PRE-OPERATIONAL SAFETY REVIEWS

A GUIDELINE TO SUPPORT NUCLEAR OPERATORS WITH SAFE START-UP AND INITIAL OPERATION OF A NEW NUCLEAR POWER UNIT.

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New Unit Assistance Industry Working Group
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1. Introduction

1.1 Background & Purpose

This guideline was developed by the New Unit Assistance Industry Working Group (NUA I-WG) to support nuclear operators with the safe start-up and initial operation of new nuclear power units. *The NUA I-WG is a group of nuclear professionals who are engaged with new plant operations.*

The purpose of this guideline is to provide practical implementation guidance for pre-operational safety reviews. Such reviews include the IAEA Pre-Operational Safety Review Team (Pre-OSART) mission and the WANO Pre-Startup Review (PSUR) for new build nuclear power plants.

This guideline is based on experience gained and documented in the industry document "Roadmap to Operational Readiness" (R2OR) - which presents a collection of success stories, lessons learned and is referencing applicable internationally recognised and approved standards - and in-line with the intent of the IAEA Safety Standards.

Many models and different organisational arrangements exist for construction and commissioning of a new nuclear power unit, and all of them can be effective. Careful consideration has been given to ensure that this guideline accommodates the needs of all WANO members and IAEA member states, either progressing with their first nuclear project, or creating a new operational company in a country with a mature nuclear power industry. This guideline was developed using input from international experts experienced in and familiar with construction and commissioning of new units, as well as with the best international standards across the WANO members and IAEA member states.

A NUA I-WG gap analysis identified the need for practical implementation guidance for pre-operational safety reviews for new entrants. However, limited guidance and good practices exist for the implementation of these pre-operational safety reviews for plant managers.

Practical implementation guidelines do not exist to support plant management in the preparation, conduct and follow-up of these pre-operational safety reviews. Current guidance is aimed at use by IAEA and WANO professionals but not plant management. Lessons learned from new units who experienced Pre-OSARTs and PSURs have not been systematically captured at an industry level and are thus not easily available for new entrants.

The OSART Mission Results (OSMIR) database contains the results of derestricted OSART missions and their follow-up visits from 1991 onwards. This database is shared on request with organizations and individuals in the nuclear industry. New units may not be familiar with this database.

The WANO member website contains the results of operational Peer Reviews with some results on Pre-Startup Reviews (PSURs). This database is not available to non-WANO members and newcomers who may not yet be WANO members.

1.2 Scope

It is expected that this guideline will be used primarily for nuclear power plants designed for commercial purposes.

In most IAEA Member States, the operating organization is the legal entity responsible for safety and for financial and commercial obligations, as well as for other obligations that are connected with the operation of a nuclear power plant. This Guideline is solely concerned with those responsibilities and obligations that are necessary to ensure the safe operation of the nuclear power plant(s) under the control of the operating organization.

IAEA Pre-Operational Safety Review Team (Pre-OSART) missions are conducted during the commissioning phase. The aim of the mission is to assist the utility in achieving highest standards of commissioning and readiness for safe operations. Pre-OSART missions are ideally conducted within six months before the first fuel load, after plant processes and procedures affecting safety have been established, plant staff recruited and trained, and some systems have moved to a pre-operational or full operational state. This allows the review to focus on the state of the plant's preparations for initial fuel load, reactor start-up and operation.

WANO Pre-Startup Reviews (PSURs) are conducted during the pre-operational phase to assess the operational readiness of new units. The PSUR of new plants preparing for commercial operation are typically scheduled after completion of the hot functional tests, i.e., one to two months before the first core loading. Although some programmes and processes may not be fully operational at the time of the PSUR, plans should be sufficiently defined and implemented such that operational readiness can be determined in support of major milestones, including fuel load, start-up and eventual full-power operation.

2. An Overview of Pre-Operational Reviews

This guideline addresses the practices used in planning and executing pre-startup reviews versus those methods used during operational peer reviews by WANO and the IAEA. Both WANO and the IAEA have extensive guidance assisting newcomer nuclear companies in the construction, commissioning, and preparation for future plant operation of new units.

Broad and exhaustive lists of valuable resources and guidance can be found on these websites:

- https://www.iaea.org/ (publicly available)
- https://members.wano.org/ (accessible for WANO Members only)

2.1 Purpose of Pre-Operational Reviews

Pre-Operational reviews are conducted by WANO and/or the IAEA to assess the readiness of a new unit to start safely and reliably. There are numerous benefits for new units in conducting pre-operational reviews. They provide:

- The host organization with an opportunity to improve their performance based on recommendations and suggestions, and to enhance operational safety of their nuclear power plant(s) and closely related organizations.

- The host organization with an opportunity to review its conformance and alignment with relevant safety standards and performance criteria, and identify possible self-identified issues by conducting a self-assessment during the preparation phase prior to the review.
- The host organization with support for their continuous improvement of operational safety (through capacity building) for self-identification, self-analysis, and self-resolution of issues having an impact on operational safety.
- The CEO of the host organization with an independent accurate picture of operational readiness.
- Other WANO members and IAEA Member states with generic information regarding areas for improvement and good practices that could be used to improve performance at other sites.
- WANO and IAEA staff with an opportunity to identify areas where their own safety standards and criteria could be further strengthened.

An IAEA Pre-OSART also provides the host country (regulatory body, operating organization, holder of the operating licence and governmental authorities) with an objective and independent assessment of the status of operational safety with respect to the IAEA safety standards. A WANO PSUR could provide similar confidence to regulators if the host organization shares the results within the guidelines of its WANO membership obligations.

2.1 Types of Pre-Operational Reviews

- **WANO Pre -Startup Review (PSUR)**

  A PSUR forms part of WANO members' obligations to host and support peer reviews of member organisations. At a time agreed with the utility, but usually between the end of Hot Functional Testing (HFT) and the first fuel load, WANO will conduct a PSUR at each new unit. Using the Performance Objectives and Criteria (PO&C) as a basis, the PSUR team will review the areas necessary for the safe and reliable operation of the plant during and following the start-up process. They will also verify that certain key processes are in place.

- **IAEA Pre -OSART Review**

  Operational Safety Review Team (OSART) Reviews form part of the IAEA's safety review services. The main purpose of the IAEA's OSART programme is to assist Member States in strengthening the operational safety of their nuclear power plants and closely related organizations by comparing actual practices with the IAEA safety standards. Each OSART mission is conducted by a team of experts from all regions of the world. The OSART programme is an important tool for ensuring better conformance and alignment with the IAEA safety standards, related to operational safety of nuclear installations. An OSART review can also take place at a nuclear power plant project at the main commissioning phases when many organizational and technical decisions are being taken that will affect operational safety performance of the nuclear power plant or closely related organization – this is known as a Pre-Operational OSART (or Pre-OSART). [OSART guidelines 2022 Edition]. A pre-OSART mission comprises the same scope (areas) as an OSART mission based on the same pre-requisite (Safety Standards) with an additional specific focus on commissioning (COM area).

2.1 Basic Overview of Pre-Operational Reviews

Pre-Operational Review	Conducted by	When	Criteria assessed against	Initiator	More Information
PSUR	WANO	To be agreed with the utility, but usually after HFT, before first fuel load	PSUR PO&Cs	WANO membership obligation *	WPG 06
Pre-OSART	IAEA	Usually within 6 months of first fuel load	IAEA Safety Standards Series	Requested by the Member State	OSART Guidelines

** For units that have a pre-OSART, some WANO personnel may participate and the results of the pre-OSART may be used by the Regional Centre (RC) to modify the scope of the PSUR based on the timing and results from the pre-OSART provided the report is available to the RC for review. Therefore, based on the results and timing of the pre-OSART, the PSUR scope can be optimised, with approval of the RC director.*

3. Roles and Responsibilities

3.1 Pre-Operational Reviewers

3.1.1 Approach and Principles

The approach of the review is to assess the readiness of a new unit to start safely using pre-operational standards, objectives and criteria, as appropriate for the type of visit. The reviewers apply the same peer review principles used for operating nuclear units, specifically regarding nuclear safety culture attributes. The focus is on nuclear safety. Reviewers and team leaders are in the plant with the people and equipment, observing important plant activities. Key events and plant performance are thoroughly understood. Conclusions and assessments are grounded in facts. Review teams build strong professional relationships with station counterparts. The review team is prepared well before arriving on-site. Reviewers reinforce the integrity of the review process. The desired outcomes of a fair and thorough pre-operational review portray an accurate picture of new unit readiness to start-up.

3.1.2 Pre-Operational Team Leader

The team leader (TL) is responsible for the overall conduct of the pre-operational review. They coordinate and liaise with the host utility, the host plant, and they train and lead the teams to help ensure coherent and consistent reviews. They provide nuclear power plants with objective evaluations of performance, comparing results with industry-developed performance objectives and supporting criteria. They fully leverage the collective knowledge and experience of team members. They establish effective working relationships with senior station managers. They develop team members and others using effective coaching, mentoring and feedback.

3.1.3. Composition of the Pre-Operational Review Team

The pre-operational review team comprises reviewers for each of the review areas. Industry peers and experts from around the world are included as part of the review team.

Reviewers are familiar with the unique challenges associated with an evaluation of a nuclear plant preparing for first core load and plant operations. Unlike a review at an operating plant where team members focus on all aspects of plant operations, a pre-operational review is strategically focused on

reviewing the readiness of the station to transition from a construction site to an operating nuclear plant. Also, pre-operational review team members focus on safety system readiness and performance, with minimal focus on the plant's secondary systems and equipment.

3.1.4 Scope

Pre-operational reviews can include the following areas:

- Leadership and management for safety
- Operations
- Maintenance
- Chemistry
- Engineering
- Radiological Protection
- Training and Qualification
- Organisation & Administration
- Plant Status and Configuration Control
- Work Management
- Equipment Performance and Condition
- Operating Experience
- Fire Protection
- Emergency Preparedness
- Accident Management
- Commissioning

WANO Areas	**IAEA Areas**
Organisation and Administration Industrial Safety (Part of Fire Protection)	Leadership and Management for Safety Operating Experience Feed-back
Training	Training
Operations Plant Status and Configuration Control Fire Security and Safety (Part of Fire Protection)	Operations
Maintenance Work Management	Maintenance
Engineering Plant Status and Configuration Control	Technical Support
Chemistry	Chemistry
Radiological Protection	Radiological Protection
Emergency Preparedness and Response	Emergency Preparedness and Response Accident Management
	Commissioning

3.1.5 The Pre-Operational Review Methodology

The pre-operational review teams assess the readiness of a new unit to start up safely based on document reviews, interviews and field observations.

