MX0500152

Congreso Internacional Conjunto Cancún 2004 LAS/ANS-SNM-SMSR/International Joint Meeting Cancun 2004 LAS/ANS-SNM-SMSR
XV Congreso Anual de la SNM y XXII Reunión Anual de la SMSR/XV SNM Annual Meeting and XXII SMSR Annual Meeting
Cancún, Q.R., México, 11-14 de Julio, 2004/Cancún, Q.R., Mexico, July 11-14, 2004

Improved Technical Specifications and Related Improvements to Safety in Commercial Nuclear Power Plants

Donald R. Hoffman,
Thomas Demitrack, Ray Schiele, and Jerry C. Jones
EXCEL Services Corporation
11921 Rockville Pike, Suite 100, Rockville, MD 20852 USA
donaldh@excelservices.com; thomasdemitrack@yahoo.com;
rays46@earthlink.net; and jerrycjones100@earthlink.net

Abstract

Many of the commercial nuclear power plants in the United States (US) have been converting a portion of the plant operating license known as the Technical Specifications (TS) in accordance with a document published by the US Nuclear Regulatory Commission (NRC). The TS prescribe commercial nuclear power plant operating requirements. There are several types of nuclear power plants in the US, based on the technology of different vendors, and there is an NRC document that supports each of the five different vendor designs. The NRC documents are known as the Improved Standard Technical Specifications (ISTS) and are contained in a separate document (NUREG series) for each one of the designs. EXCEL Services Corporation (hereinafter EXCEL) has played a major role in the development of the ISTS and in the development, licensing, and implementation of the plant specific Improved Technical Specifications (ITS) (which is based on the ISTS) for the commercial nuclear power plants in the US that have elected to make this conversion. There are currently 103 operating commercial nuclear power plants in the US and 68 of them have successfully completed the conversion to the ITS and are now operating in accordance with their plant specific ITS. The ISTS is focused mainly on safety by ensuring the commercial nuclear reactors can safely shut down and mitigate the consequences of any postulated transient and accident. It accomplishes this function by including requirements directly associated with safety in a document structured systematically and taking into account some key human factors and technical initiatives. This paper discusses the ISTS including its format, content, and detail, the history of the ISTS, the ITS development, licensing, and implementation process, the safety improvements resulting from a plant conversion to ITS, and the importance of the ITS Project to the industry.

1. INTRODUCTION

Commercial nuclear plants in the US were licensed from 1969 through 1996. There are currently 103 commercial nuclear plants in operation in the US. In addition, some plants have already been decommissioned. As a result, plant personnel, vendor, engineering companies, and the NRC have achieved many years of nuclear operating experience.

Each one of these commercial nuclear plants are licensed by the NRC and all are required to operate in accordance with the plant operating license and TS. The TS cannot be revised without prior NRC approval.

The format, content, and detail of the TS varies between each commercial nuclear power plant depending on many factors (e.g., vendor design, when the plant was licensed, and personnel involved in the licensing). Prior to the early 1980s, the TS technical content covered safety and non-safety plant operating requirements and therefore covered the requirements of a wide range of structures, systems, components, and plant variables.

Commercial nuclear power plants are regularly being modified to improve plant performance and safety. Many times these changes require TS modifications. Therefore, to make these improvements, this requires NRC review and approval of changes before any plant optimization can be made. Because of the extensive technical content covering both normal and safety operation, many TS changes were unnecessarily being processed throughout the industry.

In the mid 1980s the NRC and industry came to the conclusion that to better serve the industry and the NRC it was time to improve the basic technical content and format of the plant TS. After years of studies, and meetings with the industry, four criteria were established in the Final Commission Policy Statement on Technical Improvements for Nuclear Power Reactors [1] and placed into the Code of Federal Regulations [2]. The change to the Code of Federal Regulations allows the licensee of the commercial nuclear power plants to remove from the plant TS those requirements associated with plant structures, systems, components, or variables that do not satisfy one of the four criteria and relocate the requirements to other plant controlled documents. Those requirements associated with plant structures, systems, components, or variables that do satisfy one or more of the four criteria must remain in TS.

