



Service and Maintenance Subcontractor Environment, Safety & Health Manual



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List of Acronyms and Abbreviations

ACGIH	American Conference of Governmental Industrial Hygienists
ACM	asbestos-containing material
ALARA	as low as reasonably achievable
ANSI	American National Standards Institute
APCD	Air Pollution Control Division (Colorado)
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
BMPs	best management practices
CCR	Colorado Code of Regulations
CFR	Code of Federal Regulations
CMS	Central Monitoring Station
CPR	cardiopulmonary resuscitation
CRS	Colorado Revised Statute
CSWP	Construction Safe Work Permit
dB	decibels
dBA	decibels, A-weighted scale
DOP	di-octyl phthalate
DOE	U.S. Department of Energy
ECT	equivalent chill temperature
EEWP	Energized Electrical Work Permit

ESH	Environment, Safety and Health
EPA	U.S. Environmental Protection Agency
FHA	Fall Hazard Analysis
FM	Facility Manager
GFCI	ground fault circuit interrupter
HEPA	high efficiency particulate absolute
H&R	hoisting and rigging
IH	industrial hygiene
IPT	Integrated Project Team
JSP	Job Safety Plan
LEED	Leadership in Energy and Environmental Design
LO/TO	lockout/tagout
mA	milliamps
MEC	munitions and explosives of concern
MUTCD	Manual on Uniform Traffic Control Devices
NEPA	National Environmental Policy Act
NFPA	National Fire Protection Association
NIST	National Institute of Science and Technology
NREL	National Renewable Energy Laboratory

OSHA	Occupational Safety and Health Act, or Occupational Safety and Health Administration
PFAS	personal fall arrest system
POC	point of contact
POD	plan of the day
PPE	personal protective equipment
RCRA	Resource Conservation and Recovery Act
RFP	request for proposal
RSO	radiation safety officer
SAIA	Scaffold & Access Industry Association
SDS	safety data sheet
S/CI	suspect and counterfeit items
STM	South Table Mountain
SWP	Safe Work Permit
SWPPP	stormwater pollution prevention plan
TTCP	Temporary Traffic Control Plan
TLV	threshold limit value
TWA	time-weighted average
UL	Underwriter's Laboratory
USC	United States Code

1 Introduction

The Service & Maintenance Subcontractor Environment, Safety & Health (ESH) Manual (hereafter referred to as “this Manual”) has been developed to identify the minimum requirements for Service Subcontractors and their lower-tier subcontractors (hereafter referred to as “Subcontractor”) which require personnel to perform work activities at the Department of Energy’s National Renewable Energy Laboratory (NREL) Sites.

1.1 Background

It is DOE policy that all Subcontractors shall provide a safe and healthful workplace for their personnel. In part, these conditions will be ensured by implementing the worker safety and health program established in 10 CFR Part 851—Worker Safety and Health Program. Each Contractor is responsible for ensuring compliance with “all applicable requirements” that govern their work at NREL facilities, including any consensus standards incorporated in 10 CFR Part 851 by reference.

1.2 Definitions

Competent Person: One who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt, corrective measures to eliminate them. A Competent Person is also one who has extensive training knowledge/experience in a particular activity or job function. A Competent Person at NREL shall be capable of demonstrating the “knowledge and skill-sets” that match their “Competent Person” designation.

Service/Maintenance Activity: Servicing, installing, adjusting, modifying repairing, inspecting and maintaining of new or existing property and assets including the site, structures, buildings, laboratories, offices and equipment.

Subcontractor: A person, corporation, or other entity, other than the prime contractor (NREL), who furnishes labor, supplies, materials, equipment, or services in furtherance of the DOE’s mission under a service contract with NREL including a task order agreement. A subcontractor's site tenure may vary depending on the nature of the project, and its employees are not considered a permanent force.

Vendor, Maintenance and Service Subcontractor Safety Orientation Checklist: An NREL form used to document the project-relevant ESH information conveyed to the Subcontractor. The Subcontractor then has the responsibility to ensure that the content covered in the checklist/orientation is effectively flowed down to all of their employees and their Subcontractors prior to the start of any work.

Graded Approach: Applying a level of rigor commensurate with the importance or significance of the activity, in relation to the associated hazards and consequences to ensure that available resources are used most efficiently and effectively.

Hold Point: A point of defined circumstances (i.e., Hot Work Permit) beyond which an activity must not proceed without the approval of a designated authority.

Imminent Danger: A condition or practice that could reasonably be expected to cause death or serious injury, severe property damage, or environmental impairment unless immediate actions are taken to mitigate the effects of the hazard created.

Non-NREL Site: Land, buildings, or structures, including installed equipment and utilities, that are used by NREL workers for the conduct of NREL work but are neither leased or government owned specifically for NREL operations. Examples are sites owned by research partners or other government agencies and used by NREL workers for the conduct of NREL business.

NREL Site: A geographic area owned or leased by or for the account of the federal government for the performance of Department of Energy program activities. This includes extant building, infrastructure, and other improvements. Some of the areas included in the NREL Site that are more commonly referred to include the South Table Mountain Site, the Flatirons Campus, and leased facilities, including but not limited to Denver West buildings and ReFUEL.

Qualified Person: One who by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated his ability to solve or resolve problems relating to the subject matter, the work, or the activity.

Subcontractor Administrator: An NREL employee who is authorized to award and administer a subcontract on behalf of NREL.

Worker: A leased worker, subcontractor, independent contractor/consultant, volunteer, or other individual providing services to NREL or working on NREL sites.

1.3 Layout and Use of this Manual - Imperative Information

1.3.1 Scope

This Manual contains excerpts from, and references to, numerous regulations, codes, and standards which are not presented in their entirety. Similarly, not all ESH subject matter is covered in this Manual. Each Subcontractor is responsible for ensuring compliance with “all applicable requirements” that govern their work at NREL facilities, including any consensus standards incorporated in 10 CFR 851 by reference. If the manual does not contain information relative to a particular ESH topic, the Subcontractor shall ensure that the governing regulatory provisions or national consensus standards as applicable are implemented. Subcontractors are always encouraged to apply best management practices in all their endeavors.

1.3.2 Layout of this Manual

The chapters in this manual are arranged according to topic area and, in general, are laid out in the same format. The chapter will identify who the requirements apply to, the broad regulatory drivers and the Subcontractor’s responsibilities.

Each chapter will also identify any requirements that are specific to the NREL site and/or the Department of Energy. Also presented in each chapter are issues of special emphasis that NREL has identified or for which additional risk control mechanisms are required (i.e., safety plans that shall be submitted for review and acceptance by the Environment, Safety and Health POC, or permits that shall be obtained prior to performing work, etc.).

1.3.3 Use of this Manual

It is the responsibility of the Subcontractor to know, understand and plan for the NREL-specific requirements/special emphasis programs. Further, it is the responsibility of the subcontractor to ensure that their lower tier subcontractors know, understand and comply with the requirements identified in this manual. The NREL-specific requirements may affect what the Subcontractor includes in their Fall Hazard Analyses, Lockout-Tagout Equipment Specific Procedures, Electrical Job Safety Plan (JSP), etc. and can impact how the Subcontractor conducts their work or may affect their schedule.

Note: Whenever there is a conflict between any requirements contained or referenced in this manual, the most stringent requirement shall apply, unless specifically exempted by the NREL ESH POC or NREL AHJ.

2 Program Policy

2.1 Applicability

The requirements of this section apply to all Subcontractors and lower-tier sub-contractors (hereafter referred to as “Subcontractor”) performing work activities on the NREL Site.

This section provides requirements for identifying key aspects of the Subcontractor ESH policies to provide all employees a safe and healthful workplace while also protecting the environment in compliance with the Department of Energy (DOE) and the Occupational Safety and Health Act.

2.2 Regulatory Requirements

The NREL facilities are Government-owned or leased facilities and subject to 10 CFR 851 Worker Safety & Health Program requirements. While the enforcement provisions of the Occupational Safety and Health Act of 1970 do not apply since the NREL facilities are Government-owned facilities, DOE has exercised its statutory authority to prescribe that all subcontractors will comply with the OSHA Safety and Health Standards for General Industry (29 CFR 1910) and Construction (29 CFR 1926) and DOE will enforce compliance with these standards. Further, subcontractors must comply with the following specific safety and health standards, codes and requirements, including:

- Title 29 CFR, Parts 1904.4 through 1904.11, 1904.29 through 1904.33; 1904.44, and 1904.46, “Recording and Reporting Occupational Injuries and Illnesses.”
- Title 29 CFR, Part 1910, “Occupational Safety and Health Standards,” excluding 29 CFR 1910.1096, “Ionizing Radiation.”
- Title 29 CFR, Part 1926, “Safety and Health Regulations for Construction.”
- ACGIH TLVs for Chemical Substances and Physical Agents and Biological Exposure Indices, Latest edition
- Welding Safety – ANSI Z49.1-2012
- Respiratory Protection – ANSI Z88.2-2015
- Laser Safety – ANSI Z136.1-2014
- Electrical Safety – NFPA 70-2017 (NEC) and NFPA 70E, Latest edition
- Boiler and Pressure Vessel Code – BPVC-2015
- Pressure Piping Codes – ASME (B31.1-2016, B31.3-2014, B31.4-2016, B31.5-2016, B31.8-2016, B31.8S-2014, B31.9-2014, B31.11-2002, B31.G-2012)
- Current edition of all NFPA standards
- 2015 International Fire Code
- 2015 International Building Code
- 2015 International Mechanical Code
- Implement a Biological Safety Program compliant with CDC, NIH, WHO and USDA/APHIS (as applicable to the scope of work)

- Title 10 Code of Federal Regulations CFR 850 Chronic Beryllium Disease Prevention Program

It must be understood that 10 CFR 851 provides the basic foundation for a worker safety and health program and that Subcontractors may need to go beyond the Rule's minimum requirements in establishing programs to protect workers from hazards associated with their activities.

2.3 NREL Specific Requirements

2.3.1 Training and Documentation

For all Subcontractor workers at NREL, site-specific environment, safety and health orientation training will be required. This orientation will be documented by having each affected worker sign the Subcontractor Safety Orientation Checklist.

For work activities in which specific training is required by safety regulations (e.g., OSHA mandated), the subcontractor shall maintain records on-site, showing proof of current training records for all authorized workers. Designated "Competent Persons" are expected to have a higher level of experience, training and qualification. Subcontractors shall have in place a mechanism to verify that the "Competent Person(s)" knowledge and skill-sets match their "Competent Person" designation (i.e., written test, training certifications).

Documentation verifying worker training, qualification, or certification shall be submitted to NREL for the below listed training topics, as applicable to the scope of work.

- Aerial Lift/Aerial Work Platform/Scissor Lift
- Chemical Safety / Hazard Communication
- Confined Space (Entrant, Attendant, Entry Supervisor)
- Control of Hazardous Energy (LOTO)
- Fall Protection (Authorized Worker, Competent Person)
- Forklift/Powered Industrial Truck
- Hoisting & Rigging
- Laser
- Qualified Electrical Worker (Electrical Safety in the Workplace) Note: Worker exposure of 50 volts or more requires training on the latest edition of NFPA 70E. The training provider and course content must be accepted by NREL. Contact NREL for a listing of currently accepted providers. Online training is not acceptable for exposures greater than 150 volts.
- Radiation Safety
- Respiratory Protection
- Scaffolding (Competent Person)

- Silica Awareness
- Toxic and Hazardous Substance Specific
- Waste Management/Minimization
- Other Applicable Training (as requested by NREL ESH)

Photocopies of training certificates, certification cards, wallet IDs, licenses, etc. identifying the individual, the specific training, who conducted the training and the date completed (and/or expiration date) are accepted in lieu of originals.

In addition, NREL may require some projects to have specific qualifications for their designated on-site safety representative (e.g., 10- or 30-hour General Industry Safety, Safety Trained Supervisor, Board of Certified Safety Professionals Certification), depending upon the complexity of the work and the hazards involved. NREL will identify this requirement in the statement of work.

2.3.2 Subcontractor Incident Response and Notification

The Subcontractor shall report all incidents involving injury, property damage and near misses, no matter how minor, to the NREL Technical Monitor as soon as the scene is stabilized, but in all cases notification shall be made as soon as possible, but within two hours of the occurrence. This reporting time frame is necessary in order to meet DOE notification time requirements and so that any necessary event investigation, scene security, cleanup, traffic rerouting, etc. may begin.

For all emergencies at the NREL site (excluding the Flatirons Campus), the subcontractor shall contact the Security by:

- Utilizing any building red phone
- Dialing extension 1234 from the building landline
- By calling (303) 384-6811 from any outside line (cell phone)

Note: DO NOT call 911, as this will cause confusion and delays. The Central Monitoring Station (CMS) will coordinate and direct the emergency response services to your location.

- For work at the Flatirons Campus, the subcontractor shall call 9-911, ask for Boulder County, inform them that location is the Flatirons Campus and provide details of the emergency. Following the call to 9-911, make an additional call to CMS at 303-384-6811 so they are aware of the emergency as well. All other incident response requirements apply to work at the Flatirons Campus.
- For ReFUEL call 9-911 and provide details of the emergency. Following that contact CMS.

2.3.3 NREL Response to Emergencies

Upon notification of an emergency situation, NREL will provide notification to external and internal responders. Internal responders include: ESH POC's, Security & Emergency Preparedness personnel, and if applicable, our internal Chemical Response Team (CRT).

2.3.4 Subcontractor Event Investigation

After the response has occurred and the scene is stabilized and secure the subcontractor must initiate an event investigation and/or participate with the ESH event investigation, as determined by NREL. There is an expectation and responsibility to fully understand what occurred, the causation of the event and the identification of corrective actions. The subcontractor is further responsible for the prompt implementation of corrective actions for deficiencies identified through an ESH event investigation, or as reported by DOE, the Technical Monitor, ESH POC, or other authorities having jurisdiction.

2.3.5 Subcontractor Initial Screening Process

All NREL subcontractors and all of their lower-tier subcontractors are required to meet pre-established ESH risk criteria prior to being awarded a subcontract to perform work at NREL sites. The NREL Procurement Office includes the Environment, Safety, and Health Subcontract Risk Evaluation Worksheet as part of solicitations and confirms and verifies that all potential subcontractors and lower-tier subcontractors have properly completed the worksheet. NREL ESH Point of Contact (POC) will complete an initial review of the subcontractor or lower-tier Experience Modification Rate (EMR). The EMR shall be updated annually and provided to NREL.

The Subcontractor is responsible for ensuring that all of their lower-tier subcontractors ESH Subcontract Risk Evaluation Worksheets are submitted to NREL for review and NREL approval prior to performing work on an NREL site. All subcontractors are required to maintain a minimum EMR of 1.0 or less. Exceptions will have to be evaluated and accepted by ESH&Q.

2.4 NREL Special Emphasis

2.4.1 Integrated Safety Management (ISM) System

The Subcontractor shall incorporate the elements of ISM into their work planning. An effective ISM plan establishes a single system that integrates requirements into the work planning and execution process to protect the workers, public, and the environment. NREL implements the following five core ISM functions for work activities that could potentially affect workers, the public, or the environment and applies them as a continuous cycle with the degree of rigor appropriate to address the type of work activity and the hazards involved.

- **Define the Scope of Work.** Translate missions into work, set expectations, identify and prioritize tasks, and allocate resources.
- **Analyze the Hazards.** Identify, analyze, and categorize hazards and potential environmental impacts associated with the work.
- **Develop and Implement Hazard Controls.** Identify and agree upon standards and requirements, identify controls to prevent/mitigate hazards, establish the ESH parameters, and implement controls.
- **Perform Work Within Controls.** Confirm readiness and perform work safely and in the prescribed manner to protect workers, the public, and the environment.
- **Provide Feedback and Continuous Improvement.** Gather feedback on the adequacy of controls from workers and appropriate stakeholders, identify and implement opportunities for improvement, and conduct line management and independent oversight.

Subcontractor program flexibility is understood and encouraged as long as the Subcontractor's program tenets adequately address the spirit and intent of the ISM provisions. For specific information on instituting an ISM program, refer to DOE document M450.4-1, <https://www.directives.doe.gov/directives-documents/400-series/0450.4-DManual-1/@@images/file>

2.5 Stop Work Authority

Workers have the authority to stop work and the work of others upon discovery of imminently dangerous conditions or other serious hazards to workers or the public, and are not subject to reprisal or retaliation. The NREL Technical Monitor and the Environment, Safety and Health point of contact (ESH POC) shall be immediately notified of any "stop work" action. All workers (including subcontractor workers) at NREL sites have the authority to stop work. Work may not proceed until the circumstances are reviewed and deficiencies corrected.

2.6 Subcontractor Responsibilities

As required in 10 CFR 851, the Subcontractor shall establish a worker safety and health program. Worker protection measures should be based on the use of a graded approach to ensure that available resources are used most efficiently and effectively. Worker safety and health programs shall be integrated into other related site-specific worker protection activities and within the integrated safety management system. There must be an open and continuous line of communication between the Subcontractor and NREL to discuss any unsafe acts or conditions that may arise during the project.

The Subcontractor has overall accountability for the safety of their project and shall allocate the resources necessary for implementing all required safety-related codes and contract/subcontract requirements. The subcontractor shall:

- Follow all NREL site specific ESH requirements and associated permits as defined by this manual.
- Implement ESH flow-down requirements in all subcontracts.
- Implement the appropriate requirements of this manual into their work planning.
- Provide training to employees in safe-work practices.
- Document all required training and have available for review.
- Provide required personal protective equipment (PPE), training employees on how to use the equipment and enforcing its use in the field.
- Monitor the workplace for unsafe conditions and take immediate action to correct unsafe conditions, acts, and other deficiencies identified during inspections.
- Perform necessary personal exposure monitoring.
- Coordinate and conduct pre-job planning with subcontractors, affected lab managers, and others, as required.
- Instruct all employees, initially and periodically, on matters pertaining to employee safety and health rights, protections, obligations, and responsibilities.

2.7 References

- 10 CFR 851, Worker Safety & Health Program
- 29 CFR 1910, Occupational Safety and Health Standards for General Industry.

3 Occupational Medicine

3.1 Applicability

The requirements of this section apply to all Subcontractors' and lower-tier subcontractors' (hereafter referred to as "Subcontractor") activities which require personnel to work on NREL Sites if *either* of the two criteria applies:

- The Subcontractor's workers are on site for more than 30 days in a 12 month period
- The Subcontractor's workers on site are enrolled for any length of time in a medical or exposure monitoring program required by any rule or other obligation.

