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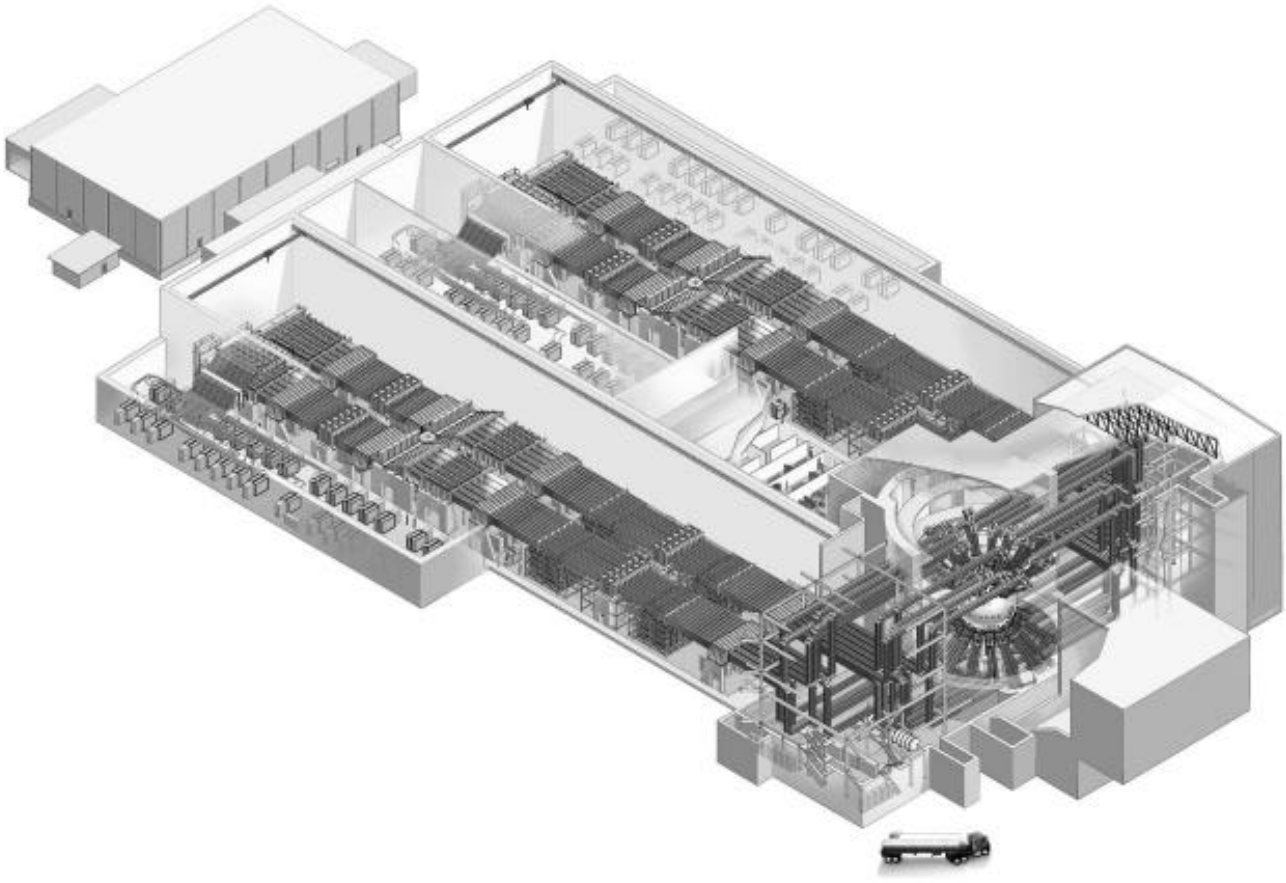
# Software Quality Assurance Plan for the National Ignition Facility Integrated Computer Control System

November 1996



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# Software Quality Assurance Plan
# for the
# National Ignition Facility
# Integrated Computer Control System

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# Contents

## Tables



## Figures



## Appendices

# Acronyms

| | |
|---|---|
| COTS | Commercial off the Shelf |
| CSC | Computer Software Components |
| DOE | Department of Energy |
| FEP | Front End Processor |
| ICCS | Integrated Computer Control System |
| ICD | Interface Control Documents |
| NCR | Nonconformance Report |
| NIF | National Ignition Facility |
| QA | Quality Assurance |
| QAPP | Quality Assurance Program Plan |
| SDD | Software Design Documents |
| SDR | System (or Subsystem) Design Requirements |
| SQAP | Software Quality Assurance Plan |
| SRS | Software Requirements Specification |
| SSDR | Software Subsystem Design Requirements |
| WBS | Work Breakdown Structure |

# Introduction

Quality achievement is the responsibility of the line organizations of the National Ignition Facility (NIF) Project. This Software Quality Assurance Plan (SQAP) applies to the activities of the Integrated Computer Control System (ICCS) organization and its subcontractors. The Plan describes the activities implemented by the ICCS section to achieve quality in the NIF Project's controls software and implements the *NIF Quality Assurance Program Plan* (QAPP, NIF-95-499, L-15958-2) and the Department of Energy's (DOE's) Order 5700.6C. This SQAP governs the quality affecting activities associated with developing and deploying all control system software during the life cycle of the NIF Project. The following activities are affected by this Plan:

- Software and documentation development.
- Management practices supporting software.
- Strategies for reviewing critical components.
- Software development.

The life-cycle software tasks covered by this SQAP include:

- Requirements analysis.
- Design.
- Implementation.
- Testing.
- Installation
- Configuration management.
- Verification and validation.
- Training.
- Maintenance.
- Software Operation.

The objective for developing this plan is to ensure that controls are developed and implemented for management planning, work execution, and for assessing the results of the ICCS section's activities. By issuing this Plan, the Systems Control Manager establishes:

- Responsibility and authority for developing and implementing a quality program for ICCS.
- That this quality program meets all applicable codes, standards, and regulations.
- The effective QA activities that are to be implemented by ICCS, its subcontractors, and suppliers.
- That issues affecting quality adversely are to be identified and corrective action(s) should be taken when necessary.

