U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Functional Arrangement Tier 1 Definition (AP1000)

Christopher Welch, Travis Chapman, Tony Cerne
(Construction ITAAC Team)

March 10, 2010

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Background

- The functional arrangement ITAAC for the AP1000 Passive Containment Cooling System (PCS) was selected for the ITAAC Closure Demonstration Project.
- NRC staff reviewed the § 52.99(c)(1) ITAAC closure letter (ICL) and concluded the ICL lacked sufficient information for closure.
- Differing views, with respect to the required scope of inspection, were identified:
  - only the SSCs provided in the Tier 1 figure (or tables)

    vs
  - those SSCs necessary for the system to perform the function(s) as described in the design description whether they are shown in the Tier 1 figures (or tables) or not .

§ 52.80 Contents of applications; additional technical information

- The application must contain:
- (a) The proposed inspections, tests, and analyses, including those applicable to emergency planning, that the licensee shall perform, and the acceptance criteria that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, the facility has been constructed and will be operated in conformity with the combined license, the provisions of the Act, and the Commission's rules and regulations.

AP1000 Tier 1 Definitions

Functional Arrangement (for a system) means the physical arrangement of systems and components to provide the service for which the system is intended, and which is described in the system design description.

As-built means the physical properties of a structure, system, or component following the completion of its installation or construction activities at its final location at the plant site.

Acceptance Criteria means the performance, physical condition, or analysis result for a structure, system, or component that demonstrates that the design commitment is met.

Design Commitment means that portion of the design description that is verified by ITAAC.

Design Description means that portion of the design that is certified.

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Key points SECY 00-092

- The design descriptions and functional system drawings are not adequate for actual construction or construction inspection activities.
- Licensees should ensure the certified design and site-specific design information, including that required by the design acceptance criteria (DAC), has been translated into detailed, plant-specific design and construction drawings.
- The NRC will verify completion of ITAAC and conformance with the approved design, in part, by using these detailed drawings.
- The licensee should ensure detailed drawings and other documentation reflect the final as-built configuration of the facility so that they can be used as part of the bases, where appropriate, for demonstrating conformance with the COL ITAAC.

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Key points SECY 96-028

- ITAAC were not reviewed and approved by the staff with the understanding that if a specific type of information is not explicitly set forth in the words of the ITAAC, then it is not part of the ITAAC and may not be considered in determining whether the ITAAC has been successfully completed.
- The staff accepted the applicants' proposal that top-level design information be stated in the ITAAC to ensure that it was verified, with an emphasis on verification of the design and construction details in the "as-built" facility.
- Thus, the staff reviewed and approved the ITAAC under an industry understanding which is inconsistent with industry's current position.

Interpretation of Figures (Tier 1)

In many but not all cases, the design descriptions in Section 2 include one or more figures. The figures may represent a functional diagram, general structural representation, or another general illustration. For instrumentation and control (I&C) systems, figures may also represent aspects of the relevant logic of the system or part of the system. Unless specified explicitly, the figures are not indicative of the scale, location, dimensions, shape, or spatial relationships of as-built structures, systems, and components. **In particular, the as-built attributes of structures, systems, and components may vary from the attributes depicted on the figures**, provided that those safety functions discussed in the design description pertaining to the figure are not adversely affected.

Functional Arrangement ITAAC

2.2.2 Passive Containment Cooling System

Design Description

The passive containment cooling system (PCS) removes heat from the containment during design basis events.

The PCS is as shown in Figure 2.2.2-1 and the component locations of the PCS are as shown in Table 2.2.2-4.