3.2 Regulatory Requirements

The Subcontractor shall establish and provide comprehensive occupational medicine services to workers on the site, as required in Appendix A.8. of 10 CFR Part 851—Worker Safety and Health Program.

3.3 NREL Specific Requirements/Permits

Where applicable, NREL requires Subcontractors to submit health and safety plans that document compliance with the occupational medicine provisions contained in Appendix A.8. to 10 CFR Part 851—Worker Safety and Health Program.

3.4 NREL Special Emphasis

The occupational medicine requirements in 10 CFR Part 851 are unfamiliar to many subcontractors and "flowing down" or transferring the responsibility for compliance with these requirements to lower-tier subcontractors, is irregular and generally tends to lack proper oversight to ensure high quality compliance. Further, Subcontractors may fail to inform occupational medicine services providers of their responsibilities specified in 10 CFR Part 851—Worker Safety and Health Program, which is a regulation unique to DOE sites and applicable at NREL.

3.5 Subcontractor Responsibilities

The Subcontractor is responsible for compliance with Appendix A.8. of 10 CFR Part 851—Worker Safety and Health Program, including: the accurate and timely flow down of these requirements to all of their lower-tier subcontractors, and, for insuring that all of their lower-tier subcontractors comply with these requirements.

The Subcontractor is responsible for providing their occupational medicine services providers access to worksite hazard information.

- The Subcontractor is responsible for coordinating with the NREL Technical Monitor and providing the occupational medicine services provider with access to the following:
 - Current information about actual or potential work-related site hazards (chemical, radiological, physical, biological, or ergonomic)
 - Employee job-task and hazard analysis information, including essential job functions
 - Actual or potential work-site exposures of each employee

- Personnel actions resulting in a change of job functions, hazards, or exposures.
- Subcontractors shall notify the occupational medicine services providers when an employee has been absent because of an injury or illness for more than five consecutive workdays (or an equivalent time period for those individuals on an alternative work schedule).

The Subcontractor and occupational medicine services provider is responsible for developing and maintaining a record, containing any medical, health history, exposure history, and demographic data collected for the occupational medicine purposes, for each employee for whom medical services are provided. All occupational medical records shall be maintained in accordance with Executive Order 13335, Incentives for the Use of Health Information Technology.

The Subcontractor is responsible for notifying the occupational medicine services provider of the requirements contained in Appendix A.8. of 10 CFR Part 851—Worker Safety and Health Program. The occupational medicine services provider and Subcontractor are responsible for implementing and ensuring compliance with the following requirements:

- The occupational medicine services provider determines the content of the worker health evaluations.
 - Workers shall be informed of the purpose and nature of the medical evaluations and tests offered by the occupational medicine services provider.
 - The occupational medical provider shall determine the necessary health evaluations.
 - Diagnostic examinations will evaluate employee’s injuries and illnesses to determine work-relatedness, the applicability of medical restrictions, and referral for definitive care, as appropriate. After a work-related injury or illness or an absence due to any injury or illness lasting 5 or more consecutive workdays (or an equivalent time period for those individuals on an alternative work schedule), a return to work evaluation will determine the individual’s physical and psychological capacity to perform work and return to duty. At the time of separation from employment, individuals shall be offered a general health evaluation to establish a record of physical condition.
- The occupational medicine services provider shall monitor ill and injured workers to facilitate their rehabilitation and safe return to work and to minimize lost time and its associated costs.
- The occupational medicine services provider shall include measures to identify and manage the principal preventable causes of premature morbidity and mortality affecting worker health and productivity.
 - The Subcontractor shall include programs to prevent and manage these causes of morbidity when evaluations demonstrate their cost effectiveness.
- The occupational medicine services provider shall review and approve the medical and behavioral aspects of employee counseling and health promotional programs, including the following types:
 - Subcontractor-sponsored or Subcontractor supported EAPs
 - Subcontractor-sponsored or Subcontractor supported alcohol and other substance abuse rehabilitation programs

- Subcontractor-sponsored or Subcontractor supported wellness programs.

3.6 References

- 10 CFR Part 851 Appendix A - Worker Safety and Health Functional Areas
- 10 CFR Part 851, Worker Safety and Health Program
- Executive Order 13335, Incentives for the Use of Health Information Technology
- 10 CFR 712.38(b)(2) - Maintenance of medical records
- 5 USC Sec. 552a. - Records maintained on individuals
- 10 CFR Part 1008 - Records maintained on individuals
- 29 CFR 1910.1020, Access to employee exposure and medical records
- 42 USC Sec. 7384, Energy Employees Occupational Illness Compensation Program Act.

4 Hazard Identification and Control Process

4.1 Applicability

The requirements of this chapter apply to all Subcontractors and lower-tier subcontractors (hereafter referred to as “Subcontractor”) work activities on NREL Sites unless otherwise specifically exempted by NREL. This chapter provides the requirements for establishing a method for identifying, controlling, and documenting hazards associated with Subcontractor work activities and communicating this information to all affected workers.

4.2 Regulatory Requirements

Subcontractor methods for identifying, controlling, and documenting hazards associated with subcontractor work activities shall be conducted in accordance with the following statutory requirements:

- 29 CFR 1910, General Industry
- 29 CFR 1926, Construction
- 10 CFR 851, Worker Safety and Health Program.

4.3 NREL Specific Requirements/Permits

In addition to Section 4.2, all Subcontractor work activities shall meet the following specific NREL requirements for hazard identification and control.

4.3.1 General Requirements

The Subcontractor is responsible for understanding the scope of work in sufficient detail to ensure that the work is effectively planned for each definable work activity, the hazards associated with the work are identified and the planned protective measures are implemented. The subcontractor is further responsible for adhering to the NREL Safe Work Permit and any established Hold Points.

4.3.2 Worker Training

The Subcontractor shall ensure that affected workers are made aware of the foreseeable hazards and the protective measures described within the NREL Safe Work Permit prior to beginning work on the affected activity.

4.3.3 Record of Training

The Subcontractor shall ensure that workers acknowledge being informed of the hazards and protective measures associated with assigned work activities and understand those requirements.

4.4 Subcontractor Responsibilities

The provisions of this procedure apply to the development and implementation of the Subcontractor’s Hazard Identification and Control program. The Subcontractor shall be responsible for implementing an effective Hazard Identification and Control program that:

- Identifies, evaluates, and controls potential and existing hazards/agents in the workplace through the pre-job safety planning process.
- Adequate hazard controls are incorporated into the NREL Safe Work Permit.

- Determines that engineering devices, administrative controls, and personal protective equipment are available, appropriate, tested, and utilized by employees
- Determines employees are trained as required
- Have provisions to manage and notify NREL when there are changes related to the work scope, materials, and/or processes that may introduce new or different hazards to the project.

4.5 References

- 10 CFR 851, Worker Safety and Health Program
- 29 CFR 1910, General Industry Standards.

5 Control of Hazardous Energy, Lockout/Tagout

5.1 Applicability

The requirements of this chapter apply to all Subcontractors and lower-tier subcontractors (hereafter referred to as “Subcontractor”) activities (i.e., constructing, installing, setting up, adjusting, inspecting, modifying and maintaining/servicing equipment) where the unexpected release of hazardous energy (i.e., electrical, hydraulic, pneumatic, chemical, thermal, compressed gases, mechanical & gravity) or startup of the machines, equipment, and systems could cause injury on NREL Sites.

5.2 Regulatory Requirements

The subcontractor control of hazardous energy program and associated work activities as defined in Section 5.1 where the unexpected release of hazardous energy or startup of the machines, equipment, and systems could cause injury shall be conducted in accordance with the following statutory requirements:

- 29 CFR1910.147, The Control of Hazardous Energy (Lockout/Tagout)
- 29 CFR 1910.333, Selection and Use of Work Practices

5.3 NREL Specific Requirements/Permits

In addition to Section 5.2, all work activities requiring the use of lockout/tagout shall meet the following NREL requirements as applicable in Sections 5.3.1-5.3.5 of this manual.

5.3.1 Energized Electrical Work

Work on energized systems at NREL must be strenuously avoided unless it is approved by the NREL AHJ, and that there is no reasonable alternative course of action. If energized electrical work must be performed on hazardous circuits, the subcontractor shall obtain an NREL authorized Energized Electrical Work Permit (EEWP) from the Technical Monitor prior to performing any energized electrical work. If energized work must be performed on any other type of energy system (excluding electrical), it shall be authorized by the appropriate Manager, with concurrence from the ESH POC.

Exception: Taking voltage, current measurements for diagnostic purposes and/or verification of the absence of energy by using standard test equipment such as voltmeters and current probes is permitted on energized electrical systems without an issuance of an EEWP. All other hazard identification, control and PPE requirements to include shock protection and arc flash protection continue to apply and shall be documented in the Electrical Job Safety Plan (per chapter 6).

5.3.2 NREL Building Equipment and Systems Lockout/Tagout

Prior to conducting any work which requires lockout/tagout within an existing NREL building or that interfaces with an existing NREL utility system, the subcontractor shall first notify the NREL Facility Manager (through their host or Technical Monitor). This includes lockout/tagouts that occur on building temporary and/or permanent electrical power tie-ins at the point of NREL supplied power distribution. The NREL Facility Manager shall control, coordinate and approve lockout/tagout work being conducted on these equipment/ systems and shall ensure that the subcontractors are aware of and comply with the requirements of the NREL lockout/tagout

program. The Subcontractor shall ensure that the ESH POC is provided with the provisions of the Subcontractor(s) lockout/tagout program/procedures. When NREL equipment/system specific procedures are available, they shall be provided to the subcontractor and utilized as part of the lockout/tagout.

When the subcontractor performs work which is downstream of the NREL power distribution point for temporary or permanent power tie-in, is downstream of an existing NREL lockout/tagout or is completely independent of existing NREL building equipment/systems, the lockout/tagout shall be performed in accordance with the subcontractor's accepted lockout/tagout program.

5.3.2.1 Tagout Only Requirements

When equipment/system cannot physically be locked out and a tagout is applied to equipment/system in place of lockout, the subcontractor shall attempt feasible measures to renovate or modify the equipment to accept a lockout device on the energy-isolating device(s). When this cannot be accomplished, the subcontractor shall:

- Implement additional measures to provide the equivalent level of safety (i.e., post an attendant, remove isolating circuit element, fuse, or valve handle) and document it in the SWP.
- Apply a properly completed tag at the energy-isolating device and at the control panel. Individual tags must include the name and cell phone number for each worker.
- Verify that energy sources are eliminated.
- Check the tag frequently when working under a tagout to verify that it is still in place.

5.3.3 Equipment Specific Lockout/Tagout Procedures

Written equipment specific procedures are required for complex application or when multiple crews, crafts or employers are engaged in a common lockout/tagout application. When written lockout/tagout procedures are required, the subcontractor may elect to utilize their own procedure format or the NREL lockout/tagout equipment specific procedure format. A copy of this format can be obtained by contacting the ESH POC. If the Subcontractor elects to use their own procedure format, then procedures that meet the minimum content requirements of 29 CFR 1910.147 and NFPA 70E will be deemed as acceptable by NREL.

5.3.4 Subcontractor Lockout/Tagout Inspection Procedures

The subcontractor shall ensure that weekly documented inspections are made for all active lockout/tagout applications. These inspections shall be kept at the jobsite and made available for review by NREL.

The subcontractor shall also perform daily informal (undocumented) inspections to verify lockout/tagouts remain in place.

5.3.5 Subcontractor Training Requirements

Subcontractors that are trained in accordance with the requirements identified in 29 CFR 1910.147, Control of Hazardous Energy (Lockout/Tagout) will be considered as meeting the necessary training requirements for working at NREL. The subcontractor shall provide proof of such training as requested by the ESH POC. The subcontractor is required to provide qualified and competent persons at the job site. Workers exposed to hazardous electrical energy, must be qualified electrical workers and must be trained in the current edition of NFPA 70E.

5.4 NREL Special Emphasis

5.4.1 Applying Lockout/Tagout

Each exposed subcontractor worker shall apply their own uniquely keyed lock and a properly completed tag (including name and cell number) to secure the energy source(s) prior to beginning work activities. When more than one individual is working on the same piece of equipment or project, a group lock box or multi-lock hasps (gang hasp) or other acceptable means shall be used, and each worker shall apply his or her lock. Combination locks are not acceptable. Workers shall not rely on another person's lockout for protection. Supervisory controlled lockout/tagouts are prohibited at NREL.

5.5 References

- 29 CFR1910.147, The Control of Hazardous Energy (Lockout/Tagout)
- 29 CFR 1910.333, Selection and Use of Work Practices
- NFPA 70E (2018), Standard for Electrical Safety in the Workplace

6 Electrical Safety

6.1 Applicability

The subcontractor shall be responsible for the development and implementation of an electrical safety program to be followed throughout all phases of work and this program shall apply to all Subcontractors and lower-tier subcontractors (hereafter referred to as “Subcontractor”) activities performed on NREL Sites unless otherwise specifically exempted by NREL. This program shall be documented.

6.2 Regulatory Requirements

The subcontractor electrical safety program shall be conducted in accordance with the following statutory requirements:

- 29 CFR 1910, Subpart S, Electrical
- 29 CFR 1910.147. The Control of Hazardous Energy (Lockout/Tagout).
- NFPA 70E, Latest edition, Electrical Safety in the Workplace

Note: Whenever there is a conflict between any requirements contained or referenced in this chapter, the most stringent requirement shall apply unless specifically exempted by the NREL ESH POC or Electrical Safety AHJ.

6.3 NREL Specific Requirements/Permits

In addition to Section 6.2, the subcontractor electrical safety program shall meet the following NREL requirements as applicable.

6.3.1 General Electrical Work Safety Requirements

Subcontractors shall identify the electrical hazards associated within each definable feature of work and establish the controls necessary to maintain an acceptable level of risk. To assist in the evaluation of electrical hazards, subcontractors shall employ an Electrical Risk Assessment consistent with requirements of NFPA 70E, Standard for Electrical Safety in the Workplace (Current Revision as adopted by NREL) for shock and arc flash hazards.

The safe electrical work practices that are employed shall prevent electric shock, burns, arc flash or other injuries that could result from either direct or indirect electrical contact. This may include specialized training, observing required approach distances, and the use of appropriate personal protective equipment (PPE) consistent with the requirements of NFPA 70E.

The subcontractor shall document an electrical job safety plan and performed briefings of the plan prior to starting work each day. The briefing shall cover such subjects as hazards associated with the job scope, work procedures involved, special precautions, energy source controls, PPE requirements, and the information on the energized electrical work permit, if required. Additional job briefings shall be held if changes that might affect the safety of employees occur during the course of work.

6.3.1.1 *Personal Protective Equipment*

Subcontractors are responsible for identifying, providing and maintaining their own PPE. Maintenance of PPE includes the required testing and certification. Records of such testing shall be made available for review.

PPE appropriate to the hazard present shall be used. Electrical PPE may include:

- Rubber insulating gloves (dielectric tested within the past 6 months)
- Eye, face, head and hearing protection
- Non-conductive headgear
- Arc-Flash protective clothing as required by NFPA 70E
- Hot-sticks and similar tools.

6.3.1.2 *Qualified Electrical Worker*

Only qualified workers who maintain the necessary skills and knowledge related to the construction, operations of electrical equipment and the associated hazards are permitted to work on electrical systems at NREL. A **“Qualified Electrical Worker”** is a person who has demonstrated skills and knowledge related to the construction and operation of electrical equipment and installations and has received safety training to identify and avoid the hazards involved. Such a person is familiar with the proper use of precautionary techniques, personal protective equipment, insulating and shielding materials, insulated tools, and test equipment in addition NREL specific procedural requirements. Verification of training shall be in accordance with Section 2.3.1.

Apprentice electricians shall work under the supervision of a Journeyman electrician and shall have received the appropriate electrical safety training prior to assigning work assignments that involve electrical hazards. NREL doesn't allow Apprentice electricians to perform work on energized electrical conductors or circuit parts that are not placed in an electrically safe work condition.

The subcontractor shall be responsible for documenting the qualifications of the “Qualified Electrical Workers” utilized on the project.

6.3.1.3 *Ground Fault Circuit Interrupter (GFCI) Protection*

Subcontractors shall ensure that GFCIs are used on 120-volt circuits as specified below:

- In damp or wet (standing water) work areas outdoors
- For temporary power (e.g., extension cords) during remodeling, maintenance, service, repair or similar activities, outdoor receptacles shall be enclosed with weatherproof (preferably metal) covers
- When using portable, electric hand tools and equipment with cord/plug connectors.

The users of the GFCIs shall test portable GFCIs using the test button provided before each use. If the GFCI breaker fails the test, tag out of service with a “DANGER — DO NOT USE” tag and (if portable) remove from service. Tripped circuit breakers may not be re-energized until it has been

determined that the equipment and circuit can be safely re-energized. Do not reset or operate facility circuit breakers. Contact the Facility Manager (FM) or your ESH POC if this occurs.

6.3.1.4 Flexible Cords and Cables

Use UL-listed flexible cords suitable for conditions of and location of use. Flexible cord sets used with grounding-type equipment shall contain an equipment grounding conductor. Protect flexible cords and cables from damage. When possible, hang extension cord sets appropriately in the overhead to avoid tripping hazards and damage caused by foot traffic and equipment. Avoid sharp edges, pinching, or improper storage. Cords sets that are damaged shall be removed and discarded or repaired by a qualified person. Extension cords shall not be daisy-chained together.

6.3.2 Lockout/Tagout

Subcontractors shall ensure that electrical systems and equipment are effectively isolated, locked, and tagged out in accordance with the requirements of chapter 5.0, Control of Hazardous Energy, Lockout/Tagout of this manual (and article 120 of NFPA 70E), prior to performing any work on or near the energized systems. Subcontractors shall make all feasible efforts to effectively isolated and lock and tag out energized electrical systems and equipment in order to avoid performing Hazardous Energized Electrical Work as defined in Section 6.3.3 of this manual. A lock and tag are both required, except were tagout alone is accepted (refer to 5.3.2.1)

6.3.3 Hazardous Energized Electrical Work

Hazardous Energized Electrical Work at NREL is defined as “work performed within the restricted approach boundary or interactions with the equipment when conductors or circuit parts are not exposed, but an increased likelihood of injury from an exposure to an arc flash hazard exists, on equipment operating at 50 volts or more to ground, or less than 50 volts to ground where the current exceeds 5 mA, creating the potential for injury, explosion or injuries due to electric arcs.”

When it has been determined by the subcontractor in conjunction with the appropriate NREL authorities (Facility Manager, Site Operations Electrical Engineer and the ESH POC) that there is no other reasonable alternative course of action, the subcontractor shall obtain an NREL Energized Electrical Work Permit (EEWP) in accordance with Section 6.3.3.1 from the Technical Monitor prior to performing any hazardous energized electrical work.

