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Preparing and Conducting Review Missions of Instrumentation and Control Systems in Nuclear Power Plants

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PREPARING AND CONDUCTING REVIEW MISSIONS OF INSTRUMENTATION AND CONTROL SYSTEMS IN NUCLEAR POWER PLANTS

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FOREWORD

The mission for Independent Engineering Review of Instrumentation and Control (I&C) Systems (IERICS) in Nuclear Power Plants (NPPs) has been established with the aim of conducting peer reviews of I&C design documents, implementation processes, prototype I&C systems, and actual systems already deployed in operating NPPs.

Organizations in IAEA Member States, such as nuclear utilities, regulators, and technical support organizations can benefit from I&C technical reviews through requesting IERICS missions that provide a detailed technical assessment on I&C systems, as well as recommendations for improvement.

The IERICS mission is conducted by a team of international subject matter experts from various complementing technical areas. The review is based on appropriate IAEA documents, such as Safety Guides and Nuclear Energy Series, and the mission's findings are summarized in a mission report, including a list of recommendations, suggestions, and identified good practices.

The review is not intended to be a regulatory inspection or an audit against international codes and standards. Rather, it is a peer review aimed at improving design and implementation procedures through an exchange of technical experiences and practices at the working level. The IERICS mission is applicable at any stages of the life cycle of I&C systems in NPPs and it is initiated based on a formal request through official IAEA channels from an organization of a Member State.

The formation of the IERICS mission is based on the recommendation of the IAEA Technical Working Group on Nuclear Power Plant Instrumentation and Control (TWG-NPPIC). The recommendation came from the recognition that the IAEA can play an important role in the independent assessment and review of NPP I&C systems in terms of their compliance with IAEA safety guides and technical documents.

This publication was produced by international experts from several countries. The IAEA wishes to thank all participants and their Member States for their valuable contributions. The IAEA officers responsible for this publication were O. Glöckler of the Division of Nuclear Power and G. Johnson of the Division of Nuclear Installation Safety.

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1. INTRODUCTION

1.1. PURPOSE OF IERICS MISSION GUIDELINES

These guidelines provide a basic structure and common reference across the various areas covered by an IERICS (Independent Engineering Review of Instrumentation and Control Systems) mission. The document describes in detail all steps and processes that should be followed during the preparation, implementation and closing phases of the review mission by members of the IERICS team and the counterpart (the organization that has requested the IERICS mission and the beneficiary of the review mission). Publications referenced in these guidelines could provide additional useful information for the counterpart while preparing for the IERICS mission. A template for the mission report is also given in the Appendix.

1.2. OBJECTIVES OF THE IERICS MISSION

The IERICS mission is a comprehensive engineering review service directly addressing strategy and the key elements for implementation of modern I&C systems, noting in applicable cases, specific concerns related to the implementation of digital I&C systems and the use of software and/or digital logic in safety applications of a NPP.

The IERICS mission is conducted by a team of international experts with direct experience applicable to the areas of review. Judgements of compliance are made on the basis of IAEA publications (see references of this publication), and of the combined expertise of the international review team.

The review is neither a regulatory inspection nor is it an audit against national or international codes and standards. Rather, it is aimed at improving the design implementation, procedures and practices being followed through an exchange of technical experiences and practices at the working level (peer review).

The key objectives of the IERICS mission are to:

- Assess the design approach, principles, and procedures of the system under review.
- Identify existing or potential design, operational, and licensing related issues or concerns of the system under review.
- Propose measures to address issues identified.
- Identify any outstanding good practice that could be a benefit to other NPPs.
- Facilitate exchange of experience.

In order to fulfil these objectives, the IERICS mission aims to:

- Provide the counterpart with an objective opinion, with respect to international standards and practices, of the design and design practices related to the system under review;
- Provide the counterpart with recommendations and suggestions for improvement in areas where performance may appear to fall short of recognized international good practices.
- Provide key staff at the counterpart with an opportunity to discuss their practices with experts who have experience of other practices in the same field.

— Provide the counterpart with recognition of their good practices identified during the course of the review.
— Provide experts of the counterpart, expert reviewers from Member States and the IAEA staff with opportunities to broaden their experience and knowledge of their own field.

1.3. SCOPE OF THE IERICS MISSION

The scope of the IERICS mission identifies the system under review and its boundaries, the system properties to be reviewed, and the review basis and reference documents to be used for the review. It is limited to the technical and engineering aspects of the NPP's I&C systems, unless there is a specific request for addressing additional areas, such as, (1) issues related to the overall NPP plant safety case, (2) human factors, and (3) economic assessment and long term investment strategies related to the I&C lifecycle.

The scope of the IERICS mission is determined based on a mutual agreement between the IERICS team leader and the counterpart. It is normally defined during the preparatory phase of the mission (see Section 2.2).

1.4. INTENDED AUDIENCE

This document has been prepared primarily for the members of the IERICS team, but they also provide detailed guidance to the counterpart for preparation for an IERICS mission. The guidelines are intended to help IERICS team members formulate their review in conjunction with their own experience. They should not be considered exhaustive and should not limit the reviewer's investigations, but rather should be considered as illustrative of the comprehensive requirements according to which the review is carried out. Reviewers should keep in mind that it is practically impossible, in the timeframe of a review mission, to cover the entire scope of a given section of the guidelines to the same level of detail. Therefore, it is expected that, based on the review of the advance information package prepared by the counterpart, the reviewers will apply their judgement to decide which topics need more in-depth evaluation during the review.

On the counterpart side, the potential organizations requesting the IERICS mission could be:

— nuclear utilities;
— nuclear regulators and government authorities;
— decision makers (authorities and utilities;
— research and development organizations;
— vendors and manufacturers.

1.5. ORGANIZATION OF THIS REPORT

Section 2 provides guidelines regarding the overall organization of the IERICS mission, from preparatory phase to follow-up missions.

Section 3 provides guidelines regarding the principles and techniques to be applied in the course of an IERICS mission. There may be some overlap in the recommendations of Sections 2 and 3, so that each section can be read on its own.

Section 4 provides a set of references that may be used for an IERICS mission.

Appendix I provides a list of technical subjects that could be considered when defining the scope of a specific IERICS mission. It can be used as a discussion tool with the counterpart.

Appendix II provides a mission report template, including templates for issue sheets and good practices sheets.

The two Appendixes are also available in electronic form for preparation of the specific mission reports by the IERICS team.

2. ORGANIZATION OF THE IERICS MISSION

2.1. OVERVIEW OF THE IERICS PROCESS

An IERICS mission is initiated based on a formal request through official IAEA channels from an organization of a Member State (e.g. nuclear utility, regulatory authority, technical support and design organization). The actions prior to this request are not the object of, and are not discussed in, this guideline. Throughout this guideline, the specific organization that is responsible to answer the requests and questions of the IERICS team is designated as the counterpart. An IERICS mission is typically performed prior to the introduction of a new I&C system design in a new build NPP or to the modernization of the I&C for an existing NPP (taking advantage of the benefits of modern I&C systems).The IERICS related activities are based on the following:

- Documentation describing the design and design basis of the I&C system under review including, but not limited to, documentation demonstrating how the system supports the overall plant safety case.
- Interview and discussions with staff of the counterpart.
- Written procedures, methods, and associated with the design, verification, validation, testing, installation, maintenance, and commissioning of the system under review.
- Written documentation related to the qualification of systems, structures, and components (SSCs) selected for use in the system under review.
- Observations of demonstrations of operation and / or maintenance activities of portions of the systems in the plant or representative test facility.

The review focuses on performance in technical areas, related regulatory requirements, the managerial aspects of policy implementation, the control/coordination of related activities, continuous review and improvement of activities, as well as document control.

The principles and guidance for the IERICS mission service are those outlined in the IAEA safety standards and other I&C related IAEA publications.

It is important to note that an IERICS mission is a flexible service and the review areas, and the depth of the review, can be tailored according to the request of the counterpart and agreed during the preparation for the review.

The IERICS process may be divided into three main phases, each with its own purpose and goals:

- The preparatory phase, which also includes a formal meeting between members of the IAEA staff and the counterpart staff, and is called the preparatory meeting.
- The review phase, which consists essentially of a review mission.
- The follow-up phase, which may include an optional follow-up mission.

Figure 1 provides an overview of the various tasks associated with an IERICS mission.

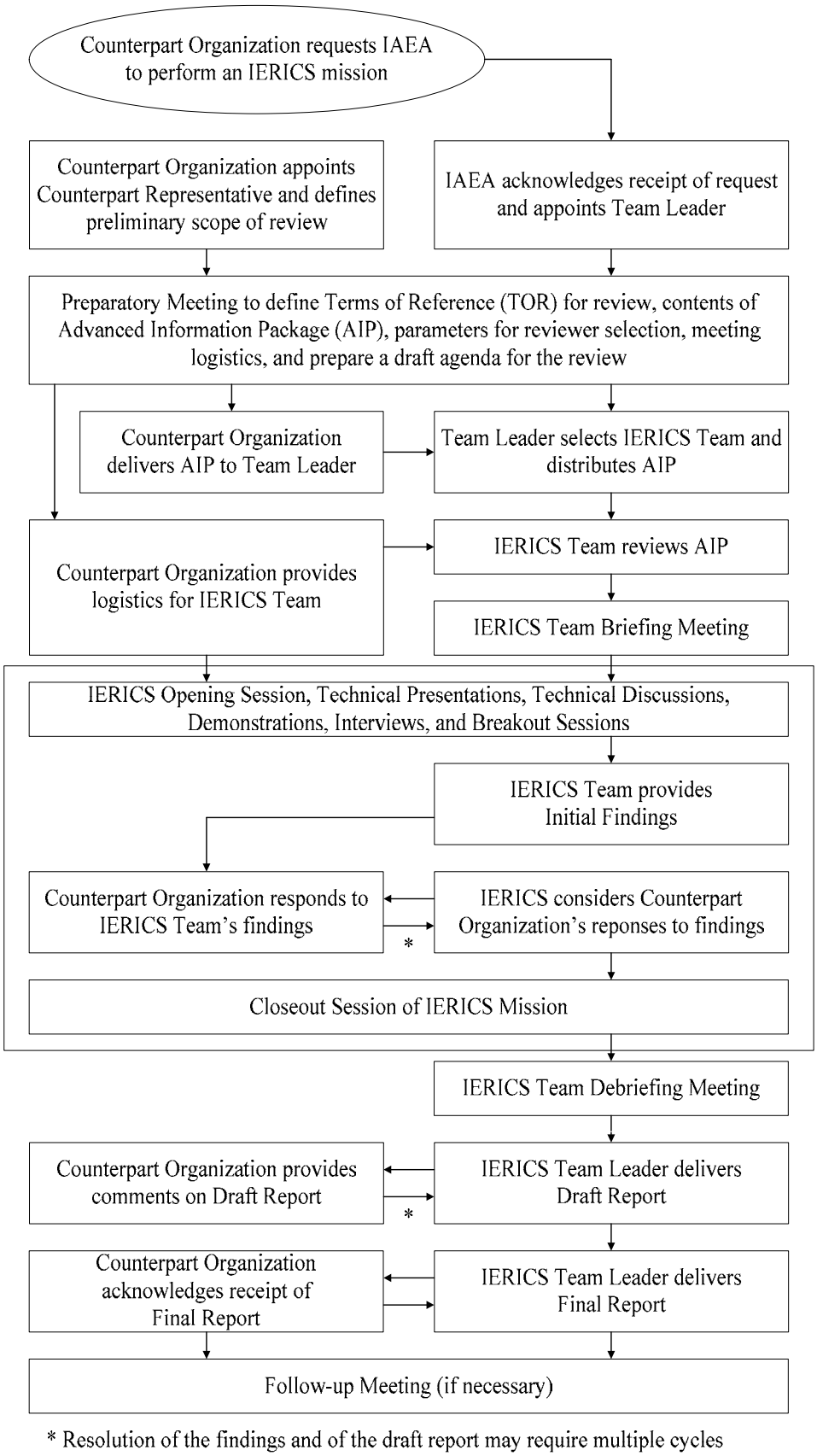

FIG.1. Overview of an IERICS mission.

2.2. PREPARATORY PHASE AND PREPARATORY MEETING

Preparation is the key element for the success of an IERICS mission. The objective of the preparatory phase is to address a number of topics, mainly:

- The appointment of the IERICS team leader, and identification of the counterpart representative.
- The clarification of the objectives and scope of the specific mission.
- The selection of the IERICS team.
- The establishment of the review mission agenda.
- The documents to be provided to the IERICS team members prior to the review mission, i.e. the terms of reference and the advance information package.
- The establishment of a code of conduct to be applied by the IERICS team.
- The resolution of logistics issues (e.g. transportation, lodging, insurance, meeting rooms) for the review mission.
- The establishment and signature of non-disclosure agreements.
- The measures to be taken to address possible language barriers (i.e. translation of review materials and/or translation services during the review mission).
- The selection of specific codes, guides and standards to be applied during the review mission

Preparation should begin no later than six months prior to the review mission. This will enable each participant (from the IERICS team and from the counterpart) to plan for specific activities and to conduct the necessary research and study prior to the review mission.

2.2.1. Appointment of the IERICS team leader

After a mission request for an IERICS mission from an organization of a Member State has been received by the IAEA, the IAEA will designate a staff member (expert in I&C) of the Division of Nuclear Power of the Department of Nuclear Energy as the IERICS team leader. In case the mission is more focused on the safety aspects of I&C systems, the IERICS team leader may be designated from the Division of Nuclear Installation Safety of the Department of Nuclear Safety and Security. At the same time, the counterpart is requested to nominate a contact person, the counterpart representative, with whom the IERICS team leader may directly correspond with. All subsequent activities of the IERICS mission will be under the leadership and responsibility of these two individuals.

In particular, the IERICS team leader is responsible for all preparatory activities, acts as an official liaison with the counterpart organization, co-chairs the review mission with the counterpart representative, prepares and issues the mission report, and is responsible for all follow-up activities. During the review mission, the IERICS team leader may delegate a part of their responsibilities to a deputy, so that they can concentrate on the most strategic issues. In such cases, the delegation should be made clear to all concerned participants.

2.2.2. Objectives and scope of the specific IERICS mission

The exact objectives and scope of the specific IERICS mission need to be stated precisely, based on the IERICS mission request. These should clearly identify:

- Background information on why the IERICS mission was requested and what its expectations are.
- The system to be reviewed (hereafter designated as the system under review), including its main components, their version, and the system boundaries, interfaces and environment.
- The system functions, properties, and features to be assessed by the review.
- The review basis and reference documents against which the system under review will be assessed. These should usually include any relevant IAEA Safety Guides, IAEA Nuclear Energy Series, and IAEA Technical Reports. Other documents describing recognised international good practices, such as IEC standards or IEEE documents may be listed.