Most plant information is reviewed using the Advance Information Package (AIP) provided to the reviewers prior to the onsite visit, including the results of the plant's self-assessment. Each reviewer may request additional information as issues emerge.

Reviewers conduct interviews with plant personnel to provide an opportunity for important information to be exchanged resulting from the documentation review and field observations.

Direct observation of work activities and plant conditions is an important part of the review process. The field observations include nuclear and industrial safety practices, use of procedures, use of quality control measures, supervision and management and the control of work. Much of the onsite review period is generally spent in the field, observing activities and the environment in which they are conducted. Plant counterparts are essential to verify that the reviewers' observation notes are correct. They also help reviewers to ensure that they correctly understand the written material, which might have been translated, and that the practices observed were representative of the way that the activity is normally carried out.

3.1.6 Initial Station Contact

The pre-operational review Team Leader (TL) will liaise with the utility. The TL arranges a preparatory meeting with the plant management to familiarize them with the pre-operational review methodology and to discuss any arrangements that need to be implemented prior to the review visit.

The preparatory meeting is held at the plant before the start of the review visit and lasts two to four days. The meeting agenda includes discussions on the exact scope of the review, the plant's preparations, the logistical arrangements for the review visit, and an update on the plant's self-assessment.

The meeting includes a seminar for the plant counterparts to highlight the pre-operational review methodology and the various techniques to be used during the review visit. This visit will familiarize the team leader with the station management team and provide opportunity to conduct some field visits for an initial onsite review of the unit readiness for fuel load and initial criticality.

Strong working relationships are developed between reviewers and station counterparts during the preparation phase through counterpart phone calls. These preliminary dialogues focus on review plans and gaps identified during information analysis.

In general, teams will usually meet and sequester in country and/or on site. Prior to arrival at the host station, the station will have submitted an advance information package (AIP) for team review. Team members review the AIP so that they understand and analyse the available information. The team is trained on the use of pre-operational performance objectives and criteria (PO&C). Prior to their arrival onsite, the reviewers identify potential gaps against the performance objectives using the information provided by the host station.

3.1.7 Simulator Observation (WANO Only)

The operations reviewers conduct a simulator observation of operating crew performance. The reviewers will develop areas for improvement (AFIs) as needed during their visit and will debrief any AFIs before leaving.

3.1.8 Conduct of the Review - Early Visits (WANO Only)

In cooperation with site management, core team members can conduct functional area visits at the appropriate preoperational/startup/testing milestones. The team can write areas for improvement (AFIs) and recommendations during these early visits. An area for improvement (AFI) is a significant gap to operational readiness at the new unit, where improvement is required to address actual (or the high potential for) adverse effects on plant safety and/or reliability. Early visits could include the following: implementation of important programs such as equipment reliability or emergency planning; operations behaviours during commissioning and hot functional testing, including clearance and tagging; engineering participation during turnover of important systems.

3.1.9 Conduct of the Review - On-Site Activities

A typical pre-operational review is usually a few weeks on site and activities are conducted in accordance with pre-operational review schedules. An entrance meeting with senior plant management and the plant counterparts is held. The reviewers join their plant counterparts to review the schedule and request any additional information required. A plant tour is carried out in several groups, with the aim of covering as many premises as possible and identifying any areas for further investigation.

For the duration of the on-site visit, the reviewers conduct individual, group interviews, and field observations. At daily review team meetings, all reviewers share notes and exchange information on facts or concerns identified. Through discussion, the review team develops a consensus on emerging issues.

The reviewers hold daily briefings with their station counterparts. Observations are discussed with counterparts and the observations are provided to counterparts for fact-checking and validation. Issues are discussed with counterparts as they develop.

Most activities during the review will validate that programs, processes and procedures meet pre-operational standards and objectives. When available, observations of field activities should occur. These observations focus on determining if the organizational transition will result in a nuclear safety and operational focus mindset. Most activities are conducted in accordance with pre-operational review timelines. The latter portion of the review focuses on the development of AFIs with station counterparts' input and insights.

The team leader informs the plant management daily on the progress made. Areas for improvement, recommendations and suggestions are discussed as they emerge. The last days of the review visit are reserved for closing any open topics, completing observation notes and discussing them with the station counterparts. Each reviewer drafts a summary of their area for presentation at the final onsite debrief meeting.

The review teams apply the latest pre-operational review standards and objectives based on observed performance, interviews and data reviews including people, plans, programs, processes, procedures, and schedules with emphasis on operational readiness. Programs and processes that support many of the standards and objectives might not be functional at the time of the review. However, station management plans should have sufficient detail so that the team can characterize progress toward operational readiness and in support of major milestones, for example, the transfer of systems to Operations. These include initial criticality, startup and eventual full-power operation. Furthermore, the team will make recommendations based on its insights regarding preparation for operational readiness.

3.1.10 Results – Areas for Improvement, Recommendations, Suggestions

The objective of pre-operational safety review teams is to identify any gaps against to the pre-operational standards and objectives. For WANO, a gap is called an Area for Improvement (AFI). For the IAEA, gaps are called either Recommendations or Suggestions. The review is focused on the identification of gaps in the new unit's readiness to start-up and operate safely and reliably. Any gap that the review team believes should be considered as safety significant will be briefed at the earliest opportunity. Safety significant gaps should be corrected before initial approach to criticality. A safety significant gap is a result that, based on the scope and significance of the gap, represents a discernible threat to nuclear safety if it is not resolved prior to the reactor reaching fuel load or first criticality.

The review team develops gaps to operational readiness. These gaps focus on issues challenging nuclear safety — for example, a station lacks a reactivity management program. The team debriefs the site leadership team on the nature and context of the results before departing the station.

3.1.11 Reporting the Results

While on the site, the reviewers record their observations and conclusions. These are discussed in detail with the plant counterparts and combined into observation reports or technical notes, which are shared with the host plant as a preliminary report of the results. The reviewers develop gaps to operational readiness. The gaps form the basis for the team leader's preparation of the report that is briefed to the utility's chief executives and senior plant management at the exit meeting. The final pre-operational review report is the official report that includes the results of the mission.

The final report summarises those gaps that have the greatest effect on the transition to an operational mindset, that influence key milestones and overall operational readiness, or that pose a higher risk to continued safe operation after fuel load. The report includes areas for improvement, recommendations, suggestions for improvements and identifies good practices for consideration by other nuclear power plants. Follow-up visits may be conducted to determine the status of proposals for improvement, to comment on the appropriateness of the actions taken and to make judgements on the degree of progress achieved.

3.2 The Roles and Responsibilities of Plant Management

3.2.1 Approach and Principles

Plant management provides the governance and oversight required for the preparation, conduct and follow-up of pre-operational reviews. Management standards and expectations are clearly stated in the organization's approach for the commissioning and start-up of the new unit.

The organization's approach for pre-operational reviews is based on the IAEA and WANO guidelines. IAEA OSART Guidelines gives guidance on how to prepare for and conduct an OSART mission to the host country that has invited the OSART mission and to the team members of the mission. WANO Programme Guidelines gives guidance on how to prepare for and conduct a PSUR for the new unit.

3.2.2 Initiating a Pre-Operational Review

For an IAEA Pre-OSART mission, a Member State requests an OSART service for the new unit in a letter transmitted to the IAEA Deputy Director General and Head of the Department of Nuclear Safety and Security 18–24 months before the envisioned mission.

For a WANO PSUR, the utility CEO requests a PSUR for the new unit in a letter to the WANO Regional Center Director 18-24 months before the envisioned review.

3.2.3 Plant Preparations

To prepare for the pre-operational review visit, the plant will prepare an Advance Information Package (AIP) and conduct a self-assessment. It will also designate plant counterparts for each review area, a host plant peer and organize logistical support.

3.2.4 Advance Information Package (AIP)

To enable the pre-operational review team to perform effectively and efficiently while on-site, the nuclear power plant prepares an advance information package (AIP) and sends it to the team leader at least one month prior to the review visit. The package highlights the plant organizational structures, current operational practices, approach to operational safety, key operational features and safety performance indicators and the general design. The AIP also includes the results of the pre-operational self-assessment of the review areas.

The standard requirements for the structure and content of an advance information package are provided by the team leader to the station. The advance information package (AIP) is prepared by the nuclear power plant hosting the review visit to convey information relevant to the team members for the preparation of their review.

The workload in preparing the package should be minimized. The compilation of the information should be based on and/or utilize existing documents such as routinely prepared reports, available procedures, and training materials. Focus on the content with limited effort on editing is encouraged. All descriptions in the package should be in English as this is the IAEA and WANO working language.

See Appendix 2 for an example of an advance information package list.

3.2.5 Host Interface Representative (WANO) or Host Plant Peers (IAEA)

The plant is requested to designate a host interface representative/host plant peer. They are usually a senior plant staff member with good overall knowledge of plant programmes, practices, and staff. They act as liaison officer between the plant and the pre-operational review team. They provide presentations on project status, program development, functional area transition plans and the system turnover process. They participate as full-time members of the review team. They participate in team meetings and activities during the review visit and advise the team when needed. They facilitate communication between the reviewers and the station counterparts and help ensure complete and accurate understanding of facts, perspectives, and conclusions. In case of misunderstandings or issues needing further clarification, the host peer finds the responsible plant staff to enable further dialogue to address any matter of concern. They challenge the review team in and outside of meetings to help validate accuracy and perspective, without defensiveness. After the review, host peers remain a resource to station management to provide continuity, help develop corrective actions, and confirm effectiveness of corrective action plans.

3.2.6 Plant Counterparts

The plant is requested to designate a plant counterpart for each review area. Station counterparts, including senior plant officials, serve as contact persons for their associated reviewers and provide any needed coordination with support staff. The station counterpart is the most senior manager of a review area. As such, the counterpart is responsible for the accurate and timely assembly of the advance information package (AIP) for their area. Strong working relationships are developed between reviewers and station counterparts during the preparation phase through counterpart phone calls. These preliminary dialogues focus on review plans, interview and observation schedules,

and gaps identified during information analysis. During the onsite visit, the reviewers hold daily briefings with their station counterparts. Observations are discussed with counterparts and the observations are provided to counterparts for fact-checking and validation. In case of misunderstandings or issues that are difficult to resolve with the reviewer, the counterpart raises the issue with the plant manager to address with the team leader. Any emerging Areas for Improvement (AFIs), Recommendations or Suggestions are discussed with counterparts as they develop. The latter portion of the onsite visit focuses on the reviewer's development of any gaps with the station counterpart's input and insights.

