SMR Utilization of Inspections, Tests, Analyses, and Acceptance Criteria

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1.0 INTRODUCTION/BACKGROUND

In the 1980s, recommendations from a task force led by the U.S. Nuclear Regulatory Commission (NRC) suggested streamlining licensing by creating an alternate to the two-stage licensing process for nuclear plants and implementing a single licensing proceeding, to be held prior to construction, in which detailed design plans were to be considered and approved. These recommendations proposed that once a license was granted, jurisdiction to oversee construction and confirm that the plant is constructed consistently with the design plans should be placed with the NRC staff. The crux of these recommendations was to ensure that the plant was constructed consistently with design plans, to promote standardization. It was further recommended that applications for final design approval and Design Certification (DC) should "define the tests, inspections, analyses, and acceptance criteria related thereto necessary to assure that the designs are properly installed in the plant." [1986 Atomic Industrial Forum ("AIF") Position Paper on Standardization. See NRC SECY-02-0067 regarding Programmatic ITAAC, Attachment 2 at 2 (Apr. 15, 2002) (NRC ADAMS Accession No. ML020700641).] In 1987, the NRC announced its intent to standardize nuclear power plants and implement a one-step licensing process that would "give licensees greater assurance that if the facility is constructed in accordance with the terms of the application/permit, it will be permitted to operate once construction is complete." [Policy Statement on Nuclear Power Plant Standardization. 52 Fed. Reg. 34,884, 34,885 (Sept. 15, 1987).] The revised licensing process was codified in 10 CFR 52 (Ref. 1), including changes through 2007 that considered participants' comments and incorporated lessons learned specific to the initial experience with the licensing process by the large reactor projects.

Each reactor vendor has the option to petition for a rulemaking to obtain a DC rule that would cover the criteria necessary for design and construction of the plant; quality assurance programs; and whatever Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC) are necessary to assure that the plant is built within the certified design specifications. [See generally i.d.; 10 CFR 52.47(b)(1).] Thereafter, each specific facility seeks a license that references a DC rule, such as a Combined Construction and Operating License (COL). This license would incorporate the standard ITAAC plus any plant-specific ITAAC that must be demonstrated to allow operation.

Operation after construction under a COL is allowed pursuant to 10 CFR 52.103(g) (Ref. 2) if the NRC finds that the acceptance criteria in the COL have been met. The ITAAC included with, or referenced by, a COL Application (COLA) must be sufficient to demonstrate that the facility has been constructed and will operate in conformity with the COL and the NRC regulatory requirements. Generally, in addition to site-specific ITAAC, a COLA incorporates standard ITAAC from the DC—although an applicant can take departures or exemptions from the DC ITAAC if the changes have benefits that outweigh the benefits from standardization. The ITAAC serves as the primary source of acceptance criteria to be applied at the end of construction. As such, the ITAAC must include all significant issues that require resolution before fuel loading.

The NRC ITAAC review and inspection process provides confidence that the licensee's ITAAC completion and verification processes are effective and thereby gives reasonable assurance that the licensee's ITAAC completion notifications to the NRC are sufficient and accurate to provide reasonable assurance that operation of the reactor will be consistent with public health and safety. This paper addresses the potential issues that may arise because the construction sequence and other commercial considerations specific to Small Modular Reactors (SMRs) were not considered when the existing 10 CFR 52 processes were codified. The current ITAAC licensing regime, created in an effort to standardize large, utility-built reactors assembled in their final in-place location, may not address the scope to reflect assembly line construction for the range of potential applications of the SMR plants, beyond those of traditional utility owners and operators.

2.0 PROBLEM/ISSUE STATEMENT

10 CFR 52.99(c)(1) (Ref. 3) states that a "licensee shall notify the NRC that the prescribed inspections, tests, and analyses have been performed and that the prescribed acceptance criteria have been met." (This notification must contain sufficient information to demonstrate that the prescribed inspections, tests, and analyses have been performed and that the prescribed acceptance criteria have been met. 10 CFR 52.99(c)(1).) 10 CFR 52.99(c)(2) provides that, "[i]f the licensee has not provided, by the date 225 days before the scheduled date for initial loading of fuel, the notification required by 10 CFR 52.99(c)(1) . . ., the licensee shall notify the NRC that the prescribed inspections, tests, or analyses for all uncompleted ITAAC will be performed and that the prescribed acceptance criteria will be met prior to operation."

