

SEPTEMBER 24, 2007

REVIEW REPORT

OFFICE OF AUDITS

EFFECTIVE INSPECTION PROGRAM KEY TO
IMPROVING LABORATORY SAFETY AT
GLENN RESEARCH CENTER

OFFICE OF INSPECTOR GENERAL



National Aeronautics and
Space Administration

Final report released by:

signed

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Acronyms

GLPD	Glenn Lewis Policy Directive
HAZCOM	Hazard Communication Program
OIG	Office of Inspector General
OSHA	Occupational Safety and Health Administration
PI	Principal Investigator
MSDS	Material Safety Data Sheets
SHED	Safety, Health, and Environmental Division
SOP	Standard Operating Procedure

OVERVIEW

EFFECTIVE INSPECTION PROGRAM KEY TO IMPROVING LABORATORY SAFETY AT GLENN RESEARCH CENTER

The Issue

This review was initiated in response to two hotline complaints concerning Glenn Safety Programs: one concerned laboratory safety and the review process for granting Glenn Research Center (Glenn) safety permits, and the second concerned the actions of “first responder” personnel to a January 2006 fire in a Glenn underground tunnel. This report addresses laboratory safety and the process for reviewing, approving, and maintaining safety permits for Glenn laboratory operations; a separate report will address the first responder’s activities as they relate to the emergency response system at Glenn.

Glenn operates scientific laboratories that conduct research and development in areas such as microgravity science, fluid physics, and combustion science. To ensure that those laboratories are operated in accordance with applicable Federal, NASA, and Glenn safety guidance, Glenn requires that each of the laboratories apply for and maintain a safety permit that gives the authority to operate a laboratory or piece of equipment within the constraints listed on the permit. In addition, the Safety, Health, and Environmental Division (SHED) of Glenn’s Safety and Mission Assurance Directorate manages a safety and health inspection program with inspectors responsible for detecting, and reporting on, hazardous conditions, unsafe work practices, and other occupational safety and health issues identified in the laboratories.

We reviewed the management of the safety permit system and the safety and health inspection program, specifically focusing on their impact on overall laboratory safety. In January 2007, we conducted a review of 22 Glenn laboratories and evaluated the laboratory conditions and operations against Glenn’s laboratory safety guidance and the constraints listed on the laboratory safety permit. We also compared the results of our review to laboratory inspections performed as part of the safety and health inspection program. The details of our review’s scope and methodology are in Appendix A.

Results

Glenn did not ensure that all of its laboratories were operated in compliance with Glenn safety guidance. Specifically, we identified incidents of noncompliance in each of the 22 laboratories that we reviewed. For those 22 laboratories,¹

- 9 did not have a safety permit, the safety permit had expired, or the safety permit remained active after laboratory operations had ceased;
- 10 did not have a current or approved standard operating procedure (SOP) (7 had no SOP, 2 had SOPs that had expired, and 1 had an SOP that lacked the required signature/approval of the Glenn Chemical Hygiene Officer);
- 16 did not properly identify and store hazardous chemicals or maintain the required information for their safe use (for example, in 14 of the 18 laboratories, we found unattended flammable chemicals that were not properly stored);
- 17 were operated without adequate engineering controls or safeguards² (for example, in 1 laboratory, water valves used to control chilled water were located directly above electrically energized equipment, where inadvertent leaks or a line rupture could cause an electrically initiated fire and/or result in serious electrical shock);
- 7 were not maintained clean and free from potential hazards, such as keeping aisles and stairways free from clutter, cleaning chemical spills, minimizing combustibles in workplace and storage areas, and keeping all exits free from obstructions;
- 7 were operated by personnel without the requisite safety training, to include laboratory management personnel; and
- 13 did not meet fire and life safety standards (for example, laboratory personnel, when queried, did not have knowledge of primary and secondary emergency evacuation routes, did not know the location of the designated safe area, and were unfamiliar with the location of the nearest fire alarm).

Because SHED relies on the facility safety and health inspection program to detect laboratory safety violations, we analyzed the SHED inspection results from laboratory inspections conducted on or about the period of our review. That analysis indicated that

¹ The initial sample selected for inspection totaled 39 laboratories, however due to on-going hazardous operations, locked doors, and/or the unavailability of laboratory personnel, we were only able to inspect 22 of the laboratories.

² Engineering controls eliminate or reduce exposure to a chemical or physical hazard through the use or substitution of engineered machinery or equipment.

the SHED inspectors did not identify all of the issues that we identified during our review. However, it was difficult to fully validate that premise because SHED did not require its inspectors to identify all of the laboratories included in a specific inspection, only those laboratories that had violations. Therefore, we did not know whether the inspectors missed some of the problems we found or whether some of the problems we found were in laboratories that were not included in their inspection.

The inspection program's effectiveness could be improved if all laboratories at Glenn were subjected to inspection through inclusion in the inspection universe. SHED had defined its inspection universe as only those laboratories that had active safety permits, which did not account for those laboratories that may have never applied for a permit or whose safety permit had expired. We compared the SHED laboratory list to a list contained in the Glenn Facilities Division database and noted that the Facilities Division database included 192 more laboratories than the SHED list. Although both lists could be partially incorrect, reconciliation should be performed periodically to ensure that SHED maintains a comprehensive laboratory universe.

The effectiveness of the inspection program is also dependent on adequate follow up of the violations identified during the laboratory inspections. Although Glenn safety guidance required that corrective action plans be prepared for safety violations remaining open after 30 days, we identified 87 violations that should have had plans but did not. Nine of those violations were considered as having the potential to cause minor or severe injury or damage to personnel or equipment.

The risk of injury and/or damage associated with Glenn laboratory operations increases when those operations are not conducted in compliance with Glenn safety guidance. According to NASA's Incident Reporting Information System, during the 17-month period from January 2006 through May 2007, Glenn reported 28 mishaps³ and close calls⁴ that were directly or indirectly related to laboratory operations and the types of noncompliance issues that we identified. Had Glenn's facility safety and health inspection program been more effective in identifying, tracking, and monitoring laboratory safety violations, we expect that we would have identified fewer incidents of safety noncompliance. Improving the effectiveness of the inspection program should improve safety compliance and, most important, should reduce the risk of injury to personnel and damage to assets and facilities resulting from laboratory operations.

³ NASA defines a mishap as an unplanned event that results in injury to personnel or damage to property. NASA categorizes mishaps as Type A through Type D based on the severity of injury to personnel or total cost of damage to property.

⁴ NASA defines a close call as an occurrence or employee concern that did not result in injury to personnel or significant damage to property but possesses the potential to cause a mishap.

Management Action

Subsequent to our laboratory review, Glenn began taking corrective action to address a number of issues that are identified in this report. Specifically, SHED has initiated a comprehensive review of the Glenn chemical management and laboratory safety programs and initiated an update of chemical inventories by use of a commercially available database. For our findings that indicated an immediate health and/or safety threat, such as the improper storage of chemicals, SHED instituted a stop-work order and effectively mitigated the threat. That action, along with corrective action taken in response to our recommendations, should continue to improve the safety posture within the Glenn laboratories.

In a draft of this report, we recommended that the Director, Safety and Mission Assurance, Glenn Research Center, ensure that SHED develops a process that will comprehensively define the laboratory universe for the facility safety and health inspections. We also recommend that the Glenn Safety Manual, Chapter 24, be revised to require the facility safety and health inspectors to indicate not only the building number in which an inspection took place, but also the specific laboratories that were inspected. We recommend that Chapter 24 be further revised to require that the safety and health violation database be monitored and that Glenn management be notified of all past-due violations and corrective action plans. Finally, we recommend that SHED coordinate a safety stand-down day, in which laboratory personnel conduct a safety self-assessment of their laboratories and that the results of those assessments be used by SHED to issue violation notices and identify any systemic safety issues.

The Director, Glenn Research Center concurred with our finding and recommendations and provided a corrective action plan that details the actions to be taken for each recommendation along with planned completion dates (see Appendix E). We consider the recommendations resolved and will close the recommendations upon completion and verification of management's corrective actions.

CONTENTS

INTRODUCTION

Background _____	1
Objectives _____	2

RESULTS

Safety Guidance Not Always Followed at Glenn Laboratories _____	4
---	---

APPENDIX A

Scope and Methodology _____	15
Review of Internal Controls _____	16
Prior Coverage _____	16

APPENDIX B

OIG Review Results _____	17
--------------------------	----

APPENDIX C

Basic Inspection Checklist _____	29
----------------------------------	----

APPENDIX D

Detailed Inspection Checklist _____	32
-------------------------------------	----

APPENDIX E

Management Comments _____	41
---------------------------	----

APPENDIX F

Report Distribution _____	49
---------------------------	----

INTRODUCTION

Background

As one of NASA's 10 Centers, the Glenn Research Center (Glenn) develops and transfers critical technologies that address national priorities through research, technology development, and systems development for safe and reliable aeronautics, aerospace, and space applications. To accomplish its mission, Glenn operates scientific laboratories where research and development is conducted in areas such as microgravity science, fluid physics, and combustion science. The laboratories play a key role in aeropropulsion and turbomachinery and are major contributors in material science, aircraft and spacecraft structures, instrumentation and controls, and aircraft icing research. According to the Glenn Facilities Division, there are 563 laboratories located at Glenn's Lewis Field, which is adjacent to Cleveland Hopkins International Airport in Ohio.

Laboratory Management. The Glenn laboratories are managed by a principal investigator⁵ (PI) for the research or technology project or projects that are ongoing in a specific laboratory. At Glenn, laboratory personnel work for three of the four NASA Mission Directorates—Aeronautics Research, Exploration Systems, and Science. Although the laboratories are managed and operated by personnel who work for NASA's Mission Directorates, the authority to conduct a research or technology project in a specific laboratory is granted through the Glenn safety permit system. An approved safety permit constitutes a license to operate a laboratory or piece of equipment within the constraints listed on the permit.

Laboratory Safety. Glenn's Safety, Health, and Environmental Board is responsible for safety, health, and environmental policy and decision making and provides management leadership and oversight for the Center's Safety and Health Management System. The Center Director chairs the Board, and members include the Glenn Operational Directors, the Director of Safety and Mission Assurance, and Glenn's Chief Counsel. The Safety, Health, and Environmental Division (SHED) of Glenn's Safety and Mission Assurance Directorate is responsible for laboratory safety and the safety permit system. SHED is comprised of three Branches—Safety, Occupational Health, and Environmental Management. The Safety Branch recommends minimum acceptable safety standards for Center operations, maintains illness and injury records, and monitors Center activities to ensure compliance with all applicable safety standards and regulations. The Occupational Health Branch is responsible for the evaluation and measurement of exposure hazards in the work environment that can cause long-term or latent illness and

⁵ NASA Procedural Requirements 1080.1, "NASA Science Policy," February 2, 2005, defines Principal Investigators as "scientists external or internal to NASA who have received funding to perform specific research tasks."

disease. The Environmental Management Branch identifies risks posed by current and past Glenn programs, operations, and activities and develops and implements processes to remediate, abate, and control those risks.

