

One important insight from studies of the Three Mile Island (TMI), Chernobyl, and other nuclear power plant (NPP) accidents is that errors resulting from human factors deficiencies, such as poor control room design, procedures, and training are a significant contributing factor to NPP incidents and accidents. Plant safety requires "defense in depth" that encompasses using multiple barriers to prevent the release of radioactive materials, and employs a variety of programs to assure the integrity of barriers and related systems (IAEA, 1999). These programs include conservative design, quality assurance, administrative controls, and human factors.



The **Nuclear Safety and Safeguards National Commission (CNSNS)** is the Mexican Regulatory Authority on Nuclear Safety, Radiological Safety, Security, and Safeguards.

This poster describes the main activities and the process carried out by the CNSNS in Mexico, over 20 years to follow up on topics related to Human Factors, including the main challenges to be solved by the regulatory body to ensure adequate monitoring of these issues in the Laguna Verde Nuclear Power Plant.



**Laguna Verde Nuclear Power Plant (LVNPP)** is located on the coast of the Gulf of Mexico; it's the only nuclear power plant in Mexico and produces about 4.5% of the country's electrical energy. It consists of two units GE Boiling Water Reactors (BWR-5). Unit-1 started its operation on July 29, 1990 while Unit-2 on April 10, 1995. Initial architects in 1975 for the plant were Burns and Roe Inc. and later Ebasco Services designed and supervised the project.

The plant is owned and operated by Comisión Federal de Electricidad (CFE), the national electric company owned by the Mexican government.

The activity related to Human Factors in Mexico was focused in two main areas:

- Improve the working environment for operators in the Main Control Room
- Improving the tools of communication, written and verbal, during operation manoeuvres

## The Control Room Environment

The Detailed Control Room Design Review (**DCRDR**), of Laguna Verde NPP was carried out in compliance with the requirements laid down in established NUREG-0737 "Clarification of TMI Action Plan Requirements", in concordance with the methodology established in NUREG-0700 "Human-System Interface Design Review Guidelines".

One of the first activities to be conducted was the measurement of lighting, noise and temperature in the Main Control Rooms of both units. Environmental factors that can have important effects on operators' performance include thermal comfort, illumination, the auditory environment, and facility layout.



## The "Darkboard" Configuration Problem

Alarms and set-points should be designed so that only parameters and conditions that fall outside of the normal and expected range and that require operator attention or action are in the alarm state. This concept has implications for the plant's operating philosophy as well, including issues such as (1) repairing failed equipment expeditiously, (2) taking corrective actions for instrument drifts that cause alarms, and (3) correcting conditions that frequently lead to repeat alarms.

The number of alarms present in Control Rooms Laguna Verde NPP, started with a total of 70 alarms in U1 (27 January 1993) and 86 of the CCP U2 (21 February 1996).

This problem was solved by the gradual implementation of design modifications, corrective maintenance and temporal changes in the systems related to the problem. Such modifications and their results have been evaluated by the CNSNS to determine the impact on the operator (Human Element) as well as on the operation of the system and therefore the safety of the plant.



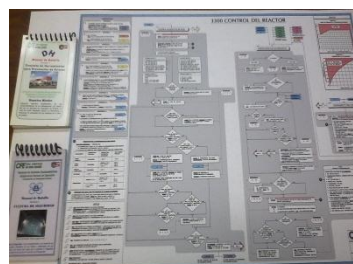
## The Hybrid Control Room

Existing I&C systems are primarily of analogue design and contain components that are or soon will be obsolete. A significant challenge that faces the plants and the system designers is how to incorporate good human factors engineering and meet human performance goals with the hybrid -- part analogue, part digital -- control rooms that will be produced at various stages of I&C modernization. Careful design of the human-system interfaces (HSI) utilizing digital technology and integration of these interfaces into control rooms can provide capabilities that permit personnel to accomplish their roles more effectively in such tasks as process and equipment monitoring, fault detection and diagnosis, situation assessment, response planning, and response execution.

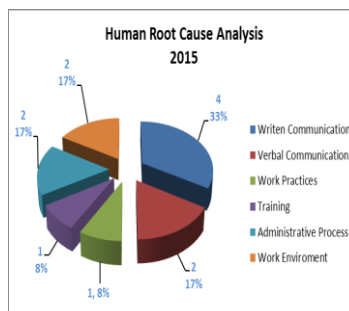


During the activities of Power Up Rate the most important modification in the main control room was made in the Pressure and Speed Control of the Turbine System and involved the installation of displays, a keyboard & a "PC mouse". The regulatory body assesses the human-machine interface by NUREG- 0700 Rev. 1, finding acceptable. Since its installation, events not caused by changes or updates in Control Room have occurred.

The results can be reduced human errors and improved human and plant performance, and thus enhanced plant safety, availability, reliability, and efficiency. In Laguna Verde NPP an aggressive program to replace analog instrumentation by digital was implemented. 100% of the recorders of Control Rooms were replaced.



Regarding with the improvement of written and verbal communication tools was first required to the Licensee the review, analysis and improvement of the Elaboration Procedures Process to remove precursors of error due to ambiguous instructions documents. As for the verbal communication were required and developing tools to improve. In response a set of tools developed as: three-way communication, self-checking, Pre-work Meetings.



A significant advance in the regulatory analysis of human behavior in Laguna Verde NPP, has been the inclusion of aspects of Human Factors in the database of Licensee Events Reports. This has allowed monitoring the human behavior and focuses the regulatory resources in such areas for improvement. For example, in the chart were observed areas for improvement in activities related to the following instructions and procedures by staff of the facility.

## CHALLENGES

Currently the CNSNS face two challenges:

- The formation of regulatory experts in Human Factors
- The inclusion within the regulatory framework applicable to Laguna Verde NPP a requirement related with the development of a Human & Organizational Factors programme.

The first one is intended to solve by involving universities of the country in this branch of engineering and the second one by the inclusion of this topic in the relicensing process of Laguna Verde NPP.

*In Memoriam of Eng. Jesus Basurto Cazares pioneer of human factors engineering in nuclear facilities in Mexico.*