This SQAP is organized according to the 10 quality assurance criteria of the total management system (as outlined in the NIF QAPP) and describes how these QA

requirements are met. This Plan is authorized by the Systems Control Manager, who has assigned responsibility for maintaining it to the ICCS Lead Engineer with assistance from the NIF's QA organization. This SQAP will be reviewed and revised, as necessary, during each phase of the Project.

The NIF QAPP comprises the functional elements listed in Table 1-1, which lists the section in the NIF QAPP where the requirements are identified, and where the ICCS implementation description is found in this document. Furthermore, in conformity with the schedule contained in the NIF QAPP, the Project is committed to a phased implementation of these elements. Accordingly, for activities planned for these Project phases, work descriptions — in the form of written procedures — need to be prepared. As a group, the procedures help to ensure achieving quality at the working level by:

- Standardizing performance through management planning.
- Ensuring that employees understand what is expected of them.
- Creating a basis for training Project team members.
- Providing a documented basis for performance evaluation.
- Establishing a baseline against which work processes and quality standards may be judged.

Approved procedures describe how work is performed on the Project. Procedures governing the generic activities of Project organizations are contained in the *NIF Project Control Manual* (NIF-96-041, L-21254-1).

# 1.0 Program

The first criterion of the *NIF Quality Assurance Program Plan*, "Program," requires that:

- A QA program must be developed.
- Organization, roles, and responsibilities must be defined.
- The management system must be documented to describe the way business is done in the organization.

This Plan, when used with the NIF's QAPP, accomplishes these goals.

## 1.1 Cost and Schedule Planning

Cost and schedule planning for ICCS activities will be done according to the following approved NIF procedures:

- Procedure 1.2, Plant and Capital Equipment Cost Estimate Preparation and Revision.
- Procedure 1.3, Schedule Preparation and Revision.

Table 1-1. Quality Assurance Program Plan Elements.

| QA Criteria | NIF QAPP | This SQAP |
|---|---|---|
| Management Criteria | | |
| Criterion 1: Program | | |
| 1.1 Quality Assurance Procedures | 6.1.1.1 | 1.0 |
| 1.2 Ancillary Quality Assurance Plans | 6.1.1.2 | 1.0 |
| 1.3 Cost and Schedule Planning | 6.1.1.3 | 1.1 |
| 1.4 Management System and Scope | — | 1.2 |
| Criterion 2: Personnel Training and Qualifications | | |
| 2.1 Professional qualifications | — | 2.0 |
| 2.2 Project specific training | — | 2.0 |
| Criterion 3: Quality Improvement | | |
| 3.1 Project Reviews | 6.1.3.1 | 3.1 |
| 3.2 Nonconforming Items | 6.1.3.2 | 3.2 |
| 3.3 Corrective Actions | 6.1.3.3 | 3.3 |
| 3.4 NIF Quality-Improvement Activities | 6.1.3.4 | — |
| 3.5 Performance Measurement | — | 3.4 |
| Criterion 4: Documents and Records | | |
| 4.1 Document Control | 6.1.4.1 | 4.0 |
| 4.2 Record Control | 6.1.4.2 | 4.0 |
| 4.3 Standard Distribution Processes | 6.1.4.3 | 4.0 |
| Performance Criteria | | |
| Criterion 5: Work Processes | | |
| 5.1 Design Review Process | 6.2.1.1 | 6.0 |
| 5.2 Calibration of Measurement and Test Equipment | 6.2.1.2 | 8.0 |
| 5.3 Preventive Maintenance | 6.2.1.3 | 5.2 |
| 5.4 Installation Control | 6.2.1.4 | 5.2 |
| 5.5 Handling, Storage, and Shipping | 6.2.1.5 | — |
| Criterion 6: Design | | |
| 6.1 Design Criteria Preparation and Control | 6.2.2.1 | 6.1 |
| 6.2 Configuration Management | 6.2.2.2 | 6.3 |
| 6.3 Design Verification | 6.2.2.3 | 6.2 |
| 6.4 As-built Evaluation | 6.2.2.4 | 6.3 |
| Criterion 7: Procurement | | |
| 7.1 Procurement Document Preparation and Control | 6.2.3.1 | 7.0 |
| 7.2 Vendor Qualification and Bidder Assessment | 6.2.3.2 | 7.0 |
| 7.3 Vendor Surveillance | — | 7.0 |
| Criterion 8: Inspection and Acceptance Testing | | |
| 8.1 Inspection Levels | 6.2.4.1 | 8.0 |
| 8.2 Acceptance Tests | 6.2.4.2 | 8.0 |
| 8.3 Certification of Vendors | 6.2.4.3 | 7.0 |
| Assessment Criteria | | |
| Criterion 9: Management Assessment | 6.3.1 | 9.0 |
| Criterion 10: Independent Assessment | 6.3.2 | 10.0 |

## 1.2 The ICCS Organization's Management System

This subsection describes how the Project activities within the Integrated Computer Control System organization are managed.

### 1.2.1 Management System and Scope

Work controls are developed through a process of defining the work to be accomplished within the Project's cost and scheduling requirements. This document provides the required planning basis for the Integrated Computer Control System and defines such issues as:

- What actions are required?
- How will these tasks be performed?
- Who will perform them?
- When will the tasks be performed?

### 1.2.2 Organization

The organizational chart for ICCS is reproduced in Appendix A. Although all personnel in the organization are responsible for achieving quality in their work, just those responsible for verifying the achievement of the requisite levels of quality are listed. (The actual verification work itself is done by individuals not responsible for originally doing the work.)

Verification personnel, whether they are in the line organization or not, must have sufficient access and authority to:

- Identify quality problems or nonconformance with requirements.
- Initiate, recommend, or provide solutions.
- Verify that corrective actions have been implemented.
- Assure that nonconforming work is either stopped or is proceeding under controlled conditions until the unsatisfactory condition is corrected.