2.2.3. Selection of the IERICS team members

The IERICS team is composed of the IERICS team leader and typically four to six additional team members. A deputy team leader may be appointed if necessary. The typical team composition includes a majority of external senior experts and one or two IAEA staff members (the team leader and the deputy team leader if applicable). In case the scope of the mission includes safety-related areas, the appropriate Sections of the Division of Nuclear Installation Safety of the Department of Nuclear Safety and Security will be consulted on the selection of the team members.
The composition and size of the team will usually depend on many factors, such as:

- The competences needed for the review. These competences may be identified based on the main characteristics (technologies, architecture) of the system, on the system properties and features to be assessed, and on the selected review basis and reference.
- The estimated volume of work for the review mission, based on a breakdown of the work to be performed during the review mission into well-defined technical sessions.
- The need to represent a wide scope of international practices. To this end, the team members should represent a variety of national approaches to I&C design and design processes. Team member should have, in addition to their particular area of expertise, knowledge of some other national approaches and some other relevant areas. Coupling this knowledge with the IAEA safety standards and other IAEA guidance publications allows good international practices to be identified.
- In some cases, the need to overcome possible language and/or cultural barriers. In such cases, a team member familiar with the language and culture of the counterpart organization may be of great benefit to the review as a whole.
- The need to avoid conflicts of interest with the counterpart. The selection of team members should consider their impartiality and the relationship of team members' organizations to that of the counterpart. In particular, reviewers from the counterpart and dependent organizations should not be included in the IERICS team. Also, reviewers from organizations considered to be competitors to the counterpart's organization should not be included in the review team.
- The possible need of security vetting. Access to certain facilities and information may require security vetting to be carried out on the IERICS review team. The responsibility for identifying the vetting requirements that allow such access to be granted lies with the counterpart. The responsibility for providing the information to satisfy these requirements lies with the IERICS team leader and team members. The counterpart is

subsequently responsible for handling the information provided and to ensure that the vetting process is completed prior to the review mission.

The selection of the team members is under the responsibility of the IERICS team leader, but the list of team members should be submitted to the counterpart for approval.

The IERICS team members are responsible for preparing for the mission by studying relevant information provided by the counterpart in the advance information package (but not limited to this), preparing plans of their review, and formulating questions and comments prior to commencing the mission.

If the IERICS team leader and the counterpart agree, observers can join the review team. Normally an observer is either an IAEA staff member who needs to be trained for subsequent IERICS missions, or a person from an organization that is going to request an IERICS mission. The observers may assist the IERICS team during the review mission. They are subject to the same rules and constraints (code of conduct, non-disclosure agreement) than the IERICS team members.

The IERICS team members should also provide feedback on the application of the IAEA safety guides (e.g. which parts need to be updated, what issues could not be referenced to the standards).

2.2.4. Review mission agenda

The review mission should be conducted following a review mission agenda. This is a key element for the good implementation of the review mission, as it will be the basis for:

- Estimating the necessary competences and resources, both for the IERICS team and for the counterpart.
- Determining whether the objectives and scope of the IERICS mission are compatible with the available resources and time schedule.
- Other aspects of the preparation phase, such as the preparation of presentations and information packages by the counterpart, and the preparation of logistic aspects (e.g. meeting rooms, technical visits).

The agenda would typically make provision and plan for different types of work sessions:

- The briefing meeting for the IERICS team, to make sure that all team members have the required background information.
- A plenary opening session, where the IERICS team and the counterpart introduce one another and present a reminder of the objectives and scope of the IERICS review and of the mission.
- Several technical sessions, where the IERICS team and the counterpart discuss the technical aspects of the system under review; different sub-types of technical sessions may be identified, such as:
  - Technical presentations, where the counterpart presents aspects of the system to the IERICS team.
  - Technical visits that allow the IERICS team to collect facts on the ground that may be otherwise difficult to determine from the documentation and/or presentations.
  - Focused reviews that allow the IERICS team to study some selected topics in deep detail.

- IERICS team meetings (involving only the IERICS team members) allow the team members to share their information and understanding, to compare points of view and to reach a team consensus on questions and findings.
- A plenary closeout session, where the IERICS team presents its findings, the counterpart expresses their point of view, and the IERICS team adjusts its findings as appropriate.
- The debriefing meeting (involving only the IERICS team members), where the team develops a quasi final state for the mission report.

Sections 2.3 provides specific guidelines for each of these work session types. Hereafter are a few general suggestions pertaining to the review mission agenda:

- The development and modification of the review mission agenda needs a close cooperation between, and the agreement of, the IERICS team leader and the counterpart representative, as both sides will need to do extensive preparation prior to the mission.
- A technical session may be a plenary session (i.e. involving the complete IERICS team) or a breakout session (i.e. involving only a part of the IERICS team). Plenary sessions facilitate the sharing of information within the team. Breakout sessions optimise the use of the team resources when many subjects need to be covered, or when the team members have very different and exclusive competencies. It is usually the responsibility of the IERICS team leader to decide which subjects will need to be covered by plenary sessions, and which by breakout sessions.
- Enough time needs to be devoted to IERICS team meetings, so that the findings and conclusions of the review are those of the team, and not only of individual team members. They should be held at the end of each day. They may be rather short the first days, but as the review mission gets closer to the closeout session, more time is necessary to harmonise viewpoints and finalise the findings list.
- Enough time should be given to the counterpart to provide adequate answers, but the counterpart should anticipate that issues will arise and should have adequate resources and competences available to respond rapidly.

2.2.5. Terms of reference

During the preparatory phase, the IERICS team leader should prepare draft terms of reference for the IERICS mission. This should be discussed with the counterpart during the preparatory meeting. The terms of reference should contain the following items:

- Background information.
- Objectives and scope of the review.
- Date and place for the review.
- Names of IERICS team leader and counterpart representative.
- Names and resumes of the IERICS team members.
- Review basis and reference.
- Review subjects (the system under review).
- Work scope of each IERICS team member (if applicable).
- Provisional review mission agenda.
- Reporting Structure.
- Contents of the advance information package.

2.2.6. Advance information package

The advance information package is the set of documents that the counterpart makes available to the IERICS team members during the preparatory phase. It should, as a minimum, contain programmatic type information for each reviewed area and should be written in English. The suggested contents of the advance information package are:

- A brief description of the system to be reviewed, including an overview of the design and / or design activities which are to be reviewed.
- Any useful background information, such as:
  - Why the IERICS mission was requested.
  - The development history of the system under review, and the roles of the various intervening organizations, including the counterpart.
  - What system the system under review is replacing, and what improvements are expected from the new system, if applicable.
  - Other applications where the system may be applied.
- Administrative arrangements, such as the accommodation for the IERICS team during the review mission, transportation of the IERICS team members to this accommodation and the counterpart's facilities, and financial arrangements for reimbursement of the IERICS team members.

The counterpart should start preparing the advance information package early enough to be submitted at least two months prior to the review mission.

The IERICS team leader should supplement the advance information package with additional resources and administrative information, such as electronic templates for the mission report, issue sheets template and good practices sheets template, and a code of conduct for the review mission.

2.2.7. Code of conduct

The counterpart should have a set of procedures covering the expectations for the code of conduct appropriate to the facilities being visited by the IERICS team. Compliance with these procedures must be adhered to ensure that the review is carried out appropriately. It is the responsibility of the counterpart to provide these procedures as part of the advance information package in order to get the IERICS team members to understand and agree with their content prior to the initial review visit.

The types of procedures likely to apply are as follows:

- Handling of sensitive information.
- Health and safety at the facilities.
- Policies and procedures for working at the facility.

In addition, there may be circumstances where IAEA expectations for code of conduct are applicable. If this is the case then these too must be discussed and agreed with the IERICS team members before the review mission takes place.

The code of conduct may also include rules or suggestions pertaining to the cultural codes of the counterpart, and to the cooperation within the IERICS team.

2.2.8. Logistics

The finalization of the logistical support for the review mission should be completed well in advance of the mission. This includes, but may be not limited to:

- The accommodation for the IERICS team during the review mission.
- The transportation of the IERICS team members to this accommodation and the counterpart's facilities.
- The meeting and presentation facilities during the review mission, including for the Internal meetings of the IERICS team.
- The availability of necessary counterpart staff and documentation during the technical sessions.
- Contact information that the colleagues and family of IERICS team members can use reach them during the mission.
- Contingency plan and mobile phone contact numbers to be used in the event that any team member encounters delays or other problems during travel.

2.2.9. Non-disclosure agreements

Portions of the review material may be deemed as proprietary information, and the contents of the mission report itself will be proprietary information. Members of the IERICS team are expected to sign non-disclosure agreements prior to the start of the mission review and to manage proprietary information in an appropriate manner.

The counterpart needs to provide reasonable access to proprietary material prior to and during the review process. It is expected that after the closeout meeting, any printed proprietary information provided to the IERICS team is returned to the counterpart (or appropriately disposed of), and any electronic files associated with the review on team members' electronic media is deleted after the draft copy of the mission report has been submitted to the counterpart. Only the IERICS team leader will retain a master copy for future reference.

2.2.10. Language barriers

The working language of an IERICS mission is English. Where required, the counterpart is expected to provide translation services during the review mission. In cases where the original design documentation is in a language other than English, a summary of its contents can be provided to the IERICS team as part of the presentations / discussions. For key documents, the IERICS team may need a translation of the full table of contents, and even a translation of selected (significant) portions of the document.

2.2.11. Contact with the IERICS team during preparation

To ensure good communications between the IERICS team members, regular contact should be maintained by the IERICS team leader. This will help to minimise the risk that the team is not fully mobilised at the start of the review and avoid the need to instigate contingency plans.

2.2.12. Preparatory meeting

The main purpose of the preparatory meeting is to facilitate the preparation of the review mission, and to minimise any risks of misunderstanding between the IERICS team leader and the counterpart representative. This is typically a two or three day mission, where the IERICS team leader and possibly some team members meet face to face the counterpart representative and management:

- To finalise the objective and scope of the IERICS mission.
- To resolve any difficulties in contract negotiations.
- To agree on a provisional review mission agenda.
- To discuss on such issues as logistics, need for translation, code of conduct, etc.

2.3. REVIEW MISSION

2.3.1. General guidelines for the review mission

Hereafter are a few general guidelines pertaining to the review mission:

- It is essential for the success of the review to set and maintain a cooperative, professional, and courteous atmosphere, both within the IERICS team and between the IERICS team and the counterpart.
- The review mission should be conducted following the review mission agenda. However, flexibility will often be necessary to take into account the findings made during the review (which could require specific investigation) and the contingencies inherent to any activity involving a large number of contributors.
- Throughout the mission, damaging misunderstandings could arise from different interpretations of technical terms, abbreviations and expressions. It is thus necessary for both the IERICS team and the counterpart to maintain a glossary that explicitly defines the terms, abbreviations and expressions that could be misleading.
- Examination of the documents provided by the counterpart must be performed under the procedural requirements of the counterpart. Agreement should be obtained from the counterpart to take documentation away from the facility if required as part of the review. Documentation taken away from the facility should be handled as required by the counterpart.
- Frequent communication between the IERICS team leader and the counterpart representative and management is necessary, e.g. to agree on agenda modifications, to clarify any misunderstandings. In particular, the counterpart representative should have daily meetings with the IERICS team and should be invited to advise the IERICS team when information may not be complete or correct. In cases of misunderstanding or where issues need further clarification, the counterpart representative should be invited to advise the IERICS team of the responsible or knowledgeable counterpart staff in specific areas who can provide clarification to clear the misunderstanding or provide clarification.

2.3.2. Briefing meeting

The objective of the briefing meeting is to make sure that the whole IERICS team has all necessary information regarding:

— The objectives, scope and background of the review and the review mission, from the IAEA standpoint; this includes in particular a clear identification of the system under review and of the review basis and reference documents.
— The code of conduct to be applied by the IERICS team members during the review mission.
— The name, background, domains of competence and role of each IERICS team member. In particular, the IERICS team leader may choose to delegate specific parts of their role to designated team members.
— The review mission agenda.
— The logistics for the review mission, from the IAEA standpoint.

The briefing meeting may also be the opportunity:

— To finalise the initial IERICS questions list resulting from the preparation phase;
— If necessary, to finalise any pending formalities, such as the signing of the non-disclosure agreement forms, or the signing of contracts.
— To deal with any last minute changes.

Hereafter are a few general suggestions pertaining to the Briefing meeting:

— The meeting is typically held the day preceding the review mission per se, and typically lasts a few hours.
— The briefing meeting is normally chaired by the IERICS team leader.
— As far as practically possible, it should involve all IERICS team members participating in the review mission.
— The IERICS team leader should ensure that each IERICS team member has a copy of terms of reference and is fully aware of its contents prior to the beginning of the review mission per se.
— In order to ensure that a quasi-final state of the mission report can be reached at the debriefing meeting, the responsibilities within the team for the different sections of the mission report should be allocated and agreed upon during the briefing meeting.
— The counterpart could participate in the meeting as an observer, or to convey information that would be difficult or awkward to address in the plenary opening session.

2.3.3. Opening session

The objective of the opening session is to make sure that all the participants to the review mission (IERICS team and counterpart) have all necessary or useful information regarding:

— The objectives, scope and background of the review and the review mission, from the counterpart and from the IAEA standpoints.
— The counterpart’s organization and background.
— The precise identification of the system under review, including its boundaries and environment.
— The review basis and reference.

— The name, background and role of each participant.
— The review mission agenda.
— The review basis and references.
— The logistics for the review mission.
— Any constraints pertaining to confidentiality of information, security and safety of the participants.

The opening session may also be the opportunity for:

— A welcome address and opening remarks by the counterpart.
— A presentation of the initial questions list from the IERICS team.

Hereafter are a few general suggestions pertaining to the opening session:

— The meeting is typically held at the very beginning of the review mission per se (excluding the Briefing meeting).
— The opening session is normally co-chaired by the IERICS team leader and by the counterpart representative.
— As far as practically possible, it should involve all participants to the review.
— When presenting themselves, the IERICS team members should describe their area of expertise and their experience: this introduction provides the counterpart with a point of reference.
— The counterpart should then be asked to introduce their staff in a similar fashion; IERICS team members should note the members of the counterpart staff who represent their area of interest.
— In the presentation of the system under review, the counterpart should be asked to provide a system overview, showing the overall system architecture, its boundaries and interfaces with its environment, and the functional flow of information and control. This overview could allow the counterpart to use presentation materials they may already have.
— An advance information package is expected from the counterpart, summarising the topics that will be presented and discussed during the review; each IERICS team member should have a copy of the package.
— The IERICS team members should note areas of interest during the overview, but leave detailed questioning for the technical sessions.

