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DUAL AXIS RADIOGRAPHIC HYDRODYNAMIC TEST (DARHT) FACILITY

FINAL REPORT ACCELERATOR READINESS REVIEW

LANL INTERNAL DOCUMENT DX-DO:99-026

Dynamic Experimentation Division
Los Alamos National Laboratory

April 12, 1999

Los Alamos
NATIONAL LABORATORY

Operated by the University of California
for the U.S. Department of Energy

STATEMENT OF SUBMITTAL

The members of the DARHT Accelerator Readiness Review Team were Dennis Erickson (LANL), Martha Zumbro (LANL), Ray Scarpetti (LLNL), Jorg Jansen (LANL), Jim Sturrock (LANL), Robert Warling (LANL), Charles Kelsey (Omega Consulting), and Michael McNaughton (LANL).

The Team expresses its appreciation for the support provided by Robert Day, Dynamic Experimentation Division Director, and Michael Burns, DARHT Project Manager. The Team acknowledges the openness and readiness of the staff of DX Division and the DARHT Project during the conduct of the review. The Team is grateful for the hospitality provided during the site review of March 22-30, 1999. Our hosts were Richard Boudrie, Group Leader for Machine Science & Technology (DX-6), and Carol Wilkinson, Deputy Group Leader for DARHT Accelerator Construction (DX-8). We are grateful for the special care extended by the two group administrators, Debra Griego (DX-6) and Corine Ortiz (DX-8).

A staff team comprising Don McClure (DX-DO), Ron Selvage (DX-6), and Eric McNamara (ESH-DO) supported the Accelerator Readiness Review Team. Dennis Erickson, the ARR Team Leader, and Eric McNamara (ESH-DO) compiled the report. Editorial support for the Final Report was provided by Don McClure (DX-DO) and Emily Martinez (ESH-DO). The Team gratefully acknowledges their contributions.

The Final Report for Accelerator Readiness Review of the DARHT Facility represents the collective judgement of the team members. The contents of the report have been reviewed and approved by all members of the team. The Final Report is hereby certified on behalf of the Accelerator Readiness Review Team to be the result of an independent, structured, and comprehensive review of the readiness of the DARHT Facility.

Dennis J. Erickson, Team Leader
DARHT Accelerator Readiness Review

Date: April 13, 1999

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EXECUTIVE SUMMARY

The Dual Axis Radiographic Hydrodynamic Test (DARHT) Facility, designated as the Hydrotest Firing Site in the DARHT Line-Item Construction Project, will combine enhanced high-resolution radiography and high explosive testing to perform hydrodynamic tests and dynamic experiments to support the stewardship of the nuclear weapons stockpile. Construction of the buildings and the support infrastructure that comprise the DARHT Facility is essentially complete. The facility is currently configured for single-axis operation, with the complete installation of the first of the two linear accelerators.

The Laboratory is owned by the U.S. Department of Energy and operated by the University of California under contract with the DOE. The Laboratory's Dynamic Experimentation (DX) Division is the designated operating line element for the DARHT Facility. DX Division has designated the Machine Science & Technology (DX-6) Group as the accelerator operator for DARHT.

Since the DARHT accelerators will routinely operate at energies greater than 10 MeV, DOE O 420.2, *Safety of Accelerator Facilities*, has been used to establish and assure the safety requirements for this new facility. The DOE, UC, and the Laboratory have agreed to incorporate this new order in the prime contract through the Work Smart Standards Process, but the contract has yet to be modified. The DOE and the Laboratory have agreed to apply this order pending final inclusion in the contract.

In accordance with DOE O 420.2, DX Division developed a Safety Analysis Document for the DARHT Facility, which defines the Accelerator Safety Envelope. The DOE has reviewed and approved the Safety Analysis Document through its DARHT Safety Evaluation Report. This approval was limited to operation of the Axis-1 accelerator. In addition, the facility has significant expectations for environmental protection as established in the Final Environmental Impact Statement and the DOE Record of Decision for the DARHT Facility.

In addition, DOE O 420.2 requires the Laboratory to conduct an Accelerator Readiness Review (ARR) for the DARHT Facility as currently configured. The cognizant DOE field element manager will use the ARR Report to support the decision to approve full-energy commissioning activities and routine accelerator operations for the new DARHT Facility. Since the DARHT Facility is currently designated as a low-hazard, non-nuclear accelerator facility, the cognizant DOE manager is the Area Manger, DOE Los Alamos Area Office. DX Division developed a Plan of Action for the ARR, which was approved by the Department of Energy.

DX Division appointed a review team to conduct the Accelerator Readiness Review. The members of the DARHT Accelerator Readiness Review Team were Dennis Erickson (LANL, ARR Team Leader), Martha Zumbro (LANL), Ray Scarpetti (LLNL), Jorg Jansen (LANL), Jim Sturrock (LANL), Robert Warling (LANL), Charles Kelsey (Omega Consulting), and Michael McNaughton (LANL). The impressive breadth of expertise provided by this team allowed a comprehensive review of the DARHT Facility for its readiness to operate.

The ARR covered the Axis-1 accelerator, the Accelerator Hall, the Power Supply Room, the beam stop, the shielding for Axis 1, and other associated hardware. Also covered were the operating limits that assure the structural integrity of the facility under dynamic loading. The ARR also included operations of the accelerator Control Room, the Optics and Analyzer Rooms where applicable, and the Personnel Safety System for Axis 1 (comprising the Radiation Safety System and the High Explosives Safety System). In addition, the ARR covered the operational interfaces that protect personnel working on the firing pad and on Axis 2 from the hazards associated with operating Axis 1.

As specified in the Plan of Action, Core Requirements were taken from DOE O 425.1A and evaluated for application to the DARHT ARR. Fourteen Core Requirements were determined to be applicable for the evaluation of the safety aspects of the DARHT Facility, the safety related controls identified in the Accelerator Safety Envelope, and the management of the facility. The 14 Core Requirements were mapped onto eight functional categories. Within each functional category, a set of Performance Objectives was developed. The 33 Performance Objectives were assessed using 112 specific Acceptance Criteria and used to test the readiness of the DARHT Facility. These acceptance criteria provided sufficient depth to demonstrate the readiness of personnel, hardware, administrative controls, and procedures to ensure safe operations. The functional approach has sufficiently tested each of the Core Requirements.

The ARR Team conducted its on-site review during the period March 22-30, 1999. The ARR Team utilized document reviews, system reviews, interviews, and observations of limited or simulated activities. Other performance-based evaluation techniques were used to assess the defined scope. This review assessed the practical implementation of the safety basis requirements. The review also assessed the formal and documented conformance to these requirements. The ARR Team used a graded approach to determine adequacy of operational documentation and implementation for the DARHT Facility. The graded approach was based on system importance to safety. The ARR Team concluded its on-site review with a formal closeout briefing on March 30, 1999.

The results of the Accelerator Readiness Review are provided in this Final Report. The Final Report relies on eight functional assessments and 99 Assessment Reports. Team members concurred on the conclusions and the readiness determination in the Final Report.

Summary conclusions of the ARR Team include that the DARHT Project has provided a safe and well-constructed facility and that the Axis-1 accelerator is well engineered and constructed. In addition, the ability to conduct safe operations of the DARHT Axis-1 accelerator has been demonstrated in practice. However, conditions have been identified which require correction. Table 1 provides a condensed listing of those findings that require correction prior to startup, Table 2 provides a condensed listing of those findings that require the development of a corrective action plan prior to startup, and Table 3 provides observations that do not require formal corrective actions. Although the review has identified deficiencies that require resolution, no individual finding undermines our confidence as to the fundamental readiness of the facility. However, DX Division needs to strengthen its commitment to the disciplined elements of quality management for the control of DARHT activities.

In its statement of readiness, the Accelerator Readiness Review Team determined that, pending closure of pre-start findings and planning of corrective actions for post-start findings, the Laboratory's Dynamic Experimentation Division can proceed with full-energy commissioning activities and routine operations of the DARHT Axis-1 accelerator. In the judgement of the Team, the post-start findings do not impact the current ability of DX Division to safely operate the DARHT Facility. However, resolution of the post-start findings is crucial for the long-term assurance of safe operations.

Table 1: Summary of Pre-Start Findings

PO	AC	Pre-Start Finding
SB-2	2	DARHT-specific training on SAD and ASE remains under development.
SB-2 RP-2	2 2	Radiation Safety Plan is not fully developed and approved.
SB-3	1,2	Test procedures for safety system checks are inadequate, inconsistent, and not appropriately documented.
SB-4 CM-2	1,2,3,4 3,7	USI Procedure is not yet being applied.
SE-1	3	Individual conducting RSS sweep cannot visually verify that beam stop is in place.
SE-1	3	Beam stop does not have passive mechanical support when in place in beam line.
SE-1	3	Allocated four minutes for a sweep of Accelerator Hall is not adequate.
SE-1 RP-4	3 1	Delay time of 20 seconds between start of bells indicating accelerator is charging and accelerator firing is insufficient time for individual caught in Accelerator Hall to reach and activate SCRAM.
SE-1	3	No administrative or computer control addresses energizing only one 8 cell block being energized at any one time while operating in Mode 1 as described in ASE.
SE-2	3	There is no formalized procedure, including assignments, for handling controlled keys.
SE-2	4	DX-6:SOP 210 and the DARHT SAD are not consistent in their definition of modes.
SE-3	1	There is no procedure in place to operate in Pulse Power Checkout mode, which may include barriers, signage, and rotating beacons.
SE-3	1	Injector high voltage power supply is not locked and tagged during diode maintenance.
ES-3	2	Barriers to certain electrical equipment are inadequate.
IS-1	6	Oxygen sensor instrumentation in Control Room does not have preventive maintenance procedure.
RP-2	2	Radiological Controls SOP requires revision to include DARHT specific hazards and instructions. Radiological posting requirements must minimally be addressed.
RP-4	1	An administrative mechanism needs to be prepared ensuring that Mode 2 access control is invoked without raising of beam stop until adequate dosimetry is collected for firing point.
RP-4	1	Installation of fences providing physical and administrative boundaries outside DARHT building must be completed.
RP-4	1	Modification of RSS display programming must be completed to accurately indicate Mode 2 boundaries.
TQ-3	3	Hazards are not consistently identified and evaluated by actual workers and their supervisors.

