Project Experiences of the Implementation of the Primary Bleed & Feed System

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Introduction/Concept

Modernization activities play a very important role in the enhancement of the safety and reliability of nuclear power plants. The main focus is on increasing plant availability, operational flexibility or integration of new, additional equipment to satisfy safety requirements, as in the case of the implementation of the design modification "Primary Bleed & Feed" (PBF) in the event of a beyond design basis accident.

Primary B&F prevents the high pressure core melt path and allows heat removal by depressurizing the primary system and providing coolant injection with passive and/or active low pressure systems.

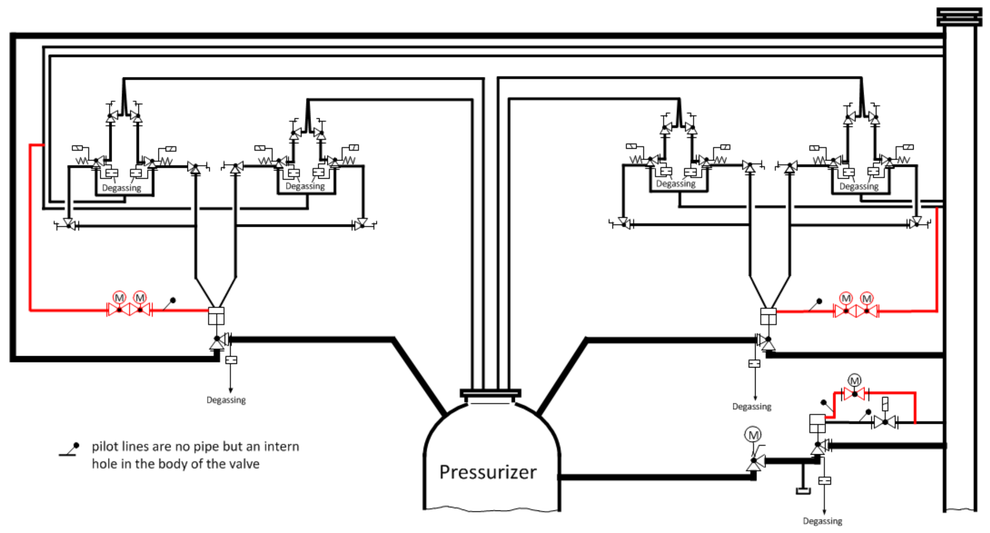

Figure 1: Schema Primary Side Overpressure Valve Station

Project Scope

AREVA provided engineering, procurement, testing, installation and commissioning until the final system handover to the client.

The project encompassed a set of disciplines such as mechanical engineering (main components like the PBF pilot valves and new casings for the safety and relief valves, piping and routing); I&C (e.g. design and supply of adapters for the PBF signals); electrical engineering; thermo-hydraulic calculations, flexibility and stress analysis and hydrodynamic loads together with the corresponding project activities of planning and harmonization of interfaces.

The PBF system was implemented during the plant outage in 2013 in NPP Trillo. The completion of this multidisciplinary project in a dynamic environment could only be completed by teams of people from different organizations with a variety of skills, all working together, meeting high safety and quality requirements. The good support and cooperation with the customer CNAT (*Centrales Nucleares Almaraz Trillo*) were key elements since the beginning of the project.

On-site Implementation

Before the implementation on-site, walk-downs and inspections were carried out during previous outages in order to integrate the new system better within the existing structures. Additionally a mock-up model allowed grinding, training in machining and welding activities beforehand, speeding up the implementation works on site while reducing the exposure to radiation levels and keeping low dose exposure of the team members. Detailed planning, shielding and protection measures described in the ALARA principle (*As Low As Reasonably Achievable*) and HSE (Health, Safety and Environmental) Plans were fully fulfilled during the execution. The main tasks performed could be clustered in 3 groups:

Mechanical and Process Engineering

The analysis of the pressurizer system, such as transient analysis for beyond design events e.g. Station Black Out (SBO) and Total Loss of Feed water (TLF), flexibility and stress analysis considering different conditions and scenarios were performed.

The main components for the implementation included two double PBF pilot valves, which were connected to the safety valves, one single PBF pilot valve connected to the relief valve and their respective actuators plus the modification and installation of existing and new pipelines.

Safety and relief valves were pilot operated and worked with pressurizer medium. The PBF pilot valves were motor operated and had a very low energy consumption. Once opened, no electrical power was necessary.