Controls may still be required for energized work on “non-hazardous circuits” to protect against secondary hazards such as startle or involuntary reactions from contact with low voltage high current sources. These would include circuits operating at 50 volts and less with a short circuit current of greater than 5 mA or energy greater than 0.25 joules.

Exception: *An EEWP shall not be required if a qualified person is provided with and uses appropriate safe work practices and PPE for the following conditions:*

1. *Testing, troubleshooting, and voltage measuring*
2. *Thermography and visual inspections, if the restricted approach boundary is not crossed.*
3. *Access to and egress from an area with energized electrical equipment, if no electrical work is performed and the restricted approach boundary is not crossed.*
4. *General housekeeping and miscellaneous non-electrical tasks, if the restricted approach boundary is not crossed.*

6.3.3.1 Energized Electrical Work Permit (EEWP)

The subcontractor shall ensure that a permit has been completed with the NREL required concurrences and approvals before work may be initiated on hazardous energized systems. The permit shall be task specific. Blanket, general, or open-ended permits are prohibited and will not be processed. After a permit has been approved, subsequent changes in the scope of work or associated hazards requires cessation of work and a timely reassessment of this permit. If necessary, additional controls will be established and a new permit issued.

An NREL approved EEWP serves as the authorization basis to conduct energized electrical work on energized circuits.

6.3.4 Two-Worker Rule

An NREL rule that requires a second qualified electrical worker to be present when work is performed within the shock restricted approach boundary or the arc flash boundary of an exposed energized electrical conductor or circuit part. An example of the work would be zero energy verification and voltage measurement. The second worker functions as a safety observer and does not participate in the actual work. The second worker cannot also serve as an attendant. The second worker shall be trained in cardiopulmonary resuscitation and be prepared to initiate other emergency response procedures. The NREL host to the subcontractor workers may serve as a second worker when requested by the subcontractor.

6.3.5 Safe Penetration of Building Surfaces

Subcontractors are required to obtain a “NREL Surface Penetration Permit” prior to performing any surface penetration inside existing NREL building and/or facilities. A **Surface Penetration** is defined as an opening made by drilling, cutting, hammering, or otherwise piercing a wall, floor, ceiling, roof, or concrete pad. The subcontractor shall adhere to all the applicable electrical safety requirements as provided in chapter 16.

The permit outlines the steps necessary for safe penetration of building surfaces such as walls, floors, ceilings, roofs, and concrete pads, specifically with respect to preventing contact with hidden hazards such as live electrical conductors. The NREL FM will issue the permit to the subcontractor. The subcontractor will be responsible for providing all the required materials, personnel and protective equipment to conduct the surface penetration. These materials may include but not limited to drill stops, GFCIs, dielectric gloves and mats.

Note: This permit is also necessary to identify other significant hazards such as natural gas, water lines, compressed air and drains.

6.3.6 Excavations

All excavations including hand digging, trenching, grading, drilling activities, including staking shall first be permitted by the appropriate NREL FM. The subcontractor shall adhere to all the applicable electrical safety requirements as provided in chapter 7.0.

6.4 References

- 29 CFR 1926, Subpart K, Electrical
- NFPA 70E, Standard for Electrical Safety in the Workplace, Latest edition

- DOE-HDBK-1092-2013 DOE Electrical Safety Handbook.
<https://www.standards.doe.gov/standards-documents/1000/1092-BHdbk-2013/@@images/file>

7 Excavations

7.1 Applicability

The requirements of this chapter apply to all Subcontractors and lower-tier subcontractors (hereafter referred to as “Subcontractor”) excavation operations and activities on NREL Sites unless otherwise specifically exempted by the NREL. This includes hand-digging and ground penetrations.

7.2 Regulatory Requirements

All Subcontractor excavation activities shall be conducted in accordance with the following statutory requirements:

- 29 CFR 1926, Subpart P, Excavations

7.3 NREL Specific Requirements/Permits

7.3.1 NREL Excavation Permit

In addition to Section 7.2, Subcontractors shall obtain an approved NREL Excavation Permit from the appropriate NREL Facility Manager (FM) and the NREL ESH POC for all excavations including trenching, grading, drilling or staking activities.

The FM and ESH POC shall complete the Excavation Permit for issuance to the Permit Holder. for the execution of work. At a minimum, the FM, EHS POC and the Subcontractor Supervisor or designee shall physically walk the proposed excavation site with a site drawing (minimum ANSI D size sheet) and compare it to the site utility locate drawing and physical markings. Any deviations identified during this walk shall be resolved prior to issuing the permit.

7.3.1.1 Utility Locates

The NREL FM will dictate the necessary underground location and identification services as part of the Subcontractor's work. The location service requirements shall be performed prior to NREL authorizing the excavation permit. The FM will verify that the all underground services have been located and identified with appropriate color-coded markers.

If there is any uncertainty as to the degree of safety protection anticipated on underground electrical power lines, the electrical service should be de-energized first with a planned outage arranged and coordinated through the affected FM and Technical Monitor.

7.3.1.2 Pot Hole Verification

The NREL Facility Manager or assigned representative shall work directly with the Subcontractor who will hand dig or otherwise safely "pot hole" (daylight) to verify location and depth of the various utilities and NREL-owned underground facilities and/or lines which may conflict with the excavation activity.

When the Subcontractor excavating activities are within 5 feet of underground services, the NREL Facility Manager or NREL accepted designated representative will be physically present for onsite monitoring to ensure compliance with the NREL accepted plan.

Note: At the FM’s discretion, the Subcontractor may be required to perform pothole activities prior to the issuance of the Excavation Permit. However, no other excavation may take place without the approved NREL excavation permit.

7.3.1.3 Confined Spaces

When the configuration of an excavation is such that the excavation is deemed to be a confined space, the provisions of the chapter 15, Confined Space program shall apply.

7.3.2 NREL Excavation Lockout/Tagout

The NREL Facility Manager or designated representative will be physically present for onsite monitoring when excavating activities are within 5 feet of underground services to ensure compliance with the approved plan. All underground electrical (50 volts and above) and other systems covered by the lockout/tagout program shall be de-energized and locked out during excavations within 5 feet of those systems, unless otherwise approved in advance by the appropriate FM and ESH POC.

During excavation activities, no locks or tags shall be installed or removed on facility systems by Subcontractors without the written approval of the applicable Facility Manager (FM) or designated representative.

7.3.3 Subcontractor Training Requirements

Subcontractor excavation Competent Person(s) that are trained and knowledgeable about soils analysis, the use of protective systems, identification of existing and predicable excavation hazards and the requirements of 29 CFR 1926, Subpart P, Excavations, will typically be considered as meeting the necessary excavation competent person training for working at NREL. The Subcontractor shall provide proof of such training as requested by the ESH POC. The Subcontractor is required to provide a qualified and competent person at the job site when excavations work is ongoing. The Subcontractor shall ensure that the “Competent Person(s)” can demonstrate that their knowledge and skill-sets is adequate for the excavation and protective system(s) required. In addition, all Subcontractors working in or around excavations shall receive general excavation hazards awareness training.

7.4 NREL Special Emphasis

7.4.1 Underground Services/Utilities

A potential hazard on NREL sites is the presence of underground services and structures such as utility lines (water, electric, sewer, gas, or communication), tanks, various gas and liquid process piping, and sewers. If these services or structures are damaged in any way as a result of excavation activities, there may be injury or death to workers, contamination or interruption of services, disruption of processes, and expensive programmatic delays. In order to prevent any incident regarding underground services, ensure all applicable provisions of the NREL Excavation Permit System are adhered to prior to any excavation work at NREL.

7.4.2 Munitions and Explosives of Concern

The laboratory facilities at the South Table Mountain (STM) site are located on a portion of the former Camp George West National Guard base. The former base had a long and varied history as a military installation from 1902 through 1953. Portions of the NREL campus are subject to the discovery of military munitions and explosives of concern (MEC).

All MEC or suspect foreign objects encountered on the STM shall be treated as extremely dangerous. These items can be Unexploded Ordnance (UXO), Discarded Military Munitions (DMM), or Munitions Constituents (MC).

All subcontractors performing work in an “STM identified area of concern” shall brief their workers and lower tier subcontractors on the potential for discovery of MEC and the required response actions. NREL ESH will assist in providing the necessary information to affected subcontractors on the types of MEC that may be found on the site and required response actions upon discovery.

In the event an employee discovers a MEC or suspect foreign object while performing work on the STM, the employee must be trained to follow the three Rs:

- **RECOGNIZE:** Do not touch, disturb or move the item. Munitions come in all shapes, sizes, and color but exposure to weather and time can alter or remove these markings.
- **RETREAT:** Mark the general location of the MEC with hazard tape, colored cloth or ribbon, hat, etc. at a point no closer than you first recognized it. Do not transmit any radio frequency when in the proximity of an MEC. Evacuate the area to a safe distance of at least 100 yards. Do not allow any co-workers to re-enter the area until it has been cleared by the Jeffco Bomb Squad or NREL Security.
- **REPORT:** Immediately upon reaching a safe distance from the MEC, contact NREL Security at 303-384-6811. Security will notify the Jeffco Bomb Squad.

7.5 Subcontractor Responsibilities

The Subcontractor shall be responsible for the following:

- Obtaining an approved NREL Excavation Permit from the FM and EHS POC
- Monitoring/daily inspections of excavation, trenching and shoring operations
- Designating a Competent Person, who has had the training to act in this position and providing the competent person the authority to effectively discharge their duties
- Ensuring the requirements of this chapter are effectively communicated and enforced to lower tier sub-contractors
- Investigate and report to the NREL Technical Monitor all incidents involving excavations, trenching and shoring.

7.6 References

- 29 CFR 1926, Subpart P, Excavations

8 Fire Protection and Prevention

8.1 Applicability

The subcontractor shall be responsible for the development and implementation of a fire protection program to be followed throughout all phases of the project and this program shall apply to all Subcontractors and lower-tier subcontractors (hereafter referred to as “Subcontractor”) activities performed on NREL Sites unless otherwise specifically exempted by NREL.

8.2 Regulatory Requirements

The subcontractor fire protection & prevention program shall be conducted in accordance with the following statutory requirements:

- 29 CFR 1926.24, Fire Protection & Prevention
- 29 CFR 1926, Subpart F, Fire Protection & Prevention
- 29 CFR 1926, Subpart J, Welding & Cutting.
- ANSI Z49.1-2012, Safety in Welding, Cutting and Allied Processes

8.3 NREL Specific Requirements/Permits

In addition to Section 8.2 of this manual, the subcontractor fire protection and prevention program shall meet the following NREL requirements as applicable.

8.3.1 Working with Open Flame, Welding, Cutting, or Grinding

The following requirements apply to Subcontractors conducting activities with open flames, welding, cutting, or grinding and other flame/spark producing tasks (hereafter referred to as “Hot Work”).

- The subcontractor shall perform Hot Work in accordance with a Hot Work Permit System as outlined in section 8.3.2 of this manual.
- The subcontractor shall ensure that all lower-tier subcontractors understand and comply with the requirements of the permit system.
- Subcontractor personnel who perform fire watch duties shall be competent. Individual(s) performing fire watch duties shall be proficient in the use of fire extinguishers.
- Alternatives to performing hot work (e.g., saw cutting instead of grinding wheel or torch cutting; crimp-type pipe fittings instead of soldered fittings) should be used where practical.
- Hot work should be performed in subcontractor shops or designated areas (e.g., pre-approved weld booths or shop areas) where practical.
- The subcontractor shall ensure that hot work is not conducted during facility fire-sprinkler system outages.
- Completed hot work permits shall be returned to the Facility Manager as applicable when the work is complete.

8.3.2 Hot Work Permit System

Subcontractors conducting hot work shall perform hot work under the NREL Hot Work Permit System issued by the NREL FM. The subcontractor will be responsible for providing all the required materials, personnel and protective equipment to conduct all hot work and the associated fire watch.

Prior to the start of any hot work activity, the subcontractor shall perform a walk-down of the work to facilitate thorough hazard identification and control. The subcontractor is ultimately responsible for compliance with the requirements of the permit, including completion of the daily checklist. The Hot Work Permit is valid for the specified task noted on the permit and may not exceed 31 days in duration. Variance from the scope of work identified on the permit is prohibited.

The NREL Hot Work Permit System and the associated Hot Work Permit Checklist can be obtained from the FM.

8.3.2.1 Hot Work Location Selection Hierarchy

The location of hot work shall be determined by utilizing the following priority list:

- If work must be conducted onsite, combustibles shall not be located within 35 feet of the work area.
- If work must be conducted onsite and combustibles cannot be removed from within 35 feet of the work area, fire barriers such as screens or blankets shall be used to protect combustibles.
- Protect openings in walls, floors, roofs, and ceilings where sparks can travel beyond the work area to inaccessible or unprotected areas. Openings or cracks in walls, floors, roofs or ceilings within 35 feet (11 m) of the site shall be tightly covered with fire-retardant or noncombustible material to prevent the passage of sparks to adjacent areas.
- Beware of heat conduction through penetrations. Hot work that is performed on pipes or other metal that is in contact with combustible walls, partitions, ceilings, roofs, or other combustibles, shall not be undertaken if the work is close enough to cause ignition by conduction.

8.3.2.2 Fire Watch

The subcontractor shall establish a fire watch to protect the safety of workers and assets. The fire watch observes staff conducting the welding, cutting, or grinding operations and monitors adjacent areas. The worker assigned to this task of fire watch shall have fire extinguishing equipment readily/immediately available.

The fire watch shall observe the hot work area for 30 minutes (60 minutes for roof work) after the completion of hot work. For overhead work, a fire watch may be necessary on multiple levels. The fire watch may not be assigned any other duties during hot work operations. The fire watch shall stop work if sparks travel beyond the area that fire watch can observe. Individuals assigned to fire watch duties shall:

- Be qualified and understand the requirements of the hot work permit system.
- Be knowledgeable about fire and emergency reporting procedures to the CMS and fire alarm pull box locations in buildings, if applicable.

- Have emergency communications, such as cellular phones or radios, available when working in remote or outside areas.
- Be trained in the use of fire extinguishing equipment.
- Prior to leaving the site, the fire watcher shall verify that the possibility of fire does not exist.

8.3.2.3 Fire Protection Equipment

Fire protection equipment shall be sufficient for the hazards present. At a minimum, a 4A:60BC rated fire extinguisher is required. The fire extinguisher shall be readily available in the immediate work area. Free access shall be maintained at all times to all exits, fire alarm boxes, fire extinguishing equipment, and any other emergency equipment. Free access means clear of all obstructions.

8.3.2.4 Hot Work Protective Clothing

Subcontractors shall ensure that the personnel protective clothing selected for hot work minimizes the potential for ignition, burning, trapping hot sparks and electric shock as identified in ANSI Z49.1, “Safety in Welding, Cutting and Allied Processes,” sections 4.3 and E4.3, current revision.

8.3.2.5 Hot Work Required Inspections.

In addition to the fire watch requirements, the subcontractor’s authorized worker/permit holder shall inspect the work area a minimum of once per day to verify compliance with permit requirements. Additionally, responsible subcontractor personnel shall also perform periodic inspections to ensure continued compliance with the requirements of the permit. When inspections identify unsafe conditions or the scope of work departs from that defined in the permit, the hot work shall be stopped immediately.

8.3.2.6 Hot Work Outdoors

The subcontractor shall ensure that vegetation and other combustibles are removed, cut back, or otherwise protected to prevent ignition during hot work outdoors. A high level of caution shall be exercised to prevent wild land fire. If wind speeds exceed a constant velocity of 10 miles per hour, hot work is not permitted outdoors.

8.3.3 Fire Protection System Outages and Impairments

Subcontractors performing work shall plan their work and take the necessary steps to minimize outages or impairments of fire suppression, detection, or alarm systems. When outages are necessary to perform a particular scope of work, they shall be coordinated and approved by the NREL Facility Manager and the ESH POC. A NREL Fire Protection System Outage Permit shall be issued by the NREL FM. Compensatory measures necessary to achieve a commensurate level of fire protection shall be incorporated into the permit.

8.3.4 Exits and Exits Access

The subcontractor shall ensure that a clear path of at least 44 inches is maintained to exits on indoor projects. Exits shall be marked by a readily visible sign. Access to exits shall be marked by readily visible signs in all cases where the exit or way to reach it is not immediately visible to the occupants.

8.3.5 Flammable and Combustible Liquids Storage

Flammable and combustible liquids shall be stored in approved containers and cabinets, such as those that are UL or FM listed, and quantities shall be limited to minimize fuel loading in accordance with NFPA Codes. Only approved containers and portable tanks shall be used for storage and handling of flammable and combustible liquids. Only approved safety cans or Department of Transportation (DOT) approved containers shall be used for the handling and use of flammable liquids in a closed container, quantities of 5 gallons or less capacity, having a flash arresting screen, spring closing lid and spout cover, and so designed that it will safely relieve internal pressure when subjected to fire exposure. Any storage of gasoline or diesel fuel at NREL must be in a flammable storage cabinet and in a location approved by NREL ESH. Rags used to apply flammable liquids are to be disposed of in a self-closing approved safety container designed for the use.

8.3.6 Smoking/Wildfire

Smoking and E-Cigarettes, if permitted by the subcontractor, shall be restricted to NREL designated areas that incorporate appropriate facilities for the safe disposal of smoking materials. Due process and control shall be employed to prevent wildfire. Open fires are prohibited.

8.3.7 Housekeeping/Trash

The subcontractor shall police the work area frequently and maintain good housekeeping. Common garbage and other waste shall be disposed of at frequent and regular intervals. Containers shall be provided for the collection and separation of waste, trash, oily or used rags, and other refuse. Containers used for garbage and other oily, flammable, or hazardous wastes, (such as caustics, acids, harmful dusts or similar materials) shall be equipped with covers. Chemical agents or substances, which might react to create a hazardous condition, shall be stored and disposed of separately.

8.3.8 Portable Electric Heaters

The following requirements apply to portable electric heaters used on the jobsite:

- Portable electric heaters must be accepted by the NREL Fire Protection AHJ or Electrical AHJ.
- Use only portable electric heaters approved by Underwriters Laboratories, Inc. (UL) or another nationally recognized test laboratory (NRTL).
- Portable electric heaters shall be equipped with a tip-over switch.
- Locate portable electric heaters in areas that minimize their fire hazards.
- Do not use portable electric heaters near flammable materials/liquids.
- Follow manufacturer's literature for clearance of listed portable electric heaters from combustible materials.
- Never place portable electric heaters on an unstable surface.
- Portable electric heaters shall not be used with extension cords, as most extension cords are not rated for the higher power demands of space heaters and may become overloaded and result in a fire.