4. Plant's Main Steps for Review Preparation

4.1 Preparation Plan

Preparations for pre-operational readiness reviews form part of the plan for readiness for fuel load and initial criticality and eventual commercial operations. The review is a predecessor to the ability to load fuel. Any safety significant areas for improvement would be remedied prior to fuel load or any other significant milestone such as initial criticality. New fuel receipt can occur independently of pre-operational review scheduled activities. The desired outcome for pre-operational reviews is no safety significant Areas for Improvements (AFIs) or Recommendations. If any safety significant gaps are identified during the review, then demonstrable proactive steps will be taken to close any of them before they can affect fuel load and initial criticality. A due date will be established for a response from the new unit management prior to the associated startup milestone for each of the safety significant gaps (if identified). For example, some gaps may require resolution before fuel load while others may be linked to other milestones, such as initial criticality. Although some programs and processes may not be fully operational at the time of the review, plans should be sufficiently defined and implemented such that operational readiness can be determined in support of major milestones, including fuel load, start-up and eventual full-power operation.

4.2 Sponsorship and Resourcing of a Preparation Team

Management mobilizes a station-led preparation team approximately 18 months before the review to coordinate self-assessments in all the review areas against the pre-operational review standards and performance objectives. A preparation team becomes the forcing function to keep the functional areas engaged with preparations for the pre-operational review amidst a strenuous major project schedule for the commissioning of the new unit, in line with an operational readiness schedule.

The preparation team establishes the governance, oversight, support and perform activities for the pre-operational review process. Station roles and responsibilities are clearly defined. The 18-month schedule is developed with station engagement. An approved resource plan is developed. Project milestones and KPIs are established, monitored, and reported at project meetings. Risks and mitigation strategies are tracked in a project risk register. A communication plan is developed and implemented for healthy stakeholder management with internal and external stakeholders.

The preparation team ensures high quality, self-critical self-assessments are conducted in all review areas, which may include: Organizational Effectiveness (including Nuclear Safety Culture and Industrial Safety), Operations, Maintenance, Work Management, Engineering, Radiological Protection, Operating Experience (including the Corrective Action Program), Chemistry, Training, Fire Protection, and Emergency Preparedness.

4.3 Roles and Responsibilities of the Preparation Team

The preparation team coordinates with the review team leader on the following:

- Manage the review team's logistical needs – country access requirements, station access and badging requirements, export control rules, unescorted access, workstations, internet access, accommodation, travel, transport.
- Deliver AIP documents to the team leader at least one month before the onsite visit.
- Arrange initial visits including assistance visits, operational readiness assistance, the team leader pre-visit, operating crew performance observations on the simulator.
- Schedule the onsite visit meetings, interviews and field observations.
- Arrange the in-country sequester week, if required.
- Arrange the onsite visit, including entrance and exit meetings.
- Coordinate the station's responses to the report.
- Arrange the Exit Meeting with utility executives and senior station management.

The preparation team coordinates with station management on the following:

- Coordinate and conduct the self-assessments against the pre-operational review standards and performance objectives with the line organizations.
- Support, coach and mentor the self-assessment leads, counterparts and host peers.
- Coordinate and conduct readiness review boards (management challenge sessions) with each station counterpart.
- Track and trend self-identified gap resolution prior to the pre-operational onsite visit.
- Collect the Advance Information Package (AIP) from each counterpart.
- Coordinate and conduct station counterpart and reviewer calls prior to the onsite visit.
- Ensure that appropriate action is applied to independent oversight findings.
- Ensure that appropriate action is applied to operating experience recommendations.
- Use lessons learned from previous pre-operational reviews at other new units globally.

Preparations for a pre-operational review benefits from a dedicated team to provide the structure and oversight of the preparation activities and station counterparts to assure high quality self-assessments and corrective action plans to avoid safety significant areas for improvement that may adversely impact safe and reliable start-up of the new unit.

5. Pre-Operational Review Schedule

5.1 Schedule Ownership

Management establishes a fuel load readiness control mechanism that provides the framework within which the pre-operational reviews are scheduled. This mechanism is typically the new unit's project command center. This command center leads the execution of a high confidence fuel load schedule,

to deliver all activities necessary to achieve the dates for Fuel Load and Commercial Operations of the new unit. The command center drives schedule development and compliance, enforces deadlines, and directs resources as required. The command center provides guidance and support for schedule owners and their teams, to plan, develop and deliver their schedules.

Schedule ownership is assigned to station counterparts. Functional area counterparts are assigned for Operations, Maintenance, Engineering, Work Management, Chemistry, Radiological Protection, Fire Protection, Operating Experience (including Corrective Action Program), Training, Emergency Preparedness, Organizational Effectiveness (including Nuclear Safety Culture and Industrial Safety). The functional areas under review are specified in the IAEA OSART and WANO PSUR Guidelines.

5.2 Schedule Framework

As with any large-scale project, the scope details mature over time and the schedule is updated accordingly. Ongoing engagement with the pre-operational review team leader is required to maintain the schedule logic. Contingency measures are used for the resolution of safety significant areas for improvement prior to fuel load or initial criticality.

The Level 1 schedule shows the pre-operation review schedule as highly visible within the baseline schedule for the new unit's fuel load and commercial operations dates.

The Level 2 schedule shows the Activity IDs, Remaining Duration and Start & Finish dates for the pre-operation review activities.

The Level 3 schedule is vital for the work breakdown structure for the pre-operation review activities. The expectation is that Level 3 activities generally have durations less than or equal to the schedule progress update cycle, for example, 7 days. This allows project controllers and management to effectively monitor progress and schedule adherence. Level 3 Schedule Build-Out relates to establishing the activities at the lowest level within the schedule, which will support and guide day to day execution of scope for the pre-operation review preparation, conduct and follow-up activities.

5.3 Guiding Principles for the Schedule

No compromise to Nuclear Safety and Quality - Nuclear Safety and Quality remain the highest priority and must be maintained in the development of schedules.

'One Team' Approach – stakeholder companies jointly develop schedules and have input in schedule revisions, including input from vendors where necessary.

Systematic Approach - Schedules are developed using a consistent, systematic approach across all work streams. The underpinning approach, "how to" guide, checklist and templates are produced.

Deterministic Schedule - Schedule is built with full scope, realistic activity durations and activities logically sequenced to determine the end date. No artificial targets or constraints.

Ethos of Realism - All schedule durations are based on current performance and available resources. No aspirational or unproven estimates. Work stream leads are signed up to and have full ownership of the schedule.

Full Scope - All areas of known scope are added including those previously accounted for only in the risk register. For areas of potential future discovery, conservative assumptions applied to the schedule and added to risk register for ongoing validation. Contingency added to areas of uncertainty to ensure schedule credibility.

6. Methods for Review Preparation

6.1 Self-assessments against reference documents

For each review area, perform a self-assessment on how pre-operational review standards and performance objectives are met. Identify specific gaps where performance or programmes do not fully meet pre-operational review standards. For each self-identified area for improvement, describe the corrective actions being taken/planned to close the gap, including leadership actions, resourcing, document development, training, equipment-related actions, etc.

Conduct self-assessments using the pre-operational review resources and guidelines available on the WANO and IAEA websites.

6.2 Conduct of Self-Assessments

Self-assessments are conducted to determine the gaps against the pre-operational review standards and performance objectives and implement corrective action plans to mitigate any potential safety significant gaps and conduct effectiveness reviews of action closure. The following guidelines are useful to ensure the conduct of quality self-assessments:

- Conduct self-assessments in line with the company's procedure for each functional area to self-identify areas for improvements against the pre-operational review standards.
- The preparation team members provide support and guidance in the conduct of the self-assessments, necessary causal evaluations resulting from self-assessments, and development of corrective action plans.
- Counterparts ensure quality self-assessments, effective corrective actions, and quality readiness reviews (management challenge meetings).
- Assign dedicated self-assessment leads and teams for each of the functional areas under the pre-operational review. For example, the self-assessment will be conducted by a team of approximately 2-3 persons, one of which is required to be self-assessment team leader qualified. The size of the team is also dependent on the scope of the review, that is, the number of performance objectives for an area.
- The self-assessments incorporate the operating experience from previous pre-operational reviews at other new units as appropriate to avoid known areas for improvements or recommendations and to gain efficiencies.
- The conduct of the causal evaluations is dependent on the significance of the identified issues. Additional subject matter expertise may be required for potential safety significant gaps.
- For each area for improvement, use a systematic technique to assist in the development of gap statements, drivers and actions to address deviations from expected levels of performance and to obtain measurable results.
- When developing corrective actions for self-identified areas for improvements, identify the 'what and how' of a performance gap and systematically identify actions to address the gap.
- Monitor the implementation of corrective actions. There is on-going level of effort work required for periodic self-assessment status meetings, and readiness review boards.
- Determine the significance of the risks associated with the self-identified areas for improvements from the station's self-assessments for a safety significant gap.
- If a self-assessment self-identifies a safety significant gap, dispatch a team of experts promptly to analyze causes, develop and implement corrective actions, and demonstrate effectiveness such that any such areas for improvements can be resolved before fuel load or initial criticality.

In general, an area for improvement has the potential to be a start-up risk if it is a nuclear safety risk for fuel load and initial criticality. The following questions will aid in determining if a self-identified area for improvements may be safety significant:

- Is it a significant nuclear safety issue which must be resolved before fuel load?
- Is it a constraint for loading fuel?
- Is it a nuclear safety related corrective action that cannot be implemented before fuel load?

If a self-identified area for improvement is determined that it may be safety significant, develop corrective actions, owners and due dates, and ensure effective closure of corrective actions before fuel load date.

In summary, there are several industry lessons learned for the conduct of effective self-assessments in preparation of pre-operational reviews:

- Knowledge of the pre-operational review standards and processes
- Review of previous functional area self-assessment reports
- Review of previous causal evaluation reports
- Knowledge of previous review findings
- Management engagement in the identification and resolution of the self-assessment findings
- Highly critical self-assessment process
- Identification and role clarity for self-assessment leads and station counterparts
- Effective corrective actions
- Effective implementation of operating experience recommendations
- Timely identification of safety significant gaps during the self-assessment.

Continuously determine emergent performance gaps against the pre-operational standards between the end of the self-assessments and the start of the onsite visit to implement corrective action plans to mitigate any potential safety significant AFIs or Recommendations.

