A Study of Construction Reactor Oversight Process in US

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1. Introduction

Since 1989, the United States Nuclear Regulatory Commission (USNRC) has revised the Construction Inspection Program (CIP) to accommodate the new licensing process. Thereafter, the Construction Reactor Oversight Process (cROP) described in IMC 2506 [1] for nuclear power plants (NPP) under construction was adopted. This process provides a risk-informed approach such as construction significance determination process (SDP) and construction program performance index analogous to those used in the Reactor Oversight Process (ROP). The cROP has been applied to Vogtle units 3, 4 and V.C. Summer units 2, 3 under construction for the regulatory inspection.

In this paper, the cROP is dissected to present its major contents and characteristics.

2. Overview of the cROP

The objective of the cROP is to evaluate licensee performance of construction activities and the effectiveness of licensee oversight and effort on quality assurance associated with construction of NPP. For this objective, the cROP makes regulatory response by assessing the safety level of NPPs under construction with inspection results. However, since construction projects are very different from the works in operating plants, assessment and enforcement criteria for construction projects were developed under consideration for their characteristics.

The main programs of the cROP are the CIP, the Construction Assessment Program (CAP) and the Construction Enforcement Program (CEP). The cROP interacts with other processes or programs such as Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC) closure verification process, vendor inspection program and public communications. An overview of the cROP is shown in Fig. 1.

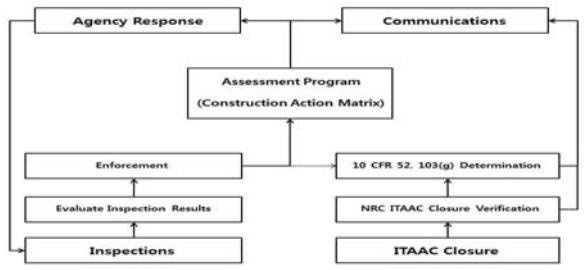

Fig. 1. Flowchart of the cROP

The cROP is implemented when an applicant announces its intent to submit an application for an early site permit, a limited work authorization, a construction permit and/or a combined construction permit operating license (COL). The cROP will remain in effect until the regulatory oversight is transitioned to the ROP. The degree to which the cROP is implemented depends on the license status. Unless a COL is issued and sufficient construction activities have occurred, all aspects of the cROP will not be implemented.

2.1 Framework of the cROP

As the cROP framework depicted in Fig. 2, there are three strategic performance areas: construction reactor safety, operational readiness, and safeguard programs. The objective of each performance area is providing reasonable assurances that the NPP is constructed in accordance with its design (construction reactor safety), that the NPP will be operated in conformity with its license (operational readiness), and that the implementation of security programs for both construction and operations is adequate (safeguard programs). Within performance areas, there are six cornerstones that reflect the essential aspects of facility construction. In addition to the cornerstones, three cross cutting areas (human performance, problem identification and resolution, and safety conscious work environment) affect each of the cornerstones and are part of each of them as well.

This framework is based on the principle that the USNRC's mission of assuring the public's health and safety is met when the USNRC has reasonable assurances that licensees are complying with the objectives of the six cornerstones of safety. The other principle is that the USNRC performs the minimum regulatory action of baseline inspection program without any supplemental inspection if the licensees maintain the performance above a certain level. More detailed information can be found in IMC 2506.