Table 2: Summary of Post-Start Findings

PO	AC	Post-Start Finding
SB-2	2	Administrative limit for explosives is not finalized in approved procedure.
SB-3	1,2	There is no procedure for annual surveillance of electrical interlocks as required by SR 5.3.4 in the SAD.
SB-3	1,2	With respect to safety functions, boundaries between facility equipment and SFE need to be better defined, including maintenance management program for SFE in accordance with LIR 230-04-01.
SE-1	3	The PA system, which serves Accelerator and Power Supply Hallways, is ineffective as an element of the PSS.
CM-1	1	A comprehensive configuration management system for DARHT Facility is not in place.
CM-2 ES-4	1 4	As-built drawings have not been comprehensively completed.
CM-2	3,7	Document Control Plan is not approved.
ES-1	1	Changes to SAD and DX-6:SOP-210 as specified in the approval of single point ground (SPG) system have not been fully implemented.
ES-2	1	No formal change control processes are in place for SFE.
ES-3	3	There is no formal testing program in place for dump relays in pulse power systems.
IS-3	2	NFPA certification that validates all fire protection systems as operational has not been completed.
IS-3	4	Items of noncompliance with the Life Safety Code have been identified in DARHT Facility.
IS-4	1,2	Deficiencies and recommendations from the approved FHA have not been fully resolved.
TQ-1	2	Worker Qualification and Training Documentation Plan, Work Authorization Matrix, and Training Matrix are in draft form.
TQ-1	4	Process for qualification and authorization is not yet formalized.
TQ-2	1	OJT questions are not consistently used to evaluate trainee comprehension of critical or high-hazard elements of operations.

Table 3: Summary of Observations

PO	AC	Observation
SB-2	1	There are inconsistencies in ASE as noted in discussion.
SB-2	3	Not all DARHT personnel are aware of ASE requirements.
SB-3	1,2	Process for tracking deficiencies at operations level should be more robust to ensure deficiencies are corrected.
SB-4	1,2,3,4	Since there are now multiple LANL facilities with this requirement, it would be good to have formalized Laboratory USI guidance.
SE-1	3	Headsets that allow clear and continuous communication between personnel working in the Accelerator Hall, Power Supply Room, Control Room, Firing Pad, and Detection Chamber are needed to maintain good communication and safe working conditions.
SE-1	3	SCRAM condition does not return all accelerator systems to safe de-energized state.
SE-2	1	Disassembly procedures for prime power tank, spark gaps, transmission lines, BCUs and TUs should be documented to ensure personnel safety as new people come on board and hardware longevity.
SE-2	4	Page 64 of the SAD states "...physical lockout of the accelerator controls when personnel are present on the firing site..." The term "accelerator controls" should be replaced with "beam stop".
SE-2	4	Test plan for commissioning accelerator does not exist.
SE-2	5	Written procedures, available expertise, and safe general work practices should adequately cover all credible contingencies as they arise.
SE-3	2	The DARHT ASE on pg. 75 of the Safety Assessment Document states that "...accelerator is incapable of generating electron energies greater than 22 MeV by design." Is this absolutely true, or can it be achieved with minimum beam loading, increasing HVPS charge settings, modified or faulty cell load cans, etc.?
CO-3	3	Project Implementation Management Plan used to track corrective actions during DARHT construction has to be transferred from construction phase to operating phase.
CM-2	5	Hardware and software changes must be controlled by Configuration Management Plan.
ES-1	1	Cable specifications in NEC Article 318 should be considered in specifications for the DARHT Axis-2 accelerator and for upgrades of the Axis-1 accelerator.
ES-4	1	DX-6:SOP-210, *DAHRT 1*, needs to be converted to Hazard Control Plan (HCP) to be compliant with LIR 300-00-01, *Safe Work Practices*.
ES-5	3	There is no formal documentation for OJT for electrical work using EDS
IS-1	1	Magnetic field survey awaits Axis-1 accelerator operations.
IS-1	1	Formalized training for proper and safe use of PRESTO lifts is recommended.
IS-1	1	Further evaluation is recommended of "chaseway" under Detector Room as to its potential classification as a confined space.
IS-1	3	Some chemical items found in flammable lockers did not appear to have Material Safety Data Sheets available.
IS-1	4	Documentation of training for handling hazardous materials needs strengthening.
IS-1	6	There is no light switch near the southeast entrance of Pulse-Power Room (injector end).

IS-2	1 to 5	Raised thresholds of six doors exiting Detection Chamber Room are potential tripping hazards.
IS-5	1	Portable, electronic controller should be locked in a storage cabinet when not in use.
IS-5	2,3	In some cases, there were inconsistencies in training records for crane and hoist operators.
IS-6	1,2	Plugging of floor drains for special activities should be should be controlled by Special Work Permit to ensure additional hazards are not created from concurrent activities.
RP-1	2	RCT orientation text should be revised to include DARHT-specific accelerator radiological hazards.
RP-1	2	RCT Facility Orientation and Training Review Checklist should be conducted again for assigned technicians so that orientation and training will certify familiarity with DARHT SOP and other current SOPs and plans revised and written specifically for DARHT operations.
RP-2	1	Self-Study Course for Accelerator Safety should be completed by RCTs supporting DARHT operations.
RP-2	1	Self-Study Course for Accelerator Safety should be included in FMU's training checklist for assigned RCTs.
RP-3	1	ALARA goal considerations for DARHT workers have not been documented by procedurally responsible party.
RP-3	1	SOP for radiological controls references a superseded LP for ALARA goal trigger levels and guidelines. SOP should be revised.
RP-6	1	Tungsten alloy used to fabricate beam stop differs from that considered for facility characterization and hazard analysis. This does not change the non-nuclear facility determination for DARHT. In addition, ferrous alloy yields doses bounded with analysis methods applied.
RP-6	3	Bags of concrete mix used as shielding in access holes through Accelerator Hall wall may become activated and present a contamination control and airborne radioactive material hazard when removed for beamline maintenance. Further analysis and replacement with solid shielding blocks should be considered.

1.0 INTRODUCTION

The Dual Axis Radiographic Hydrodynamic Test (DARHT) Facility, designated as the Hydrotest Firing Site (HFS) in the DARHT Line-Item Construction Project, will combine enhanced high-resolution radiography and high explosive (HE) testing to perform hydrodynamic tests and dynamic experiments to support the stewardship of the nuclear weapons stockpile. The DARHT Facility is located within the Los Alamos National Laboratory at Technical Area 15. Construction of the buildings and the support infrastructure that comprise the DARHT Facility is essentially complete. The facility is currently configured for single-axis operation, with the complete installation of the first of the two linear accelerators.

The Laboratory is owned by the U.S. Department of Energy and operated by the University of California under contract with the DOE. The Laboratory's Dynamic Experimentation (DX) Division is the designated operating line element for the DARHT Facility. DX Division has designated the Machine Science & Technology (DX-6) Group as the operator for DARHT.

Since the DARHT accelerators will routinely operate at energies greater than 10 MeV, DOE O 420.2, *Safety of Accelerator Facilities*, has been used to establish and assure the safety requirements for this new facility. The DOE, UC, and the Laboratory have agreed to incorporate this new order in the prime contract through the Work Smart Standards Process, but the contract has yet to be modified. The DOE and the Laboratory have agreed to apply this order pending final inclusion in the contract.

DOE O 420.2 requires the Laboratory, as the operating contractor, to conduct an Accelerator Readiness Review (ARR) for the DARHT Facility as currently configured. The cognizant DOE field element manager will use the ARR Report to support the decision to approve full-energy commissioning activities and routine accelerator operations for the new DARHT Facility. Since the DARHT Facility is currently designated as a low-hazard, non-nuclear accelerator facility, the cognizant DOE manager is David Gurule, Area Manger, DOE Los Alamos Area Office.

The Accelerator Readiness Review for the DARHT Facility employed the following three elements as the applicable safety basis:

1) ***DARHT Safety Analysis Document (SAD)***, LANL-DX-DO-8888, Rev. 0, December 1998.

2) ***Safety Evaluation Report (SER) for DARHT***, DOE-AL-DARHT-SER-Rev. 0, January 1999.

3) ***DARHT Final Environmental Impact Statement (EIS)***, DOE/EIS-0228, August 1995; ***DARHT EIS Record of Decision (ROD)***, Federal Register, Vol. 60, No. 199, pp. 53588-53596, October 1995.

The DARHT SAD identifies no radiological or hazardous material releases to workers or the public. In addition, the SAD further identifies that the hazards to be encountered in commissioning and routine operation are related to worker safety and involve energized equipment, radiological exposure, and high explosives.

Provided below are presentations and discussions detailing the process used by and the results of the ARR. Section 2 provides a statement of purpose for the ARR. Section 3 specifies the scope of the ARR, including focus, limitation, and breadth. Section 3 also summarizes the results of a Management Self-Assessment conducted prior to the ARR. Section 4 describes the conduct of the readiness review, including the functional categorization used to proscribe the review, a description of the ARR Team and its members, and the approach used. Section 4 also provides criteria used by the ARR Team to classify deficiencies, and the communication and documentation methods employed by the Team. Section 5 provides summaries of the eight functional assessments conducted by the ARR Team. Each summary includes objectives and provides conclusions, findings, and observations. Section 6 provides the summary conclusions of the review. Section 7 concludes the Final Report with a determination of readiness. Appendix A contains a list of acronyms used in this report and its supporting documents. Appendix B contains the Assessment Reports from the review. Finally, Appendix C provides the Implementation Plan used to conduct the ARR.

2.0 PURPOSE

This Final Report documents the Accelerator Readiness Review of the DARHT Facility. The ARR was performed for the Laboratory to satisfy a principle requirement of DOE O 420.2. Satisfaction of this requirement was necessary to support DOE approval of full-energy commissioning activities and routine accelerator operations for the new facility.

3.0 SCOPE

A Plan of Action was developed for the ARR. The plan, approved by DOE, is contained in

- ***Plan of Action for DARHT Facility Accelerator Readiness Review***, LANL-DX-FM:99-009, Rev. 1, March 1999.

Since DOE O 420.2 currently lacks process guidance, the Plan of Action was formulated using a graded application of DOE O 425.1A, *Startup and Restart of Nuclear Facilities*, and DOE STD-3006, *Planning and Conduct of Operational Readiness Reviews*.

The Plan of Action stipulated an independent confirmation to the Laboratory's Dynamic Experimentation Division and to the DOE as to the readiness of the DARHT Facility for commissioning of the Axis-1 accelerator at full energy and the assumption of routine accelerator operations. Explicit in the confirmation was to be assurance that workers, the public, the environment, and the facility are protected from adverse impacts.