6.3 Key Performance Indicators for Readiness

Management ensures the development and implementation of key performance indicators (KPIs) to systematically monitor pre-operational readiness milestones. The project control center monitors KPIs for operational readiness. Each function reports KPIs on a routine basis using a composite KPI dashboard template.

The following functions could report pre-operational review readiness KPIs:

- Organization and Administration
- Operations
- Maintenance
- Work Management
- Engineering
- Accident Management
- Radiation Protection
- Chemistry
- Fire Protection
- Emergency Preparedness
- Training

- Commissioning

6.4 Other Methods for Review Preparation

- Participation on pre-operational reviews at other utilities as observers or industry peers.
- Conduct of WANO Operational Readiness Assist visits.
- Participation as members of the WANO New Unit Assistance Industry Working Group (NUA I-WG).

7. Conduct of the On-Site Review Visit

7.1 Typical visit structure

Week One activities focus on the review of functional area standards and objectives. On-site review activities include those activities in which the team observes work and behaviors, validates performance issues, and briefs their counterparts on their findings. Activities will include field observations, walkdown of selected plant areas, and interface with area counterparts. During counterpart interactions, reviewers will also follow up on performance issues that require additional review and verification.

The middle weekend provides a transition from functional area to cross-functional area performance review. The team decides which issues need further team investigation to fully understand and characterize.

Week Two activities focus on further review of issues and other inputs from Week One to refine the team's understanding of current perspective or causes of these issues. Activities during the week should improve team understanding of organizational effectiveness, nuclear safety culture, and the leadership team's ability to find and fix problems.

7.2 Interactions during the onsite visit

Counterparts support the reviewers in the development of findings with inputs and insights, working together as closely as possible. Counterparts block off their calendars to ensure they have sufficient time and space for agreed-upon daily meetings with their reviewers. Counterparts make sure someone can cover their job activities if the reviewer requires additional time from them. Written drafts are shared between the counterparts and the reviewers to promote alignment on the facts. Counterparts provide daily updates to their management team on the initial gaps, findings and recommendations shared by the reviewers. Counterparts inform management continually on what further information will be provided to the review team. Counterparts continually ensure that they are familiar with what information their reviewers need.

Team activities should not distract from normal routines or prevent a full schedule of station work activities. Because of the cross-functional involvement, counterparts are more actively engaged in the process, and this generally takes more of the counterpart's time. Daily briefings with counterparts need to be succinct. Avoid over-reacting to the reviewer's observations and conclusions because this may be seen as overly defensive by reviewers. Trust the process to work through and validate issues. The review team has the option to stay longer, come back, or delay the review process, as deemed necessary to get an accurate picture of new unit performance. Inform plant management if any counterpart-reviewer relationships are not working well. Avoid taking immediate corrective actions to gaps unless there is a safety risk to people or the plant.

7.3 Engagement

It is the role of the station management to set the tone for the pre-operational review. Foster learning and continuous improvement in employee-reviewer engagements. Motivate employees to communicate openly and candidly. Provide constructive feedback to the reviewers to ensure that observations are factual (accurate). Be receptive and seek to understand – ask clarifying questions and explore different perspectives. Engage in developing conclusions to clarify issues. Help explore underlying causes. Use the review team as an opportunity to gain industry insights.

8. Use of Review Results

8.1 Types of review results

WANO and IAEA provide a range of results after a pre-operational review visit. The results include Areas for Improvement (AFIs), Recommendations and Suggestions based on the significance of the findings.

If a pre-operational review finding is determined to be safety significant, the station counterpart develops corrective actions, with owners and due dates, and ensures effective closure of corrective actions before fuel load or initial criticality, as applicable.

Typical safety significant pre-operational areas for improvement include:

- Crew Performance
- Reactivity Management
- Shift Manager Effectiveness
- Safety-related system readiness
- Foreign Material Exclusion
- Fire Protection

8.2 Responding to Areas for Improvement, Recommendations and Suggestions

WANO and IAEA provide guidance for responses to areas for improvement (AFIs), Recommendations or Suggestions associated with pre-operational reviews. Utilities are asked to develop written responses that follow a systematic evaluation of underlying causes and drivers for each finding. The responses should maintain a line of sight from the gap statement to the key actions that will close that gap to achieve the specific desired results. Actions should lead to results, not to additional investigations, data collection or administrative activities. The gap statement can be subdivided into several issues to facilitate aligning drivers, actions and results with the overall gap. Describe actions taken or planned to resolve the gap. Identify owners and due dates. Provide the expected completion dates for the corrective actions and the planned effectiveness reviews.

8.3 Using Observation Notes

A fundamental part of review methodology is the observation of station activities. WANO and IAEA reviewers write down their observation notes which can be made available to the station as a consolidated observation package at the end of the review. These observation notes are valuable information for the station on a range of gaps for which the review team did not write AFIs,

Recommendations or Suggestions. However, these observations may be used for fixing lesser gaps or enhancing performance.

Observation notes may refer to levels of staff. The performance of several individuals is likely to be representative of many personnel within a discipline or group. The observed performance of station staff provides insights into the effectiveness of management's efforts to communicate expectations and ensure proper implementation of policy and procedures. It also provides a measure of the effectiveness of supervision, procedures/processes/programs, and training. Therefore, it is inappropriate to use these observations as justification for individual personnel action, in part, because it can hinder openness and professional working relationships between station personnel and the team, now and in the future. Instead, the observations should be treated as symptoms of broader problems, and the persons involved should remain anonymous.

It is important to stress the need to control distribution of the observation package because it contains details that could be misinterpreted by those who are unfamiliar with the process.

9. Plant Actions After the Review

9.1 Use of the Corrective Action Program

All pre-operational review findings (AFIs, Recommendations or Suggestions) are uploaded into the corrective action program. Corrective actions are scheduled and tracked for effective resolution.

Utilities are asked to develop written responses in their corrective action program after a systematic evaluation of underlying causes and drivers for the findings. The responses should maintain a line of sight from the gaps to the key actions that will close those gaps to achieve the specific desired results. Actions should lead to results, not to additional investigations, data collection or administrative activities. The problem statement can be subdivided into more than one gap description to facilitate aligning drivers, actions and results with the gap. Describe actions taken or planned to resolve the gap. Identify owners and due dates. Provide the expected completion dates for the corrective actions and the planned effectiveness reviews.

Using the GAP, DRIVER, ACTION, RESULT (GDAR) Technique:

The GDAR technique is a systematic technique to assist in the development of gap statements, drivers and actions to address deviations from expected levels of performance and to obtain measurable results. This is a technique to help identify the ‘what and how’ of a performance gap and to systematically identify actions to address the gap.

GAP	Concise description of a deviation from an expected level of performance
DRIVER	Why the gap exists
ACTION	Addresses why the gap exists
RESULT	Measure(s) used to determine effectiveness of actions and closure of the gap

10. Follow-up Missions

If the fuel load date is modified, it may impact the pre-operational review schedule and validity. Pre-operational reviews are typically scheduled two to four months before the first core loading. For WANO PSURs, a new review may be conducted if the start-up process is interrupted for more than one year after completion of the review.

11. References

11.1 IAEA References

- OSART Guidelines, 2022 Edition – Reference Report for IAEA Operational Safety Review Teams (OSARTs), Service Series No.12 Rev.2
- Leadership and Management for Safety (IAEA Safety Standards Series No. GSR Part 2, 2016)
- Safety of Nuclear Power Plants: Commissioning and Operation, Specific Safety Requirements, No. SSR-2/2 Rev.1 (2016)
- Commissioning for Nuclear Power Plants, Specific Safety Guide, IAEA Safety Standards Series No. SSG-28
- The Operating Organization for Nuclear Power Plants, Specific Safety Guide, IAEA Safety Standards Series No. SSG-72

11.2 WANO References

- WPG-06, Pre-Start-Up Peer Review
- PO&C 2013-2, Pre-Startup Performance Objectives & Criteria (PSUR PO&Cs), 2013.
- PCD 2013-06, Conduct of Crew Performance Observations
- PCD 2013-03, Safety Significant AFIs
- PCD 2013-5, Scope of SOER Review in PSURs
- PCD 2014-1, Technical Support Mission Process Description
- PCD 2015-1, WANO New Unit Assistance (NUA) Process
- MN 2016-1, Conduct of Operational Readiness Assistance (ORA) Missions Rev 2, 2020
- New Unit Assistance (NUA) Modules, 2020
- Roadmap to Operational Readiness (R2OR) Revision 1, 2022
- Strategic Implementation of SOER Recommendations during Nuclear Power Plant Project Phases, 2022
- WANO RPT-2020-07, Analysis of New Units (2015-2020)

12. Appendix 1 – Support Missions

This section provides information on available support missions provided by the IAEA and WANO to support operational readiness and to assist plant management in the preparation to pre-operational safety reviews such as the IAEA Pre-Operational Safety Review Team (Pre-OSART) and WANO Pre-Startup Review (PSUR).

12.1 Support provided by the IAEA

Broad and exhaustive list of valuable resources and guidance can be found on the IAEA public website IAEA.org.

1. The IAEA Global Nuclear Safety and Security Network is both a human network and a web platform, allowing its members to share nuclear safety and security knowledge and services to further the goal of achieving worldwide implementation of a high level of nuclear safety and security.
2. IAEA Safety Standards and Publications: The industry guidance provided by the IAEA is captured within IAEA safety standards and publications. This rich and diverse collection of reference material is publicly available and can be found at https://www.iaea.org/resources/safety-standards.
3. Another bibliography of IAEA publications, more relevant for newbuilds, can be found at IAEA NE Department bibliography https://www.iaea.org/topics/infrastructure-development/bibliography#1. The content cited at this location is tailored to the new nuclear entrant and operator.
4. Review missions and advisory services (Review missions and advisory services | IAEA).

   4.1 Generic Peer Reviews:
   - ARTEMIS - Integrated Review Service for Radioactive Waste and Spent Fuel Management, Decommissioning and Remediation
   - EPREV - Emergency Preparedness Review
   - INSARR - Integrated Safety Assessment of Research Reactors
   - IRRS - Integrated Regulatory Review Service
   - OSART - Operational Safety Review Team
   - SEDO - Safety Evaluation of Fuel Cycle Facilities During Operation

   4.2 Specific Peer Reviews:
   - EduTA - Education and Training Appraisal
   - ISCA - Independent Safety Culture Assessment
   - ORPAS - Occupational Radiation Protection Appraisal Service
   - PROSPER - Peer Review of Operational Safety Performance Experience
   - SEED - Site and External Events Design
   - TSR - Technical Safety Review

   4.3 Advisory Services
   - INSServ - International Nuclear Security Advisory Service
   - IPPAS - International Physical Protection Advisory Service
   - RISS - Advisory Mission on Regulatory Infrastructure for Radiation Safety and Nuclear Security
   - SCCIP - Safety Culture Continuous Improvement Process.