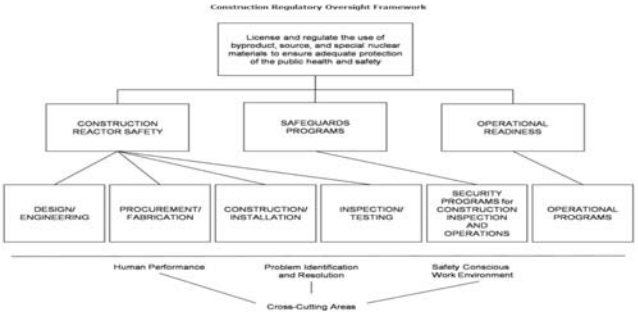

Fig. 2. The cROP Overview

2.2 Construction Inspection Program

The CIP is an integral part of the cROP. The CIP focuses on two areas: 1) Supporting a licensing decision by verifying the effective implementation of the quality assurance program and 2) verifying aspects of construction activities and supporting the transition to the operational phase. Prior to and during NPP construction, vendor activities and licensee oversight of these activities will be reviewed. During NPP construction, satisfactory completion of ITAAC, adequate development and implementation of construction and operational programs will be verified by conducting inspections, and the transition to power operations will be reviewed. These inspections are comprised of the construction baseline inspection program. NPP whose performance in the cornerstones of the cROP is outside the licensee response band in the Construction Action Matrix (CAM) will receive plant specific inspections or supplemental inspections. Reactive inspections include allegation response and event follow-up. Fig. 3 shows an overview of these inspections.

The core of the CIP is carried out by the construction resident inspector providing reasonable assurances that the as-built facility conforms to the conditions of the COL. All the inspection results are documented and will be available to the public via the website of USNRC.

More detailed information about the framework of CIP can be found in NUREG 1789 [2].

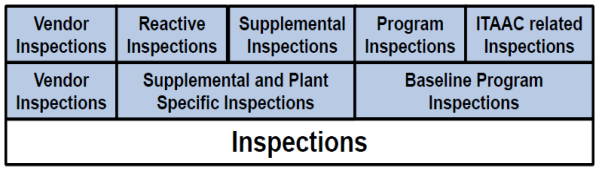

Fig. 3. Overview of inspections

2.3 Construction Assessment Program

The objective of CAP is to assess a licensee's effectiveness in assuring construction quality. The CAP collects information from inspections in order to derive objective conclusions in regards to the licensee's safety performance. Based on this information, the regulatory response of USNRC is determined. Regulatory response includes supplemental inspection and pertinent regulatory actions ranging from management meeting up to an order to stop work.

The CAP will use the construction SDP to characterize the significance of nontraditional enforcement construction findings identified during the cROP. Inspection findings in inspection reports are characterized by the construction SDP. The significance of inspection findings is represented by a color scheme (green, white, yellow, red) depending on their safety significance. The color of the construction inspection findings is used as the input to the CAM. Each finding is also evaluated to determine if the primary cause of the finding can be associated with one of the cross cutting aspects.

Each quarter as measured by the inspection findings, the performance of all NPPs under construction will be reviewed. Every half year, the final quarterly review will involve a more detailed assessment of NPPs performance over the previous 12 months and the preparation of a performance report, as well as the inspection plan for the following six months. In addition, the adequacy of regulatory response for NPP with significant performance problems is also reviewed.

Annual assessment letters will be made publicly available prior to the public meeting and the annual Commission meeting. The public meetings with utilities will be held to discuss the previous year's performance at each point.

2.3 Construction Enforcement Program

Enforcement actions for the cROP are taken in a manner similar manner to that used for issues identified at operating NPP under the ROP. All inspection findings will be screened and documented in accordance with the results of the CAP. The CAM is intended to provide consistent, predictable, and understandable regulatory responses to the licensee's performance.

The CEP begins with the identification of violations, either through USNRC inspections or investigations, or thought a licensee report, or by the substantiation of an allegation. After a violation is identified, each violations is assessed its severity or significance and categorized in accordance with USNRC Enforcement Policy [3]. Under traditional enforcement, the severity level assigned to the violation generally reflects the assessment of the significance of a violation. Traditional enforcement will be used for facilities that are not subject to as SDP.

The overall response to licensee's performance will be determined by the number of violations that rise to the level of escalated enforcement (severity level I, II, or III). For licensee having escalated enforcement issues, the USNRC will conduct additional inspections. In the case that assessments inputs are found to be at a severity level III 'unacceptable performance column', USNRC will issue an order to stop the work in the area of concern and conducts additional inspections (supplemental or special inspection) beyond the baseline inspection program.