### 1.2.3 Roles and Responsibilities

The quality-related responsibilities of key management positions of ICCS are described below. Authority to perform the duties listed may be delegated to other qualified individuals in the same organization, but the responsibility remains with the positions named.

#### 1.2.3.1 Systems Control Manager

The systems control manager is responsible for the system's overall quality and safety, and the technical success of the project's control system organization. He or she is also responsible for planning and managing the manpower and resources to accomplish the organization's scope of work.

#### 1.2.3.2 Lead Engineer, ICCS

The Lead Engineer manages the Integrated Control Systems development, and is responsible for:

- Managing the design planning, implementation, and assurances for hardware, software, and procedures comprising the ICCS.
- Recommending to the NIF Project whether the ICCS needs to incorporate upgrades or new versions, or not.

#### 1.2.3.3 Lead Software Architect, ICCS

The Lead Software Architect provides a point of contact to the Project for software issues, and is responsible for:

- Preparing and reviewing the System and Subsystem Design Requirements and Software Requirement Specifications, for software.
- Assigning Q-levels.
- Quality assurance oversight for the software produced by the members of the Front-end Processors Group.

#### 1.2.3.4 Team Leader for Front End Processors

The front-end-processor team leader is responsible for:

- Leading the design, development, testing, and operation of the front-end-processor software in the control system.
- Quality assurance oversight for the software produced by the members of the Supervisory Software Group.

#### 1.2.3.5 Supervisory Software and Front-End-Processor Development Team Members

The development team members are responsible for doing the software analysis, design, implementation, unit tests, and maintenance, as delegated by the ICCS Lead Engineer and the Software Architect.

#### 1.2.3.6 Software Change-Control Board Members

The Software Change-Control Board members are responsible for evaluating proposed changes to software that has been baselined. This includes customer coordination with the customer with respect to reviewing and accepting, rejecting, or negotiating changes, and scheduling the implementation work when it is approved. The board is chaired by the Lead Engineer for the ICCS, and its membership will be determined at his or her discretion.

#### 1.2.3.7 Test Team Members

The test team members are responsible for doing all the software tests above the unit test level (such as the subsystem, system integration, and acceptance tests) and for producing the required documentation (test specifications and reports) during each test phase. The test team is selected from members of the development team, the engineering team responsible for the equipment being controlled, and delegates from the NIF operations staff.

The activities described in this SQAP for carrying out the tasks just outlined in this subsection are shown schematically in Figure 1-1.

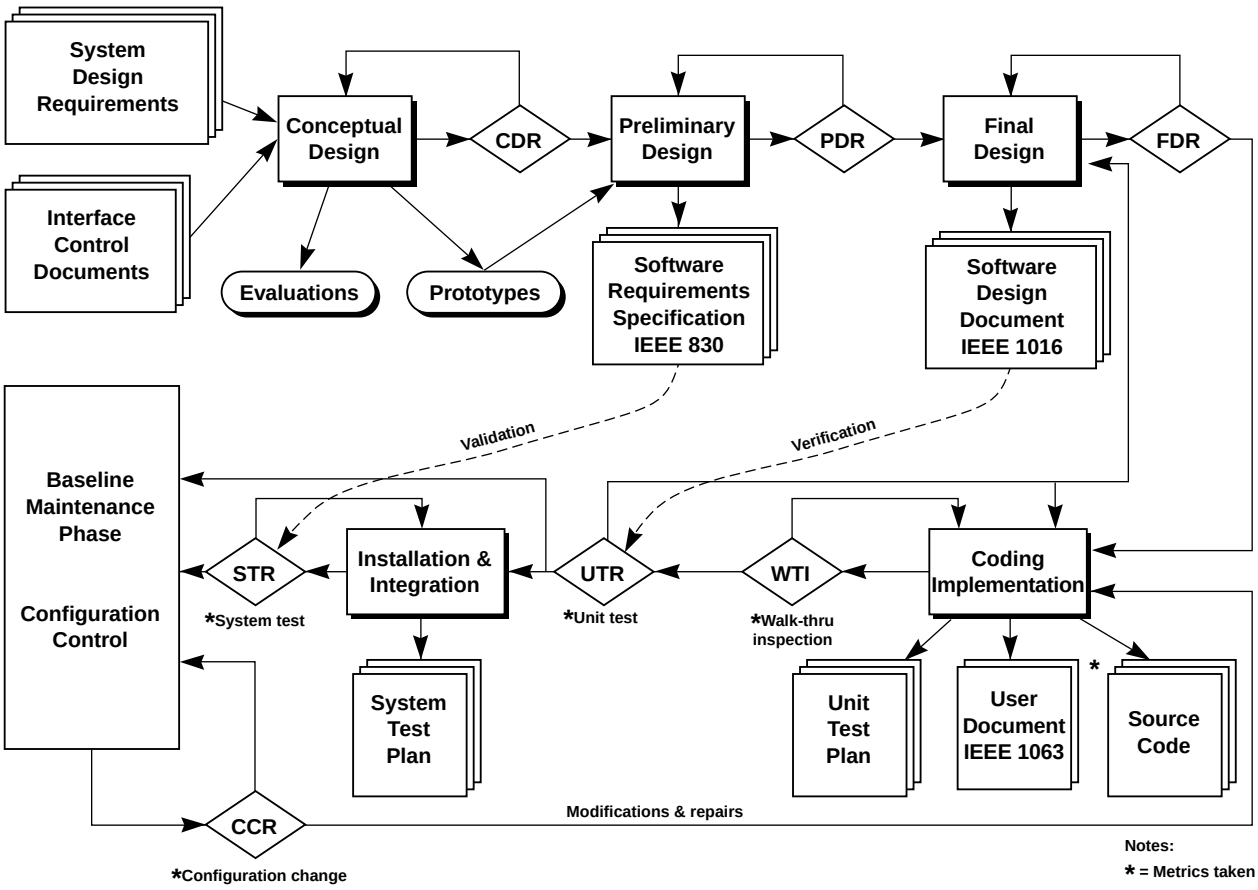


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Figure 1-1. NIF Software Project Engineering Process Flow.

