



U.S. NUCLEAR REGULATORY COMMISSION
STANDARD REVIEW PLAN
OFFICE OF NUCLEAR REACTOR REGULATION

NEW

Section 7.0. Instrumentation and Controls — Overview of Review Process

Review Responsibilities

Primary — Instrumentation and Controls Branch (HICB)

Secondary — None

I. Introduction

Chapter 7 of the SRP provides guidance for review of the instrumentation and control (I&C) portions of (1) applications for nuclear reactor licenses or permits and (2) amendments to existing licenses. The SRP guidance may also be applied in the review of topical reports submitted to NRC for safety evaluation, especially reports requesting generic acceptance of systems or components that may be used in nuclear power plant I&C systems. For an overview of the purpose, content, and use of the SRP in general refer to the introductory section of the SRP.

Section 7.0 provides an overview of the process used by HICB staff to review both the I&C portion of license applications and the I&C portions of generic safety evaluations of specific topics. Guidance is provided to the reviewer in applying Chapter 7 of the SRP to these reviews.

Figure 7.0-1 provides an overview of the HICB review process. Each of the reviewer activities shown in this figure is discussed below. Ideally, applicants will request that the Staff's review begin during the early stages

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USNRC STANDARD REVIEW PLAN

Standard review plans are prepared for the guidance of the Office of Nuclear Reactor Regulation staff responsible for the review of applications to construct and operate nuclear power plants. These documents are made available to the public as part of the Commission's policy to inform the nuclear industry and the general public of regulatory procedures and policies. Standard review plans are not substitutes for regulatory guides or the Commission's regulations and compliance with them is not required. The standard review plan sections are keyed to the Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants. Not all sections of the Standard Format have a corresponding review plan.

Published standard review plans will be revised periodically, as appropriate, to accommodate comments and to reflect new information and experience.

Comments and suggestions for improvement will be considered and should be sent to the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Washington, D.C. 20555.

of the development life cycle. Early interaction with the applicant is important so that differences between the Staff and the applicant may be identified as early as possible. The Staff should work with the applicant to expeditiously resolve these issues in order to minimize the impact upon design and implementation activities. Early resolution of fundamental issues minimizes the rework necessary in areas where changes to the design bases are needed to resolve Staff concerns. This helps to assure that the changes are correctly propagated through the design effort, thus improving the Staff's confidence in design quality.

II. Application Types

The type of application under review largely determines the review activities to be conducted and impacts the complexity and scope of the review. NRC regulations provide for the following types of license applications relevant to nuclear power reactors.

1. *Construction permits (CPs)* as discussed in 10 CFR 50.10(b) and 10 CFR 50.23. An application for a construction permit must be accompanied by a preliminary safety analysis report (PSAR). Construction permit applications may be submitted for construction of a new facility or alteration of an existing facility.
2. *Operating license (OL) applications* as discussed in 10 CFR 50.21 and 50.22. Operating license applications must be accompanied by a final safety analysis report (FSAR) and proposed technical specifications.
3. *Early site permits*, or early site permit renewal as discussed in 10 CFR 52, Subpart A. HICB will not normally be involved in the review of early site permit applications.
4. *Standard design certifications (DCs)* as discussed in 10 CFR 52, Subpart B. Applications for standard design certification are accompanied by a safety analysis report (SAR) and certified design material.
5. *Renewal of standard design certification* as discussed in 10 CFR 52.57. Applications for renewal of standard design certifications will not be submitted before the year 2007; therefore, Section 7.0 does not address these reviews.
6. *Combined licenses (CLs)* as discussed in 10 CFR 52, Subpart C. Combined license applications will be accompanied by an FSAR, plant-specific technical specifications, and plant-specific inspections, tests, analyses and acceptance criteria (ITAAC).
7. *Amendments to existing operating licenses, construction permits, or combined licenses* as discussed in 10 CFR 50.90 and 10 CFR 50.59(c). (Note that these sections apply to changes to combined licenses by the provisions of 10 CFR 52.83.) Amendments to existing licenses or permits must be accompanied by supporting information and proposed technical specification changes.
8. *Manufacturing licenses* as discussed in 10 CFR 52, Appendix M. Section 7.0 does not address review of manufacturing license applications.
9. *Review of standard designs, or major portions thereof* as discussed in 10 CFR 52 Appendix O. Applications for review of standard designs are typically accompanied by one or more topical reports describing the design.