2.3.4. Technical sessions

Hereafter are a few general suggestions pertaining to technical sessions:

— The IERICS team and the counterpart should each designate a co-chair for the session; the role of the co-chairs is to keep the session focused, maintain the session schedule, and ensure that discussions remain courteous and cooperative;
— Focus should remain on the objectives of the session, i.e. compliance to the pertaining elements of the review basis and references;
— Upon the end of the session, a discussion with the counterpart should take place in order to clarify any remaining questions from the IERICS team. A list of pending questions

that need more time to be answered (i.e. requests for clarification or more information) should be established and agreed upon by the co-chairs, and a tentative time table for resolution should be set;

— During the session, the participating IERICS team members should start noting possible issues and good practices;

— In case of a breakout session, the participating IERICS team members should prepare a brief report to inform the other team members.

2.3.5. Technical presentations

In a technical presentation, the counterpart has a leading role and presents a specific aspect of the system under review, at a level of detail that allows the IERICS team to assess the system's compliance to the review basis and references. A typical technical presentation has three main phases:

— An introductory phase, where the aspect(s) of the system to be discussed, and the pertaining elements of the review basis and references, are clearly identified;

— A presentation phase, where the counterpart presents the necessary information, in the form either of presentation slides or of documentation items;

— A discussion phase, where the IERICS team asks for clarification or additional details, and the counterpart provides immediate answers where possible.

Hereafter are a few general suggestions pertaining to technical presentations:

— Whether interruptions can be made during the presentations should be agreed upon at the beginning of the session by the co-chairs, but interruptions should not prevent the presenters from completing their presentation;

— The presentation slides, if any, should be included in the advance information package or provided to the IERICS team members.

2.3.6. Technical visits

Technical visits are usually optional but are very desirable. They may greatly help the IERICS team in obtaining information that would be difficult to gather from the documentation or from technical presentations. They may be performed at various places, such as with the real system on site (where it is operated or to be operated), at a system development facility, at a system testing facility (i.e. a system integration site), at a simulator facility, etc.

Technical visits are usually less structured and their objectives more open than technical presentations and focused reviews, but a few general suggestions may apply:

— Technical visits are usually proposed by the counterpart, but the IERICS team leader may make suggestions, based on the objectives and scope of the review.

— A technical visit usually begins with a short presentation by the counterpart of what is to be seen, of what specific rules and constraints may apply, of the accompanying counterpart staff and their domains of competence, in case IERICS team members have specific questions during the visit.

— The participating IERICS team members may decide prior to the visit or at the end of the counterpart's presentation to distribute among themselves the different aspects to be examined during the visit.
— "Surprising" observations during the visit should be shared between the participating IERICS team members, so that possible implications may be assessed more thoroughly.

2.3.7. Focused reviews

A focused review follows a specific subject through counterpart's documentation to a deep level of detail. The issues that are the object of a focused review are usually selected because of their importance with respect to the objectives of the IERICS review, or because they are representative of large parts of the system.

An example of the first category would investigate measured to cope with common cause failures. An example of the second category would follow a particular system function from inputs to outputs through all system layers. Another example of the second category would follow how failures are reported and analysed, and would track a few specific failure events from initial detection to final resolution. In the first and second examples, the focused review follows a purely technical path, whereas in the third example, it follows a work process, evaluating technical aspects at discrete locations.

A focused review is usually under the leadership of the IERICS review team. It is usually composed of three main phases:

— A short definition phase, where the IERICS team explain the subject of, and their objectives for, the review session.
— A short presentation phase, where the counterpart explains how the subject is handled in the system under review or in their work processes, and the organization of their pertaining documentation.
— A "thread analysis" phase consisting in interviews and examination of specific documents or parts of documents by the IERICS team.

Hereafter are a few general suggestions pertaining to focused reviews:

— The list of focused reviews and their scopes are usually determined by the IERICS team leader, and agreed upon by the counterpart. Though it is preferable to plan them ahead of the review mission, some may be decided during the mission based on the questions raised. Enough preparation time should be given to the counterpart so that they may make adequate provisions regarding competent staff and access to documentation.
— IERICS team members should dig deep enough to get a clear understanding of the subject, but they should also guard against wasting time on technical details that are not relevant.

2.3.8. IERICS team meeting

Meetings involve only the IERICS team members. The objective of the meeting is to allow the team members to share information and understanding, to compare points of view, to maintain a list of questions and clarification items, and to reach a team consensus on findings. Another essential objective is to develop the mission report.

Hereafter are a few general suggestions pertaining to meetings:

- The IERICS team should hold one such session at the end of each day, when impressions and information are still fresh in their minds.
- Meetings are particularly necessary in the case of breakout sessions, so that the whole team may share information.
- During the first few days, meetings will usually tend to be short (typically one hour or less), but as the review mission nears the closeout session, more time is usually necessary to merge the findings of individual team members into a consistent and well-organized list.
- Progress regarding the mission report should be checked at each meeting. In order to ensure that a quasi-final state of the report can be reached at the Debriefing meeting, any relevant information should be inserted in the report as soon as it is available.
- The IERICS team leader plays an important role in maintaining the cohesion and the focus of the team during meetings.

2.3.9. Closeout session

The objectives of the closeout session are:

- For the IERICS team to present their findings (comments, issues, recommendations, suggestions and good practices) to the counterpart.
- For the counterpart to provide their feedback on the IERICS team findings.
- For the IERICS team to make any appropriate adjustments to their findings, or to the way the findings are to be presented in the report.

The closeout meeting is also the opportunity to take leave from the counterpart Staff and consider any follow-up action.

Hereafter are a few general suggestions pertaining to the closeout meeting:

- The session is typically held at the very end of the review mission per se (excluding the Debriefing meeting).
- The closeout session is normally co-chaired by the IERICS team leader and by the counterpart representative.
- As far as practically possible, it should involve all participants to the review.
- A written list of findings should be provided to the counterpart prior to the session (typically, the day before), so that the counterpart has time to prepare their feedback.
- Any adjustment from the written findings should be made clear during the session, in such a way that the counterpart is not “surprised” by the final findings.

2.3.10. Debriefing meeting

The Debriefing meeting involves only the IERICS team. Its objective is to develop a quasi final state for the mission report, and to allocate any remaining work within the team.

Hereafter are a few general suggestions pertaining to the debriefing meeting:

- The meeting is typically held the day following the review mission per se, and typically lasts a few hours.
- The meeting is chaired by the IERICS team leader.

— As far as practically possible, it should involve all IERICS team members participating in the review mission.
— The responsibilities within the team for the finalization of the mission report should be allocated and agreed upon during the debriefing meeting.

2.4. FOLLOW-UP MISSION

The objective of a follow-up mission is to assess progress made in the resolution of the issues identified, and in particular in the implementation of the recommendations and possibly of the suggestions.

General guidelines:

— Decision, scope and timing are based on a mutual agreement between the IERICS team leader and the counterpart
— The follow-up mission team should be composed of the team leader and preferably one or two other members of the original review team
— It should be performed typically 12 to 18 months after the main mission.
— It should last typically three days, depending on the volume and complexity of work
— There should be a preparation phase like the main review mission. The counterpart sends in advance to the IAEA all issue sheets from the main mission, having completed the recent status of issues and the response to recommendations / suggestions to the IAEA in advance.
— The guidelines for the main review mission also apply.

2.5. REPORTING AND DOCUMENTING

2.5.1. Mission report

The mission report is the deliverable of the IERICS team for the mission. It presents the background, objective and scope of the mission, the system under review, the review basis and reference, and the findings made by the team during the review. A suggested report format is provided in Appendix II of this document.

Findings may be classified into two categories: Issues and good practices, and are discussed in more details in the following sections. Figure 2 provides an overview of how the mission findings will be resolved and documented in the mission report.

2.5.2. Issues and issue sheets

An issue is an identified concern or an area of improvement, which has been identified on the basis of the review basis and reference and/or the internationally recognized good practices in the subject. Each issue is presented in an issue sheet which addresses the following topics:

(1) Issue identification, with issue number and title, mission name, reviewed area.
(2) Issue clarification, with issue description, issue origin (IAEA review team or counterpart), source documents, reference to any other relevant documents.
(3) Counterpart’s view on the issue.
(4) Assessment by the IERICS team, with comments, recommendations and suggestions.
(5) Counterpart’s response on recommendations and suggestions.
(6) Counterpart’s actions taken after the mission and prior to the follow-up assessment.

(7) Follow-up assessment by the IERICS team, with possibly new comments, recommendations and suggestions.
(8) Status of the issue (no action, actions planned or under way, issue partially resolved, issue completely resolved).

An issue sheet template is given in Appendix III.

Sections 3 and 5

The purposes of Sections 3 and 5 of the issue sheets are to reflect the views of and the measures taken by the counterpart for the issue resolution. They are optional, and the counterpart may choose not to fill them in.

Sections 4 and 7

The purposes of Sections 4 and 7 of the issue sheets are to reflect the discussions with the counterpart experts, to record the conclusions, to issue possible Recommendations and Suggestions, and to synthesize the IERICS team judgment on the resolution of the issue under discussion. However, the IERICS team should not be too prescriptive in the methods to resolve the issue, and suggest only the goals to be reached. However, advice can be given if requested.

Sub-Sections 4.1 and 7.1 - Comments

They are observations of the IERICS team based on the review and the discussions during the mission. It is for information only, no action or response is required from the counterpart.

Sub-Sections 4.2 and 7.2 - Recommendations and Suggestions

A recommendation is an advice from the IERICS team on what improvements should be made that would contribute to resolve an issue. Follow-up action is required for a recommendation.

A suggestion is also an advice from the IERICS team on what improvements may be made that would contribute to resolve an issue. Follow-up actions are optional for a suggestion, as suggestions are primarily made to bring design and/or procedures more in line with internationally recognized good practices.

If an item is not considered significant enough to meet the criteria of a ‘suggestion’, but the IERICS team feels that mentioning it is still considered significant, a comment regarding on the item may be made in the text of the mission report (e.g. “the team encouraged the operating organization to…”)

Recommendations, suggestions, and comments, are numbered in sequential order for further reference. The reviewed documents (corresponding specifically to the issue under consideration) are also listed.

As much as possible, each recommendation and suggestion should be referenced to the relevant requirement/recommendation of respective review basis and reference documents.

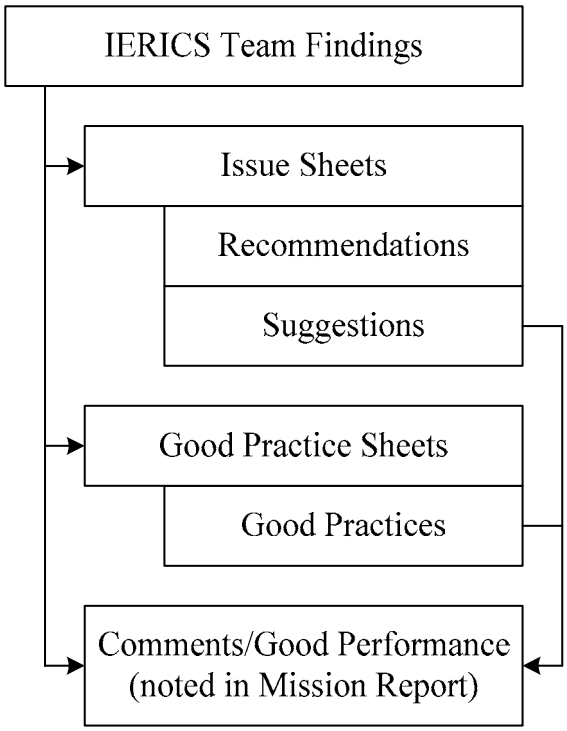

FIG.2. Resolution of the mission findings.

Status of the Issue

The status of the issue under consideration is assessed and the respective resolution degree is assigned to reflect the judgment of the IAEA review team. The degree is scaled from 1 to 4, as indicated in the issue sheet template.

The urgency degree of the issue resolution should also be evaluated and indicated in the corresponding part of the issue sheet. Promptness in the resolution of the issue may be assessed through a scale of the urgency degree, from I to II in relation to a specific deadline or critical event.

The first date in the resolution degree and urgency degree tables is the date when the issue is developed. The second date in the tables is the date when the status of the issue is checked during the follow-up mission.

2.5.3. Good practices and good practices sheets

A good practice is an outstanding and proven performance, programme, activity or design element in use that contributes directly or indirectly to system safety and sustained good performance. A good practice is markedly superior to other practices observed elsewhere, not just in its fulfilment of current requirements or expectations. It should be sufficiently superior and have broad enough application to be brought to the attention of other NPPs, suppliers, assessors, integrators, etc. and be worthy of their consideration in the general drive for excellence. A good practice has the following characteristics:

- It is novel.
- It has a proven benefit.
- It can be used at other plants.
- It does not contradict an Issue.

The attributes of a given good practice (e.g. whether it is well implemented, or cost effective, or creative, or it has good results) should be explicitly stated in the description section of the good practice sheet.

Note: An item may not meet all the criteria of a good practice, but still be worthy to take note of. In this case it may be referred as ‘good performance’, and may be documented in the text of the report. A good performance is a superior objective that has been achieved or a good technique or programme that contributes directly or indirectly to system safety and sustained good performance, that works well at the plant. However, it might not be necessary to recommend its adoption by other NPPs, because of financial considerations, differences in design or other reasons.

3. REVIEW PRINCIPLES

The IERICS mission is intended to conduct reviews of I&C system design documentation, prototype systems and systems in actual operation on the plant. The IERICS mission is based on appropriate IAEA documents, such as the Safety Guides and the Nuclear Energy Series.

The Safety Guides, specifically NS-G-1.3, should be used to establish the approach to the review. For example, for a design review, the following chapters from NS-G-1.3 would be used for the review of an I&C design:

- Chapter 4; General design guidelines requirements
- Chapter 5: Specific design guidelines requirements
- Chapter 7: Design process for I&C systems important to safety.

From these chapters, specific requirements for the mission can be drawn.

Obtaining information during the review should be based on observations, interviews, document reviews, and equipment walk downs. Information obtained through the above process becomes an important foundation for the overall review results.

3.1. REVIEW TECHNIQUES

The IERICS review team uses five steps to acquire the information needed to develop their recommendations/suggestions. The five steps are:

(1) Review of written material and / or presentations.
(2) Discussion and interviews.
(3) Direct observation of programme implementation and the status of the i&c systems.
(4) Discussions among the review team.
(5) Discussion of evaluations/tentative conclusions with counterparts.

3.1.1. Use of review techniques

The use of review techniques mentioned above should be planned in advance. Arrangements should be made with the counterpart as to how to perform the discussions / interviews and observations.

The IAEA review team has meetings in which the experts present their actual findings, summarize their concerns developed during the reviews, and discuss actual issues. This creates an opportunity for other team members to contribute their views, further strengthening the experience base of the evaluation. It is important that each expert comes to the meeting prepared to make a concise statement of their findings, in order to allow the other review areas to be discussed at the same meeting. These meetings will determine those issues to be presented to the counterpart for consideration by the counterpart's organization. A template for the issue sheets is shown in Appendix III.