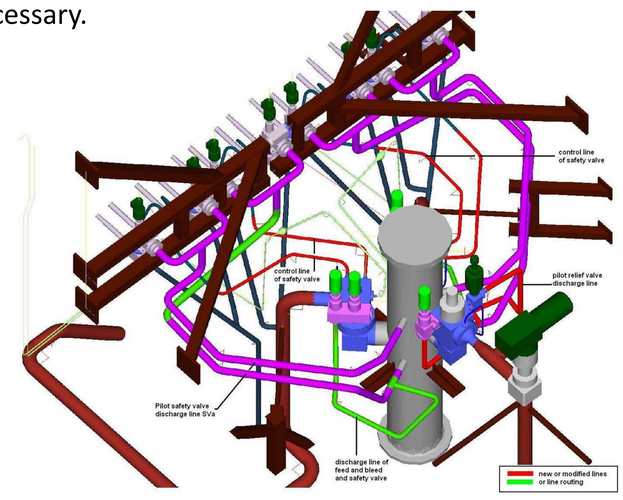

Figure 2: 3D-Modeling pressurizer station

The conditioning of the existing valves was performed through the implementation of new compact casings for relief and safety valves while maintaining the internals and reinforcing the flange connections.

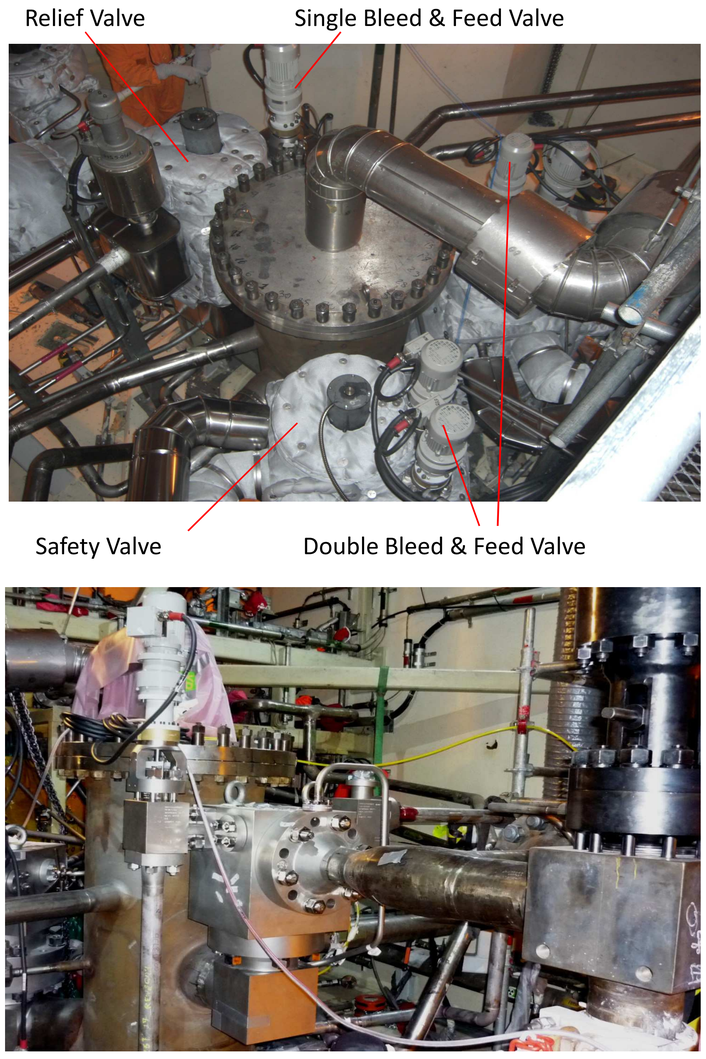

Figure 3-4 : Overviews of the pressurizer Station after Implementation of Bleed & Feed System

Electrical and I&C

PBF I&C and electrical equipment were designed independently and decoupled from the existing equipment according to the process requirements.

2x UPS (Uninterrupted Power Supply) for the PBF pilot valves were delivered together with 2x 220V Sealed lead-acid battery set with rack and battery protection (consisting on 18 blocks with 6 cells each) and also 2x PBF switchgears 380V AC 3ph. 50Hz for the power supply to the PBF bus bars.

In the event of SBO, continued power supply to the PBF pilot valves was always ensured through the UPS system. The fact that the PBF valves were motor-operated was a significant advantage for the battery design capacity.

Figure 5: Electrical Cabinets and Battery Rack

Testing and Evaluation

Hydrostatic pressure tests and functional tests were executed in addition to I&C tests, such as signal distribution and acquisition, and alarm annunciation checks in order to assess the behavior of the PBF components and the entire system.

Reaching the target

PBF implementation, on-site activities, and organizational interfaces harmonization were carried out with high safety standards and awareness in all the phases and by all entities of the project.

"Bleed and feed" systems contribute to the improvement of the plant safety and increase the performance of essential safety functions by relieving and reducing the primary pressure in the case of beyond design events to enable low pressure safety injection and core cooling in the long term.

Further technical considerations associated with process design or system performance can be provided upon request.