The ISTS documents, in part, are based on this Final Commission Policy Statement on Technical Improvements for Nuclear Power Reactors [1] and were first published in September 1992 prior to the change in the Code of Federal Regulation [2]. The publications also resulted from extensive public technical meetings and discussions among the NRC, various commercial nuclear power plant licensees, nuclear steam supply system owners group, and other organizations. EXCEL has been involved in the development of the ISTS since program inception. The ISTS is optimized, for the most part, to only include those technical requirements that are necessary to ensure the plant could safely shut down and mitigate the consequences of any postulated transient and accident.

2. IMPROVED STANDARD TECHNICAL SPECIFICATIONS (ISTS)

There are several types of nuclear power plants in the US, based on the technology of different vendors, and there is an NRC ISTS document that supports each of the five different vendor designs. Each ISTS is bounded in two volumes; the first volume is known as the Specifications and the second is the Bases. The NRC first published the documents in September 1992 [1] as a result of extensive public technical meetings and discussions among the NRC, various commercial nuclear power plant licensees, nuclear steam supply system owners group and other organizations. Since this first publication, the ISTS have been revised various times based on the experience gained from license amendment applications to convert to the ISTS of which EXCEL

has developed under contract with the industry. EXCEL is serving the Westinghouse, Combustion Engineering, Babcock and Wilcox, and BWR Owners Groups as technical consultant and licensing interface with the NRC.

The ISTS is a living document and continuously being upgraded to ensure it is the best possible standard to reflect the requirements for the standard plant to safely shut down and to mitigate the consequences of any postulated design basis transient or accident and to improve overall nuclear plant safety.

2.1. ISTS Format

A Specification includes the requirements for a structure, system, component, or variable. Each Specification in the ISTS includes a section for Limiting Conditions for Operation (LCO), Applicability, Actions, and Surveillance Requirements. The LCO is defined as the lowest functional capability or performance levels of equipment required for safe operation of the facility [1]. The format of the Specifications was developed using a human factors approach to help ensure compliance with each Specification. The human factors approach resulted in the development of Action and Surveillance Requirements in a tabular approach, using a unique numbering process, with logical connectors. The human factors approach ensures the Specifications are in effect at the appropriate plant conditions, the Actions are followed correctly when necessary, and the Surveillance Requirements are met at the appropriate plant conditions and specified frequency. An example of the format of a Specification is presented in Figure 1.

The tabular approach for Actions include a column for Conditions, Required Actions, and Completion Times. The tabular approach for Surveillance Requirements includes a column for Surveillances and Frequencies. Previous versions of the Technical Specifications did not use this tabular approach for Actions and Surveillance Requirements. The format for previous Technical Specification standards for Boiling Water Reactors can be found in NUREG-0123 [3]. For Actions, the Condition, Required Actions, and Completions Times are all described in the same sentence or paragraph. For Surveillance Requirements, the Surveillance and Frequency are also described in the same sentence or paragraph. The ISTS format is superior to previous TS formats in that it improves the understandability and usability of the TS, thus helping to ensure TS compliance. TS compliance is enhanced by the TS numbering system, which simplifies the approach to procedures. This approach helps to ensure plant variables are with the appropriate limits and systems are operating correctly or prepared to operate if needed when called upon.

2.2. ISTS Content

Each ISTS includes requirements associated with Specifications covering safety limits, reactivity control systems, power distribution limits, instrumentation, reactor coolant system, emergency core cooling systems, containment systems, plant systems, electrical systems, and refueling operations. The Specification is precisely written to ensure appropriate implementation of the requirement. These Specifications are all included in the first volume. This volume also includes a chapter on controls associated with design features and administrative controls. In addition, the

volume contains a chapter on use and application of the ITS, which includes sections that are entirely new to TS. This use and application chapter includes a set of Definitions, which apply throughout the document, as well as explicit rules for the Actions and Surveillance Requirements, thus providing the necessary guidance to ensure consistent application of the TS at each plant throughout the industry.

The ISTS also includes a Bases document. This Bases document consists of a Bases section for each Specification, and each Bases section contains a Background description, Applicable Safety Analyses description, a corresponding description for each of the sections of the Specifications (Limiting Conditions for Operation, Applicability, Actions, and Surveillances), and a Reference section.

