SNS-OPM 9.A-2
SNS System, Structure, Component or Software Development Procedure

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SNS-OPM Editor

SNS-OPM 9.A-2
SNS System, Structure, Component or Software Development Procedure

1. Purpose

This procedure defines the process and rules for ensuring that the design of SNS designed equipment and software is technically adequate and that the resulting systems or components will be fit for their intended purpose as required by SNS-QA-P01, SNS Quality Manual. This procedure implements parts of SNS-QA-P01, SNS Quality Manual. The general process flow is presented in Attachment A.

1.1 Introduction

Designing a new Structure, System, Component or Software (SSCS) involves several steps from the identification of a design need to the issuance of the final design documents. In general, these steps include:

- determining what the item is to do (function), physical restraints (fit), and other requirements (form) and listing them in a Design Criteria Document (DCD).
- exploring alternative schemes to meet the DCD requirements.
- developing the most promising scheme into a Conceptual Design.
- developing the conceptual design into a semi-detailed Preliminary Design.
- detailing the preliminary design into a Final Design suitable for fabrication.
- fabrication or procurement of the SSCS.
- pre-installation testing.
- installation testing and integration.
- acceptance and documentation.

1.2 Scope

This procedure defines the process for developing designs and performing appropriate reviews for the design of equipment and software. This procedure describes a policy for establishing and maintaining consistency of a configuration control at the SNS. This procedure applies to ISD, CEMD, BSMD, QCMD, NDAV, RAD and Site Services.

1.3 Graded Approach

Depending on the complexity of the equipment and the experience of the design team, the degree of formality of the stages and the extent and independence of the reviews should match the risks of failure associated with the design. A Design Review Plan shall be developed by the Design Engineer and approved by the relevant Group Leader.

2. Responsibilities

2.1 All ISD, CEMD, BSMD, QCMD, NDAV, RAD and Site Services personnel shall follow this Design Development Procedure when designing equipment and or software.

3. Prerequisites

3.1 None.

4. Precautions

4.1 None

5. Procedure

5.1 Identify the Need for a New Design

5.1.1 The need for a new SSCS may be identified from any source.

5.2 Begin the Design Criteria Document

A Design Criteria Document (DCD) is to be generated for the top level structure, system, component or software (SSCS). It may be as complex or simple as necessary to fully capture the essential SSCS requirements. The degree of formality of the DCD and the level of required approvals for the DCD are part of the graded approach based on the complexity and importance of the item. Attachment E provides some guidance for determining an appropriate DCD and its approval.

5.2.1 System Requirements and Interfaces - Technical Content.

The DCD describes the physical and functional requirements of an SSCS. The DCD should address the following topics:

- *General Description* – Give an overall description of the equipment to be designed. If possible, give reference to a similar component previously designed and highlight areas for improvement.
- *Performance or Capabilities* – List the desired performance and capability goals of the component or system to the extent currently known or envisioned. The functional statements should include requirement areas of operations, maintenance, and a comparison to existing components, with special consideration to As Low As Reasonably Achievable (ALARA) design principals.
- *Interface Requirements* - These requirements include sufficient detail to establish the criteria or limits within which the actual component must fit and function, including a list if interfaces to other systems.

- *Specific Standards* - These include the Codes, Standards, Regulations, and needed discipline (electrical, mechanical, nuclear, fire, radiation control, etc.) requirements to which the component or system must comply. A listing of the ORNL Design Codes and Standards that serve as a basis for the design development of ORNL facilities and is listed under SBMS Subject Area – Design Codes http://sbms.ornl.gov/sbms/SBMSearch/subjarea/design/ExhibitCodes.cfm

Attachment B is a Project Element Screening form. It is a checklist that considers many elements that may or may not influence the design of a component. The checklist of project elements should be useful in developing the DCD.

5.2.2 Project Execution Requirements

These consist of schedule milestones and funding profiles. There may be other administrative requirements such as procurement restrictions that will limit later design considerations.

5.2.3 Design Acceptance Criteria

The DCD shall also establish technical benchmarks for evaluating the derived design. The acceptance criteria usually consist of performance comparisons with existing facilities or specific testing protocols measuring the specific attributes called out in the DCD.