10. *License renewal* as discussed in 10 CFR 54. HICB will not normally be involved in the review of license renewal applications.
11. *Topical reports* may be submitted to obtain NRC review of specific proposals independent of an application for a license or license amendment. For example, systems, components, or operational practices that are being considered for use in multiple plants may be submitted for generic review.

III. Review Scope and Contents

The reviewer should determine the scope of the review needed to support evaluation of the application. The scope of the review will impact the information needed by the reviewer and the extent of review planning.

Regardless of the type of application under consideration, the fundamental purpose of the NRC review is to determine whether the facility and equipment, the proposed use of the equipment, the operating procedures, the processes to be performed, and other technical requirements provide reasonable assurance that the applicant/licensee will comply with the regulations of 10 CFR Chapter I, and that public health and safety will be protected.

It is not intended that the review, audit, or inspection activities by the reviewer completely evaluate all aspects of the design and implementation of the I&C system. The review scope needs only to be sufficient to allow the reviewer to reach the conclusion of reasonable assurance described above.

Subject to compliance with existing license commitments, compliance with current applicable regulations, and protection of the public health and safety, the HICB review may consider and use previous interpretations of the regulations as they apply to the application being reviewed. The scope of review includes those I&C systems that are identified as substantially identical to systems that have been previously reviewed and approved by the staff. The evaluation of these systems in subsequent sections of Chapter 7 may be based upon prior Staff approval. If any aspect of a design is not identical to that which is referenced, an evaluation must be made to address the adequacy of the different design. Conclusions drawn from this review must be included in the safety evaluation report.

Figure 7.0-2 illustrates the life cycle for any I&C system, and relates the application types described below to the life-cycle activities that should be addressed by the application. The review of any application should involve all the applicable life-cycle activities. Reviews should confirm the acceptability of system requirements and the adequacy with which the final system meets these requirements. Review of non-digital computer-based system implementation may focus on component and system requirements, design outputs, and validation (e.g., type testing). Review of computer-based systems should focus on confirming the acceptability and correct implementation of the life-cycle activities.

Section 7.1 discusses the review of the overall I&C system concept and generic system requirements. Appendices 7.1-A, 7.1-B, and 7.1-C discuss the review procedures for each acceptance criterion relevant to I&C systems. Sections 7.2 through 7.9 describe the review of system-specific requirements, system design, and implementation. For computer-based systems or components with embedded computers, Appendix 7.0-A describes a generic process for reviewing the unique aspects of computer-based systems, including hardware/software integration. The appendices to Sections 7.0 and 7.1 are to be used in conjunction with Sections 7.1 through 7.9.

The HICB review of each life-cycle activity should address the review points covered in Sections III.A and III.B. The Staff's review emphasis should be commensurate with the safety significance of the given system

or aspect of a system's design under review. Probabilistic risk assessments (PRAs), such as those conducted under the Individual Plant Evaluation program or required as part of applications under 10 CFR 52, provide information that may prove helpful in determining the appropriate level of review. Review scope should be coordinated with secondary review branches as discussed in Section V below.

The review considers material that is formally submitted for the docket, provided informally for Staff consideration, and material that is available for audit at the applicant's site.

HICB reviewers should be familiar with all sections of the SAR that have a bearing on the I&C systems under review. The following SAR sections are typically relevant to the review of I&C systems.