3.1 Focus and Limitation

The Laboratory, in accordance with DOE O 420.2, has developed the Safety Analysis Document for the DARHT Facility. The DARHT SAD defines and specifies, in Chapter 5, an Accelerator

Safety Envelope (ASE). The ASE provides physical and administrative bounding conditions for the single-axis mode of the DARHT Facility. The DOE has reviewed and approved the SAD through its DARHT Safety Evaluation Report (SER). The SER provided four conditions of approval. Two conditions require additional analysis and information at the first annual update of the SAD. A third condition requires a special administrative control that occurs as the result of activities at the neighboring PHERMEX Facility. The third condition was assessed in this readiness review. The fourth condition limits approval to accelerator operations only. This final condition also requires separate processes for approval of HE operations and for formal coordination and approval of integrated accelerator and HE operations.

This Accelerator Readiness Review was, therefore, limited to the operation of the Axis-1 accelerator currently installed in the DARHT Facility. The focus of the review concerned the operation of the Axis-1 accelerator. The Axis-1 Accelerator Hall is equipped with a linear induction accelerator, comprised of a 4-MeV electron source that injects a beam into a series of 250-kV accelerating cells. The power for the accelerator consists of high voltage pulses, shaped and supplied by three pulsed-power systems: the injector supplies, the induction-cell pulsed-power (ICPP) units, and the ICPP trigger systems. This accelerator is to produce a nominal 20-MeV electron beam. The electron beam is to impinge on a thin metal target producing a pulse of intense Bremsstrahlung x-rays of short duration. The x-rays will then image an experimental assembly, which is being accelerated and deformed by HE charges. The currently installed Axis-1 accelerator will eventually be joined by a second accelerator to complete the dual-axis capability. The two axes will have an included angle of 90°.

The ARR covered the Axis-1 accelerator, the Accelerator Hall, the Power Supply Room, the beam stop, the shielding for Axis 1, and other associated hardware. Also covered were the operating limits that assure the structural integrity of the facility under dynamic loading. The ARR also included operations of the accelerator Control Room, the Optics and Analyzer Rooms where applicable, and the Personnel Safety System for Axis 1 (comprising the Radiation Safety System and the High Explosives Safety System). In addition, the ARR covered the operational interfaces that protect personnel working on the firing pad and on Axis 2 from the hazards associated with operating Axis 1.

3.2 Breadth

As specified in the Plan of Action, Core Requirements were taken from DOE O 425.1A and evaluated for application to the DARHT ARR. Fourteen Core Requirements were determined to be applicable for the evaluation of the safety aspects of the DARHT Facility, the safety related controls identified in the Accelerator Safety Envelope, and the management of the facility. These Core Requirements are:

CR #1. ***There are adequate and correct procedures for operating the process systems and utility systems.***

CR #2. ***Training and qualification programs that encompass the range of duties and activities required to be performed for operations and operational support personnel have been established and implemented.***

CR #3. *Level of knowledge of operations and operations support personnel is adequate based on demonstration of abilities, reviews of examinations and examination results, as well as selected interviews of operations and operations support personnel.*

CR #4. *Facility safety documentation is in place that describes the "safety envelope" of the facility. The safety documentation should characterize the hazards/risks associated with the facility and should identify mitigating measures (such as systems, procedures, and administrative controls) that protect the workers and the public from those hazards/risks. Safety systems and systems essential to worker and public safety are defined, and a system to maintain control over the design and modification of facilities and safety-related systems is established.*

CR #5. *A program is in place to confirm and periodically reconfirm the condition and operability of safety systems, including safety-related (significant) processes and utility systems. This includes examinations of records of test and calibration of the safety systems and other instruments that satisfy the Accelerator Safety Envelope. All systems are currently operable and in a satisfactory condition.*

CR #6. *A process has been established to identify, evaluate, and resolve deficiencies and recommendations made by oversight groups, official teams, audit organizations, and operating contractor.*

CR #7. *Formal agreements establishing requirements are in place between the operating contractor and DOE, via the contract or other enforceable mechanism, which govern the safe operations of the facility. A systematic review of the facility's conformance to these requirements has been performed. These requirements have been implemented in the facility, or compensatory measures are in place, and formally agreed to during the period of implementation. The compensatory measures and the implementation period are approved by DOE.*

CR #8. *Management programs are established, sufficient numbers of qualified personnel are provided, and adequate facilities and equipment are available to ensure operational support services (e.g., training, maintenance, waste management, environmental protection, industrial safety and hygiene, radiological protection and health physics, emergency preparedness, fire protection, quality assurance, and engineering) are adequate for operations.*

CR #9. *A routine and emergency operations drill program, including program records, has been established and implemented.*

CR #10. *An adequate start-up or restart test program has been developed that includes adequate plans for a graded operations testing to simultaneously confirm operability of equipment, the viability of procedures, and the training of operators.*

CR #11. ***Functions, assignments, responsibilities, and reporting relationships are clearly defined, understood, and effectively implemented with line management responsible for control of safety.***

CR #12. ***Conduct of operations is adequately implemented in the facility.***

CR #13. ***There are sufficient numbers of qualified personnel to support safe operations.***

CR #14. ***A program is established to promote a site-wide culture in which personnel exhibit an awareness of public and worker safety, health, and environmental protection requirements and through their actions, demonstrate a high priority commitment to comply with these requirements.***

3.3 Management Self-Assessment

Prior to submission of this Plan of Action, the Laboratory's DX Division conducted a management self-assessment to determine its status for the Accelerator Readiness Review. The conclusions of the self-assessment are described in:

- *DARHT Management Self-Assessment (MSA) Report*, LANL-ESH-12-XRSC-99-070, March 9, 1999.

Top-level findings cited deficiencies in the quality assurance program, document control, personnel training documentation, and single-point ground (SPG) accident/incident analysis. Having completed the MSA, DX Division subsequently submitted the Accelerator Readiness Review Plan of Action to the DOE for Approval. In so doing, DX Division provided formal notification as to the readiness of the Laboratory for the ARR.

4.0 CONDUCT OF THE REVIEW

An Implementation Plan was developed to guide the Accelerator Readiness Review for the DARHT Facility. The plan was based on the Plan of Action discussed in Section 3.0. The ARR Team Leader approved the Implementation Plan used to begin the review on March 21, 1999. The plan was subsequently modified during the review. The updated plan,

- ***Implementation Plan for DARHT Accelerator Readiness Review***, LANL-DX-FM:99-020, Rev. 1, April 5, 1999,

is provided in Appendix C. The Implementation Plan provides a description of responsibilities, approach, classification of deficiencies, and administration.

4.1 Functional Categorization

The Accelerator Readiness Review for the DARHT Facility was organized according to eight functional categories. These functional categories were:

1) **Safety Basis (SB),**
2) **Systems Engineering (SE),**
3) **Conduct of Operations (CO),**
4) **Configuration Management (CM),**
5) **Electrical Safety (ES),**
6) **Industrial Safety (IS),**
7) **Radiological Protection (RP), and**
8) **Training and Qualification (TQ).**

Because of the hazards presented by the DARHT Facility, specific functions for electrical safety, industrial safety, and radiological protection were employed.

Within each functional category, a set of Performance Objectives (PO) was developed. The Performance Objectives used for this review are detailed in Appendix A of the Implementation Plan. For each Performance Objective, a set of primary contract standards and primary Laboratory requirements was provided. Also listed are specific Acceptance Criteria (AC) used to test the readiness of the DARHT Facility. These acceptance criteria provided sufficient depth to demonstrate the readiness of personnel, hardware, administrative controls, and procedures to ensure safe operations. Each Performance Objective was also provided with a review approach.

This review featured 33 Performance Objectives and 112 Acceptance Criteria. These were used to measure readiness of the DARHT Facility. These performance objectives and their acceptance criteria were used to establish whether the 14 Core Requirements were satisfied.

4.2 Accelerator Readiness Review Team

The Dynamic Experimentation Division appointed eight experts to conduct an independent Accelerator Readiness Review for the DARHT Facility.

4.2.1 Team Assignments

The ARR Team listed in Table 4 consisted of individuals with exceptional backgrounds in the areas of accelerator design and operations, pulsed power, line and project management, training, and ES&H. Each member was assigned lead responsibilities. The impressive breadth of expertise provided by this team allowed a comprehensive review of the DARHT Facility for its readiness to operate. The experience and qualifications for each team member are summarized below.

Table 4: Accelerator Readiness Review Team for the DARHT Facility

Member	Affiliation	Assignment
Dennis Erickson	LANL–ESH-DO	Team Leader
Martha Zumbro	LANL–LANSCE-6	Safety Basis (SB)
Raymond Scarpetti Jr.	LLNL–FXR	Systems Engineering (SE)
Hansjorg Jansen	LANL–APT-TPO	Configuration Management (CM) Conduct of Operations (CO)
James Sturrock	LANL–LANSCE-6	Electrical Safety (ES)
Robert Warling	LANL–ESH-5	Industrial Safety (IS)
Charles Kelsey	Omega Consulting	Radiological Protection (RP)
Michael McNaughton	LANL–ESH-13	Training and Qualification (TQ)

4.2.2 Experience and Qualifications

Team Leader -- Dennis Erickson

Dennis Erickson is a physicist with extensive pulsed power, operational, and ES&H experience gained over a 27-year career at the Los Alamos National Laboratory. As a Laboratory scientist, he is a recognized expert in the international field of explosive pulsed power and ultra-high magnetic field research. He has two decades of management experience at the group, division, and directorate levels. This experience includes substantial responsibility for facility-intensive operations and explosives testing activities. As division leader and deputy division leader for Dynamic Testing (1985-1990), he was the Laboratory champion for the conceptual development of the DARHT Project. As deputy associate director for Nuclear Weapons Technology (1990-1993), he guided the DARHT Project through the DOE commitment process. In 1991, Dennis led the institutional team that conducted the safety and health portion of the Laboratory Tiger Team self-assessment.

In late 1993, Dennis was appointed division director for Environment, Safety, and Health. As the Laboratory's ES&H Officer, Dennis has institutional responsibilities for occupational safety and health, radiation protection, environmental protection, and operational assurance. He has leading roles in DOE safety improvement initiatives such as Integrated Safety Management and Work Smart Standards.

Dennis received his PhD in physics from the University of Tennessee and his BA in physics and mathematics from Augsburg College.

Lead for Safety Basis -- Martha Zumbro

Martha Zumbro has extensive experience in the operation of high-energy, high-intensity linear accelerators. For the past eight years, Martha has served as the group leader for Accelerator Operations and Technical Support (LANSCE-6) in the LANSCE Division at the Los Alamos National Laboratory. The LANSCE accelerator is an 800-MeV, 1-ma proton accelerator commissioned in the early 1970s. This accelerator has been extensively used for nuclear physics, neutron spallation physics and applications, and isotope production.