The Safety, Health, and Environmental Board delegated the approval process for the safety permit system to 14 Area Safety Committees (9 geographically based and 5 specialty based). The Area Safety Committees are comprised of a chairperson, personnel with engineering and operational expertise, and representatives from SHED, as needed. The Area Safety Committees review proposals for all research and development operations, for modifications or additions to facilities and equipment, and for any project that may affect safety within their assigned safety area. For those proposals that meet Glenn safety requirements, the Committee approves and issues a safety permit; once the permit is issued, the requestor may begin the research operation or experiment. SHED's Safety Branch is responsible for maintaining a list of the issued permits and conducting periodic inspections of the laboratories to identify hazardous conditions, unsafe or unhealthy work practices, and other safety and health issues. The PI must submit a revision to the safety permit upon any deviation from the procedures or requirements listed on the permit.

Glenn Safety Guidance. Glenn's overarching safety policy is Glenn Lewis Policy Directive (GLPD) 1702.1I, "Glenn Safety and Health Program," April 2005, which parallels NASA Policy Directive 8710.2D, "NASA Safety and Health Program Policy," April 28, 2004. GLPD 1702.1I addresses the need to effectively manage operations so that risk to personnel, property, and the environment is eliminated or reduced. Policy documents for other aspects of the safety program include GLPD 1800.2, "Glenn Research Center Occupational Health Program," September 2006, and GLPD 8500.1, "NASA Glenn Environmental Management System," April 2007. The three SHED branches publish implementation instructions for Glenn safety guidance in three manuals—the Glenn Safety Manual, the Occupational Health Programs Manual, and the Environmental Programs Manual.

Objectives

Our overall objective was to determine whether the Glenn Safety Program was operated in accordance with applicable Federal, NASA, and Glenn guidance and if appropriate steps were being taken to prevent injury to Center personnel and damage to NASA assets. The review was initiated in response to two hotline complaints concerning Glenn Safety Programs: the first concerned laboratory safety and the review process for granting Glenn safety permits and the second concerned the actions of "first responder" personnel to a January 2006 fire in a Glenn underground tunnel. This report addresses laboratory safety and the process for reviewing, approving, and maintaining safety permits for Glenn laboratory operations; a separate report will address the first responder's activities as they relate to emergency response at Glenn. We also reviewed internal controls as they related to the review objective. See Appendix A for details of

INTRODUCTION

the review's scope and methodology, our review of internal controls, and a list of prior coverage.

SAFETY GUIDANCE NOT ALWAYS FOLLOWED AT GLENN LABORATORIES

Glenn did not ensure that all of its laboratories were operated in compliance with Glenn safety guidance. Specifically, we identified incidents of noncompliance in each of the 22 laboratories that we reviewed. For those 22 laboratories,⁶

- 9 did not have a safety permit, the safety permit had expired, or the safety permit remained active after laboratory operations had ceased;
- 10 did not have a current or approved standard operating procedure;
- 16 did not properly identify and store hazardous chemicals or maintain the required information for their safe use;
- 17 were operated without adequate engineering controls or safeguards⁷;
- 7 were not maintained clean and free from potential hazards;
- 7 were operated by personnel without the requisite safety training; and
- 13 did not meet fire and life safety standards.

SHED's facility safety and health inspection program was not effectively accomplishing its mission to ensure that laboratory safety violations were identified and adequately corrected. As a result, Glenn personnel, assets, and facilities were placed at an increased risk of injury and/or damage associated with laboratory operations. Review of NASA's Incident Reporting Information System for the 17-month period from January 2006 through May 2007 indicates that 28 of the 247 mishaps and close calls reported at Glenn were directly or indirectly related to laboratory operations and the types of noncompliance issues that we identified.

Laboratory Safety Guidance

The "Glenn Safety Manual," April 2007, and the "Environmental Programs Manual," April 2007, provide specific safety guidance for the Glenn laboratories. The manuals

⁶ The initial sample selected for inspection totaled 39 laboratories, however due to on-going hazardous operations, locked doors, and/or the unavailability of laboratory personnel, we were only able to inspect 22 of the laboratories.

⁷ Engineering controls eliminate or reduce exposure to a chemical or physical hazard through the use or substitution of engineered machinery or equipment.

contain instruction concerning the safety permit system, laboratory standard operating procedures (SOP), hazardous chemicals, engineering controls, employee training, and fire protection.

Glenn Safety Manual. The Glenn Safety Manual contains the requirements for safety permits and inspections, engineering controls, and fire protection. Chapter 1A, “Safety Permit System,” identifies certain activities likely to require an approved safety permit and outlines the procedures for requesting, reviewing, issuing, maintaining, renewing, and terminating safety permits. Chapter 15, “Personal Protective Equipment,” discusses requirements for identifying relevant engineering controls and the need for personal protective equipment such as ventilation and respiratory protection. Chapter 27 “Building Emergency Evacuation Plan Program,” and Chapter 31, “Fire Protection,” discuss the fire and life safety protective measures necessary to ensure safe and orderly emergency evacuations and the requisite controls designed to prevent, contain, and mitigate fires.

Environmental Programs Manual. The Environmental Programs Manual contains the requirements for the Hazard Communication (HAZCOM) Program. The purpose of the HAZCOM Program is to inform employees of the hazards associated with chemicals in the workplace. Chapter 16, “Hazard Communication Policy,” establishes the methods for communicating chemical hazard information, which includes container labeling, Material Safety Data Sheets (MSDS),⁸ and employee training. The Environmental Programs Manual also contains the requirements for laboratory SOPs, chemical management, laboratory maintenance, and training. Chapter 17, “Chemical Hygiene Policy,” requires every Glenn laboratory to develop an SOP describing the specific operations that take place in the laboratory. Each laboratory SOP, along with general measures established in the Chemical Hygiene Plan, defines the requisite engineering and procedural controls designed to protect employees from the harmful affects of chemicals used in a laboratory. Chapter 17 also contains a list of general training requirements for those laboratory employees that work with or around hazardous chemicals.

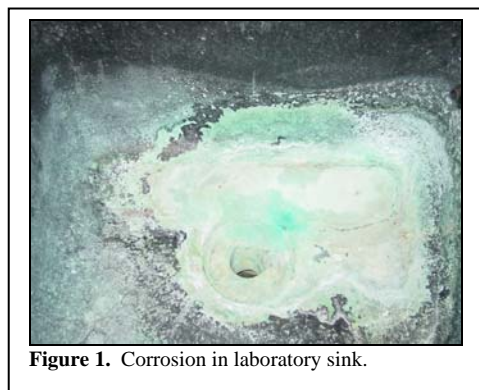
Laboratory Reviews Identified Noncompliance Issues

Glenn did not ensure that all of its laboratories were operated in compliance with Glenn safety guidance. We identified a total of 150 incidents of noncompliance in the 22 laboratories that we reviewed, pertaining to safety permits, SOPs, chemical management, laboratory safeguards, laboratory maintenance, and training. (See Appendix B for the list of noncompliance incidents.)

⁸ The Occupational Safety and Health Administration (OSHA) requires chemical manufactures to develop MSDS to inform end-users of a chemical’s composition, physical hazards, health hazards, exposure routes and limits, toxicology, instructions for safe use, emergency and first aid procedures, and the manufacture’s contact information.

Safety Permits. Safety permits were not available or valid in nine of the laboratories. In eight of the laboratories, operations were taking place that required a safety permit but the PI could not provide one. For example, in the Shape Memory Alloy Research and Technical Laboratory, laboratory personnel were working with a laser and other high-voltage equipment; however, there was no safety permit posted. According to Chapter 1A of the Glenn Safety Manual, any operation or activity that uses hazardous chemicals, pressurized systems, lasers, electrical or mechanical energy sources, or otherwise requires fire and life safety controls must have a safety permit.

The ninth laboratory had an active safety permit posted on the laboratory door, but according to documentation gathered in the laboratory, operations had been terminated for months. We were able to gain unrestricted access to the laboratory where we observed unlabeled chemical containers on top of a workbench and flammable chemicals that were improperly stored in a cabinet that was not rated for flammable chemical storage. We also observed glassware that was coated with a crystallized residue and syringes, sharps, and test equipment that was unsecured. The laboratory sink contained unidentified corrosion and discoloration that is consistent with improper waste disposal (see Figure 1). None of these conditions should have existed, as the Safety Manual specifically states that when a laboratory operation or activity is terminated, the PI should remove and return the safety permit to the Glenn Safety Branch and coordinate the phase out of the operation, including the removal and disposal of all hazardous materials.



Laboratory SOPs. Laboratory SOPs were not available or were incomplete in 10 of the laboratories. Specifically, 7 laboratories had no SOP and 2 had SOPs that had expired; one SOP lacked the required signature/approval of the Glenn Chemical Hygiene Officer. The Environmental Programs Manual, Chapter 17, establishes the Glenn Chemical Hygiene Plan, which requires the laboratory PIs to develop and submit an SOP to the Chemical Hygiene Officer if the PI plans to use chemicals in conducting his or her research. The SOP must include an overview of laboratory operations, identify the chemicals the PI plans to use in the laboratory, list the regulatory compliance requirements, describe emergency response procedures, and reflect guidance for revising the SOP, if needed. Without an SOP, laboratory personnel and personnel responding to a laboratory emergency may not have access to detailed safety and health information tailored to that specific laboratory.

Chemical Management. With regard to chemical management, we identified noncompliance issues in 16 of the laboratories. The Chemical Hygiene Plan outlines the Center's policy regarding chemical management and, in conjunction with the laboratory SOPs, contains procedural and engineering controls designed to protect laboratory workers from harmful affects presented by hazardous chemicals. The majority of the

noncompliance issues that we identified concerned improper chemical storage and labeling. In 14 laboratories, we found unattended flammable chemicals that were not properly stored. The Chemical Hygiene Plan requires that all flammable chemicals be stored in an approved flammable storage cabinet.⁹ It also requires that incompatible chemicals or chemicals that can react violently, generate substantial heat, or produce flammable or toxic by-products, be segregated from one another. In one laboratory, we discovered highly hazardous and reactive chemicals (bromine and lithium) co-located in the same unmarked storage space.¹⁰ We also observed instances where food and beverages were consumed in areas where chemicals were used and stored.

Regarding chemical labeling, we found unlabeled hazardous chemicals in six of the laboratories (see Figure 2). The Chemical Hygiene Plan requires all hazardous chemicals to be properly labeled in accordance with the HAZCOM Program. The label must match the information as stated on the MSDS. The labels should list the name of the chemical, hazard warnings, and the name and address of the manufacturer or other responsible party. Containers labeled by the chemical manufacture do not require additional labels; however, when chemicals are transferred to other containers (secondary containers), these secondary containers must be separately labeled.¹¹



Figure 2. Unattended and unlabeled containers holding hazardous chemicals.

The HAZCOM Program also requires that the employees have ready access to the MSDS and that an inventory be maintained for all hazardous chemicals used and stored in the workplace. We found that in seven laboratories, personnel did not have ready access to the MSDS and were unfamiliar with the properties and hazards of the chemicals used and stored in the laboratories. In three of the laboratories, personnel stated that they maintained MSDS for the laboratory on an automated information system; however, in each instance; computer terminals were not located in the laboratories. According to the HAZCOM Program, where electronic access is not available, laboratories should maintain the MSDS as hardcopy (i.e., provided as a paper document).

⁹ In accordance with the National Fire Protection Association's "Flammable and Combustible Liquids Code," Chapter 4.3.3 (b), and OSHA 29, Code of Federal Regulations 1910.106 (d)(3)(ii)(a), an approved flammable chemical storage cabinet is constructed of doubled walled No. 18 gauge sheet steel with 1 ½ in. (3.8 cm) of air space. The door must have a 3-point latching arrangement and the doorsill raised at least 2 in. (5 cm) above the bottom of the cabinet to retain spilled liquid.