For enforcement purposes, the new construction period starts once a COL is approved for the NPP and ends when NPP enters power operations. Once a COL is applied, potential violations from inspection activities will be processed in accordance with the Enforcement Policy of USNRC and other applicable enforcement actions taken by using traditional enforcement tools.

The findings will then be categorized as violations, deviations, non-conformances, or unresolved items. This includes the use of severity levels, notice of violations (NOV) for violations of severity level III and above, and civil penalties as appropriate. Once the facility enters power operations, there will be a transition to the ROP. During this transition period, inspection findings and enforcement actions will be processed using the ROP as much as practicable.

Vendor inspection findings do not feed into the assessment of a licensee's performance; enforcement actions are taken against the vendor. Enforcement actions are taken against the licensee for the findings identified during the baseline program and supplemental or plant specific inspections. These findings also feed into the assessment of licensee's performance.

2.3 Miscellaneous programs of the cROP

2.3.1 Self-Assessment of the cROP

The cROP has a self-assessment program, which utilizes program evaluation and performance metrics. Periodically, its self-assessment program collects information from CIPIMS, inspection program, periodic independent audits, stakeholder survey, public comments, and other stakeholder interactions. The result of the annual self-assessment is reported to Commission via a SECY paper in support of the Agency Action Review Meeting. In addition to the cROP self-assessment program, several independent evaluations have been performed since the inception of the cROP to analyze its effectiveness and recommend improvements.

2.3.2 Construction Resident Inspector Program

The construction resident inspectors directly observe and verify the construction activities of the licensee. They also evaluate events or incidents. Most construction sites will be near an existing operating NPP that will have its own resident inspection staff. The activities at the construction sites must not be allowed to detract from the safety oversight responsibilities the USNRC has toward the nearby operating NPP. In addition, the inspection program for construction and operating sites is significantly different from that for operating reactor resident inspectors. Thus, the USNRC is committed to keeping the CIP separate from the operational inspection program.

3. Programs/Processes related to the cROP

3.1 ITTAC Closure Verification Process

ITAAC inspections will focus on verifying satisfactory completion of ITAAC and compliance with regulations. If the inspections identify deficiencies such that an ITAAC will not be met, corrective action of the licensee will be expected to address any and all deficiencies, and enforcement action of USNRC may be taken. There are two key elements to ITAAC inspections. The first element is inspection of a broad range of ITAAC-related activities: (1) Targeted DCD ITAAC, (2) If there are no targeted ITAAC in a family, at least one ITAAC from that family will be selected for inspection, (3) DAC ITAAC, (4) Emergency Preparedness ITAAC, (5) Security ITAAC, and (6) Targeted Site Specific ITAAC. The second element of ITAAC inspections is the inspection of ITAAC-related construction processes.

Timely verification of ITAAC is an essential elements of the cROP because ITAAC determination is used to support a Commission finding that all of the ITAAC have been met. A Sign As You Go (SAYGO) process has been adopted to allow timely verification of ITAAC. The SAYGO process allows USNRC to perform inspections during the early stages of NPP construction for selected construction activities. If inspected, ITAAC are successfully demonstrated to the inspectors, inspector will sign off as completed ITAAC, or portions of complex ITAAC as a meaning of sign-as-you-go. The inspection findings and assessments with respect to ITAAC will be published in inspection reports, and notices of the successful completion of ITAAC will be published in the Federal Register. The SAYGO process provides an on-going record of the acceptability of the work related to the ITAAC.

Licensees who close ITAAC should submit their ITAAC closure notification (ICN) to USNRC. This ICN is expected to provide sufficient information so that the prescribed ITAAC has been performed and that the prescribed acceptance criteria have been met. For each ICN, Acceptance Review is conducted to determine if the ICN has a correct format and references based on the examples of ICNs developed by the USNRC and industry. During the ICN review, all of the information that could bear on the completion of the ITAAC, including USNRC inspection results, will be reviewed to determine the status of ITAAC. After all ITAAC determination is made as completed, the Commission is required to find if the acceptance criteria in the COL was met. The licensee cannot operate the NPP until this finding has been made. This finding means that there is reasonable assurance of adequate protection of the public health and safety. An example of ITAAC closure process is illustrated in Fig. 4.