1. The functional arrangement of the PCS is as described in the Design Description of this Section 2.2.2.
2. -------
3. -------

PCS Functional Arrangement ITAAC

Table 2.2.2-3 Inspections, Tests, Analyses, and Acceptance Criteria		
Design Commitment	**Inspections, Tests, Analyses**	**Acceptance Criteria**
1. The functional arrangement of the PCS is as described in the Design Description of this Section 2.2.2	Inspection of the as-built system will be performed	The as-built PCS conforms with the functional arrangement as described in the Design Description of this Section 2.2.2

AP1000 ITAAC Statistics

The AP1000 DCD contains 46 Functional Arrangement ITAAC:

- 25 Functional Arrangement ITAAC refer to a figure & table
- 12 Functional Arrangement ITAAC refer to a table
- 2 Functional Arrangement ITAAC refer to a figure
- 7 Functional Arrangement ITAAC do not refer to either a figure or table

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

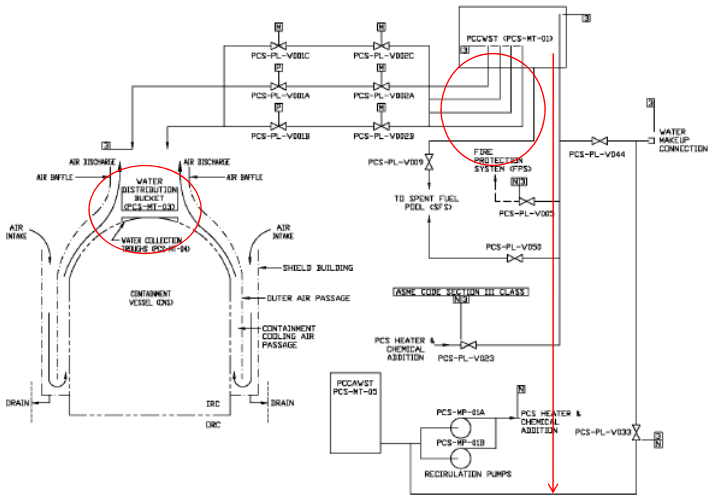
Simplified Figure - Example 1

AP1000 Passive Containment Cooling System (PCS)

- The Tier 2 system description (Section 6.2) includes both flow control orifices and standpipe-style pipe arrangement to regulate flow and provide the PCS the capability to operate for 72 hours without operator action. The system also relies on weirs to distribute the water as designed over the vessel. A recirculation line, with isolation valve VO21, keeps the PCCWST from freezing in cold weather. These features are necessary for proper operation.
- In Tier 1, these components are not shown on the figure or listed in the table as required for this function.

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

PCS Tier 1 Figure



U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

PCS Tier 1 Table

Table 2.2.2-4		
Component Name	Tag No.	Component Location
PCCWST	PCS-MT-01	Shield Building
PCCAWST	PCS-MT-05	Yard
Recirculation Pump A	PCS-MP-01A	Auxiliary Building
Recirculation Pump B	PCS-MP-01B	Auxiliary Building

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

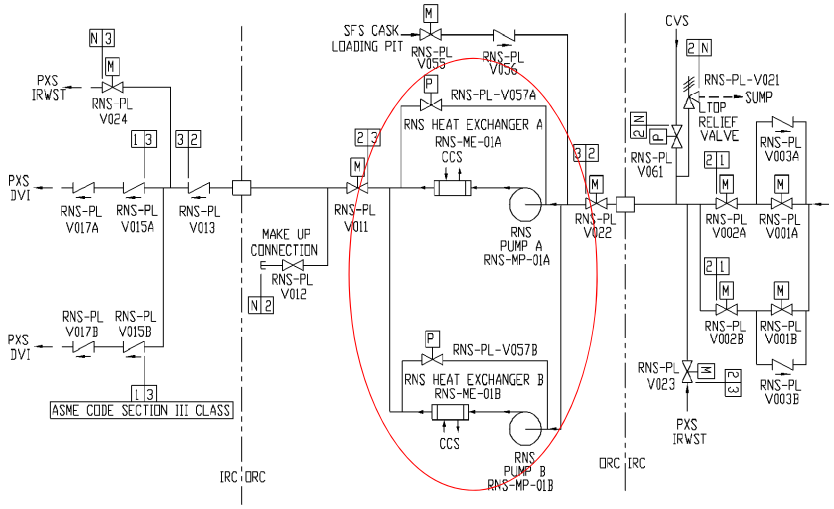
Simplified Figure - Example 2

AP1000 Normal Residual Heat Removal System (RNS)

- Tier 1 Figure does not show pump check valves necessary for operation; system could not "perform" its function without them
- Design Description:
  "The normal residual heat removal system (RNS) **removes heat from the core and reactor coolant system** (RCS) and provides RCS low temperature over-pressure (LTOP) protection at reduced RCS pressure and temperature conditions after shutdown. The RNS also provides a means for **cooling the in-containment refueling water storage tank** (IRWST) during normal plant operation."

