EURATOM SAFEGUARDS IN MELOX : ON-LINE NDA, BRANCHING ON OPERATORS' EQUIPMENT AND DATA ANALYSIS.

P. Beuseling, M. Boella, R. Mertens, S. Tsalas
European Commission, DG TREN, Euratom Safeguards Office, Inspection Unit 1
Luxembourg

Abstract

The MELOX plant is a modern Mixed Pu/U Oxide (MOX) fuel fabrication facility. The high degree of automation of the production process has led to a specific ESO safeguards approach, now running successfully since 1994. The success of this approach is due to the intimate integration of ESO NDA equipment in the production lines and branching on to the operators' flow measurement equipment, together with computerised analysis of the daily operator declarations and more conventional C/S systems.

In 1999-2000, an extension to the MELOX plant has been constructed in view of the diversification of the production capacity, including the BWR fuel fabrication for Japanese customers. This has led to some enhancements (some of them are still in development) to the approach in order to continue the successful safeguards: integration of new ESO NDA equipment, automation of sample measurements as well as major changes to the daily data analysis software.

The poster session will give a pictorial presentation of the integrated equipment in the production process, the computerised data analysis, and the latest developments as well as the practical advantages of this specific approach both for operator and EURATOM.

1. Introduction

The MELOX plant is a Mixed Pu/U Oxide (MOX) fuel fabrication facility of the new generation with a nominal throughput of 115 tons of heavy metal per year. A specific ESO safeguards approach has been developed due to the high degree of automation of the production process. This approach has been explained in the paper «Safeguarding the MELOX fabrication plant »/1/.

Intimate integration of ESO equipment at all stages of the production process, branching on operators' equipment, containment and surveillance systems and treatment of daily operator declarations form the cornerstones of this complete data analysis system for inspection purposes.

Recent changes in the facility were made to start the production of BWR fuel elements for Japan. Due to these changes, additional equipment was installed and necessary upgrades were made to the data analysis software.

This paper should be considered as a guide for the poster session. It recalls the principles applied and which have already been presented at ESARDA (/1/ and /2/), and gives some more details about the evolution since.

2. Sectors and flows

The facility has been divided in a number of sectors for safeguard purposes. /1/ These sectors have been established respecting the logic of the production process. In total, 8 main sectors are used, plus the laboratory. These sectors are:

1. PuO_2 and UO_2 input stores
2. Powder fabrication
3. Pellet fabrication
4. Rod fabrication
5. Assembly fabrication
6. Assembly store
7. Scrap handling and store
8. Wastes

In order to allow flow verifications between these sectors, 35 flows have been identified to follow all movements of nuclear material.

Operating data are transmitted daily by the operator and cover the totality of the nuclear

Template Secy 028

DS-02

material present in the storages as well as all flows.

Continuous monitoring of these flows is therefore a major milestone in the applied Safeguards Scheme. This is why big effort was spent in installing unattended measurement systems, and branching on operator's equipment.

3. On-line NDA

In order to follow the input and output of the facility as well as the input and output of some major storages, 4 neutron monitors, 2 neutron detectors and 2 neutron-gamma detectors are installed in the facility, coupled to barcode readers.

The neutron and neutron-gamma detectors were specially designed to minimise interference with the production process, presenting a gain in manpower and radiation protection, both for the operator and EURATOM

The neutron monitors are located at:

- the entry of PuO_2 containers into the facility
- the entry of PuO_2 containers into the PuO_2 storage
- the exit of assemblies out of the assembly storage before shipment
- the entry into and exit out of the scrap storages of scrap containers

The neutron coincidence counters coupled to gamma detectors are located at:

- the exit of PuO_2 containers out of the PuO_2 storage before entering the process
- the rod sector, where all rod trays are measured before assembling

The neutron coincidence counters are located at:

- the entry of assemblies in the assembly storage
- the exit of scrap containers before shipment

All coincidence counters and monitors are running unattended and are measuring continuously. The data collected are temporarily stored on the Data Acquisition Systems (DAS) inside the facility and data transfer is done automatically to the central computer systems NEGUS (Neutron and Gamma Unattended System), and RADAR located in the EURATOM office.

The NEGUS and RADAR systems allow the treatment of all data: definition of neutron objects, linking neutron and gamma measurements and their respective barcodes, creation of a data transfer file for MIDAS (MELOX INSPECTION DATA ANALYSIS SYSTEM) for further analysis.

4. Branching on operator's equipment

As independent measuring devices are not always easy to fit into the very hart of the production process, the easiest way to follow the flows there is to branch onto the operator's equipment. Therefore, 7 balances, coupled to barcode readers, are used to monitor the material flows in the bulk process. They allow weighing of all material (powder and pellets) moving between the various stages of the production process: from PuO_2 powder to MOX pellets.

These balances permit the weighing of:

- all PuO_2 cans entering the process
- all containers entering and exiting the homogeniser
- all containers transferring the accepted pellets from the pellets sector to the rod sector
- all containers transferring the rejected pellets from the pellet sector to the powder sector

The weighing results are sent to the central BRANCH computer located in the EURATOM office, and then put into a data transfer file for MIDAS.