¹⁰ Bromine is a highly reactive corrosive that poses a serious health threat. Although classified as a noncombustible material, bromine will act as an accelerant and react violently when it is exposed to combustible materials. Lithium is a combustible solid that may ignite or explode when it is exposed to flame, heat, corrosives, or oxidizers.

¹¹ The only exception to this requirement is if the chemical is intended for immediate use; however, none of the instances we are reporting involved chemicals intended for immediate use.

Lastly, in five of the laboratories, the chemical inventory list did not reflect the chemicals in use and stored in the laboratory. One of those lists had not been updated since April 11, 1991. The Chemical Hygiene Plan requires that chemical inventories be taken at least annually.

Laboratory Safeguards. With regard to laboratory safeguards, 17 of the laboratories did not have engineering controls in place that were commensurate with all recognized laboratory hazards. For example, in one of the laboratories, the PI was performing tests and conducting research into the magnetization of neodymium-iron-boron (NdFeB). In order to magnetize this material, the PI used a wide variety of electrically energized support equipment. Although the engineering design was effective to support the technical process, basic safety considerations were not incorporated into the design. For example, water used to chill the equipment was piped directly over the energized equipment where a leak or rupture could result in an electrically initiated fire and/or cause electrical shock. The design also included in-line gate valves and fittings that could fail or leak, further reducing the margin of safety (see Figure 3). In another instance, laboratory personnel were working with a laser without requisite personal protective equipment,¹² such as protective eye wear. The Safety Manual requires laboratory supervisors and SHED to perform hazard assessments for each laboratory to identify hazards and to institute engineering controls and protective equipment to mitigate recognized hazards.

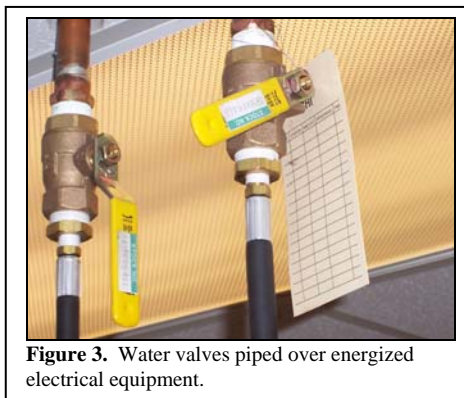


Figure 3. Water valves piped over energized electrical equipment.

Laboratory Maintenance. In seven laboratories, laboratory maintenance standards were not being met. The Safety Manual states that all personnel are responsible for laboratory safety and must follow housekeeping guidelines such as keeping aisles and stairways free from clutter, cleaning chemical spills, minimizing combustibles in workplace and storage areas, and keeping all exits free from obstructions. In the NdFeB laboratory, we found evidence of water intrusion around electrically energized laboratory equipment and along one of the laboratory walls, which created an electric shock hazard and a slip hazard (see Figure 4). In the other six laboratories, we found needles, syringes, and hazardous tools left out in unoccupied work areas and “slip, trip, and fall” types of hazards due to debris accumulation on laboratory floors.

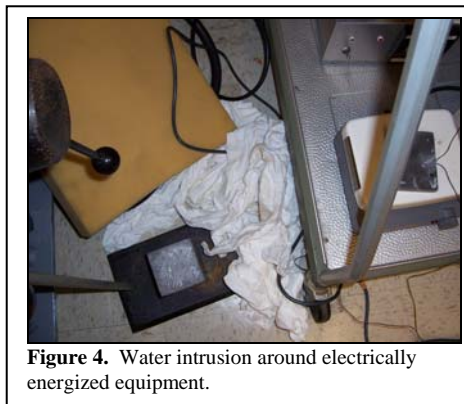


Figure 4. Water intrusion around electrically energized equipment.

¹² Personal protective equipment comprises clothing, devices, and other accessories designed to create a barrier against workplace hazards. The equipment can include safety glasses, hard hats, safety shoes, gloves, ear protection, respirators, and other protective items.

Training. Personnel in seven of the laboratories did not have training commensurate with the work being performed in the laboratory. In several of those laboratories, personnel were working with hazardous chemicals and/or biological agents. For example, in the “Vertebrate Cell Culture Laboratory,” laboratory personnel were working with quail eggs to study biological phenomena such as blood vessel and bone cell development; however, the laboratory’s PI stated that she did not have the required HAZCOM training. The HAZCOM Program requires laboratory personnel to attend HAZCOM training at least once every 3 years. HAZCOM training includes instruction on HAZCOM standards, MSDS, Glenn safety policies and procedures, chemical inventories, and provides contact information for the Safety Branch.

Fire and Life Safety. We identified 13 laboratories that were noncompliant with the Safety Manual’s fire and life safety requirements with regard to emergency egress, emergency response, and hazardous waste disposal. The Safety Manual defines emergency egress as the process by which a continuous and unobstructed way of exit travel is maintained from any point in a building to a predetermined safe location. We observed corridors and a stairway that were identified as exit routes but were obstructed by boxes and unused equipment (see Figure 5). We also noted one instance in which exit signs led personnel to a locked exit door.

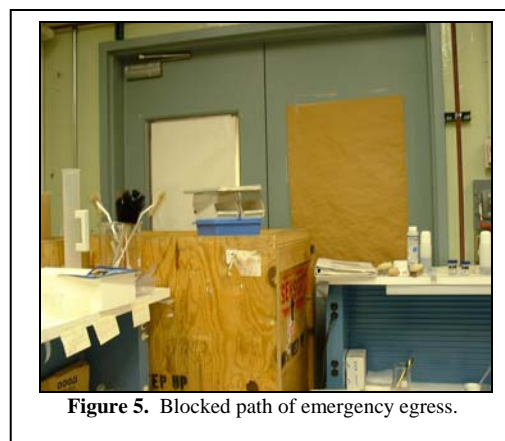


Figure 5. Blocked path of emergency egress.

With regard to emergency response, personnel in five of the laboratories stated that they were unsure of their responsibilities during a fire emergency or chemical spill or release. Other personnel stated that they were unsure as to how or when to use a portable fire extinguisher. In two of the laboratories, access to the fire extinguishers was partially blocked by crates, boxes, and laboratory equipment. The Safety Manual states that individual employees are required to be familiar with the emergency procedures for their particular work area. Familiarity includes having knowledge of the primary and secondary emergency evacuation route, the location of the designated safe area, and the identity of the building evacuation monitors. In the event of a fire, personnel are required to know the location of the nearest alarm and how to report the emergency to the Glenn dispatcher and, if qualified, to fight a fire in its beginning stages by using the appropriate portable fire extinguisher.

Finally, in the area of combustible waste, we identified such waste accumulated on workbenches and improperly deposited into ordinary trash receptacles. For the laboratories that were using the proper hazardous waste receptacles, those receptacles

were not emptied on a daily basis. OSHA regulations¹³ require combustible waste to be discarded in covered, self-closing receptacles and that those receptacles be emptied daily.

Safety and Health Inspection Program

SHED's facility safety and health inspection program was not effectively accomplishing its mission to ensure that laboratory safety violations were identified and adequately corrected.

Inspection Program. SHED relies on safety and health inspections as the principal means to detect hazardous conditions, unsafe work practices, and other occupational safety and health issues in its laboratories. The Glenn Safety Manual, Chapter 24, "Facility Safety and Health Inspection Program," identifies the types of facility safety and health inspections SHED conducts, the frequency of those inspections, and the responsibilities of the inspectors, management, and the Glenn Safety Branch. SHED performs two types of inspections—basic and detailed. Basic inspections are unscheduled inspections performed to identify fire, life safety, and industrial hygiene¹⁴ violations. Detailed inspections cover four areas—safety and health, chemical management, industrial hygiene, and health physics—and are designed to identify safety violations such as expired safety permits. Basic inspections are performed by Safety Branch representatives on a bimonthly basis and detailed inspections are scheduled inspections conducted by a team led by a Safety Branch representative. Depending on the criticality and risk¹⁵ associated with each facility, detailed facility safety and health inspections are performed on a quarterly or annual basis.

The inspectors use the SHED-developed Bi-Monthly Facility Inspection Checklist when performing basic inspections and the Facility Safety and Health Inspection Checklist when performing detailed inspections (see Appendixes C and D for copies of the checklists). SHED maintains a database that tracks the violations recorded on the checklists, generates violation notices, and provides management reports. When a violation is posted to the database, a safety violation notice is generated and distributed to the PI's chain of command and the respective building manager where the violation occurred. For violations that are open for 30 days or longer, the Safety Manual requires that the PI develop a corrective action plan, which must contain a justification as to why the violation remains unresolved, a description of the planned corrective action, timeframes for completing corrective action, and interim actions to protect employees from unsafe conditions caused by the violation.

¹³ In accordance with OSHA 29, Code of Federal Regulations 1910.106(h)(8)(iii), combustible waste material and residue must be kept to a minimum; stored in closed, metal waste cans; and disposed of daily.

¹⁴ Industrial hygiene is defined as a science devoted to the protection and improvement of the health and well-being of workers exposed to chemical and physical agents in their work environment.

¹⁵ "Risk" is characterized in the Glenn Safety Program by combining the probability that an undesired event will occur with the consequences or severity if it were to occur.

Laboratory Inspection Universe. SHED did not include all Glenn laboratories in its inspection universe and was not aware of the total number of facilities that were designated as laboratories at Glenn. When we attempted to define the universe of Glenn laboratories for our review, we requested that SHED provide us a list of all Glenn laboratories that were conducting operations that warranted inspection under the facility safety and health inspection program. SHED personnel stated that their inspection universe was based on a list of laboratories with active safety permits and provided a list containing 371 laboratories. Upon receiving the list, we became concerned that limiting the inspections to laboratories with “active” safety permits did not account for those laboratories that had not applied for a permit but should have or those laboratories whose safety permits had expired. Subsequently, we contacted the Glenn Facilities Division and requested a list of Glenn laboratories from its database. We received a list of 563 laboratories from the Facilities Division database; 192 laboratories more than the SHED list. Neither SHED nor the Facilities Division was aware that such a difference in the number of laboratories existed, and we could not confirm whether reconciliation between the two lists had ever been conducted.

SHED needs to include all laboratories in its inspection universe. In our review of 22 laboratories, we identified 9 laboratories that had no safety permit or had an expired safety permit and, therefore, would not be included in the SHED universe. Each of those laboratories was conducting operations that required a safety permit and commensurate safety controls. To ensure that SHED has visibility over each of the Glenn laboratories, it needs to periodically reconcile its list of laboratories that have active safety permits with the Facilities Division database. This will improve SHED’s ability to maintain a comprehensive inspection universe and identify those laboratories that may be operating in violation of Safety Manual requirements and without the proper safety controls.

Identification of Laboratories Inspected. The inspectors were not required to complete checklists for each laboratory inspected during the basic or detailed safety inspections. Because we identified 22 laboratories with 150 instances of noncompliance, we wanted to determine whether the results of the SHED basic and detailed inspections conducted around the period of our review contained similar findings. Because we conducted our laboratory review in January 2007, we requested all SHED inspection checklists for the period December 2006 through March 2007. Upon review, we found that only the laboratories in which violations were identified were annotated on the checklist; the checklist did not contain a list of all laboratories inspected. Therefore, we were unable to perform a laboratory-by-laboratory comparison between our results and the SHED inspection results, although according to the checklists, the SHED inspectors found only five health and safety violations in the buildings that we reviewed. Not requiring the inspectors to identify all laboratories inspected makes it difficult to hold the inspectors accountable for the inspection results because there is no evidence showing which laboratories were actually inspected and which laboratories may have been locked or otherwise inaccessible during the inspection.