3.2 Construction Significance Determination Process

The construction SDP is designed to provide a means to assess the significance of these findings. According to the IMC 0613 [4], there is no completely objective or mechanistic issue screening process that can satisfy the objectives of the cROP. Currently, issue screening process is conducted in accordance with IMC 0613 App.

B (Issue screening) and App. E (Example of Minor Issues).

Findings are evaluated and given as a color designation based on their safety significance determined through the construction SDP. An example

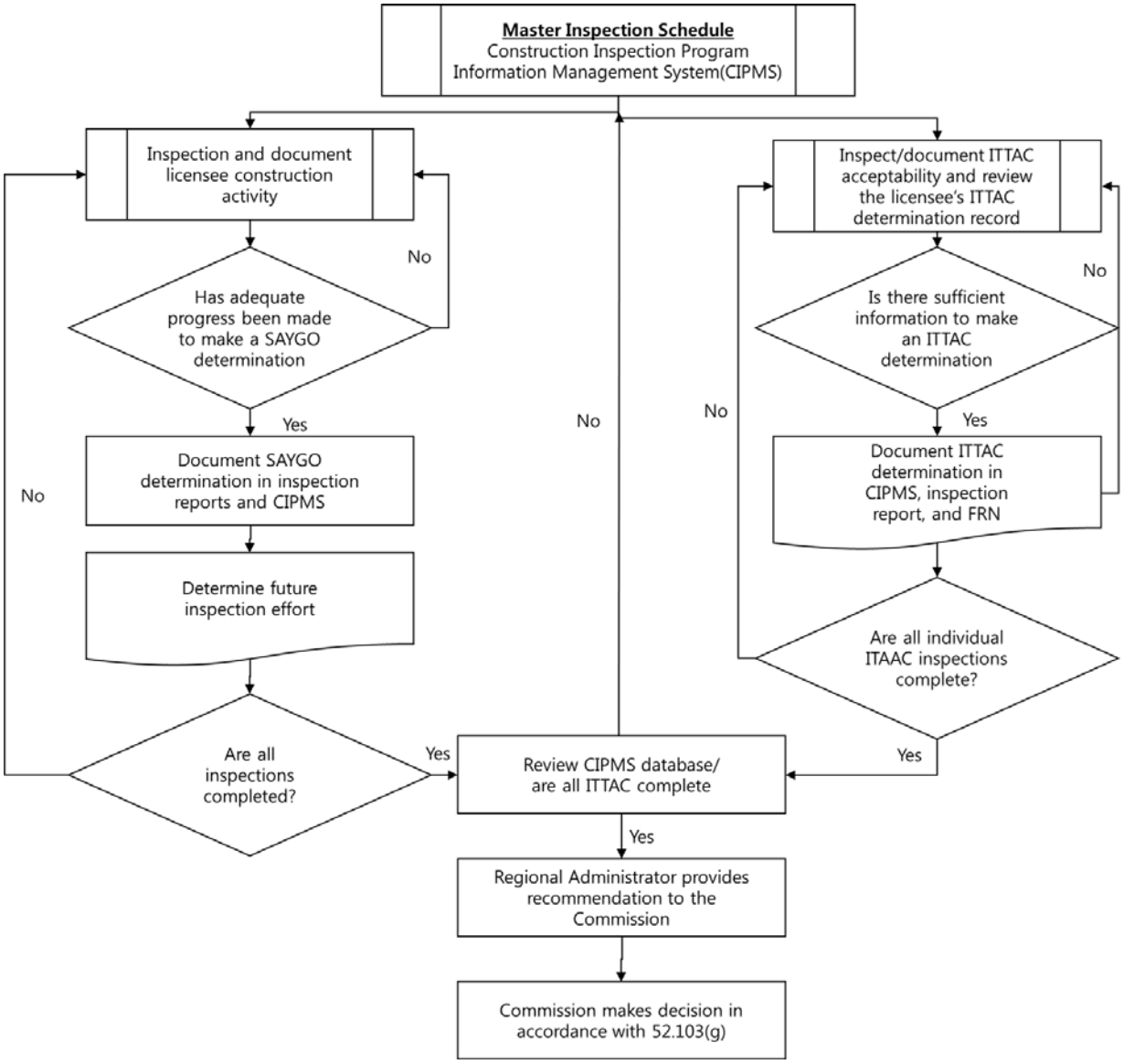

Fig. 4. An example of ITAAC closure process

of the construction SDP matrix is illustrated in Fig. 5.

