the cellular phones by the staff frees the public address system for legitimate paging. It helps to minimize excessive use of the public address system seen in many nuclear plants.

Avoiding problems associated with excessive public address use such as detracting from plant transient or emergency announcements is a difficult issue for many plants because the need of an extensive communications presses the staff to look for a quick communication tool. Thanks to the wide use of the cellular phones the public address system announcements at the plant now are considerably low number which, is a good example of solving this important issue.

Blayais, France

Mission Date; 2-19 May, 2005

Widespread use of electronic information systems that disseminate plant information site-wide in a timely manner. Examples:

Shift manager, deputy shift manager & control room operator logs (field operator logs currently completed using pen & paper, but plans are underway to convert these to an electronic application)

Minutes of operations planning meetings

Plant trend data from the results of surveillance tests.

Electronic data collection by field operators completing rounds. Data from plant equipment is input to a handheld electronic module during the rounds and then downloaded each shift to a PC-based network application, accessible by staff plant-wide.

Borssele, Netherland

Mission Date; 8 Nov.-7 Dec., 2005

The plant has completely replaced the main control room by new design, in which control room personnel lead in the design process, and currently maintain their involvement for Man-Machine related modifications.

During the 1997 outage the old control room was completely removed and replaced by a new, ergonomic design. The general layout of the control room, the layout of the control and instrumentation panels and even type of instrumentation and buttons have been defined by operators, based on sound design and ergonomical principles. This has resulted in an extremely high degree of operator acceptance despite the completely different working environment. Simulator training shows that the layout improves operator actions, both in speed and in prevention of errors.

The complete removal of the control room was at that time unprecedented, as was the chosen process. The results, however, have fully justified that approach.

Ever since, a Man-Machine Interface group chaired by Operations initiates and guards modifications in the control room, local control panels and the Process Presentation System.

Connection of all new computerized systems for plant performance control to upgraded (TITAN) Information system through the local INPP network.

The original design to control and test the MCR performance defined that INPP plant would be controlled and monitored not from the MCR but from the local (field) control boards. In case of changeovers and tests, the MCR operators used to receive the data of plant status from the departmental shift staff through communications facilities. Moreover the shift staff used to have to do some calculations required for the job process in the manual way. The technical support staff did not have direct access to database of the TITAN computer information system.

At present the following INPP upgraded computerized systems designed to control plant performance have been connected to TITAN Computer System through the local computer network which includes about 1200 PCs:

- Diverse Shutdown System (DSS);
 - Additional Emergency Protection on ORM and Coolant Flow in GDH Reduction (in Russian"ORM AZ and GDH AZ");
 - Radiation Safety Monitoring System (in Russian"SAMRB");
 - Special Water Purification Monitoring System (SWPS);
 - Gas Equipment Monitoring System (GE);
 - Fuel Claddings Integrity Monitoring System (FCIM);
 - Additional Coolant Leak Monitoring System SOT Cable-Radar;
 - Automatic Turbine Control System (ATCS);
 - Automatic Rotor Monitoring System (ASKR);
 - Additional MCP and Turbogenerators Vibrations Monitoring System (VIBRO);
 - Refueling Machine (P3M).
- Now the INPP people enable to be additionally provided with the following:
- All users are provided with data of INPP plant and system state in the common man-machine interface which has been developed for the upgraded TITAN IS;
 - The INPP departmental managers, operating and maintenance personnel, technical support personnel being at their working places are provided with current data of plant and system state which they need to control and review the plant performance conditions;
 - The MCR operators are provided with the data which they need to do the additional and independent control of plant state and changeovers which are controlled and monitored not from the Main Control Room;
 - INPP staff are provided with archive data delivered from the TITAN data base in case of potential deviations and events to review these event and deviation causes;
 - The INPP operating staff are provided with additional and processed information (namely, calculations aids like change parameter rate frequency, temperature parameters of heat exchange plant, integral parameters: water balance for a specified period of time, etc.) which the staff need to control and conduct the performance process in the proper way;
 - The staff understands and is aware of the operating process in a more extended way and ensures a better communication when they conduct common performance.

South Ukraine3, Ukraine

Mission Date; 9-25 Oct., 2006

Computerized aids for operators.

The plant has developed a comprehensive set of computerised aids for operators. They complement each other and are supplied by two independent electrical trains.

During their development the plant took special care of the ergonomic part of the design. The operating personnel confirm that these systems all together are of very convenient usage.

-The computer information system (CIS) performs acquisition, processing, display, record and archiving of process parameters, safety parameters, deviation signals and control actions performed by operating personnel. The plant modernized the CIS in 2006 to enhance the design and the ergonomics. Data are available from the systems as following:

- neutron flux monitoring equipment (NFME)
- in-core monitoring system (IMS)
- Radiation safety monitoring equipment (RSME).

-Safety parameter display system (SPDS) is a system which makes it possible to represent the unit safety functions status to the operator in online mode. SPDS is able to support the operator and to provide accurate information, which simplifies the accident management.

Besides the main control room, the system is also available at different premises such as:

- plant shift supervisor office
- emergency control room,
- internal crisis centre,
- simulator,
- full scope.

Furthermore the information is also available in other offices (e.g. chief engineer and deputies).

Yongwang, Korea

Mission Date; 17 Apr. - 4 May, 2007

Instruction Cards, placed directly on the most important equipment in the field, are used to support field operators' activities in urgent situations when the normal procedure is not available.

The instruction card describes basic equipment manipulation guidelines or a summary of the system operation procedure. Field operators can therefore promptly deal with the urgent issue and also minimize the probability of human error. On the back of the card is the equipment picture and the name and location of relevant manipulation switches and valves.

Field operators can manipulate the equipment by using the guideline card, subsequent to receive the approval of the shift supervisor. The number of cards is kept to a minimum. Currently 35 cards are used as properly controlled documentation, fully in compliance with the original procedure on the related system. Cards are made from yellow colour fire-resistant material in order to reduce the risk of a fire involving the card materials.

Chinon, France

Mission Date; 27 Nov. - 14 Dec, 2007

The plant has created a programme to reduce scrams from human interface that includes labeling equipment in the field and the control room as well as electronically identifying equipment and activities that could introduce a risk of plant scrams. Over 240 items per unit have been identified for easy identification.

The plants isolation (tagging system) specifically alerts the operator that a scram risk is present when conducting isolation activities. The work order that the craftsman receives clearly identifies the potential for scram risk as well.

These activities are clearly identified on the plants daily schedule through interface with an operations supervisor that is allocated to the TEM (on-line work management) structure.

All activities that are flagged as a plant scram risk are subject to a pre-job brief for the department involved and operations. Several activities have "standardized" pre-job briefing sheets that are available for use by individuals that will be performing such risk significant maintenance.

Since the programmes inception in 2005, there have been no plant scrams due to human interface.