### 1.2.4 Identification of ICCS Software

Computer software configuration items, consisting of the Computer Software Components (CSCs) listed here are part of the NIF Project:

1. An Integrated Computer Control System, comprising:
   - Supervisory Control software.
   - Front-End-Processor software.
   - Graphic user interfaces.
2. An operating system infrastructure.
3. Data resources.
4. The software tools and procedures required to construct, install, operate, maintain the ICCS.
5. A separate safety-related software subsystem for interlocks.

These components are further defined in the ICCS Work Breakdown Structure (WBS). Q-Levels (quality-assurance) are assigned according to *NIF Procedure 1.6, Assignment of Q-Levels*.

The primary NIF software applications are the Front End Processor (FEP) and Supervisory software programs existing within the WBS, as depicted in Figure 1-2. The principal interfaces among software components are also shown graphically in the figure. *Interface Control Documents* will specify these interfaces in greater detail.

The separate safety-related software subsystem that is contained in WBS 1.5.4, and which implements critical safety functions shall be independent of all the other software in the ICCS system.

Software is to be developed using standard compliant platforms. Where practical, components may be constructed by integrating commercial off-the-shelf (COTS) software. The *ICCS Project Schedule* describes in detail the plans and procedures for specifying, acquiring, testing, and integrating the NIF's software, including COTS.

Insofar as is practical, all code will be written in a manner that promotes its readability by future users. The NIF's software shall be developed using validated Ada compilers. In such applications where using Ada is not practical, the Integrated Computer Control Systems Lead Engineer must approve an alternate language through the design review process.

## 2.0 Personnel Training and Qualifications

The second criterion of the NIF's QAPP requires that:

- Trained personnel are assigned to the correct tasks.
- Continued training is available, to ensure proficiency.

ICCS personnel who manage, perform, or verify activities affecting quality must receive the appropriate orientation and training for doing their assigned work. The degree and amount of training required is determined by organization managers and supervisors, in accordance with *NIF Procedure 2.2, Personnel Training and Qualification*. Additional technical training for ICCS personnel shall be identified and accomplished as needed.

The training of subcontractor personnel is verified by examining personnel qualification records, observations of work in progress, and/or assessing the product output using the testing and inspection activities discussed in Section 7.0 of this document.

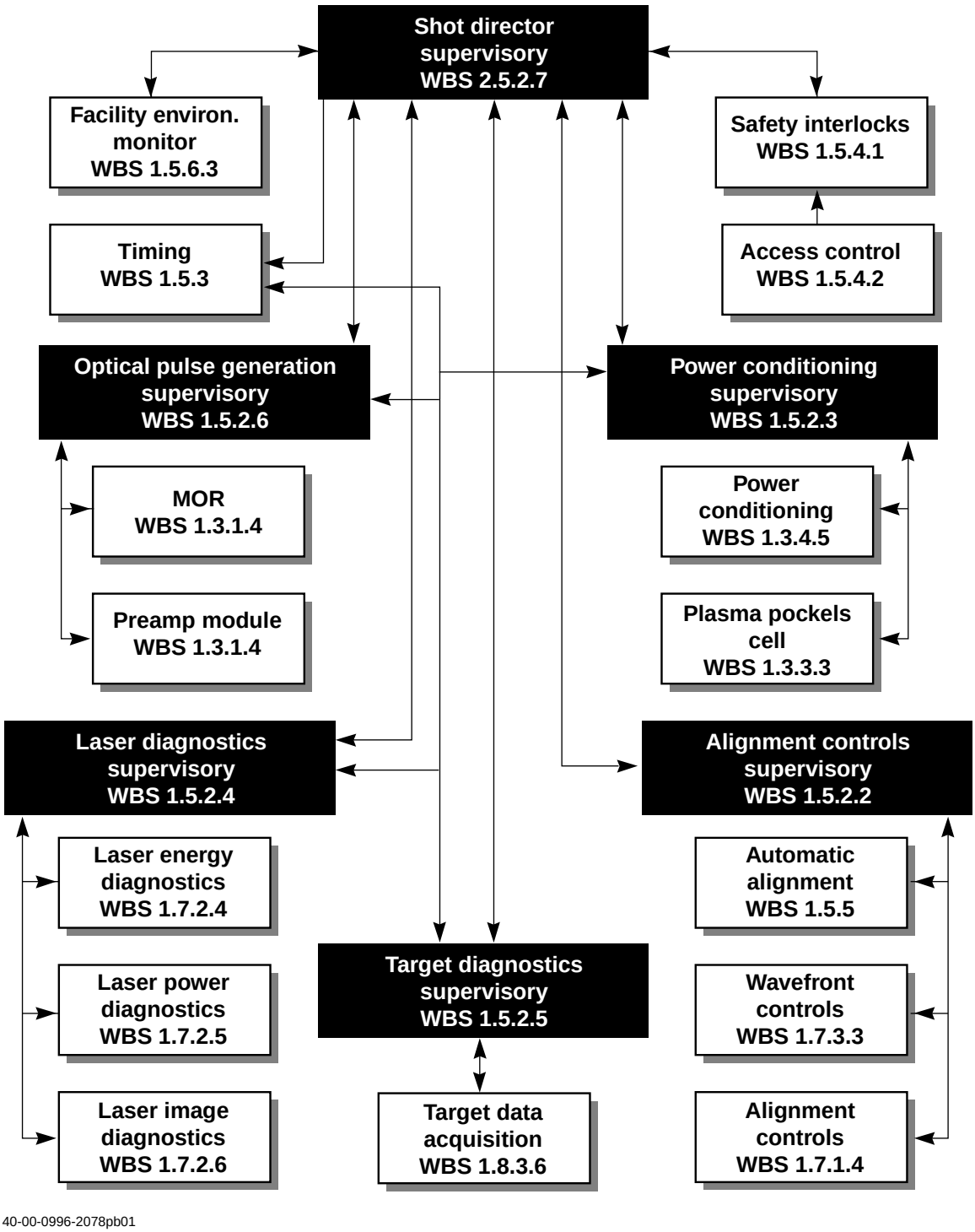



Figure 1-2. Work Breakdown Structure of the ICCS's Software Components.

