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Offshore Wind Safety Recommended Practices

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AMERICAN CLEAN POWER ASSOCIATION

Standards Committee

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FOREWORD AND BACKGROUND

This document was prepared by the Offshore Safety Subcommittee of the American Clean Power Association's (ACP) Environmental Health and Safety Standards Committee. This Offshore Wind Safety Recommend Practices document represents the current state of the United States offshore wind industry's knowledge on the safety risks along with available prevention, mitigation, and response measures during in-water activities associated with the construction, commissioning, operation, and decommissioning of offshore wind facilities in the Outer Continental Shelf, including aviation activities associated with transferring personnel to and from offshore sites. The document is informed by the experience of industry and regulators in other countries around the world where offshore wind has been more widely deployed, the experience of other offshore industries in the United States, and the experience building and operating land-based wind facilities in the United States.

This document was developed with the U.S. offshore wind industry in mind, aiming to support the creation of internal company safety policies and procedures. It also serves to guide the development of company or project-level safety management systems (SMSs) for inclusion in construction and operations plans submitted to federal regulators.

This document is not, and is not intended to be, a template SMS. There are other documents that already provide guidance on developing an effective SMS. Rather, this document builds on existing framework documents by going into detail on the specific safety risks for offshore wind and available prevention, mitigation, and response options. Figure 1 illustrates how this ACP recommended practice fits into the offshore wind operational safety hierarchy of standards and requirements.

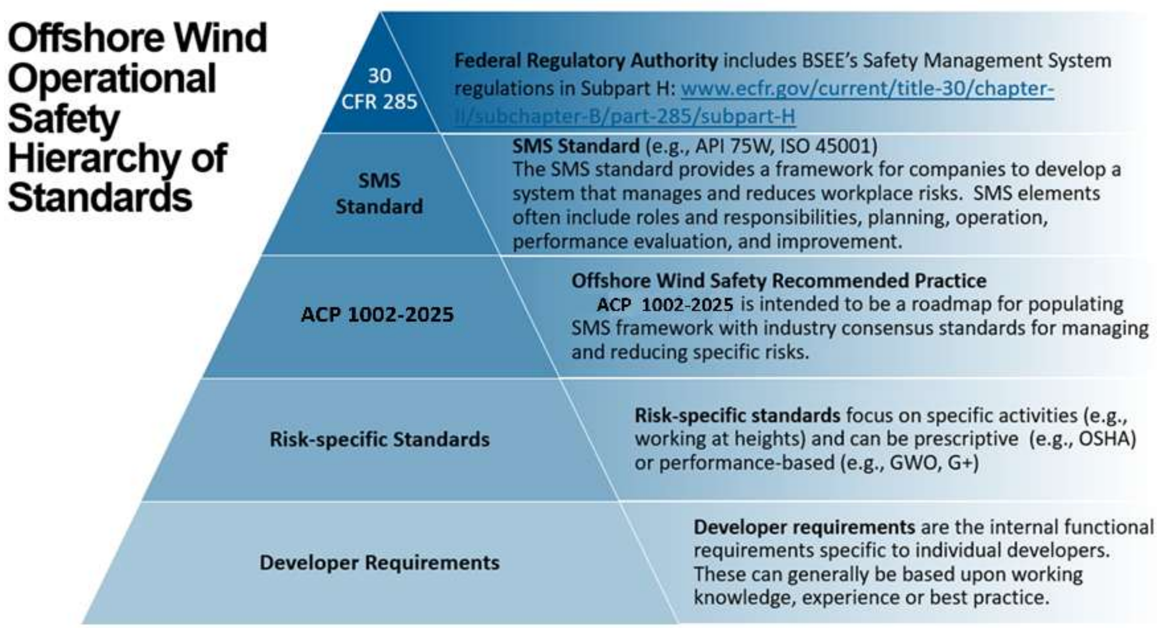

Figure 1: Offshore wind hierarchy of safety standards and requirements

The development of this recommended practice is intended to facilitate the sharing of knowledge specific to offshore wind to assist companies in the development of their own internal policies and procedures, and is in support of the development of their full SMS.

The document is relevant for the following:

- Project developers
- Project owner/operators
- Construction and other contractors/subcontractors

- Original equipment manufacturers
- Regulatory authorities
- Certification bodies
- Professional advisors (consultants, subject matter experts, etc.)
- Supply chain

The document is intended to provide an overview of key health and safety risks during in-water activities associated with the site assessment, construction, start-up, operation, and decommissioning of offshore wind facilities in the United States by identifying potential approaches to prevent and mitigate those risks and provide a roadmap to regulatory, industry standards, guidelines, and best practice documents.

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1 Scope

The document scope includes in-water activities during site assessment activities and pre-construction, offshore construction, commissioning, operation, and decommissioning of U.S. offshore wind facilities, including aviation activities associated with transferring personnel to and from offshore sites. To focus on areas that are specific to offshore wind, it does not include port- or land-based activities that occur in support of the development and operation of such facilities. Nor does it include environmental protection topics, such as prevention of spills, emissions, marine debris, or protection of species, among others. While these activities will be included in safety management systems (SMSs) and other project plans incorporated into construction and operations plans (COPs), the value add of this document is to focus on areas where there is less overlap with the lessons learned from other sectors by limiting the scope to the in-water activities specific to offshore wind in the United States. This document does not and cannot cover every relevant issue or potential risk associated with the life cycle of an offshore wind facility.

This document does not define or mandate any new industry standards or requirements. It was developed by taking account of existing and emerging industry practices within the framework of U.S. health and safety statutory and regulatory requirements. The recommended practices described herein do not aim to require any single risk management, operational, technical, or other solutions. Regulated entities are responsible for ensuring compliance with regulatory and contractual obligations and so shall make their own assessment of the relevance and suitability of any recommendations provided in the following pages.

The document provides recommendations, while still allowing options and flexibility to developers, to assess what is most appropriate for inclusion in their own SMS. Not every company will include each of the items covered in this document in their individual policies, procedures, and SMSs. What is covered will depend on the details of individual site assessment plans, COPs, facility design reports, and facility installation reports. This also includes operations, maintenance, and decommissioning. For example, if a developer does not plan to commission dive activities, then the diving section of this document would not be included in their policies, procedures, or SMSs.

2 Abbreviations, Acronyms, Terms, and Definitions

2.1 Abbreviations and Acronyms

ANSI	American National Standards Institute
API	American Petroleum Institute
BOEM	Bureau of Ocean Energy Management
BSEE	Bureau of Safety and Environmental Enforcement
CFR	*Code of Federal Regulations*
COP	construction and operations plan
DOI	U.S. Department of the Interior
D/O/O	developer/owner/operator
EHSSC	Environmental Health and Safety Standards Committee
ELV	exposure limit value
EMF	electromagnetic field
ERP	emergency response plan
HAV	hand-arm vibration
HAZID	hazard identification assessment

HSE	health, safety, and environment
ICS	Incident Command System
IEC	International Electrotechnical Commission
IMCA	International Marine Contractors Association
ISO	International Organization for Standardization
KPI	key performance indicator
LOTO	lockout-tagout
MEWP	mobile elevating work platform
NIMS	National Incident Management System
NIOSH	National Institute for Occupational Safety and Health
OCS	Outer Continental Shelf
OSHA	Occupational Safety and Health Administration
PPE	personal protective equipment
SCADA	Supervisory Control and Data Acquisition
SIMOP	simultaneous operation
SMS	safety management system
USCG	United States Coast Guard
UXO	unexploded ordnance
WBV	whole body vibration

2.2 Terms and Definitions

For the purposes of this document, the following terms and definitions apply. Definitions are aligned with ACP OCRP-1-2022.

Term	Definition
as low as reasonably practicable (ALARP)	The principle that the quantum of residual risk for an activity has been weighed against the sacrifice of money, time, or trouble involved in the measures necessary for averting the risk.
certification body	Body that performs conformity assessment services, also called conformity assessment body.
developer	Party or parties responsible for the permitting, planning, design, construction, and commissioning of offshore wind facilities.
environmental conditions	Characteristics of the physical environment (wind, waves, sea currents, water level, sea/lake ice, marine growth, scour and overall seabed movement, etc.) that may affect the offshore wind farm.
export cables	Submarine cable(s) conducting power to shore or to an offshore transmission grid for distribution to the land-based electric grid, as part of the power collection system.
foundation	Part of a support structure that transfers the loads acting on the substructure into the seabed (see ACP OCRP-1, Figure 1).

Term	Definition
life cycle	A series of stages that a project goes through from conception to cessation. The life cycle includes five main stages: initiation, planning, execution, monitoring and control, and closure.
manufacturer	Party or parties responsible for the manufacture and construction of an offshore wind turbine or other facilities of an offshore wind farm (e.g., offshore substations, cables).
marine growth	Surface coating on structural components caused by plants, animals, and bacteria.
metocean	Abbreviation of meteorological and oceanographic. Oceanographic is sometimes referred to as “marine” in the International Electrotechnical Commission (IEC) and other documents.
offshore wind turbine	Rotor-nacelle assembly and support structure, located offshore.
personal protective equipment (PPE)	Equipment worn to minimize exposure to a variety of hazards, such as gloves, foot and eye protection, protective hearing devices (earplugs, muffs) hard hats, personal fall protection (harness and lanyard), respirators, or full body suits.
return period (mean recurrence interval)	The average time until the next occurrence of a defined event.
rotor-nacelle assembly	Part of an offshore wind turbine carried by the support structure.
sea floor	Interface between the sea and the seabed.
sea state	Condition of the sea in which its statistics remain stationary.
seabed	Materials below the sea floor in which a support structure is founded.
seabed movement	Movement of the seabed due to natural geological and hydrodynamic processes.
scour	Removal of seabed soils by currents and waves or caused by structural elements interrupting the natural flow regime above the sea floor.
substructure	Part of an offshore wind turbine or offshore substation support structure that extends upward from the seabed and connects the foundation to the tower (see ACP OCRP-1, Figure 1) or topside.
support structure	Part of an offshore wind turbine consisting of the tower, substructure, and foundation (see ACP OCRP-1, Figure 1). For the offshore substation, the support structure is the substructure and the foundation.
tides	Regular and predictable movements of the sea generated by astronomical forces.
tower	Part of an offshore wind turbine support structure that connects the substructure to the rotor-nacelle assembly (see ACP OCRP-1, Figure 1).
transition piece	Part of an offshore wind turbine substructure, particularly a monopile, that may be used to provide a connection between the tower and the substructure pile (see ACP OCRP-1, Figure 1).
wave height	Vertical distance between the highest and lowest points on the water surface of an individual zero up-crossing wave.

3 U.S. Law and Regulations for Offshore Wind and Safety as a Source for Recommended Practices

The inclusion of statutory and regulatory sections referenced in the section below and throughout this document is not intended to reflect any assessment by ACP's Environmental Health and Safety Standards Committee (EHSSC) as to when or where such provisions apply. Rather, ACP's EHSSC is providing these references solely as sources of potential recommended practices and related provisions that may inform the development of a company's safety policies, procedures, and SMSs. ACP's EHSSC does not weigh in on the legal applicability of the statutory and regulatory references as they may apply to any given circumstance. Companies should evaluate the applicability of federal laws and rules in specific situations for themselves, and in support of this Industry has identified recommended standards to help facilitate the mitigation of key risks.

3.1 Bureau of Ocean Energy Management

Section 388 of the *Energy Policy Act of 2005* (EPAct05) authorized the U.S. Department of the Interior (DOI), which is carried out through the Bureau of Ocean Energy Management (BOEM), to grant leases, easements, or rights-of-way for renewable energy on the Outer Continental Shelf (OCS). One of the requirements is that the Secretary "shall ensure that any activity carried out under this subsection is carried out in a manner that provides for…safety…." These provisions can now be found in Title 43 United States Code Section 1337(p) (43 U.S. Code 1337(p)).

BOEM's regulations implementing its offshore renewable energy program can be found in Title 30 *Code of Federal Regulations* (*CFR*), Part 585 (*30 CFR* 285).

3.2 Bureau of Safety and Environmental Enforcement

The BOEM–Bureau of Safety and Environmental Enforcement (BSEE) Renewable Energy Split Rule is a final rule that transfers regulatory oversight of certain renewable energy activities on the U.S. OCS from BOEM to BSEE. The rule reassigns renewable energy regulations pertaining to safety, environmental oversight, and enforcement from BOEM to BSEE. The rule was announced on January 17, 2023.

Section 4(b)(1) of the *Occupational Safety and Health Act of 1970* allows for preemption of Occupational Safety and Health Administration (OSHA) jurisdiction in areas where other federal agencies exercise statutory authority to prescribe or enforce standards or regulations affecting occupational safety or health. BOEM and BSEE issued a joint policy statement on October 18, 2019, indicating the DOI, in which both BOEM and BSEE are located, is the "principal Federal agency for the regulation and enforcement of safety and health requirements for OCS renewable energy facilities" and that DOI regulations "occupy the field of workplace safety and health for personnel and others on OCS renewable energy facilities," but that they will collaborate with OSHA and the United States Coast Guard (USCG).

3.3 Occupational Safety and Health Administration

OSHA regulates certain workplaces to ensure safe and healthful working conditions by setting and enforcing standards and by providing training, outreach, education, and assistance pursuant to the *Occupational Safety and Health Act of 1970*. Under this Act, employers have the responsibility to provide a safe and healthful workplace that is free from serious recognized hazards. This is commonly known as the General Duty Clause.

OSHA recommends the following steps for hazard prevention and control:

- Identify control options
- Select controls

- Develop and update a hazard control plan
- Select controls to protect personnel during non-routine and emergency operations
- Implement selected controls in the workplace
- Follow up to confirm that controls are effective

OSHA further recommends evaluating and selecting controls based on a “hierarchy of controls.” In order of effectiveness as presented by OSHA, they are as follows:

- Elimination – Physically remove the hazard
- Substitution – Replace the hazard
- Engineering controls – Isolate people from the hazard
- Administrative controls – Change the way people work
- Personal protective equipment (PPE) – Protect the worker with PPE

OSHA regulations may provide informative insights on hazard identification and mitigation to inform development of policies, procedures, and SMSs. Specific regulations of potential interest, which include specific subsections that are referenced later in this document, are as follows:

- Construction, 29 *CFR* 1926
- General industry, 29 *CFR* 1910

Both of those regulatory sections include provisions on PPE, electrical safety, and fall protection among other hazards detailed in this recommended practice document.

3.4 United States Coast Guard

As DOI references in its 2019 policy statement, and as agreed in a April 2024 Memorandum of Agreement (BSEE/BOEM/USCG MOU_2024-04-01), the USCG has oversight and inspection authority over vessels used in support of offshore renewable energy facilities. Relevant regulations include the following:

- 46 *CFR*, Subchapters L, T, I, or J
- 14 U.S. Code 521, Coast Guard Life Saving Authorities, including, to render aid to distressed individuals, vessels, and aircraft on and under the high seas

In addition, other USCG regulations may provide informative insights on hazard identification and mitigation to inform development of policies, procedures, and SMSs. Specific regulations of potential interest are as follows:

- 33 *CFR*, Chapter 1 (subchapters include aids to navigation, vessel SMSs, among others)
- 33 *CFR*, Subchapter N (includes subparts on worker health and safety, PPE, and lifesaving appliances, among others)

4 Safety Management System Framework

According to 30 *CFR*, Part 285.810, offshore wind farm developers are required to develop a SMS for activities conducted on the OCS to develop or operate a lease, from met buoy placement and site assessment work through decommissioning. The SMS should be developed to address the following elements:

- How developers will ensure the safety of personnel or anyone else on or near their facilities
- Remote monitoring, control, and shutdown capabilities
- Emergency response procedures

- Fire suppression equipment
- How and when the SMS will be tested
- How developers will ensure personnel who conduct activities on their facilities are properly trained and have the capability to safely perform duties

A comprehensive project SMS provides a framework used by organizations to prevent, mitigate, and eliminate disruptions and losses caused by workplace accidents. The SMS helps manage risks, control hazard exposures, and respond to environmental challenges. Further, the SMS is key to monitoring an organization's compliance with relevant laws and industry standards. By proactively managing risks, an SMS helps prevent accidents, improves employee engagement, and enhances operational efficiency.

