POLICY ISSUE
(Information)

March 8, 2007 SECY-07-0047

FOR: The Commissioners

FROM: Luis A. Reyes
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SUBJECT: STAFF APPROACH TO VERIFYING THE CLOSURE OF INSPECTIONS, TESTS, ANALYSES, AND ACCEPTANCE CRITERIA THROUGH A SAMPLE-BASED INSPECTION PROGRAM

PURPOSE:

The purpose of this paper is to inform the Commission of the approach developed by the staff to select those inspections, tests, analyses, and acceptance criteria (ITAAC) to be given priority for inspection and how these inspection results will be used to support ITAAC closeout. The descriptions contained in this paper focus on the basis and development of an ITAAC inspection prioritization process; the means by which ITAAC are categorized; the inspection selection process; the statistical approach used for rating the importance of inspection for each ITAAC; and how this information will be used to support the ITAAC closeout process. This paper does not address any new commitments or resource implications.

BACKGROUND:

In 2001, the Construction Inspection Team, composed of representatives from each region, new reactor licensing, and inspection program management, was formed and tasked with updating the inspection program. The current effort to develop the Construction Inspection Program (CIP) has focused on ensuring that the inspection program will collect the information necessary to support the Commission in making the finding, required by 10 CFR 52.103(g), on whether the acceptance criteria in the combined license have been met.

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Inspection Manual Chapter (IMC) 2503, "Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC)," and IMC-2504, “Non-ITAAC Inspections,” were issued in April 2006, and describe the programs for inspecting construction activities. These documents are currently undergoing revision based on the evolution of the inspection program since that time, and stakeholder input from public meetings held in January 2007. Inspections under IMC-2503 will begin when ITAAC-related work begins. NRC inspection results, together with the information submitted by the licensee, will be the foundation of the staff's recommendation to the Commission in support of its finding on whether the acceptance criteria in the combined license have been met.

DISCUSSION:

10 CFR 52.103(g) requires that the licensee not operate the facility until the Commission finds that the acceptance criteria in the combined license are met. Accordingly, the CIP is structured to enable the NRC to determine if there is reasonable basis for concluding that the ITAAC have been met by the holder of a combined license. NRC inspection results, together with the information submitted by the licensee, will be the foundation of the staff's recommendation to the Commission in support of its finding on whether the acceptance criteria in the combined license have been met. The focus of this paper is the staff’s approach to verification of ITAAC closure.

While the scope of the NRC’s inspection programs are comprehensive, 100% inspection is neither necessary nor efficient when evaluating licensee performance. For this reason, NRC historically has relied on a sample-based inspection program. During construction under 10 CFR Part 50, the NRC relied on a randomly selected set of samples for inspection. The focus of the 10 CFR Part 52 CIP is to select a sample of inspection targets to determine if there is a reasonable basis for concluding that the ITAAC have been successfully completed. The method for selecting the ITAAC-related work to be given inspection priority will be further described later in this paper. Enclosure 1, “NRC Verification of ITAAC completion,” provides a graph of ITAAC closure as it relates to inspection of ITAAC-related work. NRC will focus its inspections on activities contributing to ITAAC determined to have higher inspection value to establish a baseline inspection program for the CIP. This will provide inspection results for work related to approximately 30% of the ITAAC. This 30% will include both observation of ITAAC-related work at the construction site, vendor facilities, and review of calculations and analyses by the headquarters technical staff. These inspection targets will define the minimum sample set NRC will inspect for each construction project. This will provide the staff with a comprehensive sample based on inspection records for all ITAAC-related work identified in the ITAAC Matrix as described in IMC-2503.

After construction and subsequent NRC inspections have begun, a periodic assessment of licensee performance will be conducted. If an inspection area is identified requiring additional NRC oversight during the assessment process, inspection resources will be added as necessary to provide support the conclusion that the ITAAC have been successfully completed. This assessment process, and the criteria for expanding the sample size, will be further described in IMC-2505, “Periodic Assessment of Licensee Performance During Construction,” which we plan to issue by the end of 2007.

