

MDEP Generic Common Position No DICWG-11

Related to: Digital Instrumentation and Controls Working Group activities

**COMMON POSITION ON DIGITAL I&C SYSTEM
PRE-INSTALLATION AND
INITIAL ON-SITE TESTING**

Participation

Countries involved in the MDEP working group discussions:	Canada, Finland, France, India, Japan, People’s Republic of China, Republic of Korea, Russian Federation, South Africa, Sweden, the U.A.E., the U.K. and the U.S.
Countries which support the present common position	Canada, Finland, France, India, Japan, People’s Republic of China, Republic of Korea, Russian Federation, South Africa, Sweden, the U.A.E., the U.K. and the U.S.
Countries with no objection:	
Countries which disagree	
Compatible with existing IAEA related documents	Yes

Multinational Design Evaluation Programme
Digital Instrumentation and Controls Working Group

**GENERIC COMMON POSITION DICWG NO11: COMMON POSITION ON DIGITAL I&C
SYSTEM PRE-INSTALLATION AND INITIAL ON-SITE TESTING**

Summary:

The Digital Instrumentation and Controls Working Group (DICWG) has agreed that a common position on this topic is warranted given the increased use of Digital Instrumentation and Control (I&C) in new reactor designs, its safety implications, and the need to develop a common understanding from the perspectives of regulatory authorities. This action follows the DICWG examination of the regulatory requirements of the participating members and of relevant industry standards and IAEA documents. The DICWG proposes a common position based on recent experience with the new reactor application reviews and operating plant issues¹.

Context:

Pre-installation tests and initial on-site tests are important stages within the life cycle of digital I&C systems. These tests confirm that the digital I&C systems comply with their requirements and help ensure Nuclear Power Plant (NPP) correct performance under plant states as per safety analysis.

Note: Plant states in the context of this common position refer to:

Operational states: NO - normal operation; AOO - anticipated operational occurrences;

Accident states: DBA - design basis accidents; DEC - design extension conditions

Definition of terms:

Pre-installation testing

Activity to demonstrate that an I&C system or integrated set of systems are in accordance with their specifications and to validate the systems against their requirements to the extent that this is possible outside of the plant environment.

¹ The goal of MDEP is not to independently develop new regulatory standards. Common Positions are not legally binding and do not constitute additional obligations for the regulators or the licensees but are guidelines, recommendations, or assessments that the MDEP participants agree are good to highlight during their safety reviews of new reactors. Any MDEP member may decide to implement the common positions through its national regulatory process.

Initial on-site testing

Activity to demonstrate that the installation of the various I&C systems are in accordance with the applicable specifications and installation instructions and to validate the systems against their requirements within the plant environment under all relevant plant operational states. Within the context of this common position, test activities include testing prior to fuel load, post fuel load, post-criticality and up to full power. Periodic operational testing is outside the context of this common position.

Validation

The process of determining whether a product or service is adequate to perform its intended function satisfactorily [IAEA glossary ed.2007].

Commissioning

Process during which NPP components and systems, having been constructed, are made operational and verified to be in accordance with design assumptions and to have met the performance criteria; it includes both non-nuclear and nuclear tests [IEC 61513].

Generic Common Position on pre-installation and initial on-site testing

1. Testing should be performed in both pre-installation and initial on-site testing stages. The strategy for distribution of necessary tests under different conditions should be developed at the early design stage and documented in a validation test plan. A strategy for staggering validation testing may include steps such as:
 - conduct simulation/emulation tests of safety algorithms,
 - conduct first set of validation tests during pre-installation,
 - conduct second set of validation tests during the initial on-site testing on site.
2. Testing scenarios should address all relevant events based on the plant safety analysis.
3. All test results should be documented and processed in accordance with applicable procedures.
4. Changes to design documents and procedures, and other information relevant to I&C systems, resulting from all testing activities should be documented in accordance with requirements for configuration control.
5. The following should be included in the pre-installation testing stage:
 - 5.1 Verify that results from previous stages of the digital I&C systems life cycle are complete and that open items are resolved and closed.
 - 5.2 Verify that system components, application software, and subsystems have been properly configured.
 - 5.3 Verify that the system hardware and software are properly integrated in accordance with I&C design specification and final assembly configuration.