The following standards provide a structured methodology that can be followed to develop a strong SMS:

- American Petroleum Institute (API) Recommended Practice 75W, *Safety and Environmental Management System for Offshore Operations and Assets*
- ANSI/ASSP Z10, *Occupational Health and Safety Management Systems*
- International Organization for Standardization (ISO) 45001, *Occupational Health and Safety Management Systems* (reaffirmed in 2022)

Developers should not implement their SMS in isolation. Contractors involved in offshore wind farm development activities will also have their own version of a SMS that should be bridged to the developer SMS for interlinked activities. Vessels that work internationally operate under the *International Safety Management Code*. This is a set of international standards for the safe management and operation of ships aiming to ensure safety at sea, protection of the environment, and prevention of accidents.

This document is intended to be used to support development of a SMS development through provision of industry consensus on standards and work practices for managing and reducing hazard-specific risks.

5 Leadership and Commitment

An SMS cannot be effective without clear direction and focus from those charged with leading an organization. Management is obligated to demonstrate strong and visible safety leadership and commitment throughout all business activities. With a clear direction set, management is expected to provide the resources necessary to fulfill its defined commitments.

Leadership begins with setting a personal example in everyday work, and management shall hold themselves and all personnel accountable for their safety performance. Management's safety commitment is often defined in a policy statement and this organizational ambition is clearly communicated to all stakeholders, setting the foundation for the entire SMS.

Establishing a clear partnership between, and defining responsibilities of, all companies for a collaborative safe working environment is essential to the success of all individuals working on the project, from the customer, to manufacturers, and contractors supporting the project.

Further, establishing, nurturing, and maintaining a strong health and safety culture is critical to securing optimal safety performance and sustainability. A strong safety culture should be directed from the very top of an organization. It requires visible leadership, commitment, and contribution from executives to managers to employees at every level. The requirements and expectations of an organization's safety culture shall be effectively communicated to and accepted by contractors and subcontractors through contract conditions and appropriate onboarding activities.

Organizations can continually improve their health and safety performance through comprehensive planning of work activities and the identification of associated hazards, implementing effective risk management policies and procedures, involving personnel to integrate the management system, and periodic review of policies, procedures, and SMS adequacy and effectiveness.

The following outlines clear requirements for leadership to achieve and maintain good health, safety, and environment (HSE) performance within their organization:

1. Ensure that systems for HSE management are established, communicated, effectively resourced, and supported at every level in the organization
2. Know the HSE risks associated with their business activities and how they are managed and take action where risk management controls are ineffective
3. Demonstrate commitment and personal accountability for HSE management, promote an open and trusting environment, and understand how their behaviors impact others
4. Establish clear HSE goals and objectives and ensure performance is evaluated against these goals and objectives on a regular basis
5. Ensure that the workforce is actively engaged in the HSE management system process, and relevant learnings are shared across the organization
6. Motivate, coach, and develop their people in effective HSE management
7. Ensure that the expectation of Stop Work Authority is communicated to employees and contractors so that all individuals are clear that they have the authority to stop any work, or prevent any work from starting, where adequate controls of HSE risks are found not to be in place
8. Hold individuals accountable for behavior and performance
9. Engage where appropriate with stakeholders (contractors, local communities and authorities, industry associations and non-governmental organizations) about HSE performance matters

The following resource provides additional details to support the development of a strong health and safety program:

- UK Health and Safety Executive HSG65, *Managing for Health and Safety*

6 Planning and Risk Management

As described in more detail with respect to individual hazards identified in Section 7 of this document, developers should conduct risk assessments for existing and potential hazards prior to beginning work. The SMS should include a formal process and procedure for such assessments that provides for (i) describing a system/work task, (ii) identifying the hazards, (iii) assessing the risk, and (iv) identifying mitigations to control the risk. Assessments should consider the probability of a given risk, the severity, and the effectiveness of control methods in mitigating the risk.

As referenced earlier with respect to OSHA's hierarchy of controls, wherever possible, risks should be eliminated through selection and design of facilities, equipment, and processes. If risks cannot be eliminated, they should be minimized using physical controls, or as a last resort, through operating procedures and PPE.

All personnel should agree that methods taken for risk control properly mitigate the risks identified to provide a safe working environment for the task to be carried out prior to commencing work.

Results of these risk assessments should be documented and reviewed on a periodic basis to verify effectiveness of the risk mitigation actions.

6.1 Risk Assessment and Method Statement

6.1.1 Organizational Level Risk

An organization's management of safety risk should begin with a holistic approach, clearly defining organizational activities, its stakeholders, and the binding obligations associated with the stakeholders. In taking this broad-brush approach, it will help ensure a systematic reference point is established for project and executional level risk management.

As part of this holistic approach the organization should:

1. Define its activities to be undertaken
2. Define the hazards associated with these activities
3. Calculate the risk of these hazards by:
    a. Determining the likelihood of the hazard leading to an incident
    b. Determining the potential severity of this incident
4. Analyze the risk and subsequently ensure that proper controls are established based on the hierarchy of controls model and the binding obligations with its stakeholders
5. Determine mitigation measures to further lessen the impact of the hazards

This risk profile is captured in a risk register or similar document and provides the basis for how safety is to be managed in the organization.

6.1.2 Project Risk

For any specific projects to be undertaken, project safety risk registers/profiles should be developed. These risk registers will follow a systematic approach as detailed above in Steps 1–5. The development of these registers should be informed by the higher-level organizational risk register, the scope of work for the project, the stakeholders for the project, the location(s) of the project, project design and associated hazard identification assessment (HAZID[1]), equipment selected, personnel involved and their competencies, and any other known project specific influences that may impact the safety risk profile.

The following resources provide additional details on risk assessment approaches:

- DNV-RP N101, *Risk Management in Marine and Subsea Operations*
- ISO 12100, *Safety of Machinery – General Principles of Design – Risk Assessment and Risk Reduction*
- ISO 31000, *Risk Management – Guidelines* (2018)

6.1.3 Day-to-Day Execution

To continue with the cascading approach to risk management, day-to-day risk profiling should occur through a task-based risk assessment process. The task-based risk assessment is used to identify the steps needed to execute the work activity and all the risks associated with each step, as well as documenting the required procedures and risk mitigation. Task-based risk assessments will take into consideration the specifics for that day including such variables as the personnel involved and their current state, equipment, weather, and simultaneous/other operations. A task-based risk assessment may also be known as job hazard analysis, job safety assessment, field risk assessment, pre-job brief, tool box talk, or pre-task plan.

Developers should specify work activities where a task-based risk assessment should be conducted and communicated prior to the work commencing. Consideration of which work activities should have a task-based risk assessment should involve relevant management team members and personnel who carry out the work.

[1] HAZID, also known as hazard identification, is a workshop-based qualitative risk analysis technique commonly used for the identification of potential hazards and threats in a process. The purpose is to review the process at an early stage with a view to ensuring that the process design accounts for credible hazardous scenarios and review safeguards included in the design of the process that are designed to mitigate the relevant risk for the identified hazardous scenarios.

6.2 Management of Change

Developers should establish and implement management of change procedures to cover situations when a temporary or permanent change is made to facilities, documentation, activity critical personnel, equipment (for example, in the case of safety recalls), procedures, or operations. In such cases, the changes should be assessed to verify that the health and safety risks are identified and managed during such changes, in collaboration with other relevant disciplines as appropriate. The procedure should include approval, implementation, and tracking requirements and should be able to be scaled up according to the level of risk associated with the required change.

The following resource provides additional details on risk assessment approaches:

- International Marine Contractors Association (IMCA) HSSE 001, *Guidelines for Management of Change*

6.3 Safe Control of Work Program

Developers should establish a safe control of work program prior to high-risk or specialized activities being undertaken pursuant to a risk assessment. For example, such a program could be considered for diving, hot work, confined space, energized electrical work, access to medium- or high-voltage areas, control of hazardous energies/lockout-tagout (LOTO), simultaneous operations (SIMOPs) (see Section 6.5), non-routine working at height (including rope access), and non-standard/non-routine work. An example of a safety control of work program is a permit to work program.

Awareness of the need for work authorization via a permit or other mechanism should be covered in a site safety orientation, while further training and competence assessment would be required for people carrying out work under the system.

6.4 Contractor Safety Management

Contractors providing goods and services to developers can directly impact their operations, the environment, and the communities in which they operate. Contractors should have the capacity to perform their work in a consistent manner, which appropriately controls management of change and contributes to safe operations. Developers should recognize that a contractor's ability to manage risks effectively is critical to achieving their own health and safety objectives.

It is the responsibility of the developer to select appropriately qualified and competent contractors and integrate these contractors and support services into a project safely. This is particularly important when multiple vessels and contractors are in the field together (see "Simultaneous Operations" discussion in Section 6.5 of this document for additional information) or personnel under different supervisory situations are in the turbine tower or other field locations together. If different safety policies and procedures apply, the governing policies and procedures should be defined, communicated, and confirmed as being understood by all in advance of any work beginning. It is particularly important when policies of construction firms and manufacturers may differ from the project developers/owner. In such situations where policies vary, providing written agreement on the mutually accepted way forward is an important aspect to ensure understanding by all parties of expectations on how work will be performed safely. This can be achieved by contract terms, interface documents, or bridging documents, etc.

As a part of managing the relationship with contractors, the developer should consider the following:

- Contract planning:
  - When developing a contractual scope of work, identify any site-specific or scope-related risks, including risks where multiple contractors will be working together on the same scope.
  - The initial risk assessment outcome can then form the basis for determining the contracting strategies and the risk mitigating actions that are implemented in the subsequent contract phases.
  - An initial assessment of health and safety risks associated with the scope of the contracted work should be performed.

- Evaluate contractor sourcing and capability:
  - As part of the tendering process, health and safety pre-qualification should be performed to screen potential contractors and their health and SMSs to establish they have the necessary organization, values, leadership, culture, resources, capability, communication, and processes to undertake the scope of work in a safe and responsible manner.
  - Consideration should be given to formal capability assessments for potential contractors, establishing the required bid documentation and evaluation criteria, and establishing verification and assurance strategies.
  - Need for a formal capability assessment can be determined by the contract manager (with support from the health and safety lead) and can be based on a review of the scope of work, level of risk associated, standards (required by developer or used by contractor), whether potential contractors have been recently screened, and any additional requirements relevant to the specific contract.
- Establish contractual HSE requirements:
  - Consideration should be given to establishing key performance indicators (KPIs) related to HSE performance.
  - Contract scopes that have potential risks to personnel, the environment or facilities should include a requirement for activity-specific HSE plan, including the following:
    - A process for identifying hazards and assessing HSE risks
    - Identification of controls that will be used to manage risks
    - A monitoring and reporting plan
    - A process to identify and mitigate any performance gaps
    - A process to identify and regularly review performance
  - Consideration should be given to requiring submission of proof of training and copies of certificates by contractors, including the competencies and training records of all employees who will work on the project:
    - The company should assure themselves that they are content with this information prior to commencement of work.
- Contract implementation, mobilization, and execution:
  - Potential meetings could include a post-contract award meeting (i.e., kick-off meeting) to ensure that the relevant aspects of the contract risk assessment and contract-specific HSE requirements are communicated:
    - Remedial actions required to be completed before mobilization may be identified, agreed, and verified between developer and contractor.
  - Pre-mobilization audits may be considered to verify that physical resources to be utilized are appropriate and that processes and controls are in place in accordance with the HSE plan.
  - Risk assessments (in a joint exercise with developer and contractor personnel) of the work activities should be considered:
    - Consideration should be given to establishing a work authorization requirement, which means before contractors begin a task, a contractor should submit risk assessments, method statements, lifting plans, certificates, and any other pertinent documentation to be assessed by the contracting party.
    - The contracting party should review the documents for sufficiency, including reviewing any conditions that should be in place prior to starting the work.
  - Validation of the ability of the lead contractor's capability to manage subcontractors should be performed.

- Mobilization activities are performed to ensure that the contractors' HSE plan is implemented and communicated to all relevant personnel, community contacts, and third parties.
- Monitoring of the execution activities is performed throughout the life cycle of the contract, with performance review meetings to discuss with the contractor performance against agreed KPIs, review of incidents, appraisal of safety culture, evaluation of audit outcomes, etc.

- Evaluation and close-out:
  - Contracts should be closed out with a report on HSE performance and lessons learned to support continuous learning and improvement.
  - Contractor performance should be assessed against the contract requirements and HSE plan, and any deviations, positive or negative, should be noted in a close-out report and summary.

The following references provide additional detail on managing contractors in an offshore environment:

- API Recommended Practice 76, *Contractor Safety Management for Oil and Gas Drilling and Production Operations*
- International Association of Oil and Gas Producers Report 423, *HSE Management Guidelines for Working Together in a Contract Environment*

6.5 Simultaneous Operations

Offshore wind construction and operations may involve activities at many similar offshore structures in relative proximity and staging, launching, and returning via a single port. The coordination of such activities requires careful planning, choreography, and communication to be done safely. Whilst it is recognized that SIMOPs may be necessary for project scheduling for minimization of risk, SIMOPs should be avoided wherever possible.

SIMOPs may arise due to the following:

- More than one operation being scheduled for the same time and location:
  - This may either be a consequence of intentional scheduling or a result of factors such as task durations differing from the original plan.
- Physical interference between vessels and other operations spread over a wide area, such as cabling and anchoring affecting transit routes.

To address the potential safety risks that arise during SIMOPs requires careful planning and coordination with all parties involved, with the project developer retaining overall responsibility.

Planning typically consists of the following:

- An initial meeting involving all parties to the operation to:
  - Define the scope of the SIMOPs
  - Identify and assess risks mitigation measures
- Preparation of materials that will guide the SIMOPs, including the following:
  - Procedures
  - Drawings
  - Vessel information
  - Organization chart and chain of command
  - Principle hazards and mitigation measures
  - Management of change procedure
  - Identification of escape routes
  - Metocean limitations for operations
  - Routine and emergency communications arrangements
  - Contingency plans

- Joint review of materials to ensure that all parties understand expectations, procedures, and plans and commit to adhere to them

The execution phase should include the following:

- An initial briefing of all parties prior to commencing the SIMOPs
- Ongoing communications for the duration of the SIMOPs
- Designated point of contact for monitoring and oversight or coordination (if required) of SIMOPs operations against the plan
- After action review to identify any lessons learned to inform future SIMOPs

The following resource provides additional details:

- IMCA M203, *Guidance on Simultaneous Operations*

6.6 Continual Improvement and Assurance

SMSs should include requirements for periodic inspections of equipment and work areas to support ongoing management of risk, continual improvement, and assurance. Such inspections may be conducted daily, monthly, annually, or at a combination of intervals, depending on the equipment or area in question. Guidance for individual hazards and pre-mobilization audits for specific activities is given in Section 7.

Other elements of continual improvement and assurance include the following:

- Re-training, as necessary, in response to revised policies and procedures, the introduction of new hazards, or the implementation of new activities (see Section 7)
- Periodic refresher training, even when policies and procedures remain unchanged, and in the absence of new hazards or new activities (see Section 7)
- Periodic review of employee competence (see Section 7)
- Periodic emergency response drills (see Section 8)

7 Competence and Training

Training and competence are crucial for individual and organizational success. Training provides employees with the knowledge, skills, and attitudes necessary to perform their jobs effectively, whereas competence ensures that they can consistently apply these abilities to achieve desired outcomes.

All newly hired or transferred personnel, as well as management, should be provided with an HSE orientation, including training on any specific HSE obligations related to their role. The purpose of the orientation is to:

- Introduce the project, the approach taken to HSE management, the project's HSE objectives, and the project's HSE policies
- Provide personnel with an overview of the SMS organization and their site emergency response provisions
- Summarize the site-specific HSE hazards and risks associated with the project and the key controls to be observed and adopted, including PPE and trainings
- Communicate the requirements for incident reporting, including near misses, and the main HSE contractual obligations for suppliers

Training of personnel should occur whenever there are revisions to policies or procedures, or when new hazards or activities are introduced. Periodic refresher training may be appropriate even when policies and procedures remain unchanged, and in the absence of new hazards or new activities. Records of all information, instruction, and training should be retained as evidence they were provided.

Training may be tailored to the specific level of the employee, the job being done, and the needs of the employer. This could include the requirement for employees to complete further comprehensive training (e.g., OSHA 10-hour training for all personnel or OSHA 30-hour training for personnel with designated safety responsibilities).

It is also recommended that companies have a competency assurance process for individual personnel. Competence is the ability to apply a combination of knowledge, skills, and behaviors to a specific area of expertise. Competence is relative to a position, role, standard, or task. To ensure the competence of specific roles working with HSE risks, a competence development process should be prepared and implemented using information, instruction, training, and supervision.