Martha and her LANSCE-6 group have been instrumental in developing the safety documentation for the LANSCE accelerator. They developed an accelerator safety envelope for LANSCE operations. In addition, they were integral to the development of the LANSCE SAD and USQD process. Martha develops and maintains numerous operating procedures for the LANSCE accelerator.

Martha Zumbro received her PhD in nuclear chemistry from Florida State University, her MS in mathematics from Auburn University, and her BS in chemistry and mathematics from Hardin-Simmons University.

Lead for Systems Engineering -- Raymond Scarpetti, Jr.

Ray Scarpetti is a 20 year veteran of the Lawrence Livermore National Laboratory. Ray has been a member of numerous engineering teams, including the team that designed and built the Flash X-Ray (FXR) linear induction accelerator at Livermore. FXR is the primary hydrodynamic-test facility at LLNL. FXR has provided much of the linear induction accelerator technology employed in the first of the DARHT accelerators. In the mid-1980s, Ray was involved in the Ground-Based Free Electron Laser Program for the Strategic Defense Initiative. His efforts dealt again with the conceptual design of an induction linear accelerator, which was to drive the FEL. In 1988, he joined Livermore's Atomic Vapor Laser Isotope Separation (AVLIS) Program, where he led the high-power electron gun and electron-beam transport development efforts.

For the past five years, Ray has been the FXR Project Leader. In this capacity, he has responsibilities for operating, maintaining, and upgrading the facility. During this period, he has collaborated routinely with the DARHT Project.

Ray Scarpetti received his MS in electrical engineering from Rensselaer Polytechnic Institute.

Lead for Conduct of Ops & Configuration Management -- Hansjorg Jansen

Jorg Jansen is a distinguished pulsed power and accelerator engineer. Spanning a 37-year career, he worked for Transitron Electronic Corporation, General Atomics, Maxwell Laboratories, and the Los Alamos National Laboratory. His work has encompassed thermoelectric power generation, electromagnetic metal forming, and high-voltage pulsed power. He has developed high voltage DC power supplies, Marx and LC generators, electron beam machines, high-power lasers, and ion-beam accelerators.

Joining LANL in the 1970s, Jorg led the development of the high-voltage pulsed power equipment for Antares, a CO_2 laser-fusion facility. He directed the Antares Project and the Phoenix Project, an approach to separate plutonium isotopes using tunable lasers. More recently, Jorg directed the Ground Test Accelerator Project, a 100-MeV, 100-mA pulsed-ion-beam accelerator for the Neutral Particle Beam Program of the Strategic Defense Initiative. Jorg retired from the Laboratory in 1997 and currently serves as an affiliate in LANL's Accelerator Production of Tritium Project. Most recently, Jorg led the Accelerator Readiness Assessment of the Los Alamos Low Energy Demonstration Accelerator (LEDA).

Jorg Jansen received his PhD, MS, and BS in electrical engineering at the University of Aachen in Germany.

Lead for Electrical Safety -- James Sturrock

Jim Sturrock is a registered Professional Engineer with 35 years of electrical and electronic engineering experience. During his tenure at the Los Alamos National Laboratory, he has served in the LANSCE Division's Accelerator Operations and Technical Support Group (LANSCE-6) as the team leader for Magnet Power Supplies and the team leader for Protective Systems. Jim currently is the LANSCE Division Electrical Safety Officer. He also co-chairs the LANSCE Division Electrical Safety Committee.

Jim Sturrock received his MS and BS in electrical engineering from the Georgia Institute of Technology.

Lead for Industrial Safety -- Robert Warling

Robert Warling is a veteran ES&H professional. Prior to joining the Los Alamos National Laboratory, Robert served in various capacities in the U.S. Navy. He is the former Director for Occupational Health Studies at the Naval Safety School in Bloomington Indiana. He has also been a senior industrial hygienist at the Naval Air Station, Key West, at Camp Pendleton, and at the Naval Station, San Diego (Naval Environmental and Preventive Medicine Unit).

Robert joined the Laboratory in 1992. He is a senior industrial hygienist and safety engineer in the Industrial Hygiene and Safety Group (ESH-5). Robert provides broad health and safety guidance and oversight to Laboratory organizations, facilities, and activities. His competencies include safety engineering, occupational/industrial hygiene, chemical and biological safety (including those involved in chem/biowarfare), electrical safety, the health sciences, chemistry, and laser technology.

Robert Warling received his MS in health and safety, with an emphasis in safety management, from Indiana University. He received his MPH from the University of Hawaii and his BS in microbiology from Long Beach State University. He carries certifications for industrial hygiene, safety, and as an electrical inspector. Robert continues to serve as a reserve naval officer.

Lead for Radiological Protection -- Charles Kelsey

Charles Kelsey is a nuclear engineer specializing in facility and process design. He has supported DOE work at the Rocky Flats Environmental Technology Site, the Savannah River Site, and the Oak Ridge National Laboratory, optimizing engineered and administrative radiological controls to maintain ALARA doses. He is currently supporting residue processing and repackaging at Rocky Flats in the areas of operational guidance and the design and installation of equipment and shielding. Also, at Rocky Flats, he has designed glovebox shielding for the plutonium stabilization and packaging system and developed controls for plutonium and uranium solution stabilization and disposition processes. Past projects at Savannah River involved radiological engineering support for the americium/curium vitrification facility, reactor building modifications for plutonium storage, and dry storage of spent nuclear fuels.

Charles Kelsey received his BS in nuclear engineering from Texas A&M University. He is a licensed Professional Engineer.

Lead for Training and Qualification -- Michael McNaughton

Mike McNaughton is a distinguished nuclear physicist. Much of his career at the Los Alamos National Laboratory involved the use of the LANSCE proton accelerator for experimental studies. He is well published and is a Fellow of the American Physical Society. Mike is also a long-time teacher and university lecturer. In 1993, he joined the ES&H Training Group (ESH-13) in the Environment, Safety, and Health Division. As the team leader for radiological training, he has administrated the training program for Radiological Control Technicians (RCT), and developed and implemented the oral board phase of RCT training. He has long-standing working knowledge of DOE orders and of federal and state regulations.

He has extensive knowledge and experience in research operations employing high-energy linear accelerators. Much of this experienced was gained while conducting research in Great Britain, at the University of California, Davis, and at LANL. More recently, this experience has involved the health physics aspects of accelerator operations.

Mike McNaughton received his PhD in physics from the University of London, his MA from Oxford University, and his BS from the University of London. He is a certified health physicist.

4.3 Approach

The ARR Team conducted its on-site review during the period March 22-30, 1999. Team members were assigned lead responsibilities for functional categories. The schedule for the on-site review is provided in Section 8.0 of the Implementation Plan.

The ARR Team utilized document reviews, system reviews, interviews, and observations of limited or simulated activities. Other performance-based evaluation techniques were used to assess the defined scope. This review assessed the practical implementation of the safety basis requirements. The review also assessed the formal and documented conformance to these requirements. The ARR Team used a graded approach to determine adequacy of operational documentation and implementation for the DARHT Facility. The graded approach was based on system importance to safety.

The review examined each of the major subsystems of the Axis-1 accelerator to assess that the design, installation, and testing were sufficient to safely proceed with commissioning of the accelerator at full energy. The procedures used at DARHT were also assessed, as was personnel training to procedures. Personnel knowledge was assessed through interviews and documentation.

Of special significance were reviews of administrative safety controls and safety systems identified in the SAD. Targeted assessments were conducted for the Radiation Safety System, including a complete evaluation of the design and effectiveness of the beam stop, and the electrical single-point-ground. These reviews were used to assess the adequacy of controls.

Team members documented their assessment against a specific Acceptance Criterion for a Performance Objective through an Assessment Report. Each report includes a list of documents reviewed, operations observed, and personnel involved. A report assumes applicable contractual standards and Laboratory requirements listed in the Implementation Plan. An Assessment Report also includes potential for discussion, deficiencies, and a conclusion with respect to a specific criterion. Appendix B contains 99 Assessment Reports. The team lead and the team leader signed each report. Where deficiencies are identified, classification as to pre-start finding, post-finding, or observation is noted.

4.4 Classification of Deficiencies

Deficiencies were classified using the following criteria.

- **Pre-Start Finding**: A deficiency that if not corrected will have a significant safety consequence. A Pre-Start Finding has, in the judgment of the Team, a direct (first order) impact on the operation. Correction or mitigation must be completed prior to commissioning or assumption of routine operations.

- **Post-Start Finding**: A deficiency that, in the judgment of the Team, has minor (second order) impact. Correction or mitigation must be planned prior to commissioning or assumption of routine operations.

- **Observation:** A deficiency that, in the judgment of the Team, offers an opportunity for safety improvement or provides a comment on an operational objective not related to safety. Observations do not require formal corrective action plans.

This classification was used in the Accelerator Readiness Assessment of the Los Alamos Low Energy Demonstration Accelerator (LEDA) conducted in November-December 1998 and the DARHT MSA. The team typically discussed each deficiency and proposed classification.

4.5 Communication and Documentation

Proposed deficiencies, classified as Pre-Start Findings or Post-Start Findings, were presented by the ARR Team to DX Division staff, DARHT Project participants, and appropriate DOE personnel at end-of-day closeout meetings. Accuracy of the Assessment Reports and the associated deficiencies were a product of intense and open exchange between the ARR Team and DARHT staff. Draft Assessment Reports were posted and received limited review by DARHT staff.

The ARR Team concluded its on-site review with a formal closeout briefing on March 30, 1999. The briefing provided the preliminary findings of the Team. DX Division personnel, including the division director, attended the briefing. Also in attendance were other DARHT Project personnel, including the construction project manager. DOE representatives attending the closeout briefing included the DOE-LAAO manager. The closeout briefing was video taped and can be referenced through

- ***Closeout, Accelerator Readiness Review, DARHT Facility***, LANL Videotape 99-082, March 30 1999.

The Team Leader coordinated preparation of the Final Report. The Final Report relies on the Assessment Reports provided in Appendix B and the functional assessments drafted by the team members. The functional assessments have the concurrence of the lead team member. Team members concurred on the conclusions and the readiness determination in the Final Report.

The Final Report will be issued to Robert Day, the DX Division Director, and to David Gurule, the DOE-LAAO Manager.

5.0 FUNCTIONAL ASSESSMENTS

The Accelerator Readiness Review for the DARHT Facility was organized in accordance with eight functional categories. Each category featured specific Performance Objectives and Acceptance Criteria. Summary assessments by function are provided below. Each summary discusses objectives and includes conclusions, findings, and observations. These summaries, and their supporting Assessment Reports, serve as the basis of the readiness review.