5.2.4 Review and Approvals

Attachment E provides some guidance as to who must review and approve the DCD.

5.3 Screening for Potential Unreviewed Safety Issues

5.3.1 As part of the conceptual design review process, the design shall be screened for potential Unreviewed Safety Issues (USI) using the USI Determination (USID) form (SNS-OPM-ATT 2.B-10.a).

5.3.2 If the USID indicates that a USI does not exist, then retain the USID in the design package and proceed with the design process.

5.3.3 If the USID indicates that a USI does exist, then retain the USID in the design package and proceed with processing the design package through the USI approval process in accordance with USID procedure (SNS-OPM 2.B-10).

5.4 Design Research and Development of Options

5.4.1 It is worth the time spent in researching if some form of the basic desired SSCS exists either at some other facility or in available product literature. One should be able to find some information that can serve as a basis for developing alternative conceptual approaches and initial cost estimates.

5.4.2 Design Options shall be developed from the research and independent ideas and be used as the basis of the selection of the Conceptual Design.

5.5 Conceptual Design

The conceptual design is an integrated concept that addresses all of the process functional requirements. The conceptual design is usually documented as a PowerPoint presentation that shows process flow components with only preliminary dimensioning corresponding to available space limitations. The conceptual design is supported by only top level drawings or diagrams with enveloping dimensions and possible typical hardware/software outlines at this stage of development. There may also be some scoping calculations to support critical aspects of the conceptual design. A bounding cost estimate and schedule should be developed as that may impact future design details or options.

5.5.1 Design Grade Classification

Design reviews and authorization shall be made utilizing a tailored approach depending on the significance of the SSCS being designed. The Classification Grades and their respective required approval lists are described in Attachment E

5.5.2 Conceptual Design Review

The conceptual design review should have a reasonably diverse group of reviewers who have expertise in the type of SSCS represented by the presented concept. Additional subject matter experts should be involved for those aspects such as fire safety, industrial safety, waste handling, hoisting and rigging, etc. as appropriate to the concept. The chair of appropriate safety and configuration control committees shall be notified of the Conceptual Design Review so that the committee can be represented at the review.

The completed Attachment B Project Element Screening form contains discipline areas that should be looked at during the review.

The goal of the conceptual design review is to identify all of the significant technical challenges and issues

5.5.3 Conceptual Design Review Records

Records of the conceptual design review comments, observations, and suggestions need to be kept and each item addressed as to why it was or was not incorporated into the conceptual design. ORNL Form 242, Design Review Record and 242A, DRR Continuation (Attachment D) or similar format should be used to document review comments and their disposition. Upon completion of the comment cycle, the Design Engineer and their management should be able to agree that the concept, as now modified, is workable and the design effort made to advance to a preliminary detailed design based on this concept.

5.6 **Preliminary Design (30-50%)**

Based on the approved conceptual design, the next step is to start putting some level of detail into the concept. The goal is to have all of the key technical issues identified and solutions found for them. These may not be optimal solutions, but they should be workable. There should be sufficient detail that the ability to fabricate the concept is confirmed and that there is sufficient supporting data that shows it will meet intended form, fit and function. In the continuing process, the cost estimate should be refined to reflect the solutions for technical issues.

5.6.1 Design Analysis and Calculations (DAC)

Determining the capability of the conceptual components will require some design analyses or calculations. All assumptions shall be clearly stated. The DAC shall be reviewed by an appropriate individual knowledgeable in the discipline and not directly involved in the preparation of the DAC. The DAC shall be approved by the Design Engineer's Group Leader. The DACs shall be formally assigned project identification numbers and filed in the Document Control Center (DCC)

5.6.2 Preliminary SSCS Specification

There should be sufficient information and supporting data available that an initial draft of the SSCS specification can be created. The creation is simplified through the use of standard formats, data from the DCD, and the Power Point assembly drawings from the Conceptual Design.

5.6.3 Preliminary Design Review(PDR)

The PDR should have reviewers that have expertise in the type of equipment represented by the presented design. The use of outside independent reviewers is desired. Additional subject matter experts should be involved for those aspects such as fire safety, industrial safety, waste handling, hoisting and rigging, etc. as appropriate to the design. A representative of the customer (or end user) should be part of the review team. The chair of the appropriate safety and configuration control committees shall be notified of the Preliminary Design Review so that the committee can be represented at the review.

