Fleet Modernization Upgrade

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Fleet Modernization Upgrade

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Introduction
Markets
Complex technological industries with the highest quality and safety standards

- Current Nuclear Fleet
  - New Reactors
  - Advanced Reactors
  - Research Reactors

- Gas Combined
  - Coal
  - Cogeneration

- Renewable

- Oil & Gas Manufacturing
  - Process Industry

- Aerospace
  - Railway
  - Automotive
Value proposition

Develop and implement integrated and innovative solutions that promote the safety, efficiency and reliability of your assets, processes and the performance of people.
Fleet Modernization Upgrade

Introduction

- 5 Spanish replica simulators.
- Certified according to the ANSI-3.5
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Introduction

All Spanish FSS had a specific modernization plan.

• **First Stage: Long-Term operation.**
  - Modernization of Computers and simulation environment
  - Modernization of Input/output System

• **Second Stage: Improve Operator Training.**
  - Improve new codes/models to train new scenarios (shutdown sequences, severe accident...)
  - Implementation of DCS
Computers and Simulation Environment Modernization
Computers and Simulation Environment Modernization

Avoid obsolescence of Simulator Architecture:

• New computers, from Unix to Windows
• New Simulation environment
• Porting of the source code (new compilation).
Input/output System Modernization
Input/output System Modernization

Avoid obsolesce of I/O System (hard to find spare cards)

Tesis+ is the evolutionary design of the Tesis I/O system.

It is a distributed system based on a TCP/IP network protocol (fast or GIGA-Ethernet) running under Windows OS (64 bits) with a client/server architecture.
Codes/models Modernization
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Codes/models Modernization

• Migration to the Tecnatom model builder models (Team Suite: Team_Flow, Team_Logic, Team_Electric…)

• Upgrade thermal hydraulics codes to cope with new scenarios: midloop, open vessel…

• Add new codes to cope with Severe Accident Scenarios. MAAP
Codes/models Modernization: Shutdown Scenarios

• Best Estimated codes (TRAC_RT) upgraded to cope with incondensable gas, allowing continuous operation in outage scenarios.
• Highly demanded by training schools and the regulatory body
• Scenarios to train based on PSA and plant operational experiences
• More relevant midloop operations and open-vessel
DCS Modernization
DCS Modernization

- New DCS of Spanish NPPs such as new turbine digital control systems, new feed water control systems, etc… have been implemented in FSS in the recent years.
- They are based on platforms such as Ovation MARKVI, S7, etc…
- Implementation first in Simulators lead to numerous benefits. Most important:
  - Tune the DCS in Simulator
  - Operator Training in advance
DCS Implementation. Feed Water Level Control of Cofrentes NPP

- Replace the analog control system, panel components and human machine interfaces. Under MARKVI platform of GE

- The DCS implementation pursued 4 goals:

  1. Control response analysis and tuning
  2. Plant operators training in advance
  3. Operating and Functional Procedures review and validation
  4. HFE: Validation and Regulatory Body requirements fulfillment
CONCLUSIONS

Lessons learned & operating experience
CONCLUSIONS

Benefits of the modernization process in the Spanish FSS:

• Extension of the simulators life
• Simulators stability and robustness
• Improved training in new scenarios
• The implementation in the simulator of the DCS prior than in plant, lead to these benefits:
  - Detection of discrepancies and parameters adjustment
  - Training the operators in advance
  - Simulator behaviour closer to real plant
  - Physical Fidelity
  - Review of procedures
  - Validation of the HMI
Lessons learned & operating experience

1. Planification of Simulators Modernization
   - Avoid obsolesce and ensure long-term operation. the sooner the better

2. Source code porting
   - Different results with different compilers
   - Long time of testing: Whole simulator to be tested

3. Shutdown sequences
   - Long time scenarios: make the training sessions dynamic and prioritized according to PSA

4. DCS implementation
   - DCS usually required of high level of detail models