Each certified design includes of hundreds of ITAAC. The licensee’s work to complete these ITAAC will be performed at various times over several years. Accordingly, an approach is needed to determine which ITAAC will receive direct inspection. The staff recognized the need for this approach to be scrutable and repeatable, while maintaining efficiency and effectiveness of the program. For these reasons, the staff, with assistance of specialized contractor expertise, developed a detailed statistical analysis as part of the program's development. The detailed analysis documentation, "Technical Report on the Prioritization of ITAAC," is available in ADAMS as ML060740006. An overview of how the ITAAC Matrix and ITAAC prioritization process work together in inspection planning is shown as Enclosure 2, "ITAAC Sample Selection Process."

The methodology for prioritizing the ITAAC for inspection was based in part on a quantitative process called the Analytic Hierarchy Process (AHP). AHP is a method of comparison used to reduce the subjectivity in prioritization and provide structure to the decision making process. This prioritization process is managed such that the rating given each ITAAC will correlate to the amount of assurance one can obtain from inspecting that ITAAC. In this way, it is not the ITAAC that are prioritized, but rather the value of inspecting that ITAAC to maximize the agency's ability to detect any significant construction flaw. The approach was modeled after the framework of a prioritization of operating experience in nuclear power plants for reliability engineering and safety systems.

The prioritization methodology first required that the ITAAC be classified and grouped based on the activity required to satisfy the acceptance criteria. This was necessary to create groupings of ITAAC that all involve the same activity. These groupings were achieved using the ITAAC Matrix. The grouping of ITAAC into a matrix supports the identification and use of consistent inspection guidance for similar ITAAC within a single design. The ITAAC Matrix also provides a consistent approach across individual reactor designs by imposing the same framework on existing and any future certified designs. The ITAAC Matrix was then evaluated by the staff's contracted statistical support to ensure that the classification approach formulated by the NRC staff provides a rational way to help identify component and ITAAC groups for prioritizing NRC inspections of ITAAC-related activities. The distribution of ITAAC into the matrix are shown as Enclosure 3, "The ABWR Matrix," and Enclosure 4, "The AP1000 Matrix."

In November 2005, an expert panel of NRC staff with extensive nuclear construction and NRC inspection experience was convened to weight the four attributes that contributed to determining the value of inspecting ITAAC-related work. These ITAAC attributes are:

- **Safety Significance**. This provides a focus on the most important activities or components from the standpoint of public safety. This attribute is based in part on evaluation of probabilistic risk assessment data and other attributes specific to the reactor design in question.

- **Propensity for Making Errors**. This provides a focus on the most error-prone areas, which could be more likely to have quality deficiencies and therefore provide a greater likelihood to find the problems and have them fixed. As an example, a bimetallic weld on the reactor vessel might be more difficult than welding structural steel for a pipe support.

• **Construction and Testing Experience**. This focuses on the degree of a recent demonstrated industry track record, or the lack of a high quality construction or performance history based on NRC and industry experience with similar components.

• **Opportunity to Verify by Other Means**. This focuses on whether or not there is another time or place that the ITAAC can be verified. In other words there might be only one chance to witness something important or it can be just as completely verified by observing or reviewing another activity at a later date.

The outcome of the expert panel was a numerical ranking for each attribute for each ITAAC. These rankings were then used as part of a mathematical analysis to assign a rating for each ITAAC. The rating corresponds to the importance of inspecting that ITAAC. The prioritization has been completed for the Advanced Boiling Water Reactor (ABWR) and AP1000 ITAAC.

The final step in the methodology includes a coverage check for all ITAAC that requires at least one ITAAC from every group be inspected. The ITAAC selection approach assures that a diverse set of ITAAC have been inspected, such that the results of the inspection process are representative of the entire ITAAC population.