The completed Attachment B Project Element Screening form contains discipline areas that should be looked at during the review.

The goal of the PDR is to identify any design details that may have been overlooked or any potential difficulties in developing the design to the point of release for fabrication.

5.6.4 PDR Records

Records of the PDR comments, observations, and suggestions need to be kept and each item addressed as to why it was or was not incorporated into the detailed design. ORNL Form 242, Design Review Record and 242A, DRR Continuation (Attachment D) or similar format should be used to document review comments and their disposition. Upon completion of the comment cycle, the Design Engineer and their management should be able to agree that the design, as now modified, is workable and that the design is sufficiently advanced to be released to the Final Design phase.

5.7 **Final Design (90-100%)**

The final design should contained optimized solutions for technical issues and design documentation ready for release to fabricate with a high degree of confidence that it will fully perform its intended function, work within all constraints and meet all interface requirements. The cost estimate should be refined to a point that it serves as one basis for proposal evaluations.

5.7.1 DAC Updates

The final design should be reviewed for changes from the preliminary design that may have impacted any supporting DACs or require additional DACs. If any such changes are identified, then the supporting DACs shall be accomplished to support the detailed design. Some DACs cannot be performed until the final design phase due to their sensitivity to the details of the design. These should be performed and checked before the design is released for fabrication.

5.7.2 Finalized SSCS Specification

The SSCS specification should be updated to reflect the final design. The specification shall be routed for review and approval. The approved equipment specification shall be part of the Final Design Review (FDR) presentation.

5.7.3 Spares Plan

Each SSCS that is physical equipment shall have a recommendation for the type and number of spares to be obtained with the equipment. If the SSCS is being designed for the RAD, the number and type of spares shall be determined in a manner consistent with the SNS-OPM 9.B-1, the RAD Spares Management Policy. The Spares Plan shall be presented at the FDR.

5.7.4 Preventative Maintenance Plan

Each SSCS item that is physical equipment shall have a recommendation for the type and frequency of both preventative and predictive maintenance to be performed. The Maintenance Plan shall be presented at the FDR

5.7.5 FDR

The FDR should have reviewers that have expertise in the type of equipment represented by the presented design. Additional subject matter experts should be involved for those aspects such as fire safety, industrial safety, waste handling, hoisting and rigging, etc. as appropriate to the design. A representative of the customer (or end user) shall be part of the review team. The chair of the appropriate safety and configuration control committees shall be notified of the Final Design Review so that the committee can be represented at the review.

The completed Attachment B Project Element Screening form contains discipline areas that should be looked at during the review.

The goal of the detailed design review is to identify any design details that have been overlooked or any potential difficulties in fabrication of the design. If there are no significant design details outstanding, then the design may be released for procurement.

5.7.6 FDR Records

Records of the FDR comments, observations, and suggestions must to be kept and each item addressed as to why it was or was not incorporated into the approved design. ORNL Form 242, Design Review Record and 242A, DRR Continuation (Attachment D) or similar format should be used to document review comments and their disposition.

5.7.7 Reference Design

Once Action Items from the Final Design Review have been closed, the design becomes the Reference Design for the SSCS.

5.8 Configuration Control Committee(CCC) Reviews

Design reviews and authorization shall be made utilizing a tailored approach depending on the significance of the SSCS being designed. For proposed Grade 1 SSCSs, the CCC shall meet collectively. For Grade 2-4 SSCSs, proposed designs may be reviewed individually; however, it should be recognized that group interactions often provide a more thorough review and should be considered whenever possible. The Grades which require CCC review are shown in Attachment B. Locations in the timeline for CCC Reviews are show on the Flowchart, Attachment A.

The requirements on which to base these reviews include:

- Design of SNS equipment shall be based on sound engineering / scientific principles and appropriate standards
- Appropriate technical design reviews are successfully completed
- All issues uncovered during the technical reviews are sufficiently addressed
- Appropriate ALARA design principals have been adoptes and reviewed during the design process
- All affected Facilities and groups concur with the design
- Appropriate documentation is completed
- Status of test plans and procedures is satisfactory
- Adequate installation and fall-back plans are provided
- Special hazards, considerations and accommodations required for installation and testing are addressed
- Training requirements are addressed
- Requirements for additional spare parts are addressed
- Maintenance activities are addressed

5.9 **Design Implementation**

5.9.1 Fabrication, Procurement or Development: This includes procurement or fabrication of the SSC, development of Software, as well as vendor acceptance and fabrication oversight of the SSCS.