This paper addresses the following key issues/questions:

1. Because closure of ITAAC is only prescribed with respect to operation under a COL, how does one address the ITAAC requirements outside the scope of a COL? For example, who and when are ITAAC closed during construction under a Manufacturing License (ML) or in the instances in which the ITAAC closure is pursued in an Operating License (OL) application?

2. How does one sequence or phase 10 CFR 52.99(c)(1) findings? What is the process for making these findings while the SMR is manufactured and assembled? Should these findings be made by the manufacturer before the SMR is provided to the operating licensee?

3. Considering that an SMR may be assembled in 14 months (420 days), what is the approach for preparing and determining the content of a 10 CFR 52.99(c)(2) submittal 225 days before fuel load, especially because this may be shortly after start of construction of the SMR plant? If the 10 CFR 52.99(c)(2) findings are simply predicting/asserting that the plant is going to be built in accordance with the license, what is the difference between the predictive finding pursuant to 10 CFR 52.99(c)(2) and the ITAAC identified in an ML.

4. When considering the use of ITAAC for evaluating multi-modular plants, can the ideas of safety and efficiency be properly balanced via the use of sampling? Or, will each test have to be repeated or repeatedly reviewed for each reactor?

3.0 DISCUSSION AND ACTUAL WORK

1. REVISIONS: ITAAC REQUIREMENTS OUTSIDE THE SCOPE OF A COLA

10 CFR 52.97(c) (Ref. 4) requires that a COLA include the ITAAC that are necessary and sufficient to demonstrate that a specific facility has been constructed and will operate in conformity with the COL; the Atomic Energy Act of 1954, as amended; and the NRC's regulations. 10 CFR 52.103(g) requires that the NRC find that the acceptance criteria in the COL have been met before a facility is authorized to operate. The ITAAC are the primary source of acceptance criteria. As such, it is essential that the ITAAC include all significant issues that require resolution before fuel loading. The regulations provide for NRC acceptance of ITAAC under a COL and as part of the final approval to operate. However, two issues are not addressed by the regulations: (1) how ITAAC could be accepted under licenses other than by amending a COL and (2) how ITAAC are addressed in proceedings for other types of licenses, such as OLs and MLs.

1. Because the NRC acceptance of ITAAC is covered only with respect to operating under a COL, the industry is left without a form of acceptance criteria outside the scope of a COL proceeding. The industry may find alternatives to a COL more appropriate. Two examples are where (a) the operator is overseas (the SMR is for export) and (b) the operator holds an Early Site Permit (ESP), including Limited Work Authorization (LWA) to allow site preparation work and the SMR is built to an ML.

   a. For instance, if an SMR is exported, ITAAC will not apply as the NRC approach is currently unique among international regulators. The operator would be subject to local government regulation. A method to harmonize ITAAC with the local regulatory approach would facilitate both safety and efficiency in accepting an exported SMR for operation.

   b. It is also feasible that those seeking to build SMRs would seek to obtain MLs and those seeking to deploy SMRs would seek to obtain an ESP (as a partial Construction Permit). The ESP option would allow the operator flexibility to choose among differing SMR designs that fit within the envelope of its ESP. The combination of an ESP with an OL would afford operators flexibility to maximize their ability to obtain an SMR on commercially reasonable terms by deferring the

technology decision to as late in the process as possible. Because ITAAC is not a requirement for an OL, a process for accepting ITAAC as completed as part of issuing or transferring an OL would facilitate such potentially commercially viable competitions. Closure of ITAAC is only well defined for plants constructed under a COL, restricting the potential safety and standardization benefit in licensing approaches that do not rely on a COL.

2. 10 CFR 52.80(a)(3) (Ref. 5) allows a COL applicant to include with the application a notification that a required inspection, test, or analysis has been successfully completed and that the corresponding acceptance criterion has been met. If such notification is included with the application, those ITAAC will be identified in the notice of hearing on the application. Timing issues arise. The COLA may be under review while the SMR is under construction. COLA processing times exceed the expected construction time for an SMR on its assembly line. The time to issue a COL could be further extended if the COLA is frequently revised to reflect ITAAC closure during the manufacturing. However, the regulations may not provide an efficient mechanism for the manufacturer to gain NRC acceptance of ITAAC during SMR assembly.