Inspection Follow-Up. SHED did not adequately follow up on all laboratory safety violations identified during the basic and detailed inspections. We reviewed safety violation notices issued for the 17-month period between January 2006 and May 2007. During that period, SHED issued 165 safety violation notices against the laboratory buildings that we reviewed, of which 99 violations remained open for 30 days or longer. According to the Glenn Safety Manual, a corrective action plan should be prepared for any violation remaining open for more than 30 days. However, only 12 of the 99 open violations had corrective action plans. For the 87 violations that did not have corrective action plans, 9 were classified as Code 3 or Code 2 violations. Code 3 violations have the potential of causing minor injury or damage to personnel or equipment; Code 2 violations have the potential of causing severe injury or damage to personnel or equipment. Glenn should not have those type of violations open for extended periods, without a valid corrective action plan. The Safety Manual properly addresses the issue by requiring that corrective action plans be prepared and justifications be given as to why the violation remains open; however, SHED needs to periodically monitor its violation database and ensure corrective action plans are developed for all past-due safety violations. Special attention should be given to those violations that are Code 3 or higher to ensure that appropriate action is taken to keep employees and equipment safe.

Associated Risk

The risk of injury and/or damage associated with Glenn laboratory operations increases when those operations are not conducted in compliance with Glenn safety guidance. In our review of 22 laboratories, we identified 150 instances in which that safety guidance was not properly followed. Because we did not derive our sample statistically, we cannot project our results to the entire universe of Glenn laboratories; however, we believe that our results provide a solid indication that improvements are warranted. According to NASA's Incident Reporting Information System, during the 17-month period from January 2006 through May 2007, Glenn reported 247 mishaps¹⁶ and close calls¹⁷ and sustained more than \$449,049 in related property and vehicle damage. Of those mishaps and close calls, 28 directly or indirectly related to laboratory operations and the types of noncompliance issues that we identified. Had Glenn's facility safety and health inspection program been more effective in identifying, tracking, and monitoring laboratory safety violations, we expect that we would have identified fewer incidents of safety noncompliance. Because we reviewed only 22 of the 563 Glenn laboratories (4 percent), we believe that SHED should coordinate and sponsor a laboratory stand-down day, in which the PI and his or her staff could conduct a safety self-assessment based on the SHED checklists. This would provide SHED a baseline of laboratory

¹⁶ NASA defines a mishap as an unplanned event that results in injury to personnel or damage to property. NASA categorizes mishaps as Type A through Type D based on the severity of injury to personnel or total cost of damage to property.

¹⁷ NASA defines a close call as an occurrence or employee concern that did not result in injury to personnel or significant damage to property but possesses the potential to cause a mishap.

conditions, allow for the identification of systemic issues that may need to be addressed Center-wide, and provide a universe for follow-up inspections. Such an effort, along with improving the effectiveness of the inspection program should improve safety compliance, and most important, should reduce the risk of injury to personnel and damage to assets and facilities resulting from laboratory operations.

Management Actions

Subsequent to our laboratory review, Glenn began taking corrective action to address the 150 noncompliance incidents that we identified. To facilitate that action, we briefed senior Glenn management and the SHED chief of our laboratory review results. Both were very receptive to our findings. The SHED chief has since initiated a comprehensive review of the Glenn chemical management and laboratory safety programs. SHED has also begun updating the chemical inventories by use of a commercially available database. For our findings that indicated an immediate health and/or safety threat, such as the improper storage of chemicals, SHED instituted a stop-work order and effectively mitigated the threat. We commend SHED for taking immediate action; that action, along with corrective action taken in response to our recommendations, should continue to improve the safety posture within the Glenn laboratories.

Recommendations, Management's Response, and Evaluation of Management's Response

Recommendation 1. The Director, Safety and Mission Assurance, Glenn Research Center, should ensure that the Safety, Health, and Environmental Division develops a process that will comprehensively define the laboratory universe for facility safety and health inspections that includes, at a minimum, a periodic reconciliation between the Safety, Health, and Environmental Division's list of laboratories with active safety permits against the Facility Division's list of total Glenn laboratories.

Recommendation 2. The Director, Safety and Mission Assurance, Glenn Research Center, should ensure that the Safety, Health, and Environmental Division

- a. revise the Glenn Safety Manual, Chapter 24, to require inspectors to annotate the building number and the specific laboratories that were inspected during all basic and detailed inspections; and
- b. require the safety and health violation database be monitored, by severity code, to identify and notify management of all violations that are past due and require a corrective action plan.

Recommendation 3. The Director, Safety and Mission Assurance, Glenn Research Center, should ensure that the Safety, Health, and Environmental Division coordinate a laboratory safety stand-down day, that, at a minimum, requires that the Principal Investigators and their

staff conduct a self-assessment based on the Safety, Health, and Environmental Division's checklists.

Recommendation 4. The Director, Safety and Mission Assurance, Glenn Research Center, should ensure that the Safety, Health, and Environmental Division

- a. record and analyze the results of the laboratory self-assessments and issue violation notices in accordance with the Glenn Safety Manual;
- b. identify and address, on a Center-wide basis, any systemic laboratory safety issues noted during the analysis; and
- c. based on the number of violations, conduct random or total follow up inspections to ensure that appropriate corrective action was taken.

Management's Response. The Director, Glenn Research Center, concurred, and provided a corrective action plan that addresses each of the recommendations. He stated that the Safety Branch would conduct an immediate reconciliation of the Safety, Health, and Environmental Division's safety permit list with the list of laboratories maintained by the Facility Division. Once the reconciliation is complete, Safety Branch personnel will physically review the laboratories identified as not having active safety permits and, if necessary, issue violation notices in accordance with the Glenn Safety Manual. The Safety Branch will also establish a process to ensure that the safety permit tracking system is updated when laboratories are established or terminated or if the hazards associated with a specific laboratory change.

Regarding the laboratory safety inspections, the Center Director stated that the Glenn Safety Manual will be revised to require inspectors to annotate the building number and specific laboratory inspected during all basic and detailed inspections. In addition, the safety and health violation database will be monitored for past-due violations, and when identified, the cognizant managers will be required to present a closure plan to the Center Operations Management Council.

The Center Director also agreed to hold a Center-wide safety stand-down day in conjunction with Center-wide safety day events. During the stand-down day, the laboratory principal investigators, supervisors, and employees will be required to conduct and document self-assessments based on the existing laboratory safety checklists. Any safety violations identified will be immediately corrected or documented in the safety and health violation database. The violations will be trended to identify any systemic laboratory safety concerns.

Evaluation of Management's Response. Management's comments are responsive. The recommendations are resolved and will be closed upon completion and verification of management's corrective action

Scope and Methodology

We collected, reviewed, and analyzed guidance and documents relating to laboratory safety and the Glenn safety permit system. Specifically, we evaluated OSHA requirements, Executive Orders, and applicable NASA and Glenn safety guidance. We also reviewed selected laboratory safety permits, SOPs, laboratory inspection results, corrective action plans, and facility database information. We interviewed Glenn officials including, the SHED Division and branch chiefs, Area Safety Committee chairpersons, and Glenn senior management to obtain an overview of the Glenn safety program and to gain an in-depth understanding of the safety permit process and laboratory inspection program.

We reviewed laboratory operations in 22 Glenn laboratories, the laboratories were selected for review by the Office of Inspector General (OIG) Safety Manager on the basis of severity of operational hazards identified in laboratory safety permits. During the reviews, we observed laboratory operations and interviewed laboratory management and staff to determine if each laboratory operated with the appropriate permits, maintained standard operating procedures, properly managed hazardous chemicals, had appropriate engineering controls and safeguards, maintained cleanliness, and met fire standards.

We compared the results of our inspections to the results of Glenn safety, occupational health, health physics, and chemical management inspections performed in calendar year 2006 and the first quarter of calendar year 2007. We obtained the results of those safety inspections by querying the Glenn facility inspection database and reviewing associated inspection checklists. We also queried NASA's Incident Reporting Information System for the 17-month period from January 2006 through May 2007, to identify mishaps and close calls that were reported at Glenn and determine if any of those mishaps and close calls were indirectly related to laboratory operations and the types of noncompliance issues that we identified.

We performed this review at the Glenn Research Center from May 2006 through June 2007.

Use of Computer-Processed Data. We did not perform a detailed assessment of the reliability of the data reported in the Glenn facility inspection database or the Incident Reporting Information System. We reviewed the checklists that supported the facility inspection database but could not validate the results as the checklists represented laboratory conditions at a certain point in time. We did not review supporting documentation for the Incident Reporting Information System. However, changes in the

inspection results and the incidents reported would not change our conclusions or recommendations.

Review of Internal Controls

We reviewed internal controls for Glenn laboratory safety to include applicable policies and procedures and the oversight activities of the SHED and the Area Safety Committees. We identified weaknesses in the SHED oversight activities, specifically concerning the facility health and safety inspection program. Implementing the recommendations in this report to comprehensively address the inspection program should improve the internal controls over laboratory safety.

Prior Coverage

During the last 5 years, the Government Accountability Office and the NASA Office of Inspector General have not issued any reports of particular relevance to the subject of this report.

OIG REVIEW RESULTS

Building	Room	Incidents of Noncompliance	Guidance
49	38	Laboratory safety permit had expired or did not accurately reflect the operations and materials used in the laboratory.	Chapter 1A, Glenn Safety Manual
49	38	There were no standard operating procedures for the laboratory or the standard operating procedures did not accurately reflect the operations and materials used in the laboratory.	Chapter 17, Glenn Environmental Programs Manual
49	38	Personal protective equipment was not readily accessible or was not appropriate for the laboratory operation.	Chapter 15, Glenn Safety Manual
49	38	The "Buddy System" was not employed as a means of monitoring and safeguarding persons who were participating in hazardous operations.	Chapter 17, Glenn Environmental Programs Manual
49	38	The chemical inventory did not accurately reflect the hazardous materials used or stored in the lab.	Chapter 16, Glenn Environmental Programs Manual
49	38	Flammable chemicals were not stored in National Fire Protection Association compliant flammable chemical storage cabinets (self-closing, vented, etc.).	Chapter 31, Glenn Safety Manual
49	40	Material Safety Data Sheets were not readily accessible to all laboratory workers.	Chapter 16, Glenn Environmental Programs Manual
49	40	Laboratory workers were unfamiliar with information contained in Material Safety Data Sheets.	Chapter 16, Glenn Environmental Programs Manual
49	40	Laboratory safety permit had expired or did not accurately reflect the operations and materials used in the laboratory.	Chapter 1A, Glenn Safety Manual
49	40	There were no standard operating procedures for the laboratory or the standard operating procedures did not accurately reflect the operations and materials used in the laboratory.	Chapter 17, Glenn Environmental Programs Manual
49	40	The chemical inventory did not accurately reflect the hazardous materials used or stored in the lab.	Chapter 16, Glenn Environmental Programs Manual
49	40	Flammable chemicals were not stored in National Fire Protection Association compliant flammable chemical storage cabinets (self-closing, vented, etc.).	Chapter 31, Glenn Safety Manual
49	40	Personnel exposed to respiratory hazards (chemical fumes, dusts, particulate matter, inert gasses, etc.) were not enrolled in the Center's Respiratory Protection Program.	Chapter 4, Glenn Occupational Health Manual
49	40	Laboratory workers were unfamiliar with the Center's Chemical Hygiene Plan.	Chapter 17, Glenn Environmental Programs Manual