Requesting a service from the IAEA

Member States request services through official channels and a Member State request may be preceded by discussions with the IAEA.

Funding

The requesting Member State funds the service. Depending on the request and the eligibility of the Member State, funds may also be provided, when planned, through the IAEA's Technical Cooperation Programme.

* Source: IAEA. Supporting Member States: IAEA Peer Reviews and Advisory Services: 22-00556e_ns_tech_bro_peer_review_final.pdf (iaea.org).

12.2 Support provided by WANO

WANO, which is focused on maximizing nuclear safety and reliability in civil nuclear power plants and facilities, supports new entrants and new builds through its New Unit Assistance service and other WANO programmes and services.

New Unit Assistance

New Unit Assistance (NUA) supports members and new organisations during the transition from a project phase - including construction and commissioning - to safe and reliable operation.

NUA is a suite of modules that are provided to future operating companies at various points along the design, construction and commissioning timeline. Lessons learnt from WANO pre-startup review (PSURs) and thousands of operating experience events from the construction and commissioning phase from plants across the world have been incorporated into the NUA modules. This enables WANO members to learn from past challenges and to ensure their construction and commissioning projects are delivered on time and as safely and successfully as possible.

Provision of the NUA modules can be tailored to a unit or company's specific needs, and the delivery methods are varied to ensure the member receives the right information for them at the right point in time - via training materials, sharing of best industry practices, benchmarking, use of operating experience (including construction-phase operating experience (OE) and information about events obtained from contractor organisations), targeted support missions and training.

In order to provide the most appropriate support, WANO seeks to engage with new entrant companies using a graded approach according to the type of project and familiarity the company has with the industry:

- Monitoring: provided to new unit(s) at an existing site in a country or area with a mature nuclear infrastructure and regulator.
- Increased assistance: to a new nuclear company in a country or area where other nuclear companies already exist and with a mature nuclear infrastructure.
- Focused assistance: provided to a new company in a newcomer country or area, where the regulatory framework is growing in parallel with the new build.

One additional support mission, the Operational Readiness Assistance (ORA), is designed to assist members review its level of organizational and operational readiness for formal plant pre-startup assessments. The typical scope of this assistance includes the areas of organization and administration (OR), operations (OP), maintenance (MA), including foreign material exclusion (FME), equipment performance and condition (EQ), and fire protection (FP), as well as a review progress on the

assessment and action tied to WANO SOER recommendations. Additionally, most recent industry experience suggests a careful review of corporate structure and the effectiveness of its functional support of operations is warranted.

Find more information about WANO's service in this FAQ document.

Member Support Programme

The Member Support programme works with members to improve safety and reliability.

- Member support missions

  Member support missions are carried out at the request of a member plant under operation or utility. They provide a means for WANO members to assist each other in improving safety or reliability at an individual member's plant. A team of peers is selected for a member support mission from WANO's membership on the basis of their expertise in the applicable area. The team then visits the member plant to review issues either identified during the peer review, or by the plant itself, and then works closely with the member to close the gap to excellent performance.

- Principles, Guidelines and Good Practices

  WANO principles and guidelines have been developed to help members achieve excellent performance in specific functional areas and in important cross functional areas. They can be used to review existing programmes; to develop new programmes and corrective actions to tackle identified weaknesses and to monitor the adequacy of corporate policies and plant practices.

  There are almost thirty WANO principles and guidelines and over one hundred good practices available on the WANO members' website. WANO good practices provide methods and ideas for improving plant performance and safety based on practices that have proven effective at other member stations. Presentation training supplements are also provided in parallel with WANO guidelines.

- Member performance improvement

  Member performance improvement identifies plants where prioritized WANO and/or industry support is required.

Performance Analysis Programme

The Performance Analysis programme collects, screens and analyses operating experience and performance data, providing members with lessons learnt and industry performance insight reports.

- Operating Experience Reports
  - WERs - WANO Event Reports
  - SOERs - Significant Operating Experience Reports
  - SERs - Significant Event Reports
  - JITs - Just-in-Time Reports
  - Hot Topics

- Performance Indicators

  The WANO performance indicators collect, compare, trend and disseminate nuclear plant performance data, and support the analysis of operating experience information and emulation of best practices.

- Performance Analysis: Industry Trends

  Based on a thorough analysis of the WERs that have been submitted to WANO as well as other sources of information, analyses are performed to identify industry trends and to guide WANO's supporting activities.

Industry Learning and Development

The Industry Learning and Development programme (formerly called Training & Development) provides a forum for WANO members to enhance their leadership skills and professional knowledge. Specific activities include workshops, seminars, training courses and leadership courses.

Activities are designed to help provide station personnel with the knowledge, skills and standards needed to support the highest levels of nuclear safety and excellence in operational performance.

- Workshops & Seminars

  Workshops are interactive. Their purpose is to exchange information and experience, and participants are invited to share their own experience with other members. Seminars are intended to distribute information to WANO members.

- Training Courses

  Training course are typically organised for WANO members to improve knowledge or skills in specific areas.

- Leadership Courses

  Leadership courses are intended to help existing and future leaders be successful in key positions at their stations.

Who can access NUA support?

The WANO NUA service supports all members with new nuclear power plants, whether they are newcomers or in expanding countries.

Why is early engagement with WANO so important?

Full and effective engagement with the NUA programme can significantly reduce the risk of a delay to start-up or a setback during the construction phase. Lessons learnt from PSURs have been incorporated into the NUA modules, to enable WANO members to learn from past challenges and ensure their construction and commissioning projects are as successful as possible.

To benefit from WANO's expertise to ensure they start up safely and on time, new nuclear units and entrants should join WANO as soon as the contracts for main works are signed. By becoming a member of WANO before construction begins and several years before initial criticality, new units will gain the maximum value from their membership.

WANO members are also encouraged to share operating experience (OE) events from the construction and commissioning phase, which allows each member to benefit from access to thousands of OE reports from plants across the world. These exist to provide information on how to spot and prevent common problems, enabling WANO members to become more efficient, reliable and safer.

WANO also supports the industry's NUA working group, comprised of new entrants and experienced operators alike.

13. Appendix 2 – Example – Advance Information Package List

(Mainly from OSART guidelines 2022 Edition)

I. Administrative Information

- Arrival logistics (airport, hotel, plant)
- Transportation airport-hotel, hotel plant
- Hotel accommodation information
- Contact points at the plant and list of the counterparts
- Site accommodation (site access control, controlled area access, meeting rooms, offices, clerical/interpretation support, office machines and lunch arrangements)
- Summary of site specific radiological, industrial and fire safety rules, and emergency response provisions.

II. General Information

1. Plant Description

- Overall site, plant description and which units are to be reviewed
- Brief plant operating history
- Current utility/plant organizational charts
- Arrangement of major plant structures and buildings (layout schematics)
- Performance indicators

2. Design Information

- Major process and safety systems
- Key design parameters
- Unique safety features

3. External Organizations

Brief description of main functions, structure and interaction of external organizations with the nuclear power plant:

- Utility headquarters
- Industry organizations
- Regulatory authorities
- Main suppliers and sub-contractors
- Contractors supporting plant maintenance.

4. Self-assessment

- For each review area, a self-assessment on how IAEA/WANO standards and performance objectives are met.
- Specific gaps where performance or programmes do not fully meet IAEA/WANO standards.
- For each gap identified, explanation of what corrective actions are being taken/planned to close the gap, including budget commitments, staffing, document preparation, increased or modified training, equipment purchase, etc.

III. Technical information

- Outline of operating license
- Safety performance indicators
- Proposal of detailed review schedule for each area
- List of abbreviations and acronyms used in the plant
- Plant colour coding system identification and labelling system
- List of designations of organizational units (department, division, section, group, etc.) and positions (superintendent, manager, chief, head, etc.)
- List, terms of reference and timetable of the most significant regular meetings at the plant

IV. Review Area Information

1. Leadership and Management for Safety

- Organisation and structure
- Overall management programme including management philosophy, management objectives and expectations, goals and nuclear safety policies
- Statistics on staff turnover and current age profile
- Recent plant status report (monthly, quarterly or yearly)
- Brief description of nuclear safety management practices
- Procedure and instruction philosophy
- Reviewing bodies (safety committees – internal and external)
- Brief description of document control system
- Nuclear Safety Culture policies and procedures
- Human Performance policies and procedures
- Industrial safety policies and procedures
- Human Technology and Organization (HTO)
- Leadership for Safety
- Human Factors Management
- Learning Organization
- Knowledge Management Programmes

2. Training and Qualification

- Organization of training functions
- Overall plant training programme including initial and continuing training
- List of major training procedures
- Overview of training facilities
- Qualification requirements for key plant positions
- General employee training
- Training activities planned during mission

3. Operations

- Operating organization, shift structure and staffing levels
- Overall responsibility distribution during normal operation and accident conditions, lines of command and communication
- Work request authorization, equipment isolation and tagging system, locking systems
- Plant status

- Control of modifications
- List of normal operating procedures
- Brief description of Operating Limits and Conditions
- System of emergency operating procedures
- Accident management approach
- Approach to fire protection and prevention

4. Maintenance

- Maintenance organization
- Overall programme for corrective and preventive maintenance
- Evaluation, analysis and trending of maintenance activities
- Typical outage programme/schedule
- Overview of maintenance facilities/workshops
- Brief description of In Service Inspection programme
- List of major maintenance procedures
- Material conditions strategy
- Work authorization programme
- Spare parts and material storage programme and facilities.
- Work Management organization and approach

5. Engineering

- Technical support organization and structure including interface with and support of external organizations such as the headquarters, international and national organizations, manufacturers and other institutions
- Equipment performance and condition
- Outline of surveillance test programme
- Plant modification philosophy with a list of past and planned major modifications
- Temporary modification review process and current status
- Probabilistic Safety Analysis
- Periodic Safety Report findings and current status of the Safety Analysis Report
- Reactor Physics overview
- New and spent fuel management
- Overview of computer-based systems important to safety

6. Operating Experience

- Operating experience organisation and management
- Reporting and review process of internal and external operating experience
- Reportable events including brief description and root cause analysis reports
- Sources of operating experience
- Corrective action programme
- Analysis and trending of events including low level events and near-misses
- Human performance investigations
- Use of operating experience
- Plant assessment and indicators of operating experience
- Sharing the plant’s operating experience with the rest of the nuclear industry