A review process should be used to ensure that the competence of personnel is regularly assessed and to confirm that they can fulfill their duties safely, effectively, and in accordance with established procedures. Personnel should be evaluated to ensure that they have sufficient knowledge, competence, and experience to deliver the responsibilities and expectations of their role.

The following resources provide additional details:

- ACP RP 1001-2-202x, *Recommended Practice for Offshore Safety Training and Medical Requirements*
- Global Wind Organisation, *Basic Safety Training Standard*, V19, Wind Training Standards, May 2025
- IMCA C018, *Basic Safety Training Requirements for Vessel Personnel in the Offshore Renewable Energy Sector*
- U.S. Department of Energy 2023, *Offshore Wind Workforce Safety Standards and Training Resource*, Office of Energy Efficiency and Renewable Energy Wind Energy Technologies Office: WINDExchange

8 Emergency Preparedness and Response

Comprehensive emergency preparedness and response is critical to the success of an offshore wind project. In the event of an emergency occurring at any stage of the life cycle of an offshore wind facility, the offshore wind farm should have an emergency response plan (ERP) in place, which includes actions to be taken to ensure appropriate initial response, source control, care of injured persons, and evacuation of any casualties.

The ERP should describe the actions taken to prepare for and respond to an incident, both natural and man-made, that threatens life, property, or the environment. Consideration should be given to the specific site location and characteristics, distance to onshore medical facilities, limitations and availability of emergency services, arrangements and communication and responsibility protocols with primary and emergency support services, and the assessed risks of work activities performed.

ERPs should mitigate the consequences of incidents and enable resumption of normal business operations, while ensuring business continuity is documented, accessible, and clearly communicated to stakeholders. Contractor- or facility-specific ERPs should be compatible with the overall site ERP.

8.1 Key Principles

General key principles that should apply in emergency response, including defined scope, clarity in command, adaptable and escalatory response, and mutual support are provided by the *G+ Integrated Emergency Response* good practice guidelines.

Great care shall be taken in developing response capabilities, procedures, processes, training, drills, and awareness; relevant emergencies shall be rapidly reported to the appropriate authorities to ensure that the right response, where necessary, is provided as quickly as possible. It is better to request shore-based resources and not need them than to call for them too late. Medical provision should be proportional to the assessed medical risk.

8.2 Integrated Emergency Response

The level of response required for a specific scenario will be directly related to the scale of incident and jurisdictional authorities. The offshore wind farm developer/owner/operator (D/O/O) should be competent to manage reasonably foreseeable eventualities within its activities, utilizing its own resources and procedures in accordance with its ERP and without support from outside parties. Whilst not mandatory, offshore wind farm D/O/O are encouraged to consider establishing mutual support arrangements, where applicable.

It is recommended that offshore wind farm developers adopt an ERP structure that is compatible with the National Incident Management System (NIMS) Incident Command System (ICS).

Use and understanding of the ICS framework by all organizations in the offshore renewable sector will ensure that offshore wind farm D/O/O apply the principles detailed in the *G+ Integrated Emergency Response* good practice guidelines in a manner that will integrate with other party's incident management framework, including regulatory authorities and emergency support services.

The following resources provide additional details:

- *29 CFR 1910.38, Emergency Action Plans*
- Federal Emergency Management Agency National Incident Management System
- *G+ Integrated Offshore Emergency Response (IOER-R): Good Practice Guidelines for Offshore Renewable Energy Developments*

9 Incident Reporting

In general, SMSs should include an incident reporting requirement. This should outline document retention requirements, specify who shall be notified, and mandate training on how to record and report incidents. Additionally, the system should require the reporting of incidents, as required, including near misses, to facilitate reviews and lessons learned. This helps prevent similar incidents in the future.

The procedures should also detail investigation requirements, including who should carry out the developer's organization's own investigation, the process for the investigation, root cause analysis, how the findings are reviewed, how personnel and others are notified of the findings, and how corrective actions are identified, agreed upon, and implemented.

The SMS should also include instructions for external reporting requirements from all applicable state, local, Tribal, and federal agencies, including the following, if applicable:

- BOEM
- BSEE
- Environmental Protection Agency
- OSHA
- U.S. Army Corps of Engineers
- USCG

10 Recommendations and Procedures to Mitigate Hazards

The hazards and mitigations discussed in this section are focused on the health and safety of personnel, not engineering and design issues related to equipment, components, and facilities. Technical and design issues for offshore wind facilities, including those that have an impact on worker safety, are covered in

ACP's Offshore Compliance Recommended Practice series. Facility design for occupational health and safety is specifically covered in ACP OCRP-1, Sections 5.6.5 and 5.7.5.

For each hazard, a description of the issue, the risk, or both is provided, along with a summary of potential mitigations. Finally, where available, a list of relevant resources the reader can consult for more details in the preparation of policies and procedures and to inform an SMS is provided. These resources include national or international laws, regulations, and industry guidance, standards, and best practices.

10.1 Worker Environment

10.1.1 Access and Egress

10.1.1.1 Walking-Working Surfaces

Unstable walking and working surfaces can contribute to slips, trips, and falls. The design of permanent walking and working surfaces in the offshore workplace is covered in ACP OCRP-1.

To mitigate the potential for walking-working surfaces to pose a hazard, the following elements specific to walking-working surfaces should be addressed prior to beginning work:

- Walking-working surfaces should be kept in a clean, orderly, and in a sanitary condition free of standing water, debris, and other hazards, such as sharp or protruding objects, corrosion, leaks, spills, snow, and ice.
- Regularly remove contamination, such as biofouling (e.g., algae in pooled water) and guano (i.e., bird droppings) from exposed offshore structures, such as access ladders.
- Clearly label and communicate the maximum loads intended for a particular surface, in drawings, documents, and on the structure, as appropriate.
- Ensure that a safe means of access and egress to and from work area is available before starting work.
- Verify that appropriate warning notices when approaching potentially hazardous surfaces are provided, visible, and readable.
- Highlight trip hazards on walking and working surface.
- Regularly inspect and maintain coverings, guard rails or similar means of support and protection for personnel.
- Regularly inspect and maintain anti-skid measures on ladders or other exposed surfaces on vessels and wind farm facilities.
- Regularly inspect and mitigate safety defects, including surface coatings. Repairs should be completed before an employee uses the surface again.

The following resource provides additional details:

- 29 *CFR* 1910, Subpart D (Section 21-30), *Walking-Working Surfaces*, 1910.22 and 29

10.1.1.2 Service Lifts

Where service lifts are provided, the risks that need to be mitigated may include the following:

- Falls from landings used to access the lift
- Potential for malfunction or failure of the lift
- Crushing or entrapment between the lift and other structures

Using service lifts as a working surface should be evaluated for suitability via a risk assessment and be consistent with manufacturer's instructions. If suitable, it should be considered as a part of a permit-to-work authorization prior to being done.

If a project involves using a lift, the SMS shall:

- Take account of reasonably foreseeable malfunctions, such as the lift stopping at a level other than a designated landing, and ensure that a safe means of escaping from the lift is available
- Require that personnel using the lift are trained and competent in the equipment
- Require safe use of the lift in line with manufacturer's recommendations
- Require regular inspection and maintenance to ensure that the lift operation is safe and reliable throughout the lifetime of the wind turbine generator
- Deploy retrofits to address recalls or other safety alerts

The following resource provides additional details:

- *G+ Safe by Design Workshop Report: WTG Service Lifts*

10.1.2 Adverse Weather

Adverse weather (severe storms, high wind, precipitation, fog, and temperature) can impact a variety of offshore wind activities, including lifting, vessel, aircraft, and dive operations, as well as marine transfers and working at height. Adverse weather can reduce visibility, make rescue and evacuations more difficult, reduce or eliminate the ability for safe transport, damage equipment, and increase risk from a variety of hazards such as slips, trips, and falls, falling objects, and heat and cold stress, among others.

Two scenarios should be considered: (i) deteriorating weather during operations, while workers and vessels are in the field, and (ii) severe storm events that caused evacuation during scenario (i) or which developed while there were no vessels or workers in the field and are now preventing operations. These are addressed separately below.

The following resources provide additional guidance:

- DNV-ST-N001, *Marine Operations and Marine Warranty*, Edition 2023-12
- G+ Good Practice Guideline, *Severe Weather Preparedness* (in production, with publication planned for November 2025), London: Energy Institute

10.1.2.1 Adverse Weather During Activities

To mitigate the potential risk of adverse weather during activities, it should be considered as an element of task-based risk assessments for activities that may be impacted by the potential weather. Before any offshore task begins, weather forecasts should be consulted and a sufficient weather window established for the work, including a safety time margin for the work to be completed and personnel to be sheltered and equipment stowed as appropriate prior to the onset of adverse weather.

Consideration should also be given to the following:

- How to handle unexpected weather deterioration during construction, operations, and maintenance activities, including guidance on providing time for personnel to relocate to a safe location
- Having a policy for what to do in the event of rapid weather deterioration that temporarily strands some personnel offshore
- Having supplies (food, water, clothing, spare batteries, etc.) stored at the offshore location or brought with the crew when adverse weather stranding is a possibility

10.1.2.2 Adverse Weather Preventing Activities

Develop plans to prepare for severe storm events, including hurricanes, tornados, and winter storms in areas where severe storms are likely. Severe storm event preparation plans should include a weather monitoring plan and a timeline of activities to shut down operations, if necessary. Preparation plans should address, at a minimum:

- Activities that could be impacted by the severe storm event
- Roles and responsibilities of key personnel
- Use of a meteorological service to monitor weather and sea conditions and provide real time alerts
- Timeline of events, with T-minus times to indicate when activities are to occur in relation to the anticipated arrival of severe weather; the timeline should include the following:
  - Securing loose material and preparations to make the facility safe and secure
  - Timeline and method to evacuate personnel
  - Movement of vessels out of harm's way
  - Relevant USCG port conditions that may impact vessel movement and reporting requirements
  - Shutdown of operations
- Method of communication and accountability of employees during an evacuation

Consider specifying the environmental condition thresholds (and their associated technical justification) that define a severe storm event. Previous indication in regulatory documentation indicates that post-storm monitoring would be required when environmental conditions exceed one-half the design return period. For example, a facility designed for a storm with a 50-year return period would be considered to have experienced a severe storm event when environmental conditions reach or exceed a 25-year return period.

10.1.3 Health and Welfare

The importance of ensuring safe and healthy working conditions for workers is critical for contributing to a more productive, engaged, safe and satisfied workforce. Developers should ensure that their procedures and standards address external stressors caused by fatigue, meteorological conditions such as cold heat and sun, and internal stressors caused by facility operations such as noise, vibration, and electromagnetic fields (EMFs).

10.1.3.1 Fatigue

Effective management of fatigue-related risk is essential to ensure a safe work system and a safe and productive workplace by eliminating conditions and work practices that could lead to incidents. Avoiding fatigue contributes to a healthier lifestyle and greater personal health.

The objective is that all personnel in roles subject to fatigue risk recognize the potential threat of working while fatigued and manage and minimize the associated causes and risks to prevent the occurrence of fatigue and combat the adverse effects. Fatigue risk management should include the identification of at-risk populations to support the development of management plans and to promote awareness of how fatigue can negatively impact daily activities. Focus should be placed on management of fatigue risk in populations most likely to encounter difficulty getting an appropriate amount of quality sleep, while limiting periods of wakefulness to 17 hours or less is one way to reduce conditions for human errors and incidents.

The scope of fatigue management should address employees and contractors engaged in operations, maintenance, projects, and emergency response related work, both onshore and offshore. Examples include the following:

- Personnel whose agreed work schedule, including Call-Out on-call periods, includes work between 00:00 and 06:00 hours for three consecutive calendar days or more; or
- Results in 3 consecutive calendar days or more with periods of wakefulness of 17 hours or more in a 24-hour period. This wakefulness is determined as a sum of the shift hours of service, the work location, specific standard commute time, and standard allowances for worker care of 1 hour before and after a shift; or
- Personnel fulfilling safety critical responsibilities. It is recommended that personnel having safety critical responsibilities be clearly identified using an appropriate risk assessment methodology.

Management of fatigue begins with management engagement on the subject and acknowledgement that the risk exists within the business or facility. Good management practices include the following:

- Conduct fatigue awareness training to understand fatigue in ourselves and others
- Engage staff regarding their level of fatigue and encouraging self-reporting of fatigue challenges
- Observe personnel in the workplace for symptoms of Fatigue and engage appropriately
- Perform periodic review and evaluation of fatigue risk management practices to create improvement opportunities
- Hold personnel accountable for the proactive management of fatigue risk and associated control measures
- Encouraging personnel to stop work and report if they are unfit to continue their work due to fatigue
- Considering potential fatigue risks and actively managing these when considering targets for overtime (either hours or additional shifts)

10.1.3.2 External Stressors: Cold, Heat, and Sun

The risks of heat-related injury and illness can vary significantly based on individual, job, and environmental factors. Heat-related injuries and illness include rashes, muscle cramps, headaches, nausea, confusion, weakness, fainting, seizure, high body temperature, and death. Employers should consider the following as elements of heat injury and illness prevention programs:

- Making workers aware of the factors that may put them at greater risk of heat-related illness and injury:
  - Environmental factors, such as the following:
    - Air temperature
    - Humidity
    - Radiant heat sources
    - Contact with hot objects
    - Sun exposure
    - Limited air movement
  - Job-specific factors, such as the following:
    - Physical exertion level
    - Use of bulky or less breathable PPE or clothing
  - Individual factors, such as the following:
    - Obesity
    - Diabetes
    - High blood pressure
    - Heart disease
    - Lower levels of physical fitness
    - Use of certain medications
    - Alcohol use
    - Illegal drug use
- Making workers aware of the symptoms of heat-related illnesses and injuries (i.e., cramps, stroke, exhaustion, etc.)
- Providing instructions on what to do in the event of symptoms, up to and including calling 911

- Providing recommendations to employees on acclimatization (i.e., the process of building tolerance to higher temperatures)
- Providing a heat stress index table that presents a visual depiction of risk based on temperature and humidity, describing risks based on temperature ranges and recommending measures to reduce the risk based on escalating temperature ranges
- Preparing a simple list of dos and don’ts for workers
- Recommending work/rest and hydration schedules based on heat index ranges

Cold weather-related injuries can also vary by location and individual. In general, in cold weather, the body works harder to maintain its temperature. It lowers the skin temperature and can lower the internal body temperature as well. Cold weather injuries can include the following:

- Symptoms of hypothermia may include shivering, confusion, slurred speech, a decrease in heart or breathing rate, loss of consciousness, and potentially death.
- Frostbite, which is the freezing of body tissue and can occur at temperatures above the freezing level due to wind chill and can result in amputation. Symptoms include numbness, red patches on the skin turning grey/white, blistering, and feels hard/firm to the touch.
- Trench foot (also known as immersion foot), a non-freezing injury caused by lengthy exposure to a wet and cold environment, which can occur in temperatures as high as 60.0 °F (15.6 °C) if feet are constantly wet. Symptoms include redness, swelling, numbness, and blisters.

Exposure to cold weather can also increase the risk of injuries because of dangerous driving conditions, chances of becoming stranded, shedding ice, slippery surfaces, ergonomics and material handling, and dehydration. Employers should consider the following as elements of cold weather injury prevention programs:

- Making employees aware of the risks and symptoms of cold weather injuries, including activities with risks that may be exacerbated by cold weather conditions, such as working at height and contacting metal surfaces
- Providing information on the risks of different wind chills
- Developing procedures for when icing may be present
- Providing instructions on what to do in the event of cold weather injury symptoms, up to and including contacting emergency services:
  - Establishing recommendations for hydration and vessel/vehicle preparation
  - Training employees on appropriate PPE selection and use
- Verifying the temperature ratings for the common types of equipment and PPE that your teams are using in the field to ensure that they are within the appropriate operational requirements and specifications for a site
- Preparing a simple list of dos and don’ts for workers

The following resource provides additional guidance on extremes of heat and cold:

- G+ Good Practice Guideline, *Severe Weather Preparedness* (in production, with publication planned for November 2025), London: Energy Institute

10.1.3.3 Internal Stressors: Noise, Vibration, and Electromagnetic Field

10.1.3.3.1 Noise

Prolonged exposure to high levels of noise may result in gradual hearing loss that is permanent and irreversible.