Building	Room	Incidents of Noncompliance	Guidance
49	252	The "Buddy System" was not employed as a means of monitoring and safeguarding persons who were participating in hazardous operations.	Chapter 17, Glenn Environmental Programs Manual
49	252	Flammable chemicals were not stored in National Fire Protection Association compliant flammable chemical storage cabinets (self-closing, vented, etc.).	Chapter 31, Glenn Safety Manual
49	252	Personnel exposed to respiratory hazards (chemical fumes, dusts, particulate matter, inert gasses, etc.) were not enrolled in the Center's Respiratory Protection Program.	Chapter 4, Glenn Occupational Health Manual
49	252	Exit doors were locked.	Chapter 27, Glenn Safety Manual
77	37/48	Material Safety Data Sheets were not readily accessible to all laboratory workers.	Chapter 16, Glenn Environmental Programs Manual
77	37/48	Laboratory safety permit had expired or did not accurately reflect the operations and materials used in the laboratory.	Chapter 1A, Glenn Safety Manual
77	37/48	There were no standard operating procedures for the laboratory or the standard operating procedures did not accurately reflect the operations and materials used in the laboratory.	Chapter 17, Glenn Environmental Programs Manual
77	37/48	Laboratory workers had not received safety training that was commensurate with the hazards in their work area.	Chapter 17, Glenn Environmental Programs Manual
77	37/48	The laboratory was not kept clean or free from clutter (loose equipment, cables, extension cords, etc.). Ordinary combustibles (trash, debris, paper, etc.) were allowed to accumulate in work areas.	Chapter 17, Glenn Environmental Programs Manual
77	37/48	The chemical inventory did not accurately reflect the hazardous materials used or stored in the lab.	Chapter 16, Glenn Environmental Programs Manual
77	37/48	Chemical containers, including secondary containers, were not properly identified and labeled.	Chapter 17, Glenn Environmental Programs Manual
77	37/48	Flammable chemicals were not stored in National Fire Protection Association compliant flammable chemical storage cabinets (self-closing, vented, etc.).	Chapter 31, Glenn Safety Manual
77	37/48	Engineering controls (fume hoods, gas restrictors, oxygen alarms, monitoring devices, etc.) were not in place or were not kept in operational order.	Chapter 15, Glenn Safety Manual

Building	Room	Incidents of Noncompliance	Guidance
77	37/48	Covered/self closing receptacles were not used for oil soaked or flammable liquid soaked rags and waste. Receptacles were not properly identified and emptied daily.	Chapter 10, Glenn Environmental Programs Manual
77	37/48	Fire extinguishers were not mounted in readily accessible locations. Signs were not prominently posted showing the location of the fire extinguisher.	Chapter 31, Glenn Safety Manual
77	37/48	Fire extinguishers were not inspected monthly for general condition and operability.	Chapter 31, Glenn Safety Manual
77	37/48	Employees were not trained in the proper use of fire extinguishers (either through instructional material provided to the employee or by an instructional poster located adjacent to the extinguisher).	Chapter 27, Glenn Safety Manual
77	23/24	There were no standard operating procedures for the laboratory or the standard operating procedures did not accurately reflect the operations and materials used in the laboratory.	Chapter 17, Glenn Environmental Programs Manual
77	23/24	Flammable chemicals were not stored in National Fire Protection Association compliant flammable chemical storage cabinets (self-closing, vented, etc.).	Chapter 31, Glenn Safety Manual
77	20	Compressed gas cylinders or "Dewar's" were not properly stored or secured to prevent accidental tipping.	Chapter 7, Glenn Safety Manual
77	38	Laboratory safety permit had expired or did not accurately reflect the operations and materials used in the laboratory.	Chapter 1A, Glenn Safety Manual
77	38	There were no standard operating procedures for the laboratory or the standard operating procedures did not accurately reflect the operations and materials used in the laboratory.	Chapter 17, Glenn Environmental Programs Manual
77	38	The laboratory was not kept clean or free from clutter (loose equipment, cables, extension cords, etc.). Ordinary combustibles (trash, debris, paper, etc.) were allowed to accumulate in work areas.	Chapter 17, Glenn Environmental Programs Manual
77	38	Personal protective equipment was not readily accessible or was not appropriate for the laboratory operation.	Chapter 15, Glenn Safety Manual
77	38	Chemical containers, including secondary containers, were not properly identified and labeled.	Chapter 17, Glenn Environmental Programs Manual

Building	Room	Incidents of Noncompliance	Guidance
77	38	Flammable chemicals were not stored in National Fire Protection Association compliant flammable chemical storage cabinets (self-closing, vented, etc.).	Chapter 31, Glenn Safety Manual
77	38	Incompatible chemicals (reactive) were not appropriately segregated.	Chapter 17, Glenn Environmental Programs Manual
77	38	Hazardous waste was not properly labeled, stored, or disposed.	Chapter 17, Glenn Environmental Programs Manual
77	38	Engineering controls (fume hoods, gas restrictors, oxygen alarms, monitoring devices, etc.) were not in place or were not kept in operational order.	Chapter 15, Glenn Safety Manual
77	38	Covered/self closing receptacles were not used for oil soaked or flammable liquid soaked rags and waste. Receptacles were not properly identified and emptied daily.	Chapter 10, Glenn Environmental Programs Manual
77	52	There were no standard operating procedures for the laboratory or the standard operating procedures did not accurately reflect the operations and materials used in the laboratory.	Chapter 17, Glenn Environmental Programs Manual
77	52	The laboratory was not kept clean or free from clutter (loose equipment, cables, extension cords, etc.). Ordinary combustibles (trash, debris, paper, etc.) were allowed to accumulate in work areas.	Chapter 17, Glenn Environmental Programs Manual
77	52	The chemical inventory did not accurately reflect the hazardous materials used or stored in the lab.	Chapter 16, Glenn Environmental Programs Manual
77	52	Chemical containers, including secondary containers, were not properly identified and labeled.	Chapter 17, Glenn Environmental Programs Manual
77	52	Employees did not know the location of the emergency staging area. There was no plan to establish employee accountability.	Chapter 17, Glenn Environmental Programs Manual
77	52	No persons were assigned to assist disabled personnel in the event of an emergency evacuation.	Chapter 27, Glenn Safety Manual
77	52	Employees were not trained in the proper use of fire extinguishers (either through instructional material provided to the employee or by an instructional poster located adjacent to the extinguisher).	Chapter 27, Glenn Safety Manual
77	52	Compressed gas cylinders or "Dewar's" were not properly stored or secured to prevent accidental tipping.	Chapter 27, Glenn Safety Manual
77	320		Chapter 7, Glenn Safety Manual

Building	Room	Incidents of Noncompliance	Guidance
105	111/112/113	Laboratory safety permit had expired or did not accurately reflect the operations and materials used in the laboratory.	Chapter 1A, Glenn Safety Manual
105	111/112/113	The "Buddy System" was not employed as a means of monitoring and safeguarding persons who were participating in hazardous operations.	Chapter 17, Glenn Environmental Programs Manual
105	111/112/113	Flammable chemicals were not stored in National Fire Protection Association compliant flammable chemical storage cabinets (self-closing, vented, etc.).	Chapter 31, Glenn Safety Manual
105	111/112/113	Incompatible chemicals (reactive) were not appropriately segregated.	Chapter 17, Glenn Environmental Programs Manual
105	111/112/113	Hazardous waste was not properly labeled, stored, or disposed.	Chapter 17, Glenn Environmental Programs Manual
105	111/112/113	Personnel exposed to respiratory hazards (chemical fumes, dusts, particulate matter, inert gasses, etc.) were not enrolled in the Center's Respiratory Protection Program.	Chapter 4, Glenn Occupational Health Manual
105	111/112/113	Showers and eyewash fountains were not installed in laboratories where hazardous materials were stored, dispensed, used, and transported.	Chapter 17, Glenn Environmental Programs Manual
106	121	Material Safety Data Sheets were not readily accessible to all laboratory workers.	Chapter 16, Glenn Environmental Programs Manual
106	121	Laboratory safety permit had expired or did not accurately reflect the operations and materials used in the laboratory.	Chapter 1A, Glenn Safety Manual
106	121	There were no standard operating procedures for the laboratory or the standard operating procedures did not accurately reflect the operations and materials used in the laboratory.	Chapter 17, Glenn Environmental Programs Manual
106	121	Laboratory workers had not received safety training that was commensurate with the hazards in their work area.	Chapter 17, Glenn Environmental Programs Manual
106	121	The laboratory was not kept clean or free from clutter (loose equipment, cables, extension cords, etc.). Ordinary combustibles (trash, debris, paper, etc.) were allowed to accumulate in work areas.	Chapter 17, Glenn Environmental Programs Manual
106	121	The "Buddy System" was not employed as a means of monitoring and safeguarding persons who were participating in hazardous operations.	Chapter 17, Glenn Environmental Programs Manual

Building	Room	Incidents of Noncompliance	Guidance
106	121	Flammable chemicals were not stored in National Fire Protection Association compliant flammable chemical storage cabinets (self-closing, vented, etc.).	Chapter 31, Glenn Safety Manual Chapter 17, Glenn Environmental Programs Manual
106	121	Hazardous waste was not properly labeled, stored, or disposed.	Chapter 15, Glenn Safety Manual
106	121	Engineering controls (fume hoods, gas restrictors, oxygen alarms, monitoring devices, etc.) were not in place or were not kept in operational order.	Chapter 4, Glenn Occupational Health Manual
106	121	Personnel exposed to respiratory hazards (chemical fumes, dusts, particulate matter, inert gasses, etc.) were not enrolled in the Center's Respiratory Protection Program.	Chapter 31, Glenn Safety Manual
106	121	Fire extinguishers were not mounted in readily accessible locations. Signs were not prominently posted showing the location of the fire extinguisher.	
106	121	Employees were not trained in the proper use of fire extinguishers (either through instructional material provided to the employee or by an instructional poster located adjacent to the extinguisher).	Chapter 27, Glenn Safety Manual Chapter 31, Glenn Safety Manual
106	133	Emergency lights were not installed or were not operational.	Chapter 1A, Glenn Safety Manual
106	133	Laboratory safety permit had expired or did not accurately reflect the operations and materials used in the laboratory.	Chapter 17, Glenn Environmental Programs Manual
106	133	The "Buddy System" was not employed as a means of monitoring and safeguarding persons who were participating in hazardous operations.	Chapter 31, Glenn Safety Manual
106	133	Flammable chemicals were not stored in National Fire Protection Association compliant flammable chemical storage cabinets (self-closing, vented, etc.).	Chapter 4, Glenn Occupational Health Manual
106	133	Personnel exposed to respiratory hazards (chemical fumes, dusts, particulate matter, inert gasses, etc.) were not enrolled in the Center's Respiratory Protection Program.	Chapter 27, Glenn Safety Manual
106	133	No persons were assigned to assist disabled personnel in the event of an emergency evacuation.	