The nature of ITAAC activities call for periodic inspections over the course of the entire construction project with the inspection timing corresponding to ongoing or recently completed licensee activities. The timing of the staff's performance of ITAAC-related inspections and the need for expansion of the inspection sample will be periodically assessed. Inspections will be re-prioritized as necessary to correspond with the current state of knowledge of the licensee's schedule and the licensee's performance. The staff has concluded that this approach is an appropriate method for inspecting ITAAC to determine if there is a reasonable basis for concluding that all are satisfied. The criteria NRC will use to expand the inspection sample beyond the CIP baseline will be further described in IMC-2505, "Periodic Assessment of Licensee Performance During Construction," as referenced earlier in this paper.

The licensee will inform the NRC when the acceptance criteria of each ITAAC have been met. The NRC staff will use a combination of inspection results and technical review to evaluate the licensee's determination. For the ITAAC that will not be directly inspected, the staff will review the information submitted by the licensee including a description of the specified basis on which the licensee has concluded that the ITAAC has been closed. Based on the results of the staff's inspection of licensee closure of individual ITAAC and the results of inspections of the effectiveness of licensee's QA program, the staff will decide whether further inspection of the ITAAC not included in the CIP baseline inspection program is warranted. In this manner, either by direct inspection or staff review of the licensee's submitted information, the basis for the licensee's closure of each ITAAC will be evaluated by the staff. This will allow the staff to make recommendations to the Commission on whether there is a reasonable basis for verifying the licensee's claim that all ITAAC have been satisfactorily completed.

CONCLUSIONS:

The staff has described the sample-based inspection approach and the methodology for selecting those ITAAC that will be considered the baseline for the CIP. This approach includes the ability to expand the inspection sample based on assessment of licensee performance of ITAAC-related work as well as quality assurance and other programmatic areas as described in IMC-2503 and IMC-2504. These inspections will support the ITAAC completion process under 10 CFR 52.99, enabling the staff to recommend to the Commission that a finding be made as specified in 10 CFR 52.103(g) on whether the licensee has met all the acceptance criteria of the combined license.

COORDINATION:

The Office of the General Counsel reviewed this package and has no legal objection.