Hearing damage can also result from sudden, extremely loud noises. Such damage may be temporary, but it can also cause longer lasting or permanent damage.

Noise can also impair communication, which can contribute to accidents and injuries.

Individuals may be exposed to noise from a range of activities in offshore wind, including being directly involved with or in the vicinity of:

- Power tools
- Temporary power sources such as generators or compressors
- Pile driving
- Vessels
- Helicopters
- Audible alarm systems

Noise risks may be reduced through:

- Development of risk assessments that consider the following:
  - The level, type, and duration of noise exposure, including referring to information provided by manufacturers of sources of noise
  - The potential effects on employees
  - The availability of alternative equipment or processes to reduce noise
  - Appropriate hearing protection depending on location, activity, and noise level exposure
- Considering noise levels when making procurement decisions for tools, etc. and eliminating the source of noise by adopting different tools or processes when feasible
- Modifying equipment to reduce decibel levels
- Maintaining or replacing equipment to ensure it is in proper working condition
- Limiting personnel exposure by setting noise exposure limits and reducing the time spent in noisy areas or operations
- Utilization of appropriate hearing PPE
- Education and training of employees who are exposed to noise, including on the risks and proper use of PPE
- Maintaining regular health monitoring, including periodic hearing tests as part of a hearing conservation plan based on potential exposures in accordance with applicable regulations

The following resources provide additional details:

- 29 *CFR* 1910.95, *Occupational Noise Exposure* (OSHA General Industry)
- 29 *CFR* 1926.52, *Occupational Noise Exposure* (OSHA Construction)
- National Institute for Occupational Safety and Health (NIOSH) Publication 98-126, *Occupational Noise Exposure*

10.1.3.3.2 Vibration

People may be exposed to two different forms of vibration in the course of offshore work, both of which can pose risks to personnel:

- Hand-arm vibration (HAV), most commonly arising from the use of certain tools, or
- Whole body vibration (WBV), which may arise from shocks and jolts during transit on vessels in rough sea conditions or when traveling by helicopter

In general, vibration-related injuries can impair a worker's ability to carry out work requiring fine motor skills, increase sensitization to wet and cold conditions, and reduce grip strength, which itself can pose additional risks such as during ladder climbs or in retaining a firm grip on tools.

HAV can cause damage to blood vessels, nerves, and joints, resulting in permanent pain and disablement, including through carpal tunnel syndrome. The risk depends on the level of exposure to vibration, both in terms of magnitude and duration, so personnel repeatedly carrying out tasks with vibrating tools are at highest risk. Other risk factors include temperature, working position and weight of the tools, preexisting health conditions, and whether exposure is continuous or intermittent. Depending on the level of vibration, exposure limits may be reached in as short as a few minutes to a typical working day.

WBV can lead to back pain, either due to unusually high levels of exposure or more commonly in combination with other risk factors such as muscle strains caused by heavy physical activity. Given the distance offshore wind turbines will be from shore, the potentially rougher waters further out, and the frequency of vessel trips both during construction and maintenance phases, companies should assess the risk for WBV aboard vessels and proactively plan mitigation measures.

Measures to mitigate the risk from vibration related injuries include the following:

- For HAV:
  - Assess tool choices, considering vibration factor, mounting arrangements, position of use, etc.
  - Ensure that tools are properly maintained and appropriate for the task
  - Training of employees on the proper use of tools
  - Limit exposure duration by adjusting work methods to minimize the use of vibration-producing tools or by rotating duties among team members
  - PPE that protects against cold temperatures and, thus, maintains blood circulation in extremities
- For WBV:
  - Consideration of vibration in vessel selection to minimize impact at expected speed in operating conditions
  - Engineered solutions such as suspension seating
  - Proper vessel operation such as reduced speed when conditions warrant
- For vibration, in general:
  - Consideration of alternative work methods that reduce or eliminate exposure
  - Limit the duration and magnitude of exposure (i.e., set exposure limits)
  - Consideration of temperature as a contributing factor and adjusting work in response
  - Recognizing employees whose health factors make them susceptible to this risk
  - Providing for appropriate work periods and adequate rest periods

The following resources provide additional details:

- ANSI/Acoustical Society of America (ASA) S2.70-2006 *Guide for the Measurement and Evaluation of Human Exposure to Vibration Transmitted to the Hand*
- 29 *CFR* 1926, Subpart I, *Tools – Hand and Power* (OSHA Construction)
- NIOSH Publication 83-110, *Vibration Syndrome*

10.1.3.3.3 Electromagnetic Field

Every piece of electrical equipment radiates electric, magnetic, or electromagnetic fields. Those fields can have an influence on the human body, potentially as follows:

- Direct effects: Vertigo, effects on nerves and muscles, heating of the whole body.

- Indirect effects: Interference with medical electronic equipment, interference with active implanted medical devices, interference with passive implants, effects on shrapnel, body piercings, tattoos, projectile risk from loose ferromagnetic objects, unintentional initiation of detonators, fires or explosion from ignition or flammable or explosive material, electric shocks or burns from contact currents when a person touches a conductive object in an EMF and one of them is grounded whilst the other is not.

There is no established scientific evidence indicating any long-term effects of EMF, although this remains under investigation.

Reducing potential EMF impacts is under direct control of the equipment providers. It is recommended that these providers carry out a risk assessment of the EMFs to determine those which could pose adverse effects on workers.

The offshore wind farm developer should, in conjunction with the equipment manufacturer, establish appropriate exposure limit values (ELVs), which are then incorporated into the equipment design phase of projects.

EMF risks can be further mitigated by the following:

- Providing those workers who are likely to be exposed to risks from EMF at work the necessary information and training to minimize exposure
- Ensuring that the relevant equipment is labelled with appropriate warning signs
- Conducting a regular campaign of EMF level measurements for relevant equipment to ensure that established ELVs and exposure controls remain relevant

The following resources provide additional details:

- DIRECTIVE 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery
- DIRECTIVE 2013/35/EU of the European Parliament and of the Council of 26 June 2013 on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields)

10.2 Confined Space

Facilities within an offshore wind farm may include confined spaces which pose specific hazards to occupational health and safety. Some locations are always classified as confined spaces and have permanent measures in place to restrict entry. Others require confined space management only under certain conditions. Personnel in confined spaces may face a variety of potential hazards, including the following:

- Loss of consciousness due to working in a hot environment and resulting increase in body temperature
- Loss of consciousness, or asphyxiation, due to oxygen depletion caused by the presence of hazardous substances, work activities, or inadequate air exchange
- Drowning due to ingress of water in subsurface structures
- Injury or death due to fire or explosion

It is important to recognize that due to the often-limited exchange of air in a confined space, a hazardous concentration of substances may occur from a relatively small release that would not endanger people in an open-air situation.

To mitigate the risks posed by confined spaces, an SMS should include the following:

- Identification of confined spaces
- Assessment of what is a permit-required confined space
- Assessment of whether work is required in a confined space

- Establishing in policies and procedures the required precautions for confined space work, including qualifications and training for staff authorized to work in confined spaces
- Policies, procedures, and work plans that consider the following:
  - Engineering controls, permitting needs, testing and training verification, LOTO safeguards, emergency response and rescue methods, and communications
  - Means of purging hazardous gases or vapors from the space
  - Ventilation, whether natural or forced
  - Arrangements for removal of residues
  - Isolation from hazards, including materials, electrical and mechanical equipment, and sources of stored energy
  - Methods of fire prevention, and response in the event of fire
  - Selection and use of work equipment, PPE, and respiratory protective equipment
  - Arrangements for the use of gases, such as for welding, whether supplied from portable cylinders or hoses
  - Physical arrangements for, and control of, access and egress, for all situations including planned operations, escape, and rescue
  - Provision of suitable lighting, taking account of the intended task and working environment
  - Protection against static electricity
  - What PPE is required based on the risks present
  - Selection of suitable rescue equipment, training of users, and bringing the equipment to the required location
  - Notification of others, beyond the immediate work group, that a confined space entry is in progress, in case assistance is required for evacuation after initial rescue
  - Assessment of the need to limit working time
  - Use of a Permit to Work system, when appropriate
  - Establish requirements for training, supervision, and competence of personnel, which should be in proportion to the risk, for personnel who will enter the confined space, and those who will support them
  - Communication systems, between personnel within the confined space and supporting personnel outside, should be provided to summon help in an emergency
  - Arrangements should be made to test and monitor the confined space for factors that may contribute to the risk in the space (for example, atmospheric, mechanical, etc.); if there is any change of intent, or conditions, from those expected when the work was planned and the pre-work briefing was held, the changes should be reviewed before the job continues
- Risk assessments prior to work being done should consider the following:
  - Substances that may previously have been present in the space
  - Residues, including rust
  - Contamination, which may have entered the confined space from adjacent equipment or other sources
  - Oxygen deficiency or enrichment
  - Physical dimensions and layout of the space
  - Chemicals to be used or handled during the operation
  - Sources of ignition
  - Potential for ingress of substances, such as seawater, or gases

The following resources provide additional details:

- ANSI/ASSP Z117.1-2022 *Safety Requirements for Entering Confined Spaces*
- *29 CFR* 1910.146, *Permit Required Confined Spaces*
- *29 CFR* 1926, Subpart AA, *Confined Spaces in Construction*

10.3 Work at Height

Work at height is inherent in offshore wind. It could include work on the turbines themselves, but also on vessels, and offshore substations depending on their design and the operations involved.

Work at height can expose individuals to various hazards, including the following:

- Trips, slips, and falls resulting in severe injury or death
- More complicated evacuations
- Dropped objects impacting team members below
- Suspension for a period, including if a fall has been arrested, can result in suspension trauma, fainting, and a loss of consciousness

Such hazards can be mitigated through:

- Proper planning and training, including for safe work practices, adequate access and egress, foreseeable emergencies and rescues, and deployment and utilization of proper PPE and evacuation equipment and materials (see Section 8 for more information)
- Verifying that relevant personnel are competent to perform work at height
- Ensuring that risk mitigation measures are put in place before the work is performed
- Regular inspections and prompt repairs of anchor points, surface coatings, structural integrity, and equipment to ensure reliability and proper performance
  - The demanding nature of the offshore environment can lead to accelerated deterioration, which makes inspections increasingly important

Prior to having employees work at height, a company should develop a comprehensive managed fall protection program with input from personnel. Considerations in the risk analysis and mitigation measures included in the program may include, but are not limited to (more detailed recommendations are provided in the topic-specific subsections below):

- Overall working conditions, including stability of surfaces, potential for slips and trips, gaps where an individual could fall, and weather impacts, among others
- Access/egress
- Fall distance and consequence of falls
- Duration and frequency of the equipment in use
- The need for timely rescue or evacuation
- PPE appropriate for the task
- Potential for additional mitigation measures, including work platforms, guardrails, ladders, covers and barricades, floor openings, warning lines, restraint systems, anchorage points, positioning device systems, lifeline systems, safety net systems, and employee lifts
- Other employees in the work area
- Training needs
- Documentation requirements

The following resources provide guidance for the development and use of a comprehensive managed fall protection program:

- ANSI Z359.2, *Minimum Requirements for a Comprehensive Management Fall Protection Program*
- *G+ Working at Height in the Offshore Wind Industry*

10.3.1 Fall Protection

PPE and fall protection systems (guard rails, personal fall arrest systems, etc.) should be verified as in good working order. Recommended practices regarding the design of the offshore workplace to mitigate risks associated with fall from heights can be found in ACP OCRP-1.

The hierarchy of fall protection includes (i) elimination of hazards, (ii) passive fall protection (i.e., barriers, covers over holes, etc.), (iii) fall restraint systems (i.e., restricting the range of movement personnel so they cannot fall, and (iv) fall arrest systems and PPE to stop a fall within an acceptable safety range.

PPE and fall protection systems' characteristics and dimensions should be appropriate to the nature of the work to be performed and the foreseeable loadings. A hazard analysis should inform equipment selection.

A personal fall protection system should be used if a risk assessment has demonstrated that:

- The work can be performed safely while using that system.
- The use of other, safer work equipment is not reasonably practicable.
- The user and enough available persons have received adequate training specific to the operations to be undertaken, including rescue procedures and the equipment to be used.

A personal fall protection system should:

- Be suitable and of sufficient strength for the purposes for which it is being used (follow equipment limits on weight, etc.).
- Be correctly fitted.
- Be designed to minimize injury to the user and, where necessary, be adjusted to prevent the user from falling, or slipping from it.
- Be so designed, installed, and used as to prevent unplanned or uncontrolled movement of the user.
- If designed for use with an anchor, it should be securely attached to at least one anchor, and the means of attachment should be suitable and of sufficient strength and stability for the purpose of supporting the load.

The following resources provide guidance for fall protection measures (equipment and anchor points):

- 29 CFR 1910.28, *Duty to have Fall Protection and Falling Object Protection* (OSHA General Industry)
- 29 CFR 1910.29, *Fall Protection Systems and Falling Object Protection - Criteria and Practices* (OSHA General Industry)
- 29 CFR 1910.140, *Personal Fall Protection Systems* (OSHA General Industry)
- 29 CFR 1926, Subpart M, *Fall Protection* (OSHA Construction)
- 33 CFR 142.87, *Guarding of Deck Openings* (USCG)
- EN 362, *Personal Protective Equipment Against Falls from a Height – Connectors*

10.3.2 Ladders and Scaffolds

Ladders may be present for various aspects of offshore wind work, including transfers from workboats to platforms, in turbine towers, and on offshore substations, among other locations. Some ladders are fixed; others may be portable. The design of permanent ladder installations and recommended practices regarding this can be found in ACP OCRP-1.

Ladders present a fall hazard and dropped objects hazard (see Section 10.5.1 on dropped objects hazards). Illustrative safe work practices to mitigate these risks include the following:

- Ladders should be used only for the purposes for which they were designed.
- Verify that any surface upon which a ladder rests is stable, firm, of sufficient strength and of suitable composition to support the ladder safely, and so that its rungs or steps remain horizontal with any loading placed on it.
- Verify whether a ladder is positioned to ensure its stability during use.
- Employees should face the ladder when climbing up or down.
- Verify that a suspended ladder is attached in a secure manner so it cannot be displaced and swinging is prevented.
- Loads carried by an employee using a ladder should not cause the employee to lose their balance while climbing.
- A portable ladder should:
  - Be prevented from slipping during use.
  - Be inspected prior to use.
  - Comply with manufacturer instructions and limits.
  - Securing the stiles at or near its upper or lower ends.
  - Installing an effective anti-slip or other effective stability device.
- If a ladder is damaged, a process should be established to remove it from service until it is evaluated for the capability to use safely.
- Ladders should be protected against corrosion.
- Ladder surfaces should be free from puncture and laceration hazards.
- Ladders should be inspected frequently, including for icing in external environments.
- Verify that a ladder used for access is long enough to protrude sufficiently above the place of landing to which it provides access.
- No interlocking or extension ladder should be used unless its sections are prevented from moving relative to each other while in use.
- Every ladder should be used in such a way that a secure handhold and secure support are always available to the user and the user can maintain a safe handhold when carrying a load.
- If a ladder is used over water, a life jacket should be worn.
- If a ladder is used on an elevated surface, fall protection should be considered.

The following resources provide additional details:

- 29 *CFR* 1910.23, *Ladders* (OSHA General Industry)
- 29 *CFR* 1910.27, *Scaffolds and Rope Descent Systems* (OSHA General Industry)
- 29 *CFR* 1926, Subpart X, *Stairways and Ladders* (OSHA Construction)

10.3.3 Aerial Lifts

Mobile elevating work platforms (MEWPs), also known as aerial lifts, pose several safety risks if not used properly. Most fatal and serious injuries involving MEWPs arise from the following:

- Entrapment: Operator trapped between part of the basket and a fixed structure (e.g., when maneuvering in confined overhead areas of steelwork). Operators may become trapped against the platform controls, and if this happens, they may not be able to stop the machine running.
- Overturning: The machine may overturn, throwing the operator from the basket.
- Falling: An operator may fall from the basket during work activities.
- Collision: The vehicle may collide with pedestrians, overhead cables, or nearby vehicles.