This approach ensures plant personnel and the NRC have a Bases document for each specification. The Bases links the Specifications with the assumptions of the safety analyses. This improves the plant safety culture by improving nuclear plant personnel and regulatory authority personnel understanding of plant licensing and design basis and enhances interface between engineering, operations, technical support organizations, and licensing. It also provides a structured approach for plant training.

2.3. Criteria in the Code of Federal Regulations

The Code of Federal Regulations [2] includes four criteria for specifying requirements for structures, systems, components, and variables in the TS. Each specification in the ISTS, for the most part, satisfies one of the four criteria specified in the code of federal regulation. The four criteria are:

1) Installed instrumentation that is used to detect and indicate a significant abnormal degradation of the reactor coolant pressure boundary;

2) A process variable, design feature, or operating restriction that is an initial condition of a design basis accident or transient analysis;

3) A structure, system, or component that is part of the primary success path and which function to actuate to mitigate a design basis accident or transient; and

4) A structure, system, or component which operating experience or probabilistic risk assessment has shown to be significant to public health and safety.

The criteria of the ISTS are focused on nuclear plant safety. The criteria permit plant operators and plant staff to focus both efforts and resources on safety related activities. The first criterion is focused on detecting degradation in the reactor coolant pressure boundary. This provides the operator information to detect the potential for an accident to occur. The first and second criteria help to ensure the consequences of a postulated design basis accident or transient will remain within the assumptions of safety analysis by ensuring important variables are within limits prior to an event and if an event occurs ensures the appropriate equipment will be available for mitigation. The structures, systems, or components that satisfy the fourth criteria are not credited in the safety analyses, however for the most part will improve the mitigation capability of the

plant and reduce plant risk to the health and safety of the public. These criteria are considered acceptable with respect to regulatory control of commercial nuclear power plants since there are other regulatory processes to control other aspects of plant operation.

3.6 CONTAINMENT SYSTEMS (BWR)

3.6.1.1 Primary Containment

LCO 3.6.1.1 Primary containment shall be OPERABLE.

APPLICABILITY: MODES 1, 2, and 3.

ACTIONS

CONDITION	REQUIRED ACTION		COMPLETION TIME
A. Primary containment inoperable.	A.1	Restore primary containment to OPERABLE status.	1 hour
B. Required Action and associated Completion Time not met.	B.1	Be in MODE 3.	12 hours
	AND		
	B.2	Be in MODE 4.	36 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.6.1.1.1	Perform required visual examinations and leakage rate testing except for primary containment air lock testing, in accordance with the Primary Containment Leakage Rate Testing Program.	In accordance with the Primary Containment Leakage Rate Testing Program

Figure 1. ISTS Format [4]

3. IMPROVED TECHNICAL SPECIFICATION PROJECT

An ITS project is basically split into three parts. During the first part of the project, the Development Phase, the licensing amendment is prepared and then submitted to the NRC. The second part of the project, the Licensing Phase, the amendment request is reviewed and approved by the NRC. The third phase, known as the Implementation Phase, includes an upgrade of plant procedures, programs, safety analyses report, and other related documents, as well as detailed training activities for operations and other nuclear plant staff. The implementation phase normally starts during the later part of the development phase. All phases are important since safety concerns and other inconsistencies are continuously evaluated and if necessary, corrected. The time for an ITS conversion, from the beginning of the Development Phase to the completion of the Implementation Phase, is approximately 24 to 30 months depending upon various variables including personnel, status of plant documentation, and plant operating conditions. Plant activities such as a refueling outage may affect the project since resources are sometime re-focused. The project design ensures that all improvements factored into the ISTS are captured as well as plant specific improvements based on differences in design and licensing bases.

3.1. ITS Development Phase

EXCEL has developed the ITS licensing submittal for all 70 commercial nuclear power plants in the US that have developed and submitted their ITS to the NRC to date. The licensing submittal must address every requirement of the current TS as well as every requirement in the ISTS.

In order to compile the licensing submittal, a thorough review of the plant design, licensing basis, and plant analyses is required. The plant design and licensing basis is compared to that described in the ISTS. Those systems, structures, components, and variables covered by the current TS and that perform similar functions to those systems, structures, components, and variables in the ISTS are retained in the plant specific ITS. In most cases, those structures, systems, components, and variables which are retained in the plant specific ITS, must satisfy at least one of the four criteria.

