Provisional	Life Cycle Management Approaches for Nuclear Facility Instrumentation and Control (I&C)
Title	Systems

## 1. RATIONALE

I&C for nuclear facilities need to ensure that objectives for functionality and high dependability performance can be satisfied whilst delivering against tight schedules and budgets. Many modern I&C systems that utilize digital technologies can be characterized as highly complex and, as such, this can present additional challenges for developers and operators to meet demands for regulatory assurance of high levels of safety and security whilst demonstrating cost effectiveness for major new build and modernization projects. The adoption of a life cycle management-based approach to I&C systems in an engineering context is recognized to be an effective approach in helping to resolve challenges associated with system complexity. In practice the introduction of life cycle management principles at the conceptual design and development stage of system development is essential to ensure that key requirements for safety, security and operability applicable to I&C systems are satisfied. Adherence to these principles can be used in subsequent operational phases of a nuclear facility to provide an effective contribution towards satisfying safety and security objectives. This approach is intended to support I&C systems throughout all engineering life cycle phases in addressing operability and utility issues that can be informed by innovative approaches for modelling, simulation, requirements capture and specification, and system verification and validation in order to establish and maintain an I&C system's configuration baseline.

The role of life cycle management can influence the design of I&C systems and their capability in satisfying requirements for a nuclear facility using innovative approaches for modelling, simulation to support system validation and, where necessary, capability development in these areas to help establish and maintain the I&C systems configuration baseline throughout all engineering life cycle phases. In addition, the role of I&C engineers within organizational frameworks for life cycle management in terms of activities for their establishment and maintenance needs to be clarified. The specification and design of I&C systems, including those important to safety and security, need to take the entire life cycle into account at both system and facility levels.

## 2. OBJECTIVE

The aim of the publication is to provide an overview on the current knowledge, up to date good practices, experiences, benefits, and challenges related to the approaches for I&C systems life cycle management. This includes the coordination of life cycle management methods applied to I&C systems and those applicable to any safety systems that they might interconnect or otherwise interface with. The report is intended to be used by Member States to ensure that appropriate considerations are made to support the introduction of life cycle management approaches for all relevant stakeholders involved in the development of I&C for nuclear facilities and to discuss how these activities can support their safe, reliable, and long-term operation.

## SCOPE

Areas within the scope of this publication include:

 $\cdot$  The role and introduction of life cycle management within an I&C system engineering methodology for nuclear facilities; interconnections between the I&C lifecycle, the NPP lifecycle and the licensing lifecycle will also be discussed.

 $\cdot$  A model-based framework for a life cycle management applicable to the development of I&C systems, including those based on digital technologies, and the activities associated with its management in new build development and modernization projects.

 $\cdot$  The application of innovative technologies (e.g. digital twins, simulation and development tools used for requirements traceability, design support, system validation and virtual commissioning) in supporting I&C systems' development and ongoing optimization throughout their life cycle.

 $\cdot$  Methodologies and tools that can be used for the development of functional requirements and their specification, including approaches for requirements capture and verification.

• Regulatory/licensing aspects, including operator training and alignment with associated safety documentation for I&C systems.

· Lessons learned from practical I&C development experience (previously completed projects, proven practices, etc.), including case studies related to I&C systems' development in both nuclear new build and modernization projects.