7. Radiation Protection

- Radiation protection organization and staffing level
- Outline of applicable radiation protection regulations
- Radiation exposure and contamination control policy
- Radiation protection instrumentation
- Radioactive waste management
- List of radiation protection procedures
- Measures applied in emergency situations
- A list of actual or anticipated high radiation areas (HRA), locked HRAs (LHRA) and/or Access Control areas

8. Chemistry

- Chemistry organization and staffing level
- List of chemistry procedures
- Quality control of operational chemicals
- Overview of chemistry specifications, system of parameter limits, operational history
- Overview of on line monitors and sampling stations
- Laboratory facilities, equipment and instruments
- Inter-laboratory comparisons
- Chemistry surveillance programme
- Post-accident sampling system operation

9. Emergency Planning and Preparedness

- National and plant organisation
- EPP documentation hierarchy diagram
- Emergency response philosophy, emergency classification
- Outline of plant emergency plan and interface with external organizations
- Plant emergency facilities on-site and off site
- Emergency notification and communication
- Emergency response
- Intervention levels
- Emergency training, drills and exercises

10. Accident Management

- Overview of accident management
- Analytical support for severe accident management
- Procedures for severe accident management
- Plant emergency arrangements with respect to severe accident management
- Verification and validation of procedures and guidelines
- Training needs and training performance

11. Fire Protection

- Organisation, programme requirements and responsibilities
- Fire prevention
- Fire response

- Design features and equipment management
- Fire protection personnel knowledge and skills
- Fire hazard and risk analyses
- Programme assessments and investigations
- Safe shutdown following a fire

12. Commissioning

- Commissioning process
- Organization and management of commissioning
- Implementation of Commissioning Programme
- Control of plant configuration
- Use of PSA and OEF

14. Appendix 3 - Survey on Beneficial Practices and Lessons Learned

This section summarises beneficial practices and key lessons learned on the preparations and conduct of pre-operational reviews. A survey was conducted to obtain feedback from recent pre-operational reviews.

Objective of the Survey

The objective of the survey was to obtain industry feedback on lessons learned and beneficial practices on the preparations and conduct of pre-operational reviews.

Target Population of the Survey

The survey was conducted with new units with recent IAEA Pre-OSARTs and WANO PSURs (2017 to current). The target population was two-fold:

- Units with recent Pre-OSARTs and PSURs (2017 to current)
- IAEA and WANO team leaders.

Survey Items

The survey consisted of a total of 11 items as listed below:

1. Plant management had sufficient knowledge and experience of pre-operational safety reviews prior to the review visit.
2. Self-assessments identified and addressed gaps against the pre-operational review standards prior to the review visit.
3. The pre-operational safety review preparation schedule was well scoped, highly visible and guided the day to day execution of the review preparations within the baseline schedule for the new unit’s fuel load and initial criticality dates.
4. Communication between the review team and station personnel prior to the onsite review visit was effective.
5. The advance information pack (AIP) was easy to assemble and was delivered to the review team in a timely manner.

6. Industry assistance (WANO or IAEA support missions) was used to review operational readiness, diagnose shortfalls and assist the management team, with sufficient lead time, to make mid-course corrections and be prepared for a successful review visit.
7. What additional actions could be taken by WANO or IAEA to assist plant management with their preparations for pre-operational review visits?
8. What could the management team have done differently to make the preparation for the review visit more effective for the readiness for startup of the new unit?
9. How much time and how many people were dedicated to the preparation for the review visit?
10. Which group or department in your company coordinated and managed the preparation for the review visit?
11. What success factors and beneficial practices during the pre-operational stage contributed to a safe and reliable startup of the new unit?

Survey Responses:

A total of 29 responses were received:

- Number of Units with recent Pre-OSARTs and PSURs (2017 to current): 21 (72%)
- Number of WANO team leaders: 4 (14%)
- Number of IAEA team leaders: 4 (14%)

Survey Responses were received from WANO, IAEA, and the following companies:

ID	**Company**
1.	China National Nuclear Corporation (CNNC)
2.	Eletronuclear
3.	Nawah Energy Company
4.	Slovenské elektrárne
5.	China Huaneng Group
6.	Ontario Power Generation (OPG)
7.	China General Nuclear Power Group
8.	Nucleoelectrica Argentina
9.	Sellafield Ltd
10.	Teollisuuden Voima (TVO)
11.	Korea Hydro & Nuclear Power (KHNP)
12.	Rosenergoatom

Some companies listed above represent several new units with pre-operational reviews in the timeframe covered by this survey.

Most Favourable Response:

Question 4: Communication between the review team and station personnel prior to the onsite review visit was effective.

Least Favourable Response:

Question 6: Industry assistance (WANO or IAEA support missions) was used to review operational readiness, diagnose shortfalls and assist the management team, with sufficient lead time, to make mid-course corrections and be prepared for a successful review visit.

Key Lessons Learned:

1. Knowledge: Insufficient plant knowledge and lack of available training and experience on IAEA/WANO reviews.
2. Self-assessment: Self-assessments were overly positive, and the review identified issues that should have been self-identified. Timing of self-assessments did not allow plants to complete their corrective actions before the review started.
3. Schedules: Changed too often or conducted the reviews without safety-related systems turned over or operators being ready to be observed in the simulator. Over-focus on commissioning. The reviews were carried out too early with few activities completed timely. Wide variations existed on duration and resources for schedules and preparation plans.
4. Communications: Inconsistent communications between the site leadership and IAEA/WANO, especially on commissioning progress and readiness for the review.
5. Advance Information Packages (AIP): Information sharing platforms were confusing. Country and company policy on export control and confidentiality complicated the provision of the AIP during the preparation phase.
6. Support Missions (e.g., WANO ORA) were conducted inconsistently and too late. Limited follow-up from either party on the effectiveness or completion of the recommendations in preparation for the review visit.

The narrative inputs received are summarized as key themes below for each of the survey items.

Survey Item #1: Plant Knowledge

Plant Management of New Units:

- On the positive side, for some new units, previous peer reviews at their utilities provided deep understanding on PSURs and pre-OSARTs.
- Conversely, at new-to-nuclear utilities with no previous peer review experience, PSURs and pre-OSART processes were not well-known as it was a first-time experience and there was insufficient knowledge because of the wide scope of IAEA/WANO requirements.

IAEA & WANO Team Leaders of Pre-OSARTs and PSURs:

- In general, the feedback on plant knowledge of PSURs/Pre-OSARTs received mixed reviews from the team leaders
- The knowledge and experience of new unit managers varied widely because they had little opportunity to participate in a peer review. After the preparatory meeting all seemed to be clear but once the actual pre-operational review mission was done, many activities came as a surprise; preparatory meetings are usually conducted about six months before the mission, and the plant managers were trained on the methodology.

Survey Item #2: Use of Self-Assessments

Plant Management of New Units:

- On the positive side, good use of self-assessments resulted in a low number of issues received during the review, including no startup-related (safety significant) findings. Support missions prior to reviews identified gaps and focus areas to fix prior to the review.
- Conversely, a systematic process was not used as there was no dedicated team or schedule for self-assessments. It is possible that the quality of self-assessments was negatively affected by the high employment of personnel in start-up operations.

IAEA & WANO Team Leaders of Pre-OSARTs and PSURs:

- In general, the feedback on the effective use of self-assessments was not viewed positively by team leaders.
- Maybe most plants did some form of self-assessment but did not leverage it effectively. Some units really did not do a self-assessment of their readiness. There was insufficient focus on assessing operational readiness (organization and staff). Self-assessments were overly positive, and the review identified issues that should have been self-identified. The timing of self-assessments did not allow plants to complete their corrective actions before the review started. Some host organizations did not readily communicate the results of their self-assessments with the IAEA/WANO teams.

Survey Item #3: Schedule

Plant Management of New Units:

- On the positive side, some new units used well-scoped schedules which were continuously being refined throughout the review preparation phase. The pre-operational schedules were very detailed and provided a clear path through fuel load to operations. Schedule were used as a forcing function to align and complete all review preparation activities.
- Conversely, the review preparation schedules were impacted negatively by postponements due to the technical and organizational issues. In some cases, the reviews were held too early compared with work remaining at the unit and these reviews needed to be repeated later.

IAEA & WANO Team Leaders of Pre-OSARTs and PSURs:

In general, the feedback on the effective use of review preparation schedules was not viewed positively by team leaders.

- New units placed more focus on the completion of commissioning activities than pre-operational activities. Schedules changed too often or the reviews were conducted without safety-related systems turned over or operators being fully ready to be observed in the simulator. The reviews were carried out too early with few activities completed timely. In many cases originally planned milestones for missions were not met and missions were postponed several times until criteria for the missions were met.

Survey Item #4: Communication between the review team and station personnel prior to the onsite review visit was effective.

Plant Management of New Units:

- On the positive side, some new units set up routine calls from about T-18 months between the senior management team and the team leader to manage important preparation activities for the review visits. Rapid exchange of information on the progress of commissioning made it possible to organize and schedule reviews in accordance with the sites' commissioning and preoperational readiness schedules.
- Conversely, some new units did not establish ongoing communications between the site leadership and the team leader often resulting in reviews carried out too early. Prior to the onsite review visits, some sites experienced communication delays due to the review teams being occupied with reviews at different plants in different countries.

IAEA & WANO Team Leaders of Pre-OSARTs and PSURs:

- On the positive side, the use of preparatory meetings onsite by the team leader with senior management and counterparts, was an effective communication tool for review preparations.
- Conversely, communications between the site and the team leaders were impacted by some plants' reluctance to provide some relevant information prior the mission. At times, the country and company policy regarding export control and confidentiality resulted in some

documents not being provided during the preparation phase. Some reviewers did not provide adequate perspectives as they did not have extensive communication with their station counterparts prior to the review.

Survey Item #5: The advance information pack (AIP) was easy to assemble and was delivered to the review team in a timely manner.

Plant Management of New Units:

- On the positive side, some new units developed the AIP taking into account all the review requirements, translated into English and promptly transmitted to the review team leader.

In general, the feedback on the advance information pack (AIP) was not viewed positively by plant personnel:

- Discrepancies were identified between the AIP request and the associated agency folder structure, which led to the schedule buffer being partially utilized in order for the AIP to be delivered on time. Although at times the information package was easy to assemble, but during the visit it was clear that team had not reviewed material completely. A weak system was in place to share information in a systematic way with the regional center. The functional areas experienced difficulties with assembling of plant information as this was a new-to-nuclear country and much information did not yet exist. WANO/IAEA should adapt their AIP approach in line with the availability of information for a new unit. A generic AIP list was not helpful and was not tailored for specific plants. The large amount of information in the AIP requests seemed excessive, requiring many personnel involved in its preparation.