Chapter 1	For familiarization with the general operation of the plant, both safety and non-safety aspects.
Chapter 2	For familiarization with environmental conditions and natural phenomena hazards that could affect I&C systems.
Chapter 3	For a general understanding of the principal architectural and engineering designs of those structures, components, equipment, and systems important to safety.
Section 3.1	For exceptions to criteria applicable to the I&C control systems, and for structures suitable for housing this equipment.
Section 3.10 and 3.11	For an understanding of the seismic and environmental qualification program for I&C sections control system components.
Chap. 4 & 5	For an understanding of the reactor and the reactor coolant system and its interconnections with the ESF systems.
Chapter 6	For the design bases, design features, and functional performance requirements of the ESF systems.
Chapter 8	For an understanding of the electrical power systems.
Chapter 9	For the design bases, design features, and functional performance requirements of essential auxiliary support (EAS) systems.
Chapter 10	For an understanding of the steam and power conversion systems and their interconnections with the I&C systems.
Chapter 12	For an understanding of radiation monitoring systems and their interaction with the I&C systems addressed in Chapter 7.
Chapter 14	For an understanding of the initial test program and its role in verification and validation of I&C systems. For applications made under 10 CFR 52, HICB will also participate in the review of ITAAC as described in Chapter 14.
Chapter 15	For a description of accidents for which the I&C system actuates or controls protective functions, the effects of failures of the protective functions, and the assumptions and initial conditions that form the bases of the accident analyses.

Chapter 16	For the proposed limiting conditions for operation and surveillance requirements for the I&C systems.
Chapter 17	For an understanding of Quality Assurance activities during design and construction and the role QA plays in the engineering life cycle for I&C systems.
Chapter 18	For the human factors considerations in the design of I&C control system user interfaces.
Chapter 19	For a discussion of the contribution to risk of the I&C control systems in the probabilistic risk assessment and the insights into I&C control system design features derived from that assessment.

III.A Design Certification or Construction Permit Applications

The review scope for design certification or construction permit applications should include evaluation of the system concept, system requirements, system design, and plans for implementing the system design.

System Concept Evaluation

The system concept evaluation should be based on the following review points:

1. The overall I&C system design's relationship to both the functions required by 10 CFR 50 and the functions required to support the assumptions of the plant accident analysis. (See Section 7.1.)
2. The adequacy of any research and development plan necessary to resolve any outstanding questions concerning the design of systems or components.
3. Compliance with the technically relevant portions of 10 CFR 50. (See Section 7.1.)
4. Proposed resolution of technically relevant unresolved safety issues and medium- and high-priority generic safety issues identified more than six months prior to the application. (See SRP Chapter 20.)

System Requirements Evaluation

The system requirements evaluation should be based on the following review points:

1. Principal design criteria with respect to the guidance of 10 CFR 50.55a(h) (ANSI/IEEE Std 279¹) and 10 CFR 50, Appendix A. (See Section 7.1.)
2. The design bases, including functional design requirements, and the relationship of the design bases to the principle design criteria. (See Sections 7.2 through 7.9.)

¹IEEE Std 603 is an alternative to ANSI/IEEE Std 279, "Criteria for Protection Systems for Nuclear Power Generating Stations," which is no longer an active standard. The current version of this standard is IEEE Std 603-1991, "Criteria for Safety Systems for Nuclear Power Generating Stations."

The following additional review points apply to applications under 10 CFR 52 only:

3. Inspections, tests, analyses and acceptance criteria (ITAAC) proposed to provide reasonable assurance that, if the inspections, tests, and analyses are performed, the acceptance criteria are met, and a plant is built according to the design, then the plant will operate in accordance with the design certification. SRP Section 14.3 describes the general acceptance criteria and review procedures for ITAAC. Section 14.3.5 describes the specific acceptance criteria and review procedures for I&C system ITAAC.
4. The interface requirements and a representative conceptual design for those portions of the plant not included in the design certification application. (See Sections 7.2 through 7.9.)