5.9.2 Tracking the SSCS: Prior to Pre-Installation Testing, equipment shall be recorded in the SNS Maintenance Management System (Datastream) and software shall be loaded into the appropriate software repository.

5.9.3 Pre-Installation Testing: A plan for pre-installation testing, where possible, must accompany each Design. The test plan shall be executed by a combination of the System Engineer, the Operating Engineer and others who they deem necessary. After the successful execution of the test plan, the plan shall be signed off by the System Engineer and the Operating Engineer. For Grade 1 and 2 SSCSs an additional CCC review must take place after the test plan has been completed and prior to installation.

5.9.4 Installation: Once the Pre-Installation tests have been successfully completed and reviewed by the CCC, the SSCS may be installed. Installation proceeds under the supervision of the Operating Engineer. At this time, the Operations Engineer assumes responsibility for operating the SSCS. At this time a level of documentation consistent with the operation of the SSCS must be available.

5.9.5 Acceptance Testing and Integration: Once the SSCS has been successfully installed, it must be tested and integrated horizontally and vertically, with the Integrated Control System in the Central Control Room, if applicable. The SSCS must be accompanied by sufficient documentation at this stage to enable testing and assure performance.

5.9.6 Acceptance and Final Documentation: At the end of the Integration process, the SSCS is Accepted and turned over to the proper Operations organization via a System Turnover form. This final step includes completion of the SSCS documentation.

6. Documentation

6.1 For Conceptual Design documentation, see Section 5.5.

6.2 For Preliminary Design documentation, see Section 5.6.

6.3 For Final Design documentation, see Section 5.7.

7. References

7.1 DOE O 420.2B, Safety of Accelerator Facilities.

7.2 DOE O 414.1C, Quality Assurance.

7.3 SNS-QA-P01, SNS Quality Manual.

7.4 SNS-QA-P60, SNS Design Processes.

7.5 SBMS Subject Area – Design
http://sbms.ornl.gov/sbms/sbmsearch/subjarea/design/sa.cfm

7.6 SBMS Subject Area – Design Codes
http://sbms.ornl.gov/sbms/SBMSearch/subjarea/design/ExhibitCodes.cfm

8. Attachments

8.1 **Attachment A:** DCD & Development Process Flow Chart.

8.2 **Attachment B:** Project Element Screening Checklist.

8.3 **Attachment C:** Mechanical Design Checklist.