8.4 References

- 29 CFR1926.24, Fire Protection & Prevention
- 29 CFR 1926, Subpart F, Fire Protection & Prevention
- 29 CFR 1926, Subpart K, Welding & Cutting
- ANSI Z49.1, “Safety in Welding, Cutting and Allied Processes,” Sections 4.3 and E4.3, current revision.

9 Hoisting and Rigging

9.1 Applicability

The requirements of this chapter apply to all Subcontractors and lower-tier subcontractors (hereafter referred to as “Subcontractor”) hoisting and rigging (H&R) activities on NREL Sites unless otherwise specifically exempted by the NREL.

The equipment covered under this procedure includes H&R devices and associated equipment such as slings, ropes, and chains, which provide mechanical assistance in raising and lowering a load. This includes either power or manually operated equipment.

9.2 Regulatory Requirements

All Subcontractor H&R activities shall be conducted in accordance with the following statutory requirements:

- 29 CFR 1926, Subpart CC, Cranes and Derricks in Construction
- Rigging of loads being lifted by cranes shall comply with the requirements of 29 CFR 1926.251, Rigging Equipment for Material Handling
- Hoisting and Rigging during steel erection activities shall comply with the requirements of 29 CFR 1926.753, Hoisting & Rigging.

Exception: This section does not include requirements for powered industrial trucks (PIT).

9.3 NREL Specific Requirements/Permits

In addition to section 9.2, all Subcontractor hoisting and rigging (H&R) activities shall meet the following specific NREL requirements as applicable.

Subcontractors bringing H&R equipment on site shall be able to demonstrate that their equipment is properly maintained, in safe operating condition, and that operators are experienced and qualified. Subcontractor crane operators are not permitted to operate NREL H&R equipment. All H&R equipment brought on site shall be in a new or like new condition free of hydraulic or oil leaks.

9.3.1 Operator Training and Certification

Subcontractors who provide and operate H&R equipment, as part of a construction project or similar activity, shall provide:

- **Proof of Training/Certification:** NREL requires proof of training, such as an NCCCO license or other NREL accepted licenses/certification appropriate for the equipment. NREL recognizes the NCCCO national certification program as demonstrating that the certified H&R operator meets OSHA’s and NREL’s requirements for crane operator proficiency. This certification/license shall be current for the crane type they will be operating. (i.e., Mobile Crane Operator, Tower Crane Operator) Any other forms of crane certification must be accepted by the NREL POC.
- **Medical Requirements:** Crane operators shall complete a medical certification examination at least every three years in accordance with ASME B.30.5. A valid medical card shall be provided to document this requirement.

9.3.2 Hoisting and Rigging Operating Requirements

9.3.2.1 Planning

The subcontractor shall evaluate and plan H&R operations in advance. A competent person shall identify the hazards and determine the controls necessary to maintain an acceptable level of risk. A Hoisting and Rigging Lift Plan is required for all lifts. This plan shall be documented using the NREL Hoisting and Rigging Lift Plan or similar plan accepted by NREL.

9.3.2.2 Critical and Complex Lifts

All critical and/or complex lift plans require the review and concurrence of the Facility Manager and ESH POC.

Critical lifts are defined as lifts for which any of the following conditions exist:

- The weight of the load is 90 percent or more of the crane's rated capacity in the configuration that will be used during the lift.
Exception: During steel erection, a critical lift is defined as a lift that exceeds 75 percent of the crane's rated capacity or requires the use of more than one crane.
- Lifts involving non-routine or difficult rigging arrangements or where loads will require exceptional care in handling because of size, weight, close-tolerance installation or high susceptibility to damage.
- Hoisting of personnel with a crane or derrick.
- If the item being lifted were to be damaged or upset, it could result in a release of hazardous material into the environment or the release of airborne concentrations that could exceed established occupational exposure limits.
- The item being lifted is unique and, if damaged, would be irreplaceable or not repairable and is vital to a system, facility, or project operation.
- The cost to replace or repair the item being lifted, or the delay in operations of having the item damaged, would have a negative impact on the facility, organization, or project to the extent that it would affect project commitments.
- The item, although non-critical, is to be lifted above or in close proximity to a critical item or component.

Complex Lifts are defined as lifts that present logistical difficulties or lift coordination complications, thus requiring a higher level of planning and execution. Complex lifts may involve the following:

- A lift involving multiple cranes
- Axial rotation of an object in the vertical plane or other complex movement of the load
- A lift where the behavior of the load while in suspension is precarious or questionable.

9.3.2.3 Pre-Lift Meeting

Prior to performing any lift, the subcontractor shall conduct a pre-lift meeting with workers involved in the work activity. The following items shall be reviewed:

- The scope and sequence of work
- Roles and responsibilities
- Hazards and controls
- Other relevant information identified in the Hoisting and Rigging Lift Plan.

When performing lifts designated as critical and/or complex lifts, this meeting shall be documented utilizing the NREL Pre-Lift Meeting Checklist or other equivalent NREL ESH accepted checklist. A copy of the NREL Pre-Lift Meeting Checklist template can be obtained from the ESH POC.

9.3.2.4 Communication

The subcontractor shall require the use of ANSI B30.5 standard hand signals or voice/radio communications during the course of crane operations.

9.3.2.5 Area Access Control

The subcontractor shall cordon off or manually control the lift area to prevent access by unauthorized workers by deploying barricades and warning signs and/or utilizing personnel to monitor and control access to the area. The subcontractor shall cordon off the swing radius area for mobile cranes with warning tape or other barricade apparatus, such as cones.

9.3.2.6 Protection of People

Do not place people in jeopardy by moving a suspended load over people or an occupied section of a facility. Work beneath a suspended load is prohibited unless the load is supported by cribbing, jacks, or a solid footing that safely supports the entire weight. All personnel shall remain clear of moving and shifting loads.

9.3.2.7 Rated Load Capacity

The rated load capacity of monorails and other H&R structural elements, such as jibs, shall match, at a minimum, the rated load capacity of a hoist employed.

Know the weight of the object being lifted or use a dynamometer or load cell to determine the weight. If the weight of the load is unknown, a minimum 50% safety factor shall be employed. This means that the crane or hoist, slings, and rigging hardware shall have twice the capacity of the estimated load.

Fully extend outriggers or reduce the cranes rated load capacity as directed and allowed by the crane manufacturers operating manual.

9.3.2.8 Electrical Distribution Lines

Watch for overhead electrical distribution and transmission lines and maintain a safe working clearance of at least 10 feet or as required from energized electrical lines. Any overhead wire shall be considered to be an energized line unless and until the NREL Electrical Engineer or the electrical utility authorities indicate that it is not an energized line. Exercise caution when working near overhead lines having long spans as they tend to move laterally or vertically due to the wind, which could cause them to breach the safety zone.

9.3.3 Environmental Factors

Environmental factors, such as weather and terrain can adversely affect a lift. When performing outdoor lifts, the following environmental factors shall be considered:

9.3.3.1 High Winds

Lifts shall be suspended if prevailing wind conditions may adversely affect the lift. As a general rule, this applies to wind speeds of 25 miles per hour or more. However, based on the nature of the load—such as size, surface area, or fragility—a lower wind speed limit may warrant suspension of a lift. The H&R operator and/or lift master shall evaluate behavior of the load in prevailing winds and the stresses placed upon H&R equipment to the extent necessary to safely complete the lift.

9.3.3.2 Freezing Surfaces

Check surface conditions to determine if the load may be frozen to the ground. Do not use H&R equipment to “break loose” a load that is frozen to the ground. This subjects H&R equipment to severe and unintended loads.

9.3.3.3 Ground Conditions

Check ground conditions around the hoisting equipment for proper support, including settling under and around outriggers, ground water accumulation or other similar conditions.

9.3.4 Crane Inspection, Maintenance, and Testing

9.3.4.1 Crane Initial Inspection

Prior to being placed into service, all Subcontractor-owned and/or rented cranes shall undergo an initial inspection. The NREL Subcontractor Crane Inspection Checklist or equivalent accepted checklist shall be utilized to document these inspections. When qualified third party inspections are performed to meet the requirements of this inspection, a copy of the third party inspection shall be attached to the Subcontractor Crane Inspection Checklist, which will satisfy the crane physical inspection portion of the checklist. The NREL Subcontractor Crane Inspection Checklist template can be obtained from the ESH POC. NREL ESH may elect to oversee or facilitate the subcontractor’s initial inspection of the crane.

All crane inspection deficiencies shall be identified and documented and the safety implications shall be determined. The ESH POC shall maintain a copy of the inspection report. The crane owner shall take immediate action to correct the identified deficiencies.

- **Mobile Boom Cranes:** For wheel mounted or crawler type boom cranes, the Subcontractor competent person shall inspect the crane. The subcontractor may elect to utilize a qualified independent third-party inspector to meet this requirement.
- **Lattice Boom or Tower Cranes:** Lattice boom and tower cranes require a thorough inspection prior to being placed into service on NREL property. If the Subcontractor is utilizing a lattice boom or tower crane, the crane shall undergo a thorough initial inspection prior to the start of work by a qualified independent third-party inspector. The subcontractor shall bear the expense of this inspection.

9.3.4.2 *Daily Pre-Operational Inspections*

H&R operators shall visually inspect the following items each day or prior to first use if the hoist has not been in regular service. Records are required.

- Functional operating mechanisms for maladjustment interfering with proper operation
- Deterioration or leakage in lines, tanks, valves, drain pumps, and other parts of air systems
- Hooks for cracks, deformation, latch engagement, and damage from chemicals
- Hoist rope for significant wear, kinking, crushing, bird-caging, corrosion, or broken strands or wires
- Hoist chains, including end connections, for excessive wear, twist, distorted links interfering with proper function, or stretch beyond manufacturer's recommendations
- Primary hoist upper-limit device for proper operation.

Deficiencies: H&R operators or other designated qualified workers shall examine deficiencies and determine whether the equipment should be removed from service or if a more detailed inspection is required.

9.3.4.3 *Monthly Inspections*

Cranes active on the site for periods extending beyond 1 month shall receive monthly documented inspections. The competent person shall at a minimum visually inspect the following items for damage, wear, or other deficiency that might reduce capacity or adversely affect the safety of the crane.

- Critical items such as brakes and crane hooks
- Hoist ropes.

Signed and dated inspection records shall be kept on file and shall be readily available. Before the crane is returned to service, correct deficiencies that could reduce its capacity or adversely affect its safety.

9.3.4.4 *Annual Inspections*

Annual crane inspections shall conform to the requirements identified in 29 CFR 1926, Subpart N and as recommended by the manufacturer. Documentation of these inspections shall be available for review by NREL.

9.3.4.5 *Idle Equipment*

H&R equipment that is idle for a period of greater than one month (fully operational but not used) does not require monthly inspections. Idle H&R equipment shall be removed from service and tagged with an administrative "CAUTION – Do Not Operate" label to alert potential users of the start-up inspection requirements to include the requirements contained in the daily and monthly inspections. Documentation of these inspections shall be available for review by NREL.

9.3.4.6 *Maintenance*

A preventive maintenance program shall be established and based on the recommendation of the crane manufacturer. If equipment maintenance procedures deviate from published manufacturer's

recommendations, the alternate procedures shall be approved in advance by the manufacturer or another qualified person and be kept readily available. Dated maintenance records should be kept readily available to appointed personnel. Replacement parts shall be at least equal to the original manufacturer's specifications.

9.3.4.7 Rated Load Test

Prior to initial use, all cranes in which load sustaining parts have been modified, replaced, or repaired shall be load-tested by a qualified inspector or under the direction of that inspector. All rated load tests shall be performed in accordance with manufacturer's recommendations.

9.3.5 Rigging Safety Requirements

9.3.5.1 Rigging Component Procurement

Rigging components shall be obtained from reliable sources and shall be rated for H&R applications. Do not use damaged or suspect rigging. Only shackles made in the USA are permitted to be used. See section 9.4.2 for additional information on suspect and counterfeit rigging and hoisting requirements.

9.3.5.2 Storage and Maintenance

Rigging equipment shall be stored and maintained in accordance with the manufacturer's recommendations. Protect rigging hardware from weathering and harsh environments. Rust, corrosion, and/or UV damage can degrade rigging performance.

9.3.5.3 Labeling

Rigging hardware shall be labeled for identification purposes with a durable tag.

9.3.5.4 Rigging Safe Work Practices

The subcontractor shall ensure that the following safe work practices are utilized when rigging a load:

- Determine the weight of the load. Do not guess. The weight of the load shall be within the rated load capacity of the rigging.
- Determine the proper size for slings and components. Refer to the manufacturer's literature and the DOE Hoisting and Rigging Standard for details.
- Select slings so that the rated load capacity is adequate when the appropriate de-ratings are applied based on sling angle and/or hitch angle considerations (chocker angle de-rating).
- Verify that shouldered eyebolts are installed in accordance with the manufacturer's recommendations. Beware of side pull applications. Eyebolts shall be de-rated when subject to side loads.
- Do not use shoulderless eyebolts for lifting purposes.
- Use safety hoist rings (swivel eyes) as a preferred substitute for eyebolts when possible.
- Pad sharp and small diameter edges to protect slings. Machinery foundations or angle-iron edges may not feel sharp to the touch but could cut into rigging when under load. Dense foam, tire rubber, or other dense, pliable materials may be suitable for padding.

- Do not use slings, eyebolts, shackles, hooks, or other hardware that appear to have been cut, welded, brazed, damaged or are otherwise suspect.
- Determine the center of gravity and balance the load before moving it. Keep the attachment points of rigging accessories as far above the center of gravity as possible.
- Lift the load initially just a few inches to test the rigging and balance.
- Place blocks beneath loads prior to setting down the load to allow removal of the sling, where applicable.

9.3.6 Inspection Criteria for Slings, Below-the-Hook Lifting Devices and Rigging Hardware

9.3.6.1 Prior to Use Inspection

At the beginning of each shift or prior to use, if it has not been in regular service, the competent person shall visually inspect the rigging equipment (slings, below the hook devices and rigging hardware) in accordance with the appropriate ASME/ANSI standard or according to the manufacturer's instruction, whichever is more stringent. Defective rigging equipment shall be removed from service and destroyed to prevent reuse.

9.3.6.2 Periodic Inspections

Rigging equipment shall be inspected periodically in accordance with the appropriate ASME/ANSI standard or according to the manufacturer's instruction, whichever is more stringent. This inspection shall be performed by a qualified inspector and have a documented inspection history, with records readily available.

9.3.7 Personnel Hoisting

9.3.7.1 Personnel Platform Lift Plan

The use of H&R equipment to hoist workers onto a platform is generally prohibited, except when the use of a conventional means of reaching the work area, such as a ladder, scaffold, or man lift, would be more hazardous or is not possible because of structural design or worksite conditions. Personnel lifts shall be properly planned and executed. The NREL ESH POC shall authorize this type of activity in advance of the lift. The NREL Personnel Platform Lift Plan or other NREL ESH accepted equivalent plan shall be utilized to document these lifts. The NREL Personnel Platform Lift Plan template can be obtained from the ESH POC. A test lift shall be performed prior to lifting personnel.

9.3.7.2 Pre-Lift Meeting

A pre-lift meeting shall be conducted prior to initiating a personnel lift. Workers involved in the work activity shall attend the pre-lift meeting, including subcontractors, man basket occupants, and the H&R operator.

9.4 NREL Special Emphasis

9.4.1 Department of Energy Hoisting and Rigging Standard

NREL adheres to the Department of Energy (DOE) Hoisting and Rigging Standard as a best management practice. The Hoisting and Rigging Standard is a DOE-wide consensus standard for rigging, crane, and hoist operations. It references applicable industry standards and regulations

governing this type of work. The Hoisting and Rigging Standard contains detailed information on H&R inspection, testing, maintenance, and operational requirements.

9.4.2 Suspect and Counterfeit (S/CI) Rigging and Hoisting Components

Per the DOE standard, shackles must meet or exceed the requirements of Federal Standard RR-C-271D. Each shackle body must be permanently and legibly marked in raised or stamped letters on the side of the bow and must be used to show:

- Manufacturer's name or trademark
- Size
- Safe working load or working load limit.

The American Society for Testing and Materials standard for hooks requires that the manufacturer's identification be forged, cast, or die-stamped on a low-stress or non-wearing area of the hook.

The following are some indicators of S/CI hoisting and rigging components such as shackles, wire rope clips, slings, or hooks:

- Metallurgy is suspect.
- Original markings have been ground off and re-stamped.
- Identification tags have altered markings.
- Item appears used.
- Parts are identified only as "China," "Korea," "Mexico," "Thailand," or "India."
- Documentation does not exist or is incomplete.
- Red hooks are not labeled with Crosby Group markings ("Crosby" or "CG").

Note: Only shackles made in the USA are acceptable for use at NREL.

9.5 References

- 29 CFR 1926, Subpart N, Cranes and Derricks
- DOE-STD-1090-2007; Hoisting and Rigging Standard
- ASME B30.5, Mobile and Locomotive Cranes - 2014
- ASME B30.9, Slings - 2014
- ASME B30.10, Hooks - 2014
- ASME B30.20, Below-the-Hook Lifting Devices - 2013
- ASME B30.26, Rigging Hardware - 2015.

10 Fall Protection

10.1 Applicability

The requirements of this chapter apply to all Subcontractors and lower-tier subcontractors (hereafter referred to as “Subcontractor”) activities which require personnel to work or potentially be exposed to unprotected heights of four feet or more (six feet or more for construction activities) on NREL Sites, unless otherwise specifically exempted by NREL. This includes working at unprotected heights of six foot or more cause by excavation and trenching activities.

10.2 Regulatory Requirements

The subcontractor fall protection program shall be conducted in accordance with the following statutory requirements:

- 29 CFR 1910, Subpart D, Walking-Working Surfaces
- 29 CFR 1910.140, Personal Fall Protection Systems.
- 29 CFR 1926, Subpart M, Fall Protection

Note: The increased height allowances, for unprotected workers, provided in Scaffold Activities (29 CFR 1926.451) do not apply at NREL.

Additionally, all workers exposed to fall hazards of 4 feet or more above a lower level (6 feet or more for construction activities) shall be protected from falling by a guardrail system, restraint system, safety net system, or personal fall arrest systems.

10.3 NREL Specific Requirements/Permits

In addition to section 10.2, all work activities and/or potential personnel exposures to unprotected heights of four feet or more (six feet or more for construction activities) shall meet the following NREL requirements as applicable in sections 10.3.1-10.3.4 of this manual.