# 3.0 Quality Improvement

The third criterion of the NIF's QAPP requires that processes be implemented to:

- Detect and prevent problems.
- Identify, control, and correct items and activities that do not meet specified requirements.
- Identify the root causes of problems, to prevent their recurrence.

## 3.1 Project Management Reviews

Routine (informal) reviews of the design are planned for the ICCS organization. A discussion of design activities during Title I can be found in the *NIF Title I Design Plan*, L-20357-1, NIF-95-650. Project design reviews are conducted according to the *NIF Procedure 5.1, Rev 1, Title I Design Review,* which is the formal design review procedure for ICCS throughout the life of the Project.

## 3.2 Control of Nonconformances

Each person in the ICCS organization is authorized to identify conditions adverse to quality, and has the responsibility to report them to the appropriate management using a *Nonconformance Report* (NCR), according to *NIF Procedure 3.2, Nonconformance Reporting*. Deficient conditions will be investigated and dispositions will be determined by the appropriate technical authority. The Software Architect is responsible for resolving these problems.

Deficiencies identified by inspections, assessments, or other reviews are also reported on NCRs, which shall periodically be analyzed for possible trends, in order to identify opportunities for improving quality.

## 3.3 Corrective Action

As part of the nonconformance-control process, consideration is given to root causes and generic implications, and corrective action is taken according to the established methods of that process. When necessary, further action may be taken to prevent recurrence of significant reported deficiencies.

### 3.4 Performance Measurement

Performance standards for software activities are established in the procedures that govern the work. Compliance information is collected and analyzed through the nonconformance/corrective action processes described above. This process provides the necessary feedback information for ICCS technical personnel to address problems commensurate with assigned Q-Levels, the degree of importance, and frequency of occurrence.

## 4.0 Document and Record Controls

The fourth criterion of the NIF's QAPP requires that controls be implemented to:

- Manage, control, and maintain documents that describe processes, specify requirements, or establish designs.
- Manage, control, and maintain records that provide evidence of quality.

A system of managing records and documents that allows retrieving pertinent Project files has been established by the Project in *NIF Procedure 4.1, Document and Records Control*. The approved process of managing the Project's correspondence is described in *NIF Project Procedure 4.2, Control of Project Correspondence*. These procedures apply to controlling the documentation for all work on the NIF Project, including that of the ICCS organization. Subcontractors and suppliers are also required to furnish information describing their document and record controls.

Furthermore, the NIF Project Office uses specialized commercial product-data-management software in its configuration-management and engineering-change control processes. This software is located on a server connected to the Project's computer network, and can access several databases. The data in this system are managed according to the controls described in *NIF Procedure 6.4, Configuration Data Management*.

The ICCS documentation controlled by the procedures just referred to is associated with the development and furnishing of software for the NIF, and is described in Section 5.0 of this document.

## 5.0 Work Processes

The fifth criterion of the NIF's QAPP requires that controls be implemented to:

- Perform work to established technical standards.
- Use approved procedures or other appropriate means to control the work being done.

- Identify and control items and activities, to ensure their proper use and prevent damage or loss.
- Calibrate and maintain the equipment used for monitoring and data collection.

This section defines the work process controls and documentation governing the developing, testing, verifying and validating, using, and maintaining the ICCS software. The ICCS organization will develop and document such organization-specific work controls as are needed.

## 5.1 Design Documentation

This subsection identifies the required documents and describes their functions. Each of these documents or segment of a document is required for the overall system and for each CSC that is identified in Subsection 1.2.4 of this document.

### 5.1.1 System Design Requirements

The *System Design Requirements* (SDR) document, SDR004 - Controls, specifies the performance functions and requirements for the ICCS, which are needed for installing, operating, and maintaining the NIF. The requirements for the supervisory software are further refined in *NIF SSDR 1.5.2 Supervisory Control Software Subsystem Design Requirements*. The SDRs are prepared according to *NIF Procedure 6.1, Preparation and Revision of System Design Requirements*.

### 5.1.2 Software Requirements Specifications

Software Requirements Specification (SRS) documents, or Subsystem Design Requirements (SDR) documents, describe each of the essential requirements (such as functions, performances, design constraints, and attributes) for the software and the external interfaces. The SRSs are written to comply with *ANSI/IEEE Standard 830-1984, IEEE Guide to Software Requirements Specification*. This states that:

"A good SRS is;

1. Unambiguous
2. Complete
3. Verifiable
4. Consistent
5. Modifiable
6. Traceable
7. Usable during the operation and maintenance phase."

System Requirements Specification documents are subordinate to the SDRs and SSDRs and are prepared to document the detailed software requirements of subsystem elements.

### 5.1.3 Interface Control Documents

Interface Control Documents (ICDs) accompany the SDRs and SRSs and make explicit the assumptions that the software-component designer and the controlled-component designer (e.g. power supply, diagnostic instrumentation) make about each other's designs. ICDs are prepared according to *NIF Procedure 6.2, Preparation and Revision of Interface Control Documents*.

### 5.1.4 Software Design Descriptions

Software Design Descriptions (SDDs) depict how the software is structured to satisfy the requirements stated in the SRSs for all components and sub components, including databases, and internal interfaces. The SDDs are written to comply (where possible) with the *ANSI/IEEE Standard 1016-1987, IEEE Recommended Practice for Software Design Descriptions*. Wherever possible, SDDs are represented in a machine-readable form for ease of archiving and reproduction.

### 5.1.5 Software Verification and Validation Plan

An ICCS organization *Software Verification and Validation Plan* will be written to identify and describe the methods (such as inspections, analyses, demonstrations, and tests) to be used to verify at least that:

- All SRSs and SDDs have been identified for the NIF Project, and have been reviewed and approved by the appropriate technical authorities and reviewing bodies.
- Requirements defined in the SRS are implemented in the design.
- Design attributes expressed in an SDD are implemented in the code.
- The code, when executed, complies with the requirements defined in the appropriate SRS.