Next to the balances, the 3 operator's rod scanners, coupled to barcode readers, are also used for branching. They allow verifying the active length of the rods and offer the advantage that every single rod is measured. The data is collected by the RADAR system, and is transferred in the same way as for the NEGUS system. Again, a data transfer file is being generated for further use in MIDAS.

5. Video surveillance

Beside measurement systems, a complete and independent video-surveillance network is installed, covering the entire facility. It is composed of a total of 20 cameras of which the images are send to the central computer located at the EURATOM office.

Its function is double:

1. confinement and surveillance (C/S) of the most important storages, as a double layer on top of the neutron monitors and detectors,

2. verification of the data recorded by the on-line measurements by detailing the different movements through the recorded images.

Video review is performed daily, and all information is used to confirm NEGUS data before creating the data transfer file for MIDAS.

6. Interim verifications

Although the highly automated systems cover the most important part of the facility (storage and flows), in the bulk process, branching onto the balances is insufficient to attain Safeguards Goals. Therefore, manual verifications are made on a weekly basis. They cover the storage of powder and pellet containers and consist of the weighing, identification and NDA verification on a selection of items.

The sampling plan used to calculate the number of items to be verified during these interim verifications was originally based only on the size of the storage (number of items – Pu content). This inevitably leads to high number of items to be presented, and is thus very time-consuming, both for the operator and for EURATOM. Advantage can be taken from the fact that a big number of items are constantly monitored by EURATOM equipment, and as a consequence a new approach for the sampling plan has been developed.

This approach takes into account the material flow that has been monitored by the unattended measurement systems, which can be considered as if part of the storage already has been verified. This means that the amount of material to be used in the sampling plan calculations is smaller and therefore so is the final sampling plan. The impact on the sampling size in normal production conditions is a 50% reduction of items to be verified.

A subset of items is selected for sampling for analysis. These samples are sent to the EURATOM NDA station, located in the facility itself, for neutron and gamma measurement. The measurement results are entered in the central database of the MIDAS system.

7. MIDAS (MELOX Inspection Data Analysis System)

The MIDAS software application has been developed to handle all data coming from the different acquisition systems and the daily operator declaration.

The MIDAS treatment of the data sets consists of:

- the integrity verification of the operating data
- the flow consistency verification of the operating data
- the consistency between he operating data and measurement data recorded on the NEGUS, RADAR and BRANCH systems
- the consistency between the operating data and the rest of the inspection data

If errors occur in the various steps of the data treatment process, MIDAS will automatically signal them., and in this way maximises the inspectors effort, and the use of the available manpower.

Besides the automatic data treatment, MIDAS allows

- calculating the weekly sampling plan and integrates the results obtained during these interim verifications
- statistical evaluation of all inspection relevant data
- accountancy verifications including the consistency with the physical situation
- global data analysis for a Material Balance Period

8. Experience

Since the MIDAS application is in use, the importance of such a tool has been shown. It has indeed become unimaginable to safeguard a facility as MELOX without the help of on-line data acquisition systems and the according data analysis systems. The major advantages of these kinds of tools are:

- efficient use of manpower both for EURATOM and the operator
- minimising human errors
- immediate reaction in case of problems or discrepancies
- reduced effort for upgrading in case of changes in the facility

As the equipment is fully integrated in the production process, it is clear that every change inside the facility has its consequences on the system. The most important changes that have been implemented are:

- integration of the new calculation method for interim verifications
- the expansion of the facility in view of the production of BWR fuel for Japanese customers. This led to a modification of the operating data and to some additional data acquisition systems.

9. Conclusions and future evolution

The Safeguards Approach in MELOX is operational since 1994. Ever since, a number of changes have taken place in the facility: expansion of the facility and installation of additional equipment.

The flexibility and the effectiveness of the network of data acquisition and analysis systems became clear as adapting it to the changes showed to be quite easy. It never caused any interruption in the inspection activities nor in the production process.

As a result of the diversification of the production process, it will be necessary to continue to limit the manual activities in future. Therefore, new acquisition systems are being developed to take over part of these activities such as:

- unattended NDA measurements of the samples taken during interim verifications by automating the measurement station
- on-line detectors to do extra gross defect and partial defect measurements during interim verifications

This will lead to an expansion of the network whilst maintaining manual activities at the same level.

In this way EURATOM will be able to continue to achieve the safeguards goals with the same effort whilst reducing the impact on the operator to a minimum.

10. References

/1/ "Safeguarding the MELOX fabrication plant", ESARDA Symposium 95
Arenz, Dossogne, Kaiser, Paternoster, Schenkel, Beaudoin, Molinari, Petit

/2/" The role of data treatment in the Safeguards Approach in MELOX",
ESARDA Symposium 95
Boella, Dossogne, Kaiser, Paternoster

/3/"The Euratom tailored Safeguards Approach for the MELOX MOX fuel fabrication plant – Quantitative effects on interim verifications",
INMM Florida 1998
Boella