10.3.1 Fall Protection Program

Subcontractors providing services to NREL that meet the applicability as defined in section 10.1 shall have in place a Fall Protection Program ensuring that a procedure to identify and eliminate or control new and existing fall hazards is established and implemented. The program shall identify the following key personnel (as identified in ANSI Z359.2) who maintain the requisite knowledge and responsibility for the successful implementation of the program at the project:

- Program Administrator
- Qualified Person
- Competent Person.

Additionally, the subcontractor shall ensure personnel that are required to utilize fall protection meet the qualification of an “Authorized Person” as defined by ANSI Z359.2.

10.3.1.1 Fall Hazard Analysis

An NREL Fall Hazard Analysis (FHA) form, or an NREL Environment, Safety, Health, and Quality-accepted equivalent FHA, shall be completed by the subcontractor fall protection competent person, prior to allowing workers to be exposed to fall hazards.

At a minimum, a Fall Hazard Analysis (FHA) must be completed when:

1. An authorized worker is using an active fall protection system

Exceptions:

- Work performed from aerial lifts, scissor lifts, mobile vertical lifts, or elevating (work) platforms do not require a Fall Hazard Analysis provided (1) the integrity of the guardrail system is maintained and not compromised, (2) workers maintain their footing on the platform floor, and (3) workers do not transition in or out of an elevated work platform or basket.
 - Ascending or descending a fixed ladder more than 20 feet in height while using an installed ladder safety device or PFAS system does not require a Fall Hazard Analysis.
2. An authorized worker is using either a fixed ladder or a portable ladder in an application that does not meet the (fixed or portable) ladder general requirements and exceptions.

The FHA must be site- and activity-specific and may not exceed 90 days in duration. Complete the analysis and review with the affected workers prior to the start of work for each definable activity. A briefing must reoccur with authorized workers every 30 days. If conditions, workers, or equipment change, complete a new analysis prior to starting the work. Authorized issuers are limited to NREL accepted competent persons. The FHA must be revised and updated when changes occur that render the analysis obsolete. The ESH POC verifies that the FHA is being used where required. Once the work has been completed, the signed FHA must be returned to the ESH POC. A copy of the NREL Fall Hazard Analysis form can be found on the NREL ESH&Q subcontractor extranet site.

Elevated work activities that are not captured in a FHA (see above for minimum requirements), may be addressed through the subcontractor's own fall hazard analysis, but must at a minimum address the following elements:

- Location
- Scope of work
- Hazards
- Controls
- Specific anchorage type, location(s), and connecting means
- Falling object protection
- Rescue procedure (if an arrest system is used)

10.3.2 Fall Protection Hierarchy of Control and Mitigation Methods

The subcontractor shall incorporate the following hierarchy of control when selecting methods to eliminate or mitigate fall hazards:

- **Hazard Elimination.** First consider eliminating fall hazards. This might involve moving the work surface to ground level or changing a task so that workers do not approach the fall hazard.
- **Passive Fall Protection.** Take actions that isolate or effectively separate the hazard from workers, such as installing floor coverings or guardrail systems.
- **Fall Restraint.** Establish a travel restraint system that prevents a worker from accessing a position from which he or she could fall.
- **Fall Arrest.** Configure a Personal Fall Arrest System (PFAS) designed to arrest a fall after it has begun.
- **Administrative Fall Protection System.** Establish controlled-access zones and safety-monitoring systems. Generally, these controls are considered ineffective and are prohibited at NREL, unless specifically authorized by the ESH POC.

10.3.3 Fall Protection Equipment System Requirements

Fall protection equipment and systems shall be used in accordance with the manufacturer's recommendations and the requirements of this procedure. Misapplication or use of this equipment in a way contrary to those requirements is prohibited. A competent person shall supervise the work and verify that the fall protection system is properly established and maintained. An authorized worker required to use an active fall protection system must not work remotely alone. A second authorized worker is required when an authorized worker is required to: 1) use an active fall protection system. 2) when aerial activities requiring the use of fall protection systems are conducted, such as use of an aerial work platform, tower climbing, or turbine climbing.

10.3.3.1 Personal Fall Arrest System Strength Requirements

Subcontractors shall ensure that the strength and testing requirements for personal fall arrest systems, components and subsystems shall comply with the provisions of ANSI Z359.1, The Fall Protection Code and ANSI Z359.12, Connecting Components for Personal Fall Arrest Systems. All other applicable fall protection equipment and system requirements shall at a minimum meet the requirements of ANSI A10.32 Standard for Personal Fall Protection used in Construction and Demolition Operations.

10.3.3.2 Personal Fall Arrest System (PFAS) Inspections & Storage

Routine Inspection. PFAS equipment shall be inspected by the authorized worker using the equipment prior to each use. Equipment inspections shall follow the guidelines established by the manufacturer damaged or questionable equipment shall be immediately removed from service and tagged accordingly. Equipment that cannot be repaired shall be destroyed.

Post-Fall Inspection. PFAS components subject to a fall shall be immediately removed from service and destroyed or returned to the manufacturer for inspection, repair, and re-certification. Contact the manufacturer to determine the available options.

Periodic Inspection. A competent person, other than the user, shall periodically inspect PFAS equipment. This inspection shall follow the intervals and guidelines established by the manufacturer but shall not be greater than twelve months. The results of these inspections shall be recorded and available for review by NREL.

Equipment Storage. Fall protection equipment shall be stored in a manner that protects it from exposure to adverse conditions, such as ultraviolet light or harsh weather, that could result in damage or diminished performance and/or other specific requirements established by the manufacturer.

10.3.3.3 Anchorages

The application and use of all fall protection anchorages (certified or non-certified) must be reviewed and accepted by a competent person. The design, selection and installation of certified fall arrest anchorages shall be performed under the supervision of a qualified person. Anchorages used for horizontal lifeline systems shall be certified, and designed, prior to use, by a qualified person with experience and training in designing and using horizontal lifeline systems.

10.3.3.4 Horizontal Lifelines

The adequacy of the fall protection system shall be demonstrated through evaluation by a qualified person or by test force. Unless otherwise specified, newly installed horizontal lifelines shall be either pre-engineered systems or systems approved by a qualified person.

10.3.3.5 Fixed Ladders

General Requirements and Exceptions: Fixed ladders more than 20 feet in height must be equipped with a ladder safety device or PFAS. Authorized workers must be trained to use these systems. These systems are not required on fixed ladders of 20 feet or less in height provided:

- The authorized worker is only ascending or descending the ladder
- The authorized worker maintains three points of contact with the ladder
- The authorized worker's body is positioned between the rails
- The ladder is not located next to an opening or edge, thus exposing the worker to a fall hazard greater than the distance to the base of the ladder, and the worker's elevated position does not expose him or her to other hazards including impalement, mechanical, electrical, chemical, or environmental.

An FHA is not required for the use of fixed ladders under these provisions.

10.3.3.6 Portable Ladders

General Requirements:

- Portable ladders must be set up and used in compliance with Occupational Safety and Health Administration (OSHA) and manufacturer requirements. Additionally, the portable ladder must be a minimum Type I (250 lbs. rated) Heavy Duty Classification.
- The capacity rating must not be exceeded. Light duty, medium duty and wooden ladders are prohibited.

- Non-conductive ladders must be used for electrical work.
- Extension ladders must be tied or secured to prevent displacement.

Fall Protection – Portable Ladder Exception:

Neither a FHA nor a fall arrest system are required when portable ladders are used in accordance with the general requirements and the following provisions:

- The portable ladder is 20 feet or less in working length.
- The worker maintains three points of contact (when ascending or descending) with his or her body position centered between the ladder rails.
- The ladder is not positioned next to an opening or edge, thus exposing the worker to a fall hazard greater than the distance to the base of the ladder, and the worker’s elevated position does not expose him or her to other hazards including impalement, mechanical, electrical, chemical, or environmental.

10.3.3.7 Scaffolding Systems

General Requirements:

- A competent person must perform and document an inspection each shift, prior to starting work.
- Fall protection is required for all workers at 4 feet or more above the lower level (6 feet or more for construction activities).
- A FHA must be completed when scaffold erectors (or authorized workers) are required to utilize and active fall protection system.
- A self-retracting lanyard shall be utilized for workers ascending or descending a scaffold access ladder more than 20 feet in height.

10.3.3.8 Aerial Lifts, Scissor Lifts and Elevating Aerial (Work) Platforms

General Requirements:

- All personnel lifts shall be operated in accordance with Occupational Safety and Health Administration (OSHA), appropriate ANSI standard and manufacturer requirements.
- The operator must be trained and qualified to operate the equipment.
- The equipment must be inspected pre-use daily.

Fall Protection:

- Fall Protection must be utilized as required by OSHA, ANSI/SAIA and the manufacturer.
- Note: The following activities require NREL ESH POC evaluation and acceptance prior to performing, and shall be considered “Hold Points”:

1. Compromising the guardrail system

2. Gaining elevation above the platform height
3. Transitioning in or out of an elevated work platform or basket.

10.3.4 Fall Protection on Roofs

Subcontractors performing work on low-slope roofs (means a roof having a slope less than or equal to 3 in 12, vertical to horizontal) are permitted to perform work as prescribed below without the use of a conventional fall protection system. When this method of work area control is employed, a warning line system must be used for the purpose of keeping employees away from an unprotected roof edge.

No work activity or personnel access is permitted to take place in the area between the warning line and the roofs edge without a fall protection system in place.

10.3.4.1 Roofing Work

Roofing Work, as defined by OSHA, means the hoisting, storage, application, and removal of roofing materials and equipment, including related insulation, sheet metal, and vapor barrier work, but not including the construction or repair of the roof deck.

The following requirements apply to roofing work:

- When mechanical equipment is not being used, the warning line shall be erected not less than 6 feet (1.8 m) from the roof edge. When mechanical equipment is being used, the warning line shall be erected not less than 6 feet (1.8 m) from the roof edge which is parallel to the direction of mechanical equipment operation, and not less than 10 feet (3.1 m) from the roof edge which is perpendicular to the direction of mechanical equipment operation.
- The warning line meets or exceeds the requirements in §1926.502(f)(2).
- The employer effectively implements a work rule prohibiting the employees from going past the warning line unless the worker(s) is protected by a PFAS or restraint system when performing any activities in the area between the warning line and the roof edge.
- The use of a Safety Monitor without employing other accepted controls is prohibited at NREL.

10.3.4.2 Other Trades Working on Roofs

The following requirements apply to other trades performing work on unprotected roofs:

- A warning line is erected not less than 15 feet or more from the edge.
- The warning line meets or exceeds the requirements in §1926.502(f)(2).
- The employer effectively implements a work rule prohibiting the employees from going past the warning line unless the worker(s) is protected by a PFAS or restraint system when performing any activities in the area between the warning line and the roof edge.

10.3.5 Subcontractor Training Requirements

Subcontractors that are trained in accordance with the requirements identified in 29 CFR 1910.30 will be considered as meeting the necessary fall protection training requirements for working at NREL. The subcontractor shall provide proof of such training as requested by the ESH POC. The

subcontractor is required to provide authorized and competent persons as defined in ANSI Z359.0 at the job site.

10.3.6 Flatirons Campus

Work activities conducted at the Flatirons Campus may be subject to additional fall protection system, training and rescue requirements. Contact the NREL Flatirons Campus ESH point of contact for additional requirements that may be applicable to that site.

10.4 NREL Special Emphasis

10.4.1 Presumption of Feasibility

NREL presumes that using conventional fall protection (that is, passive systems, restraint systems, personal fall arrest systems, or safety nets) is feasible and will not create a greater hazard to use. However, if circumstances exist when an employer believes that convention fall protection is infeasible or creates a greater hazard, this shall be communicated to the EHS POC in advance of performing that work and the subcontractor shall also propose alternative measures of protection for the ESH POC to evaluate for acceptance.

10.4.2 Rescue Planning

A rescue procedure is required whenever a fall arrest system is used by an authorized person to control a fall hazard. Typically, rescue must be achieved by one of four means:

- Auto-rescue device
- Means of self-rescue
- Assisted rescue where the rescuer is not exposed to the same fall hazards as the victim
- Authorized rescuers (rescue professionals who perform or assist in workplace rescues, such as fire department rescue teams using high-angle rope access and suspended rescue techniques).

Workers are not permitted to serve as authorized rescuers. Rescue planning shall be addressed in the FHA form, or NREL accepted equivalent. NREL recommends employing suspension trauma straps on all full body harnesses, but these alone do not constitute a rescue plan.

10.5 References

- 29 CFR 1910, Subpart D, Walking-Working Surfaces
- 29 CFR 1910.140, Personal Fall Protection Systems
- ANSI A10.32-2012, Fall Protection Systems for Construction and Demolition Operations
- ANSI Z359.0-2012, Definitions and Nomenclature Used for Fall Protection and Fall Arrest
- ANSI Z359.1-2016, The Fall Protection Code
- ANSI Z359.2-2017, Minimum Requirements for a Comprehensive Managed Fall Protection Program
- ANSI Z359.12-2009, Connecting Components for Personal Fall Arrest Systems
- ANSI/SAIA A92.2-2015, Vehicle-mounted Elevating and Rotating Aerial Devices

- ANSI/SAIA A92.3-2006, Manually Propelled Elevating Aerial Platforms
- ANSI/SAIA A92.5-2006, Boom-supported Elevating Work Platforms
- ANSI/SAIA A92.6-2006, Self-propelled Elevating Work Platforms

11 Hearing Conservation

11.1 Applicability

The requirements of this chapter apply to all Subcontractors (hereafter referred to as “Subcontractor”) hearing conservation programs on NREL Sites unless otherwise specifically exempted by the NREL.

11.2 Regulatory Requirements

Subcontractor Hearing Conservation Program shall meet or exceed requirements in the OSHA standard:

- 29 CFR 1910.95 Occupational Noise Exposure
http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9735 and,
- American Conference of Governmental Industrial Hygienist (ACGIH), “Threshold Limit Values for Chemical Substances and Physical Agents and Biological Indices,” Latest edition (for noise dose TLV and 3 dB exchange rate).

11.3 NREL Specific Requirements

Subcontractor Hearing Conservation Program shall meet or exceed requirements in the OSHA standard as well as complying with the noise dose ACGIH TLV (85 dBA) and 3 dB exchange rate.

11.3.1 Control Measures

NREL uses a hierarchy of control measures to reduce noise levels as low as feasible. The order of precedence for mitigating hazards establishes the actions to be considered in an order of effectiveness to achieve intended risk reduction. The hierarchy is as follows:

1. Elimination or substitution of the hazards
2. Engineering controls
3. Work practices and administrative controls that limit worker exposures
4. Personal protective equipment (PPE).

Every feasible effort shall be made to “engineer out” noise exposures greater than or equal to an eight-hour, time-weighted-average (TWA) sound level of 85 decibels (dBA) on the A-weighted scale prior to using personal hearing protection as a noise attenuation device. When controls are not feasible or fail to reduce noise to acceptable levels, hearing protection shall be required.

Additionally, if work is to be performed in an environment that is suspected to exceed the allowable noise exposures, mandatory hearing protection requirements shall be implemented.

Hearing protection must be evaluated to determine that it will protect the wearer from being exposed to noise above the TLV of 85 dBA TWA. The formula to determine hearing protection adequacy is;

(Noise Reduction Rating (NRR) of hearing protection – 7)/2.

11.3.2 Noise Evaluation

The Subcontractor shall survey and evaluate suspected high noise areas and work efforts. Employees may observe surveys and evaluations, and the results shall be made available to employees. Subcontractors must control employee exposures when noise levels meet or exceed 85 dBA as an 8-hr TWA, or if impact/impulse noise exceeds 140 dBC. Maximum allowable noise exposure shall not exceed the permissible noise exposures shown in the ACGIH TLV's. Noise exposure shall be determined without regard to hearing protection provided.

11.3.3 High Noise Area Posting

High noise areas shall be posted with appropriate warning signs at all entrances.

11.4 References

- 29 CFR 1910.95 Occupational Noise Exposure
- American Conference of Governmental Industrial Hygienists, "Threshold Limit Values for Chemical Substances and Physical Agents and Biological Indices," Latest edition

12 Industrial Hygiene

12.1 Applicability

The requirements of this chapter apply to all Subcontractors and lower-tier subcontractors (hereafter referred to as “Subcontractor”) activities regarding industrial hygiene matters as they relate to the work activities on NREL Sites unless otherwise specifically exempted by the NREL.

This chapter defines the requirements and responsibilities for anticipating, recognizing, evaluating, and controlling employee exposures to chemical, physical, and biological agents encountered during work activities. The Subcontractor industrial hygiene (IH) program shall address the following elements (as applicable to the scope of work):

- Noise (See chapter 11)
- Hazardous materials
- Subcontractor work site dust control
- Sanitation
- Personal exposure monitoring
- Respiratory protection
- Temperature extremes
- Lighting and illumination
- Ventilation
- Lead
- Hexavalent Chrome
- Silica
- Asbestos
- Lasers
- Safety showers and eyewash apparatus
- Ionizing radiation
- Blood-borne pathogens
- Other significant project-related hazards such as OSHA chemical specific standards.

The Subcontractor shall provide personnel adequately trained/qualified to manage and implement their industrial hygiene program to a level required for the scope of work.

12.2 Regulatory Requirements

The subcontractor industrial hygiene program shall be conducted in accordance with the following statutory requirements:

- 10 CFR 851, Worker Safety & Health Program
- ANSI Z88.2, “American National Standard for Respiratory Protection - 2015
- 29 CFR 1926, Construction
- 29 CFR 1910, General Industry
- American Conference of Governmental Industrial Hygienist, “Threshold Limit Values for Chemical Substances and Physical Agents and Biological Indices,” Latest edition

12.3 NREL Specific Requirements/Permits

In addition to the requirements in section 12.2, the subcontractor industrial hygiene program shall meet the following NREL requirements as applicable.

12.3.1 General Requirements

12.3.1.1 Identification of Health Hazards

The Subcontractor shall identify and document, existing and potential physical, chemical and biological health hazards. The SWP should capture appropriate hazards/controls and any additional hazards/controls revealed by supplemental site information provided by NREL (e.g., site characterization data, as-built drawings, information regarding adjacent operations, etc.); and should be kept updated to reflect significant changes in exposure potential, new information, monitoring data, etc.