Formulation of comments, recommendations and suggestions should be based on the identified issues. Similarly, good practices discovered during the process of the review that should be documented for the benefit of other Member States are described in the good practices sheets in sufficient detail as to be readily understood.

Based upon the discussions and observations, the reviewers can, if necessary, modify their preliminary view. Multiple cycles of document review, discussions, interviews, and observations may be required for a clarification and resolution of complex issues and/or findings.

3.1.2. Review of written material

Appendix I of this document provides a broad range of I&C topics and issues that the IERICS team should consider during the IERICS review. It should be noted, however, that the scope of the review mission will dictate which portions of the Appendix are relevant (and within the scope of the review mission).

Reviewers should consider and utilize this material during their review of the advance information package in both the preparatory phase and the implementation phase of the IERICS mission.

3.1.3. Presentations, discussion and interviews

The IERICS team will conduct discussions / interviews with the counterpart with the aim to:

- Provide additional information not covered by the advance information package.
- Answer questions, and satisfy concerns arising out of the documentation review.
- Obtain an in-depth understanding of :
  - The important characteristics of the system.
  - The development processes applied (lifecycle, V&V, methods, ...).
  - The associated work procedures and activities.
- Form a joint judgment on the findings.

The discussions / interviews are also used to provide the opportunity for exchanging all the important information between the IERICS team members and their counterparts, and therefore should be held at the working level between peers. These interviews should be a 'give and take' discussion and not an interrogation of the counterparts by the team members. Properly conducted, these discussions / interviews are possibly the most important part of the IERICS mission.

In addition, presentations by the counterparts (both formal and informal) can be used as a means of obtaining further information and to fill in the information gaps identified as a result of the review of the advance information package.

Where possible, equipment demonstrations and technical visits may be held to provide the review team with a deeper understanding of the system. This may include demonstrations with prototype hardware/systems or at system test and validation facilities.

3.1.4. Direct observation of performance, status and activities

Direct observation of the application of processes and use of procedures supporting the design, functionality, operation and performance of the system under review means on-site observation of the following:

- Implementation of development procedures and plant programmes:
  - Use of procedures, tools and instructions.
  - Regular and specific reporting.
  - Quality assurance and quality control processes.
  - Collection, storage and retrieval of data.
  - Configuration management.
  - Change control.
  - Record keeping and trend monitoring.

- Arrangement for monitoring of effectiveness of the processes.
- Management control.

— Where appropriate, physical conditions of the selected I&C systems within the scope of the review:
  - Equipment walk-downs.
  - Inspection reports.

From these observations, the reviewers will form a position on:

— The quality of the processes supporting the design, functionality, operation and performance.
— The level of commitment of the staff and the overall safety culture of the counterpart;
— Capability of the staff in terms of resources and technical knowledge and skills.
— The overall condition of the facilities and I&C systems within the scope of the review.

3.2. SOURCES OF INFORMATION

3.2.1. Background information

Background information will be required to achieve a common understanding of the starting point of the review process. In particular, the following should form the basis of this common understanding:

— Position and role of the counterpart in the plant design and/or operation.
— History of development and changes in the system under review.
— Previous assessments by other organizations (e.g. regulatory assessments, third party qualification, audits …).
— Environment and interfaces of the reviewed system.
— System role (particularly with regards to safety role).
— Boundaries and constraints.

Other common background information may be agreed as part of the background information.

3.2.2. Information provided by the counterpart

Examples of the main information sources to be provided by the counterpart are as follows:

— The advance information package.
— Design basis documentation:
  - System and equipment specifications.
  - Design documents.
  - Test reports.
  - Qualification reports.
  - Reliability evaluation reports.
  - V&V documentation.
  - Configuration management procedures.

— Programme for modifications and replacements; rationales for previous modifications (based on operations feedback where applicable).
— Lifecycle management and processes.
— Already identified issues based on a self-assessment by the counterpart.

The scope of information sources should be defined and agreed in the terms of references.

3.3. DEVELOPMENT OF FINDINGS

During the course of the review, the IERICS team will hold internal consolidation sessions (IERICS team meetings) to develop a common set of findings. The team will write down the issue and good practice sheets, and will update them as necessary after discussion with the counterpart. In writing the sheets, the following should be taken into account:

— Emphasis should be given to the reviewers' observations, with minimum description and clear conclusions.
— Wherever possible, reference to IAEA safety standards and other reference documents should be provided.
— Language should be clear, concise, objective and impersonal.
— Short, direct sentences aid understanding.
— Official names should be used to designate organizational units, positions and systems.
— Abbreviations or acronyms shall be introduced upon their first use and compiled in a list.

The issue and good practice sheets should be written in English, and modified and supplemented, if necessary, through the entire period of the review. Templates for the Issue and good practice sheets are provided in Appendix III and Appendix IV.

3.4. WORKING WITH THE COUNTERPART

Besides the interviews and meetings with the counterpart described in section 3.1, the work with the counterpart on site involve the following activities:

— The Opening Session.
— Regular meetings arrangements (meeting with the counterpart, summary team meetings, etc.), and
— The closeout session.

During the opening session with the counterpart, the organization and performance of the review should be presented. Possible, focused working teams for specific areas may be established. The working teams in each area consist of designated IERICS team members, counterpart experts and their technical support. It is advisable to have every day a short regular meeting of all participants to discuss the actual organizational issues for the working day.

The IERICS team members will plan their schedules such that a primary and an alternate objective are always scheduled. Schedule of activities should be updated daily and discussed with the counterpart.

The counterpart should be informed on a regular basis of the preliminary findings and recommendations made by the review team. Whenever possible, an agreement should be reached between the IERICS team and counterpart on every finding and recommendation. Representatives of the counterpart may attend the daily team meeting, if necessary.
The day before the closeout session, the IERICS team experts should deliver their part of the mission report as already agreed upon with the counterpart.

A formal closeout session is held the last day of the review mission. At this session, all the IERICS team members provide short conclusive statements summarizing findings, recommendations and suggestions.

4. REFERENCES

An IERICS mission may refer to the following IAEA documents published on I&C systems.

4.1 IAEA SAFETY STANDARDS SERIES

— INTERNATIONAL ATOMIC ENERGY AGENCY, Software for Computer Based Systems Important to Safety in Nuclear Power Plants, IAEA Safety Standards Series No. NS-G-1.1, IAEA, Vienna (2000).

— INTERNATIONAL ATOMIC ENERGY AGENCY, Instrumentation and Control Systems Important to Safety in Nuclear Power Plants, IAEA Safety Standards Series No. NS-G-1.3, IAEA, Vienna (2002).

— INTERNATIONAL ATOMIC ENERGY AGENCY, Design of Emergency Power Systems for Nuclear Power Plants, IAEA Safety Standards Series No. NS-G-1.8, IAEA, Vienna (2004).

4.2 IAEA NUCLEAR ENERGY SERIES

— INTERNATIONAL ATOMIC ENERGY AGENCY, On-line Monitoring for Improving Performance of Nuclear Power Plants; Part 1: Instrument Channel Monitoring, IAEA Nuclear Energy Series No. NP-T-1.1, IAEA, Vienna (2008).

— INTERNATIONAL ATOMIC ENERGY AGENCY, On-line Monitoring for Improving Performance of Nuclear Power Plants; Part 2: Process and Component Condition Monitoring and Diagnostics, IAEA Nuclear Energy Series No. NP-T-1.2, IAEA, Vienna (2008).

— INTERNATIONAL ATOMIC ENERGY AGENCY, The Role of I&C Systems in Power Uprating Projects in Nuclear Power Plants, IAEA Nuclear Energy Series No. NP-T-1.3, IAEA, Vienna (2008).

— INTERNATIONAL ATOMIC ENERGY AGENCY, Implementing Digital I&C Systems in the Modernization of Nuclear Power Plants, IAEA Nuclear Energy Series No. NP-T-1.4, IAEA, Vienna (2009)

— INTERNATIONAL ATOMIC ENERGY AGENCY, Protecting Against Common-Cause Failures in Digital I&C Systems, IAEA Nuclear Energy Series No. NP-T-1.5, IAEA, Vienna (2009).

— INTERNATIONAL ATOMIC ENERGY AGENCY, Integration of Analog and Digital Instrumentation and Control Systems in Hybrid Control Rooms, IAEA Nuclear Energy Series No. D-NP-T-3.10, IAEA, Vienna (to be published in 2010).

— INTERNATIONAL ATOMIC ENERGY AGENCY, Core Knowledge on Instrumentation and Control Systems in Nuclear Power Plants, IAEA Nuclear Energy Series No. D-NP-T-3.12, IAEA, Vienna (to be published in 2010).

4.3 IAEA TECHNICAL DOCUMENTS (TECDOC)

— INTERNATIONAL ATOMIC ENERGY AGENCY, Management of Life Cycle and Ageing at Nuclear Power Plants: Improved I&C Maintenance, IAEA-TECDOC-1402, IAEA, Vienna (2004).

— INTERNATIONAL ATOMIC ENERGY AGENCY, Managing Modernization of Nuclear Power Plant Instrumentation and Control Systems, IAEA-TECDOC-1389, IAEA, Vienna (2004).
— INTERNATIONAL ATOMIC ENERGY AGENCY, Solutions for Cost Effective Assessment of Software Based Instrumentation and Control Systems in Nuclear Power Plants, IAEA-IAEA-TECDOC-1328, IAEA, Vienna (2003).
— INTERNATIONAL ATOMIC ENERGY AGENCY, Harmonization of the Licensing Process for Digital Instrumentation and Control Systems in Nuclear Power Plants, IAEA-TECDOC-1327, IAEA, Vienna (2002).
— INTERNATIONAL ATOMIC ENERGY AGENCY, Information Integration in Control Rooms and Technical Offices in Nuclear Power Plants, IAEA-TECDOC-1252, IAEA, Vienna (2001).
— INTERNATIONAL ATOMIC ENERGY AGENCY, Assessment and Management of Ageing of Major Nuclear Power Plant Components Important to Safety: In-containment Instrumentation and Control cables. Volume I, IAEA-TECDOC-1188, IAEA, Vienna (2000).
— INTERNATIONAL ATOMIC ENERGY AGENCY, Assessment and Management of Ageing of Major Nuclear Power Plant Components Important to Safety: In-containment Instrumentation and Control cables. Volume II, IAEA-TECDOC-1188, IAEA, Vienna (2000).
— INTERNATIONAL ATOMIC ENERGY AGENCY, Management of Ageing of I&C Equipment in Nuclear Power Plants, IAEA-TECDOC-1147, IAEA, Vienna (2000).
— INTERNATIONAL ATOMIC ENERGY AGENCY, Specification of Requirements for Upgrades Using Digital Instrument and Control Systems, IAEA-TECDOC-1066, IAEA, Vienna (1999).
— INTERNATIONAL ATOMIC ENERGY AGENCY, Modernization of Instrumentation and Control in Nuclear Power Plants, IAEA-TECDOC-1016, IAEA, Vienna (1998).
— INTERNATIONAL ATOMIC ENERGY AGENCY, Pilot Study on the Management of Ageing of Instrumentation and Control Cables, IAEA-TECDOC-932, IAEA, Vienna (1997).
— INTERNATIONAL ATOMIC ENERGY AGENCY, The Role of Automation and Humans in Nuclear Power Plants, IAEA-TECDOC-668, IAEA, Vienna (1992).

4.4 IAEA TECHNICAL REPORTS SERIES (TRS)

— INTERNATIONAL ATOMIC ENERGY AGENCY, Modern Instrumentation and Control for Nuclear Power Plants: A Guidebook, IAEA Technical Report Series No. TRS-387, IAEA, Vienna (1999).
— INTERNATIONAL ATOMIC ENERGY AGENCY, Verification and Validation of Software Related to Nuclear Power Plant Instrumentation and Control, IAEA Technical Report Series No. TRS-384, IAEA, Vienna (1999).
— INTERNATIONAL ATOMIC ENERGY AGENCY, Nuclear Power Plant Instrumentation and Control: A Guidebook, IAEA Technical Report Series No. TRS-239, IAEA, Vienna (1984).

APPENDIX I

SUBJECTS FOR THE IERICS MISSION AND ASSOCIATED REFERENCES

The objective of this Appendix is to help the IERICS team leader and the counterpart clarify the Scope and the basis and reference of the IERICS mission. It suggests a list of subjects that could be considered and discussed. Where applicable, it identifies related IAEA documents, and possibly other documents, that could be used as reference for the mission. The list of subjects may also be used by the IERICS team leader and the counterpart to determine the technical sessions to be included in the IERICS mission agenda.

Note. The IERICS team leader and the counterpart should feel free to include in their discussion any other subject that might be relevant to the mission.

The proposed subjects are organized into 9 main themes:

- System identification
- Critical attributes
- Functional review
- System review
- Development processes review
- Operation & maintenance processes review
- Operating history review
- focused reviews
- Technical visits

For each theme, a table lists the associated subjects. The tables below have four columns:

- The “ID” column associates a short identification to the subject for further reference.
- The “Subject and Description” column explains what the subject is about.
- The “References” column suggests some possible reference documents.
- The “Conclusion” column is there for the IERICS team leader and the counterpart to note their decisions regarding the subject.

This Appendix is available in editable electronic form. The IERICS team leader and the counterpart would typically:

- Adjust the Reference column as applicable and necessary.
- Note in the Conclusion column whether the subject is to be addressed by the IERICS mission, and if so, may add any necessary precision or alteration to the Subject and Description column.
- Add new lines for any subject that need to be addressed and were not in the tables.

System identification

The objective of system identification is to provide general information regarding the system that will serve as background information when addressing the other themes.

Possible subjects for the IERICS mission

Id.	Subject and Description	References	Conclusion
ID1	**System Identification** Unambiguous identification of the system to be reviewed, including name and version.	Instrumentation and Control Systems Important to Safety in Nuclear Power Plants; NS-G-1.3, 2002 Core Knowledge on Instrumentation and Control Systems in Nuclear Power Plants, D-NP-T-3.12 (2010) Modern Instrumentation and Control for Nuclear Power Plants: A Guidebook, TRS-387, 1999 Nuclear Power Plant Instrumentation and Control: A Guidebook, TRS-239, 1984	
ID2	**System Description** Main functional objectives, main characteristics of the system.		
ID3	**System Composition** Identification and description of the main sub-systems / components of the system, identification of their versions.		
ID4	**System Boundaries and Interfaces** Limits of the system, identification of the entities interacting with the system (equipment, other systems, personnel), interfaces characteristics.		
ID5	**Application(s) of the System** Intended uses of the system, where applicable.		
ID6	**System Physical Environment** Characteristics of the physical environment of the system, including ambient conditions, seismic conditions, ...		
ID7	**System Development History** Overview of the different stages that led to the current version of the system. Identification of the different organizations that were implied during this history, and their roles and responsibilities.		