There are a number of precautions that can reduce the risk from MEWP hazards. These are as follows:

- Identify relevant hazards within a risk assessment.
- Select the right MEWP for the job and site.
- Ensure that the MEWP operator has attended a recognized operator training course and received a certificate, card or "license," listing the categories of MEWP the bearer is trained to operate:
    - In addition to formal training for the type of MEWP, operators should have familiarization training on the controls and operation of the specific make and model of MEWP they are using.
- Have a plan for rescuing someone from a MEWP and practice it – ensure that someone on the ground knows what to do in an emergency and how to operate the machine's ground controls.
- A program of daily visual checks, regular inspections, and servicing schedules should be established in accordance with the manufacturer's instructions and the risks associated with each MEWP:
    - Operators should be encouraged to report defects or problems. Reported problems should be put right quickly and the MEWP taken out of service if the item is critical.
- Confined overhead working:
    - Brief operators on the dangers, and the safe system of work to be followed. If there are overhead structures against which an operator could be trapped and then pushed onto the MEWP controls, consider selecting a MEWP that has been designed to prevent such accidental contact.
    - MEWPs with shrouded or otherwise protected controls are available.
    - Keeping the platform tidy will reduce the risk of the operator tripping or losing balance while in the basket.
- Ground conditions:
    - The platform should be used on firm and level ground. Any temporary covers should be strong enough to withstand the applied pressure. Localized ground features (e.g., trenches, manholes, and uncompacted backfill) can all lead to overturning.
- Outriggers:
    - Outriggers must be extended and chocked before raising the platform. Spreader plates may be necessary – check the equipment manual.
- Guardrails:
    - Make sure that the work platform is fitted with effective guardrails and toe boards.
- Arresting falls:
    - If there is still a risk of people falling from the platform, a harness with a short work restraint lanyard must be secured to a suitable manufacturer-provided anchorage point within the basket to stop the wearer from getting into a position where they could fall from the carrier.
- Falling objects:
    - Barrier off the area around the platform so that falling tools or objects do not strike people below.

- Weather:
  - High winds can tilt platforms and make them unstable. Set a maximum safe wind speed for operation. Storms and snowfalls can also damage platforms. Inspect the platform before use after severe weather.
- Handling materials:
  - If used to install materials, check the weight and dimensions of materials and consider any manual handling and load distribution issues. You may need additional lifting equipment to transport materials to the work position.
- Nearby hazards:
  - Do not operate a MEWP close to overhead cables or other dangerous machinery, or allow any part of the arm to protrude into a traffic route.

10.3.4 Crane-Hoisted Baskets

In general, the use of crane-hoisted man-basket should be selected for work at height only when the erection, use, and dismantling of conventional means reaching the work place, or providing a safe working platform, such as a ladder, scaffold, MEWP stairway, etc., would be more hazardous or impracticable because of structural design or worksite conditions.

Use of crane-hoisted man-baskets should be conducted only following completion of a number of tasks:

- Risk assessment of work
- Activity-specific procedure
- Appropriate LOTO authorization
- Establishment of clear means of communication

The procedures for these activities should include the following clear requirements:

- Load lines should be capable of supporting at least 10 times the maximum intended load (man-basket, plus workers inside, plus tools, etc.).
- Load and boom hoist drum brakes, as well as locking devices should be engaged when the occupied man-basket is in a stationary elevated position.
- The total weight of the loaded hoisted man-basket including related rigging should not exceed 50% of the rated capacity for the applicable radius and configuration of the crane.
- The total anticipated working load, the maximum operational radius of the crane, and the crane’s capacity at that radius should be clearly marked on the man-basket permit.
- The use of cranes for which lowering is controlled only by a brake, without a secondary device that slows the lowering speed, should be prohibited.
- The load line hoist drum shall have a system or device on the power train, other than the load hoist brake, which regulates the lowering rate of speed of the hoist mechanism. Free fall is prohibited.
- Only cranes with positive drive-up and -down winch capabilities should be used.
- Cranes with variable angle booms should be equipped with a boom angle indicator, easily visible to the operator.
- Cranes with telescoping booms should be equipped with a device to indicate in any moment, the boom’s extended length.
- A device shall be used to prevent the contact between the load block and the boom tip (anti-two-blocking device).

10.3.5 Rope Access

In general, rope access activities should be selected for work at height only when the erection, use, and dismantling of conventional means reaching the work place or providing a safe working platform, such as a ladder, scaffold, MEWP stairway, etc., would be more hazardous or impracticable because of structural design or worksite conditions.

Rope access work is ordinarily performed by specialist companies with certified personnel. Rope access companies shall be affiliated to the institutes such as the IRATA2 or equivalent and employ suitably qualified personnel.

Actions to mitigate the risks posed by rope access activities include the following:

- Comprehensive planning and risk assessment of the work scope.
- Management of the work scope by a suitably qualified and experienced individual.
- Ensure that technicians have suitable training, competence, and physical capability to undertake the work scope.
- Ensure that the work scope is carried out under suitable onsite supervision.
- Back-up devices must always be used and be capable of safely arresting a fall, without catastrophic damage to the device or the safety rope; this is achieved through a combination of the design and operation of the back-up device – keeping it as high as possible on the safety rope, to minimize the fall factor (ratio of fall length to rope length).
- Descender devices should fail to safe (i.e., they lock onto the rope if the user either lets go or squeezes too hard).
- Equipment should be subject to pre-use inspection and periodic thorough examination.
- Technicians should be competent to determine when equipment should be withdrawn from use.
- Equipment should be procured with full traceability to the manufacturer and properly stored and maintained.
- Other PPE should be used, as appropriate to the location and task.
- Technicians should connect to the rope access systems in a location where there is no risk of a fall from height or use other means of protection.
- Technicians should always be connected, through their harness, to both the working and safety ropes, even if using a work seat.
- The ropes should be set up to avoid inadvertent descent off the bottom of the rope, such as by tying a stopper knot in each rope.
- The minimum size of a rope access team is two technicians:
  - One of whom shall have supervision competencies (IRATA 3, CQP 2 or equivalent).
  - Other rope technicians may have lower qualifications (IRATA 1&2, CQP 1, CATC4 or equivalent).
  - With a maximum quota of 33% having IRATA level 1 when the team is IRATA certified.
- An effective communication system must be in place; if necessary, equipment such as radios may be used (and should, of course, be prevented from being dropped).
- Tools and other accessories used by rope technicians shall be secured to their harness or seat or by some other appropriate means.
- Suitable exclusion zones should be established.
- In some instances, it may be necessary to have a look out to guard against ropes being damaged.
- A rescue plan and resources should be in place prior to work commencing.

10.4 Manual Handling and Mechanical Lifting

10.4.1 Manual Handling

With respect to manual handling performed by individuals, risks of musculoskeletal injuries and disorders can occur (both acute and chronic) when handling heavy items (such as tooling, equipment, tool bags, etc.), through repetitive tasks, working in size restricted areas, working in situations requiring reaching above shoulder height, and through stooping, twisting, traveling, and climbing with heavy or awkward loads. For example, employees may be required to move or drag heavy items in bags from vessels to service platforms, and potentially to different levels. The bags often vary in size and weight.

These risks can be mitigated through:

- On-site self-assessment by personnel of capability and readiness prior to performing the task
- Assessment of relevance of mechanical aids for a given lift and making aids available, as appropriate
- Providing training on proper techniques for manual handling, including stretching exercises prior to handling loads, recommended body position for lifts, and circumstances in which manual lifts should be done by two or more individuals
- Whenever possible, marking loads with their weight (or use color coding to designate certain weight ranges) and providing suitable hand holds
- When utilizing bags, reduction of weight in each bag, when feasible

The following resources provide additional information:

- *G+ Manual Handling Case Studies*
- NIOSH, *Applications Manual for the Revised NIOSH Lifting Equation* (September 2021)

10.4.2 Mechanical Lifting Operations

Lifting operations are required over the entire life cycle of an offshore wind farm, with heavy lifting operations required during construction, major maintenance operations, and decommissioning.

The construction phase for fixed Offshore Wind farm facilities includes the repetitive lifting of large and heavy loads at sea, including foundations, rotors, and potentially entire offshore substations. This may include lifts from vessel to vessel and from vessel to installation point.

Maintenance activities involve a wide range of lifting operations, which include light maintenance such as lifting components or tools from vessels to platforms and to different levels of platforms to complex lifts of major components. In many cases, further lifting within the structure is necessary to bring the load to the precise location where it is needed, which may also involve moving the load in very restricted spaces.

Lifting operations involve both the use of cranes mounted on structures, and on vessels, which range from large floating, leg-stabilized, and jack-up crane vessels to versatile workboats. Vessels may either have been purpose-designed for lifting or have had cranes retrofitted. In either case, all personnel on-site should have a clear understanding of the combined capability of the vessel and its crane.

The main hazard in any lifting operation is if an object is dropped during the lift. This poses a risk to individuals beneath the suspended load and can also impact all personnel on board if damage is done to a vessel or platform that contributes to destabilization or the environment if debris falls into the ocean.

Ways to mitigate the risks from lifting operations include the following:

- Perform a risk assessment and prepare detailed plans prior to lifts, including the need for additional risk mitigation for higher risk lifts, define actions and necessary equipment for emergency situations, and provide the ability for personnel to halt a lift that has already started.

  - The preparation may vary depending on the complexity of the lift, with the most complex potentially including detailed modeling and hazard studies, whereas more basic lifts may focus on checks on load stability and equipment quality and feasibility.
  - In the plan, consideration should be given to (i) the load and its properties, (ii) the mechanism and equipment to carry out the lifting operation (including crane selection and vessel selection being appropriate for the task), and (iii) the environmental conditions that influence and may constrain the operation based on established operating limits of the equipment (i.e., wind, weather, waves, etc.).

- Brief appropriate personnel as identified in the risk assessment, such that they have a full understanding of the plan before operations begin, with repeat briefings as needed.
- Prefer to lift over water than over vessels.
- Utilize bridle for multi-bag lifts.
- Assess rollout risk (i.e., hinged latches vs. spring-loaded latches for lifting hooks)
- Ensure that lifting equipment, supporting structures, and the load have adequate strength and stability to safely perform the lift.
- Ensure that the lifting method can safety be completed given the equipment and type of lift to be performed.
- Plan operations so the suspended load will not pass over locations where people will be present during the lifting operation.
- Ensure that equipment has appropriate markings and documentation so that periodic inspections can easily identify whether the equipment is suitable for use.
- Plan for contingencies in the event of interruptions in power and communications, failures of load-bearing components, and unexpected problems with the parts to be assembled, and other incidents.
- Establish requirements to verify competency of personnel involved in the lift.
- Periodically inspect equipment for performance, wear, and soundness.

The following resources provide additional details:

- American Society of Mechanical Engineers P30, *Planning of Load Handling Activities*
- ANSI/American Society of Safety Engineers A10.4, *Safety Requirements for Personnel Hoists and Employee Elevators on Construction and Demolition Sites*
- API Recommended Practice 2D, *Operation and Maintenance of Offshore Cranes*
- British Standards Institute 7121, *Code of Practice for the Safe Use of Cranes*
- IMCA LR 006, HSSE 019, *Guidelines for Lifting Operations*
- IMCA M171, *Crane Specification Document*
- 1910.179, *Overhead and Gantry Cranes* (OSHA General Industry)
- *Safe Use of Lifting Equipment: Lifting Operations and Lifting Equipment Regulations* (Health and Safety Executive, United Kingdom)

10.5 Line of Fire

In general, being in the line of fire means being in the path of a moving object or potential release of stored energy (i.e., snapback) that can impact your body. Line of fire hazards are not always obvious or constant and can be introduced as a task progresses. Individuals should continually monitor their surroundings and position themselves to avoid being in the line of fire. This includes ensuring that they are visible to equipment operators.

10.5.1 Falling/Dropped Objects

If people are beneath work being carried out at height, then dropped objects present a hazard. Dropped object risks can include something like a tool, which while perhaps small, can still cause severe injuries, including fatalities, depending on the weight of the tool and height at which it is dropped, or larger loads that are the subject of a lifting operation. Both risks should be mitigated via policies, procedures, and an SMS. This section focuses on tools and similar objects utilized by individuals as the risk from larger loads is covered in Section 10.4.2 “Mechanical Lifting Operations.”

Every item carried and used when working at height has the potential to be a dropped object. Commonly dropped objects include communications devices, tools, equipment, keys, parts, and bags.

An effective program should be put into practice that addresses the following:

- The worksite should have a plan for the prevention of falling/dropped objects. The plan can include scenarios such as ways to minimize exposure to falling/dropped objects by promoting ground assembly where practicable, preparation for high wind conditions, personal tool inventory, minimization of any work activities in and around established exclusion zones, and performing falling/dropped object surveys for the removal of potential falling/dropped objects prior to movement and transport of equipment or modules.
- An identified person is assigned as responsible for the site’s falling/dropped object prevention plan.
- Potential falling/dropped objects are identified (including personal items and fixed equipment), mitigating controls are established, and coaching/training is included and conducted as part of the pre-job job safety analysis/toolbox talks.
- Barricades and signs/tags are in place to restrict access to areas under and around elevated surfaces and platforms where work is being performed to prevent entry into a potential falling/dropped object area.
- If work is necessary that puts workers into the line of fire of potential falling/dropped object area, workers below are shielded from falling/dropped objects using catch nets, temporary roofing, floor fabric, or other means adequate to retain objects with the potential to fall.
- Personnel use mechanized means (e.g., hoist, pulley systems, and ropes) or closed top tool bags to securely move tools and materials to or from an elevated work area to eliminate hand carrying tools and equipment up and down stairs and ladders.
- All tools, loose materials and equipment that have potential to fall or drop to lower areas during work are secured using lanyards, material bags, closed top tool bags/boxes, etc.
- Personnel working in elevated work areas maintain the highest possible housekeeping standard at all times to reduce the risk of potential falling/dropped objects.
- Regular inspections and periodic “hazard hunts” are performed at the worksite to ensure that effective precautions are taken to maintain control of and prevent objects from falling from height (e.g., hand tools are tied off, no loose objects, no holes in grating, toe boards are in place, regular housekeeping, barriers are in place where necessary, head protection is worn where required, etc.).
- Tools and materials are not thrown to or dropped from elevated work surfaces (e.g., hoists, lifts, and scaffolds).
- Tools and other equipment for use at height should be appropriate for the task.
- If a work crew identifies their work could have line of fire hazard associated with falling/dropped object potential, they include this on the permit to work/job safety analysis and communicate it to the affected work parties.
- Fit-up tools are secured by appropriate means to avoid their fall in case of any failure.

The following resources provide additional details:

- ANSI/ISEA 121-2018, *American National Standard for Dropped Object Prevention Solutions*
- *G+/DROPS Reliable Securing Booklet for Offshore Wind*, June 2019
- IMCA Line of Fire video

10.5.2 Snapbacks

A snapback occurs when a line or cable (such as a mooring line) is under tension, and it breaks. In such a circumstance, the stored energy is released and the line snaps back toward and past the point where it is secured. The velocity of lines that recoil in this manner can be significant. Anyone within the snap back zone risks serious injury or death.

The risk of snapback can be mitigated through:

- Establishment of snap back exclusion zones, in which personnel should not be physically present
- Working with one line at a time
- Proper inspection of lines, chains, bridles, and links (e.g., shackles and swivel-hooks) to identify excessive wear or other potential weaknesses and prevent failures by replacing suspect components before use

10.5.3 Exclusion Zones

To be in the line of fire is known as “being in harm’s way.” A line of fire hazard occurs when a moving object has a trajectory that goes through an area occupied by a person or object. Establishing an exclusion zone (no-go zone) helps ensure that personnel are restricted from entering an established exclusion zone around potential line of fire trajectories and ensure that people stay safe in the event of a failure.

In situations where line of fire hazards are identified, a responsible person should be designated to ensure that an exclusion zone is established, marked, and defined with appropriate delineators and signages and that access to the zone is controlled.

Examples of where exclusion zone should be established include the following:

- Crane work: People should be kept clear of the load path of suspended loads by barrier isolation and attendant monitoring of the area below the crane swing path, boom length and load travel direction. The restriction should also cover around the rotating equipment of the crane, including the counterweights where applicable. The overhead impact (such as overhead lines and collision points) should be identified in the lift-plan, and lift-controls should be implemented.
- Manual lifting: A designated exclusion zone should be established when performing manual lifting to keep the workers and others out of the line of fire. Synthetic, load-rated ropes with integral connectors are preferred for manual lifting.
- Elevated worksite: Where there is significant work along the perimeter of an elevated work area or structure with a lot of foot traffic below, a hard-barricaded exclusion zone is useful to limit exposure to frequent but intermittent activities above.
- Hot work: An exclusion zone (when required) is established as the area to exclude everyone except the hot work team at the center where hot work takes place. All exposed flammable sources should be removed from the exclusion zone or have adequate protection measures in place, such as a fire blanket covering. If the hot work occurs in an enclosed area, then the entire enclosed space will form the exclusion zone.
- Electrical work: Exclusion zones are established around energized electrical work based on the distance from exposed energized conductors or energized parts, or from the potential origination point of an electrical arc flash. This exclusion zone (e.g., approach boundary) ensures that only workers who are competent and authorized are permitted to enter the hazardous work area.