For each of the systems, structures, components, and variables included in the ITS, the design, licensing basis, analyses, and calculations are reviewed to developed the plant specific bases and the other requirements of the licensing submittal.

The Development process involves an extensive integrated review of the plant design, licensing basis, analyses, and calculations, which results in a better plant awareness, and understanding of the TS by the plant staff. This ITS development process involves such an integrated review of the plant, it discovers inconsistencies in such documents thus avoiding potential license events and condition reports. Since most of the plants have been operating for a number of years resulting in experienced and knowledgeable plant personnel involved in the project, development guarantees a successful project thus improving the safety and the safety culture of the operating facility.

3.2. ITS Licensing Submittal

The proposed licensing submittal is compiled and reviewed and approved by the plant staff (including operations, engineering, licensing), designated experts, and plant onsite and offsite safety review committees in accordance with the licensing amendment request process. The licensing submittal includes:

1) A markup of the current TS identifying all changes (with a classification of the type of change) and location of the requirement in the ITS;

2) A discussion of each change including a description of the change and justification;

3) A markup of the ISTS identifying all changes and the location of the same requirement in the current TS;

4) A description and justification of each change to the ISTS;

5) A cleaned typed version of the plant specific ITS and associated Bases; and

6) A no significant hazard and environment evaluation.

3.3. ITS Licensing Phase

During this phase, the NRC reviews the plant specific ITS license amendment. Meetings and teleconferences are held to discuss NRC questions and issues with the license amendment. Upon completion of the review process, a license amendment is issued containing the NRC Safety Evaluation Report and the approved ITS. EXCEL has supported the Licensing Phase for all the US plants that have had the ITS licensed by the NRC.

3.4. ITS Implementation Phase

EXCEL has participated in the implementation phase for each commercial nuclear power plant in the US. The implementation phase is a significant portion of the level of effort of the ITS project since it includes an upgrade of all affected plant procedures, programs, safety analyses reports, and other related documents to ensure compliance with the proposed ITS. It also includes plant staff training to ensure the entire organization is familiar with the ITS.

EXCEL has gained much experience over the years and utilizes experienced personnel for implementation, independent of the development group, which ensures an independent review of the ITS licensing amendment. This team ensures the TS requirements can be performed and are consistent with the plant design. If not, modifications to the license amendment may be necessary. During the implementation phase, the NRC is also reviewing the ITS licensing submittal. The implementation group and the NRC review provide an additional assurance that the licensing amendment is accurate and of high quality. If the implementation group or the NRC

discovers concerns, the licensing submittal may be revised. The revisions to the submittal are tracked and factored into the project and the plant documents are corrected as required.

3.5 Plant Documentation

The implementation of the ITS involves a global review and upgrade of the plant documents to ensure procedures, programs, the final safety analysis report, the offsite dose calculation manual, the quality assurance program, and other related plant documents are revised to reflect the changes to the current Technical Specifications. The ITS project requires the addition of some new requirements. The new requirements reflected in the ITS may require modifications to procedures, additional procedures, and new plant programs and associated plant procedures.

The approach used to accomplish a successful implementation is to become familiar with current TS, the ITS licensing submittal, and other documents currently associated with plant TS. The procedure project scope includes a wide range of procedures but mainly includes surveillance procedures, operating procedures, emergency procedures, radioactive effluent procedures, and alarm procedures.

Each individual procedure is reviewed to determine its scope. If the procedure scope involves a current TS requirement it is reviewed to ensure that it satisfies the requirement and then modified as necessary to meet the corresponding ITS requirement and associated bases. The modifications are reviewed by plant staff for approval consistent with the plant review and approval process.

To ensure all changes to the license are accounted for, the current TS requirements, the ITS requirements, the procedures, and other documents are captured into a database so that there is an additional assurance that all changes and modifications are made.

3.6 ITS Training

The ITS incorporates many new conventions, ground rules, and philosophies, as well as numerous technical changes. To ensure that the transition from the current TS to the ITS is successful, it is important that EXCEL develops training material and conducts the training because of our detailed understanding of the ITS. This training ensures a consistent understanding of the TS throughout the organization thus improving the plant safety culture.