12.3.1.2 Control Measures

The Subcontractor's industrial hygiene program shall require that controls are implemented to eliminate or reduce employee exposures to below recognized occupational exposure limits (PEL's & TLV's) whichever is more conservative. Subcontractors should strive to maintain exposures to as low as reasonably achievable (ALARA). Control measures to eliminate or reduce industrial hygiene-related exposures shall be identified during the pre-job planning process.

The implementation of control measures shall follow the following hierarchy:

1. Substitute to a less hazardous material if possible
2. Use engineering controls
3. Use administrative controls
4. Use PPE.

12.3.1.3 Exposure Assessment

The subcontractor shall perform monitoring as necessary to document and control exposures to chemical and physical hygiene hazards to the applicable PEL or TLV. Negative exposure assessments are encouraged even when not specifically required by a substance-specific standard. Exposure assessments may be performed using various methodologies (integrated sampling, direct-reading instrumentation, modeling, etc.), as appropriate for the material(s) of concern, the site conditions and the type of data needed.

12.3.2 Control of Hazardous Materials

A hazardous material is any substance that presents a physical or health hazard to humans. Hazardous material exposures should be maintained at the lowest exposure levels practical. A chemical shall not be used in any situation unless an individual has information indicating how the material can be used safely. Control measures to prevent overexposure to chemicals shall be incorporated by the subcontractor.

12.3.2.1 Carcinogen Control

The Subcontractor shall make every attempt to substitute less hazardous substances for any carcinogenic material (as defined by OSHA in 29 CFR 1910.1200). If hazardous materials containing carcinogenic components are used, the subcontractor shall ensure that exposures are eliminated or effectively maintained "as low as reasonably achievable" (ALARA).

Where the subcontractor's use of carcinogens may impact NREL workers, NREL may impose additional, specific controls upon the subcontractor.

12.3.2.2 Subcontractor Worksite Dust Control

All Subcontractor projects shall address dust control during pre-job planning. Outdoor areas to be cleared shall be limited to keep dust generation to a minimum. Earthwork activities shall be suspended when winds are 25 mph or more. Fugitive dust emissions resulting from grading and/or wind shall be controlled in accordance with the requirements of the Colorado Department of Public Health and Environment. Visible outdoor fugitive dust emissions are limited to 20%, the Subcontractor may need to perform worker exposure monitoring at much lower levels to demonstrate negative exposures to silica.

During facility renovation activities barriers are to be installed as needed to prevent dust migration from work areas to other occupied space. Sufficient equipment shall be kept at the work site to control dust whenever a nuisance or hazard occurs. Indoors, dry sweeping is discouraged.

12.3.3 Sanitation

Housekeeping shall be maintained on a daily basis. All work areas, shops and offices shall be kept clean to the extent the nature of the work allows. Walking/working surfaces shall be maintained, so far as practicable, in a dry condition. Waste receptacles that do not leak and may be thoroughly cleaned and maintained in a sanitary condition shall be used. All sweepings, wastes, refuse, and garbage shall be removed in a timely and sanitary manner. Cleaning and sweeping shall be done in a manner, which minimizes the contamination of the air with dust or particulate matter. Building entrances and openings shall be maintained to minimize the entry of vermin.

When provided, water facilities and containers shall be maintained, cleaned, and sanitized in accordance with applicable regulations. Use of common utensils (e.g., sharing the same cup) is prohibited. Adequate and fully-equipped toilets and wash stations shall be readily accessible to workers and maintained in a sanitary manner at all times.

12.3.3.1 Personal Exposure Monitoring

The subcontractor shall perform monitoring as necessary to document employee exposures to chemical and physical hygiene hazards, and to meet regulatory requirements. Negative exposure assessments are encouraged even when not specifically required by a substance-specific standard. Workers shall be informed of monitoring results within the OSHA-specified timeframe. Co-located workers (who have similar exposure potential as those who were monitored) shall also be informed of the results, after removing any personal/confidential information.

The subcontractor shall notify the NREL ESH point of contact of the results of monitoring as soon as they are obtained and provide NREL with copies of the results.

12.3.4 Temperature Extremes

Provisions to prevent heat stress and cold stress shall be incorporated into the work plan when conditions may reasonably be expected to present such hazards. The Thermal Stress section of the American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit values (TLVs) shall be the governing guidelines.

12.3.4.1 Heat Stress

The Subcontractor shall provide for appropriate mitigating measures prior to heat stress becoming an issue. The American Conference of Industrial Hygienists (ACGIH) threshold limit value (TLV) guidelines shall be followed for developing and implementing heat stress mitigation strategies. The

use of heat stress controls shall be addressed during the planning stages for all work that is to be performed in elevated temperature environments, and whenever impermeable clothing or multiple layers of clothing shall be worn to conduct work.

12.3.4.2 Cold Stress

The ACGIH cold stress threshold limit value (TLV) is the prescribed standard for cold exposure. When work involves continuous employee exposure to an equivalent chill temperature (ECT) below 10° F, the following safe work practices shall be observed:

- Workers are instructed on symptoms of frostbite and hypothermia, and appropriate preventive and first aid measures.
- Warming areas are conveniently available and workers shall be allowed to access the warming areas at will.
- Work is conducted using the “buddy system” or under continued supervision.

Non-emergency work is curtailed when the ECT in the work area is below -25° F.

Workers who experience physical illness or injury from cold exposure are to be immediately moved to a warm area, and then examined by a physician.

12.3.5 Lighting and Illumination

The minimum lighting level for work areas both indoors and outdoors shall be an average of 5 feet candles measured 30 inches above the floor. Illumination for general plant and shop areas shall maintain an average lighting level of 10 foot candles. Auxiliary lighting shall be used when needed for task specific activities. Care shall be exercised with the use of halogen lamps so that fire hazards are not created.

12.3.6 Ventilation

Local exhaust ventilation is a primary engineering control and is required to reduce concentrations of hazardous, irritating, and odiferous air contaminants below allowable exposure limits (where feasible). The operability of such systems shall be evaluated prior to the start of the work. The ACGIH’s Industrial Ventilation manual is the reference of standard for the design, testing and operation of ventilation systems. Ventilation systems requiring HEPA filtration should be leak- or DOP-tested at installation and at least annually thereafter, to verify their effectiveness.

12.3.7 Silica Exposure

The Subcontractor is responsible for keeping worker exposures to crystalline silica at, or below, the ACGIH TLV (0.025 mg/m³, respirable fraction, which is ½ of the OSHA PEL). In general, engineering controls such as wet methods or ventilation shall be employed whenever dust-producing activities are anticipated. The Subcontractor should substitute non-crystalline silica containing products where possible. Compliance with the TLV in most cases will require wet methods, local exhaust ventilation or other engineering controls. Control methods described in Table 1 of 1926.1153 may not be sufficient to control respirable silica concentrations to “at or below” the TLV. Use of control methods described in Table 1 as well as respiratory protection is required until the Subcontractor can demonstrate through personal air monitoring that exposures are at or below the TLV. The Subcontractor may use historical air monitoring results obtained

during similar work to prove that their control methods are likely to result in exposures at or below the TLV during work at NREL. Specific OSHA requirements as identified in 29 CFR 1910.1053 (excluding the PEL) such as exposure monitoring, written exposure control plan, hazard communication, and medical surveillance must still be complied with for work conducted at NREL.

Please refer to Chapter 13 for more details on Silica Management. See also section 12.3.2.2, “Subcontractor Worksite Dust Control.”

12.3.8 Lead Program

Prior to performing work activities involving the use or potential release of lead, the Subcontractor shall provide a Lead Compliance Plan to NREL ESH for review and concurrence. NREL complies with requirements of OSHA 1910.1025. However, employee exposure limits must comply with the ACGIH lead TLV.

12.3.9 Hexavalent Chrome

The General Industry Chromium (VI) Standard (29 CFR 1910.1026) will apply to all work performed by the Subcontractor that may expose workers to airborne hexavalent chromium. The Subcontractor shall be responsible for compliance with all requirements of the standard, with the exception of the exposure limit. NREL complies with the TLV for hexavalent chromium which is 0.0002 mg/m³ (inhalable) 8 hr.-TWA and 0.0005 mg/m³ STEL

12.3.10 Asbestos

No disturbance of presumed, suspect or known asbestos-containing materials (ACM) shall take place unless authorized by NREL ESH in the SWP or CSWP. If suspect asbestos-containing materials are unexpectedly encountered during the course of work activities, the Subcontractor shall immediately cease work and contact the NREL ESH POC and Facility Manager. Asbestos-containing construction/building materials shall not be brought on-site without the express, advance and written consent of NREL. A listing of known ACM is posted in each building on a common bulletin board.

The Subcontractor conducting asbestos-related work shall be responsible for compliance with the OSHA Construction Standard 29 CFR 1926.1101, Colorado Regulation 8 Part B and be a licensed asbestos abatement contractor. This type of work must be contracted under a construction project and not performed by a service subcontractor. Refer to the Construction ESH Manual for additional requirements.

12.3.11 Lasers

Class 1 laser systems incorporated into commercially available devices for use by the general public are exempt from these requirements, unless opened, serviced or modified. Laser equipment shall bear a conspicuously displayed label to indicate hazard classification.

Users of Class 1, Class 1M, Class 2, Class 2M, Class 3a, or Class 3R lasers shall read and abide by the safety documentation provided in the operator’s manual. Only qualified and trained personnel may service, adjust, or repair laser equipment. Employees, when working in areas in which a potentially hazardous exposure to direct or reflected laser radiation exists, shall be provided with anti-laser protection devices.

12.3.11.1 Class 3B and Class 4 Laser Use

Class 3B and 4 laser equipment shall not be used without the express written permission of the NREL Laser Safety Officer.

12.3.12 Safety Showers and Eyewashes

Suitable facilities for quick drenching or flushing of the eyes and body (e.g., eyewash/shower apparatus) shall be provided within the work area for immediate emergency use where the eyes or body of any person may be exposed to injurious corrosive materials (e.g., corrosives, skin sensitizers, etc.). An eyewash/shower apparatus shall be located such that it would require no more than 10 seconds to reach from the hazard. Access shall be free of any impediments. For battery handling areas, facilities for quick drenching of the eyes and body shall be provided within 25 feet.

Employees who may have a need for an eyewash/shower apparatus shall know where the nearest eyewash/shower apparatus is located and how it operates.

12.3.13 Ionizing Radiation

Radioactive materials, sealed radioactive sources, or devices that generate ionizing radiation shall not be brought on the NREL site without express written permission of the NREL Radiation Safety Officer. Any Subcontractor needing to bring radioactive material, sources or radiation-generating devices onto NREL property shall allow sufficient lead time in their schedule for NREL's review of their program, documentation, training records, other submittals, etc.

12.3.14 Blood-Borne Pathogens

Employees who may reasonably be expected to be exposed to blood or other body fluids shall comply with OSHA requirements relating to this subject. First aid kits shall contain "Universal Precautions" items, including chemical splash goggles, medical gloves, cardiopulmonary resuscitation (CPR) masks (with one-way valve), antiseptic hand cleaner, drying cloths, and red bags labeled "BIOHAZARD." Medical waste generated as a result of first aid response shall be placed in labeled red bags, and disposal shall be coordinated through NREL's Occupational Health Services.

12.3.15 Manual Material Handling

Manual material handling involves lifting, lowering, and carrying objects. If ergonomics principles are ignored, stresses on the muscles, joints, and disks in the back can eventually lead to or aggravate a work-related injury. For objects that are too heavy or bulky for safe manual handling by workers, mechanical lifting devices must be used for lifting and moving.

Subcontractors must comply with the ACGIH TLV for lifting Tables 1, 2, and 3. The three tables, one each for low, moderate, and high frequency lifting, consider the horizontal (from the spine) and vertical (from the floor) location of the load. Their intersection yields the recommended limit for that type of lift. The three tables represent different frequencies and duration of exposure to lifting during the workday. To choose a table, determine the duration of the task and the frequency of lifts per hour. Table 1 below shows the lifting limits for low-frequency lifting. The Table below is the most applicable for service work related activities.

Table 1. Low-Frequency Lifting

Less than or equal to two hours per day with less than or equal to 60 lifts per hour, or more than two hours per day with less than or equal to 12 lifts per hour.

<u>Vertical Location</u>	<u>Horizontal Location</u>		
	Close: 0 – 12 in.	Intermediate: 12 – 24 in.	Far: 24 – 31 in.
Shoulder to 12 inches above shoulder	33 lbs	15 lbs	NSL
Knuckle to chest	70 lbs	35 lbs	20 lbs
Shin to knuckle	40 lbs	31 lbs	15 lbs
Floor to shin	32 lbs	NSL	NSL

NSL – No Safe Limit

12.3.16 Other Health Hazards

Other hazards that may be present during the course of the Subcontractor’s work which is not specifically addressed in this manual shall be identified by the Subcontractor. Subcontractors are encouraged to discuss their potential hazards in advance with NREL ESH to help ensure minimal impact to the work schedule and the smooth coordination of logistics.

12.4 NREL Special Emphasis

Some chemicals are considered by NREL to be extremely hazardous and have additional requirements for bringing on NREL property and/or specific worker exposure monitoring requirements (see section 14.4 for a listing of extremely hazardous chemicals).

Additionally, subcontractors performing work on LEED certified buildings are required to use low or no volatile organic compounds (VOC) indoor paint and coating materials in accordance with LEED criteria in order to reduce the quantity of indoor contaminants that are odorous, irritating and or harmful to the comfort and well-being of installers and occupants.

Subcontractors performing work on buildings that are not LEED certified, are also encouraged to utilize LEED criteria as a best management practice during the selection and application of indoor paint and coatings when applicable to their scope of work.

12.5 Subcontractor Responsibilities

The provisions of this section apply to the development and implementation of the Subcontractor’s industrial hygiene program. The Subcontractor shall be responsible for implementing an effective IH program that:

- Identifies, evaluates, and controls potential and existing hazards/agents in the workplace through the pre-job safety planning process.

- Determines that engineering devices, administrative controls, and personal protective equipment are available, appropriate, tested, and utilized by employees.
- Determines employees are trained as required.
- Stops work that is not being safely performed.
- Reports occupational exposure data to affected employees in a timely manner.

12.6 References

- 29 CFR 1910, Occupational Safety and Health Standards
- 29 CFR 1926, Safety and Health Regulations for Construction
- American Conference of Governmental Industrial Hygienists, “Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices,” Latest edition
- American Conference of Governmental Industrial Hygienists manual, “Industrial Ventilation”, current edition
- Colorado Department of Public Health and Environment, Regulation 8, Part B - Asbestos
- Colorado Department of Public Health and Environment, Regulation 3 - Stationary Source Permitting and Air Pollutant Emission Notice Requirements.

13 Silica Management

Silica is the main component found in sand, quartz, and granite rock. Excessive amounts of silica dust may be generated during activities including, but not limited to, sandblasting, rock drilling, grinding concrete, stonecutting, drilling, quarrying, brick concrete cutting, gunnite operations, asphalt grinding, opening and pouring bags of cement products, demolition operations, jackhammering, chipping, soil excavation and sweeping concrete or masonry dust.

13.1 Applicability

The requirements of this section apply to all subcontractors and lower-tier subcontractors performing activities on NREL-owned/leased buildings or properties which will disturb or have potential to disturb silica containing materials (SCM). If suspect silica-containing materials are unexpectedly encountered during the course of work activities, the subcontractor shall immediately cease work and contact the NREL Facility Manager (FM) or NREL Environment, Safety, & Health Point of Contact (ESH POC).

SCM should be identified by the NREL Technical Monitor, Project Manager and/or ESH POC, based on the scope of work and the building materials and soils that must be disturbed.

NREL and its subcontractors must perform work in compliance with federal and state requirements and additionally NREL requirements, as identified below.

13.2 Regulatory Requirements

Silica controls are addressed through the following statutes/laws/regulations and guidance documents:

- OSHA 29 CFR 1926.1153 Respirable Crystalline Silica
- OSHA 29 CFR 1910.1053 Respirable Crystalline Silica
- Latest edition of the American Conference of Governmental Hygienists (ACGIH) TLVS/BEIs

13.3 NREL Specific Requirements/Permits

A surface penetration is required, prior to disturbance of a building surface and must be obtained from the NREL FM. A **surface penetration** at NREL is defined as an opening made by drilling, cutting, hammering, or otherwise piercing a wall, floor, ceiling, roof or other building surface. Surface penetration may expose subcontractors to silica from drywall or concrete as well as electrical and other hazards. Consult chapter 16 *Building Surface Penetrations* for NREL requirements before conducting any building surface penetrations.

13.3.1 Subcontractor Responsibilities

The Subcontractor is responsible for keeping worker exposures to crystalline silica at, or below, the ACGIH TLV (0.025 mg/m³, respirable fraction, which is ½ of the OSHA PEL). In general, engineering controls such as wet methods or ventilation shall be employed whenever dust-producing activities are anticipated. Compliance with the TLV in most cases will require wet methods, local exhaust ventilation or other engineering controls. Control methods described in Table 1 of 1926.1153 may not be sufficient to control respirable silica concentrations to “at or

below” the TLV. Use of control methods described in Table 1 as well as respiratory protection is required until the Subcontractor can demonstrate through personal air monitoring that exposures are at or below the TLV. The Subcontractor may use historical air monitoring results obtained during similar work to prove that their control methods are likely to result in exposures at or below the TLV during work at NREL. Specific OSHA requirements as identified in 1926.1153/1910.1053 (excluding the PEL) such as exposure monitoring, written exposure control plan, hazard communication, and medical surveillance must still be complied with for work conducted at NREL. See also section 12.3.2.2, “Subcontractor Worksite Dust Control.”

In order to determine whether a product contains silica, the Safety Data Sheet must be obtained and inspected by the Subcontractor (reference section 15.3.1). In the event silica is present in the products, the following safe working procedures must be followed to eliminate or control silica dust exposure:

- Engineering controls must be utilized to eliminate the hazard whenever feasible.
- Air monitoring or historical data are required to confirm the controls in place are working and whether personal protective equipment, (including respiratory protection), is adequate.

After working with products that contain silica, each individual will be required to thoroughly wash their hands and face before eating, drinking, or smoking. Eating, drinking, or smoking near silica dust is strictly prohibited.

Wet down dry materials and surfaces before cutting, chipping, grinding, sanding, sweeping, or cleaning. All block-cutting operations must be performed by the wet cut method.

Use power tools with built-in dust extraction units to capture the dust before it is released into the air.

For abrasive blasting, replace silica sand with safer materials. NREL does not allow the use of sand or any abrasive material that contains more than 0.1% crystalline silica. Garnet, slags, steel grit and shot may be good substitutes.