### 5.1.6 User Documentation

A User / Operator Manual will be written and will describe the system's operation. It will specify the required operator inputs, the output sequences that the programs generate, and the activities necessary for the successful start-up, use, and shutdown of the system. The User / Operator Manual will be written in compliance with *ANSI/IEEE Standard 1063-1987, IEEE Standard for Software User Documentation*. When the interface used by the operator employs a graphic interface for interaction, on-line help should be available to convey significant instructions to the operator, so that reference to printed documentation is less frequently needed. All error messages shall be identified and all corrective actions shall be described in the User / Operator Manual.

The principal user of FEP software is the programmer who implements the software in the supervisory computer. The documentation for FEP software specifies the interface in the I / O-Library, which is provided by the FEP for invocation by the supervisor.

## 5.2 Standards and Practices

This section identifies the standards, practices, conventions, and metrics to be applied in ICCS activities. It also states how compliance with these standards is monitored and assured.

### 5.2.1 Documentation Standards

Reviews and audits of each activity include checking the documentation described in Section 5.1 of this document for completeness and clarity.

### 5.2.2 Implementation Standards

The Software Productivity Consortium's document, *Ada Quality and Style*, is the standard for ICCS software written in Ada. It provides appropriate guidelines for program structure, coding style, and in-line comments. Languages other than Ada may be used when necessary. The decision to depart from Ada binds the implementation to an appropriate set of standards for that language.

Documentation for the ICCS software system consists of system block diagrams, data flow diagrams, data dictionaries, object interrelationship drawings, and complete Ada (or alternate language) sources. Every source-code file shall contain header documentation that includes at least the following identifying information:

- Name of the component.
- WBS number.
- Name of the original author.
- Copyright information: Originating organization. Date of initial copyright.
- Relation to other components.
- Interface description.
- Overview of use.
- Block of revision entries. (An entry for every revision after baselining.)

The code shall be inspected during assessments or audits conducted by qualified inspectors designated by the Software Architect to verify that the software and its documentation are complete, correct, and internally consistent.

### 5.2.3 Measures and Metrics

Measures and metrics may be selected to measure the quality of software products and to promote improvement in the process by which software is constructed. The measures and metrics to be chosen follow *IEEE Standards 982.1, Standard Dictionary for Measures to Produce Reliable Software*, and *982.2, Guide for the Use of IEEE Standard Dictionary for Measures to Produce Reliable Software*. When selected, these metrics are applied according to guidance in the *LLNL Software Guidelines Standards, Practices, and Conventions*, Applications Development Dept.

The metrics considered for application at the several phases in the process are:

- Source Code metrics:
  —Number of lines of source code.
  —Number of modules and module size.
- Walk through inspection metrics:
  —Number of lines of code inspected.
  —Number and kinds of flaws identified.
    For each flaw: in which development phase did the flaw arise?
- Unit test metrics:
  —Number of units tested.
  —Number of tests executed.
  —Number and kinds of flaws identified
    For each flaw: in which development phase did the flaw arise?
- System test metrics:
  —Number of units tested.
  —Number of tests executed.
  —Number and kinds of flaws identified.
    For each flaw: in which development phase did the flaw arise?
- Configuration change metrics:
  —Source of the change request.
  —Estimated cost of implementing the change.
  —Number of modules modified to accomplish the change.
  —Actual cost to accomplish the change.
  —Reference to the source and testing metrics generated by the change.

# 6.0 Design

The sixth criterion of the NIF's QAPP requires that project designs:

- Use accepted engineering principles.
- Incorporate approved design bases and requirements into the design work.
- Verify design basis with personnel who did not perform the work.
- Validate the design work before it is approved and implemented.

## 6.1 Design Criteria Preparation and Control

The development and documentation of design criteria, design interfaces, and design descriptions are to be done in accordance with industry standards and NIF Procedures described in Subsections 5.1.1 through 5.1.4 of this document.

## 6.2 Design Verification

This section defines the technical and management reviews, assessments, and audits that will be conducted to verify the adequacy and accuracy of ICCS software designs. These reviews will be supplemented by less formal walk throughs that will occur throughout the software development process.

Formal reviews include design presentations that allow participants to review and comment on software products. Review participants include representatives of NIF's Project management, the software development team, software tester, and end users, as described in the *Design Review Plan* described in *NIF Procedure 5.1, Title I Design Review,* which is the formal design review procedure throughout the life of the project. Reviews and assessments of ICCS software are conducted as described in the following paragraphs.

### 6.2.1 Conceptual Design Review

The conceptual design review will be held early in the design process and will cover the requirements specification, initial constraints, and the approach planned for meeting the requirements. This review addresses the plan for prototyping important elements of the design, including alternatives, uncertainties, and schedule and cost estimates.

### 6.2.2 Preliminary Design Review (Title I)

The preliminary design review will be held to ensure the adequacy, accuracy, and completeness of the SRS, to review the results of evaluations and prototyping, the design approach for the final design, and cost and schedule estimates. It is conducted in accordance with *NIF Procedure 5.1, Title I Design Review*.

### 6.2.3 Final Design Review (Title II)

The final design review is held to determine whether the detailed software design acceptably satisfies the requirements of the SRS. The final design review will be conducted in accordance with the appropriate Design Review Plans described in the latest version of *NIF Procedure 5.1, Title I Design Review*.

### 6.2.4 Software Release Design Reviews (Title III)

The ICCS software is planned to be released in several increments in order to deliver needed functionality in a timely manner, and to permit iterative development practices to be followed. Software release design reviews will be conducted in accordance with the appropriate Design Review Plans described in the latest version of *NIF Procedure 5.1, Title I Design Review*.

### 6.2.5 Software Upgrade Design Reviews (Operations)

The ICCS software will be maintained and upgraded for the operating lifetime of the NIF. In order to preserve the quality of the maintained software, any changes to the

software and related imports will be reviewed according to the latest revision of *NIF Procedure 6.4, Engineering Change Requests*.