Additional guidance for the IERICS team

System identification, system composition

This evaluation may consider the following topics:

— Unambiguousness of versions identification. Ideally, any modifications in components that might affect the functioning and behaviour of the digital system (either by design changes, component changes, or manufacturing process changes) should result in a different system version and a different identification.
— Differences between system versions. This might be of particular interest in particular for the operating history review.

Critical attributes

The objective of critical attributes is to identify and characterise the system attributes that the counterpart considers as important and that could be addressed by the IERICS mission. These attributes will also serve as background information when addressing the other themes.

General reference documents

- INTERNATIONAL ATOMIC ENERGY AGENCY, Fundamental Safety Principles, IAEA Safety Standards Series No. SF-1, IAEA, Vienna (2006).
- INTERNATIONAL ATOMIC ENERGY AGENCY, Safety of Nuclear Power Plants: Design Safety Requirements, IAEA Safety Standards Series No. NS-R-1, IAEA, Vienna (2000).
- INTERNATIONAL ATOMIC ENERGY AGENCY, Safety of Nuclear Power Plants: Operation Safety Requirements, IAEA Safety Standards Series No. NS-R-2, IAEA, Vienna (2000).
- INTERNATIONAL ATOMIC ENERGY AGENCY, Instrumentation and Control Systems Important to Safety in Nuclear Power Plants, IAEA Safety Standards Series No. NS-G-1.3, IAEA, Vienna (2002).
- INTERNATIONAL ATOMIC ENERGY AGENCY, Software for Computer Based Systems Important to Safety in Nuclear Power Plants, IAEA Safety Standards Series No. NS-G-1.1, IAEA, Vienna (2000).
- INTERNATIONAL ATOMIC ENERGY AGENCY, Operational Limits and Conditions and Operating Procedures for Nuclear Power Plants Safety Guide, IAEA Safety Standards Series No. NS-G-2.2, IAEA, Vienna (2000).
- INTERNATIONAL ATOMIC ENERGY AGENCY, Solutions for Cost Effective Assessment of Software Based Instrumentation and Control Systems in Nuclear Power Plants, IAEA-TECDOC-1328, IAEA, Vienna (2003).
- INTERNATIONAL ATOMIC ENERGY AGENCY, Verification and Validation of Software Related to Nuclear Power Plant Instrumentation and Control, IAEA Technical Report Series No. TRS-384, IAEA, Vienna (1999).
- INTERNATIONAL ATOMIC ENERGY AGENCY, Validation Procedures of Software Applied in Nuclear Instruments, IAEA-TECDOC-1565, IAEA, Vienna (2007).

Possible subjects for the IERICS mission

Id.	Subject and Description	Specific References	Conclusion
CA1	**Adequacy of Upgrade Project** Upgrade projects usually involve the replacement of an existing system by a new one. Technology transition (often from analogue to digital) and recovery of the existing system design basis are often critical to the project success.	Integration of Analog and Digital Instrumentation and Control Systems in Hybrid Control Rooms, D-NP-T-3.10 Information Integration in Control Rooms and Technical Offices in Nuclear Power Plants, IAEA-TECDOC-1252 (2001) The Role of Automation and Humans in Nuclear Power Plants, IAEA-TECDOC-668 (1992)	

CA2	**Physical Adequacy** Ability of the system to operate as required in its physical environment. This may include aspects like: — Adequacy to ambient conditions. — Behaviour in seismic conditions. — Susceptibility to Electrostatic Discharge (ESD). — Electromagnetic compatibility (EMC), Electromagnetic Interference (EMI) and Radio Frequency Interference (RFI). — Radiation exposure. — Ageing. — Power supplies. — Heating, Ventilation, Air Conditioning (HVAC).		
CA3	**Reliability** Ability of the system to perform to its required missions as specified under given operational conditions for a given time interval, assuming that the necessary external resources are provided.		
CA4	**Availability** Ability of the system to perform its required missions as specified under given conditions at a given instant or over a given time interval, assuming that the necessary external resources are provided. This includes in particular the ability of the system to maintain nominal service even during maintenance, and to return to nominal service rapidly should a failure occur.	Management of Life Cycle and Ageing at Nuclear Power Plants: Improved I&C Maintenance; IAEA-TECDOC-1402 (2004) Maintenance, Surveillance and In-service Inspection in Nuclear Power Plants Safety Guide; IAEA Safety Standards Series No. NS-G-2.6 (2002) Safety Culture in the Maintenance of Nuclear Power Plants; Safety Reports Series No. 42 (2005)	
CA5	**Maintainability** Ability of the system under given operational conditions, to be retained in, or restore to, a state in which it can perform its required missions as specified, when maintenance is performed under given conditions and using stated procedures and resources.	Management of Life Cycle and Ageing at Nuclear Power Plants: Improved I&C Maintenance, IAEA-TECDOC-1402 (2004) Maintenance, Surveillance and In-service Inspection in Nuclear Power Plants Safety Guide; IAEA Safety Standards Series No. NS-G-2.6 (2002)	

CA6	**Safety** Safety provides assurance that the failure modes most adverse to plant safety will not occur.	Safety Assessment and Verification for Nuclear Power Plants Safety Guide; IAEA Safety Standards Series No. NS-G-1.2 (2002). Site Evaluation for Nuclear Installations Safety Requirements; IAEA Safety Standards Series No. NS-R-3 (2003). Management of Life Cycle and Ageing at Nuclear Power Plants: Improved I&C Maintenance, IAEA-TECDOC-1402 (2004). Equipment Qualification in Operational Nuclear Power Plants: Upgrading, Preserving and Reviewing; Safety Reports Series No. 3 (1998). Deterministic Safety Analysis for Nuclear Power Plants; IAEA Safety Standards Series No. SSG-2 (2010).	
CA7	**Robustness** Ability of the system to perform its required missions as specified even in abnormal internal or external conditions, or to behave in a pre-defined, acceptable manner (graceful degradation) if it can no longer maintain the expected services and performance.	On-line Monitoring for Improving Performance of Nuclear Power Plants; Part 1: Instrument Channel Monitoring, NP-T-1.1, 2008 On-line Monitoring for Improving Performance of Nuclear Power Plants; Part 2: Process and Component Condition Monitoring and Diagnostics, NP-T-1.2 (2008) Implementing Digital I&C Systems in the Modernization of Nuclear Power Plants, NP-T-1.4, 2009 Protecting Against Common-Cause Failures in Digital I&C Systems, NP-T-1.5 (2009).	

CA8	**Testability** Ability of the system to be tested and / or monitored so that any faults appearing in the system during manufacturing or operation can be revealed with good chance of success and with reasonable effort. This property is particularly significant for systems operating on demand, i.e., for systems that remain in a stand-by mode most of the time, and whose behaviour changes significantly in demand situations.	On-line Monitoring for Improving Performance of Nuclear Power Plants; Part 1: Instrument Channel Monitoring, NP-T-1.1 (2008). On-line Monitoring for Improving Performance of Nuclear Power Plants; Part 2: Process and Component Condition Monitoring and Diagnostics, NP-T-1.2 (2008). Maintenance, Surveillance and In-service Inspection in Nuclear Power Plants Safety Guide; IAEA Safety Standards Series No. NS-G-2.6 (2002)	
CA9	**Computer Security** Its objectives are to protect the confidentiality, integrity and availability of electronic data or computer systems and processes, so that unauthorised persons and systems cannot read or modify them, and so that authorised persons are not denied access to them.	Computer Security at Nuclear Facilities; IAEA Nuclear Security Series, Reference Manual, to be published	
CA10	**Modifiability** Ability of the system and of its documentation (including development documentation) to be modified as necessary at acceptable cost and effort without degradation of any critical attributes.		
CA11	**Ageing and Long Term Operation** Ability of the system to be operated for extensive period of time while maintaining all critical attributes to acceptable levels.		

Additional guidance for the IERICS team

Reliability

To gain reasonable assurance of high reliability, one may focus on characteristics such as defensive measures (including testability and verifiability of design and software), development and V&V processes, operating history (in the case of pre-developed systems or platforms already in use for other applications), complementary tests, and measures constraining the operational conditions.

Functional review

The objective of the functional review is to assess the quality of the system requirements specification, and its adequacy with respect to the plant needs assigned to the system.

General reference documents

- INTERNATIONAL ATOMIC ENERGY AGENCY, Safety of Nuclear Power Plants: Design Safety Requirements, IAEA Safety Standards Series No. NS-R-1, IAEA, Vienna (2000).
- INTERNATIONAL ATOMIC ENERGY AGENCY, Instrumentation and Control Systems Important to Safety in Nuclear Power Plants, IAEA Safety Standards Series No. NS-G-1.3, IAEA, Vienna (2002).

— INTERNATIONAL ATOMIC ENERGY AGENCY, Core Knowledge on Instrumentation and Control Systems in Nuclear Power Plants, IAEA Nuclear Energy Series No. D-NP-T-3.12, IAEA, Vienna (to be published in 2011).
— INTERNATIONAL ATOMIC ENERGY AGENCY, Specification of Requirements for Upgrades Using Digital Instrument and Control Systems, IAEA-TECDOC-1066, IAEA, Vienna (1999).

Possible subjects for the IERICS mission

Id.	Subject and Description	Specific References	Conclusion
FR1	**Input Documents** Appropriate identification of the upstream documents defining the system background, and from which system requirements are derived.	Basic Safety Principles for NPPs; IAEA Safety series 75-INSAG-3 rev. 1 (1999).	
FR2	**Requirements Specification** Assessment of properties such as completeness and adequacy with respect to Input Documents, non-ambiguity and clarity for the intended readership, freedom from contradiction, usability as a reference for subsequent development activities.	Safety of Nuclear Power Plants: Operation Safety Requirements; IAEA Safety Standards Series No. NS-R-2 (2000). Draft Safety Standard DS367 - Safety Classification of Structures, Systems and Components in Nuclear Power Plants.	
FR3	**Functional Adequacy** Ability of the system to meet the plant needs, considering the system main objectives and functional characteristics, the needs resulting from upstream studies, the various plant and system conditions, and the various effects of the system environment.		
FR4	**Risk Analysis** To determine — The hazards and hazardous events of the system in all modes of operation, for all reasonably foreseeable circumstances including fault conditions and misuse. — The event sequences leading to the hazardous events determined. — To determine the plant risks associated with the hazardous events determined.	Safety Assessment and Verification for Nuclear Power Plants Safety Guide; IAEA Safety Standards Series No. NS-G-1.2 (2002). The Role of Probabilistic Safety Assessment and Probabilistic Safety Criteria in Nuclear Power Plant Safety; IAEA Safety Series No. 106 (1992). Development and Application of Level 1 Probabilistic Safety Assessment for Nuclear Power Plants; IAEA Safety Standards Series No. SSG-3 DS365 - Risk-Informed Decision Making	

Additional guidance for the IERICS team

Input documents

For functions important to safety, the information provided by the input documents should include (but is not limited to):

- All relevant postulated initiating events (PIE) and successive barriers to keep radiation exposure to workers, public, and environment within limits.
- The quality level for the plant functions and systems necessary to maintain the plant in a normal operating state, to ensure the correct response to all Postulated Initiating Events, and to facilitate the long-term management of the plant following an accident.
- The defence-in-depth concept of the plant.
- The groups of functions provided to address postulated initiating events sequences in order to fulfil the safety objectives.
- The functional and performance requirements of the functions of the plant important to safety needed to meet the general safety requirements.
- The role of automation and prescribed operator actions in the management of anticipated operational occurrences and accident conditions.
- A task analysis in accordance with 6.3 of IEC 60964 defining which functions should be assigned to operators and which functions should be assigned to machines.
- The variables to be displayed for the operator to use in taking manual actions.
- The priority principles between automatic and manually initiated actions, taking into account functional categories, operator rooms or locations.

Requirements specification

This review may determine whether the system requirements specification adequately covers all necessary subjects, including:

- Functionality for plant systems operation, possibly depending on plant state.
- Performance under various possible influencing conditions (e.g. system configuration; operational modes, including degraded modes; excessive communication message traffic).
- Interfaces to other systems and equipment, in normal and abnormal conditions.
- Human-system interfaces, considering not only the system operator, but also the maintainer and the technicians performing system configuration or system testing.
- System testing (self-monitoring, external surveillance, periodic testing).
- Customization, including how the system is configured or programmed and the kinds of parameters involved in the configuration or programming.
- Installation, operation, and maintenance constraints.
- Any applicable limitations.
- Any new support infrastructure required at the plant, including training and simulator.
- System failure modes and failure management, including the state of each input and output when powered on and powered off, and when applicable, requirements regarding internal independence / separation.
- Reliability and availability requirements, including possible design constraints.
- Computer security and the protection of the system and its configuration from malicious or inadvertent modifications.
- On-site installation and support for commissioning testing.
- Support for operation and maintenance.
- Potential risks of, and compensatory measures for, system obsolescence.

Functional adequacy

The evaluation of the adequacy of the system to the intended application(s) is a summary activity based on engineering judgment. The IERICS team may need to understand the place of the system in the plant, as well as the way it will interface with other systems and equipment, and the way it and its associated plant system will be operated and maintained. The IERICS team may also determine how the plant system requirements, normal and failure modes, and operation and maintenance (O&M) could affect the system and its design and failure modes, including the way it is configured, operated and maintained.

In the case of a safety or safety-related system, the IERICS team may also determine the nuclear plant safety requirements for this system. Among the issues are things like fail-safe operation to a defined state, or fail-as-is. The IERICS team may need to consider the types and capabilities of each of the inputs and outputs against the plant interface requirements. The IERICS team may also need to define the state of these inputs and outputs in various failure conditions. The IERICS team may need to assess requirements regarding reliability, availability, maintainability and inspectability (or testability) with respect to the plant application.

The IERICS team may consider any data communications requirements that exist for the system, and determine how the counterpart might have to change the existing plant equipment to interface with the system. The IERICS team may consider the system's preventive maintenance requirements, life limited parts, and plant requirements for surveillance testing, and calibration, to determine if changes are required in the plant's programmes to accommodate this system. The IERICS team may also evaluate needs for technician, engineer, and operator training. The IERICS team may consider how this equipment will affect the plant Simulator, and whether new or changed operator training is required. For purposes of the review, the IERICS team may compare the system capabilities against the plant needs.

Risk analysis

The Risk Analysis can be the most important facet of an IERICS mission. This activity will use the knowledge gained in the previous sections to help answer the questions: "Is the use of this digital system a reasonable solution? Are there risks of undesirable behaviour?" This phase may combine both a qualitative fault tree analysis (FTA), and a qualitative failure modes and effects analysis (FMEA). The term qualitative is used deliberately to avoid any confusion with FTA or FMEA approaches that seek to quantify failure potential and reliability. No method for predicting digital failure rates or digital faults has been established for the diverse range of digital systems that utilities are likely to use.