The Subcontractor must use engineering controls as specified in 1926.1153 and respiratory protection at the work site to keep worker exposure to crystalline silica dust within the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) of 0.025 mg/m³. This requirement applies to all tasks that either disturb building materials that contain crystalline silica or when products are used / applied that contain crystalline silica.

Dust control measures require either spraying / misting with water or the use of HEPA filtered local exhaust engineering controls at the dust generating points. Controls also require the use of respirators, disposable coveralls to protect personal or work clothing in some cases, industrial grade HEPA vacuums, and HEPA filtered negative air machines.

HEPA vacuums (new or used) used to control silica dust in indoor or outdoor environments where lab employees, guests, passers-by, etc., may be exposed due to the risk of leaky vacuums, must be maintained and tested per the manufacturer’s recommendations and equipment must be in good working condition with no missing parts. Also, obtain manufacturers HEPA filter test

certification if available. Copies of calibration and testing of HEPA vacuums must be provided to NREL.

For ongoing projects, HEPA vacuums and other HEPA equipment used for indoor silica filtration related work must be tested to verify sufficient filtration efficiency immediately after changing HEPA filters and remain on site during the duration of the project. If the vacuum or other equipment leaves the NREL site, it must be retested. HEPA vacuums and other equipment must not be used for indoor work after changing HEPA filters or bags until it's been determined by the subcontractor or NREL that any manufacturer required testing has been completed.

Examples of work activities / demolition operations known to cause the release of silica dusts, including with or without controls, include, but are not limited to:

- Chipping, sawing, grinding, hammering, or drilling of concrete, rock, brick, etc.,
- Work with cementitious materials or other products that may contain silica such as grout, masonry mortar, stucco, gunnite, shotcrete, plaster, sheetrock joint/taping compound, soil etc.
- Dry sweeping or sanding of materials that generate dust originating from concrete/cement, rock, or sheetrock joint/taping compound.

The subcontractor must submit copies of the following to NREL:

- An Exposure Control Plan including:
 - A description of the tasks involving disturbance to respirable crystalline silica.
 - A description of the engineering controls, work practices and respiratory protection used to limit employee exposure.
 - Housekeeping measures used to limit employee exposure
 - A description of procedures used to restrict access to work areas
- Subcontractor respiratory protection program
- Silica training certifications for Competent Person and Workers (working at NREL).
- Competent Person and Workers' respiratory protection credentials indicating that they are medically qualified, trained, and fit-tested.
- Subcontractor medical surveillance program (required if using respiratory protection 30 or more days per year).

13.4 References

- OSHA 29 CFR 1926.1153 Respirable Crystalline Silica
- OSHA 29 CFR 1910.1053 Respirable Crystalline Silica
- American Conference of Governmental Hygienists (ACGIH) TLVS/BEIs, Latest edition

14 Personal Protective Equipment (PPE)

14.1 Applicability

The requirements of this chapter apply to all Subcontractors' and lower-tier subcontractors' (hereafter referred to as "Subcontractor") work activities on NREL Sites unless otherwise specifically exempted by the NREL. This chapter provides the requirements for the use of personal protective equipment, where substitution, engineering or administrative controls are inadequate to fully protect the worker's body (including eyes, face, feet, hands, head, and hearing) from hazards capable of causing injury, illness, or impairment of any bodily function.

14.2 Regulatory Requirements

The selection, use, and design of PPE shall comply with the following requirements:

- 29 CFR 1910, Construction, Subpart I, Personal Protective Equipment
- 10 Code of Federal Regulations (CFR) 835, Occupational Radiation Protection
- Applicable American Standards Institute (ANSI) standards
- Manufacturers' recommendations.

14.3 NREL Specific Requirements/Permits

14.3.1 General Requirements

Personal protective equipment (PPE) is not a substitute for engineering and administrative controls. These controls shall be implemented, to the extent feasible, to mitigate the hazard so that the need for PPE is reduced or eliminated. Subcontractors shall provide PPE to their employees in accordance with OSHA requirements.

At a minimum, all subcontractor personnel shall wear safety glasses with rigid side-shields, closed-toe work shoes, long pants, and shirts with 4 inch sleeves. Personnel working on construction sites shall also wear hard hats. Outdoor work further requires reflective, high visibility (e.g., orange) traffic safety vests (minimum ANSI Class 2). Exceptions to these minimum requirements shall be approved by the NREL ESH POC and shall be notated in the SWP.

The subcontractor is responsible for supplying and requiring the use of appropriate personal protective equipment in all operations where there is an exposure to hazardous conditions; and/or where this manual indicates the need for using such equipment to reduce the hazards to the employees.

14.3.2 Training

Subcontractors shall provide training to each employee who is required to use PPE. Each affected employee must demonstrate understanding of training to their specific PPE. Retraining may be necessary if work activities change or the employee exhibits lack of understanding of the PPE.

14.3.3 Specific Requirements

14.3.3.1 PPE Hazard Assessment and Selection

The minimum appropriated PPE for the work being performed shall be specified in the SWP. The PPE selection shall be based on the hazard assessment results conducted for the work activity. Examples of applicable hazard assessment documentation include:

- Fall Hazard Analysis (FHA)
- Confined Space Entry Permit
- Hot Work Permit
- Electrical Safe Work Permit
- Building Surface Penetration Permit
- Other work control documents.

The SWP shall address (at a minimum) the following PPE requirements, as applicable to the work activity:

- Foot protection
- Hand protection
- Respiratory protection
- Head protection
- Eye and face protection
- Hearing protection
- Body protection
- Fall protection.

14.4 Subcontractor Responsibilities

The subcontractor shall:

- Perform an assessment identifying hazards or potential hazards and determine necessary PPE for activities to be performed
- Adhere to prescribed NREL postings and/or NREL pre-job planning documentation requiring use of PPE
- Provide adequate PPE for all its employees
- Properly maintain, use and store PPE
- Remove damaged and/or defective equipment from service
- Provide appropriate training to PPE users and document through site-specific training, and/or daily safety meetings.

14.5 References

- 29 CFR 1910, Occupational Safety and Health Standards
- 29 CFR 1910.134, Respiratory Protection
- 29 CFR 1926, Safety and Health Regulations for Construction
- 29 CFR 1910, Subpart I, Personal Protective Equipment
- 10 Code of Federal Regulations (CFR) 835, Occupational Radiation Protection
- ANSI Z87.1, Occupational and Educational Personal Eye and Face Protection Devices - 2015
- ANSI Z89.1, Protective Headwear for Industrial Workers - 2014
- American National Standards Institute (ANSI) Z88.2, “American National Standard for Respiratory Protection,” (2015)
- ASTM F2413-05 Standard Requirements for Protective Footwear.

15 Hazard Communication

15.1 Applicability

The requirements of this chapter apply to all Subcontractors and lower-tier subcontractors (hereafter referred to as “Subcontractor”) activities involving hazardous materials as they relate to the work activities on NREL Sites unless otherwise specifically exempted by the NREL.

This chapter defines the requirements and responsibilities for subcontractors who use, apply, store or generate hazardous materials at the NREL.

15.2 Regulatory Requirements

The Subcontractor’s Hazard Communication program shall be conducted in accordance with the following statutory requirements:

- 10 CFR 851, Worker Safety & Health Program
- 29 CFR 1910, Subpart Z, Toxic and Hazardous Substances, Occupational Safety and Health Standards
- 29 CFR 1910.1200, Hazard Communication

The Hazard Communication Program shall comply with the applicable statutory requirements of 29 CFR 1910.1200, Hazard Communication. Required components of a Hazard Communication Program include hazard determination, safety data sheets (SDS), labels and other forms of warning, employee information training, and a written Hazard Communication Program.

15.3 NREL Specific Requirements/Permits

In addition to the requirements in section 15.2, the subcontractor’s Hazard Communication program shall meet the following NREL requirements as applicable.

15.3.1 General Requirements

When selected for subcontract award, submit for approval, prior to beginning work, a list of all hazardous materials to be used on the project to the Subcontract Administrator with copies to the NREL ESH POC.

The subcontractor is responsible for maintaining an up-to-date chemical inventory and copies of safety data sheets (only of those chemicals brought on site). These shall be maintained at the task or project support facilities and made readily available for review by site workers, the DOE or NREL employees. The list (inventory) may include a book of SDSs, appropriately labeled and periodically updated to reflect the workplace inventory.

Prior to using any newly introduce hazardous material or product, supervisors shall obtain a copy of the appropriate SDS and review it with their employees. Project activity hazard analyses should be updated to reflect health and safety controls specific to chemical use.

Each original container of hazardous materials shall have the manufacturer’s label affixed to it or be labeled, marked, or tagged showing the identity of the hazardous chemicals, the appropriate hazard warning, and the name and address of the chemical manufacturer, importer, or other responsible party.

Secondary and subsequent containers of hazardous chemicals shall be labeled, marked, or tagged prior to use with the identity of the hazardous materials and the appropriate hazard warnings. The only exception to this is for portable containers into which hazardous chemicals are transferred, which need no label if all of the following conditions are met:

- The contents of the portable container are for the immediate use of only the person making the transfer, and the container remains under their direct control.
- The unlabeled portable container is used only within the work shift during which it was originally filled.

15.3.2 Specific Communication Requirements

If the subcontractor uses a labeling system that is an unusual format, or not readily understandable, the subcontractor shall inform other affected workers of how to read/understand their labeling system.

The subcontractor shall determine if their use of hazardous materials may affect (expose, or pose a potential danger in the event of an emergency) other subcontractor or NREL employees. If the hazardous materials create or the way it will be used creates a potential for affecting other employees, the subcontractor shall take appropriate notification steps. The subcontractor shall inform the other employer(s) of any precautionary measures that need to be taken to protect other subcontractor and/or NREL employees from inadvertent/unnecessary exposure to the subcontractor's hazardous materials during normal operating conditions and in foreseeable emergencies.

Work areas where chemical and/or biological hazards are known to pose an exposure potential shall be clearly designated as such (with signs, placards, postings, etc.) along with control requirements (PPE requirements, ventilation, authorization for access required, etc.).

15.4 NREL Special Emphasis

Some chemicals are considered by NREL to be extremely hazardous and have additional requirements for bringing on NREL property. Extremely hazardous materials at NREL include the following classes of chemicals:

- Alkali metals
- Beryllium
- Perchloric acid and other peroxide-forming chemicals
- Unstable, reactive, pyrophoric, or explosive chemicals
- Hydrofluoric acid
- Radioactive materials
- Highly toxic chemicals and reproductive toxins (depending upon the form, the quantity and method of application or use)
- Pesticides/herbicides

- Bio-chemicals.

Use of these chemicals at NREL may necessitate additional control mechanisms such as establishing dedicated use areas, specific postings/warning signs, notification to adjacent workers, ventilation controls, decontamination procedures, personal hygiene facilities, etc. It is the subcontractor's responsibility to notify the NREL ESH point of contact prior to bringing the material on site (preferably during the project planning stages) if intending to use extremely hazardous materials on their project, in order to ensure that the proper controls are provided and accepted.

15.5 Subcontractor Responsibilities

The Subcontractor shall be responsible for:

- Administering their own Hazard Communication Program.
- Maintaining an on-site list of hazardous materials and SDSs to be used on the project.
- Determining the hazards of materials used in the workplace, making SDSs available to employees, labeling containers, and providing information and training to employees on hazardous materials.
- Developing work practice requirements for hazardous materials to be used.
- Bringing on-site only those chemicals needed to perform the work for which they are contracted, and only in quantities needed for the job at-hand.
- Identifying when the subcontractor's use of hazardous materials may affect (expose, or pose a potential danger in the event of an emergency) other subcontractor's, or NREL's, employees and taking appropriate notification steps.
- Storing and using chemicals in accordance with the manufacturer's instructions, applicable regulations and best management practices.
- Remove chemicals from the work area and properly dispose of them when no longer needed.
- Comply with exposure monitoring and medical surveillance requirements associated with chemical use.

15.6 References

- 10 CFR 851, Worker Safety & Health Program
- 29 CFR 1910, Occupational Safety and Health Standards for General Industry.
- Title 10 Code of Federal Regulations (CFR) 850, "Chronic Beryllium Disease Prevention Program."

16 Confined Space

16.1 Applicability

The requirements of this chapter apply to all Subcontractors and lower-tier subcontractors (hereafter referred to as “Subcontractor”) activities which require personnel to work in permit-required and non-permit-required confined spaces on NREL Sites unless otherwise specifically exempted by the NREL.

16.2 Regulatory Requirements

The Subcontractor confined space entry program and the associated work activities conducted in permit-required and non-permit-required confined spaces shall be accordance with the following statutory requirements:

- 29 CFR 1910.146, Permit Required Confined Spaces

16.3 NREL Specific Requirements/Permits

In addition to meeting the OSHA requirements in section 16.2, all work activities conducted in permit-required and non-permit-required confined spaces shall meet the following NREL requirements, as applicable.

16.3.1 Confined Space Work at NREL

If known at the time of contracting, NREL will include information on the need for confined space entry in the request for proposal (RFP). NREL will describe the confined space, whether it is permit-required or non-permit-required, the known hazards of the space, and the purpose for entry. NREL will request and review a copy of the Subcontractor’s written confined space program. NREL will require the Subcontractor to have a competent entry supervisor, attendant, and workers who are properly trained in confined space entry, all the necessary equipment to perform work in the confined space and a rescue retrieval device for entries greater than 5 feet in depth.

16.3.2 Confined Space Classification

NREL has established a system for classifying (consistent with OSHA definitions) confined spaces as permit-required or non-permit-required based on the actual and/or potential hazards related to entry into the space. Prior to entry, all confined spaces will be evaluated and classified as either permit-required or non-permit based on the actual and/or potential hazards related to entry into the space while the confined space is in its normal operating condition. Confined space classification is performed in advance of entries by NREL ESH. However, a non-permit space may be reclassified as a permit space, based on the activities performed in the space.

16.3.2.1 Labeling and Signage

When feasible, identified confined spaces are posted with a sign stating “Confined Space, Entry by Permit Only” or “Caution, Non-Permit Confined Space, Contact the NREL Central Monitoring Station (CMS at 303-384-6811) and Facility Manager (FM) Before Entering.” When signage is not feasible Subcontractors will be informed by NREL of the location and classification of known confined spaces.

16.3.3 New or Previously Unidentified Confined Spaces

There is a possibility that ongoing activities may create new confined spaces (such as new utility vaults, manholes, ventilation ducts, tanks, sumps, and/or elevator pits). It is also possible that Subcontractors may encounter a confined space that had not been previously identified. During project design, NREL will attempt to identify situations that may result in the creation of new confined spaces. However, it is not always possible to anticipate every potential confined space.

It is the Subcontractor's responsibility to watch for new or previously unidentified confined spaces and to inform the NREL Technical Monitor and ESH POC whenever new confined spaces are identified or created.

16.3.3.1 Identifying a Confined Space

All Subcontractors should be on the lookout for confined spaces. As defined by OSHA a confined space is:

- Is large enough and so configured that an employee can bodily enter and perform assigned work
- Has limited or restricted means for entry or exit (for example, tanks, vessels, silos, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry)
- Is not designed for continuous employee occupancy.

16.3.3.2 Hazard Recognition

Confined spaces shall be considered hazardous until determined to be otherwise. Hazards will be identified and evaluated by a competent person prior to entry. The Subcontractor shall be watchful of confined space work activities that may increase hazards, such as hot work, painting, cleaning or electrical work. Such work may change a non-permit-required confined space into a permit required confined space. The Subcontractor will continuously evaluate confined space conditions and will stop work if hazards increase or change. Additional controls shall be implemented to control the new hazards. In lieu of the requirement for an entry supervisor and attendant for permit-required entries, non-permit entries require a partner or buddy to be involved with each entry.

16.3.4 NREL Verification of Subcontractor's Compliance with Confined Space Entry

NREL will require verification that the Subcontractor is able to safely perform confined space entries. NREL will verify that the Subcontractor has the following:

- A confined space competent entry supervisor and attendant
- The entry team/authorized personnel - adequate number of workers to staff an entry team including entry supervisor and attendant, and that their training is current and documented
- Functioning, calibrated monitoring equipment and that their staff are familiar with the use of the equipment. Alarm levels on monitoring equipment must be set to ACGIH TVLs.
- Appropriate PPE, ventilation equipment, supplemental lighting if necessary, fall protection and rescue equipment/plan where required.

NREL and the Subcontractor will discuss acceptable entry conditions. NREL may request a copy of the Subcontractor’s Lockout Tagout program if energy isolation is necessary. NREL and the Subcontractor will agree who’s confined space permit system will be used—either NREL’s or the Subcontractor’s. NREL ESH may observe Subcontractor confined space entries until such time that NREL is comfortable that all performance expectations are being met. A copy of each completed confined space entry permit must be submitted to the NREL ESH POC.

16.3.4.1 Confined Space Entry Controls

Entries into confined spaces shall be controlled either through administrative controls for non-permit confined spaces or through the permit procedure for permit-required confined spaces. Controls for confined space entries include, but are not limited to:

- Mechanical ventilation
- Use of isolation procedures (LOTO)
- Cleaning of confined space
- Electrical precautions
- Fire precautions
- PPE
- Communication procedures
- Fall Protection and Rescue/Retrieval Equipment

16.3.4.2 NREL Confined Space Entry Experience/History Review

NREL ESH shall inform Subcontractors of NREL’s experience, if any, with the confined space being entered, by reviewing, Confined Space Evaluations, and associated confined space classification, and previous cancelled permits for the space in question, if available.

16.3.4.3 Subcontractor Confined Space Post Entry Evaluation Review

Subcontractors shall inform NREL ESH of their experience with the permit-required confined space following the entry by utilizing the “Entry Review/Critique” section contained in the NREL Confined Space Entry Permit or as part of the Subcontractor’s accepted Confined Space Entry Permit. Completed NREL permits or copies of the Subcontractor’s permit shall be made available to NREL ESH.

16.3.5 Confined Space Entry Notification

In general, the following coordination and notification is required for permit and non-permit required confined spaces prior to entry.

Non-Permit Confined Space: Entries shall be coordinated with the Central Monitoring Station (CMS) and the FM.

Permit-Required Confined Space: Entries shall be coordinated with the CMS, FM, and ESH POC.

The ESH POC will provide phone numbers and will instruct the Subcontractor of specific notifications to be made. Exact notification requirements may vary from job to job.

16.3.6 Subcontractor Training Requirements

Subcontractors that are trained in accordance with the requirements identified in 29 CFR 1910.146, Permit Required Confined Spaces will be considered as meeting the necessary confined space entry training requirements for working at NREL. The Subcontractor shall provide NREL proof of such training upon request.