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

RNS Tier 1 Figure



U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

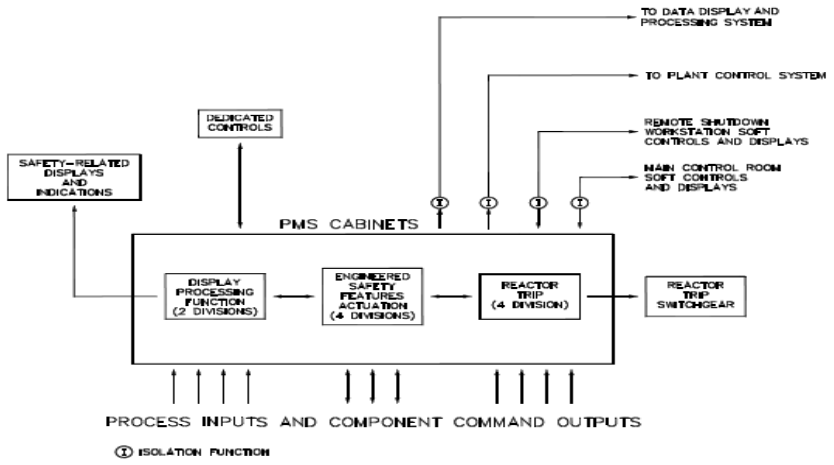
Simplified Figure - Example 3

AP1000 Protection and Safety Monitoring System (PMS)

- The Design description points to two locations; a figure and component location table. Neither show significant detail (or prove operation is possible).
- Design Description: "…The functional arrangement of the PMS is depicted in Figure 2.5.2-1 and the component locations of the PMS are as shown in Table 2.5.2-9."

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

PMS Tier 1 Figure



U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

PMS Component Table

Table 2.5.2-9	
Component Name	**Component Location**
PMS Cabinets, Division A	Auxiliary Building
PMS Cabinets, Division B	Auxiliary Building
PMS Cabinets, Division C	Auxiliary Building
PMS Cabinets, Division D	Auxiliary Building
Reactor Trip Switchgear, Division A	Auxiliary Building
Reactor Trip Switchgear, Division B	Auxiliary Building
Reactor Trip Switchgear, Division C	Auxiliary Building
Reactor Trip Switchgear, Division D	Auxiliary Building
MCR/RSW Transfer Panels	Auxiliary Building
MCR Safety-related Displays	Auxiliary Building
MCR Safety-related Controls	Auxiliary Building

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Simple Table - Example 4

AP1000 Diverse Actuation System (DAS)

- Tier 1 System-ITAAC does not include any figures to compare the "as-built" components against the design. The Table of components lists four cabinets to be verified; no associated cabling, controls, or actuators are listed in the "Component Location" table.
- Design Description: "The diverse actuation system (DAS) initiates reactor trip, actuates selected functions, and provides plant information to the operator."

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

DAS Tier 1 Table

Table 2.5.1-5		
Component Name	**Tag No.**	**Component Location**
DAS Processor Cabinet 1	DAS-JD-001	Annex Building
DAS Processor Cabinet 2	DAS-JD-002	Annex Building
DAS Squib Valve Control Cabinet	DAS-JD-003	Auxiliary Building
DAS Instrument Cabinet	DAS-JD-004	Auxiliary Building

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Staff's Preliminary View

- The as-built functional arrangement ITAAC is more than verification of the simplified Tier 1 diagram by inspection.
- The as-built functional arrangement ITAAC (for a system) is the verification by inspection; following the completion of installation and construction activities; that the required structures, systems, and components (SSCs) are installed and in the required physical arrangement to provide the service for which the system is intended.
- Inspection of the as-built system should be performed using detailed drawings and confirm the required components are physically arranged to provide the service intended as described in the design description.