5.1 Safety Basis

5.1.1 Objectives

The readiness of the DARHT Facility for accelerator operations was reviewed with respect to its safety basis according to the performance objectives in Table 5. Fourteen acceptance criteria were used to assess the approval of a documented safety basis, inclusion of an appropriate Accelerator Safety Envelope, conformance to the safety basis through implementation of adequate controls and surveillances, and maintenance of the safety basis through formal change control.

The documented safety basis for the DARHT Facility as assessed here comprises three principal elements. The first is the Safety Assessment Document, developed by DX Division in accordance with DOE O 420.2. The SAD includes the definition of the DARHT ASE in Chapter 5. The second element is the DOE Safety Evaluation Report, which provides approval of the DARHT SAD subject to four conditions. The final element is the DARHT Environmental Impact Statement and the DOE Record of Decision.

Table 5: Performance Objectives for Safety Basis

SB-1	The facility/operation safety basis documentation for DARHT operations is approved and adequately defines the safe operating envelope.
SB-2	The safety basis specifies adequate and correct controls for performing the DARHT operations and for operating and maintaining associated process and utility systems, and these controls have been implemented adequately.
SB-3	A program is in place to confirm and periodically reconfirm the condition and operability of safety systems and equipment, including safety-related process systems and safety-related utility systems.
SB-4	A change control process for DARHT operations is in place to determine if a change is within the approved safety basis.

5.1.2 Summary

In general, the safety basis, including the definition of the ASE, has been clearly defined and approved. The safety basis is adequate to protect workers, the public, the environment, and the facility. The controls and surveillances as defined in the safety basis have been implemented satisfactorily with the exception of a few administrative issues. A change control process has been established through an appropriate USI Procedure.

The fourteen Assessment Reports for this function are found in Appendix B. These reports provide the basis for assessment, the identified deficiencies, and the conclusions. The resulting findings and observations are listed in Table 6, Table 7, and Table 8. The findings, both pre-start and post-start, as well as observations, reflect weaknesses in the quality management system for the operation and maintenance of the DARHT Facility. This weakness was identified in the DX Division MSA. Once these issues have been resolved, the integrity of DARHT operations, including their safety, can be assured.

Critical to the startup of the DARHT Axis-1 accelerator are the implementation of the USI Procedure, the completion of the Radiation Safety Plan, the completion of necessary training, and the resolution of deficiencies in test procedures for safety systems. With respect to test procedures, it is important that DX Division implement control and approval of checklists used to conduct surveillances in accordance with ASE requirements. The extensive checks specified by the constructing group (DX-8) provide a strong basis for operational test procedures. This approach is encouraged.

Post-start findings need to be addressed promptly, but not necessarily before Axis-1 accelerator operations begin. These include formalizing HE limits before commencement of such operations, development of maintenance procedures for surveillance of electrical interlocks, and assurance of an adequate maintenance program for SFE.

The adequacy of the beam stop and associated administrative controls was a special issue in the ARR. Assessed here was the relationship of the beam stop to the safety basis and the Radiation Safety System. It is our view that the beam stop is an integral component of the RSS and should be considered within the operational requirements in the ASE. This consideration should be included at the next annual review of the SAD. This issue was also assessed through the systems engineering and radiological protection functions.

With respect to the DARHT EIS and its Record of Decision, no deficiencies were identified. This positive result reflects an effective working relationship between the Laboratory's environmental protection organizations and the DARHT project and operations staffs. The strong and supportive relationship is to be complimented.

Table 6: Pre-Start Findings for Safety Basis

SB-2	AC-2	DARHT-specific training on the SAD and ASE remains under development.
SB-2	AC-2	The Radiation Safety Plan is not approved.
SB-3	AC-1,2	Test procedures for safety system checks are inadequate, inconsistent, and not appropriately documented.
SB-4	AC-1,2,3,4	The USI Procedure is not yet being applied.

Table 7: Post-Start Findings for Safety Basis

SB-2	AC-2	The administrative limit for explosives is not finalized in an approved procedure.
SB-3	AC-1,2	There is no procedure for annual surveillance of electrical interlocks as required by SR 5.3.4 in the SAD.
SB-3	AC-1,2	With respect to safety functions, the boundaries between facility equipment and SFE need to be better defined, including the maintenance management program for SFE in accordance with LIR 230-04-01.

Table 8: Observations for Safety Basis

SB-2	AC-1	There are inconsistencies in the ASE as noted in the discussion.
SB-2	AC-3	Not all DARHT personnel are aware of the ASE requirements.
SB-3	AC-1,2	The process for tracking deficiencies at the operations level should be more robust to ensure deficiencies are corrected.
SB-4	AC-1,2,3,4	Since there are now multiple LANL facilities with this requirement, it would be good to have formalized Laboratory USI guidance.

5.2 Systems Engineering

5.2.1 Objectives

The readiness of the DARHT Facility for accelerator operations was reviewed with respect to systems engineering according to the performance objectives in Table 9. Eleven acceptance criteria were used to assess safety-related systems, including their proper installation and operation, the adequacy of operating procedures, and appropriateness of established controls.

Assessment in this functional area was conducted through interviews of key personnel and reviews of critical documentation. Design documentation, operational procedures and checklists, and the documented safety basis were reviewed. In addition several operations such as injector testing and operation of an eight-cell block were observed for conformance to requirements. Special emphasis was placed on review of the Radiation Safety System and the adequacy of the beam stop as a control device.

Table 9: Performance Objectives for Systems Engineering

SE-1	Systems and equipment for DARHT operations will perform their required safety functions and ensure worker safety.
SE-2	Procedures for operating safety-related systems and equipment are technically correct and consistent with the safety basis for DARHT operations.
SE-3	There are adequate and correct safety requirements (i.e., controls) for operating and maintaining the designated process systems and utility systems.

5.2.2 Summary

With minor exceptions, the safety-related systems, equipment and procedures for the operation of the DARHT Axis-1 accelerator are well thought out and effectively implemented. Thorough procedures describe the steps for safely de-energizing potentially lethal pulse power systems. The RSS, along with administrative controls, will adequately protect workers from the radiation hazards that exist in the DARHT Facility. The RSS, coupled with the HESS, provide the necessary safeguards to protect personnel when high explosives are present at the firing point and the accelerator is in operation, a situation that will frequently exist after the DARHT Facility becomes a fully functioning hydrodynamic testing facility. The beam stop has been thoroughly assessed as a critical element of personnel protection. Upon resolution of specific technical details, the beam stop will adequately perform its function.

The eleven Assessment Reports for this function are found in Appendix B. These reports provide the basis for assessment, the identified deficiencies, and the conclusions. The resulting findings and observations are listed in Table 10, Table 11, and Table 12.

Pre-start findings identify the need for physical improvements to the beam stop to ensure its adequacy as a control device. The issues with the beam stop have been understood for some time, and the hardware modifications are being designed and fabricated. Additional pre-start findings call for evaluation and modification of procedural and software details of the RSS to ensure personnel safety and integrity of operations. Of particular note is to ensure adequate time is allotted for the safety sweep of the Accelerator Hall and for the delay between the alarm and the start of accelerator operations. The final pre-start findings require additional controls for electrical safety during specific operations.

The single post-start finding notes the inadequacy of the current public address system in the Accelerator Hall and Power Supply Room. Improvement to the PA system will require additional study and is not considered to have a first-order impact on safety.

Considered noteworthy were the color-coding of injector start-up and shutdown procedures. Color-coding provides easy identification of procedural instructions. Also, the Limited Access Procedure in the RSS is an excellent safety feature that allows personnel access to the Accelerator Hall while maintaining the integrity of the sweep.

Table 10: Pre-Start Findings for Systems Engineering

SE-1	AC-3	The individual conducting the sweep cannot visually verify that the beam stop is in place.
SE-1	AC-3	The beam stop does not have any passive mechanical support when in place in the beam line.
SE-1	AC-3	The 4 minutes allotted for a Sweep of the Accelerator Hallway is not adequate.
SE-1	AC-3	A 20-second delay time between start of bells indicating the accelerator is charging and the accelerator firing is insufficient time for an individual caught in the accelerator hallway to reach and activate a SCRAM.
SE-1	AC-3	No administrative or computer control addresses energizing only one 8 cell block being energized at any one time while operating in Mode 1 as described in the ASE.
SE-2	AC-3	There is no formalized procedure, including assignments, for handling controlled keys.
SE-2	AC-4	The DX-6 SOP 210 and the DARHT SAD are not consistent in their definition of modes.
SE-3	AC-1	There is no procedure in place to operate in the Pulse Power Checkout mode, which may include barriers, signage, and rotating beacons.
SE-3	AC-1	The injector high voltage power supply is not locked and tagged during diode maintenance.

Table 11: Post-Start Findings for Systems Engineering

SE-1	AC-3	The PA system, which serves the Accelerator and Power Supply Hallways, is ineffective as an element of the PSS.

Table 12: Observations for Systems Engineering

SE-1	AC-3	Headsets that allow clear and continuous communication between personnel working in the accelerator hallway, power supply hallway, control room, firing point, and detection chamber are needed to maintain good communications and safe working conditions.
SE-1	AC-3	The SCRAM condition does not return all accelerator systems to the safe de-energized state.
SE-2	AC-1	Disassembly procedures for the prime power tank, spark gaps, transmission lines, BCUs and TUs should be documented to ensure personnel safety as new people come on board and hardware longevity.
SE-2	AC-4	Page 64 of the SAD states "...physical lockout of the accelerator controls when personnel are present on the firing site..." The term "accelerator controls" should be replaced with "beam stop".
SE-2	AC-4	A test plan for commissioning the accelerator does not exist.
SE-2	AC-5	Written procedures, available expertise, and safe general work practices should adequately cover all credible contingencies as they arise.
SE-3	AC-2	The DARHT ASE on pg. 75 of the Safety Assessment Document states that "...accelerator is incapable of generating electron energies greater than 22 MeV by design." Is this absolutely true, or can it be achieved with minimum beam loading, increasing HVPS charge settings, modified or faulty cell load cans, etc.?

5.3 Conduct of Operations

5.3.1 Objectives

The readiness of the DARHT Facility for accelerator operations was reviewed with respect to conduct of operations according to the performance objectives in Table 13. Thirteen acceptance criteria were used to assess the adequacy of procedures, pre-operational testing, and deficiency tracking required for the safe conduct of operations. In addition, roles and responsibilities were assessed.