Experience has shown that no single method of risk analysis can provide full coverage of all risks. Studies have shown, however, that combining a top-down method with a bottom-up method provides better coverage than either method alone. While the use of a combined method increases coverage, no method or combination of methods can guarantee full coverage of all potential risks.

The risk analysis requires in-depth knowledge of software, hardware, interfaces, operation, and application. The counterpart should be asked to have knowledgeable staff present during these sessions. The IERICS team, having examined the various system documents, should indicate the documents that need to be available during the sessions. These documents may include both formal and informal documents.

System architecture documents, which are critical for the review, are most useful in the form of drawings and/or diagrams. The ideal set of documentation for system architecture would include information regarding the following:

- System partitioning.
- Data flow.
- Function flow.
- Critical timing and throughput.
- Hardware interfaces.

System review

The objective of the system review is to determine if, in the operational context and conditions, the overall design of the system under review complies with the review basis and reference and provides adequate assurance that necessary levels for the critical attributes selected for the IERICS mission will be reached.

General reference documents

- INTERNATIONAL ATOMIC ENERGY AGENCY, Fundamental Safety Principles, IAEA Safety Standards Series No. SF-1, IAEA, Vienna (2006).
- INTERNATIONAL ATOMIC ENERGY AGENCY, Safety of Nuclear Power Plants: Design Safety Requirements, IAEA Safety Standards Series No. NS-R-1, IAEA, Vienna (2000).
- INTERNATIONAL ATOMIC ENERGY AGENCY, Instrumentation and Control Systems Important to Safety in Nuclear Power Plants, IAEA Safety Standards Series No. NS-G-1.3, IAEA, Vienna (2002).
- INTERNATIONAL ATOMIC ENERGY AGENCY, Software for Computer Based Systems Important to Safety in Nuclear Power Plants, IAEA Safety Standards Series No. NS-G-1.1, IAEA, Vienna (2000).
- INTERNATIONAL ATOMIC ENERGY AGENCY, Core Knowledge on Instrumentation and Control Systems in Nuclear Power Plants, IAEA Nuclear Energy Series No. D-NP-T-3.12, IAEA, Vienna (to be published in 2011).
- INTERNATIONAL ATOMIC ENERGY AGENCY, Modern Instrumentation and Control for Nuclear Power Plants: A Guidebook, IAEA Technical Report Series No. TRS-387, IAEA, Vienna (1999).
- INTERNATIONAL ATOMIC ENERGY AGENCY, Nuclear Power Plant Instrumentation and Control: A Guidebook, IAEA Technical Report Series No. TRS-239, IAEA, Vienna (1984).
- INTERNATIONAL ATOMIC ENERGY AGENCY, Implementing Digital I&C Systems in the Modernization of Nuclear Power Plants, IAEA Nuclear Energy Series No. NP-T-1.4, IAEA, Vienna (2009).
- INTERNATIONAL ATOMIC ENERGY AGENCY, Specification of Requirements for Upgrades Using Digital Instrument and Control Systems, IAEA-TECDOC-1066, IAEA, Vienna (1999).
- INTERNATIONAL ATOMIC ENERGY AGENCY, Modernization of Instrumentation and Control in Nuclear Power Plants, IAEA-TECDOC-1016, IAEA, Vienna (1998).

Possible subjects for the IERICS mission

Id.	Subject and Description	Specific References	Conclusion
SR1	**System Architecture** Overall organization of the system in terms of functional units (sensors and data acquisition units, logic processing and control units, actuator controls, interface units, data storage, ...) and main data communication links and equipment. Nature, identity, technology and role of the functional units of the system.		
SR2	**Hardware** Hardware technologies and products used, e.g. microprocessors, programmable electronic circuits, data communication media, memory technologies, ...		

SR3	**Software / Logic** For the main functional units of the system architecture, identification and characterization of the main software components, of their roles, of the application logic.	Solutions for Cost Effective Assessment of Software Based Instrumentation and Control Systems in Nuclear Power Plants, IAEA-TECDOC-1328 (2003)	
SR4	**Overall Internal Behaviour** Determination, for the main functional units and data communication links of the system architecture, of the main behavioural characteristics, e.g.: — Operation on demand vs. continuous operation. — Time-driven vs. event-driven behaviour. — Static vs. dynamic resource allocation. — Synchronous vs. asynchronous behaviour.		
SR5	**Functional Allocation** Determination of the functional units that support each function of interest of the system.		
SR6	**Data Communication** Data communication protocols, data communication rates.		
SR7	**Data Flow** Data communication flow to and from external interfaces, and between functional units, for each function of interest of the system. Description of data exchanges: data structures, types, volumes and semantics.		
SR8	**Human-System Interfaces** For system initialization, operation, maintenance, testing, calibration.	Integration of Analog and Digital Instrumentation and Control Systems in Hybrid Control Rooms, D-NP-T-3.10 (to be published in early 2010) Information Integration in Control Rooms and Technical Offices in Nuclear Power Plants, IAEA-TECDOC-1252 (2001) The Role of Automation and Humans in Nuclear Power Plants, IAEA-TECDOC 668 (1992).	
SR9	**Diagnostics** Measures taken within, or external to, the system, to detect and signal incorrect or failed states of the system, functional units, communication links or communication equipment.	On-line Monitoring for Improving Performance of Nuclear Power Plants; Part 1: Instrument Channel Monitoring, NP-T-1.1, 2008 On-line Monitoring for Improving Performance of Nuclear Power Plants; Part 2: Process and Component Condition Monitoring and Diagnostics, NP-T-1.2 (2008).	

SR10	**Margins** Margins taken in the utilization of the internal system resources (such as computing power, data communication bandwidth and memory) to prevent system failure and to allow future system modifications.		
SR11	**Failure Modes & Mechanisms** Measures taken to prevent failure modes that could have unacceptable or significant consequences. This may include the identification of the failure mechanisms that could lead to these unwanted modes, and of the measures taken to preclude or minimise these mechanisms.	Deterministic Safety Analysis for Nuclear Power Plants**;** IAEA Safety Standards Series No. SSG-2 (2010).	
SR12	**Computer Security** Measures taken to protect the confidentiality, integrity and availability of the system and its data and processes, so that unauthorised persons and systems cannot read or modify them, and so that authorised persons are not denied access to them.	Computer Security at Nuclear Facilities; IAEA Nuclear Security Series, Reference Manual, to be published Assessment of Defence in Depth for Nuclear Power Plants; Safety Reports Series No. 46 (2005)	
SR13	**Fault Tolerance** Measures taken to ensure that the system can tolerate faults or errors, i.e., that it can continue to perform the required functions in the presence of faults or errors, or that it will have acceptable, specified degraded modes.		
SR14	**Diversity – Independence – Common-Cause Failure** Measures taken to ensure that the system is sufficiently different and independent from other designated systems that it will not fail concurrently with any these other systems. Diversity and independence may also be assessed internally to the system in order to provide a high level of fault tolerance.	Protecting Against Common-Cause Failures in Digital I&C Systems of Nuclear Power Plants IAEA Nuclear Energy Series No. NP-T-1.5 (2010).	
SR15	**Known System Faults – System Operating History** Analysis of the known system faults: — To ensure that in the operating conditions of the system, the known, yet uncorrected system faults will not lead to unacceptable system failures. — To determine whether the system failures after the system is put into service do not form tends or patterns indicative of deeper causes needing corrective action.		

Additional guidance for the IERICS team

System architecture

Describing the system architecture will usually entail the use of system design documents showing the nature, identity, technology and role of the main units (data acquisition, processing

units, actuator controls, interface units, etc.) and main data communication links and equipment of the system. The availability, the quality, and the formality of documents should be noted. The team should critically examine the architecture, identify the items that are key to the correct and robust functioning of the system or that could be at the origin of unanticipated situations (e.g. external interrupts), and begin to consider possible failure scenarios. The team should also examine the configurability of the system architecture, i.e. the possibility of defining simpler architectures that confer a higher degree of confidence.

Software / logic

The IERICS team should ask the developers to sketch the major software components on a white board if no documentation exists, or if the documentation is not sufficient for a critical examination. An impromptu sketch will often reveal more about the software architecture than a ten page write up. The IERICS team should capture any sketches or white board drawings. Where possible, the software architecture should be left on the board for reference during the remainder of the review.

Regarding application logic, the IERICS mission may consider the following subjects:

— How the system processes each input.
— The specific functions and algorithms used in the system.
— The response time, response time variability, and throughput for the system.
— Issues associated with various system attributes including accuracy, variable ranges, rounding, numerical errors, hysteresis, and stability.

Data communication

Topics to be analysed may include:

— Initialization.
— Default values.
— Data communication latency.
— Power on, off, and rapid power cycling.
— Disconnection – reconnection to network and behaviour; and the
— Handling of unanticipated, undefined or corrupted data.
— Prevention of data communication failures, failure propagation, data communication storms.

Human-system interfaces (HSIs)

Poorly designed HSIs are the most prevalent failure source in nuclear power plants. The IERICS team needs to evaluate the HSI using the human factors engineering principles, to determine if the interface is acceptable. First, the team should identify the actions that can lead to human errors during operation or maintenance. Potential for human error exists during:

— Initial configuration.
— Configuration modification, including setpoint modification.
— Manual operation.
— Maintenance.
— Status monitoring.
— Periodic tests.
— Calibration.

Diagnostics

The IERICS mission may consider the following subjects:

- On-line and off-line test and diagnostic capabilities of the system.
- On-line external monitoring of the system.
- Methods that the operations, maintenance, and engineering staff use to determine when the system or its plant system are failed, and when they are operable.
- Any features provided for surveillance testing or calibration.

Diversity

Depending on context, various forms of diversity may be considered: functional diversity, design diversity, diversity of operating conditions. The possible adverse consequences of diversity (e.g. increased complexity in design and operation) need also to be assessed.

Known Faults and Failures

The IERICS team may evaluate any known hardware and software faults and failures, assessing also how the counterpart resolved or addressed each. The team may evaluate if these faults affect the system functionality, and if the counterpart has addressed these faults and failures in the documentation. The IERICS team may look for patterns of failures that could reveal system weaknesses, either in the system or in counterpart programmes and practices. The team may also look at the history of the system, and analyse the faults history and the trends in failure rates.

Development process review

The objective of the development process review is to determine whether the engineering processes applied by the counterpart during development comply with the review basis and reference and the best international practices.

General reference documents

- INTERNATIONAL ATOMIC ENERGY AGENCY, Fundamental Safety Principles, IAEA Safety Standards Series No. SF-1, IAEA, Vienna (2006).
- INTERNATIONAL ATOMIC ENERGY AGENCY, Safety of Nuclear Power Plants: Design Safety Requirements, IAEA Safety Standards Series No. NS-R-1, IAEA, Vienna (2000).
- INTERNATIONAL ATOMIC ENERGY AGENCY, Instrumentation and Control Systems Important to Safety in Nuclear Power Plants, IAEA Safety Standards Series No. NS-G-1.3, IAEA, Vienna (2002).
- INTERNATIONAL ATOMIC ENERGY AGENCY, Software for Computer Based Systems Important to Safety in Nuclear Power Plants, IAEA Safety Standards Series No. NS-G-1.1, IAEA, Vienna (2000).
- INTERNATIONAL ATOMIC ENERGY AGENCY, Core Knowledge on Instrumentation and Control Systems in Nuclear Power Plants, IAEA Nuclear Energy Series No. D-NP-T-3.12, IAEA, Vienna (to be published in 2011).
- INTERNATIONAL ATOMIC ENERGY AGENCY, Implementing Digital I&C Systems in the Modernization of Nuclear Power Plants, IAEA Nuclear Energy Series No. NP-T-1.4, IAEA, Vienna (2009).
- INTERNATIONAL ATOMIC ENERGY AGENCY, Modernization of Instrumentation and Control in Nuclear Power Plants, IAEA-TECDOC-1016, IAEA, Vienna (1998).

Possible subjects for the IERICS mission

Id.	Subject and Description	Specific References	Conclusion
DP1	**Corporate Culture & Organization, Quality Assurance**	The Management System for Facilities and Activities Safety Requirements; IAEA GS-R-3, 2006 The Management System for Nuclear Installations, GS-G-3.5 (2009)	
DP2	**Standards & Regulations** List of standards and regulatory documents applicable to the system and its components. Measures taken to ensure and maintain compliance.		
DP3	**Development Lifecycle** Set of activities involved in the development of the system (including the selection and use of pre-developed or Commercial-Off-The-Shelf components), starting from the derivation of system requirements from the plant safety design base and finishing when the system is no longer available for use.		
DP4	**V&V** Verification: Confirmation by examination and provision of objective evidence that the results of an activity meet the objectives and requirements defined for this activity. Validation: Confirmation by examination and provision of other evidence that the system fulfils in its entirety the requirement specification as intended (functionality, response time, fault tolerance, robustness).	Verification and Validation of Software Related to Nuclear Power Plant Instrumentation and Control, TRS-384, 1999 Solutions for Cost Effective Assessment of Software Based Instrumentation and Control Systems in Nuclear Power Plants, IAEA-TECDOC-1328 (2003) Validation Procedures of Software Applied in Nuclear Instruments IAEA TECDOC-1565 (2007).	
DP5	**Selection of Pre-developed / COTS Components** Identification and characteristics of the Pre-Developed or Commercial-Off-The-Shelf components (including software components) of the system, and assessment of the measures used to ensure that they are functionally adequate, of sufficient quality, and used as appropriate.	Equipment Qualification in Operational Nuclear Power Plants: Upgrading, Preserving and Reviewing; Safety Reports Series No. 3 (1998).	
DP6	**Configuration Management** Identification and documentation of the characteristics of the system structures and components (hardware and software), and of ensuring that changes to these characteristics are properly developed, assessed, approved, issued, implemented, verified, recorded and incorporated into the system documentation.		