Background Information

From SECY 00-092:

The design descriptions and functional system drawings available for review during the design certification and COL application stages are sufficient to perform licensing reviews and make final safety determinations but are not adequate for actual construction or construction inspection activities. Therefore, before construction begins on any given portion of the facility the licensee should ensure that the certified design, plus site-specific design information in the COL application, including that required by the design acceptance criteria (DAC), has been translated into detailed, plant-specific design and construction drawings. The level of detail in the certified design and the use of DAC allow for some variation in implementing the certified design. The applicant or licensee also has some flexibility in completing the final design by means of the change process in each DCR. The NRC staff will verify completion of ITAAC by the licensee and conformance with the approved design in part by using these detailed drawings. Therefore, the licensee should ensure that the drawings and other documentation reflect the final as-built configuration of the facility so that they can be used as part of the bases, where appropriate, for demonstrating conformance with the COL ITAAC.

From SECY 96-028:

In the staff's view, the fundamental principle underlying the industry's position is a mechanistic and literal interpretation of the nature of the ITAAC and the determination of successful completion: i.e., if a specific type of information is not explicitly set forth in the words of the ITAAC, then it is not part of the ITAAC and may not be considered in determining whether the ITAAC has been successfully completed. However, the ITAAC were not reviewed and approved by the staff with that understanding, in accordance with the wishes of the applicants and industry representatives. During the ITAAC development, the applicants complained that it was impossible (or extremely burdensome) to provide all details relevant to verifying all aspects of ITAAC (e.g., QA/QC) in Tier 1 or Tier 2. Therefore, the staff accepted the applicants' proposal that top-level design information be stated in the ITAAC to ensure that it was verified, with an emphasis on verification of the design and construction details in the "as-built" facility. Thus, the staff reviewed and approved the ITAAC under an industry understanding which is inconsistent with the industry's current position. If we could modify the ITAAC to specify in detail every requirement (such as QA/QC) that the staff believes must be addressed in coming to a determination that an ITAAC has been successfully completed, in order to accommodate the industry's current position, it would result in a considerable expansion of the design control document and a reopening of the design reviews.

The NRC has determined that a QA/QC deficiency may be considered in determining whether an ITAAC has been successfully completed if: (1) The QA/QC deficiency is directly and materially related to one or more aspects of the relevant ITAAC (or supporting Tier 2 information); and (2) the deficiency (considered by itself, with other deficiencies, or with other information known to the NRC) leads the NRC to question whether there is a reasonable basis for concluding that the relevant aspect of the ITAAC has been successfully completed. This approach is consistent with the NRC's current methods for verifying initial test programs. The NRC recognizes that there may be programmatic QA/QC deficiencies that are not relevant to one or more aspects of a given ITAAC under review and, therefore, should not be relevant to or considered in the NRC's determination as to whether an ITAAC has been successfully completed. Similarly, individual QA/QC deficiencies unrelated to an aspect of the ITAAC in question would not form the basis for an NRC determination that an ITAAC has not been met. Using the ITAAC for pump flow rate example, a specific QA deficiency in the calibration of pump gauges would not preclude an NRC determination of successful ITAAC completion if the licensee could demonstrate that the original deficiency was properly corrected (e.g., analysis, scope of effect, root cause determination, and corrective actions as appropriate), or that the deficiency could not have materially affected the test in question.

Furthermore, although Tier 1 information was developed to focus on the performance of the structures, systems, and components of the design, the information contains implicit quality standards. For example, the design descriptions for reactor and fluid systems describe which systems are "safety-related;" important piping systems are classified as "Seismic Category I" and identify the ASME Code Class; and important electrical and instrumentation and control systems are classified as "Class 1E." The use of these terms by the evolutionary plant designers was meant to ensure that the systems would be built and maintained to the appropriate standards. Quality assurance deficiencies for these systems would be assessed for their impact on the performance of the ITAAC, based on their safety significance to the system. The QA requirements of 10 CFR Part 50, Appendix B, apply to safety-related activities. Therefore, the Commission anticipates that, because of the special significance of ITAAC related to verification of the facility, the licensee will implement similar QA processes for ITAAC activities that are not safety-related.