System Design Evaluation

The system design evaluation should be based on the following review points:

1. The key characteristics, performance requirements, general arrangements, and materials of construction of the systems to confirm that there is reasonable assurance the final design will conform to the design bases with adequate margin for safety. (See Sections 7.2 through 7.9.)
2. The identification of I&C functions and variables to be probable subjects of technical specifications for the facility. (See Sections 7.2 through 7.9.)
3. Proposed technical specifications (Technical Specifications Branch (TSB) has lead responsibility. See SRP Chapter 16.)
4. The applicant/licensee's analysis and technical justification to show that the I&C system design, including the underlying design bases and performance requirements, can perform appropriate safety functions.

Hardware and Software Planning Evaluation

The evaluation should include reviewing plans for the implementation and overall management of system development, quality assurance, integration, installation, maintenance, training, operations, safety analysis, verification and validation, and configuration management. (See Appendix 7.0-A.)

Note: Review of design certification applications should extend to cover detailed design. However, for digital computer-based I&C systems, it may be premature to complete final design details at the design certification (DC) stage. Waiting until the combined license (CL) stage to complete the final design of such systems will allow the CL applicant/licensee to use the most recent technology for each plant. Therefore, the review of DC applications for digital computer-based I&C may be limited to (1) a detailed review at the functional block diagram level, (2) a review of the applicant/licensee's commitment to prescribed limits, parameters, procedures, and attributes for the detailed design process, and (3) ITAAC adequate to demonstrate that the as-built facility conforms to these commitments. Branch technical position (BTP) HICB-16 provides guidance for use in judging the completeness of a DC application where the applicant/licensee proposes to wait until the CL stage to complete the final design of digital computer-based I&C systems.

III.B Operating License and Combined License Applications

For operating license and CL applications, normally the NRC will have reviewed the items discussed in Section III.A above and issued a safety evaluation report (SER) based upon that review. Therefore, NRC review at the OL and CL stage is confined to the following items and changes to commitments made at the construction-permit or design-certification stage.

Hardware and Software Requirements, Detailed Design, Fabrication, Test, and Integration Evaluation

The hardware and software requirements, detailed design, fabrication, test, and integration evaluation should be based on the following review points:

1. Implementation of development plans. (See Appendix 7.0-A.)
2. Conformance of design outputs with system requirements. (See Sections 7.2-7.9 and Appendix 7.0-A.)
3. Evidence of design process characteristics in design outputs. (See Appendix 7.0-A.)
4. The description and evaluation of the results of the applicant/licensee's research and development to demonstrate that any safety questions identified at the CP stage have been resolved. (See Section 7.2 through 7.9 and Appendix 7.0-A.)

System Validation Evaluation

The system validation evaluation should be based on the following review points:

1. The applicant/licensee's testing, analysis, and technical justification to show that I&C system design, including the underlying design bases and performance requirements, can perform appropriate safety functions. (See Section 7.2 through 7.9 and Appendix 7.0-A.)

The following additional review points apply only to CL applications:

2. The applicant/licensee's demonstration of compliance with interface requirements, for applications referencing a certified standard design.
3. ITAAC proposed to provide reasonable assurance that, if the inspections, tests, and analyses are performed, the acceptance criteria met, and a plant is built according to the design, then the plant will operate in accordance with the design certification. (Applications that reference a certified standard design must apply the certified design ITAAC to those portions of the facility covered under the DC.) (See SRP Chapter 14.)

Installation, Operations, and Maintenance Evaluation

The installation, operations, and maintenance evaluation should be based on the following review points:

1. Site visit. (See Appendix 7-B.)

The following additional review point applies only to CL applications:

2. Implementation of ITAAC. (See SRP Chapter 14.)

III.C License Amendments and Topical Reports

The scope of license amendment applications and topical reports is highly variable. The reviewer should develop an application-specific review scope for the item under consideration. All of the points discussed above that are relevant to the application under consideration should be considered.