3.7 ITS Safety Improvements

The plant ITS licensing submittal is developed by EXCEL personnel and a team of plant personnel with operating, system, instrumentation, and engineering experience. Their effort is reviewed and approved by the plant staff (operations, engineering, licensing, and other affected organizations), certain experts, and onsite and offsite organizations. The license submittal is also reviewed in detail by the implementation group and the NRC. This development and implementation process, therefore, ensure a complete accurate licensing amendment.

The ISTS, which has been developed by industry experts with years of expertise, includes both technical and human factor enhancements that result in improvements to safety.

Some of the technical improvements are:

1) The establishment of the four NRC criteria that enables the TS to focus on safety;

2) Development of a thorough Bases document describing the detailed Bases for each Specification. This document provides a better understanding of each Specification for the purposes of plant and NRC personnel by linking the Specifications to the plant safety analysis;

3) Improvement to Action requirements are made to increase plant availability by avoiding unnecessary plant shutdowns, by developing appropriate compensatory actions and extending Completion Times to repair inoperable equipment;

4) Improvement to Surveillance Requirements by allowing the performance of online maintenance and helps to ensure risky Surveillance requirements are performed during plant shutdowns or outages; and

5) Optimization of Surveillance Requirements in order to eliminate excessive and unnecessary testing.

Some of the human factor improvements are:

1) The establishment of a tabular approach to Actions and Surveillance Requirements which helps ensure TS compliance and operator usability;

2) The establishment of a use and application section geared to ensure consistent application of the TS throughout the industry; and

3) The establishment of programs to ensure unambiguous direction is provided to guide the operating staff with regard to support system inoperability and multiple inoperable conditions.

A plant specific ITS conversion project can take advantage of all of the technical and human factor improvements of the ITS.

The objectives of the ITS conversion project are to improve safety of commercial nuclear power plants, provide clearer understanding of the safety significance of the TS requirements, and ease administrative burdens imposed by the TS to both the utility and the NRC. Operational safety is improved by reducing the size and complexity of the TS, making them "user-friendly," making specific technical improvements, and by reducing the number of operational transients imposed by TS. Understanding of the safety significance of the TS requirements is clarified through improved and significantly expanded bases, utilizing risk insights, and a format and content that facilitates training operators. Administrative burdens will be reduced considerably, primarily by reducing the number of licensee amendment requests required, since extraneous materials will be

moved to more appropriate licensee controlled documents such as the safety analysis report, and licensee developed programs, procedures, and other administrative controls.

4. CONCLUSIONS

As a result of many years of commercial nuclear power plant operating experience, studies, and plant site implementation of the plant specific ITS, the US nuclear industry is improving safety by implementing a regulatory document optimized in content and format to ensure operations and the plant staff have a complete and concise set of rules for operating to help ensure plants can safely shut down and mitigate the consequences of any postulated transient or accident.

EXCEL has converted all of the 68 US nuclear power plants that have completed ITS conversion to date in collaboration with each of the nuclear plant staffs. More US commercial nuclear plants are interested in the ITS conversion projects and EXCEL expects most of them to convert in the near future. This will ensure US nuclear plants can operate safely through the end of the normal licensing period or through the end of an extended licensing period for those plants that are approved for licensing renewal.

The ITS safety improvements can be applied to commercial nuclear power plants throughout the world to ensure safe and efficient operation and strengthen the industry in this global economy.

ACKNOWLEDGMENTS

EXCEL would like to acknowledge the commitment, dedication, and hard work of our associates, the nuclear plants and their parent organizations, and the NRC in their support of the generic and plant specific ITS activities.

REFERENCES

1. Nuclear Regulatory Commission, “Federal Register,” Rules and Regulations, Volume 60, No. 138, p. 36593-36599 (July 1995).
2. Nuclear Regulatory Commission, "Section 36 of Part 50 of Title 10 of the Code of Federal Regulations."
3. NUREG-0123, Nuclear Regulatory Commission, General Electric Plants, Draft Standard Technical Specifications, Revision 4.
4. NUREG-1433, Nuclear Regulatory Commission, General Electric Plants, Standard Technical Specifications, BWR/4, Specifications, Revision 2, June 2001.