During the ITAAC development, the design certification applicants determined that it was impossible (or extremely burdensome) to provide all details relevant to verifying all aspects of ITAAC (e.g., QA/QC) in Tier 1 or Tier 2. Therefore, the NRC staff accepted the applicants' proposal that top-level design information be stated in the ITAAC to ensure that it was verified, with an emphasis on verification of the design and construction details in the "as-built" facility. To argue that consideration of underlying information which is relevant and material to determining whether ITAAC have been successfully completed, ignores the history of ITAAC development. In summary, the Commission concludes that information such as QA/QC deficiencies which are relevant and material to ITAAC may be considered by the NRC in determining whether the ITAAC have been successfully completed. Despite this conclusion, the Commission has decided to add a provision to this appendix (IX.B.1), which was requested by NEI. This provision requires the NRC's findings (that the prescribed acceptance criteria have been met) to be based solely on the inspections, tests, and analyses. The Commission has added this provision, which is fully consistent with 10 CFR Part 52, with the understanding that it does not affect the manner in which the NRC intends to implement 10 CFR 52.99 and 52.103(g), as described above.

2. DCD Introduction

Comment Summary. The proposed rule incorporated Tier 1 and Tier 2 information into the DCD but did not include the introduction to the DCD. The SOC for the proposed rule indicated that this was a deliberate decision, stating:

> The introduction to the DCD is neither Tier 1 nor Tier 2 information, and is not part of the information in the DCD that is incorporated by reference into this design certification rule. Rather, the DCD introduction constitutes an explanation of requirements and other provisions of this design certification rule. If there is a conflict between the explanations in the DCD introduction and the explanations of this design certification rule in these statements of consideration (SOC), then this SOC is controlling.

Both the applicant and NEI took strong exception to this statement. They both argued that the language of the DCD introduction was the subject of careful discussion and negotiation between the NRC staff, NRC's Office of the General Counsel, and representatives of the applicant and NEI. They, therefore, suggested that the definition of the DCD in Section 2(a) of the proposed rule be amended to explicitly include the DCD Introduction and that Section 4(a) of the proposed rule be amended to generally require that applicants or licensees comply with the entire DCD. However, in the event that the Commission rejected their suggestion, NEI alternatively argued that the substantive provisions of the DCD Introduction be directly incorporated into the design certification rule's language (refer to NEI Comments dated August 4, 1995, Attachment B, pp. 90–108, and July 23, 1996, pp. 43–49; GE Comments, Attachment A, pp. 10–11).

Response. The DCD Introduction was created to be a convenient explanation of some provisions of the design certification rule and was not intended to become rule language itself. Therefore, the Commission declines the suggestion to incorporate the DCD introduction, but adopted NEI's alternative suggestion of incorporating substantive procedural and administrative requirements into the design certification rule. It is the Commission's view that the procedural and administrative provisions described in the DCD Introduction should be included in, and be an integrated part of, the design certification rule. As a result, Sections II, III, IV, VI, VIII, and X of this appendix have been revised and Section IX was created to adopt appropriate provisions from the DCD Introduction. In some cases, the wording of these provisions has been modified, as appropriate, to achieve clarity or to conform with the final design certification rule language.

3. Duplicate Documentation in Design Certification Rule

Comment Summary. On page 4 of its comments, dated August 7, 1995, the Department of Energy (DOE) recommended that the process for preparing the design certification rule be simplified by eliminating the DCD, which DOE claims is essentially a repetition of the Standard Safety Analysis Report (SSAR). DOE's concern, which was further clarified during a public meeting on December 4, 1995, is that the NRC will require separate copies of the DCD and SSAR to be maintained. During the public meeting, DOE also expressed a concern that § 52.79(b) could be confusing to an applicant for a combined license because it currently states: "The final safety analysis report and other required