DP7	**Engineering Rules, Methods &Tools** Assessment of the efficiency of, and of the risks associated with, the engineering rules, methods and tools applied to specify, design, implement, verify and validate the system. The efficiency is evaluated in terms of ability of avoid or detect errors, the risks in terms of potential for introducing errors in the system.	Safety of Nuclear Power Plants: Design Safety Requirements; IAEA Safety Standards Series No. NS-R-1, 2000 Validation Procedures of Software Applied in Nuclear Instruments; IAEA TECDOC Series No.1565, 2007 Safety of Nuclear Power Plants: Design Safety Requirements; IAEA Safety Standards Series No. NS-R-1 (2000).	
DP8	**Computer Security Plan** Measures taken during development and modification to ensure that no adverse features are willingly and maliciously introduced in the design of the system.	Computer Security at Nuclear Facilities Reference Manual; IAEA Nuclear Security Series, Technical Guidance, to be published	
DP9	**Addressing Long Term Issues** Measures taken to ensure that the system can be modified and upgraded as necessary during its operational life while maintaining the Critical Attributes to acceptable levels, and can be replaced by a new system if its lifetime ends before the lifetime of the plant.		
DP10	**Modification Process** Process for deciding and authorising modifications / upgrades. Process for implementing, verifying and validating modifications / upgrades, and putting them into operation (installation on site, commissioning, re-training of any concerned personnel).	Modifications to Nuclear Power Plants Safety Guide; IAEA Safety Standards Series No. NS-G-2.3, (2001). Equipment Qualification in Operational Nuclear Power Plants: Upgrading, Preserving and Reviewing; Safety Reports Series No. 3 (1998)	
DP11	**Independent Assessments** Analysis of the independent system and / or process assessments previously made: scope, basis and reference, assessors, findings, corrective actions.	Verification and Validation of Software Related to Nuclear Power Plant Instrumentation and Control; TRS No.384 (1999). Solutions for Cost Effective Assessment of Software Based Instrumentation and Control Systems in Nuclear Power Plants; IAEA-TECDOC-1328 (2003). Safety Assessment and Verification for Nuclear Power Plants Safety Guide**;** IAEA Safety Standards Series No. NS-G-1.2, 2002 Safety Assessment for Facilities and Activities; IAEA Safety Standards Series No. GSR Part 4 (2009). Assessment of Defence in Depth for Nuclear Power Plants; Safety Reports Series No. 46 (2005).	

DP12	**Manufacturing** Assessment of the manufacturing methods and practices, in particular to ensure consistent quality, to signal any changes in the manufacturing process (including the use of alternative, equivalent hardware components), and to report any issues detected by others users of the manufactured components or systems.		
DP13	**Training** Of the personnel involved in the development of the system.		
DP14	**Issues Tracking & Resolution** Assessment of the procedures and guidelines for: — Recording and analysing the reports of system misbehaviour and failure. — Ensuring that adequate enquiries are made to identify the root causes. — Ensuring that any corrective actions are fully implemented wherever they are necessary (in particular when they may affect other parts of the system). — Monitoring the effectiveness of these corrective actions.		

Operation & maintenance review

The objective of the operation & maintenance review is to determine whether the corresponding processes applied by the counterpart comply with the review basis and reference and the best international practices.

General reference documents

- INTERNATIONAL ATOMIC ENERGY AGENCY, Fundamental Safety Principles, IAEA Safety Standards Series No. SF-1, IAEA, Vienna (2006).
- INTERNATIONAL ATOMIC ENERGY AGENCY, Safety of Nuclear Power Plants: Design Safety Requirements, IAEA Safety Standards Series No. NS-R-1, IAEA, Vienna (2000).
- INTERNATIONAL ATOMIC ENERGY AGENCY, Instrumentation and Control Systems Important to Safety in Nuclear Power Plants, IAEA Safety Standards Series No. NS-G-1.3, IAEA, Vienna (2002).
- INTERNATIONAL ATOMIC ENERGY AGENCY, Core Knowledge on Instrumentation and Control Systems in Nuclear Power Plants, IAEA Nuclear Energy Series No. D-NP-T-3.12, IAEA, Vienna (to be published in 2011).

Possible subjects for the IERICS mission

Id.	*Subject and Description*	*Specific References*	*Conclusion*
OM1	**System Operation Procedures**		
OM2	**Maintenance Procedures**		
OM3	**Periodic Testing Procedures**		
OM4	**Training** Of operation and maintenance personnel.	Recruitment, Qualification and Training of Personnel for Nuclear Power Plants Safety Guide**;** IAEA Safety Standards Series No. NS-G-2.8, 2002	
OM5	**Failure detection & Reporting**		

Technical visits

Id.	*Subject and Description*	*Reference*	*Conclusion*
TV1	**System Operating Site**		
TV2	**Factory Integration Site**		
TV3	**System Development Facility**		
TV4	**System Manufacturing Facility**		

APPENDIX II

MISSION REPORT TEMPLATE

This Appendix may be used by the IERICS team as a template for the mission report. It is available in electronic form. On the following pages the text in italics should be replaced with the attributes of the given IERICS mission.

IERICS-*location*-20XX

Original: English

Distribution:
Restricted

INTERNATIONAL ATOMIC ENERGY AGENCY

REPORT

INDEPENDENT ENGINEERING REVIEW OF INSTRUMENTATION AND CONTROL SYSTEMS (IERICS)

IAEA REVIEW OF

(Review Mission Title)

Review Location and Review Period

INDEPENDENT ENGINEERING REVIEW OF
INSTRUMENTATION AND CONTROL SYSTEMS
(IERICS)

IAEA REVIEW OF (*Title of System Reviewed*)

MISSION REPORT

INDEPENDENT ENGINEERING REVIEW OF INSTRUMENTATION AND CONTROL SYSTEMS (IERICS)

IAEA REVIEW OF

(Review Mission Title)

(Graphic of the plant or system may be added on this page.)

REPORT TO

Counterpart Organization

Review location and review period

MISSION REPORT

INDEPENDENT ENGINEERING REVIEW OF INSTRUMENTATION AND CONTROL SYSTEMS (IERICS)

IAEA REVIEW OF

(Review Mission Title)

Mission date: *Review period*

Location: *Location of review*

Facility: *Counterpart organization*

Organized by: International Atomic Energy Agency (IAEA)
Department of Nuclear Energy
Division of Nuclear Power

IAEA review Team: *Participant Name* *(Organization, Country)*
Participant Name *(Organization, Country)*

Issued *Date*

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EXECUTIVE SUMMARY

In 2009, the Nuclear Power Engineering Section of the IAEA established the "Independent Engineering Review of I&C Systems" (IERICS) mission to conduct peer reviews of design documents, prototype systems and systems in actual operation in the NPP I&C area. This report documents the IERICS review performed during the week of review period and review location, on the system(s) being reviewed.

The IERICS mission is conducted by a team of international experts with direct experience applicable to the areas of review. Judgements of compliance are made on the basis of IAEA publications and of the combined expertise and experience of the international review team. The review is not a regulatory inspection or audit against national or international codes and standards. The mission is a peer review, whose results can be used to make improvements in the various processes, such as design, testing, implementation, licensing, operation, and maintenance.

Background of the system(s) being reviewed

History of the review request and the discussion of the preparatory meeting and the basis for the review such as ….These guidelines were based on the guidance defined in the IAEA Safety Guide NS-G-1.3 entitled "Instrumentation and Control Systems Important to Safety in Nuclear Power Plants" [1] and related IAEA Nuclear Energy Series Reports [3], [4], [5]. The IERICS review was performed by a group of invited subject matter experts. The results of their review were published in a mission report at the end of the review, which provided recommendations, suggestions and comments on the design and noted good practices in the design process.

Goals of the counterpart organization….such as their goals were that the mission would provide them with a basis for improving the acceptance and reliability of the counterpart's I&C system by implementing the recommendations and findings of the mission and also would assist in meeting the requirements of the future implementations. It was also expected that the report would assist in developing a firm design basis for projects in the domestic and international markets.

Description of the general manner as to how the review was conducted…such as

The IERICS activities consisted of a series of formal presentations by counterpart organization staff (supported by associated organizations) clarification discussions between the IAEA review team and the designers after these presentations, as well as a tour of the facilities. The IAEA mission review team then submitted a series of written questions to the designers, which were followed up by written responses by the designers, and subsequent discussions between the two parties.

The conclusions of this report summarize the findings of the review mission and provide number (99) recommendations and number (99) suggestions for the designers to consider along with acknowledging number (99) good practices from which other design organizations may benefit. Through the review of the presented documents and discussions with the counterparts, the IAEA review team confirmed that extensive engineering work of high quality has been performed to develop the system under review. In general, the reviewed parts of the I&C system meet the requirements of the relevant sections of the IAEA Safety Guide NS-G-1.3. Specific issues, identified as areas for further improvement, are listed in the issue sheets, as suggestions and recommendations.

If deemed appropriate by the review team, text similar to the following may be used in the report….

It should be noted that modern digital monitoring and control systems, such as those of the system under review, are extremely complex systems and the review mission was conducted for only a relatively short time period. It is the opinion of the review team that some comments in the report should not be seen as deficiencies in the design or the design

process, but may be a result of the difficulty in resolving all of their concerns in such a limited time period.

1. INTRODUCTION

1.1. BACKGROUND OF THE MISSION

A review mission titled the "Independent Engineering Review of I&C Systems (IERICS) in Nuclear Power Plants (NPPs) was established in 2009 at the Nuclear Power Engineering Section of the IAEA. The mission is intended to conduct peer reviews of design documents, prototype systems and systems in actual operation in the NPP I&C area. The IERICS mission is performed by a group of invited subject matter experts from various IAEA member states. The IERICS mission is based on appropriate IAEA documents, such as Safety Guides and Nuclear Energy Series.

This portion may be tailored based on the results of the preparatory meeting….

The guidelines for the current IERICS mission were established at a consultancy meeting in location and date of the preparatory meeting. The review methodology follows the structure of the IAEA Safety Guide NS-G-1.3 titled "Instrumentation and Control Systems Important to Safety in Nuclear Power Plants" [1]. More specifically, sections in the following chapters were used as reference guides in the review:

— Chapter 4: General Design Guidelines Requirements
— Chapter 5: Specific Design Guidelines Requirements
— Chapter 7: Design Process for I&C Systems Important to Safety

From these chapters, twenty two (22) specific requirement areas (shown in bold in the table below) were selected for the review:

Chapter 4. GENERAL DESIGN GUIDELINES REQUIREMENTS (12)	Chapter 5. SPECIFIC DESIGN GUIDELINES REQUIREMENTS (3)	Chapter 7. DESIGN PROCESS FOR I&C SYSTEMS IMPORTANT TO SAFETY(7)
• **Performance requirements** • **Design for reliability** • **Independence** • **Failure modes** • **Control of access to equipment** • **(Set points)** • **(Human-machine interface)** • **Equipment qualification** • **Quality** • **Design for electromagnetic compatibility** • **Testing and testability** • **Maintainability** • **Documentation** • **Identification of items important to safety**	• **Safety systems** • **Protection systems** • **(Power supplies)** • **Digital computer systems**	• **Quality assurance** • **Project planning** • **Change control and configuration management** • **(Integration of human factors)** • **Description of the design process** • **(Upgrades and backfits)** • **Analyses required for safety systems** • **(Probabilistic safety assessment)** • **Assumptions made in the analyses** • **Documentation for the I&C system**

The subject of the current IERICS review was the system under review and a brief discussion of its background including a discussion of any previous third party qualifications and/or regulatory reviews.

1.2. OBJECTIVE AND SCOPE OF THE MISSION

The objectives of the IERICS review mission were:

- To conduct an independent and comprehensive review of the technical information provided by the counterpart in accordance with the recommendations of the IAEA Safety Guide NS-G-1.3;
- To produce a mission report at the end of the review, including issue sheets and good practices sheets.

The following subjects were requested by counterpart to be reviewed by the IERICS team with respect to design, functionality, and performance:

- System, process, and/ or component 1
- System, process, and /or component 2…
- System, process, and/ or component n

Additional areas to be consulted on were:

- System, process, and/ or component a
- System, process, and /or component b…
- System, process, and/ or component z

It is the counterpart organization's expectation that the findings of IAEA's IERICS review, as an independent international technical review, will provide the following benefits to their development project:

- To enhance the acceptance and reliability of the system(s) under review system by implementing the recommendations and findings of the mission;
- Other expectations of the counterpart

1.3. BASIS AND REFERENCE FOR THE REVIEW

1.3.1. Guideline reference to conduct the review

The basis for the review was the IAEA Safety Guides NS-G-1.3 [1], NS-G-1.1 [2] and related IAEA Nuclear Energy Series [3], [4], [5]. In addition, sections of the IAEA Safety Guide NS-G-1.3 were further explained and clarified using a number of IEC Standards [6]-[14]. The review team members also used their expert judgments to compare the review subjects against other existing international good practices.

1.3.2. Information reviewed

The information provided by counterpart or the review purposes was supported by the following documents:

Item No.	Title	Revision (date)	Page
1	*Listing of review basis documents…*		
2			
3			
4			
5			

1.4. CONDUCT OF THE REVIEW

The IERICS review mission was conducted based on the technical information provided by counterpart in the following forms:

- Presentations by counterpart experts and representatives of other companies, delivered on the first two days of the mission
- Description of the review material and discussion of any demonstrations and tours held during the review process.
- As required…Additional presentations and discussions, including the counterpart's response to the initial list of items to be clarified. (The list of XX general and YY specific questions and requests compiled by the review team on the second day of the mission can be found in Appendix V of this report.)

Counterparts from counterpart, as the component designer of the advanced I&C system, and additional counterparts from participating organizations were involved in the technical meetings and discussions. A list of all participants can be found in Appendix I of this report.

The counterpart organization was very well prepared and comprehensive, and was presented very well also. This material on the selected subjects included:

- Summary of the topics covered during the presentations and discussions

During the course of the mission, the counterpart also prepared responses and additional presentations to clarify details addressed by the IAEA experts.

Discussion of any tours and/or demonstrations during the review follows…

Assessment of the contents and compliance of the design have been carried out based mainly on comparison to the IAEA Safety Guide NS-G-1.3, as well as international good practices, with the purpose of identifying strong points and opportunities for improvement.

The conclusions, recommendations, suggestions, comments, and good practices (documented in Section 2.2 and Appendices III to IV of this report) were presented and agreed upon with the counterparts during the exit meeting.

This report is a joint effort of the IAEA review team at large and its content was shared among all the review team members.

The review was conducted in an excellent atmosphere of mutual understanding with a positive sharing of experience between the team members and the counterparts.

1.5. CONTENT OF THE MISSION REPORT

Chapter 1 of the report provides general mission information. Chapter 2 provides a summary with general conclusions, a list of specific recommendations, suggestions, and comments or observations, as well as a list of good practices. Chapter 3 provides an outline of the findings in each area reviewed.

Appendices I and II of the report provide the list of participants to the meetings and the mission programme.

Detailed technical recommendations and suggestions in the form of issue sheets developed by the IAEA experts are collected in Appendix III, while identified good practices are presented in detail in Appendix IV.

2. MAIN CONCLUSIONS AND RECOMMENDATIONS

2.1. GENERAL CONCLUSION

Remarks in the conclusions will be dependent on the observations made during review but a suggested format is…

Through the review of the presented documents and discussions with the counterparts, the IAEA review team confirmed that extensive engineering work of high quality has been performed to develop the advanced I&C systems for system(s) under review. In general, the reviewed parts of the I&C system meet the requirements of the relevant sections of the IAEA Safety Guide NS-G-1.3. Specific issues, identified as areas for further improvement, are listed in the issue sheets, as suggestions and recommendations.