Regardless of the review scope, the reviewer should examine Section 7.1 and Table 7.1-1 to identify the SRP sections, BTPs, and acceptance criteria applicable to the application. If the application involves the use of digital computer-based I&C systems or computers embedded in systems or components, the review process of Appendix 7.0-A also applies.

IV. Acceptability of Applications

Before substantial review effort is expended, the reviewer should confirm that the application contains enough information to allow the review to begin and to substantially progress. Table 7.0-1 below identifies the acceptance criteria for the various types of applications and the guidance that may be used in assessing acceptability. Detailed guidance on the specific I&C system information that an application should contain may be found in Reg. Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants," each applicable SRP section, the "Information to be Reviewed" sections of each applicable BTP, and SRP Appendix 7.0-A. BTP HICB-16 and SRP Chapter 14 contain additional information on the material that should be contained in an application for standard design certification under the provisions of 10 CFR 52.

Table 7.0-1. Acceptance Criteria for Applications

Type of Application	Acceptance Criteria
Construction Permit	10 CFR 50.34(a)
Operating License	10 CFR 50.34(b) and (f)
Standard Design Certification	10 CFR 52.47
Combined License	10 CFR 52.79
Manufacturing License	10 CFR 50.34(a)
Topical Report	Depends upon scope
License Amendment	10 CFR 50.90
Design Certification Renewal	10 CFR 52.57(a)

V. Application-Specific Review Plan

The reviewer should develop a review plan specific to the application under consideration. The purpose of the plan is to (1) communicate planned activities and schedules to management, (2) identify, early in the review, resources that the reviewer needs to support the review, and (3) ensure that review participants have a common understanding of review criteria and the roles of the individual reviewers.

Scope

The plan should briefly describe what is to be reviewed as determined in Section III above.

Review Criteria

The plan should identify the criteria against which the application will be evaluated. For new applications, the applicable criteria will normally be the applicable CFR sections and the detailed acceptance criteria contained in the SRP, supporting BTPs, and regulatory guides. Safety evaluation reports for previous applications, topical reports, and unreviewed or generic safety issue closeouts are also useful sources of information about Staff positions and interpretations that can be used to develop specific review criteria.

For license amendment applications, the review criteria will consist of original license commitments. Where the original license commitments do not completely cover all aspects of the proposed modification, the Staff may supplement the original commitments with additional criteria from the SRP.

Review Activities

The plan should describe the review activities planned to accomplish the review, and the approximate order in which these activities will be performed. Activities that have a broad impact on the review, such as the review of commitments to codes and standards or the defense-in-depth and diversity review, should occur early in the review process.

Review activities should give particular emphasis to the review of functional design requirements, as errors at this level impact all successive aspects of the system design.

For each activity, the plan should identify the approximate resources required (e.g., number of staff-weeks, access to detailed design documents, access to completed hardware), the approximate start and finish dates, and the external meetings or audits anticipated as part of the activity. The goals of the external meetings and audits that will be part of the review activities should be defined.

Review Assignments

NRC staff and contractors who will participate in the review should be named, and their roles defined with respect to the review activities.

Interfaces

The plan should identify interfaces with other NRC organizations such as the project manager, regional offices, other technical branches, and applicant/licensee personnel. The plan should describe the actions and information that the HICB needs from each organization and include a schedule showing when each item is to be delivered. Likewise, the plan should also identify the information and actions the interfacing organizations

need from HICB and include a schedule showing when these items will be needed. The plan should identify meetings and site trips as necessary. Schedule information may be absolute (a specific date) or relative (time before or after some milestone). The plan should address time required for requests for additional information (RAIs) and iterations of reviews.

HICB will coordinate with other NRC technical branches in the review of the following I&C system design features:

- The adequacy of the monitored variables, e.g., the suitability of parameters, such as pressure, for initiating operation of reactor trip or a given ESF or EAS system included in Chapter 15 of the SAR.
- The acceptability of the proposed setpoints, time delays, accuracy requirements, and actuated equipment response, and consistency with the safety analysis included in Chapter 15 of the SAR.
- The acceptability of the human-machine interface as described in Chapter 18 of the SAR.