IAEA & WANO Team Leaders of Pre-OSARTs and PSURs:

In general, the feedback on the advance information pack (AIP) was not viewed positively by team leaders:

- Challenges existed with the receipt of documents that were not in the native language (or English) of the regional centre. Although recent software tools could be used, they slowed the ability to process the documents and introduced errors. At times, the country and company policy regarding export control and confidentiality resulted in some documents not being provided during the preparation phase. Perhaps the guidance to write the AIP did not give sufficient information about expectations.

Survey Item #6: Industry assistance (WANO or IAEA support missions) was used to review operational readiness, diagnose shortfalls and assist the management team

Plant Management of New Units:

- On the positive side, some management teams effectively used industry support pre and post review. Operational readiness review visits added a lot of value to identify operational readiness gaps and to familiarize staff with reviewers. Plants used the support missions as mock review visits. Some plants used the experience of the other plants effectively in their preparations.
- Conversely, although some plants conducted support missions, there was limited follow-up from either party on the effectiveness or completion of the recommendations in preparation for the review visit. Some issues had been identified by the power plant before, but effective solutions were not provided during and after the review visits. Some support mission team members often lacked experience of the needs of new units.

IAEA & WANO Team Leaders of Pre-OSARTs and PSURs:

In general, there was mixed feedback by team leaders on the effective use of industry assistance and support missions:

- Although some new units improved due to support missions, workshops and previous reviews, some long standing gaps were not effectively addressed. For those areas where

assistance was provided, it had a significant added value and the number of issues identified during the mission was lower but end goal to improve operational safety was reached. Some sites used support missions extensively and provided feedback that the trips were effective; however, some of the review gaps were not previously recognized during support visits. In general, industry assistance prior to the missions added considerable value to the enhancement of operational safety.

Survey Item #7: What additional actions could be taken by WANO or IAEA to assist plant management with their preparations for pre-operational review visits? (1/2)

Plant Management of New Units:

The following key themes were identified for additional actions requested by plant management:

- Knowledge and Experience: I think it would be beneficial for WANO to have prior knowledge and familiarisation of the facility being reviewed, especially with unique facilities. There should be a kind of ePM for PSUR. It is not representative enough having a few isolated pictures of the station before start up - a continuous follow up would be worth. Discussions with persons with good experience about pre-operational missions were helpful. Actively involve plant personnel to participate in missions at other nuclear power plants.
- Self-Assessments: It is suggested WANO draft fleet analysis report on PSUR, including common gaps and good practices as input to the self-assessment of plant.
- Communications: Before pre-operational review visits, a communication between senior management of WANO/IAEA and power station management can be conducted to deepen power station management's understanding of PSUR. Enhance pre-evaluation communication. Online training. Materials sharing.
- Schedule: Regular update on the development of the schedule. Preparations for the reviews should begin at an earlier date.
- Advanced Information Package: WANO could try to provide the AIP, interview and observation requests as early as possible, in order to assist plant management with handling these requests together with any emergent competing priorities. Revise the approach and the volume of the AIP to reduce workload on personnel. All information needed will be discussed and verified at the plant.
- Logistics: To decrease "paperwork", for example, to summarize all needed personal info into one form. The team leaders should visit the new sites earlier to familiarize themselves with the specifics of the site, clarify the specifics of interaction, and assist in scheduling the review at the appropriate time.
- Support Missions: Develop a standard set of support missions at a set frequency. The visits should build on one another. Ensure a coordinated approach between WANO and IAEA visits to avoid duplication or sending confusing messages to the new unit leadership. Develop and implement operational readiness review visits specific functional areas, for example, operations, maintenance, etc.

IAEA & WANO Team Leaders of Pre-OSARTs and PSURs:

The following key themes were identified for additional actions requested by team leaders:

- Knowledge and Experience: Develop a series of standard Workshops focusing on pre-operational readiness - i.e., what the operating organisation must have in place to effectively take on the responsibilities for the running of a nuclear power plant. Facilitate opportunities to benchmark and for plant management teams to participate on a review team at another utility well in advance of their first review. We provide opportunities for the host plant to send observers or experts to other pre-OSART mission to fully understand the process and carry this experience back to their plant.

- Support Missions: A best practice is to hold an Operational Readiness Assistance Visit (ORA) which is just like a pre-PSUR or practice PSUR. It is done in time for the station to check and adjust to help them be ready for their PSUR. It uses a full team and is done 6-9 months before the actual PSUR. Provide an ORA (Organizational Readiness Review on year before the PSUR. Identify repeated issues and carry out workshops and MSMs. There is the full suite of WANO NUA modules that should help, but many of these are developed and performed by persons not actually doing PSURs so this disconnect could be improved. Ensure that support missions are conducted well in advance (3 years before FCL) for the insights to be effectively taken into account.
- Communications: Management should deliver the message to plant personnel staff that the pre review is done to help the new unit to operate more safely. Team leaders should ensure that management understands the purpose of the review.

Survey Item #8: What could the management team have done differently to make the preparation for the review visit more effective for the readiness for startup of the new unit?

Plant Management of New Units:

The following key themes were identified for what could be done differently by plant management:

- Knowledge and Experience: Ensure that the review team fully grasp the technical characteristics of the power station, and grasp the organizational and management issues of the power station. Conduct preparation conference with departments managers. The management team transforms the mindset of employees from construction to operation by conducting training and inviting external experts to communicate with the company and employees. Engagement and familiarity of the mission by the plant management team is key factor for work effectiveness. Participate in the PSURs and pre-OSARTs elsewhere.
- Advanced Information Package: Be more familiar with information sharing platforms used by the regional centre.
- Self-assessments: Stay continuously engaged with their self-assessment teams to ensure high quality results as the teams lacked the experience to identify the specific gaps for their functional areas. It was too late to fail the self-assessment reports at the self-assessment review board stage.
- Schedule: NPP Management should start preparation more in advance. Develop assessment plan, designate the counterpart, do self-assessment, and complete AIP preparation and delivery. Communicate schedule uncertainties to stakeholders. Adopt a project-based approach with a high fidelity, high confidence schedule at least five years in advance of fuel load. Use a dedicated project teams at a utility and functional area levels.
- Support Missions: WANO could be more proactive in recommending the available resources such as the pre visits i.e., ORA / Industry Peer support etc. to support preparations. We accessed these services through the experience of a former WANO Secondee who was aware of the support we could request from WANO.

IAEA & WANO Team Leaders of Pre-OSARTs and PSURs:

The following key themes were identified for what could be done differently by plant management:

- Schedule: Have integrated pre-operational readiness and commissioning programmes. Provide a model for preparing for startup, including a schedule that coordinated regulatory and WANO reviews. The IAEA Preoperational OSART mission is an important aspect in the host organization’s nuclear project for both counties (nuclear) newcomers and counties with existing nuclear programme as it demonstrates to which extent the new plant meets the internationally recognized and endorsed the IAEA Safety Standards. It is desirable that preparations for the Preoperational OSART mission are organized based on a ‘project’ approach with all the necessary attributes resources.

- Knowledge and Experience: Benchmark with other recent units which have had a PSUR or participate as a team member on a PSUR. I also think senior managers (plant/general managers and vice presidents of new units) should actively seek opportunities to act as the industry advisor on PSURs. Their insights are key and the learnings they glean in doing this helps them in their subsequent unit PSURs. Management should pay special attention to the expertise of counterparts at the plant. Their willingness to strive for improvements and to be open minded even to the minor challenges. Challenging attitude is great if there is a basis for it which is not always the case.
- Advanced Information Package: Better understanding of the impact of export control and confidentiality policies to provide data and documents to the PSUR team during preparation phase.

Survey Item #9: How much time and how many people were dedicated to the preparation for the review visit? (1/2)

Plant Management of New Units:

The following resources were identified by plant management:

- A wide variety of approaches to resource allocation were used by new units. Durations spanned between about one month to eighteen months of preparation time prior to a review visit. The number of employees spanned from between two to sixty individuals engaged with preparations.

IAEA & WANO Team Leaders of Pre-OSARTs and PSURs:

The following key themes were identified for team leader resources:

- Typically, the bulk of the preparation is done by the Team Leader and Coordinator (OR Leader in Atlanta Center). These preparations take months of part-time (30%FTE) up until the final 6 weeks where it becomes almost a full-time job for 2 WANO staff prior to the visit. This includes team formation, scope of review, AIP drafting and review, scheduling with station and team members, logistics, pre-visit, review etc. From a station perspective it varies widely. One challenge seen with some stations is the person assigned to interact with WANO TL/Coordinator is not really the decision maker so that discussions take place and things are agreed upon and then the actual decision maker has a different perspective and/or questions. One AC best practice is that the site vice president and the TL personally hold frequent (weekly) discussions where decisions are made. The ORL (Coordinator) also participate in these conversations or are able to interact with the decision makers directly themselves.
- Team Leader and SOER reviewer were involved 6 months before the review, with a 3-day Pre-Visit on site.
- 4 weeks of preparation for the TL and for the SOER Reviewer. 1 week of preparation for each reviewer before the PSUR.
- Team Leader, Deputy Team Leader and assistants at IAEA. Team experts also approached their counterpart prior the mission. The work at the Agency is distributed throughout many months.
- It is desirable that preparations for the Preoperational OSART mission are organized on the basis of a ‘project’ approach with all the necessary attributes and resources at least two years prior to the projected mission date and reflecting the scope of the review.

Survey Item #10: Which group or department in your company coordinated and managed the preparation for the review visit?

Plant Management of New Units:

The following key coordinating departments were identified by plant management:

- Nuclear Safety Department: OE section, Nuclear Safety department. Nuclear Safety Department. Nuclear Safety Department. For both WANO and OSART there were more departments but mainly Safety department for WANO and Operation department for MAAE, both in some cooperation with corporate department Nuclear Safety. Nuclear Safety and Licensing Division. Nuclear Safety coordinated preparations.
- Working Groups: Assessment Team. External Reviews Team. A PSUR working group will be set up led by the station director and participated by all counterparts and assistants. The coordination was managed through the internal SL WANO team and the Facility HIR and counterparts.
- International Stakeholder Relations. Organizational activities (orders, programmers, AIP preparation, translation etc.) were carried out by the International Cooperation Department. Department of international cooperation
- Functional Areas: Engineering. Safety & Engineering Support Section coordinated and managed PSUR. Quality Management Department
- CNO-sponsored Projects Group: (a) at utility level: dedicated PSUR project team with ex-WANO project lead, specialist and an admin reporting within a nuclear assurance department. (b) operational readiness control center reporting to the chief nuclear officer. Deputy Chief Engineer. Deputy Chief Engineer was assigned responsible for coordination and organizational matters. Preparation for the PSUR was carried out under the Director and Chief Engineer's vigilant control.