- Equipment operators: Before initiating a movement, perform a walk-around or have a designated person perform a walk-around to ensure that the movement path is clear of personnel.

10.6 Safe Electrical Work Practices

During the servicing and maintenance of machines and equipment, the unexpected startup or release of stored energy can result in serious injury or death to workers. Such stored energy can result from electrical, mechanical, hydraulic, pneumatic, chemical, and thermal equipment and processes. Injuries resulting from the failure to control hazardous energy can include electrocution, burns, crushing, cutting, lacerating, amputating, or fracturing body parts, among others.

The primary method to control hazardous energy and prevent injuries is the establishment and utilization of LOTO equipment and procedures to ensure that equipment is in a zero-energy state prior to working on it.

Companies should establish a program consisting of hazardous energy control procedures, employee training, and periodic inspections to ensure that before any employee performs any servicing or maintenance on a machine or equipment where the unexpected energizing, start-up, or release of stored energy could occur and cause injury, the machine or equipment is isolated from the energy source and rendered inoperative.

Elements of a LOTO program should include the following:

- The scope, purpose, authorization, rules, and techniques to be utilized for the control of hazardous energy, and the means to enforce compliance
- Specific procedural steps for isolating, blocking, and securing machines or equipment to control hazardous energy
- Specific procedural steps for the placement, removal, and transfer of lockout devices or tagout devices and the responsibility for them
- Specific requirements for testing a machine or equipment to determine and verify the effectiveness of lockout devices, tagout devices, and other energy control measures
- Periodic review and audits of the program and implementation by personnel

Policies and procedures may include the following provisions:

- LOTO device application and removal should be performed only by the authorized employee:
  - A written procedure for emergency lock removal should also be prepared.
- Lockout devices and tagout devices should be the only devices used for controlling energy and standardized within the facility.
- LOTO devices should include provisions for the identification of the employee applying the device.
- Tagout devices should warn against hazardous conditions if the machine or equipment is energized and should include a legend such as Do Not Start, Do Not Open, Do Not Close, Do Not Energize, or Do Not Operate.
- Notification should be given to the affected employees by the authorized employee before the controls are applied and after they are removed from the machine or equipment.

In general, policies and procedures should provide that LOTO devices are as follows:

- Durable, meaning capable of withstanding the environment to which they are exposed for the maximum period that exposure is expected
- Standardized, meaning in at least one of the following criteria: color, shape, or size
- Substantial, meaning strong enough to prevent removal without the use of excessive force or unusual techniques, such as with the use of bolt cutters or other metal cutting tools
- Identifiable, meaning it should indicate the identity of the employee applying the device(s)

During the construction, commissioning, operations, maintenance, and decommissioning of offshore facilities, personnel may be exposed to a wide range of electrical systems, including the following:

- High-voltage systems for power collection and export, such as transformers and switchgear within the turbines themselves and offshore substations, along with inter-array cabling within the wind farm and export cabling to connect onshore
- Low-voltage systems in generators and other devices, including temporary installations
- Portable equipment used by technicians

Equipment failures or improper work execution can expose personnel to the following:

- Electric shock
- Arc flash/arc blast

These hazards can lead to involuntary muscular contraction (which can lead to injury, for example, by falling from height), respiratory failure, cardiac arrest, internal and external burns, fire and smoke (which can lead to injuries due to limited visibility), explosions, and death.

Opportunities to mitigate the risks posed by electrical hazards include the following:

- Requiring work be performed on de-energized equipment whenever feasible:
  - Utilization of LOTO equipment and procedures to ensure control of hazardous energy prior to working on it
- Defining qualification levels for type of electrical work authorized individuals can perform
- Initial training as a part of the qualification process and then periodic refresher training of personnel on electrical safety equipment and procedures
- Requiring appropriate PPE for the work to be conducted and verifying that it is in good condition
- Prior to work being performed, convening a briefing to communicate the potential hazards, the work procedures to be performed, energy source controls, PPE requirements, and any other special precautions to be implemented
- Verifying that signage on all electric generating equipment, junction boxes, switchgear panels, and doors to identify the health and safety risks that personnel may be exposed to should they open covers, doors, or panels is present, visible, and readable, including equipment labeling for arc/shock hazards
- Verifying that all covers, doors, and panels are locked, or otherwise prevented from being opened without a mechanical device/tool to restrict access and prevent exposure to live electrical components and systems
- Upon completion of construction, as-built drawings should be produced, and the accuracy of labeling of components confirmed
- New facilities should conduct an arc flash study and have it reviewed by personnel qualified to evaluate the results
- Certification and periodic testing and inspection of personal safety-related equipment to prove that it is in working order
- Verifying that any condition monitoring systems to provide notice of problems as early as possible are working as intended through periodic inspection
- The potential for electric shock and burns to occur should be considered as part of the first aid and emergency medical response risk assessment, and appropriate training (including on use of automated external defibrillator and “contact release”) and supplies are provided
- Portable appliance testing for all hand-held power tools or portable electrical equipment used on-site to ensure that the tool or equipment is safe to use

- Training on safe use of portable generators, including with respect to grounding and risk of back feeding
- Inspections should be carried out at a frequency that reflects the likelihood of damage occurring
- Users should carry out a pre-use check and arrange for repair of any damage noted
- Developing methods to discharge static electricity when it may pose a risk

The following resources provide additional details:

- 29 *CFR* 1910.147, *Control of Hazardous Energy* (OSHA General Industry)
- 29 *CFR* 1910, Subpart S, *Electrical* (OSHA General Industry), 1910.269, 1910.303, 1910.22
- 29 *CFR* 1926, Subpart K, *Electrical* (OSHA Construction), 1926.403
- NFPA 70, *National Electrical Code*
- NFPA 70E, *Standard for Electrical Safety in the Workplace*
- OSHA Control of Hazardous Energy website
- OSHA LOTO Fact Sheet
- EI *Wind Turbine Safety Rules* (WTSR) (for high-voltage work), expected September 2025
- EI *Wind Turbine Safety Rules* (WTSR) (for low-voltage work)
- NEMA SG 10-2019, *Guide to OSHA and NFPA 70E Safety Requirements When Servicing and Maintaining Medium-Voltage Switchgear, Circuit Breakers, and Medium-Voltage Controllers Rated above 1000 V*

10.7 Safe Mechanical Work Practices

Mechanical work offshore is most likely to be conducted during operations and maintenance campaigns and could include abrasive blasting and painting.

Abrasive blasting operations can create high levels of dust and noise. Abrasive material and the surface being blasted may contain toxic materials (e.g., lead paint and silica) that are hazardous to workers:

- Silica sand (crystalline) can cause silicosis lung cancer, and breathing problems in exposed workers.
- Coal slag and garnet sand may cause lung damage similar to silica sand (based on preliminary animal testing).
- Copper slag, nickel slag, and glass (crushed or beads) also have the potential to cause lung damage.
- Slags can contain trace amounts of toxic metals, such as arsenic, beryllium, and cadmium.

Opportunities to mitigate the risks posed by abrasive blasting include the following:

- Preparation of abrasive blasting procedure.
- Wherever possible, all blasting operations should be conducted indoors or in an enclosed designated area, provided with suitable ventilation, ideally in a blasting chamber that prevents the escape of dust, with a mechanical exhaust system for extracting dust and prevention of re-entry of the extracted dust into the chamber.
- If blasting is done in open space, it should be a specified area, where dust is visible and the blasting zone shall be roped-off, segregated, or barricaded-off with clear warning signs.
- If contaminants are present in the blasting media (lead, zinc, etc.), the respirator that will be used must be able to provide protection against such contaminants.
- If blasting needs to be performed inside confined spaces, the activity should be supported by comprehensive method statement, risk assessment, appropriate LOTO authorization and clear means of communication.

The abrasive blasting machine/equipment should include the following safety devices:

- An abrasive valve used to control the amount of grit metered into the blasting system
- An air valve that supplies air to the blast hose when the system is turned on
- A breathing air filter designed to remove water, oil mist, and particulate from the breathing air
- A choke valve to control the flow of air into the blast hose
- A dead man-switch that triggers the abrasive delivery system of a blasting machine
- A blast hood that consists of a helmet that covers the entire head, a cape that covers the shoulders, and an apron that hangs from the bottom of the cape to the crotch

Before being put into service and during periodic inspections also, every component of the blasting machine must be checked, and its proper function ensured.

The following resource provides additional details:

- OSHA Factsheet, *Protecting Workers from the Hazards of Abrasive Blasting Materials*

The typical hazards related to painting activities include, but are not limited to, the following:

- Use of chemical agents – contact, burn, irritation, inhalation, and swallow.
- Micro clime – presence of vapors (toxic and flammable), spills, jet, throwing of drops, etc.
- Static electricity – potential of fire and explosion
- Normal handling – cut, abrasion, and puncture
- Machine/tools contact with moving and rotating parts
- Falls from different levels, posture, slip/trip – falls on the same level

Opportunities to mitigate the risks posed by painting include the following:

- Selection and purchasing of painting materials that consider HSE aspects, technical performance, and costs
- Completion of a risk assessment of the painting activities and paints to be utilized
- Risk assessments that include consideration of weather conditions (to minimize painting in windy conditions) and ventilation requirements (to ensure that appropriate natural or forced ventilation is available as necessary)
- Specific training of the workforce involved in painting activities, which includes information on the MSDSs of the painting and any other solvents to be used, the general hazards related to the activity, the correct handling of chemicals, and the correct use of the equipment
- Material MSDS readily available on-site

The following paint handling, storage, preparation, and application safety measures can be implemented to reduce risk during physical painting activities:

- Painting shall be carried out only by trained workers.
- Use and storage of flammable paints and solvents shall be kept to a well-ventilated restricted area.
- Storage and preparation activities areas shall be suitably marked with the appropriate warning signs.
- No painting preparation and application should be carried out close to ignition sources (welding, cutting, smoking areas, sparking tools, etc.) unless safe measures are taken.
- Electrical lighting and equipment shall be explosion-proof when required in areas where solvent vapors are likely to be present.

- Fire extinguishers shall be located at the storage and at the work areas.
- Face, eyes, and skin shall always be protected to avoid contact with irritating materials, and adequate washing facilities should be provided for use in the event of contact.
- All pressurized equipment shall be handled carefully. System, hoses, etc. shall be anti-static type and grounded as needed.
- Workers shall know how to operate and de-energize the equipment in accordance with the manufacturer's recommendations.
- Workers should be provided with appropriate respiratory apparatus, where necessary, as identified by the activity risk assessment.
- Fall protection systems shall be used when working at height.

10.8 Compressed Air and Gas Cylinders

Compressed air and gas cylinders pose significant HSE risks due to their high pressure and potential for hazardous gas releases. These risks include physical hazards, such as explosions and projectiles, and chemical hazards, such as asphyxiation, toxicity, flammability, and corrosion.

To minimize the risk of incidents involving compressed air and gas cylinders, the following actions should be implemented:

- Only trained and qualified personnel should handle compressed gas cylinders.
- Accept only cylinders that meet the applicable specifications and those that have a valve protection cap.
- Cylinders should be secured in an upright position with chains or straps to prevent them from falling.
- Cylinders should be stored in an approved rack or cylinder truck.
- Use the correct regulators and valves for the specific gas and ensure that they are properly installed.
- Valves should be closed tightly when the cylinders are not in use.
- Store cylinders in a well-ventilated, dry, and secure location away from heat and flammable materials.
- Ensure adequate ventilation in areas where compressed gases are used to prevent oxygen depletion or the buildup of hazardous gases.
- Have a plan in place for handling leaks, spills, and other emergencies.
- Use appropriate PPE, such as safety glasses, gloves, and respirators, when handling compressed gases.
- Always consult the safety data sheet for specific information on the hazards of a particular gas.

10.9 Fire Prevention and Suppression

A range of fire risks are present in offshore wind farm construction, operations, and decommissioning. However, substations and the offshore wind turbines themselves normally operate as unmanned structures, so there is only a direct risk to people during maintenance activities. There is also a risk of fire on vessels used for construction, maintenance, or decommissioning.

Fires pose the following risks to people, which can contribute to serious, life-altering injuries, or fatalities, due to the following:

- Burns
- Smoke inhalation, even if not in the immediate vicinity of a fire, particularly if the burning materials release toxic fumes

- Carbon monoxide
- Explosions and arc flashes from electrical faults

General fire safety includes measures to reduce the risk of fire occurring, and if one does occur, to:

- Have measures in place to detect fires and warn people
- Have the means to extinguish incipient (i.e. small, emerging) fires
- Have measures and means to minimize its spread
- Have procedures and infrastructure to ensure people can escape

In general, a fire requires the presence of the following:

- Fuel, which can be any combustible material
- Oxygen, generally from air
- A source of ignition such as heat, a spark or flame
- Chemical chain reaction

If any of these is eliminated, then a fire cannot be sustained.

To prevent fires and mitigate consequences, if a fire occurs:

- Train personnel periodically on:
  - Fire safety and prevention, including means of disposing of combustibles
  - How to active alarms and summon help
  - Evacuation procedures
  - Use of firefighting equipment (i.e. extinguishers) – incipient fires only
  - PPE, if provided (i.e., smoke hoods)
- Conduct regular fire drills
- Inspect equipment (including fire suppression systems that provide warning of deterioration) and monitoring and alarm systems for proper function
- Establish rigorous procedures around hot work, which can introduce a source of ignition, such as welding, cutting, or grinding
- Require high cleanliness standards to limit build-up of combustible materials
- Deploy fire protection systems and instructions on their operation
- Make clear the types, usage, and locations of manual fire extinguishers
- For any automatic fire extinguishing systems, make available to personnel information on any potential risks they present to people, measures to limit these risks, and clear indication of the status of such systems
- Clearly mark emergency escape routes and always keep them clear
- Assess the time needed for emergency escape routes from challenging locations to ensure fire protection measures provide adequate time for people to escape
- Provide a means of summoning help

The following resources provide additional details:

- 29 *CFR* 1910, Subpart L, *Fire Protection* (OSHA General Industry)
- 29 *CFR* 1910.39, *Fire Prevention Plans* (OSHA General Industry)

- 29 CFR 1926, Subpart F, *Fire Protection and Prevention* and 29 CFR 1926.24 (OSHA Construction)
- 33 CFR 145.01, *Portable and Semi-Portable Fire Extinguishers* (USCG)
- 33 CFR 145.10, *Location, Number and Installation of Fire Extinguishers* (USCG)
- IMCA M119, *Fires in (DP) Vessels*
- ISO 23932-1, *Fire Safety Engineering: General Principles*
- NFPA 30, *Flammable and Combustible Liquids Code*
- NFPA 850, *Recommended Practice for Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations*

10.9.1 Hot Work

Hot work includes welding, flame cutting, burning, grinding, or using a torch. Hot work poses a risk of fires and explosions if sparks ignite nearby flammable fuels.

When possible, hot work should be done in a shop, outside the facility, or in a specifically designated area that has been established based on a risk assessment. Company procedures should detail how specifically designated areas for hot work are identified, what features they should have, and how they should be marked and secured.

Companies should consider establishing a safe control of work programs for hot work. This program should include the specific hazards and special precautions necessary to conduct the work pursuant to a task-based risk assessment.