   Furthermore, logistical problems, not limited to the SMR context, arise regarding the lack of ITAAC closure process prior to approval of the COL. While many reactors potentially face some issues arising from fabrication of long lead components—like the reactor vessel or steam generator application prior to a COL—the SMR vendor may have the SMR essentially fabricated before the COL is finalized. An example of the potential administrative complexity that can arise is the Dominion North Anna Unit 3 experience with Economic Simplified Boiling Water Reactor (ESBWR) reactor vessel fabrication. In 2007, Dominion Virginia Power (Dominion) submitted a COL application to the NRC for an ESBWR. Dominion had partnered with GE Hitachi Nuclear Energy and Bechtel Corporation to build the multimillion-dollar ESBWR reactor vessel. In 2010, Dominion selected an alternate technology to an ESBWR. (On May 10, 2010, a World Nuclear News press release announced that Dominion had selected Mitsubishi Heavy Industries' ("MHI's") Advanced Pressurized Water Reactor ("APWR") for the potential third unit at its North Anna nuclear power plant in Virginia. Available at http://www.world-nuclear-news.org/print.aspx?id=27686.) Some paperwork has been prepared to support the closure of ITAAC related to the reactor vessel. If the reactor vessel is resold to another customer, full value can be obtained only if the documentation prepared to date is fully transferable. If closure of the ITAAC by the vendor is allowed, there will be greater certainty in reselling the reactor vessel. If a similar case arose for an in-process SMR, the in-process documentation could be more extensive and lead to even greater due diligence effort for the ultimate customer compared to a process where the vendor could complete the ITAAC.

2. 10 CFR 52.99(c)(1) AND (10 CFR 52.99(c)(2) REQUIREMENTS

Regulations regarding the inspections to be conducted during plant construction, i.e., after the COL is issued and before the completed facility is allowed to load fuel, engender questions regarding how these inspections are to be completed. 10 CFR 52.99(c) ensures that the NRC will have sufficient information to complete all of the activities necessary to determine whether all of the ITAAC have been, or will be, met prior to the initial operation and that sufficient notice will be given to interested persons on both completed and uncompleted ITAAC so that they can decide whether to request a hearing on compliance with the acceptance criteria. For that reason, the information included with the notification provided under 10 CFR 52.99(c)(1) and 10 CFR 52.99(c)(2) concerning the completed and uncompleted ITAAC must be sufficient to allow judgments to be formed by reference to that information.

1. 10 CFR 52.99(c)(1) states that a "licensee shall notify the NRC that the prescribed inspections, tests, and analyses have been performed and that the prescribed acceptance criteria have been met." The notification must contain sufficient information or, at a minimum, a summary description of the bases for the licensee's conclusion that the inspections, tests, or analyses have been performed and that the prescribed acceptance criteria have been met.

    a. In the process of assembling the SMR, the ultimate customer may change for commercial reasons or changing demand in the Owner's business. Restricting the ITAAC acceptance process introduces administrative inefficiencies if the ultimate customer changes.

    b. Some ITAAC are closed based on type testing. Such tests or analysis would not be specific to the individual SMR being assembled. Reports for a type-test–based ITAAC can be expected to cover multiple projects. Such ITAAC should not require recertification absent a design change or other changes in the procurement documents that could impact the conclusions of the type test.

2. 10 CFR 52.99(c)(2) provides that "[i]f the licensee has not provided, by the date 225 days before the scheduled date for initial loading of fuel, the notification required by 10 CFR 52.99(c)(1) . . ., the licensee shall notify the NRC that the prescribed inspections, tests, or analyses for all uncompleted ITAAC will be performed and that the prescribed acceptance criteria will be met prior to operation." This additional notification must provide sufficient information to demonstrate that the inspections, tests, or analyses will be successfully completed and that the acceptance criteria for the uncompleted ITAAC will be met, including, but not limited to, a description of the specific procedures and analytical methods to be used for performing the inspections, tests, and analyses and determining that the acceptance criteria have been met.

SMR vendors can expect to face practical scheduling issues with regard to 10 CFR 52.99(c)(2) findings. For instance, it has been estimated that an SMR may be assembled in 14 months (420 days). If assembly includes fuel load, a 10 CFR 52.99(c)(2) submittal required 225 days before fuel load may be due shortly after start of construction of the SMR plant. At that point, the COL may not have been issued, and the COL applicant may be tentative. For commercial reasons, there may be flexibility with the specific location or operator that will take delivery of a particular SMR, given demand growth or other commercial factors. Furthermore, because 10 CFR 52.99(c)(2) findings are inherent in the findings required for a DC or ML that the vendor is technically qualified, with a 10 CFR 52.99(c)(2) letter simply predicting or asserting that the SMR is going to be built in accordance with the specifications, there seems to be no difference with explanations already made by the vendor in its DC petition or its ML application.