16.4 References

- 29 CFR 1910.146, Permit Required Confined Spaces
- 29 CFR 1910.147, The Control of Hazardous Energy (Lockout/Tagout)

17 Building Surface Penetrations

17.1 Applicability

The requirements of this chapter apply to all Subcontractors and lower-tier subcontractors (hereafter referred to as “Subcontractor”) activities involving the penetration of building surfaces such as walls, floors, ceilings, and roofs. These requirements are in place to preventing contact with hidden hazards such as live electrical conductors and other significant hazards such as natural gas, water lines, and compressed air, as they relate to the work activities on NREL Sites, unless otherwise specifically exempted by the NREL.

17.2 Regulatory Requirements

The subcontractor’s building surface penetration activities shall be conducted in accordance with the following statutory requirements as applicable:

- 29 CFR 1926, Safety and Health Regulations for Construction
- 29 CFR 1910, Occupational Safety and Health Standards.

17.3 NREL Specific Requirements/Permits

In addition to the requirements in section 17.2, the subcontractor shall conduct surface penetrations in accordance with the following NREL requirements. **Note:** All outside excavations including trenching, grading, or drilling activities shall be performed in accordance with chapter 7, Excavations.

17.3.1 Surface Penetrations

A **surface penetration** at NREL is defined as an opening made by drilling, cutting, hammering, or otherwise piercing a wall, floor, ceiling, roof or other building surface. Subcontractors shall ensure that the provisions and necessary steps are in place to provide protection against contact with unseen enclosed electrical lines, gas lines, waste lines, water lines, steam lines, high pressure lines, or other utilities that, if disturbed, may injure workers or damage equipment.

The subcontractor will be responsible for providing all the required materials, personnel and protective equipment necessary to conduct safe surface penetrations.

17.3.1.1 Surface Penetration Permit, Existing NREL Buildings and Facilities

Subcontractors conducting surface penetrations in existing NREL buildings and facilities shall perform this work activity in accordance with the NREL Surface Penetration Permit System. Prior to performing any building surface penetrations, the subcontractor shall coordinate the activity through the NREL building FM. The NREL FM will issue the surface penetration permit to the subcontractor.

In accordance with the requirements of the permit, the subcontractor shall perform an initial evaluation to include a walk-down of the area with the NREL FM. The walk-down shall identify:

- Any visible indications that utilities and equipment might be present
- Any utilities and equipment that might be disturbed during the work activity.

Preapproved Surface Penetration Methods

Based on the results of the walk-down, the NREL FM will make a determination if the subcontractor work activity falls within the category of a “preapproved surface penetration method.” NREL’s preapproved methods include the following:

- Hanging pictures or board where the length of the nail or screw will not fully penetrate the wall material.
- Penetrations into masonry block wall that do not exceed ¾” in depth.
- Penetrations in pre-cast tilt-up concrete walls to mount signs and facility accessories. The penetration cannot exceed the thickness of the wall.
- Penetrations in drywall, sheetrock, or similar construction material with a drill bit fitted with a “stop” to prevent penetration beyond the depth of the material. Once a hole is made just through the material, use a fiber optic scope to verify the absence of utilities prior to proceeding with work.
- Penetrations in drywall, sheetrock, or similar construction material with a utility knife where the blade is adjusted to prevent penetration beyond the depth of the material. If the size of the opening does not allow for visual verification, use a fiber optic scope to verify the absence of utilities prior to proceeding with work.
- Penetrations in drywall, sheetrock, or similar construction material with a non-conductive object. If the size of the opening does not allow for visual verification, use a fiber optic scope to verify the absence of utilities prior to proceeding with work.
- Penetrations in drywall, sheetrock, or similar construction material with a laminate trimmer with the cutting bit adjusted to prevent penetration beyond the depth of the material. If the size of the opening does not allow for visual verification, use a fiber optic scope to verify the absence of utilities prior to proceeding with work.
- Penetrations into a single layer of drywall, sheetrock, or similar construction material where both sides can be visually inspected to verify the absence of utilities that may be disturbed.

If it is determined that the surface penetration meets the requirements of a preapproved method, then the NREL FM will issue the permit to the subcontractor. The permit may include additional subcontractor project controls and work instructions as deemed necessary by the FM.

Non-Preapproved Surface Penetration Methods

If the surface penetration does not meet the criteria for a “preapproved surface penetration method,” then one or more of following utility locate measures (as determined by the NREL FM and ESH point of contact) shall be applied:

- Review facility and the utility drawings.
- Perform nondestructive examination of the area with utility locate equipment.
- Interview individuals involved with the construction of the area to identify how utilities were laid out.
- Use typical work practices as an indicator of the potential for utility system to be disturbed.

- Other means or method as applicable.

The subcontractor shall incorporate the following electrical safety precautions as required by the permit:

- GFCI when using corded electrical power tools

Note: A GFCI is required even if a drill interrupter/stop is used.

- Eye Protection
- Drill interrupter/stop
- Wear dielectric gloves rated for the voltage
- Dielectric mats
- Wear dielectric rubber outer boots over required foot protection when using water coolant or in a wet environment.

When utilities have been detected within the general area that the penetrations will be performed, the subcontractor shall incorporate that following project controls and instructions as applicable and defined in the permit:

- Relocate planned penetration location.
- Maintain the distances from the identified and marked utilities as defined in the permit.
- Lockout and tagout the detected utilities prior to proceeding with the surface penetration activities.

In all instances, the subcontractor shall immediately stop work if:

- Unexpected utilities are encountered
- The tools encounter unexpected resistance
- Utilities are damaged during the work activity.

17.4 References

- 29 CFR 1926, Safety and Health Regulations for Construction
- 29 CFR 1910, Occupational Safety and Health Standards.
- 29 CFR 1910.147, The Control of Hazardous Energy (Lockout/Tagout)

18 Environmental Requirements

18.1 Applicability

The requirements of this chapter apply to all Subcontractors and lower-tier subs (hereafter referred to as “Subcontractor”) activities which have the potential to affect natural resources that include stormwater, wetlands, streams, air quality, vegetation and wildlife. Potential impacts to existing historical and archeological items as well as historical and archeological items unearthed during activities on NREL sites are also addressed in this chapter. Any exceptions to these requirements must be approved by NREL.

18.2 Regulatory Requirements

Environmental protection is addressed through the following statutes/laws/regulations and guidance documents:

- National Environmental Policy Act (NEPA)
- Clean Water Act, Section 404
- National Historic Preservation Act
- Endangered Species Act
- Migratory Bird Treaty Act of 1918
- Bald and Golden Eagle Protection Act
- 40 CFR Part 122, Subpart B, National Pollutant Discharge Elimination System
- State of Colorado Noise Statute (CRS 25-12-101 through CRS 25-12-109)
- Colorado Department of Public Health and Environment, Air Pollution Control Division, Particulates, Smokes, Carbon Monoxide and Sulfur Oxides, Regulation No. 1
- Colorado Division of Wildlife Recommended Buffer Zones and Seasonal Restrictions for Colorado Raptors, 2008
- Colorado Noxious Weed Act (CRS 35-5.5-101 thru 119) and associated regulations, Rules Pertaining to the Administration and Enforcement of the Colorado Noxious Weed Act (8 CCR 1206-2).

18.3 NREL Specific Requirements/Permits

In addition to section 18.2, all work activities shall meet the following NREL requirements, as applicable.

18.3.1 National Environmental Policy Act Requirements (NEPA)

A provisional NEPA review may have been initially completed so that the project design could be completed. Once the details of the project have been described in the preliminary design, but before initiation of work activities, additional environmental review may be required. Depending on the nature and scope of the activity, the environmental review process could take a few days to several weeks.

18.3.2 Stormwater Discharge Requirements

Stormwater discharges associated with work sites that disturb greater than one acre at NREL's STM and Flatiron Campus sites are regulated by the EPA via the EPA General Construction Permit. Subcontractors performing activities on these sites are responsible for obtaining coverage under the EPA's Construction General Permit. This requires filing a Notice of Intent with the EPA and preparation of a Stormwater Pollution Prevention Plan (SWPPP). Subcontractors are required to utilize a template provided to them by NREL ESH POC for preparation of the SWPPP. The NREL ESH POC shall review and accept the subcontractor SWPPP in advance of applying for EPA coverage and before beginning work activities.

Work activities that disturb less than one acre do not require coverage under the EPA Construction General Permit. However, the subcontractor shall prepare a site-specific erosion control plan that shall be accepted by NREL ESH before work activities can begin. SWPPP shall include a spill prevention, response and cleanup plan.

18.3.3 Air Emissions Requirements

18.3.3.1 Fugitive Dust

The Subcontractor shall adhere to NREL's Particulate Emissions Control Plan for Construction Activities (state air permit numbers 08JE0889L).

18.3.3.2 Vehicular Emissions

Motorized mobile equipment, including subcontractor's personal vehicles shall be operated to minimize emissions. Unnecessary idling of vehicles and equipment is prohibited. Idling of vehicles for occupant heating/cooling comfort is prohibited. Colorado Revised Statute No. 4241206.

18.3.4 Pipe Flushing

Pipeline flushing of new water lines, storm and sanitary sewer lines, or fire line flushing requires preparation and approval by NREL ESH of a plan that describes the location, nature of activity to be performed, description of the discharge (duration, anticipated volume and rate, source of the water, potential pollutants in the water used), and the Best Management Practices (BMPs) to be used to prevent potential pollutants from reaching the storm drainage system, a stream, drainage channel, ditch or groundwater.

Flushing water may be discharged to the Pleasant View Water and Sanitation District's sanitary sewer system, if approved by the District. NREL ESH will coordinate the approval with Pleasant View.

18.3.5 Trash, Debris, and Sanitary Waste

The Subcontractor shall provide waste storage and removal as required to maintain the work site in a clean and orderly condition with periodic disposal of waste off-site. Open free-fall chutes and containers without lids are prohibited. Trash and debris is prohibited from migrating outside the work area. All trash and debris is to be collected daily.

18.3.6 Wastewater

NREL limits wastewater discharges to sewer or septic systems. NREL does not permit other direct wastewater discharges to the environment, including land and surface water. NREL complies with Pleasant View Water and Sanitation District (Pleasant View) and Metro Wastewater Reclamation District (Metro) prohibitions, criteria, restrictions, and notification requirements for wastewater discharges. Discharges of certain volumes of wastewater, chemical content, pH, and specific physical characteristics require a special approval from the wastewater districts. Contact NREL ESH if such a discharge is planned on a routine, periodic, or occasional basis.

18.3.7 Hazardous Waste

NREL holds the necessary Resource Conservation and Recovery Act (RCRA) generator identification numbers to conduct waste generation and collection activities. NREL prohibits treating (evaporation, neutralization, dilution, or reduction of volume or toxicity) or disposing of hazardous waste on site. The Subcontractor shall contact NREL ESH prior to any work activity that will generate hazardous or chemical waste. Special handling, storage, and labeling requirements may apply depending upon the type and quantity of chemical waste. The subcontractor is responsible for removal and proper disposal of any hazardous waste. The Subcontractor shall implement appropriate spill prevention, control and countermeasures, where liquid fuel and oil is stored, processed, distributed, or consumed, and could reasonably be expected to discharge oil in harmful quantities.

18.3.8 Asbestos

The use of asbestos containing material (ACM) is not authorized. However, it is possible that unidentified ACM may be discovered during excavation activities. Should ACM be discovered, the Subcontractor shall stop the affected work and notify the NREL Facility Manager and ESH POC. For requirements on Asbestos Abatement, please refer to the Construction ESH Manual.

18.3.9 Noise

Per State of Colorado Noise Statute, construction projects are limited to permit conditions or 80 dBA for the period within which the construction is to be completed or a reasonable amount of time.

18.3.10 Pesticide and Herbicide Use

All pesticide and herbicide use shall be approved by the NREL ESH prior to application.

18.3.11 Vegetation

Project design shall attempt to minimize the elimination of existing trees/shrubs, which provide local wildlife habitat, reduce cooling needs in summer by providing shade, and remove carbon dioxide from the air, thus contributing to a reduction of greenhouse gases generated at NREL. Those trees/shrubs that must be eliminated as a result of work activities shall be tagged/otherwise marked and noted on drawings to be reviewed by NREL ESH. Removal of existing trees/shrubs will typically require replacement.

18.3.12 Natural Resources—Wildlife

Natural resource protection at NREL is guided by NEPA, the Migratory Bird Treaty Act, the Colorado Division of Wildlife Recommended Buffer Zones and Seasonal Restrictions for Colorado Raptors, the Threatened and Endangered Species Act, and other applicable state and federal wildlife guidelines. The following topics represent areas that may impact individual project costs and schedules.

18.3.12.1 Nesting Birds

In general, for any work activities (grading/clearing, mowing, heavy equipment use, herbicide application, demolition activities, etc.) that occur between mid-March to mid-September, NREL ESH shall conduct a nesting bird survey prior to the beginning of work activities. Ideally, NREL ESH should be contacted as soon as the work is planned. Whenever possible, projects should be planned to occur between mid-September and mid-April. NREL ESH shall be notified at least 14 days prior to the start of work activities, to ensure the availability of staff to conduct the survey. Surveys shall be completed within 48 hours before work, depending on local and species-specific breeding activities (consult with NREL ESH). Project delays of a few days to several weeks may occur if an active nest is found in the work area, depending on the species, the nesting progress, the species relative tolerance to human/work activities, and the amount of activity that will occur near the nest (consult with NREL ESH). Active nests may occur on the ground, in shrubs or trees, in onsite nest boxes, or in building entryways or open areas. If raptor (hawks, owls, falcons) nests are found, buffer zones from 200 yards to 1/2 mile shall be kept free of work activities until the young leave the nest. Early coordination with NREL ESH can help mitigate issues before they arise. **Note:** Walking in ground-nesting habitat is permitted. If a bird is spotted flying from the ground, avoid the area by several feet, as a nest may be occupied or under construction.

18.3.12.2 Snakes

Subcontractors shall not pursue, capture, harass, harm, or kill wildlife, including snakes, encountered onsite. Minimal project delays (less than one hour) may occur if a snake is discovered in a project area. When a snake is discovered in an area frequented by workers or visitors, the observer shall call security at 303-384-6811 or 303-275-1234 to report its location. NREL ESH or Office of Security and Emergency Preparedness employees shall capture and relocate the snake to an uninhabited area of the site.

18.3.12.3 Other Wildlife Species

Subcontractors shall avoid adverse impacts to other wildlife species, including coyotes, deer, salamanders, bats, small rodents, rabbits, squirrels, swarms of bees, and any other form of wildlife encountered. Concrete washout pits/utility vaults and other similar structures shall be constructed and operated in a manner to preclude entrapment and drowning of wildlife. During the construction and installation, such structures shall be covered nightly or otherwise protected to prevent wildlife from falling in, entrapment, or drowning. For shallow pits (i.e., concrete washout pits), one approach is to place a large piece of wood at an angle into the pit so that an animal can climb out if it falls into the space. For utility vaults, the entire vault shall be surrounded by plastic construction fencing at night and on weekends. The fencing should contact the ground as much as possible.

18.3.12.4 Wildlife Corridor

A wildlife corridor at the STM campus has been designated along the Middle Drainage. Work activities that involve roadways, bridges, pedestrian trails and other features within 100 feet of the Middle Drainage Channel (running between FTLB and SERF) shall be designed to facilitate wildlife movement through the corridor. NREL ESH shall approve such designs.

18.3.13 Preservation of Historical Resources

In the event potential archeological items are unearthed or discovered during activities, work in the area shall stop. NREL ESH will make a determination within 24 to 48 hours if work in the area can continue. Potential archeological items may not be moved or stockpiled upon discovery.

18.3.14 Wetland and Drainage Areas

Work within jurisdictional wetlands requires permitting through the U.S. Army Corps of Engineers under Section 404 of the Clean Water Act. At this time, no jurisdictional wetlands have been identified at STM or the Flatirons Campus. Work within non-jurisdictional wetlands requires approval from NREL ESH. Areas within your work site that hold water after storm events or snow melt may be considered non-jurisdictional wetlands. Please contact NREL ESH if such conditions exist on your work site.

18.4 Subcontractor Responsibilities

The provisions of this procedure apply to Subcontractors performing activities which have the potential to affect natural resources that include stormwater, wetlands, streams, air quality, vegetation and wildlife. The Subcontractor and all lower-tier subcontractors shall be responsible for implementation and compliance with all federal, state and local laws as well as NREL procedures as described above and referenced below.

19 Temporary Traffic Control Requirements

19.1 Applicability

The requirements of this chapter apply to all Subcontractors and lower-tier subs (hereafter referred to as “Subcontractor”) activities which have the potential to affect the safety of road users including motorists, motorcyclists, bicyclists, pedestrians, employees and workers. Any exceptions to these requirements must be approved by the NREL Traffic Safety Authority Having Jurisdiction (AHJ) or his designee.

19.2 Regulatory Requirements

Temporary traffic controls are addressed through the following statutes/laws/regulations and guidance documents:

- Manual on Uniform Traffic Control Devices (MUTCD) 2010 edition
- Americans with Disabilities Act of 1990 (ADA), Title II, Paragraph 35.130
- OSHA 29 CFR 1926 Subpart G, Signs, Signals, and Barricades

19.3 NREL Specific Requirements/Permits

In addition to the above regulatory requirements, all work activities shall meet the requirements identified in the NREL Temporary Traffic Control Manual for Roadway Construction, Utility Work, and Maintenance Operations. This manual shall serve as a site supplement to the MUTCD for work performed on NREL owned property. This includes South Table Mountain and the Flatirons Campus. This supplement is not intended to replace the MUTCD, but to provide standard practices for specific conditions on NREL campuses.

19.3.1 Temporary Traffic Control Plan (TTCP)

The NREL Temporary Traffic Control Manual identifies the need for traffic control planning, it provides acceptable controls for typical applications and it identifies under what conditions a TTCP must be submitted to the NREL Traffic Safety AHJ for approval.

19.4 NREL Special Emphasis

The subcontractor shall ensure that they are in compliance with the NREL Temporary Traffic Control Manual. This includes the submission of a TTCP to the NREL Traffic Safety AHJ, where required, as a part of pre-planning work.

19.5 References

- Manual on Uniform Traffic Control Devices (MUTCD) 2010 edition
- Americans with Disabilities Act of 1990 (ADA), Title II, Paragraph 35.130
- OSHA 29 CFR 1926 Subpart G Signs, Signals, and Barricades
- NREL Temporary Traffic Control Manual for Roadway Construction, Utility Work and Maintenance Operations
https://www.nrel.gov/about/assets/pdfs/temp_traffic_control_manual.pdf