Building	Room	Incidents of Noncompliance	Guidance
106	133	Employees were not trained in the proper use of fire extinguishers (either through instructional material provided to the employee or by an instructional poster located adjacent to the extinguisher).	Chapter 27, Glenn Safety Manual
106	230	Flammable chemicals were not stored in National Fire Protection Association compliant flammable chemical storage cabinets (self-closing, vented, etc.).	Chapter 31, Glenn Safety Manual
106	230	Personnel exposed to respiratory hazards (chemical fumes, dusts, particulate matter, inert gasses, etc.) were not enrolled in the Center's Respiratory Protection Program.	Chapter 4, Glenn Occupational Health Manual
106	230	Covered/self closing receptacles were not used for oil soaked or flammable liquid soaked rags and waste. Receptacles were not properly identified and emptied daily.	Chapter 10, Glenn Environmental Programs Manual
106	230	Emergency lights were not installed or were not operational.	Chapter 31, Glenn Safety Manual
110	117	Laboratory safety permit had expired or did not accurately reflect the operations and materials used in the laboratory.	Chapter 1A, Glenn Safety Manual
110	117	Personal protective equipment was not readily accessible or was not appropriate for the laboratory operation.	Chapter 15, Glenn Safety Manual
110	117	Personnel exposed to respiratory hazards (chemical fumes, dusts, particulate matter, inert gasses, etc.) were not enrolled in the Center's Respiratory Protection Program.	Chapter 4, Glenn Occupational Health Manual
110	117	Showers and eyewash fountains were not installed in laboratories where hazardous materials were stored, dispensed, used, and transported.	Chapter 17, Glenn Environmental Programs Manual
110	117	Showers and eyewash fountains were not operational or tested regularly.	Chapter 17, Glenn Environmental Programs Manual
110	117	Employees were not trained in the proper use of fire extinguishers (either through instructional material provided to the employee or by an instructional poster located adjacent to the extinguisher).	Chapter 27, Glenn Safety Manual
110	209	Personnel exposed to respiratory hazards (chemical fumes, dusts, particulate matter, inert gasses, etc.) were not enrolled in the Center's Respiratory Protection Program.	Chapter 4, Glenn Occupational Health Manual

Building	Room	Incidents of Noncompliance	Guidance
110	220	Material Safety Data Sheets were not readily accessible to all laboratory workers.	Chapter 16, Glenn Environmental Programs Manual
110	220	Laboratory workers had not received safety training that was commensurate with the hazards in their work area.	Chapter 17, Glenn Environmental Programs Manual
110	220	Flammable chemicals were not stored in National Fire Protection Association compliant flammable chemical storage cabinets (self-closing, vented, etc.).	Chapter 31, Glenn Safety Manual
110	220	Incompatible chemicals (reactive) were not appropriately segregated.	Chapter 17, Glenn Environmental Programs Manual
301	157	Material Safety Data Sheets were not readily accessible to all laboratory workers.	Chapter 16, Glenn Environmental Programs Manual
301	157	There were no standard operating procedures for the laboratory or the standard operating procedures did not accurately reflect the operations and materials used in the laboratory.	Chapter 17, Glenn Environmental Programs Manual
301	157	Laboratory workers had not received safety training that was commensurate with the hazards in their work area.	Chapter 17, Glenn Environmental Programs Manual
301	157	The laboratory was not kept clean or free from clutter (loose equipment, cables, extension cords, etc.). Ordinary combustibles (trash, debris, paper, etc.) were allowed to accumulate in work areas.	Chapter 17, Glenn Environmental Programs Manual
301	157	The "Buddy System" was not employed as a means of monitoring and safeguarding persons who were participating in hazardous operations.	Chapter 17, Glenn Environmental Programs Manual
301	157	The chemical inventory did not accurately reflect the hazardous materials used or stored in the lab.	Chapter 16, Glenn Environmental Programs Manual
301	157	Chemical containers, including secondary containers, were not properly identified and labeled.	Chapter 17, Glenn Environmental Programs Manual
301	157	Flammable chemicals were not stored in National Fire Protection Association compliant flammable chemical storage cabinets (self-closing, vented, etc.).	Chapter 31, Glenn Safety Manual
301	157	Compressed gas cylinders or "Dewar's" were not properly stored or secured to prevent accidental tipping.	Chapter 7, Glenn Safety Manual

Building	Room	Incidents of Noncompliance	Guidance
301	157	Personnel exposed to respiratory hazards (chemical fumes, dusts, particulate matter, inert gasses, etc.) were not enrolled in the Center's Respiratory Protection Program.	Chapter 4, Glenn Occupational Health Manual
302	109/110/111	Laboratory workers were unfamiliar with the Center's Chemical Hygiene Plan.	Chapter 17, Glenn Environmental Programs Manual
302	109/110/111	Employees did not know the location of the emergency staging area. There was no plan to establish employee accountability.	Chapter 27, Glenn Safety Manual
302	109/110/111	Covered/self closing receptacles were not used for oil soaked or flammable liquid soaked rags and waste. Receptacles were not properly identified and emptied daily.	Chapter 10, Glenn Environmental Programs Manual
302	109/110/111	Fire extinguishers were not inspected monthly for general condition and operability.	Chapter 31, Glenn Safety Manual
302	109/110/111	Stand mats, platforms, or similar protection was not provided to protect employees from wet floors and wet processes.	Chapter 1, Glenn Safety Manual
302	214/215	Material Safety Data Sheets were not readily accessible to all laboratory workers.	Chapter 16, Glenn Environmental Programs Manual
302	214/215	Laboratory workers were unfamiliar with information contained in Material Safety Data Sheets.	Chapter 16, Glenn Environmental Programs Manual
302	214/215	There were no standard operating procedures for the laboratory or the standard operating procedures did not accurately reflect the operations and materials used in the laboratory.	Chapter 17, Glenn Environmental Programs Manual
302	214/215	Laboratory workers had not received safety training that was commensurate with the hazards in their work area.	Chapter 17, Glenn Environmental Programs Manual
302	214/215	Chemical containers, including secondary containers, were not properly identified and labeled.	Chapter 17, Glenn Environmental Programs Manual
302	214/215	Flammable chemicals were not stored in National Fire Protection Association compliant flammable chemical storage cabinets (self-closing, vented, etc.).	Chapter 31, Glenn Safety Manual
302	214/215	Compressed gas cylinders or "Dewar's" were not properly stored or secured to prevent accidental tipping.	Chapter 7, Glenn Safety Manual
302	214/215	Personnel exposed to respiratory hazards (chemical fumes, dusts, particulate matter, inert gasses, etc.) were not enrolled in the Center's Respiratory Protection Program.	Chapter 4, Glenn Occupational Health Manual

Building	Room	Incidents of Noncompliance	Guidance
302	214/215	Employees did not know the location of the emergency staging area. There was no plan to establish employee accountability.	Chapter 27, Glenn Safety Manual
302	214/215	Covered/self closing receptacles were not used for oil soaked or flammable liquid soaked rags and waste. Receptacles were not properly identified and emptied daily.	Chapter 10, Glenn Environmental Programs Manual
302	214/215	Fire extinguishers were not inspected monthly for general condition and operability.	Chapter 31, Glenn Safety Manual
302	214/215	Employees were not trained in the proper use of fire extinguishers (either through instructional material provided to the employee or by an instructional poster located adjacent to the extinguisher).	Chapter 27, Glenn Safety Manual
309	204	The "Buddy System" was not employed as a means of monitoring and safeguarding persons who were participating in hazardous operations.	Chapter 17, Glenn Environmental Programs Manual
309	204	Compressed gas cylinders or "Dewar's" were not properly stored or secured to prevent accidental tipping.	Chapter 7, Glenn Safety Manual
309	204	Personnel exposed to respiratory hazards (chemical fumes, dusts, particulate matter, inert gasses, etc.) were not enrolled in the Center's Respiratory Protection Program.	Chapter 4, Glenn Occupational Health Manual
309	204	Employees were not trained in the proper use of fire extinguishers (either through instructional material provided to the employee or by an instructional poster located adjacent to the extinguisher).	Chapter 27, Glenn Safety Manual
309	204	Corridors and stairways were obstructed and blocked the path of egress.	Chapter 27, Glenn Safety Manual
309	205B	Material Safety Data Sheets were not readily accessible to all laboratory workers.	Chapter 16, Glenn Environmental Programs Manual
309	205B	Laboratory workers were unfamiliar with information contained in Material Safety Data Sheets.	Chapter 16, Glenn Environmental Programs Manual
309	205B	Laboratory safety permit had expired or did not accurately reflect the operations and materials used in the laboratory.	Chapter 1A, Glenn Safety Manual
309	205B	There were no standard operating procedures for the laboratory or the standard operating procedures did not accurately reflect the operations and materials used in the laboratory.	Chapter 17, Glenn Environmental Programs Manual

Building	Room	Incidents of Noncompliance	Guidance
309	205B	Laboratory workers had not received safety training that was commensurate with the hazards in their work area.	Chapter 17, Glenn Environmental Programs Manual
309	205B	The laboratory was not kept clean or free from clutter (loose equipment, cables, extension cords, etc.). Ordinary combustibles (trash, debris, paper, etc.) were allowed to accumulate in work areas.	Chapter 17, Glenn Environmental Programs Manual
309	205B	Personal protective equipment was not readily accessible or was not appropriate for the laboratory operation.	Chapter 15, Glenn Safety Manual
309	205B	The "Buddy System" was not employed as a means of monitoring and safeguarding persons who were participating in hazardous operations.	Chapter 17, Glenn Environmental Programs Manual
309	205B	Chemical containers, including secondary containers, were not properly identified and labeled.	Chapter 17, Glenn Environmental Programs Manual
309	205B	Flammable chemicals were not stored in National Fire Protection Association compliant flammable chemical storage cabinets (self-closing, vented, etc.).	Chapter 31, Glenn Safety Manual
309	205B	Incompatible chemicals (reactive) were not appropriately segregated.	Chapter 17, Glenn Environmental Programs Manual
309	205B	Employees did not know what to do in the event of a chemical spill or release.	Chapter 17, Glenn Environmental Programs Manual
309	205B	Hazardous waste was not properly labeled, stored, or disposed.	Chapter 17, Glenn Environmental Programs Manual
309	205B	Engineering controls (fume hoods, gas restrictors, oxygen alarms, monitoring devices, etc.) were not in place or were not kept in operational order.	Chapter 15, Glenn Safety Manual
309	205B	Showers and eyewash fountains were not operational or tested regularly.	Chapter 17, Glenn Environmental Programs Manual
309	205B	Laboratory workers were unfamiliar with the Center's Chemical Hygiene Plan.	Chapter 17, Glenn Environmental Programs Manual
309	205B	Employees were unsure as to what they should do in the event of an emergency.	Chapter 27, Glenn Safety Manual
309	205B	Employees did not know the location of the emergency staging area. There was no plan to establish employee accountability.	Chapter 27, Glenn Safety Manual

Building	Room	Incidents of Noncompliance	Guidance
309	205B	Emergency telephone numbers were not posted on laboratory phones.	Chapter 27, Glenn Safety Manual
309	205B	Covered/self closing receptacles were not used for oil soaked or flammable liquid soaked rags and waste. Receptacles were not properly identified and emptied daily.	Chapter 10, Glenn Environmental Programs Manual
309	205B	Portable fire extinguishers were not commensurate with laboratory operations (insufficient number or wrong type).	Chapter 31, Glenn Safety Manual
309	205B	Fire extinguishers were not mounted in readily accessible locations. Signs were not prominently posted showing the location of the fire extinguisher.	Chapter 31, Glenn Safety Manual
309	205B	Employees were not trained in the proper use of fire extinguishers (either through instructional material provided to the employee or by an instructional poster located adjacent to the extinguisher).	Chapter 27, Glenn Safety Manual
333	100 East	Compressed gas cylinders or "Dewar's" were not properly stored or secured to prevent accidental tipping.	Chapter 7, Glenn Safety Manual
333	100 East	Employees were not trained in the proper use of fire extinguishers (either through instructional material provided to the employee or by an instructional poster located adjacent to the extinguisher).	Chapter 27, Glenn Safety Manual