3. MULTI-MODULAR ITAAC

The COL-specific nature of closing ITAAC under the current regulations leaves much to be desired when considering how to handle multi-modular reactor COLs. For example, if a COL covers multiple modules, the 10 CFR § 52.103(g) proceeding to allow operation would need to permit bifurcation—so that each module could start operation while awaiting the installation of the next one. Closure of ITAAC based on a sampling plan or type testing across multiple modules should be allowed. This would facilitate efficiency rather than propagating uncertainty, or associated administrative inefficiencies, by having the same verification package resubmitted for approval for sequential modules. Repetitive review of the

same ITAAC closure documentation is inconsistent with the NRC goals for achieving the benefits of standardization and applying the principles of the Design Centered Working Group (DCWG) (one review of each issue one time). Much, if not almost all, ITAAC will be common among SMR designs, including multiple copies of the same design. The repetitive review of the same ITAAC closure documentation in the context of SMRs is an increasing administrative burden, particularly where the ITAAC are closed based on type testing or other sampling-based verification.

4. FREE-RIDERS ON INITIAL ITAAC DEVELOPMENT

ITAAC are largely not design specific. Many, if not almost all, tests, inspections and analyses needed to verify that a reactor will operate properly are common to all projects.

Today, those reactor designs with DC rules or undergoing NRC review for DC rulemaking have >90% of their ITAAC in common. For large reactors, the later reactor vendors with follow-on designs essentially copied much of the ITAAC from the initial DC rules.

While conceptually the ITAAC for SMR designs can be expected to be similar to other designs, it will differ from those ITAAC for large plants to reflect the construction phasing of SMRs. SMRs will have to develop ITAAC that should be complete at the assembly plant, post-transportation ITAAC, and other ITAAC revisions that would be specific to the construction of SMRs compared to large plants constructed in situ. The initial SMR manufacturer will perform the lion's share of effort redrafting large plant ITAAC to suit the special needs of SMR vendors. Other vendors will "free-ride" off this initial work, copying the ITAAC agreed to by the initial vendor and the NRC.

4.0 CONCLUSIONS/RECOMMENDATIONS

Based on the discussion above, the American Nuclear Society President's Special Committee on SMR Generic Licensing Issues (SMR Special Committee) recommends that the industry pursue a Petition for Rulemaking to provide additional flexibility and certainty to the ITAAC process for SMR projects. The regulations and procedures currently used to regulate large reactors should be modified in order to facilitate SMRs with respect to

- optimizing the role of ITAAC requirements for SMR that are not constructed and operated pursuant to an NRC-issued COL
- the vendor's ability to gain NRC acceptance of ITAAC during SMR assembly
- the vendor's ability to make the 10 CFR 52.99(c)(1) report as the agent for the ultimate customer in order to minimize administrative inefficiencies if the ultimate customer changes
- the vendor's ability to make the 10 CFR 52.99(c)(1) reports for a type-test–based ITAAC on a multiproject basis
- scheduling issues that SMR vendors can be expected to face concerning 10 CFR 52.99(c)(2) findings
- allowance for closure of the ITAAC by the vendor

- allowance for closure of ITAAC based on a sampling plan or for type testing across multiple modules.

Such revisions will enhance the effectiveness of standardization by better matching the ITAAC process to the commercial needs of SMRs manufactured and assembled for delivery essentially ready to use at a prepared site.

Specifically, the SMR Special Committee recommends the following:

1. **Allow SMR vendors to act as agent of licensees**. In the process of assembling the SMR, the ultimate customer may have changed. The ITAAC acceptance process should provide for the manufacturer to make the 10 CFR 52.99(c)(1) report as the agent for the ultimate customer in order to minimize administrative inefficiencies if the ultimate customer changes.

2. **Optimize recertification process for generic tests**. Some ITAAC are closed based on type testing. Such tests or analysis are not specific to the individual SMR being assembled. The ITAAC acceptance process should provide for the manufacturer to make the 10 CFR 52.99(c)(1) reports for a type-test–based ITAAC on a multiproject basis. Such ITAAC should not require recertification absent a design change or other procurement changes that could impact the type-test performance.