/RA/

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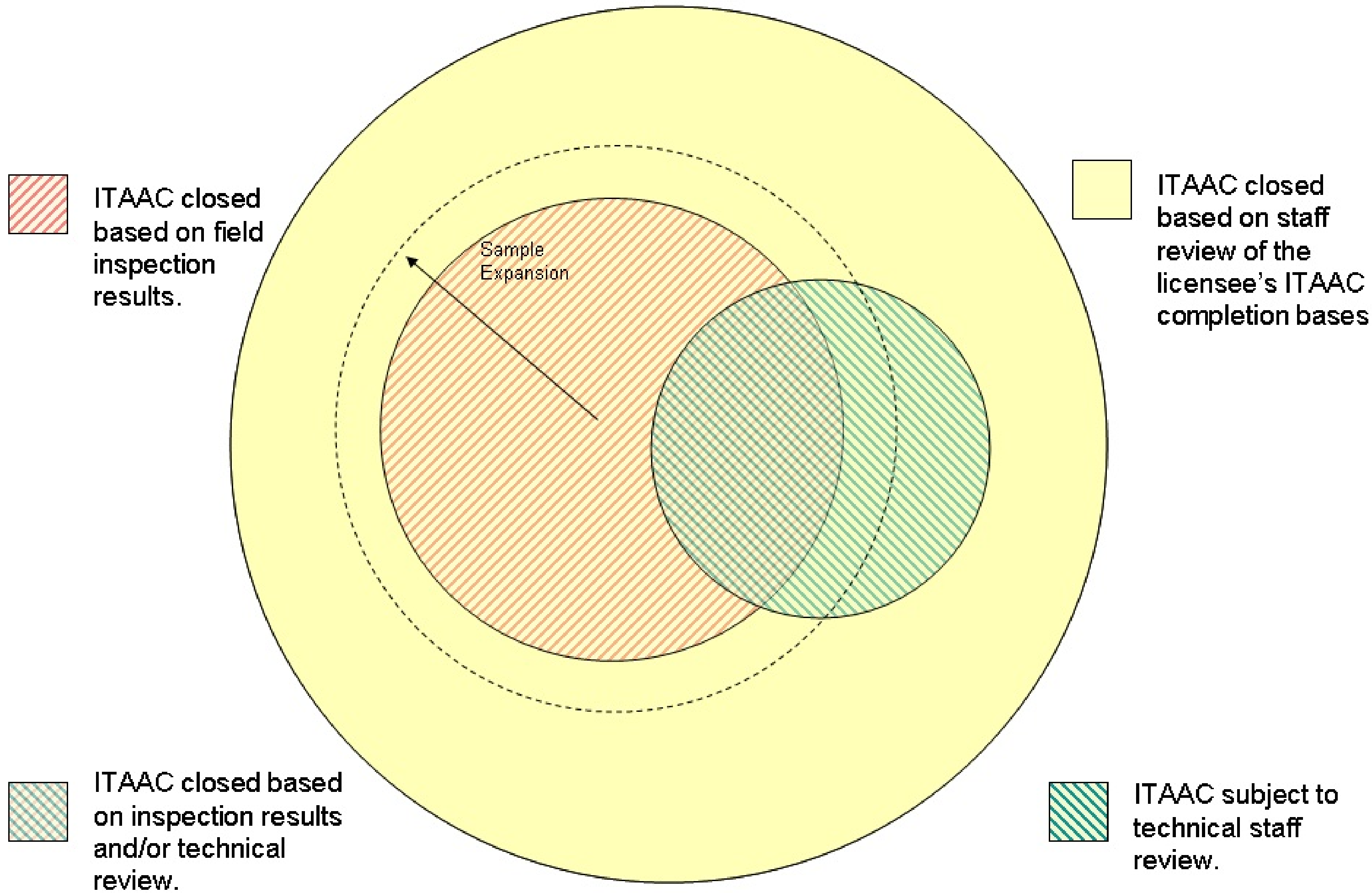
Enclosures:
1. NRC Verification of ITAAC Completion
2. ITAAC Sample Selection Process
3. The ABWR ITAAC Matrix
4. The AP1000 ITAAC Matrix

NRC VERIFICATION OF ITAAC COMPLETION

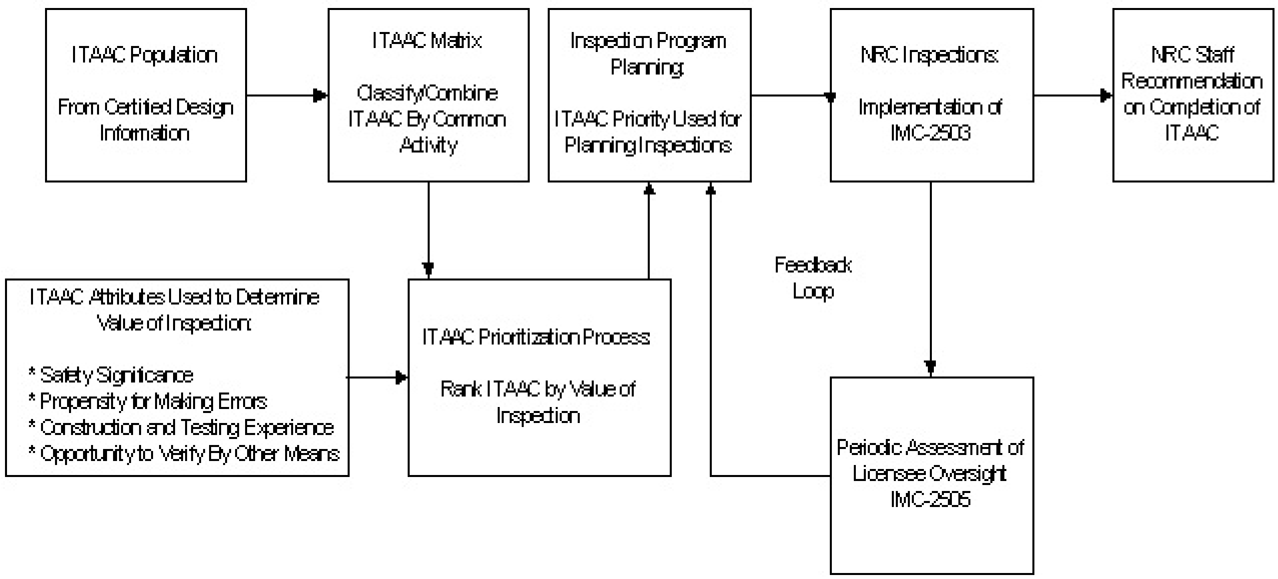
ITAAC closure to be based on 4 types of reviews.