### 6.3 Configuration Management

The NIF Project Configuration Management Plan, (L-21635-1, NIF-LLNL-96-070) describes Project-wide methods of controlling system configuration. Implementation of this Plan applies to all Project work, including that of the ICCS organization. The Configuration Management Plan describes the relations among the Project's baselines, design controls, physical audits and assessments, and the change management process.

ICCS-software-specific configuration information is provided below and in the document: *NIF Procedure 6.5, Software Configuration Management*. Software configuration items are identified by the WBS item that owns them. A configuration item is given a unique identifier when it achieves baseline status; that identifier remains permanently with that unique software component. The identifier consists of the WBS number, the name of the component, and a version number.

Each configuration item that is an executable program and is part of the installed NIF control system shall be capable of identifying itself during execution. This run-time identification will enable users to determine unambiguously what source files (and other configuration items) were employed in building the executable program.

The Apex program development system from Rational Software Corporation will be used as the software configuration management tool. Every controlled configuration item shall retain its unique identity for the life of the NIF. Items that become obsolete may cease to be part of the active equipment, but will retain their existence for historical and auditing purposes.

Software developers use specific information in the *Software Configuration Management Procedure* to manage versions of the software as they are completed. Systems are backed-up on a regular basis; periodically, backup media are saved at a separate physical site to protect the growing software investment.

## 7.0 Procurement

The seventh criterion of the NIF's QAPP requires that procurement controls be implemented to:

- Ensure that purchased products and services meet established requirements.
- Evaluate and select suppliers on the basis of specified criteria.
- Ensure that suppliers continue to provide acceptable products and services.

The NIF Acquisition Plan (L-16865-2, NIF-LLNL-96-062-1) describes the schedule, contracting plan, and method of vendor selection for NIF procurements.

*NIF Procedure 7.2, Standard Procurement Policies and Practices*, describes the controls to be used for NIF procurements.

*NIF Procedure 7.1, Procedure for Supplier Qualification*, describes the process for evaluating and qualifying suppliers and subcontractors.

Verifying supplier compliance with the quality requirements of Q-Level 1 and 2 software components is done by qualified ICCS personnel, in accordance with *NIF Procedure 7.3 Vendor Surveillance*. This activity may include source inspections and reviews of suppliers' records to verify achieving quality at the source. Compliance with quality requirements of Q-Level 3 components during production will be verified by vendor certification, or other means.

The software that will be acquired from commercial vendors includes the operating system, computer-aided software engineering tools, database system, user interface builders and environment, and a validated Ada compiler.

After these systems are delivered, any upgrades or new-version releases of vendor-supplied software will be evaluated by the NIF software development team. The ICCS Lead Engineer recommends to the NIF Project whether or not the system needs to incorporate upgrades or new versions. When an upgrade or new version is incorporated into the ICCS, all relevant acceptance tests will be rerun to ensure that no defects have been introduced into the system.

# 8.0 Inspection and Acceptance Testing

The eighth criterion of the NIF's QAPP requires inspection and testing processes be implemented that:

- Use established acceptance and performance criteria to conduct inspection and acceptance testing.
- Calibrate and maintain equipment used for inspections and tests.

Teams made up of software implementers and component engineers will test the NIF Project software in accordance with the *NIF Software Test Plan* and the *NIF Software Verification and Validation Plan*. The testing includes component (unit) testing, and integration and system acceptance testing.

Unit testing will be done by the NIF software development team in accordance with the unit test specification. Integration testing and software system testing will be done by ICCS test team members. Acceptance Testing is to be done by selected NIF personnel after the system is delivered to the operations and maintenance staff. The NIF software development organization will support acceptance test activity. The following test documentation containing requirements and specific details is to be provided for each CSC (identified in Section 1.2.4 of this document):

- Unit Test
  —Write:
    Unit Test Specification (from the Unit Design Specification).
    Unit Test Report.
  —Perform:
    Unit Tests.
- Integration Test
  —Write:
    Subsystem Integration Test Specification (from the Subsystem Design Specification).
    Subsystem Integration Test Report.
  —Perform:
    Subsystem Integration Tests.
- System / Acceptance Testing
  —Write:
    System Integration Test Report.
    Acceptance Test Specification.
  —Perform:
    System Integration Tests (from the Requirements Specification).
  —Validate Required Capabilities:
    Hardware faults / failures.
    Communications and inputs / outputs.
    Transactions.
    Performance.
    User / Operator Manual(s).

## 9.0 Management Assessment

The ninth criterion of the NIF's QAPP requires that managers:

- Periodically assess all levels of the integrated management system.
- Identify and correct problems that are keeping the Project from achieving its objectives.

The ICCS organization participates in periodic self-assessments conducted by the NIF Project Manager, Project Engineer, and / or the Associate Project Engineer for Special Equipment. The Systems Control Manager, ICCS Lead Engineer, and Software Architect may independently determine the need to evaluate ongoing activities within

the organization, regardless of other Project assessments. When so determined, internal assessments are conducted using *NIF Procedure 9.2, Management Self-Assessments*, for guidance.