2.1.1. Review of the presented documents

The review areas covered (as appropriate):

- Review area 1
- Review area 2....
- Review area n

2.1.1.1. Review area 1

Discussion of review area 1

2.1.1.2. Review area 2

Discussion of review area 2

2.1.2. Describe and tours and/or demonstrations held during the review…

Summary of the findings made during the review…

After the review and discussion with the counterparts, the IAEA review team compiled AA recommendations, BB suggestions, CC good practices, and DD comments (See Sections 0, 0 and Appendices III and IV for more details.)

2.2. SPECIFIC RECOMMENDATIONS / SUGGESTIONS / COMMENTS

2.2.1. Recommendations

R1) Text of recommendation 1.
R2) Text of recommendation 2.

2.2.2. Suggestions

S1) Text of suggestion 1.
S2) Text of suggestion 2.

2.2.3. Comments

C1) Text of comment 1
C2) Text of comment 2

2.3. GOOD PRACTICES
GP1) Text of good practice 1
GP2) Text of good practice 2

3. ASSESSMENT OF THE ISSUES

3.1. PRESENTATION AND TREATMENT OF THE ISSUES

3.1.1. General

Issue sheets, developed in accordance with Section 2.5.2 of the IERICS review mission protocol should be included at this point,

In this section, the design issues of the engineering review performed by the IAEA review team are presented in detail, following the prepared format for the IERICS mission.

Recommendations and suggestions are numbered in sequential order for further reference. The reviewed documents, corresponding specifically to the design issue under consideration, are also listed in the issue sheets.

3.1.2. Summary of the reviewed issues

The following table summarizes the situation with the issues:

Issue No.	**Title of Issue**	**Recommendation No.**	**Suggestion No.**
I1-AAA	*Text from Section 2 of the issue sheet I1-AAA*	Applicable R# (if one exists)	Applicable S# (if one exists)
I1-BBB	*Text from Section 2 of the issue sheet I2-BBB*	Applicable R# (if one exists)	Applicable S# (if one exists)
Total	***# of Issue sheets***	***# of Recommendations***	***# of Comments***

All the issue sheets are collected in Appendix III.

3.2. PRESENTATION OF GOOD PRACTICES

Good practice sheets, developed in accordance with Section 2.5.2 of the IERICS review mission protocol, should be included at this point.

In this section of the report, the good practices identified by the IAEA review team are presented, following a prepared format for the good practices.

The good practices are presented in sequence and numbered, with a "good practices sheet" specific for each item.

The following table summarizes the identified good practices:

GP No.	Title of good practice
GP-1	Text from Section 1 of the good practice sheet GP1
GP-2…	Text from Section 1 of the good practice sheet GP2
GP-n	Text from Section 1 of the good practice sheet GPn

All the good practice sheets are collected in Appendix IV of the mission report.

These practices may be considered and may serve as good engineering examples for other nuclear power plant I&C system design projects.

4. ACKNOWLEDGEMENT

Tailored based on how the review went….

The host organization provided excellent conditions for conducting the mission. The counterpart organization staff was fully prepared for the technical discussions, presentations and demonstrations, and they promptly responded to the questions and clarification requests from the IAEA review team.

5. REFERENCES

IAEA Safety Standards Series:

[1] INTERNATIONAL ATOMIC ENERGY AGENCY, Instrumentation and Control Systems Important to Safety in Nuclear Power Plants, Safety Guide, IAEA Safety Standards Series No. NS-G-1.3, IAEA, Vienna (2002).

[2] INTERNATIONAL ATOMIC ENERGY AGENCY, Software for Computer Based Systems Important to Safety in Nuclear Power Plants, Safety Guide, IAEA Safety Standards Series No. NS-G-1.1, IAEA, Vienna (2000).

IAEA Nuclear Energy Series:

[3] INTERNATIONAL ATOMIC ENERGY AGENCY, Implementing Digital I&C Systems in Modernization of Nuclear Power Plants, IAEA Nuclear Energy Series No. NP-T-1.4, IAEA, Vienna (2009).

[4] INTERNATIONAL ATOMIC ENERGY AGENCY, Protecting Against Common-Cause Failures in Digital I&C Systems, IAEA Nuclear Energy Series No. NP-T-1.5, IAEA, Vienna (2009).

[5] INTERNATIONAL ATOMIC ENERGY AGENCY, Core Knowledge on Instrumentation and Control Systems in Nuclear Power Plants, IAEA Nuclear Energy Series No. D-NP-T-3.12, IAEA, Vienna (2011).

IEC Standards

[6] IEC 60709, Nuclear power plants - Instrumentation and control systems important to safety – Separation (2004).
[7] IEC 60780, Nuclear power plants - Electrical equipment of the safety system – Qualification (1998).
[8] IEC 60880, Nuclear power plants - Instrumentation and control systems important to safety - Software aspects for computer-based systems performing category A functions (2006).
[9] IEC 60987, Nuclear power plants - Instrumentation and control important to safety - Hardware design requirements for computer-based systems (2007).
[10] IEC 61225, Nuclear power plants - Instrumentation and control systems important to safety - Requirements for electrical supplies (2005).
[11] IEC 61500, Nuclear power plants - Instrumentation and control important to safety - Data communication in systems performing category A functions (2009).
[12] IEC 61513, Nuclear power plants - Instrumentation and control for systems important to safety - General requirements for systems (2001).
[13] IEC 62003, Nuclear power plants - Instrumentation and control important to safety - Requirements for electromagnetic compatibility testing (2009).
[14] IEC 62340, Nuclear power plants - Instrumentation and control systems important to safety - Requirements for coping with common cause failure (CCF) (2007).

6. ABBREVIATIONS USED IN THE MISSION

LIST SHOULD BE TAILORED FOR THE REVIEW....

CCF	common cause failure
CEA	control element assembly
CH	channel
COTS	commercial off-the-shelf
CPLD	complex programmable logic device
CPS	computerized procedure system
CRCS	control rod control system
DCS	digital control system
DDS	document delivery schedule
DPS	diverse protection system
EMI	electromagnetic interference
EQ	equipment qualification
ESF	engineered safety features
EWS	engineering workstation
FMEA	failure mode and effect analysis
FPGA	field programmable gate array
I&C	instrumentation and control
IAEA	International Atomic Energy Agency
IEC	International Electrotechnical Commission
IERICS	independent engineering review of instrumentation and control systems
IT	information technology
MCR	main control room
MMI	man machine interface
MMIS	man machine interface system
MTBF	mean time between failure
MTP	maintenance and test panel
MTTR	mean time to repair
NPP	nuclear power plant
PAMI	post accident monitoring instrumentation
PCM	power converter module
PLC	programmable logic controller

PLD	programmable logic devices
PPS	plant protection system
QA	quality assurance
R&D	research and development
RPS	reactor protection system
RTM	requirements traceability matrix
SDN	safety data network
SER	safety evaluation report
SFC	single failure criterion
SPV	single point vulnerability
SW	software
TR	technical report
TTL	transistor-transistor-logic
V&V	verification and validation

APPENDIX I

LIST OF PARTICIPANTS

I. IAEA expert team

(1)	Reviewer 1	IAEA/NENP, Team Leader
(2)	Reviewer 2…	Organization, country
(3)	Reviewer n…	Organization, country

II. counterpart participants

(1)	Participant 1	Organization
(2)	Participant 2..	Organization
(3)	Participant n	Organization

APPENDIX II

MISSION PROGRAMME

Agenda/Timetable of the review meeting

APPENDIX III

ISSUES

Insert issue sheets in sequential order I1, I2,...

ISSUE SHEET # X	
1. ISSUE IDENTIFICATION	Issue Number:
Mission: **IAEA REVIEW OF THE (*SYSTEM TITLE)***	
Reviewed Area:	
Issue Title:	

2. ISSUE CLARIFICATION	**Date:**
2.1 - ISSUE DESCRIPTION	
2.2 – IDENTIFIED BY: Review Team ☐ counterpart ☐	
2.3 – ISSUE CREATED BASED ON THE FOLLOWING DOCUMENTS / PRESENTATIONS PROVIDED BY THE COUNTERPART:	
2.4 - REFERENCE TO IAEA AND OTHER RELEVANT DOCUMENTS	

3. COUNTERPART VIEW ON THE ISSUE (OPTIONAL)

4. ASSESSMENT BY THE IAEA REVIEW TEAM
4.1 – COMMENTS:
4.2 – RECOMMENDATIONS AND SUGGESTIONS:

5. COUNTERPART RESPONSE ON THE RECOMMENDATIONS / SUGGESTIONS (OPTIONAL)

FOLLOW UP *(if required)*

6. COUNTERPART ACTIONS TAKEN AFTER THE MISSION	**Date**:

7. FOLLOW-UP ASSESSMENT BY THE IAEA REVIEW TEAM	**Date:**
7.1 - COMMENTS:	
7.2. RECOMMENDATIONS AND SUGGESTIONS: **R1)**	
7.3 - DOCUMENTS REVIEWED:	

STATUS OF THE ISSUE			**Date:**
Resolution Degree:			
1	**No action**	The issue was not agreed on by the counterpart and no action was taken to resolve it. No progress in the resolution of the issue, or unsatisfactory resolution.	
2	**Action planned or under way**	The issue was agreed on by the counterpart, but the solution has not yet started. or The issue was agreed on by the counterpart and work has started to resolve it.	
3	**Issue partially resolved**	The issue was agreed on by the counterpart and actions are completed in the counterpart's view. The implemented actions meet only partially the intent of the recommendations of the previous IAEA review.	
4	**Issue resolved**	The issue was agreed on by the counterpart and the solution provided is fully satisfactory. Issue closed. The intent of recommendations of previous IAEA review is fully met. Issue closed.	

APPENDIX IV

GOOD PRACTICES

Insert good practice sheets in sequential order GP1, GP2,...

GOOD PRACTICES (GP) SHEET		
1. GP IDENTIFICATION	GP Number:	
Mission: **IAEA REVIEW OF THE (*SYSTEM TITLE)***		
Reviewed Area:		
GP Title:		

2. GP CLARIFICATION	**Date:**
2.1 - GP DESCRIPTION:	
2.2 – GP WAS IDENTIFIED BASED ON THE FOLLOWING DOCUMENTS / PRESENTATIONS PROVIDED BY THE COUNTERPART:	
2.3 - REFERENCE TO IAEA AND OTHER RELEVANT DOCUMENTS:	

3. COUNTERPART VIEW ON THE IDENTIFIED GP (OPTIONAL)

4. ASSESSMENT BY THE IAEA REVIEW TEAM
4.1 – COMMENTS (meets expectations of international practices): ***M1)***
4.2 – COMMENTS (exceeds expectations of international practices): ***E1)***

APPENDIX V

IAEA REVIEW TEAM QUESTIONS, REQUESTS FOR ADDITIONAL EXPLANATION

These are the clarification questions submitted by the review team prior to the development of the issue sheets…

General questions

(1) General question 1

(2) General question n

Detailed questions

(1) Detailed question 1

(2) Detailed question n

Besides “IAEA REVIEW TEAM QUESTIONS” add any other Appendices as needed here after Appendix V.

CONTRIBUTORS TO DRAFTING AND REVIEW

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End of mission report template

GLOSSARY AND MAIN ABBREVIATIONS

GLOSSARY

advance information package: A set of documents provided to the IERICS team members by the counterpart Organization during the preparatory phase prior to the review mission.

breakout session: A technical session during the review mission where only a part of the IERICS team is involved.

briefing meeting: A meeting of the IERICS team typically held the day prior the review mission, to ensure that all members of the IERICS team have all necessary information

code of conduct: A set of policies and practices that the IERICS team members must observe during the review mission.

closeout session: Final plenary session during the review mission, where the IERICS team presents its findings, the counterpart expresses their point of view, and mutual agreement is attained on any remaining outstanding issues.

comment: Observations of the IERICS team based on the review and the discussions during the review mission. It is for information only, no action or response is required on the counterpart side.

counterpart: Organization that has requested the IERICS mission, that is responsible for providing information and answers necessary to the review, and that hosts the review mission.

counterpart representative: Person designated by the counterpart to be the counterpart of the IERICS team leader.

debriefing meeting: Meeting of the IERICS team held the day after the review mission per se, to develop a quasi final state for the mission report.

finding: Comment, Issue, Recommendation, Suggestion or good practice that the IERICS team mentions, or intends to mention, in the mission report.

focused review: Technical session during the review mission that allows the IERICS team to study a selected topic in deep detail.

good practice: An outstanding and proven performance, programme, activity or design element, markedly superior to other practices observed elsewhere, and not just in its fulfilment of current requirements or expectations.

IERICS mission: Engineering review service directly addressing strategy and the key elements for implementation of modern I&C systems, noting in applicable cases, specific concerns related to the implementation of digital I&C systems and the use of software and/or digital logic in safety applications of a NPP.

IERICS team meeting: Meeting during the review mission involving the IERICS team only and allowing the team members to share information and understanding, to compare points of view and to reach a team consensus on questions and findings.

IERICS team leader: An IAEA staff member designated to be responsible for all preparatory activities, to act as an official liaison with the counterpart, to co-chair the review mission with the counterpart representative, to prepare and issue the mission report, and to be responsible for all follow-up activities.

issue: An identified concern or an area for improvement, which has been identified on the basis of the review basis and reference and/or internationally recognized good practices in the subject.

opening session: Initial plenary session during the review mission, to make sure that all the participants to the review mission (IERICS team and counterpart) have all necessary or useful information.

plenary session: Session during the review mission involving the complete IERICS team and the counterpart.

recommendation: Advice from the IERICS team on what improvements should be made that would contribute to resolve an issue. Follow-up action is required.

review basis and reference: A set of documents against which the system under review will be assessed.

suggestion: Advice from the IERICS team on what improvements may be made that would contribute to resolve an issue. Follow-up action is not strictly required, it is only optional in order to get closer to internationally recognized good practices.

system under review: The item to be reviewed, its properties and boundaries.

technical presentation: Technical session where the counterpart presents a specific aspect of the system under review, at a level of detail that allow the IERICS team to assess the system's compliance to the review basis and references.

technical session: A session during the review mission involving the IERICS team and the counterpart, where the IERICS team reviews specific technical subjects.

technical visit: Technical session where the IERICS team can collect facts on the ground that would otherwise be difficult to gather from the documentation or presentations.

ABBREVIATIONS

AIP	advanced information package
I&C	instrumentation and control
IERICS	independent engineering review of I&C systems
NPP	nuclear power plant
SSC	systems, structures, and components
TOR	terms of reference
V&V	verification and validation

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