Assessment in this functional area was conducted through a systematic review and evaluation of operations documents (e.g., SOPs) and the related instructions that govern the procedural process (e.g., DX Division Operations Manual). Also reviewed were the facility design and construction documentation (e.g., the Project Improvement Management Plan), including the disposition of findings and actions from construction project reviews. Selected test processes and their computer-based tools were examined. Roles and responsibilities were examined through comparison of organization charts and personnel files against feedback from DARHT Project, DX-6, and DX-8 personnel.

Table 13: Performance Objectives for Conduct of Operations

CO-1	There are adequate and correct procedures in place to assure safe conduct of DARHT.
CO-2	Pre-operational testing has been completed and was adequate to demonstrate that DARHT operations can be conducted safely.
CO-3	A process has been established to identify, evaluate, and resolve deficiencies and recommendations made by oversight groups, official review teams, and audit organizations, and the operating contractor.
CO-4	Roles and responsibilities are defined, understood, and practiced within the DARHT Facility.

5.3.2 Summary

Systems are in place to ensure that operations are conducted in a safe and reliable manner. In particular, an elaborate document control system for procedures has been in place for many years and is rigorous and effective. Most importantly, it involves affected workers in the development of operational procedures (SOPs and SWPs) and ensures thorough and adequate review. Also, thorough pre-operational testing was planned, executed, and documented to ensure that equipment was ready for operation. The use of transient overlays on computer displays is considered noteworthy. Deficiencies identified during review of DARHT activities have been thoroughly documented and the resulting corrective actions have been tracked effectively. Finally, organizational relationships are well defined, both internally to DX Division and externally. Extensive use of work packages has ensured definition of work and interfaces in the construction of the facility and the installation of SFE.

The twelve Assessment Reports for this function are found in Appendix B. These reports provide the basis for assessment, the identified deficiency, and the conclusions. There are no identified pre-start or post-start findings. The resulting observation is listed in Table 14.

It is noteworthy that transition plans for the facility, as well as the accelerator equipment, have been prepared for turnover from construction to operation. In addition, a plan has been prepared for the transition of each individual from the constructing group (DX-8) to the operating group (DX-6). This approach ensures continuity of systems, processes, and knowledge to maintain a strong conduct of operations environment.

Table 14: Observations for Conduct of Operations

CO-3	AC-3	The Project Implementation Management Plan used to track corrective actions during DARHT construction has to be transferred from the construction phase to the operating phase.

5.4 Configuration Management

5.4.1 Objectives

The readiness of the DARHT Facility for accelerator operations was reviewed with respect to configuration management according to the performance objectives in Table 15. Ten acceptance criteria were used to assess the system used to maintain the configuration of the DARHT Facility.

Assessment in this functional area was conducted through reviews of plans and systems, including the DX Division Configuration Management Plan and Configuration Management Implementation Plan. Also assessed were specific drawings to examine changes, retrievals, and signatures. Relevant operating procedures were assessed and interviews were conducted.

Table 15: Performance Objectives for Configuration Management

CM-1	Safety-related and mission critical systems and equipment for DARHT operations are defined, and a comprehensive CM system/procedure to maintain control over the design and modifications of these is established.
CM-2	Modifications to the facility for DARHT operations have been reviewed to ensure that the design, software, and hardware introduced by the project maintain the safe operating envelope described in the safety basis documentation.

5.4.2 Summary

There are effective elements of configuration management in place. Examples of effective configuration management elements are those for mechanical design and the design of electronics hardware and software. The computerized drawing system that supports these elements is judged as excellent. Personnel were familiar with configuration control at the working level. Log books, computer records, spreadsheets, and weekly meetings and minutes are used effectively to manage the configuration of the facility and the SFE. However, a comprehensive configuration management system is not yet implemented.

The eight Assessment Reports for this function are found in Appendix B. These reports provide the basis for assessment, the identified deficiencies, and the conclusions. The resulting findings and observations are listed in Table 16, Table 17, and Table 18.

It is critical that the USI Procedure be implemented prior to commencing Axis-1 accelerator operations (see also Section 5.1.2). Implementation will ensure any changes to the configuration of the facility or the SFE are adequately reviewed and approved against the safety basis.

Post-start findings call for the implementation of a comprehensive system for configuration management, which includes a complete set of as-built drawings. Currently, the configuration is known and documented in "red-line" drawings. The situation here is not atypical for a facility in transition from construction to operation. However, it is important to expedite the implementation of this comprehensive plan to ensure modifications are adequately documented. Prompt completion and approval of as-built drawings is necessary to ensure adequate documentation of the current configuration of the facility and the SFE. In addition, the Document Control Plan needs approval. This plan will ensure documents, such as as-built drawings, can be adequately maintained. These findings are again indicative of a quality management system that needs strengthening.

Table 16: Pre-Start Findings for Configuration Management

CM-2	AC-3,7	The USI Procedure is not implemented.

Table 17: Post-Start Findings for Configuration Management

CM-1	AC-1	A comprehensive configuration management system for the DARHT Facility is not in place.
CM-2	AC-1	As-built drawings have not been comprehensively completed
CM-2	AC-3,7	The Document Control Plan is not approved.

Table 18: Observations for Configuration Management

CM-2	AC-5	Hardware and software changes must be controlled by the Configuration Management Plan.

5.5 Electrical Safety

5.5.1 Objectives

The readiness of the DARHT Facility for accelerator operations was reviewed with respect to electrical safety according to the performance objectives in Table 19. Fifteen acceptance criteria were used to assess system design, configuration control, engineering and administrative controls, and the effectiveness of training. The underlying principle for this functional assessment is the effective separation of workers from the risks and consequences of electricity.

Assessment in this functional area was conducted through walkthroughs; reviews of design documents, construction and operating procedures, authorization documents, and training plans; and interviews of personnel involved in the design, installation, and operations of electrical systems. The single point ground system received special attention. Also, several operations and procedures were demonstrated by DARHT personnel.

Table 19: Performance Objectives for Electrical Safety

ES-1	Systems are designed to preclude inadvertent contact with energized electrical components or conductors.
ES-2	A configuration control process for electrical equipment and systems has been developed and implemented to ensure consistent hazard mitigation throughout the DAHRT Facility.
ES-3	Engineered controls are in place to preclude inadvertent contact with energized electrical components or conductors.
ES-4	Administrative Controls have been developed and implemented to prevent hazardous situations from occurring during the operation or maintenance of the DAHRT complex.
ES-5	A program has been implemented utilizing classroom and On-the-Job training to ensure qualification of electrical workers in the DAHRT Facility.

5.5.2 Summary

From an electrical installation and safety standpoint, the DARHT Facility is in good shape. The Axis-1 area is reasonably clean. The facility equipment and the vast majority of the SFE are extremely well installed and safe with respect to the barriers that keep people away from electrical hazards. The single point ground (SPG) is a hybrid electrical system that combines elements of the facility and SFE into a single system. This system was well designed and engineered. The SPG is safe, meets programmatic requirements, and is properly approved. The excellent design and installation of the SFE has resulted in a first-rate facility that should be a "show place" for years to come.

The fifteen Assessment Reports for this function are found in Appendix B. These reports provide the basis for assessment, the identified deficiencies, and the conclusions. The resulting findings and observations are listed in Table 20, Table 21, and Table 22.

In facilities such as DARHT, the electrical system can be divided into two categories, the facility electrical system and the programmatic electrical equipment (SFE). The facility electrical system is well understood, constructed by commercial electricians, and rigorously inspected to meet appropriate standards. The SFE are unique, one-of-a-kind devices built by commercial vendors to Laboratory specifications and installed by DX-8 technicians and engineers. The acceptance and testing of the SFE was carried out by DX-8 technicians with assistance of subject matter experts external to DX Division.

The pre-start finding concerns two elements of the SFE that need to be addressed prior to start-up to increase the effectiveness of electrical barriers. The first concerns an inadequate barrier at the connection of power supply cables to the solenoid magnets. The other is the potential for hazardous voltages being present on certain diagnostic ports in the pulse power equipment.

A finding of the Management Self-Assessment (MSA) for the DARHT Facility identified a possible accident scenario involving the SPG. At the DARHT Facility, the wiring of the grounding conductor, which is common to both the facility electrical system and the SFE, was designed at variance to the National Electric Code to satisfy programmatic noise specifications. To assure safe operations, an extremely detailed analysis of the system was conducted. Based on this analysis and review by the Site-wide Electrical Safety Committee, the Laboratory's Chief Electrical Safety Officer approved the variance. The variance was issued with the condition that operating procedures and authorization documents be modified to address two concerns. The first of these concerns is to ensure that maintenance conducted on the electrical system maintain the special configuration of the SPG. The second is that, in the event the programmatic mission of DARHT is terminated or significantly modified, the facility's electrical system be restored to a conventional ground. These procedural modifications have yet to be completed. This is a post-start finding.

Additional post-start findings are related to the need to complete as-built drawings and to institute a formal change control process. There are several areas where formal documentation has not kept pace with the rapid progress of machine construction. An excellent drawing management system has been put into place and as the equipment installation and design is finalized, the data is entered into the system. Since the facility is still being assembled and tested, not all of the drawings have been entered into the system. This should be done so that operation and maintenance activities can be done accurately and safely. Similar issues of configuration management have been cited in previous functional area assessments (see for example Section 5.4.2).

The final post-start finding cites the need for a formal testing program for the dump relays in the pulsed power systems.

Table 20: Pre-Start Findings for Electrical Safety

ES-3	AC-2	Barriers to certain electrical equipment are inadequate.

Table 21: Post-Start Findings for Electrical Safety

ES-1	AC-1	Changes to the SAD and the SOP as specified in the approval of the single point ground (SPG) system have not been fully implemented.
ES-2	AC-1	No formal change control processes are in place for SFE.
ES-3	AC-3	There is no formal testing program in place for the dump relays in the pulse power systems.
ES-4	AC-4	As-built SFE drawings are not fully available.

Table 22: Observations for Electrical Safety

ES-1	AC-1	Cable specifications in NEC Article 318 should be considered in specifications for the DARHT Axis 2 accelerator and for upgrades of the Axis-1 accelerator.
ES-4	AC-1	DX-6:SOP-210, *DAHRT 1*, needs to be converted to a Hazard Control Plan (HCP) to be compliant with the LIR 300-00-01, *Safe Work Practices*.
ES-5	AC-3	There is no formal documentation for OJT for electrical work using the EDS

5.6 Industrial Safety

5.6.1 Objectives

The readiness of the DARHT Facility for accelerator operations was reviewed with respect to industrial safety according to the performance objectives in Table 23. Twenty-two acceptance criteria were used to assess awareness, training and protection of personnel from physical and chemical hazards; hazards presented by the facility and its equipment; the fire protection program; and environmental compliance.