Examples of conditions could include the following:

- Authorizing only certified personnel to perform hot work
- Identifying appropriate PPE and how to use it
- Requiring inspections of the equipment and work area prior to beginning any hot work, including verifying that the equipment is in good working order and verifying the absence of explosive atmospheric conditions, flammable materials, etc.
  - If flammable materials are identified, remove them to a safe distance.
  - If the equipment is not in good working order, procedures should authorize the work to be delayed until it is repaired or replaced.
- Requirements for ventilation to disperse flammable vapors or gases
- If hot work needs to be performed outside of the specifically designated area, especially if inside a nacelle, companies should consider requiring all fire hazards in the vicinity that can be moved should be moved to a safe distance or guards used to confine the heat, sparks, and slag, and to protect the immovable fire hazards
- Establishing a fire watch during and after the hot work is completed
- Requiring portable fire extinguishers appropriate for the type of potential fire to be located nearby
- Requiring training on emergency procedures

10.10 Hazardous Substances and Dangerous Goods

Hazardous substances can be in solid, liquid, or gaseous form and may:

- Always be present in a device, such as coolants or lubricants
- Be introduced during specific operations, such as cleaning fluids, or
- Arise as a by-product of work activities, such as fumes from welding, paints, and glass fiber repair compounds

Substances may present hazards to health due to:

- Chemical or physical composition, or
- Explosive or flammable properties

Hazardous substances can harm individuals through skin contact or puncture, ingestion, absorption, and inhalation. The severity can range from minor and temporary irritation to chronic illness and potentially death. The onset of symptoms may be immediate, but they can also show up years after exposure.

In some cases, hazardous substances may not be visible, such as dust, gases, and vapors.

Further, the same substance may present different hazards in different stages of the project life cycle.

10.10.1 Storage and Transportation of Hazardous Material

Employees should be informed about chemicals and other potential hazardous substances they are working with, around, or with which they may have contact.

Options to mitigate the risks posed by hazardous substances, including during their transportation, are as follows:

- Conduct a risk assessment and establish a communication plan to help ensure that the hazards of chemicals or other substances located in the workplace are properly identified and evaluated and that information concerning physical and health hazards is transmitted to potentially exposed employees
- Policies and procedures should be developed to address:
  - Method of hazard determination
  - Safety data sheets on the specific substances
  - Labels and other forms of warning
  - Employee information and training
  - Creation of a hazardous substance inventory
  - Plans for monitoring workforce exposure and health surveillance where the risk assessment identifies this need
  - Having arrangements in place to deal with accidents, incidents, and emergencies, including testing and training on such plans
  - Identifying control measures that should be used to mitigate risks that are appropriate for the task (i.e., the specific substance and situation at issue)
  - Ensuring that when more than one control measure is in place, they are compatible with each other
  - Plans for safe transportation using appropriate methods
- Control measures to consider include the following:
  - Use of warning signs to designate potentially hazardous areas and substances
  - Establishment of policies and procedures that cover:
    - Identification and use of appropriate PPE to the task to be performed
    - All chemicals and other substances used on-site (i.e., epoxy-based materials, oils, lubricants, and fuels)
    - Processes causing dust and fumes (i.e., welding, grinding, etc.)
    - The need to use the substance, substitution with a safer alternative, or reduction of quantities used and stored on-site
    - Correct handling of chemicals and substances, including disposal
    - Correct storage of chemicals and substances, including ventilation and control of temperature, humidity, and light level

  - Safe transportation using appropriate methods
  - Provision of suitable first aid facilities
  - Hygiene facilities
  - Containment, clean-up, and reporting of spillages
  - Detection and management of vapors and fumes where necessary
  - Environmental monitoring
  - Employee health surveillance

- Consideration should be given in policies and procedures to methods to reduce risk further through:
  - Reducing the quantity of dangerous substances at site
  - Avoiding or minimizing release of substances
  - Collecting and containing accidental releases
  - Preventing the formation of an explosive atmosphere
  - Avoiding ignition sources
  - Segregating incompatible substances

The following resources provide additional details:

- 29 CFR 1910.1200, *Hazard Communication* (OSHA General Industry)
- 49 CFR, Subchapter C, *Hazardous Materials Regulations* (U.S. Department of Transportation), Part 176 *Carriage by Vessel*
- 49 CFR 171.22-25, *Authorization and Requirements for the Use of International Transport Standards and Regulations* (U.S. Department of Transportation)
- NFPA 30, *Flammable and Combustible Liquids Code*
- United Nations Globally Harmonized System of Classification and Labeling of Chemicals (GHS)

10.10.2 Transfer and Use of Hazardous Material

10.10.2.1 Fluid Transfer Facilities

Ensuring safe fluid transfers entails regular inspection of fittings, hoses, breakaway couplings and hard piping, which can be damaged and subject to leakage, particularly at tank attachment points. Operators should document the types of fluids used in a facility, the quantities stored, and how they arrive. When a complete picture has been obtained, the next step is to inspect dispensing and receiving areas for any spills. Inspect nozzles, faucets, hoses, and pipes to ensure that they are connected correctly and undamaged.

10.10.2.2 Fluid Transfer Processes

OSHA safety guidelines address the transfer of flammable and combustible liquids, for example refueling an emergency standby generator:

- Flammable and combustible liquids should always be kept in approved storage containers when not in use.
- Any leakage or spillage should be disposed of quickly and with caution.
- The transfer hose and nozzle type need to be approved. The nozzle must be an automatic-closing type, without a latch open device.
- All switches on dispensing devices should be clearly identified and provided at a remote location. This allows to switch off all the power to these devices from a safe location in the event of an emergency.

- Ensure that there are no open flames or other ignition sources within at least 50 feet (15.25 m) of the transfer operation and be aware that conditions such as high winds may warrant greater clearance.
- Absolutely no smoking or open flames near fuel is allowed. This includes areas where fuel is received or dispensed.
- All “No Smoking” signs must be clearly visible and legible.
- The motors of all equipment being fueled must be shut down for the entirety of the process.

At least one fire extinguisher must be available within 75 feet (22.86 m) of each pump, dispenser, and fill pipe opening. The fire extinguisher must have a rating of no less than 20B:C.

10.10.2.3 Packaged Solids

The International Maritime Organization is responsible for maintaining and updating the *International Maritime Dangerous Goods Code* that governs seaborne transport of hazardous materials. The *International Maritime Dangerous Goods Code* is intended to provide for the safe transportation of hazardous materials by vessel, protect crew members, and prevent marine pollution. The Code is based on the United Nations Model Regulations, but also includes additional requirements specific to maritime transport, such as requirements for marine pollutants, freight container loading procedures, stowage and segregation of incompatible substances, and other requirements applicable to shipboard safety and preservation of the marine environment that are not covered by the United Nations Model Regulations.

10.10.2.4 U.S. Department of Transportation’s HazMat vs. OSHA’s HazCom

When transporting, transferring, and using hazardous substances, employers and workers must maintain compliance with an array of safety regulations. Two of the more prominent rule sets are the Department of Transportation’s Hazardous Materials Regulations (HazMat) and OSHA’s Hazard Communications Standard (HazCom). While the two regulations cover many of the same hazards, there are a few key differences between the two.

Substances regulated by HazCom but not regulated by the Department of Transportation’s HazMat reflect OSHA’s concern about chronic or long-term health hazards that the Department of Transportation does not include in its regulations. These include the following:

- Respiratory/skin sensitizers
- Germ cell mutagens
- Carcinogens
- Reproductive toxins
- Specific target organ toxins
- Aspiration hazards
- Combustible dusts

Substances regulated by the Department of Transportation’s HazMat but not covered by OSHA’s HazCom include the following:

- Marine pollutants
- Elevated-temperature materials
- Infectious substances (which are covered by other OSHA standards)

10.11 Remote Monitoring and Control

Remote monitoring and control capabilities for offshore wind turbines contribute to safety by providing the ability for continuous oversight of the functioning of the turbines and the ability to make modifications to plant operations remotely, including interventions that may eliminate the need to send a technician offshore for repairs and to prevent potential incidents that could create safety concerns.

10.11.1 Communication Policies

Remote monitoring and control capabilities also introduce risk of miscommunication or misunderstanding between control room operators and personnel performing work on-site that could lead to high-consequence incidents, such as restarting a turbine remotely on which work is being performed locally. To mitigate this risk, control system design should incorporate reliable and redundant communications channels between the control room and workers on-site in the event one of the channels is unavailable:

- Establishing procedures and control measures such that when work is being performed locally, the control room operators have visibility that the work is being done and the ability to control the turbine remotely is locked, including specifying the required steps and communication to confirm remote access is locked prior to performing local work and that the control room operators know why it is locked.
- Providing written procedures that specify the required communication between on-site personnel and control room operators for how to test and re-start the turbine once on-site personnel are confirmed to be in a safe location.
- If work is required on a turbine while it is in operating mode, the work should only be done by an authorized technician adequately trained to do so. Before such work commences, procedures should require communication between the technician and the control room operator. Any other work on the turbine should be delayed until the work being done in an operating mode is complete.

The SMS should also establish procedures for safe remote operation, control, and startup/shutdown of turbines when workers are not on-site. The project's Supervisory Control and Data Acquisition (SCADA) system provides the operator with the capability to remotely and continuously monitor and control the project facilities, including the ability to shut down the equipment remotely if necessary. It also allows the control room operator to adjust turbine operations remotely.

Primary remote communication is normally via fiber-optic cables within the subsea power cables interconnecting the wind turbines, offshore substations, and onshore substations. For communication redundancy, one or more secondary channels should be provided by wireless, radio, or satellite.

In addition to the capabilities of the SCADA system, wind turbines have standard fail safe mechanisms (e.g., mechanical brakes, pitch systems to feather blades) and protocols. Should wind turbines lose power or communications with the operations facility, these systems will ensure that the turbines initiate a safe shutdown until the connection is restored and system integrity is verified.

10.11.2 Cybersecurity

The cybersecurity requirements of offshore wind SCADA systems are similar to those of onshore wind and other components of the wider power grid. Additional vulnerabilities are present in offshore wind:

- The unattended, distributed, and remote nature of offshore wind projects is highly dependent on cellular, satellite, and wired communications, which combine to create a large attack surface for malicious actors to exploit.
- The large spatial scale of offshore wind turbine arrays and their physical accessibility by recreational fishing vessels and recreational diving vessels provide potential vectors for interception of cellular and satellite communications by malicious actors on these boats.
- The substantial physical distance between offshore installations and onshore control centers increases the risk of interception or disruption of communications. This is particularly true of the subsea power export cables, which are tens of kilometers long and which house fiber-optic two-way communication links, vulnerable to tampering, damage or interception of communications by divers or autonomous underwater vehicles.

- The offshore wind industry lacks standardized communication protocols and cybersecurity measures, which can hinder interoperability between different systems and components.
- The integration of advanced digital technologies (e.g., Internet of Things) in offshore wind facilities may be connected to older legacy components in the existing onshore power grid, such as switchgear and transformers that may be 20–30 years old, which creates additional vulnerabilities.

Interception or spoofing of communications is particularly threatening to the occupational safety of offshore wind farm workers. Satellite or wireless communications among workers on a turbine or substation, and their communications with service vessels can be intercepted or spoofed, leading to misinformation and attendant potential for high consequence incidents. Likewise, satellite or wireless communications between the onshore marine coordination center also can be intercepted or spoofed, compromising maritime situational awareness, leading to potential vessel collisions. Finally, fiber-optic communication between the onshore control center and turbines can be intercepted or spoofed, which has the potential for high-consequence incidents, such as restarting a turbine remotely on which work is being performed locally, creating direct and severe safety hazards for personnel.

Design measures to mitigate cybersecurity risks include a segmented network architecture that establishes distinct security “zones,” such as a turbine area network and a farm area network, each with its own specific security controls. This segmentation, which can be implemented through approaches like VLANs, VRFs, and micro-segmentation, limits lateral movement by potential attackers and isolates critical systems from less secure network segments.

Additionally, establishing a dedicated Security Operations Center for continuous intrusion detection and security event management is essential. The Security Operations Center should leverage advanced monitoring tools, including anomaly-based intrusion detection systems and security information and event management platforms, to provide real-time threat detection, rapid incident response, and ongoing assessment of network integrity.

Operational measures to mitigate cybersecurity risks encompass eight elements:

1. Regular updates and patching: This strategy must be part of a wider risk management approach. Regularly updating and patching systems involves not just applying the latest fixes but also testing these updates in a controlled environment to ensure they do not disrupt system stability or operational safety. For SCADA systems, where uptime is crucial, patches should be applied in a manner that minimizes downtime, with clear communication to all affected personnel. It is also important to have a rollback plan in case an update introduces new vulnerabilities or system incompatibilities.
2. Access control and authentication: Beyond basic measures, access control in SCADA systems should involve a comprehensive management of user privileges. This includes role-based access controls, where users are granted access rights depending on their job function, and time-based access controls, limiting access to certain times for specific users. Strong authentication methods also include biometric verification or the use of security tokens alongside traditional passwords. The goal is to create a robust barrier where access is tightly regulated and monitored, thereby reducing the risk of unauthorized actions or privilege escalation.
3. Employee training and awareness: This involves creating a culture of security awareness within the organization. Training programs should be regular, engaging, and tailored to different roles within the company. This might include simulated phishing exercises, workshops on recognizing social engineering tactics, and training on the specific types of threats that target SCADA systems. The goal is to ensure that employees are not just aware of the protocols but are also invested in the security of the system.
4. Data encryption: Encryption should be implemented using advanced algorithms and should encompass all data relevant to the SCADA system. This includes operational data, logs, and any communication between field devices and control centers. Implementing end-to-end encryption ensures data integrity and confidentiality, especially when transmitted over potentially insecure networks. It is also vital to manage encryption keys securely, ensuring that they are stored and handled with the same level of security as the data they protect.

5. Regular security audits and assessments: Conducting regular, thorough security audits and assessments—both internally and by third-party experts is vital to ensure adherence to security policies and regulatory requirements. These reviews should encompass technical controls, physical security, user access privileges, and the effectiveness of employee training programs. Findings should drive continuous improvement in security posture.
6. Penetration testing: This involves simulating a cyberattack under controlled conditions to test system resilience in a high-fidelity testbed environment. This should be done by experienced professionals who can mimic the tactics and techniques of real-world attackers in a high-fidelity testbed. This approach should reveal not only where the vulnerabilities are but also how an attacker might exploit them and how the system would respond.
7. Incident response planning: A comprehensive incident response plan for a SCADA system should include specific procedures for different types of incidents, clear roles and responsibilities, and communication strategies for internal and external stakeholders. Regular drills and simulations of cyberattack scenarios should be conducted to ensure readiness. The plan should also include procedures for forensic analysis to understand the attack vector and to prevent future incidents.
8. Compliance with industry standards and regulations: This involves staying abreast of and complying with standards like NERC CIP, ISA/IEC 62443, and others relevant to SCADA systems. Compliance ensures a baseline of security, but organizations should strive to exceed these standards when possible. Regular compliance status reviews, including gap analysis against the latest standards and regulatory requirements, help ensure that SCADA systems are compliant and following the best security practices.

The following resource provides additional information on cybersecurity issues for wind energy systems:

- U.S. Department of Energy 2020, *Roadmap for Wind Cybersecurity*

10.12 Specialized Systems

Specialized systems identified in this section are considered as presenting significant safety risks and shall be performed under direct control of appropriately qualified contractors. These specialized systems have their own specific regulatory requirements from authorities that have jurisdiction well beyond offshore wind, such as the USCG, the Federal Aviation Administration, and OSHA.

10.12.1 Marine Vessel Safety and Operations

Any accident involving a vessel has the potential to harm personnel on board. In the most extreme cases, the sinking or capsizing of a vessel could endanger the lives of all aboard. The risk of accidents is highest if a task is being undertaken that goes beyond the capability of the vessel, or the competence of its crew. Therefore, vessel selection is essential to safe operations.

To support safe operations, vessel selection for construction, operations, and decommissioning should be based on the activity to be undertaken, the site-specific conditions and hazards, and facilities and capabilities required on the vessel. Consideration should be given to vessel suitability (i.e., Is the vessel capable of doing the job for which it would be selected?) and a vessel technical standard (i.e., Is the vessel kept up/maintained to standard?). A vessel provider's training, certifications, safety management, communications, competence, and capacity of the crew to support the intended operations should be evaluated.

To mitigate the potential for harm to personnel on vessels, companies should:

- Require employees to follow instructions of the vessel captain for loading/unloading, cargo storage, and seating.
- Establish procedures for appropriate behavior on vessels, including no running allowed on deck and a requirement that personal floatation devices be always worn.
- All vessels should follow USCG and flag state requirements for inspections.

- Prepare emergency response and rescue plans, and periodically train and drill to those plans.
- Plan vessel movements considering areas of high-density vessel traffic, port usage, areas of intense construction activity, etc.
- Establish liaison to other ocean users who can share regular updates on activities of which others should be aware, particularly when different phases of activities are about to commence.
- Utilize Notices to Mariners to broadcast appropriate notices and warnings.