The coordinated reviews include the following:

- The Reactor Systems Branch (SRXB) evaluates the adequacy of protective, control, display, and interlock functions and confirms that they are consistent with the accident analysis, the operating requirements of the I&C systems, and the requirements of GDC 10, 15, 28, 33, 34, and 35.
- The Plant Systems Branch (SPLB) evaluates the adequacy of the requirements for the EAS systems to ensure the EAS systems satisfy the applicable acceptance criteria. These systems include compressed (instrument) air, cooling water, boration, lighting, heating, and air conditioning. This review confirms that (1) the design of the EAS systems is compatible with the single-failure requirements of the I&C systems and (2) the EAS systems will maintain the required environmental conditions in the areas containing I&C equipment. This review includes the design criteria and testing methods employed in the seismic design and installation of EAS equipment. SPLB also evaluates the adequacy of protective, control, display, and interlock functions, and confirms that they are consistent with the operating requirements of the supported system and the requirements of GDC 41 and 44.
- The Containment Systems and Severe Accident Branch (SCSB) reviews the containment ventilation and atmospheric control systems provided to maintain required environmental conditions for electrical and instrumentation equipment located inside containment. SCSB also evaluates the adequacy of protective, control, display, and interlock functions associated with containment systems and severe accidents, and confirms they are consistent with the accident analysis, operating requirements, and GDC 16 and 38.
- The Electrical Engineering Branch (EELB) (1) evaluates the adequacy of physical separation criteria for cabling and electrical power equipment, (2) determines that power supplied to redundant systems is supplied by appropriate redundant sources, and (3) confirms the adequacy of the instrumentation and controls associated with the proper functioning of the onsite and offsite power systems. EELB also reviews the environmental qualification of I&C equipment. The scope of this review includes the design criteria and qualification testing methods and procedures for I&C equipment.
- The Mechanical Engineering Branch (EMEB) reviews the seismic qualification demonstration for I&C equipment including the design criteria and qualification testing methods and procedures.

- The Human Factors Assessment Branch (HHFB) evaluates the adequacy of the arrangement and location of instrumentation and controls, and confirms that the capabilities of the instrumentation and controls are consistent with the operating procedures and emergency response guides.
- The Quality Assurance and Maintenance Branch (HQMB) reviews the adequacy of administrative, maintenance, testing, and operating procedure programs as part of its primary review responsibility for SRP Sections 13.5.1.2 and 13.5.2.2. The reviews of design, construction, and operations phase quality assurance programs, including the general methods for addressing periodic testing, maintenance, and reliability assurance, are also coordinated and performed by the HQMB as part of its primary review responsibility for SRP Chapter 17. HQMB also reviews the proposed preoperational and startup test programs to confirm that they are in conformance with the intent of Regulatory Guide 1.68 as part of its primary review responsibility for SRP Section 14.2.

For design certification or combined license applications made under 10 CFR 52, proposed or completed inspections, tests, analyses, and acceptance criteria (ITAAC) are reviewed by HICB as part of its review responsibility for SRP Section 14.3.5.

VI. Review

The review is to be accomplished in accordance with the application-specific review plan using the acceptance criteria and review processes of the SRP. The review will be documented by the preparation of an SER.

VII. References

ANSI/IEEE Std 279-1971. "Criteria for Protection Systems for Nuclear Power Generating Stations."

IEEE Std 603-1991. "Criteria for Safety Systems for Nuclear Power Generating Stations."

Regulatory Guide 1.70. "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants."
Office of Standards Development, U.S. Nuclear Regulatory Commission, November 1978.