Assessment in this functional area was conducted through facility walkthroughs; examination of facility configuration, certifications, and equipment records; reviews of procedures and documents; observation of personnel; review of personnel training and certification records; review of the Fire Hazard Analysis; and review of applicable environmental permits and other regulatory authorizations.

Table 23: Performance Objectives for Industrial Safety

IS-1	The industrial safety program ensures that personnel are aware of chemical and physical hazards associated with the DARHT operation and facilities and trained to control these hazards.
IS-2	Walking and working surfaces in facilities used for DARHT operations are free of hazards.
IS-3	A fire protection program is established for DARHT operations and associated facilities to prevent and suppress fires and to ensure fire protection support services are adequate.
IS-4	Risks from a fire in the facility (used for DARHT operations) have been adequately addressed.
IS-5	Hoisting and rigging activities at the DARHT Facility are conducted so that personnel injuries and property damage are prevented.
IS-6	The DARHT Facility conforms to applicable environmental and waste management regulations.

5.6.2 Summary

Activity hazard analysis is employed in the DARHT Facility. Chemical inventories are current. Effective procedures are in place to minimize and control exposures to hazardous materials. Observation of personnel handling hazardous materials confirmed adequate training. Personnel are aware of emergency procedures and demonstrate competence with respect to the DX Division Emergency Guide. The layout of the DARHT Facility, including the installed equipment, appears to minimize occupational hazards with some notable exceptions. Walking and working surfaces are in generally good condition and are free of hazards. Hoisting and rigging equipment are in good operating condition and are adequately maintained and tested. Technicians are adequately qualified and trained to conduct hoisting and rigging operations. Good housekeeping practices have minimized flammable and combustible loading. Although the facility fire protection system is not complete because of on-going construction in the west Accelerator Hall, the occupied portions of the facility, which are the focus of this review, have operable and sufficient fire protection services, although final certification of the system and resolution of FHA findings remain. The DARHT Facility and its operations are in full compliance with environmental regulations.

The sixteen Assessment Reports for this function are found in Appendix B. These reports provide the basis for assessment, the identified deficiencies, and the conclusions. The resulting findings and observations are listed in Table 24, Table 25, and Table 26.

The pre-start finding notes the need for a maintenance procedure for an oxygen sensor.

The post-start findings relate to deficiencies in the fire protection program, including Life Safety Code violations. NFPA certification of the fire protection systems, which is the responsibility of the construction contractor, is imminent. In addition, DX Division has not fully resolved the deficiencies and recommendations of the Fire Hazard Analysis.

Finally, several non-compliances of the Life Safety Code were identified as a post-start finding. Overall, the DARHT Facility is in reasonable compliance. The items cited within this finding are important safety issues that need prompt attention. However, these items do not directly impact the safety of accelerator operations and their correction can be addressed independently.

Table 24: Pre-Start Findings for Industrial Safety

IS-1	AC-6	The oxygen sensor instrumentation in the Control Room does not have a preventive maintenance procedure.

Table 25: Post-Start Findings for Industrial Safety

IS-3	AC-2	The NFPA certification that validates all fire protection systems as operational has not been completed.
IS-3	AC-4	Items of noncompliance with the Life Safety Code have been identified in the DARHT Facility.
IS-4	AC-1,2	The deficiencies and recommendations from the approved FHA have not been fully resolved.

Table 26: Observations for Industrial Safety

IS-1	AC-1	Magnetic field survey awaits Axis-1 accelerator operations.
IS-1	AC-1	Formalized training for the proper and safe use of PRESTO lifts is recommended.
IS-1	AC-1	Further evaluation is recommended of the "chaseway" under the Detector Room as to its potential classification as a confined space.
IS-1	AC-3	Some chemical items found in flammable lockers did not appear to have Material Safety Data Sheets available.
IS-1	AC-4	Documentation of training for handling hazardous materials needs strengthening.
IS-1	AC-6	There is no light switch near the southeast entrance of the Pulse-Power Room (injector end).
IS-2	AC-1 to 5	The raised thresholds of the six doors exiting the Detection Chamber Room are potential tripping hazards.
IS-5	AC-1	The portable, electronic controller should be locked in a storage cabinet when not in use.
IS-5	AC-2,3	In some cases, there were inconsistencies in the training records for crane and hoist operators.
IS-6	AC-1,2	Plugging of floor drains for special activities should be should be controlled by a Special Work Permit to ensure additional hazards are not created from concurrent activities.

5.7 Radiological Protection

5.7.1 Objectives

The readiness of the DARHT Facility for accelerator operations was reviewed with respect to radiological protection according to the performance objectives in Table 27. Sixteen acceptance criteria were used to assess the adequacy of the radiological protection program. This includes assessment of personnel, processes and procedures, support facilities, and equipment. Also assessed were the Radiation Safety System and the engineering and administrative controls of the facility, including the beam stop.

Assessment in this functional area was conducted through review of the institutional radiation protection program; the draft Radiation Safety Plan for the DARHT Facility; and site-specific procedures, controls, and instrumentation. Radiation protection staff were interviewed and assessed, including their training, certification, and orientation. Also assessed were design studies for shielding and the beam stop; facility drawings; and design review records. Interviews were conducted with design and project engineers. Facility walkthroughs were conducted and selected operations were observed.

Table 27: Performance Objectives for Radiological Protection

RP-1	A radiological protection program is established, sufficient numbers of qualified personnel are provided, and adequate facilities and equipment are available to ensure operational support services are adequate for safe DARHT operations.
RP-2	Level of knowledge of radiological protection support personnel assigned to DARHT operations is adequate.
RP-3	A formally structured, auditable ALARA program is in place to ensure that radiation exposures are maintained as low as reasonably achievable (ALARA) for DARHT operations.
RP-4	Radiation monitoring and alarm systems are provided to protect and inform personnel or radiation hazards during DARHT operations.
RP-5	The Radiation Work Permit (RWP) process for controlling non-routine activities associated with DARHT operations is adequate.
RP-6	Physical design features, rather than administrative controls, are the primary methods for exposure control in the DARHT Facility.

5.7.2 Summary

The services and requirements provided by the Laboratory's Radiation Protection Program are adequate to support DARHT operations. The radiation protection personnel who provide technical support to DARHT are knowledgeable of the operations, hazards, and necessary controls. ALARA engineering features are present in the facility. These facility features support access control for radiological purposes and provide radiation shielding and contamination control. From a design perspective, the beam stop provides effective protection to workers (see also Section 5.2.2). The RSS, along with administrative controls, will adequately protect workers from the radiation hazards that exist in the DARHT Facility.

The sixteen Assessment Reports for this function are found in Appendix B. These reports provide the basis for assessment, the identified deficiencies, and the conclusions. The resulting findings and observations are listed in Table 28 and Table 29.

One category of pre-start findings involves general radiological controls and documentation. The Radiation Safety Plan needs to be completed, approved, and implemented. The Radiological Controls SOP needs revision to include DARHT specific details and requirements, including those for posting.

A second category of pre-start findings identifies deficiencies in the RSS. These include adjustment of the 20-second alarm period (see also Section 5.2.2), the completion of boundary fence installation, and the modification of RSS programming and administrative controls for Mode 2 operations.

Table 28: Pre-Start Findings for Radiological Protection

RP-2	AC-2	The Radiation Safety Plan is not completed or approved. The document must consistently reflect the facility knowledge and control plans of the currently assigned radiation protection personnel.
RP-2	AC-2	The Radiological Controls SOP requires revision to include DARHT specific hazards and instructions. Radiological posting requirements must minimally be addressed.
RP-4	AC-1	An alarm period of 20 seconds preceding accelerator operation is insufficient.
RP-4	AC-1	An administrative mechanism needs to be prepared ensuring that Mode 2 access control is invoked without raising of the beam stop until adequate dosimetry is collected for the firing point.
RP-4	AC-1	Installation of fences providing the physical and administrative boundaries outside the DARHT building must be completed.
RP-4	AC-1	Modification of the RSS display programming must be completed to accurately indicate Mode 2 boundaries.

Table 29: Observations for Radiological Protection

RP-1	AC-2	The RCT orientation text should be revised to include DARHT-specific accelerator radiological hazards.
RP-1	AC-2	The RCT Facility Orientation and Training Review Checklist should be conducted again for the assigned technicians so that orientation and training will certify familiarity with the DARHT SOP and other current SOPs and plans revised and written specifically for DARHT operations.
RP-2	AC-1	The Self-Study Course for Accelerator Safety should be completed by RCTs supporting DARHT operations.
RP-2	AC-1	The Self-Study Course for Accelerator Safety should be included in the FMU's training checklist for assigned RCTs.
RP-3	AC-1	ALARA goal considerations for DARHT workers have not been documented by the procedurally responsible party.
RP-3	AC-1	The SOP for radiological controls references a superseded LP for ALARA goal trigger levels and guidelines. The SOP should be revised.
RP-6	AC-1	The tungsten alloy used to fabricate the beam stop differs from that considered for the facility characterization and hazard analysis. This does not change the non-nuclear facility determination for DARHT. In addition, the ferrous alloy yields doses bounded with analysis methods applied.
RP-6	AC-3	The bags of concrete mix used as shielding in the access holes through the accelerator hall wall may become activated and present a contamination control and airborne radioactive material hazard when removed for beamline maintenance. Further analysis and replacement with solid shielding blocks should be considered.

5.8 Training and Qualification

5.8.1 Objectives

The readiness of the DARHT Facility for accelerator operations was reviewed with respect to training and qualification according to the performance objectives in Table 30. Eleven acceptance criteria were used to assess the training program for the DARHT Facility, including the numbers, training, qualifications, and knowledge of operations and support personnel.

Assessment in this functional area was conducted through interviews of key personnel including group-level managers, team leaders, staff members and technicians from the constructing and operating groups (DX-8 and DX-6); facility management staff (FMU 67); and deployed ES&H training staff (ESH-13). Also assessed were qualification and training documentation, including checklists, plans, OJT plan descriptions, and personnel records. OJT was observed. Training and operations procedures were assessed. An RSS sweep and operations for start-up/shutdown of the injector were observed.

Table 30: Performance Objectives for Training and Qualification

TQ-1	A training and qualification program is established and sufficient numbers of qualified personnel are provided to support safe DARHT operations.
TQ-2	Training and qualification programs for DARHT operations and operations support personnel have been established, documented, and implemented.
TQ-3	The level of knowledge of DARHT technicians and support personnel is adequate.