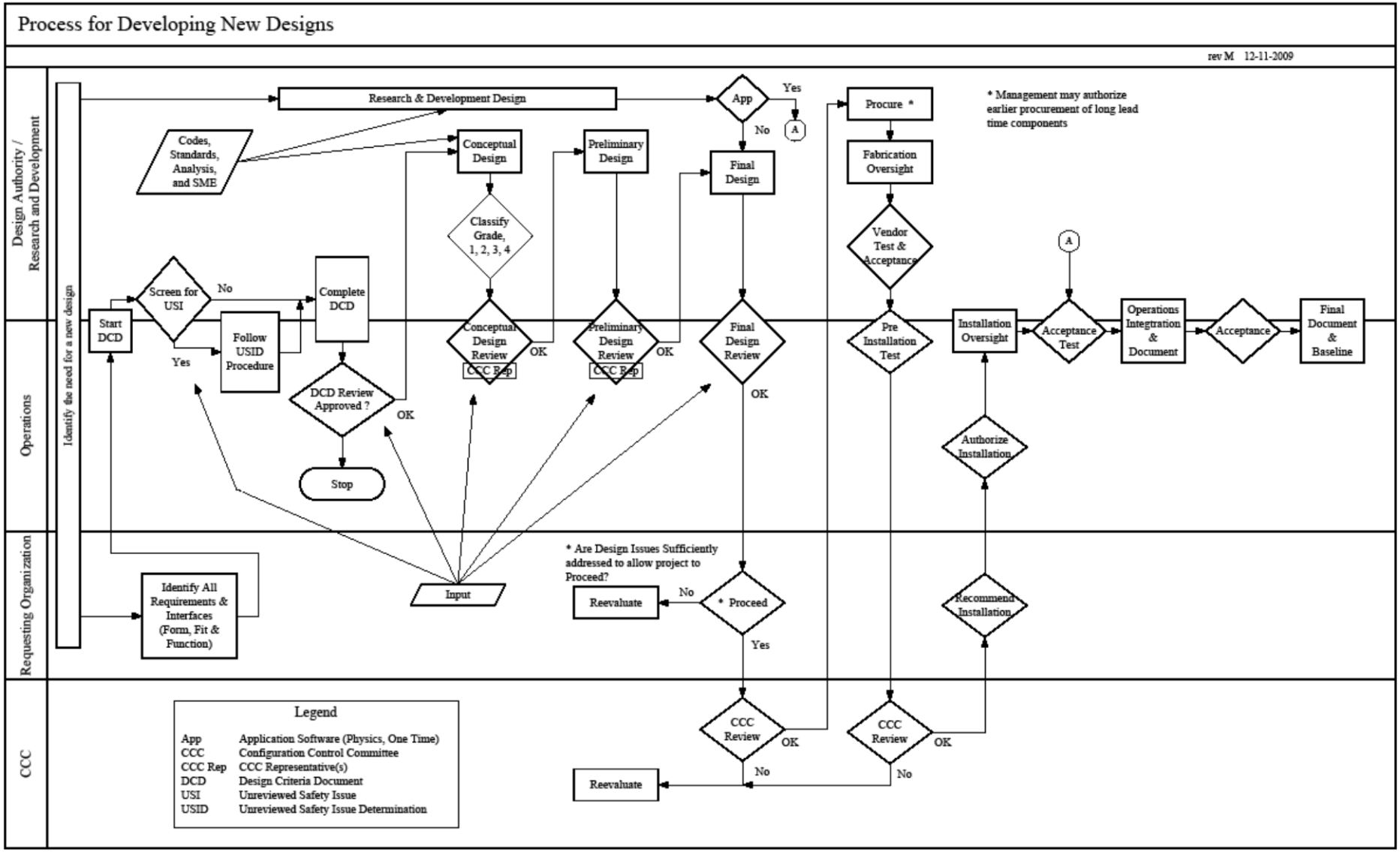
8.4 **Attachment D:** Design Review Record.

8.5 **Attachment E:** DCD Format and Approvals.

9. Revision History

- Rev. 02.1 February 10, 2015 – Triennial Review. Removed all signature blocks except SNS Operations Manager on signature page. Updated Division names for NFDD and NSSD to reflect current Division names. Minor editorial changes to format. Added **Section 9 - Revision History**.

ATTACHMENT A
DCD & Development Process Flow Chart



ATTACHMENT B
PROJECT ELEMENTS SCREENING CHECKLIST

TITLE OF PROJECT: _____

LOCATION OF FACILITY: _____

SCOPE: _____

_____

Check if Applicable:

[ ] FISSIONABLE MATERIALS

[ ] EXPLOSIVE / FLAMABLE MATERIALS

[ ] HAZARDOUS MATERIALS (Lead, Cadmium, Beryllium, Mercury, etc)

[ ] MAGNETIC FIELDS / NON-IONIZING RADIATION (RF, EMI, or Lasers)

[ ] EQUIPMENT RADIATION ENVIRONMENT ISSUES

- [ ] Material Activation Concerns
- [ ] Functional Life Issues

[ ] REQUIRED UTILITIES

[ ] Compressed Air	[ ] Gases	[ ] Cooling Water
[ ] Vacuum	[ ] Electrical Power	[ ] Process Water
[ ] Drains	[ ] Exhaust / Off Gas	[ ] Waste Systems

[ ] CONTROL SYSTEMS (SOFTWARE or HARDWARE)

[ ] DATA ACQUISITION SYSTEM

[ ] HUMAN INTERFACES

[ ] INTERFACES WITH OTHER DESIGN ORGANIZATIONS (Controls, Utilities, Safety)