# 10.0 Independent Assessment

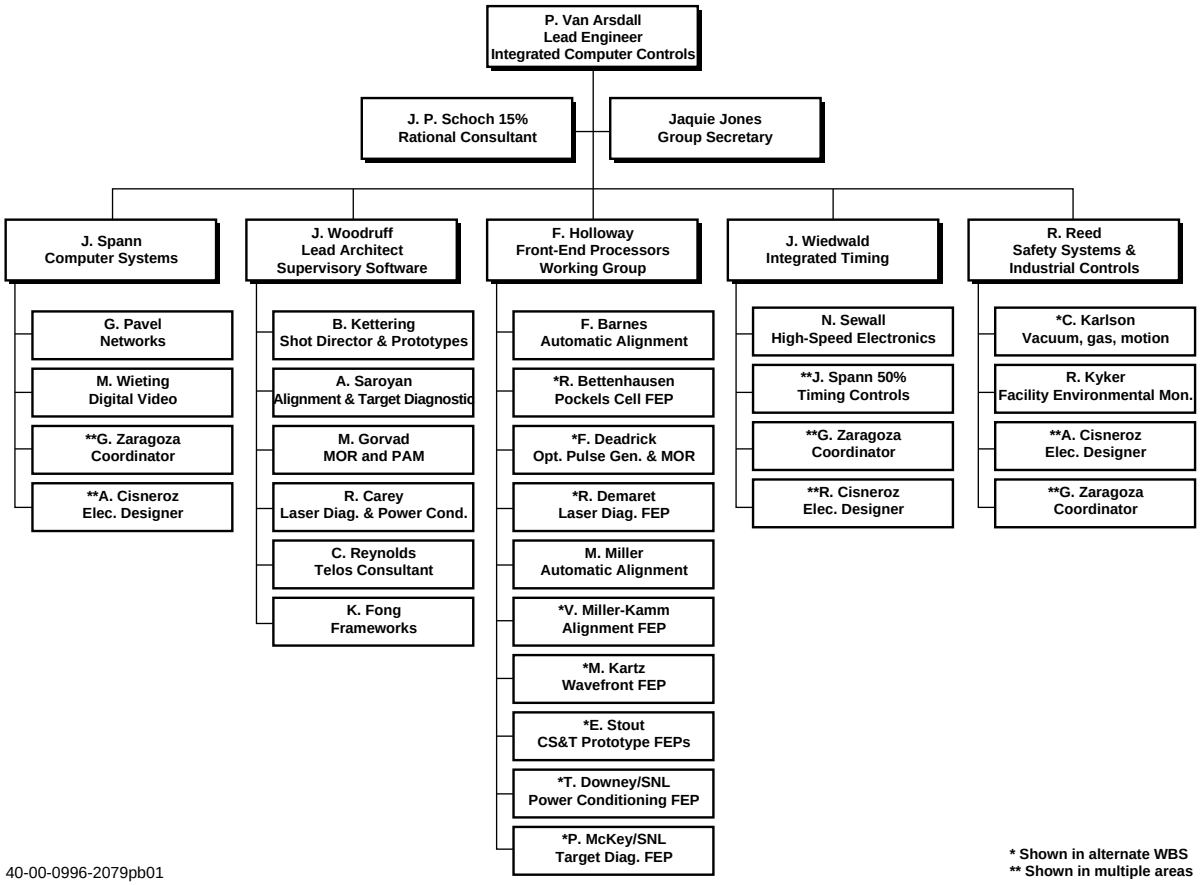
The tenth criterion of the NIF's QAPP requires that processes be implemented to:

- Plan and conduct periodic independent assessments to measure effectiveness.
- Provide sufficient authority and freedom for the independent organization to conduct its assessments.
- Ensure that the personnel conducting the independent assessments are technically knowledgeable in the area being assessed.

The NIF Project QA organization will schedule, plan, and conduct periodic assessments, audits, and other reviews to evaluate the line organizations' achievement of requisite quality objectives. This system of QA oversight is designed to advise management of potential problems, and makes use of technically knowledgeable advisors working with QA evaluators to focus on the effectiveness of the Project's QA program, its performance, and its results.

Independent assessments of the ICCS organization's activities are conducted in accordance with *NIF Procedure 10.1, Independent Assessments*.

# Appendix A. ICCS Table of Organization.




NIF Computer Controls Engineering Organization for Title I

# Appendix B. Implementing Documents.

| QA Program Criteria | ICCS Implementing Documents |
|---|---|
| 1. Program | • This SQAP document<br>• NIF Project Control Manual, NIF-96-041, L-21254-1<br>• NIF Procedure 1.6, Assignment of Q-Levels |
| 2. Personnel Training and Qualification | • NIF Procedure 2.2, Personnel Training and Qualification |
| 3. Quality Improvement | • NIF Procedure 3.2, Nonconformance Reporting |
| 4. Documents and Records | • NIF Procedure 4.1, Document and Records Control<br>• NIF Procedure 4.2, Control of Project Correspondence<br>• NIF Procedure 6.4, Configuration Data Management |
| 5. Work Processes | • NIF Procedure 6.1, Preparation and Revision of System Design Requirements<br>• ANSI/IEEE Std 830-1984, IEEE Guide to Software Requirements Specification<br>• NIF Procedure 6.2, Preparation and Revision of Interface Control Documents<br>• ANSI/IEEE Std 1016-1987, IEEE Recommended Practice for Software Design Descriptions<br>• ANSI/IEEE Std 1063-1987, IEEE Standard for Software User Documentation<br>• Ada 95 Quality and Style, Department of Defense, Ada Joint Program Office, SPS-94093-CMC, October 1995<br>• ANSI/IEEE Std 982.1, Standard Dictionary for Measures to Produce Reliable Software<br>• LLNL Software Guidelines Standards, Practices, and Conventions - Applications Department |
| 6. Design | • NIF Procedure 5.1, Title I Design Review<br>• NIF Project Configuration Management Plan, NIF-96-070, L-21635-1<br>• NIF Procedure 6.5 Software Configuration Management |
| 7. Procurement | • NIF Acquisition Plan, NIF-96-062-1, L-16865-2<br>• NIF Procedure 7.1, Procedure for Supplier Qualification<br>• NIF Procedure 7.2, Standard Procurement Policies and Practices<br>• NIF Procedure 7.3, Vendor Surveillance |
| 8. Inspection and Testing | • NIF Software Test Plan<br>• NIF Software Verification and Validation Plan<br>• NIF Procedure #TBD, Control of Measuring and Test Equipment<br>• Unit Test Specification<br>• Subsystem Integration Test Specification<br>• Acceptance Test Specification |
| 9. Management Assessment | • NIF Procedure 9.2, Management Assessments |
| 10. Independent Assessment | • NIF Procedure 10.1, Independent Assessments |