5.8.2 Summary

There are sufficient trained, qualified, and knowledgeable personnel to support the safe operations of the DARHT Facility. The training program being established by DX-8 and the facility management team (FMU-67) is excellent. The program features formal systematics for training, qualification, and worker authorization. The approach is noteworthy and should be emulated by other groups in DX Division. Training plans are being tracked through the Laboratory's EDS, although some personnel have incomplete or expired training. On-the-job training is being adequately conducted, and OJT trainers and mentors are knowledgeable. As a result of many decades of safe operations with radiographic accelerators, pulsed power, and x-ray machines, procedures are extensive and well thought out. Personnel demonstrate the ability to execute procedures.

The eleven Assessment Reports for this function are found in Appendix B. These reports provide the basis for assessment, the identified deficiencies, and the conclusions. The resulting findings and observations are listed in Table 31 and Table 32.

The pre-start finding cites the need for a more systematic identification and analysis of hazards specific to the development and implementation of procedures for DARHT operations. Also cited is the need for full involvement by the responsible workers and supervisors. The process used by DX Division must establish better conformance with LIR 300-00-01, Safe Work Practices.

Post-start findings call for conclusion of the DX-8 training program development. Conclusion must provide formal processes for qualification and authorization. In addition, a post-start finding identifies a need to ensure that understanding of critical or high-hazard elements of operations are evaluated in OJT.

Table 31: Pre-Start Findings for Training and Qualification

TQ-3	AC-3	Hazards are not consistently identified and evaluated by the actual workers and their supervisors.

Table 32: Post-Start Findings for Training and Qualification

TQ-1	AC-2	The Worker Qualification and Training Documentation Plan, Work Authorization Matrix, and Training Matrix are in draft form.
TQ-1	AC-4	The process for qualification and authorization is not yet formalized.
TQ-2	AC-1	OJT questions are not consistently used to evaluate trainee comprehension of critical or high-hazard elements of operations.

6.0 SUMMARY CONCLUSION

6.1 Basis for Conclusions

The eight functional assessments provide the basis for the conclusions of the Accelerator Readiness Review. Thirty-three performance objectives were established to focus the review and to measure conformance to the fourteen Core Requirements identified in the Plan of Action (see Section 3.0). Specific tests of the DARHT Facility and its readiness to begin full-energy commissioning and routine operations of the Axis-1 accelerator were administered through 112 Acceptance Criteria. The results of these tests are documented in 99 Assessment Reports, which are provided in Appendix B. These reports document the eight functional assessments.

6.2 Conclusions of Readiness Review

The DARHT Facility has a fully developed Safety Assessment Document. The DOE Safety Evaluation Report for the DARHT Facility approved this SAD subject to four conditions. Conformance to these conditions was confirmed. The SAD, in Chapter 5, defines an adequate Accelerator Safety Envelope for Axis 1 of the DARHT Facility, subject to resolution of a few important findings. In addition the facility, relative to Axis-1 accelerator operations, has fully satisfied the significant expectations for environmental protection as established in the Final Environmental Impact Statement and the DOE Record of Decision for the DARHT Facility.

The DARHT Project has provided a safe and well-constructed facility. The project has employed contemporary management techniques with an impressive Work Breakdown Structure. The primary records for the constructed facility are available and current. These records need to be comprehensively entered into a formal system to ensure their long-term availability. It is noted, however, that the needs to finalize, control, and archive facility construction documents is typical of a project transitioning from construction to operations. Satisfaction of this need will establish the baseline for managing the configuration of the facility.

The Axis-1 accelerator is well engineered and constructed. The five years of operational experience gained in prototype development and testing is reflected in the finished product. The design team has been in place from conceptual design, through prototype development and operation, and into construction. The team is now preparing for operation. The continuity of essential personnel in a project of this size and complexity is unusual. It provides additional confidence as to the readiness to assume full operations. In our judgement, the exceptional quality of both equipment and staff will result in safe and reliable operations, and in superior programmatic performance.

The ability to conduct safe operations of the DARHT Axis-1 accelerator has been demonstrated in practice. The highly experienced operators and support staff are well trained and qualified. They have sufficient knowledge of the facility and the installed SFE to safely operate. However, confidence needs to be strengthened that the current ability to operate can be maintained. DX Division needs to enhance processes that assure the continued adequacy of safe procedures and the sustained training and qualification of authorized staff. The continued development of these processes, and their formality should be an imperative for DX Division to ensure the long-term integrity of operations.

DX Division has demonstrated, both organizationally and individually, a culture based on a long-standing safety ethic. The culture is manifested in the division's safe operating procedure system. This review has highlighted, from several functional perspectives, the strength of the traditional SOP system, as well as the need to reconcile this system with the Laboratory's new requirements for Hazard Control Plans under the Safe Work Practices LIR. It is critical that DX Division develops a stronger method in their SOP process to clarify the identification and analysis of hazards. This method must incorporate the involvement of impacted workers, be they technicians, technical staff members, or support staff. The method must also ensure specific authorization of individual workers. An important note is the seeming openness of DX Division managers and staff to constructive criticism. This characteristic is crucial to DX Division's ability to make these important changes without losing the strengths of its traditional system.

Implementation of the USI Procedure needs immediate priority. Implementation will resolve several findings from this review. The practice defined in the USI Procedure should be viewed as a routine and effective tool to evaluate the facility, the SFE, and related activities against the safety basis as defined in the ASE.

The roles and responsibilities of DX Division as an organization, of the DARHT Project, and of individuals within these organizations are reasonable and understood. DX Division's approach to facility management, including its support of the DARHT Facility and its operations, is effective. Organizing facility management as a project, which is staffed by a matrix of personnel drawn from internal groups and external support organizations, provides appropriate integration of support.

The review focused directed specific assessments on several safety-related systems. The first was the Radiation Safety System. The RSS is the central safety control for accelerator operations. The RSS assures protection of personnel in and around the Axis-1 accelerator, including staff operating on the firing pad. The RSS is well designed and configured. Upon correction of specific technical and administrative control details, the RSS will provide adequate and reliable protection to DARHT personnel.

In our judgement, the beam stop is a critical component of the Radiation Safety System. As such, the use of the beam stop as a protection device to allow the operation of the accelerator concurrent with firing pad operations was critically evaluated. The beam stop will provide sufficient protection, if its position can be visually verified and passively maintained. The DARHT SER, in approval Condition #1, directs additional consequence analysis. The condition implies that the beam stop may be a stand-alone safety system. The ARR Team differs. It is our recommendation that the beam stop be considered integral to the RSS. Any additional consequence analysis should be conducted within the context of the RSS.

The Single Point Ground (SPG) system was the second safety-related system receiving special attention. The special configuration of the facility and SFE grounding system, designed to reduce noise, required extra consideration to maintain a safe electrical configuration over the life of the facility. The facility has obtained the proper authorization for this special configuration. The SPG has been clearly evaluated, it is considered safe, and is recognized by experts as exceptional and "sweet". The extensive involvement of the DARHT Project electrical designers and the Laboratory's electrical safety practitioners in the review and approval of the SPG is considered noteworthy. DX Division must make appropriate changes to the SAD and SOP-210 to ensure this system is not unknowingly compromised during routine maintenance or modification. Provisions must also be made to restore the electrical system to a conventional ground if the facility is converted from its current use.

The purpose of this review was to establish the current state of readiness for assumption of Axis-1 accelerator operations at the DARHT Facility. Although the review has identified deficiencies that require resolution, no individual finding undermines our confidence as to the fundamental readiness of the facility. However, one should ask whether the totality of our findings exposes an underlying inadequacy that abrogates our confidence as to readiness.

Upon consideration, 20% of the pre-start and post-start findings determined from this review can be categorized as design or installation issues. The remaining 80%, such as incomplete or inconsistent plans, procedures, and documentation, are in our judgement indicative of a systematic deficiency. DX Division needs to strengthen its commitment to the disciplined elements of quality management for the control of DARHT activities.

DX Division previously identified this deficiency. The division conducted a Management Self-Assessment of the DARHT Facility prior to the readiness review. Three of the top-level findings of the MSA aggregate to the same quality management deficiency. We have confirmed in much greater detail what DX Division had already identified.

In our judgement, the systematic need to strengthen and practice effective quality management does not compromise the current abilities of the staff, the SFE, and the facility (i.e., the current state of readiness) to support safe operations of the DARHT Axis-1 accelerator. The concern raised by this systematic deficiency, however, is whether DX Division can sustain the current condition of readiness. In our view, implementation of a robust configuration management system, enhanced training and qualification processes, and improved operating procedures will provide keystones to assuring rigorous quality management. Such rigor will assure the long-term ability of DX Division to conduct safe operations at the DARHT Facility.

6.3 Assessment of Core Requirements

This review has evaluated the readiness of the DARHT Facility according to eight functional categories. These functional categories, through their respective performance objectives, are cross-referenced to the 14 Core Requirements extracted from DOE-STD-3006 for this review. The matrix shown in Table 31 relates the 33 performance objectives to specific Core Requirements. The functional approach has sufficiently tested each of the Core Requirements.

Table 33: Core Requirements vs. Functional Categories

Core Requirement	Functional Category							
	Safety Basis	Systems Engineering	Conduct of Operations	Configuration Management	Electrical Safety	Industrial Safety	Radiological Protection	Training and Qualification
CR #1	SB-2	SE-2, 3	CO-1		ES-4			
CR #2					ES-5			TQ-1, 2
CR #3						IS-1	RP-2	TQ-3
CR #4	SB-1, 4	SE-1, 2		CM-1, 2	ES-1, 2, 3	IS-4	RP-4, 5, 6	
CR #5	SB-3				ES-2, 3, 4			
CR #6			CO-3					
CR #7	SB-1							
CR #8					ES-1, 4, 5	IS-1, 2, 3, 5, 6	RP-1, 3, 4, 5	TQ-1
CR #9								TQ-2
CR #10			CO-2					
CR #11			CO-4					
CR #12			CO-1		ES-1			
CR #13					ES-5			TQ-1
CR #14	SB-2, 3		CO-4					TQ-3

7.0 READINESS DETERMINATION

The Accelerator Readiness Review Team for the DARHT Facility determines that, pending closure of pre-start findings and planning of corrective actions for post-start findings, the Laboratory's Dynamic Experimentation Division can proceed with full-energy commissioning activities and routine operations of the DARHT Axis-1 accelerator. In the judgement of the Team, the post-start findings do not impact the current ability of DX Division to safely operate the DARHT Facility. However, resolution of the post-start findings is crucial for the long-term assurance of safe operations.