BASIC INSPECTION CHECKLIST

BI-MONTHLY FACILITY INSPECTION CHECKLIST

Building Number: _____ Inspector's Name: _____ Date: _____

Violation Description	Deficiency Exists	Risk Category	Find Code	Location(s)
General				
Work areas cluttered, excessive loose paper, or paper stored on floor?			GS01	
Floors				
Poor housekeeping, Slip, trip, or fall hazards?			FL01	
Floors wet, greasy, or oily?			FL02	
Hoisting and Lifting Equipment				
Safety latch on crane hook missing?			HL08	
Means of Egress				
Exit pathway less than 32 inches in width?			EG03	
Locked or barred exits?			EG04	
Inadequately marked or illuminated emergency exits?			EG05	
Emergency lighting accessible without ladder, inoperable?			EG06	
Pathway to exit not easily recognizable?			EG07	
Pathway to exit contains flammable materials?			EG08	
"Dial 911 for Emergency" stickers not posted on phones? (Post Sticker)			EG11	
Fire door propped open?			EG13	
Storage in exits or stairwells?			EG14	
Fire Protection				
Improperly identified or mounted fire extinguisher?			FP02	
Blocked access to fire extinguisher?			FP03	
Inadequate sprinkler head clearance? (less than 18 inches from stacked items)			FP04	
Fire extinguisher not fully charged?			FP05	

BI-MONTHLY FACILITY INSPECTION CHECKLIST

Building Number: _____ Inspector's Name: _____ Date: _____

Violation Description	Deficiency Exists	Risk Category	Find Code	Location(s)
Fire extinguisher safety seal or tamper indicator broken or missing? (safety seal color code Green-2004, Orange-2005)			FP06	
Evacuation alarm pull station obstructed?			FP07	
Hazard Communication Program				
Chemicals stored or labeled improperly?			HA03	
Safety Permit Program				
Expired facility or project safety permit?			SP01	
Electrical Safety				
Disconnecting means not labeled according to use when use is not evident?			ES05	
Exposed wires, frayed or spliced cords, or deteriorated insulation?			ES07	
Uncovered junction boxes, outlets, or switches?			ES08	
Access to electrical panels blocked?			ES09	
Receptacles within 6 feet of working sink, in kitchens, in bathrooms or other areas GFCI protected?			ES13	
Compressed Gasses				
Compressed gas cylinder not stored upright and secured?			CG02	
Compressed gas cylinder not labeled or not properly segregated?			CG03	
Loose or missing valve-protection caps?			CG04	
Oxygen				
Weeds or long dry grass within 15 feet of oxygen storage?			OP02	

BI-MONTHLY FACILITY INSPECTION CHECKLIST

Building Number: _____ Inspector's Name: _____ Date: _____

Violation Description	Deficiency Exists	Risk Category	Find Code	Location(s)
Welding, Cutting and Brazing Oxygen cylinders stored less than 20 feet from fuel gas cylinders?			WC01	
Acetylene tanks not stored vertically? Valves left open and pressurized when cylinders are not in use?			WC03 WC07	
Materials Handling Stored materials not stable and secured?			MH08	
Personal Protective Equipment Eyewash or safety shower obstructed?			PP10	
Other Unsafe Conditions Found				

DETAILED INSPECTION CHECKLIST

GRC Facility Safety and Health Inspection Checklist

Building Number: _____ Date: _____
 Building Area: _____
 Inspector: _____
 Escorts: _____

GENERAL	Yes	No	N/A	SC	Location/Comments
Are violations posted in a conspicuous location in the					
Are "Dial 911 For Emergency" stickers on phones?					
GS01 Are work areas clean and free of clutter or large quantities of loose or improperly stored paper?					

GLENN SAFETY MANUAL	Yes	No	N/A	SC	Location/Comments
1.5 Safety Permit Program					
SP01 Are posted safety permits current?					

Oxygen Propellant (29 CFR 1910.104; GSM Chapter 5)	Yes	No	N/A	SC	Location/Comments
OP01 Is liquid oxygen storage container located so that potential leakage will occur on a non-combustible surface?					
OP02 Is the area within 15 ft. of oxygen containers free of weeds, long dry grass or other combustible materials?					
OP04 Are bulk oxygen storage locations labeled "Oxygen - No Smoking - No Open Flames"?					

Hydrogen Propellant (29 CFR 1910.103; GSM Chapter 6)	Yes	No	N/A	SC	Location/Comments
HP02 Are gaseous hydrogen containers stored outdoors at least 15 ft. from unclassified electrical equipment?					
HP03 Is the area within 25 ft. of LH2 equipment free of weeds, dry vegetation, or combustible material?					

HP04	Is the area within 15 ft. of GH2 equipment free of weeds, dry vegetation, or combustible material?					
HP05	Are liquid hydrogen pipes and equipment insulated to prevent liquid air from contacting asphalt or other combustible material?					
HP06	Are liquid hydrogen containers protected against physical damage?					
HP07	Is grounding and bonding apparatus available to bond mobile hydrogen equipment during hydrogen discharge?					
HP08	Has resistance to ground been tested within last 6 months (less than 10 ohms)?					
HP10	Are bulk hydrogen storage locations labeled "Gaseous (or Liquefied) Hydrogen - Flammable Gas - No Smoking - No Open Flames"?					

Pressure Systems (GSM Chapter 7)		Yes	No	N/A	SC	Location/Comments
PS01	Are pressure vessels marked with certification information?					
PS02	Is the pressure vessel certification current?					
PS03	Are pressure system valves, regulators, and relief devices tagged/marked with identification, MAWP, and calibration date?					
PS05	Do safety relief devices discharge away from personnel and equipment?					

Flammable and Combustible Liquids (29 CFR 1910.106)		Yes	No	N/A	SC	Location/Comments
FC01	Are oily rags and other combustible waste materials stored in covered metal receptacles.					
FC02	Is grounding and bonding equipment provided for flammable liquid containers for use during dispensing?					

FC03	Are storage cabinets for flammable and combustible liquids labeled "Flammable - Keep Fire Away"?												
FC04	Are flammable liquids stored in DOT or NRTL approved containers?												
FC05	Are flammable liquids stored in flammable materials storage cabinets?												

Compressed Gases (29 CFR 1910.101 & CGA Pamphlet P1) Yes No N/A SC Location/Comments

CG02	Are cylinders stored upright and secured?												
CG03	Are cylinders labeled and properly segregated?												
CG04	Are valve caps in place?												

Welding, Cutting, & Brazing (29 CFR 1910.251-255) Yes No N/A SC Location/Comments

WC01	Are oxygen cylinders stored greater than 20-feet from acetylene (except on welding cylinder carts) , other fuel gas cylinders, and other combustible materials including oil or grease?												
WC03	Are acetylene cylinders stored vertically?												
WC07	Are valves closed and hoses depressurized when cylinders not in use ?												

Electrical Safety (29 CFR 1910.301-399; GSM Chapter 8) Yes No N/A SC Location/Comments

ES01	Are face shields, rubber gloves and protective rubber aprons available at battery stations?												
ES02	Is an eye wash station located near each battery station?												
ES03	Are lineman's type rubber gloves tested at least semiannually?												
ES05	Are disconnecting means legibly marked to indicate purpose where purpose is not evident?												
ES07	Have exposed wires, frayed or spliced cords, and deteriorated insulation been handled?												

ES08	Are junction boxes, outlets, and switches covered and are unused openings in boxes, wire ways, etc. covered?							
ES09	Is there sufficient clearance in front of electrical panels?							
ES10	Are flexible cords utilized properly (i.e. not in place of fixed wiring)?							
ES11	Are flexible cords utilized properly (i.e. not through holes, doorways, attached to building surfaces, etc.)?							
ES13	Are GFCI receptacles used within 6 feet of sinks, in kitchens, in bathrooms or other areas?							

Lockout/Tagout (29 CFR 1910.147; GSM Chapter 9)		Yes	No	N/A	SC	Location/Comments
LT01	Are lockout/tagout procedures followed?					

Shop Safety (GSM Chapter 14)

Portable Power Tools and Equipment (29 CFR 1910.241-244)

HT01	Are portable power tools (except double insulated tools) electrically grounded?	Yes	No	N/A	SC	Location/Comments
HT02	Are electrical cords and air hoses in good condition?					
HT03	Are guards in place and in good condition?					
HT05	Are jacks legibly marked with a load rating?					
HT07	Are jacks free of excessive wear, fluid leakage or mech. defects?					

Machine Guarding (29 CFR 1910.212-222)

MG01	Are machine guards available to protect the operator and other employees?	Yes	No	N/A	SC	Location/Comments
MG02	Are machine guards utilized?					
MG03	Are machine controls easily accessible?					

MG04	Are machine controls clearly labeled?								
MG05	Are grinder work rests adjusted to 1/8" max. from the wheel?								
MG06	Are grinder tongues adjusted to 1/4" max. from the wheel?								
MG07	Do side guards adequately cover the spindle end, nut, flange, and grinding wheel?								
MG08	Are bench and pedestal grinders permanently mounted?								

Powered Industrial Trucks (29 CFR 1910.178) Yes No N/A SC Location/Comments

IT01	Is the load capacity indicated?								
IT03	Are forklift operators certified?								
IT05	When unattended, is the load lowered, controls neutralized, brakes set, and power shut off?								
IT08	Is sit down rider type forklift equipped with a working backup warning device?								
IT09	Is sit down rider type forklift equipped with at least one Class B or C fire extinguisher?								

Personal Protective Equipment (29 CFR 1910.132-140; GSM) Yes No N/A SC Location/Comments

PP02	Is proper PPE utilized for task being performed?								
------	--	--	--	--	--	--	--	--	--

Eyewash Stations, Safety Showers and Drench Hoses Yes No N/A SC Location/Comments

PP09	Are eyewash stations, safety showers, and drench hoses inspected annually?								
PP10	Are eyewash stations, safety showers, and drench hoses accessible?								
PP12	Are signs posted that identify eyewash station, safety shower, and drench hose locations?								
PP13	Are eyewash stations working properly?								

Confined Space Entry (29 CFR 1910.146; GSM Chapter 16)		Yes	No	N/A	SC	Location/Comments
CS01	Are confined spaces properly identified?					

Cranes and Lifting Devices (29 CFR 1910.179; GSM Chaptie		Yes	No	N/A	SC	Location/Comments
HL01	Is the crane/hoist rated capacity clearly marked?					
HL02	Was crane/hoist load tested within the last 4 years (non-critical lift)?					
HL08	Does crane hook have safety latch?					
HL09	Are crane controls marked to indicate direction of motion?					
HL10	Is sling marked with rated load information?					
HL11	Have slings been load tested in the last 4 years (non-critical lift)?					
HL13	Are crane disconnect switches clearly identified?					

Materials Handling (29 CFR 1910.176)		Yes	No	N/A	SC	Location/Comments
MH04	Are aisles clean, dry, and unobstructed?					
MH06	Are pallets and skids in good condition?					
MH07	Are unused pallets and skids stored out of the way?					
MH08	Are materials stored in a secure and stable manner?					