IAEA & WANO Team Leaders of Pre-OSARTs and PSURs:

The following groups were identified for WANO and IAEA as their coordinating departments:

- IAEA: Operational Safety Section. OSART Programme manager and relevant TL and DTL.
- WANO: The WANO-AC Plant Evaluations Division (and specifically the TL) manages all aspects of the PSUR. Support is given from WANO-AC operations division in assisting with visa, travel, scheduling, peers and team formation. Assessment Department, WANO PC.

Survey Item #11: What success factors and beneficial practices during the pre-operational stage contributed to a safe and reliable startup of the new unit? (1/2)

Plant Management of New Units:

The following key themes for success factors and beneficial practices were identified by plant management:

- Communication: Effective communication between staffs and reviewers. WANO had a positive impact on the facility due to the relationships and interaction they had built across the workforce during the pre-visits. Also gaps that were identified during the pre-visits were addressed and standards improved, this contributed to an overall safe and reliable start-up.
- Self-assessment: Use the learnings from previous PSURs. Do a critical self-assessment. In depth Self-Assessments. The conducted self-assessment based on the PO&Cs.
- Safety first mindset: traits of a healthy nuclear safety culture emphasized regularly by leadership. Utilization of the Corrective Action Program (CAP). Focus on continuous learning.
- Schedule: Development of and adherence to a detailed deterministic schedule. Weekly project update meetings with all functional area leads. In our case reviews were conducted too early. Some operational practices were taken in use a bit too early, but that was one

driver to move operational mode during the project. But "heavy" practices were in use too early compared to real fuel loading date "years". The original startup date was postponed by a few years. Once a high-level project team and functional area project teams using a very detailed schedule, the new unit was safely started up on schedule. (a) operational readiness control centre with a high confidence schedule. (b) dedicated PSUR project team.

- Knowledge and Experience: Skilful and experienced nuclear professionals from more departments of our company. Training and development of functional area leads on WANO/IAEA standards. Progressive design improvement based on proven technology. Matrix organization: project management by site as front desk and shared construction platforms. Long term partnership with civil and construction contractors. Self-reliance in commissioning and swift experience feedback. Preservation activities were well developed across the station.

IAEA & WANO Team Leaders of Pre-OSARTs and PSURs:

The following key themes for success factors and beneficial practices were identified by team leaders:

- Schedule: Ensuring that the plant was technically ready for first core load, that all the equipment required to support first core load had been commissioned correctly and its' safety function verified. Having a prioritised programme targeted on ensuring all necessary equipment to support first core load was ready and having safety-significant graded list of defects, some which must be resolved before first core load and others which can be resolved later. Ensure that the PSUR is not too early (1 to 2 months before first core loading).
- Support Missions: Participating in an Operational Readiness Assistance (mock PSUR) in advance of each unit PSUR. Member Support Mission and Organizational Readiness Review to be carried out at least one year before the PSUR. The plants actions to react on identified gaps in their operational safety. Some of the gaps were more significant than others, but because the most important ones were addressed the reliable startup was possible.
- Communications: Direct TL discussion with the site vice president and APOC and ORL coordination with PSUR coordination staff and plant manager.
- Knowledge and Experience: Key leader participation in other PSURs prior to their first unit PSUR. Having another operating company president with extensive PSUR experience serving as the Industry Advisor providing keen insights to both the team and to station leaders. This directly contributed to the success of the mission. Station staff was open mind and had in depth knowledge of the PSUR process and of the objective of the mission. Staff and managers were eager to learn. Early leadership team development and alignment. Setting high standards early by benchmarking and learning from reference plant and industry peers. Managers and supervisors actively present in the field, coaching and correcting unsafe behaviours and unsafe conditions.
- Construction and Commissioning: From a construction standpoint, the unit was ready to startup well before the workforce was. The leadership team was self-critical and set high standards for readiness before proceeding with a PSUR. This limited the need for conflict and ensured the team was well prepared before the PSUR. The plant commissioning programme is a principal document that, when executed completely and successfully, provides assurances that the plant has been constructed in accordance with the design intent and can be operated safely and objectives of the commissioning process are met demonstrating that the nuclear power plant as constructed meets the design requirements and the safety requirements as specified in the safety analysis report and in the licence conditions.

Survey Item #12: Additional Comments

Plant Management of New Units:

The following key themes were identified as additional comments by plant management:

- Number of Reviews: I would prefer only one review before start-up. In our case it was discussed with organizations that one peer review would be conducted. Even that other review scope was reduced that resulted a bit confusion. If both reviews are conducted indicate that already in first discussions and not change scope during the project.
- Schedule Oversight: The postponement of the first startup provided significant lessons learned on how to develop a project-based approach with daily/weekly engagement from each functional area. Oversight of the updated startup schedule was provided on a continuous basis by the chief nuclear officer. The project reported directly to him.
- Pre-operational reviews will provide more benefit if teams include personnel with new build and operational readiness experience. Such experience provides a higher degree of confidence to the site management team regarding operational readiness of the new-build unit.

IAEA & WANO Team Leaders of Pre-OSARTs and PSURs:

The following key themes were identified as additional comments by team leaders:

- Simulator: You cannot understate the importance of getting a functional simulator as soon as possible so that operators can get trained and proficient prior to the PSUR. This seems to be the number one issue resulting in a startup related AFI and potentially delaying the startup schedule.
- Operational Standards: Have a clear understanding (both the station and the review team) of what standards are expected of station personnel when the team is on site. And, these standards should be very close to what will be expected during operation. Obviously with no nuclear source term, some RP standards may be relaxed (standing in a low dose area during a job is clearly not needed if there is no dose and the areas are not defined yet). But certain operational standards should be expected during the PSUR and the team should not hear people say that they will start that after fuel load or startup. These are habits and are not turned on and off with a switch or a milestone. The review team is there to see these habits in action.
- Equipment: The station and reviewers need to understand that while CFT and HFT are important to ensure equipment will operate, system turnover and walkdown processes are also important, and operational alignment of the equipment. Protection of the equipment after it is turned-over, and walked-down, and aligned is very important. The aforementioned processes show the equipment is ready at a specific time, however protection and monitoring are what ensures it remains ready (including physical controls, operator rounds, and all people understanding what is turned over and how it should be treated.
- Schedule: Some new units are role models for a high level of coordination, but most plants do not provide this high level of planning and coordination. This will likely result in challenges as the number of units in startup increases.
- The pre-operational review process should include focused evaluation activities performed at appropriate times during the project as specific phases are completed. As a result, the evaluation period could occur over a longer period leading up to fuel load. (These focused activities are like outage review visits and crew performance evaluations conducted for current evaluations.)
- With appropriate consideration given to the above, teams will review operational personnel behaviours to determine that they are aligned with those of an operating unit. Therefore,

teams should perform observations of actual field activities (for example, testing, operator rounds and maintenance activities) closer to fuel load to gain better insights regarding overall performance. This will help minimize suppositions based primarily on interviews and document reviews, which might result if the pre-operational review occurs too early.

- Performing a pre-operational review as the site completes various aspects of operational readiness can provide schedule flexibility for both the review team and site personnel. Team leaders can size the teams as needed for these initial focused evaluation visits. Performing a pre-operational review in this manner can also minimize the effect of a large team on site during a critical time in the schedule (right before fuel) and allow more time for gaps to be resolved if discovered sooner during the focused evaluation activities.

15. Glossary

This section includes definitions of key terms and abbreviations.

- AREA FOR IMPROVEMENT (AFI) – Issues noted during reviews as the most important gaps against the pre-operational performance objectives and standards.
- CHIEF NUCLEAR OFFICER (CNO) – the most senior executive in charge of the nuclear safety aspects of the business.
- COUNTERPART - The reviewer's plant point of contact, for example, the maintenance reviewer's counterpart during a review would be the plant maintenance manager.
- EXIT MEETING - Usually conducted a few weeks after the review at the utility's corporate offices. The team leader and other senior WANO/IAEA managers, discuss with senior utility managers the significant concerns and recommendations resulting from the review.
- IAEA – International Atomic Energy Agency
- MANAGEMENT – the responsibilities of an individual or a team of managers to control, direct, plan, organise, coordinate and staff the organisation to achieve safe, reliable station operations.
- MEMBER SUPPORT MISSION (MSM) – WANO members assist each other and actively exchange information and experience amongst the membership. Assistance can be provided through an exchange of information, a review of specific aspects of performance, or to address previously identified areas for improvement.
- NEW UNIT ASSISTANCE (NUA) - NUA is a cross-programme process applicable to all WANO members that are planning or constructing nuclear power reactors from the start of WANO membership until the start-up of the reactors.
- OBSERVATION - The act of watching personnel during the normal course of their duties during the review period. The observation may later be written to highlight performance problems. This written report is termed an "observation." Written observations are combined to form an "observation package" which is given to plant management at the conclusion of a review.
- OPERATIONAL READINESS ASSISTANCE (ORA) - a comprehensive and complex MSM whereby WANO experts give the new plant recommendations in several areas to close the last gaps before the PSUR.
- PERFORMANCE OBJECTIVES & CRITERIA (PO&C) - A published document with specific written areas of expected performance by the plants. Each performance objective covers a single, well-defined area. Each performance objective has supporting criteria that are narrower in

scope to assist the reviewer and the management in understanding the expected performance.

- Pre-operational – prior to the first core loading of a new reactor.
- Pre-OSART (Pre-Operational Safety Review Team) - Reviews form part of the IAEA's safety review services.
- PRE-STARTUP REVIEW (PSUR) - The purpose of a pre-startup review visit is to focus on the preparation and readiness of a new plant to start safely and reliably.
- RESPONSE - A formal reply from utility management on the final report. The response outlines the corrective action taken or planned, to correct the gaps identified in the report.
- SOER - Significant Operating Experience Report
- STRENGTH - Those activities identified at nuclear plants during the course of review visits which achieve results of exceptional quality and would benefit the industry as a whole.
- WANO - World Association of Nuclear Operators