ITAAC = Inspections, Tests, Analyses, and Acceptance Criteria

Enclosure 1

ITAAC Sample Selection Process



Key Concepts of the ITAAC Sample Selection Process

- Prioritized sampling will provide reasonable assurance that a significant construction flaw does not go undetected (i.e., all ITAAC have been satisfied).
- A prioritization methodology provides an educated and dynamic inspection program.
- The value of inspecting each ITAAC is prioritized, rather than the ITAAC itself.
- Expert panels, defined attributes, and structured decision-making process is used to evaluate each ITAAC.
- A coverage review ensures that a diverse set of ITAAC are inspected.

THE ABWR ITAAC MATRIX

	A)As-Built Inspection	B)Welding	C)Construction Testing	D) Operational Testing	E)Qualification Criteria	F)Design/Fabrication Requirements
01)Foundations & Buildings	12					
02)Structural Concrete	5					
03)Piping	2	22	23		1	1
04)Pipe Supports & Restraints						1
05)RPV & Internals	3	2	2	1	2	5
06)Mechanical Components	25		8	15	2	13
07)Valves			9	26	15	2
08)Electrical Components & Systems	74		64	4	12	30
09)Electrical Cable	8					6
10)I&C Components & Systems	88		3	161		2
11)Containment Integrity & Penetrations	3	1	3	12	1	6
12)HVAC	22		1	7	16	1
13)Equipment Handling & Fuel Racks	4		1	3	1	3
14)Complex Systems w/ Multiple Components	33			2	16	23
15)Fire Protection	5		2	2	4	2
16)Engineering	1				22	12
17)Security						
18)Emergency Planning	3		2			
19) Radiation Protection	3			10		5

NOTE: The values specified in this table include ITAAC for the certified design only. Additional site specific ITAAC will be added when they are identified in the COL application.

Enclosure 3

THE AP1000 ITAAC MATRIX

	A)As-Built Inspection	B)Welding	C)Construction Testing	D) Operational Testing	E)Qualification Criteria	F)Design/Fabrication Requirements
01)Foundations & Buildings	14				1	4
02)Structural Concrete			1			
03)Piping	10	10	10	4		17
04)Pipe Supports & Restraints						8
05)RPV & Internals	7	2	1	2	1	4
06)Mechanical Components	28	5	6	22	4	22
07)Valves	8	4	6	27	12	20
08)Electrical Components & Systems	15		5	24	8	8
09)Electrical Cable	10		1			11
10)I&C Components & Systems	61		35	63	16	9
11)Containment Integrity & Penetrations	6			1	1	1
12)HVAC	11	3	3	14	2	10
13)Equipment Handling & Fuel Racks	6			5	3	3
14)Complex Systems w/ Multiple Components	25			4	4	6
15)Fire Protection	7		1	2		
16)Engineering	5				2	10
17)Security	3				1	
18)Emergency Planning						
19) Radiation Protection	5				1	1

<u>NOTE</u>: The values specified in this table include ITAAC for the certified design only. Additional site specific ITAAC will be added when they are identified in the COL application.