NAME: RAULT
COUNTRY : FRANCE
REGISTRATION NUMBER : 1625

GROUP REF. : B4
PREF. SUBJECT : PS1
QUESTION N° : Q1.13

Real-time simulation facility for the Johan Sverdrup Phase2 project

The Johan Sverdrup Phase 2 project is the first multivendor HVDC system that feeds an islanded offshore oil & gas grid.
Utsira High platforms are located in the North Sea, approximately 155 km west of Stavanger, the Johan Sverdrup is among the largest Oil &Gas fields on the Norwegian continental shelf. The field has been developed in several phases. The first phase comprises a field centre with four platforms. The second phase comprises the fifth platform named P2. Electrical power is supplied from shore via DC power cables. The power required for the Johan Sverdrup is supplied by two parallel HVDC links connected to the onshore grid. The two HVDC links have been constructed in two stages. The first link is a 100 MW 2-level VSC HVDC link supplied by Hitachi Energy, in commercial operation since in Q3-2019. The second HVDC link is a 200 MW MMC-HVDC link, supplied by Siemens, in-service since July 2022.

To preserve the intellectual property protecting both VSC technologies involved in this project, a third party (i.e. RTEi) has been selected:

- to specify the functions of a global controller coordinating steady state operation of the overall system.
- to perform the offline Electro-Magnetic Transient (EMT) studies including manufacturers models.

In order to de-risk the parallel operation of Johan Sverdrup HVDC systems, EQUINOR decided to use Hardware In the Loop (HIL) simulations. The main principle of HIL simulation is to include C&P cubicles in the simulation platform instead of using C&P generated models. It is becoming a complementary and mandatory tool for complex interaction studies involving power electronic based devices as discussed in [1]. The main justification to invest in C&P replicas for this project are:

- Long and cumbersome iterative process to analyse and solve interactions in a multivendor system with offline simulation tools
- HVDC manufacturers cannot use a detailed and open offline model of their HVDC system connected in parallel with the second HVDC link. Such open model would help them to better understand phenomena and quickly test adaptations.
- EMT offline models are designed to run simulations within a limited time window (usually 10 to 30s). As a consequence, slow acting controls and protections are usually not included in the offline models (e.g. startup and shut-down sequences are simplified in order to speed up the simulation time).
- The SCADA and especially the Power Management System functions are not available and cannot be easily provided in the offline model. HIL simulation using the replicas is used to validate PMS functionality and for preparation of commissioning.

HIL simulation presents the following advantages for this project:

- C&P replicas offer the opportunity to reproduce conditions of tests similar to the onsite conditions (for instance Human Machine Interface, interlocks, communication delays between the systems …)
- HVDC C&P systems can be updated remotely by manufacturers
- Manufacturers can instantaneously access parallel test records on their system
- The same software code deployed in the onsite control cubicles can be validated
- Possibility to test and validate the communication interfaces and the control sequences coordination with the SCADA system considering realistic scenarios
- Possibility to observe how the system reacts with regards to emergency situation, such as the trip of one HVDC link, where, in combination with the fast active load shedding and gradual load shedding, the other HVDC link shall stay connected.

Simulations with C&P replicas are not the only solution to analyse and solve interactions. They provide complementary functions to the offline models. Offline simulations continue to be performed because they present many advantages

To comply with the confidentiality requirements of each HVDC manufacturer, replicas have been installed in separate rooms with secured access. Remote accesses have been configured. Manufacturers can access their equipment including cubicles and Operator Workstations remotely. This platform offers a unique opportunity to perform detailed analysis of parallel operation, but it requires special care to the following topics:

- Coordination with all manufacturers to respect confidentiality requirements
- Strict tracking of software changes: simulation results depend on the software changes implemented in controllers (HVDC1, HVDC2, PCS/PMS, SyncRelay) and in the real time model. This is particularly sensitive for this project because it is intended to limit software changes as much as possible for HVDC1, which is presently in operation.
- Coordination with HVDC2 standalone tests (Functional Performance Tests and Dynamic Performance Tests) that are done in HVDC2 manufacturer factory before delivery of real cubicles on site. The software changes, required for parallel operation, may impact HVDC2 standalone operation and vice versa. Changes done in both HIL platform shall strictly be coordinated.

A simplified layout of the real-time lab dedicated to this project is presented in Figure 1.

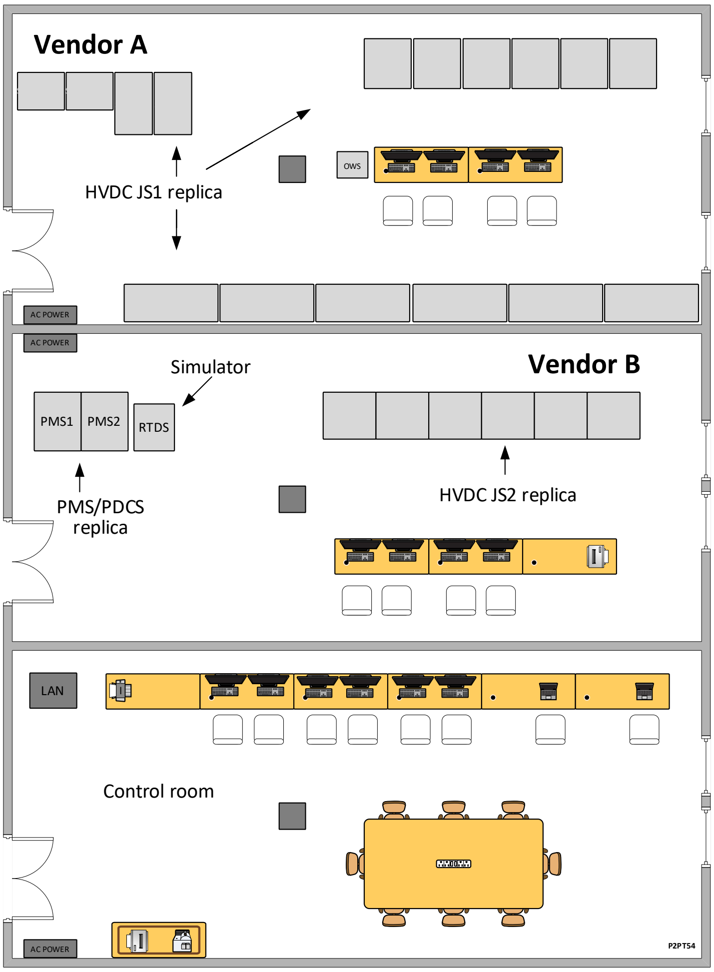

Figure 1 - Simplified layout of the real-time lab dedicated to the JS project

References

[1] S. Dennetière, H. Saad, Y. Vernay, P. Rault, C. Martin and B. Clerc, "Supporting Energy Transition in Transmission Systems: An Operator's Experience Using Electromagnetic Transient Simulation," in IEEE Power and Energy Magazine, vol. 17, no. 3, pp. 48-60, May-June 2019