3. **Endorsement/support of DCWG/task force methodology**. A continuing effort to examine ITAAC for SMRs is needed. While 90% of all ITACC will be common among SMRs because basic demonstrations needed to allow a reactor to operate are largely design independent, SMR vendors will need ITAAC that reflect the phasing unique to SMR assembly, e.g., line manufacturing, diverse functional manufacturing methods and their effects, and ultimately consideration of specific issues for “types” of reactors, i.e., light water reactors (LWRs), high temperature gas reactors (HTGRs), and liquid metal reactors (LMRs). A DCWG should further consider the differences between ITAAC closure processes being developed for large plants currently under licensing review and future SMR modular construction approaches—to specifically consider how these differences will affect the current ITAAC regime and any potential changes to be made via rulemaking. This evaluation should include a review of the phasing of ITAAC requirements for either MLs or OLs and possible solutions toward integration, the vendor’s ability to gain NRC acceptance of ITAAC during SMR assembly, allowance for closure of the ITAAC by the vendor, and allowance for closure of ITAAC based on a sampling plan or type testing across multiple modules.

4. **Allow effective parallel working; rulemaking with FOAKE exemptions**. A continuing Technical Working Group/DCWG should also propose establishing interim guidance, to be submitted to the NRC for consideration as rulemaking, to help ensure that first-of-a-kind-engineering (FOAKE) for SMRs is defined early—so that the SMR designs proceed through the regulatory process with transparency and certainty. Additionally, it may be appropriate to provide exemptions to some early movers to facilitate FOAKE. (Rulemaking with FOAKE exemptions would also enable methods that support proper and effective export via new use of 10 CFR 110/10 CFR 810 (Refs. 6 and 7) permits and MLs. These methods could serve as the first steps toward harmonizing foreign regulatory approaches with respect to export of nuclear technology.)

5.0 APPENDIX

DRAFT RULE LANGUAGE—INSPECTIONS, TESTS, ANALYSES, AND ACCEPTANCE CRITERIA (ITAAC) MAINTENANCE PROVISIONS

Recently, the NRC made available the draft wording of a proposed amendment to requirements in 10 CFR 2.340 (Ref. 8) and 10 CFR 52.99 related to verification of nuclear plant construction activities through ITAAC under a combined license. The NRC's proposed new rules would require (1) licensee reporting of new information raising a reasonable concern that a prescribed inspection, test, or analysis was not performed as required, or that a prescribed acceptance criterion is not met; (2) licensee documentation of the basis for all ITAAC notifications; and (3) licensee notification of completion of all ITAAC activities. The NRC's proposed changes would also correct existing language in 10 CFR 2.340 and 10 CFR 52.99 for consistency with other sections in 10 CFR 52 and with language in the Atomic Energy Act, as amended. With respect to 10 CFR 52.99(c)1 and 10 CFR 52.99(c)(2) specifically, the proposed changes amount to a change in verb tense, so that the licensee notifies the NRC that the prescribed inspections, tests, and analyses have been performed and that the prescribed acceptance criteria *are* met.

6.0 REFERENCES

1. C*ode of Federal Regulations*, Title 10, "Energy," Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," U.S. Nuclear Regulatory Commission.

2. C*ode of Federal Regulations*, Title 10, "Energy," Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," Sec. 103, "Operation Under a Combined License," U.S. Nuclear Regulatory Commission.

3. C*ode of Federal Regulations*, Title 10, "Energy," Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," Sec. 52.99, "Inspection During Construction," U.S. Nuclear Regulatory Commission.

4. C*ode of Federal Regulations*, Title 10, "Energy," Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," Sec. 52.97, "Issuance of Combined Licenses," U.S. Nuclear Regulatory Commission.

5. C*ode of Federal Regulations*, Title 10, "Energy," Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," Sec. 52.80, "Contents of Applications; Additional Technical Information," U.S. Nuclear Regulatory Commission.

6. C*ode of Federal Regulations*, Title 10, "Energy," Part 110, "Export and Import of Nuclear Equipment and Material," U.S. Nuclear Regulatory Commission.

7. C*ode of Federal Regulations*, Title 10, "Energy," Part 810, "Assistance to Foreign Atomic Energy Activities," U.S. Department of Energy.

8. C*ode of Federal Regulations*, Title 10, "Energy," Part 2, "Rules of Practice for Domestic Licensing Proceedings and Issuance of Orders," Sec. 2.340, "Initial Decision in Certain Contested Proceedings; Immediate Effectiveness of Initial Decisions; Issuance of Authorizations, Permits, and Licenses," U.S. Nuclear Regulatory Commission.