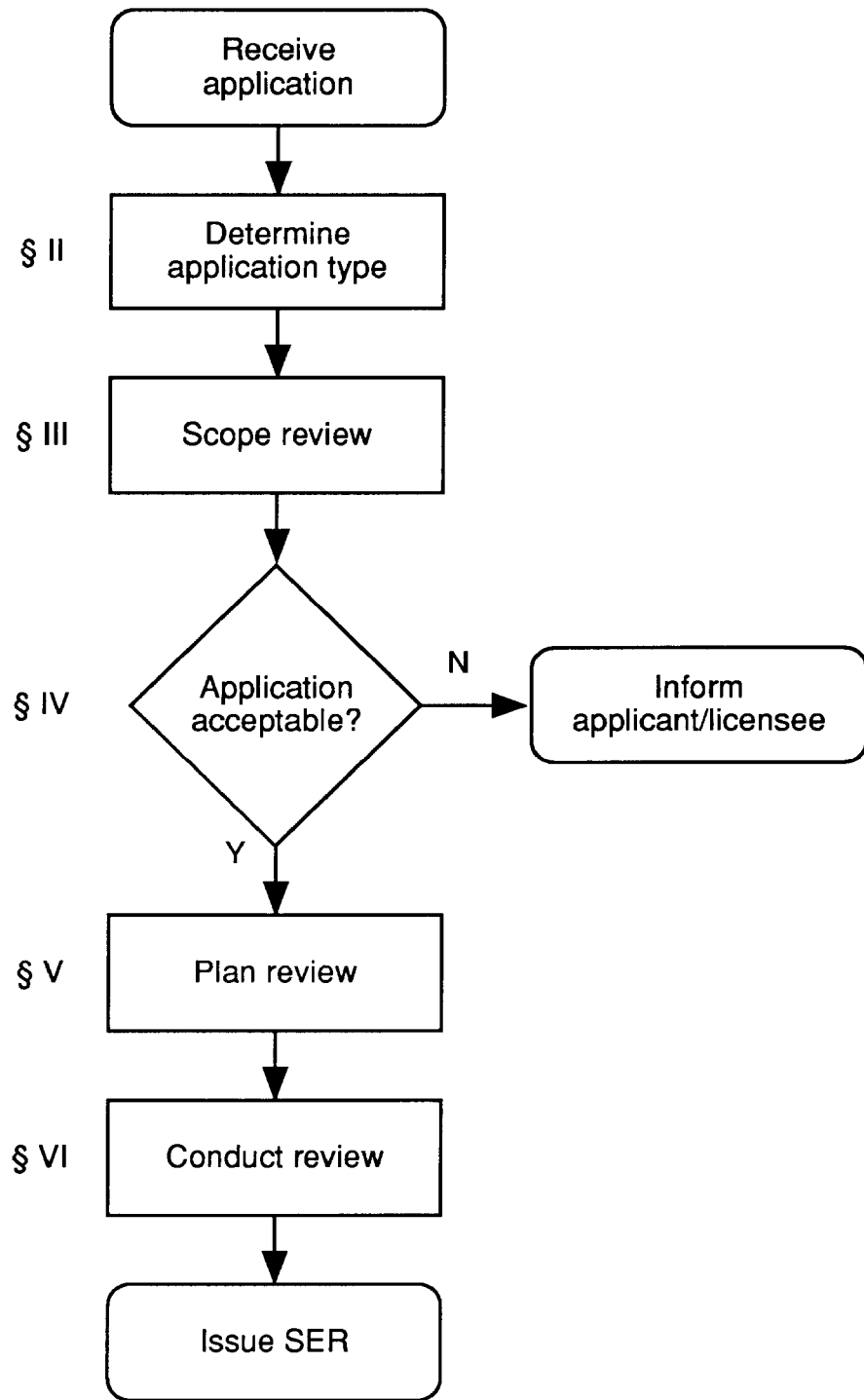


Figure 7.0-1 Overview of Review Process

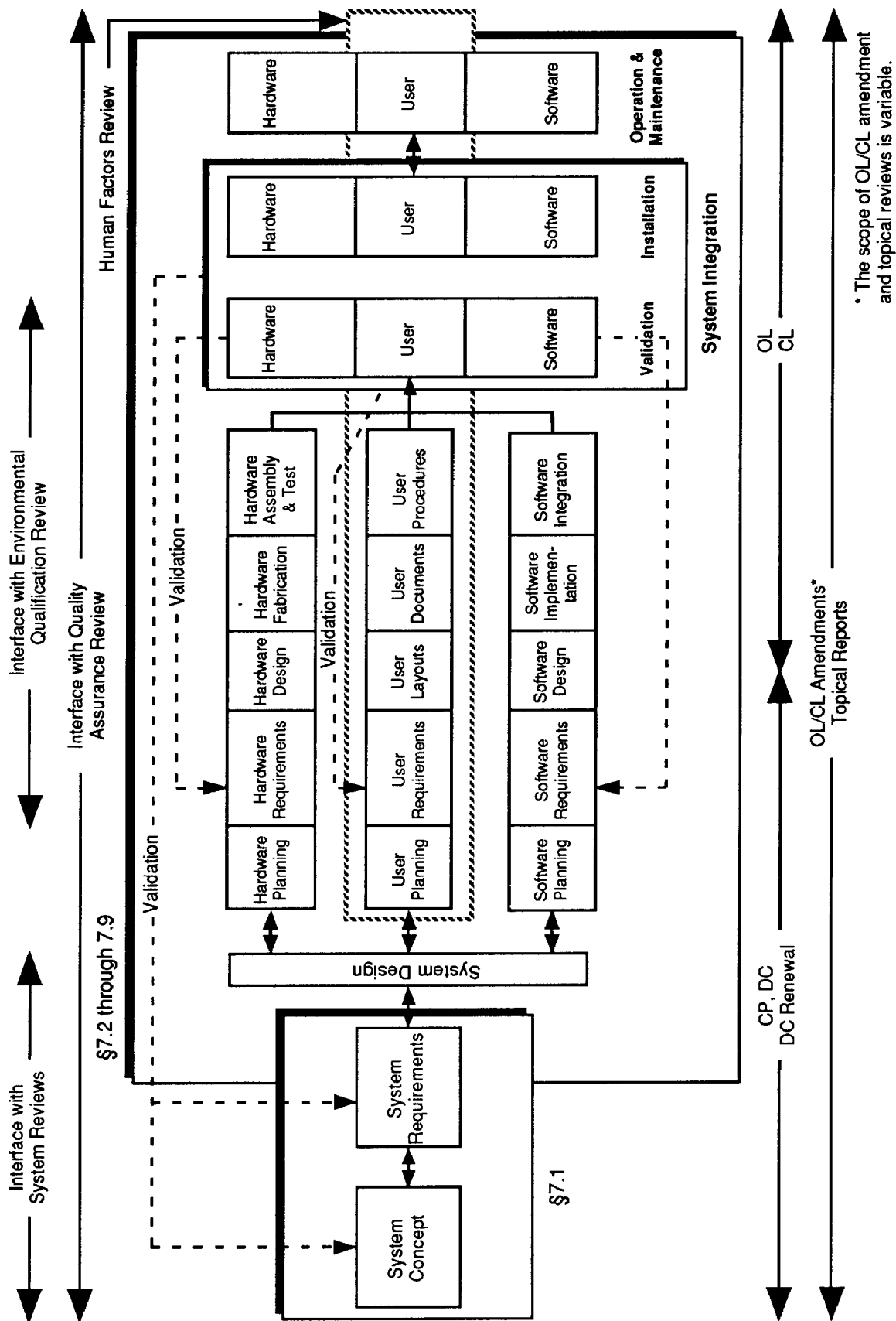


Figure 7.0-2. Relationship Between Development Life Cycle Stages, Review Types, and SRP Sections