- 5.4 Perform pre-installation testing in accordance with test procedures which include defined acceptance criteria.
 - 5.5 Test system behaviour by conducting static and dynamic simulations of the plant as appropriate. These tests help validate the correctness of the system design.
 - 5.6 Test results should be used to help confirm system response to potential internal faults (e.g., hardware, data communication links, loss of internal power supply).
 - 5.7 Test results should be used to help confirm system response to potential external faults and abnormal behaviour of external systems (e.g., interfaces, loss of external power supply, electro-magnetic interferences, loss of heating, ventilation and air conditioning, abnormal voltage and frequency variations).
 - 5.8 Test all relevant digital I&C system requirements (including other performance requirements and quality of service characteristics) that can be performed at this stage. These tests should also address relevant requirements for human factor considerations.
 - 5.9 Test for potential systematic design vulnerabilities. Examples of such tests include: processor stress test, stability tests.
 - 5.10 Confirm that analysis or inspections are provided to complement testing as appropriate to justify conformance to system requirements and performance.
 - 5.11 Ensure the equipment used for test is properly calibrated and configured.
 - 5.12 Credit may be taken for pre-installation test results of replicated I&C systems, including those used in multiple NPP units, as long as equivalency is demonstrated and operability of hardware and correctness of software loading is confirmed. Any deviation from the replication should be verified and their impact fully assessed.
6. The following should be included in the initial on-site testing stage:
- 6.1 Perform initial on-site testing in accordance with test procedures with defined acceptance criteria
 - 6.2 Verify that the system delivered on site corresponds with the system tested during pre-installation test.
 - 6.3 Verify that the system meets its functional and performance requirements that were not verified during pre-installation testing. Tests performed during pre-installation testing need not be fully repeated during initial on-site testing if test equivalence can be demonstrated.
 - 6.4 Before digital I&C systems are declared fully operational, perform the following activities:
 - 6.4.1 Test all interfaces (e.g., assessment of accuracy of plant response to system actuation, accuracy of providing information to operating personnel, accuracy of information being archived).
 - 6.4.2 Confirm that environmental conditions, including electromagnetic conditions, are compatible with correct operation of digital I&C equipment.

- 6.4.3 Verify that the I&C design principles (e.g. redundancy, independence, diversity, protection against CCF, implementation of defense in depth) are correctly incorporated as part of the overall I&C systems integration.
- 6.4.4 Verify the physical installation of the I&C systems.
- 6.4.5 Verify the installation of I&C systems against NPP site specific design characteristics.
- 6.4.6 Confirm integration of I&C systems and human machine interfaces performance of the Main Control Room and supplementary control rooms.
- 6.5 Perform all initial on-site test activities that should be done prior to fuel load to confirm integrity and operability of digital I&C systems. After fuel loading, perform the remaining initial on-site test activities whose testing requires loaded fuel (e.g., calibration of neutron flux measurement channels).
- 6.6 Confirm that initial on-site tests address the relevant principles and objectives defined in the commissioning programme, including a step by step approach to full power.
- 6.7 All test results should be documented and processed in accordance with applicable procedures.

References

- Seven party report titled “Licensing of safety critical software for nuclear reactors”. Common position of seven European nuclear regulators and authorised technical support organizations.
- Four Party Regulatory Consensus Report On The Safety Case For Computer-Based Systems In Nuclear Power Plants, November 1997.
- IEC 61513 Rev.2 2011-08.
- IAEA NS-G-2.9
- IAEA SSR 2/1
- IAEA Safety Glossary Terminology Used in Nuclear Safety and Radiation Protection, Edition 2007.