[ ] ELEVATED WORK/PLATFORMS

[ ] SEISMIC REQUIREMENTS

[ ] FLOOR LOADING LIMITATIONS

[ ] HOISTING & RIGGING REQUIREMENTS

[ ] INTERFACES WITH MATING EQUIPMENT

[ ] FOOT PRINT CONSTRAINTS

[ ] INSTALLATION CONSIDERATIONS

- [ ] Pre-fabricated
- [ ] Site Built
- [ ] Crane Capacity
- [ ] Truck Access

[ ] APPLICABLE GOVERNING CODES AND STANDARDS

[ ] ASME B&PV [ ] DOT [ ] NFPA

[ ] EPA [ ] AWS [ ] OTHER

[ ] MATERIAL REQUIREMENTS

[ ] Non-Magnetic [ ] Corrosion Resistant [ ] Process Compatible

[ ] Forging [ ] Casting [ ] Heat Treated

[ ] Plated [ ] Coated [ ] High Density

[ ] SHIELDING REQUIREMENTS

[ ] Gamma [ ] Neutrons [ ] Magnetic

[ ] Thermal [ ] EMI [ ] Laser

[ ] MAINTENANCE ISSUES

[ ] Direct Access [ ] Remote

[ ] MAINTENANCE HAZARDS

[ ] Preventive Maintenance Hazards

[ ] Radiological [ ] Confined Space

[ ] Safety Work Permit [ ] Other Permits

[ ] Breakdown Maintenance Hazards

[ ] Radiological [ ] Confined Space

[ ] Safety Work Permit [ ] Other Permits

[ ] CONFINED SPACE

[ ] Permitted [ ] Non-Permitted

[ ] PRESSURE VESSELS / PIPING

[ ] VACUUM VESSELS / PIPING

[ ] LASERS

[ ] Above OSHA Limits PPE Class = [ ] Below OSHA Limits PPE Class =

[ ] HIGH VOLTAGE

[ ] HIGH CURRENT

[ ] CRYOGENICS

[ ] Liquids [ ] Closed Cycle

[ ] RADIOLOGICAL

[ ] Access Control

[ ] Engineered Restriction [ ] Administrative Restrictions

[ ] Shielding Issues

[ ] Activation [ ] Prompt Radiation [ ] Scatter

[ ] Background Contribution

[ ] Neutrons [ ] Gamma [ ] Adjacent Instruments

[ ] MACHINE GUARDING

[ ] Pinch Points [ ] Motion/Speed [ ] Gears/Chains

[ ] Electro-pneumatic / Electro-mechanical Lifters / Drivers [ ] Rotating

[ ] Hydraulics [ ] Hot Surfaces [ ] Other

[ ] WASTE STREAMS

[ ] Physically Hazardous

[ ] Solids [ ] Liquids [ ] Gaseous

[ ] Bio-hazardous

[ ] Solids [ ] Liquids [ ] Gaseous

[ ] Environmentally Sensitive

[ ] Solids [ ] Liquids [ ] Gaseous

[ ] Radioactive

[ ] Half-Lives [ ] Disposal Options

[ ] Others

[ ] THERMAL SOURCES

[ ] High- Temperature Surfaces [ ] Open Flame [ ] Other

[ ] AUTOMATED SERVICE(S) (LN2, etc)

RESOLUTION PLAN REQUIRED (circle one) YES NO

COMMENTS:

_____

_____

_____

_____

REVIEWER SIGNATURE: _____DATE: _____

REVIEWER SIGNATURE: _____DATE: _____

ATTACHMENT C
MECHANICAL DESIGN CHECKLIST

PROJECT TITLE:			BUILDING:	SME:
SUB-TASK:			GROUP LEADER:	DESIGNER:
RESPONSIBLE DESIGN ENGINEER:			SYSTEM ENGINEER / INSTRUMENT SCIENTIST:	
KEY ACTIVITIES	APPLICABLE Yes	No	DATE COMPLETED	COMMENTS / REFERENCES
1. Identify supporting / interfacing design organizations.				
2. Establish design requirements. If complex or impacts other designs, document in a formal manner. Involve SMEs as much as possible.				
3. Confirm existing interface drawings represent As-Built conditions.				
4. Identify applicable industry standards that must be addressed in the design.				
5. Check for access restrictions and location interferences.				
6. Research existing technology for off-the-shelf applications.				
7. Research existing designs that can be utilized with some modifications.				
8. Hold feasibility review to consider alternative concepts. Pick the concept with the highest likelihood of success.				
9. Prepare Conceptual drawings, Pro-E models, or PowerPoint Aids.				
10. Hold Conceptual Design Review. Involve applicable SMEs. Does concept meet form, fit, & function? Issues identified and answers for most?				
11. Address CDR comments.				
12. Perform Design Calculations based on the CDR Pre-E model.				
13. Prepare Preliminary Design.				

KEY ACTIVITIES	APPLICABLE Yes	No	DATE COMPLETED	COMMENTS / REFERENCES
14. Draft Preliminary Technical Specifications / Data Sheets.				
15. Hold Preliminary Design Review. Involve as many applicable SMEs as practical. Are there workable solutions to every issue?				
16. Address PDR comments.				
17. Prepare Final Design. Optimize solutions for all issues.				
18. Update design calculations based on Final Design.				
19. Update Technical Specifications and Data Sheets.				
20. Perform detailed check of drawings.				
21. Hold Final Design Review. Have independent reviewers as appropriate.				
22. Address FDR comments and update all associated design documents as necessary.				
23. Determine Quality Grading Grade and develop Acceptance Criteria Listing.				
24. Submit to Customer for approval. This may be done as part of FDR.				
25. Incorporate customer comments.				
26. Release Final Design for procurement.				
27. Evaluate Vendor exceptions that impact the final design.				
28. Resolve Exceptions. Document acceptance of exceptions on SDR or revised design documents.				
29. Award fabrication Contract.				
30. Develop Installation Instructions.				
31. Develop System Startup procedures as appropriate for the designed equipment.				

ATTACHMENT D
Design Review Record
ORNL-242 & -242A

ATTACHMENT E
DCD Grade Classification and Approval

Grade 1: Impacts Safety Systems, Credited Engineered Controls (CEC), Accelerator Safety Envelope (ASE) provisions, equipment important to personnel safety, equipment whose failure could render the facility inoperable for an extended period of time, or with requirements imposed by a higher organizational authority.

Due to the nature of Grade 1 systems**,** a dedicated separate DCD shall be prepared and reviewed by all affected SMEs and organizations. These DCDs shall be approved by the Design Engineer, Team Leader, their respective Group Leader, and Engineering Manager or Chief Engineer, as appropriate. Representatives from the customer or outside authority should review and approve the DCD.

Grade 2: Impacts SSCS that involves interfaces with other organizations or other facilities.

If the Grade 2 item requirements can be contained within an Equipment Specification where limited interfaces can be addressed, then the Equipment Specification may serve as the DCD. However, if the Grade 2 item has several interfaces or multiple jurisdictional issues, then a dedicated separate DCD may be the clearest way to establish and agree on the appropriate requirements. Either of these documents should be approved by the Design Engineer, Team Leader, and their respective Group Leader. Representatives from the interfacing facilities or organizations should review and concur with the Equipment Specification or DCD. Obtaining formal approval signatures on the documents is optional but recommended.

Grade 3: Impacts multiple SSCSs within the same facility or has significant potential cost and/or schedule impacts.

If the Grade 3 item is relatively simple, but is a Grade 3 due to is potential costs or schedule impacts, then a simple Data Sheet may be sufficient as a DCD. If the Grade 3 item has several interfaces or is a relatively complex mechanism, then an Equipment Specification may contain all the requirements. Either of these documents should be approved by the Design Engineer and their respective Team Leader, as applicable.

Grade 4: Impacts only one SSCS without significant cost and/or potential schedule impacts.

If the Grade 4 item is simple enough, then no DCD is required – the item drawing has all requirements clearly identified. If the Grade 4 item has only a few requirements that cannot be clearly stated on the drawing, a simple Memo-to-File signed by the Design Engineer is sufficient.

NOTE: In the context of applying the above grading scheme, the term “Facility” is extended down to include individual functional entities such as: an individual beam line; the switch yard; the cooling tower; the proton storage ring; or the Central Helium Liquefier.