- Green: inspection findings with very low safety or security significance
- White: inspection findings with low-to-moderate safety or security significance
- Yellow: inspection findings with low safety or security significance
- Red: inspection findings with high safety or security significance

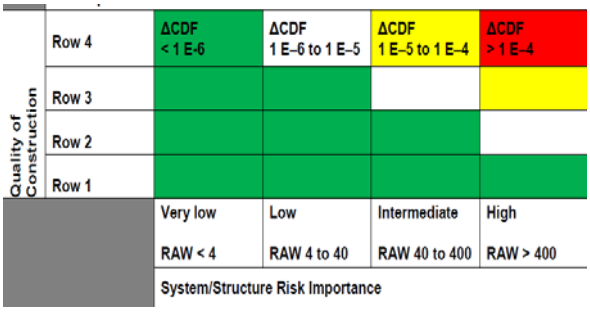

Fig. 5. An example of construction SDP Matrix

3.3 Vendor Inspection Program

Vendor Inspection Program verifies effective licensee oversight of supply chain through the inspections of a sample of vendors. Licensees are ultimately responsible for vendor oversight and vendor performance. It means that licensees consider USNRC's vendor inspection findings as potential weakness in their procurement programs.

Vendor Inspection Program inspects vendors providing safety-related materials, equipment, and services in support of new reactor construction. Routine and reactive inspections are conducted at the vendor facilities to examine whether vendors of safety-related components or services have complied with the regulation as required under vendor procurement contracts with licensees.

3.4 CIP Information Management System

The Construction Inspection Program Information Management System (CIPIMS) is a dedicated, computer-based inspection scheduling and information system intended for deployment at NPPs, which are under construction. CIPIMS is used to organize and manage inspection information and integrate the licensee's construction schedule, inspection results and findings to support ITAAC determinations. CIPIMS provide a standard, consistent, system-based approach to coordinating, scheduling, collecting, organizing, and recording inspection data necessary to establish a reasonable assurance in the findings for ITAAC determinations and eventual transition activities from construction to operational inspection.

The vision of CIPIMS is that the USNRC inspection scheduler will plan construction inspection activities in advance based on the initial schedule from the licensee. The schedule would then be automatically updated as the licensee's schedule changes. For this, CIPIMS scheduling software is designed to be able to easily interface with the licensee's scheduling software.

4. Conclusion

The main features of the cROP can be summarized as followings:

1) The cROP which adopts the concept of the ROP used for operating NPPs assesses NPP under construction periodically to determine the appropriate level of regulatory response.
2) The cROP consists of three parts: the CIP, the CAP and the CEP.
3) The inspections for NPPs under construction can be categorized into three parts: vendor inspection, baseline inspection and supplemental and plant specific inspections. USNRC's regulatory resources can be used effectively based on baseline inspection, which is using ITAAC inspections.
4) Prior to and during NPP construction, USNRC inspections focus on licensee's QA program and capability to verify the effectiveness of corrective actions.
5) During inspections performed, the SAYGO process is adopted to allow timely verification of ITAAC.
6) The CIP is coordinated by CIPIMS that is computer-based management system to integrate all relevant information of construction activities.
7) The results of the CIP are assessed by the CAP. At this step, the construction SDP is used to assign the color scheme to categorize the significance of inspection findings. Regulatory actions are taken from CAM to which the significance of inspection findings input.

In this paper, major contents and characteristics of USNRC's cROP have been presented. Based on this study, domestic regulatory systems will be analyzed by comparing them to the USNRC's cROP to improve domestic regulatory systems.

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