High Pressure Hoses (GSM Chapter 23)		Yes	No	N/A	SC	Location/Comments
HO01	Are high-pressure hoses tagged to indicate date of pressure test, the maximum rated operating pressure, the vendor part number, and the liquid or gas it will accommodate?					
HO02	Are high-pressure hoses over 6-foot long restrained by Kellems restrains?					
HO03	Have high-pressure hoses been recertified within the last 2 to 5 years?					

Means of Egress (29 CFR 1910.35-37)		Yes	No	N/A	SC	Location/Comments
EG01	Are means of egress illuminated?					
EG03	Do doors or other points of access into rooms and individual workstations have a clear opening width of at least 32 inches?					
EG04	Are exits unlocked and unobstructed?					
EG05	Are exits adequately marked and illuminated?					
EG06	Is emergency lighting operable?					
EG07	Is pathway to exit clearly recognizable?					
EG08	Does the means of egress avoid areas containing flammable materials or other hazards?					
EG13	Are fire doors closed or held open by auto release device?					
EG14	Are exits and stairwells clear of all storage?					
EG15	Are telephones in elevators and limited access areas operational as evidenced by dial tone??					

Fire Protection (29 CFR 1910.155-165)		Yes	No	N/A	SC	Location/Comments
FP01	Are hazard/occupancy specific fire extinguishers available?					
FP02	Are fire extinguishers properly identified and mounted?					
FP03	Is access to fire extinguishers unobstructed?					
FP04	Is there at least 18" of clearance between sprinkler heads and stacked materials or equipment?					
FP05	Are fire extinguishers (equipped with gauges) fully charged?					
FP06	Is fire extinguisher safety seal or tamper indicator in place?					
FP07	Is access to evacuation alarm pull station unobstructed?					

FP08	Has annual fire extinguisher maintenance been performed as evidenced by safety seal color code(Green-2004, Orange-2005, Black-2006, Red-2007)								
Warning Signs, Lights, Sirens, and Barricades									
WS01	Are hazardous areas properly designated?	Yes	No	N/A	SC				Location/Comments
Floors (29 CFR 1910.22 and 23)									
FL01	Are slip, trip, and fall hazards removed?	Yes	No	N/A	SC				Location/Comments
FL02	Are floors free of moisture, grease, oil, etc?								
FL03	Are floor openings covered and/or barricaded?								
FL04	Are railings and 4" toe boards installed on open sided platform > 4 ft high?								
Stairs (29 CFR 1910.24)									
ST01	Are stair railings sturdy?	Yes	No	N/A	SC				Location/Comments
ST02	Are stairs clean, dry, and unobstructed?								
Portable Ladders (29 CFR 1910.25 and 26)									
LA02	Are ladder rungs clean, dry and in good condition?	Yes	No	N/A	SC				Location/Comments
LA06	Have defective ladders been removed from service?								

MANAGEMENT COMMENTS

National Aeronautics and
Space Administration
John H. Glenn Research Center
Lewis Field
Cleveland, OH 44135-3191



September 10, 2007

Reply to Attn of: **Safety and Mission Assurance Directorate**

TO: NASA Headquarters
Attn: Assistant Inspector General for Auditing

FROM: A/Director

SUBJECT: Glenn Research Center's(GRC) Response to the Draft Audit Report, "Effective Inspection Program Key to Improving Laboratory Safety at Glenn Research Center" (Assignment No. S-06-011-00)

Enclosed is the Glenn Research Center's formal response to the audit findings and recommendations provided in the NASA Office of Inspector General (OIG) draft report, "Effective Inspection Program Key to Improving Laboratory Safety at Glenn Research Center" (Assignment No. S-06-011-00). As stated in this response, I concur with the audit findings and recommendations presented by the audit team, and the Center will complete all the corrective actions by December 31, 2007.

I appreciate the effort and thoroughness of the audit team and their desire to improve the overall safety of the Glenn Research Center personnel, facilities, and hardware.

A handwritten signature in cursive script that reads "Woodrow Whitlow, Jr." with a stylized flourish at the end.

Woodrow Whitlow, Jr.

Enclosure



Glenn Research Center

**Corrective Action Plan Response
To Office of Inspector General Report**

**“Effective Inspection Program Key to
Improving Laboratory Safety at
Glenn Research Center”
Assignment No. S-06-011-00**

September 10, 2007

Enclosure

TABLE OF CONTENTS

	PAGE
Executive Summary	1
1.0 Recommendations from OIG	2
2.0 Corrective Action Plan	3
3.0 Scheduled Completion Dates	5

Executive Summary

The Office of the Inspector General (OIG) received two hotline complaints related to the Glenn Research Center (GRC) safety program. One complaint was related to laboratory safety and the review process used at GRC for safety permits. The second was related to the actions of First Responder personnel on January 9, 2006, in response to the Underground Utility Tunnel Fire. The OIG, upon initiation of the audit, determined that the scope of the audit conducted in January 2007 would be limited to an assessment of laboratory safety, with the other issue deferred to a future audit. The draft OIG report dated August 21, 2007, addresses the findings and recommendations in the area of laboratory safety at Glenn Research Center at Lewis Field.

The draft OIG report evaluated the current programs related to laboratory safety as defined in the GRC Safety Manual, the Occupational Health Manual, and the Environmental Manual. The evaluation of the safety permit process was included in the review. In addition, it included a review of the Facilities Safety Inspection Program as defined in the GRC Safety Program. The OIG staff inspected 22 laboratories as part of their assessment.

The OIG staff found several deficiencies in the implementation of laboratory safety guidance at Lewis Field. They also had findings in the areas of Chemical Management and Facilities Safety Inspections.

The OIG report recommends a comprehensive review of our Laboratory Safety Program, as well as improvements in our Chemical Management and Facilities Safety Inspection Programs. We believe the thoroughness and attention to detail in the OIG's findings and recommendations will help to improve our overall program and improve the safety of our employees, facilities, and hardware.

This document defines the Corrective Action Plan to facilitate the resolution of these findings at Glenn Research Center at Lewis Field. As stated in our response, we concur with the audit findings and recommendations presented by the audit team and will complete all the corrective actions by December 31, 2007.

1.0 Recommendations from OIG

The following recommendations are included in the draft report issued by the Office of the Inspection General:

The Director, Safety and Mission Assurance, Glenn Research Center, should ensure that the Safety, Health, and Environmental Division

1. develop a process that will comprehensively define the laboratory universe for facility safety and health inspections that includes, at a minimum, a periodic reconciliation between the SHED list of laboratories with active safety permit against the Facility Divisions list of total Glenn laboratories;

GRC Concurs; corrective action will be instituted as laid out in the Corrective Action Plan, Section 2.1

2. revise the Glenn Safety Manual, Chapter 24 to

a. require inspectors to annotate the building number and the specific laboratories that were inspected during all basic and detailed inspections, and

b. require the safety and health violation database be monitored, by severity code, to identify and notify management of all violations that are past due and require a corrective action plan;

GRC Concurs; corrective action will be instituted as laid out in the Corrective Action Plan, Section 2.2

3. coordinate a laboratory safety standdown day, that as a minimum, requires that the Principal Investigators and their staff conduct a self-assessment based on the SHED checklists; and

GRC Concurs; corrective action will be instituted as laid out in the Corrective Action Plan, Section 2.3

4. record and analyze the results of laboratory self-assessments and

a. issue violation notices in accordance with the Glenn Safety Manual,

b. identify and address, on a Center-wide basis, any systemic laboratory safety issues noted during the analysis, and

c. based on the number of violations, conduct random or total followup inspections to ensure that appropriate corrective action was taken.

GRC Concurs; corrective action will be instituted as laid out in the Corrective Action Plan, Section 2.4

2.0 Corrective Action Plan

2.1 Identification of the laboratory universe to ensure thorough and complete safety permit tracking.

a. The Safety Branch will conduct an immediate review of the safety permit list and compare it to the current Facility Division list of total laboratories to establish an initial list of Center laboratories.

– Planned completion date October 20, 2007

b. With this initial list, any laboratories which do not have an active approved safety permit will be personally visited by Safety Branch personnel to determine the status of the laboratory activity with the following actions to be taken:

1) Active laboratories which have identified hazardous operations as defined by the GRC Safety Manual, but either have no safety permit or have an expired permit, will have a violation issued, and all violations will be corrected in accordance with the GRC Safety Manual.

2) Undocumented active laboratories which do not have identified hazardous operations will be required to notify the applicable Area Safety Committee to ensure that a safety permit is not required.

This effort will be done, to the maximum extent possible, in conjunction with the Center-wide chemical inventory process to fully document all the associated hazards on the Center.

– Planned completion date November 30, 2007

c. Establish a documented process to ensure the safety permit tracking system is updated whenever a new laboratory is established or terminated, or when the hazards associated with a facility change.

– Planned completion date October 28, 2007

d. A status of completion of this action will be presented at the monthly GRC Operation Management Council meeting.

– Initial implementation by October 30, 2007, with ongoing reporting

2.2 Updates to the Glenn Research Center Safety Manual

a. The GRC Safety Branch will make the following changes to the GRC Safety Manual (GLM-QSA-1700.1):

- 1) All inspectors will annotate the building number and specific laboratory inspected during all basic and detailed inspections. Any location of any violations will be clearly detailed to allow correct identification and followup inspections.
- 2) The safety and health violation database will be monitored and tracked by severity code. Any violations which are past due and require a Corrective Action Plan will be highlighted. Responsible supervisors will be notified of the delinquency. To ensure proper management, delinquent violations will be presented on a monthly basis to the Operations Management Council (OMC). Cognizant managers will be required to present a closure plan to the OMC.

– Planned completion date November 30, 2007

2.3 Conduct a GRC Center-wide Laboratory Safety Standdown

a. Glenn Research Center will conduct a Center-wide laboratory safety standdown with emphasis on the following areas. (This event is currently planned to be in conjunction with the Center-wide safety day events)

- 1) The GRC Safety Branch will provide training information to all Center personnel on the hazards associated with laboratory operations, the GRC Safety Permit process, and the Safety Committee procedures.
- 2) All GRC laboratory principal investigators, supervisors, and employees will be required to conduct and document self-assessments of their laboratory areas based on the existing safety checklists. All violations will be noted with planned Corrective Action Closure Plans.
- 3) The self-assessment forms will be turned in to the Safety, Health, and Environmental Division (SHED) for documentation, trending, and followup.

– Planned completion date December 15, 2007

2.4 Follow-on Activities to the Laboratory Self-Assessments

a. The GRC SHED will record and analyze the laboratory self-assessments and conduct the following activities:

- 1) Any violations which are not immediately corrected will be documented in the safety and health violation database in accordance with the GRC Safety Manual.
- 2) All issues identified from the self-assessment will be analyzed to determine if systemic safety concerns exist. The SHED will present a summary of the finding to the GRC Strategic Management Team.
- 3) The SHED will develop a process so that adequate followup inspections are performed to ensure appropriate corrective action was taken.

– Planned completion date December 30, 2007

5

3.0 Scheduled Completion Dates

3.1 Identification of the GRC Laboratory universe–November 30, 2007

3.2 Updates to GRC Safety Manual–November 30, 2007

3.3 Conduct GRC Center-wide Laboratory Safety Standdown–December 15, 2007

3.4 Follow-on Analysis presented to Senior Management–December 30, 2007

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Major Contributors to the Report:

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