The following resources provide additional details:

- G+ Good Practice Guideline, *The Safe Management of Small Service Vessels Used in the Offshore Wind Industry*
- IMCA M103, *Guidelines for the Design and Operation of DP Vessels*
- Maritime Institute of Technology and Graduate Studies, *Good Housekeeping and Safe Working Practices for Vessels at Sea*
- MGN 372, *Offshore Renewable Energy Installations (OREIs): Guidance to Mariners Operating in the Vicinity of UK OREIs* (UK Maritime and Coastguard Agency)
- MGN 654, *Offshore Renewable Energy Installations (OREI) Safety Response* (UK Maritime and Coastguard Agency)
- Renewable UK, *Guidelines for the Selection and Operation of Jack-ups in the Marine Renewable Energy Industry*

10.12.1.1 Marine Transfers of Personnel

Offshore wind construction, maintenance, and decommissioning will involve frequent transfer of personnel between vessels and wind farm facilities (turbines, offshore substations) and from one vessel to another vessel. Transfers involving vessels may expose people to risks of:

- Falling onto the vessel, or into the sea, or being suspended by a fall arrest system
- Crushing or entrapment due to relative movement between the vessel and the ladder
- Serious injury from any objects that may drop from the offshore structure during transfer operations
- Stranding – if metocean conditions change, such as weather or sea state deteriorating, or if very low tides prevent access in areas of shallow water

The risk of marine transfer varies based on the following:

- Metocean conditions, such as wind speed and direction, wave height and direction, currents, visibility, water temperature, and air temperature
- Site characteristics, such as the structural strength and condition of the access point
- Vessel characteristics
- Human factors, such as experience, fatigue, desire to get off the vessel and onto the structure, etc.

Marine transfers between vessels and wind turbine platforms can also be safely and efficiently achieved, particularly in challenging weather conditions, through use of personnel hoists. These hoists are most often heave-compensated and utilize technology such as lasers and sensors to adjust for vessel motion, ensuring smooth and safe access to the turbines, minimizing the risks associated with ladder transfers.

Types of personnel hoists include the following:

- Motion-compensated hoists: These hoists are specifically designed to counteract the effects of wave motion and vessel movement, ensuring a safe and stable transfer.
- Davit cranes: Some systems combine davit cranes with transfer baskets, allowing for the transfer of both personnel and cargo using the same equipment.

These hoists are increasingly integrated into the design and operation of offshore wind farms. Where personnel hoist systems are present, technicians should be fully trained with their operation including under situations involving emergencies or system malfunction.

The following resources provide additional details for how to execute safe transfers:

- ACP *Offshore Marine Transfer Guidance*
- G+ Good Practice Guidelines, *Offshore Wind Farm Transfer*
- IMCA, *Guidance on the Transfer of Personnel to and from Offshore Vessels and Structures*

10.12.1.2 Sea Fastening of Equipment and Components

Sea fastening is the routine practice of fastening cargos to a vessel or barge for transport, either from a staging port to the offshore project site or transit from port to port. Executed properly, sea fastening enables the safe and efficient seaborne carriage of project equipment, minimizing the number of trips required to install the offshore components, which vary not only in size and weight, but also shape.

Foundation monopiles are carried horizontally in cradles, whereas foundation transition pieces and tower sections are carried vertically on grillages. Turbine nacelles are the heaviest offshore wind component and represent the most concentrated load, requiring a more extensive grillage deck area as compared with transition pieces or tower sections. Turbine blades are the lightest offshore wind components and are carried horizontally in racks, typically stacked three high, so they are available to be installed after the nacelle is in place atop the tower and thus complete the offshore turbine assembly.

Grillage refers to a framework fabricated from steel structural shapes (e.g., beams and stiffened plates) that are arranged and welded together to form a sturdy platform or base that spreads the concentrated load of a component or heavy piece of equipment over a larger deck area, ensuring even weight distribution and preventing damage to the vessel or barge.

The design aspects of grillage and sea fastening entail structural engineering and naval architecture, and as such are covered in ACP OCRP-1, Section 7.6.2. The stability and safety of the load during sea transport requires a good understanding of load potential movements (e.g., tipping vs. sliding) to ensure the correct choice and installation of fasteners to prevent cargo shifting or damage.

Operational aspects, such as lifting, securing, and releasing of offshore wind components are subject to oversight by the vessel master and fall under USCG regulatory jurisdiction. These activities also have elements covered by other sections in this chapter, such as Section 10.4 “Manual Handling and Mechanical Lifting” and Section 10.5 “Line of Fire.”

Review of sea fastening incidents, some involving fatalities, suggest the following specific practices:

- Securing of project cargo should comply with instructions given in the vessel’s Cargo Securing Manual or in the case of barges or vessels under 500 gross tons, a predetermined load and securing plan. The Cargo Securing Manual identifies the location and strength rating of built-in lashing points (e.g., eyes, D-rings), and the Cargo Securing Manual instructions should be followed precisely – there are good reasons for each step.
- The Cargo Securing Manual should include an adverse weather policy with specific guidelines regarding what constitutes adverse weather, and what measures should be implemented to prevent cargo shifting in the event of the various criteria. Routines for inspections following adverse weather also should be included in the adverse weather policy.
- In addition to securing cargo against undesirable shifting at sea, cargo should also be secured so that it does not block escape routes and means of evacuation.
- All fastening elements should be visually inspected prior to use, and any element showing signs of damage (e.g., deformed chain links, fretted or kinked wire cables, and torn or frayed fiber straps) should be discarded.

- Multiple lashings on one item should be kept under equal tension, and use of different lashing materials having different strengths and elasticity should be completely avoided.
- Chain hooks should be secured only to appropriate eyes or shackles and not to the chain itself.
- Straight or crossed lashings are used when the lashing can be attached directly to dedicated lashing points on both the cargo and in the deck of the vessel. Lashings applied at an angle or in a cross are more effective in preventing sliding, whereas straight lashings attached at the side of the cargo and pulling straight down are more effective in preventing tipping.
- Top-over lashings increase the contact force between cargo and the underlying surface, thus improving prevention of sliding by increased frictional resistance and not directly by the lashings themselves. Top-over lashings secured at 90° angles with the deck are most efficient at producing the added frictional resistance.
- When cutting away welded sea fastenings, the cutting torch flame should be horizontal to the deck at all times. Even a relatively small inclination of ±5° could damage the deck.

The following resources provide additional details:

- Offshore Energy UK, 2018, *Best Practice Transportation of Project Related Cargo Items: Guidance Note*
- Offshore Energy UK, 2020, *Oil & Gas UK Best Practice for the Safe Packing and Handling of Cargo to and from Offshore Locations*, Issue 6

10.12.2 Helicopter and Aircraft Safety and Operations

Helicopters and aviation services may be used for transferring personnel to and from offshore sites, emergency response, certain lifting operations, and project surveys. Unmanned aircraft systems may be used for monitoring. In the event helicopters or aviation services are utilized during the development, construction, operations, or decommissioning of the offshore wind farm facilities, the SMS should establish policies and procedures to ensure safe operation as aircraft operations pose a risk of injury or death to personnel in the aircraft, workers on-site, individuals in vessels, and other aircraft.

To mitigate the potential risk from helicopter and aircraft operations, consider establishing requirements for:

- Contractors/suppliers to have:
  - The Federal Aviation Administration-issued Air Operators Certificate (AOC) and Operations Specifications commensurate with the type of operation required
  - An SMS in accordance with Federal Aviation Administration Advisory Circular 120-92D; International Civil Aviation Organization Annex 19, Edition 2; International Association of Oil and Gas Producers Report 690-1 *Safety Management System*; or equivalent
  - A drug and alcohol policy consistent with *CFR* Title 14, Chapter I, Subchapter G, Part 120
- Flight operations adhering to the Federal Aviation Administration rules
- Two-way communications protocols for entering the offshore wind farm area
- Specific procedures for specialized operations, such as helicopter hoisting operations
- Pilot licensing, training, and proficiency checks depending on the operation, as well as flight crew experience
- Aircraft maintenance and technicians
- Aircraft certifications, technical capabilities, and performance
- Passenger training and PPE
- Flight safety occurrence reporting per Federal Aviation Administration requirements and incident investigations through the National Transportation Safety Board

The following resources provide additional details:

- *14 CFR*, Part 5, *Safety Management Systems*
- *14 CFR*, Part 133, *Rotorcraft External-Load Operations*
- *14 CFR*, Part 135, *Operating Requirements*
- Energy Institute 3442, *Good Practice Guidelines for Safety Helicopter Operations*
- Federal Aviation Administration Advisory Circular 120-92D, *Safety Management Systems for Aviation Service Providers*
- Federal Aviation Administration Order 8020.11D, *Aircraft Accident and Incident Notification, Investigation and Reporting*
- Federal Aviation Administration, Safety Management System Policy and Requirements (website)
- HeliOffshore, *Wind Farm Recommended Practice*
- International Civil Aviation Organization, Annex 19

10.12.3 Diving Operations

Diving is a high-risk activity that requires specialist personnel with specific and extensive training and experience to plan, support and carry out safely. Serious incidents, including fatalities, can occur. The principal risks to divers result from the pressure experienced in the subsea environment, the need to correctly manage breathing apparatus, and the need to decompress safely returning to the surface. Decompression requirements can prevent immediate evacuation, which can quickly escalate the severity of any accident or health issue.

Other risks divers may face include, but are not limited to, the following:

- Differential pressure (for example, breaching a seal on a J-tube underwater) that could cause a sudden flow of water due to the difference in water levels inside and outside, with the potential to trap and seriously injure a diver
- Adjacent marine operations involving vessel movement, and particularly the wash and mechanical hazards of propellers and thrusters, as well as the risk of entrapment of severing of divers' tethers or cables
- Any work being carried out above the dive location, presenting the risk of dropped objects
- Restricted visibility, both on the surface and subsea, which may be further impaired by sediment disturbed by the subsea operations or other SIMOPs
- Underwater noise can impede communication, or, in extreme cases, cause hearing damage
- Change in sea conditions during a dive, which can create hazardous conditions upon exit
- Entanglement of diver's umbilical cord

As a result of these hazards, diving operations should be planned, managed, and completed only by expert third-party contractors. In addition, consideration should also be given to whether the risks of diving can be eliminated for subsea operations via use of remotely operated vehicles or autonomous underwater vehicles.

Where diving activities are essential, the risks associated may be mitigated by ensuring that a competent person undertakes a comprehensive risk assessment of detailed plans for the operations to identify hazards at every stage of the diving operations, and necessary mitigation measures. Early planning and coordination can also reduce risks, including by working to minimize the diving operation complexity and duration. Further risk mitigation steps include the following:

- Develop a risk assessment prior to each diving project to inform development of a dive plan:

- Each should consider the specific work scope, location, environmental conditions, resources required to carry out the work safely, other operations in the area, and any other elements that can influence the safety of the dive.

- Hire a competent diving contractor.
- Develop a comprehensive dive plan in conjunction with diving contractor.
- Ensure that divers have approved valid qualifications, including a valid certification of medical fitness and first aid training, for any activities they may be expected to do.
- Keep a daily log of plans, operations, and performance.

The following resources provide additional details:

- 29 *CFR* 1910, Subpart T, *Commercial Diving Operations* (OSHA General Industry)
- 29 *CFR* 1926, Subpart Y, *Diving* refers to 1910 Subpart T (OSHA Construction)
- 46 *CFR* 197, *Commercial Diving Operations* (USCG)
- IMCA D014, *International Code of Practice for Offshore Diving*
- IMCA D035, *The Selection of Vessels of Opportunity for Diving Operations*
- International Association of Oil and Gas Producers Report 411, *Diving Recommended Practice*
- USCG Policy Letter, *Commercial Diving Operations – Equivalent Levels of Safety*, October 14, 2020

10.12.4 Unexploded Ordnance

Unexploded ordnance (UXO) is present in U.S. waters off the Atlantic, Pacific, and Gulf Coasts because of live-fire testing and training (both ongoing and past); combat operations (acts of war through World War II); sea disposal (conducted through 1970); accidents (periodic); and disposal (e.g., jettisoning) during emergencies.

Disturbance of UXO can lead to detonation, which can cause damage to vessels even at a relatively far distance, including sinking. UXO can lead to various injuries, as well as cause fatalities depending on the size of the munition and proximity to vessels and individuals. While some UXO may no longer be viable, many retain their full explosive capacity and may increase in instability over time due to deterioration in their conditions in the years since they were deposited.

With respect to offshore wind, the risk from UXO is highest when performing activities that disturb the seabed, such as foundation installation and subsea cabling. In addition, due to waves and currents, UXO can become exposed over time. It is not safe to assume that a location that was previously clear of UXO will remain so over time.

In general, prior to undertaking activities that will disturb the seabed, it is recommended that developers undertake the following actions:

- Complete an assessment of the UXO risk in the area via desktop studies and, if necessary.
- Conduct specific site surveys to confirm the presence and nature of any potential UXO.

Both actions will require hiring specialists in UXO. In the event that desktop studies or site surveys confirm the presence of UXO a mitigation plan should be developed to address and manage this risk within the project. This could include avoidance of the area for all project activities or removal or relocation of the identified UXO.

The following actions are advised if a UXO is encountered during site activities:

- Stop work, note location, and move away from UXO.
- Reassess project plan – Can operations be moved a safe distance? Does it make sense to have the UXO removed by a qualified contractor?
- Contact BOEM and apprise them of the situation.

The Department of Defense Environment, Safety and Occupational Health Network Information Exchange describes these steps as the "3 Rs" of explosives safety: (i) Recognize, (ii) Retreat, and (iii) Report.

The following resources provide additional details:

- BOEM 2017-063, *Munitions and Explosives of Concern Survey Methodology and In-field Testing for Wind Energy Areas on the Atlantic Outer Continental Shelf*
- BOEM 2022-012, *Supporting National Environmental Policy Act Documentation for Offshore Wind Energy Development Related to Munitions and Explosives of Concern and Unexploded Ordinances*
- Carbon Trust, *Guidance for geophysical surveying for unexploded ordnance and boulders supporting cable installation*
- Ciria, *Assessment and Management of Unexploded Ordnance (UXO) Risk in the Marine Environment (C754)*
- Department of Defense Environment, Safety, and Occupational Health Network and Information Exchange, *3 Rs Explosives Safety Education Program*
- Department of Transportation, *National Guidance for Responding to Munitions and Explosives of Concern in Federal Waters*
- Fugro Marine Services, *Munitions and Explosives of Concern Desktop Study*
- Marinecadastre.gov (link to underlying UXO data set and here)

11 Personal Protective Equipment

Appropriate PPE should be provided to employees based on the task(s) for which it will be used, the working environment, and the characteristics of the user (such as physical size, facial hair, existing health conditions, gender, etc.). Many tasks may require the use of more than one item of PPE. In such cases, the different items should be compatible.

Information, instruction, and training on appropriate use, care, and storage of the PPE should be provided to users. The information should include an explanation of the role the PPE plays in doing the work safely. The extent of such training should reflect the complexity of the equipment involved. It should be made clear that employees are accountable to wear PPE required by a particular job assignment.

PPE should be stored in a clean and protected environment to maintain it in good condition and prevent contamination and deterioration. PPE should be maintained and replaced as necessary, to ensure that it functions effectively.

Procedures should be established to enable employees to report any defects in PPE.

The following are some examples of standards for specific types of PPE commonly used for offshore wind work (Table 1). However, it is important to define a project specific list of PPE requirements dependent on location and forecast project activities. The specific PPE should only be finalized after completing a risk assessment for the specific task to be performed and all other mitigations have been considered.

Table 1: Recommended PPE Standards and Recommended Practices Available by Type

Type of PPE	Example Standards and Recommended Practices
Head protection	ANSI Z89.1, Class E (for electrical hazards) EN 397 EN 50365 EN 13463-1 EN 166 (integrated visor)

<table>
<tr><th>Type of PPE</th><th>Example Standards and Recommended Practices</th></tr>
<tr><td>Foot protection</td><td>ASTM F2413
ASTM F1117 (dielectric)
EN ISO 20345 (S3)
EN 345
Electrical hazard rated boots or shoes for any personnel conducting electrical work</td></tr>
<tr><td>Hand protection</td><td>ASTM D120 (rubber insulating gloves)
ANSI ISEA 105
ASTM F696 (leather protectors for rubber insulating gloves)
EN 60903 (gloves used to protect against electrical shock)
EN 388 (gloves for mechanical risks)
Consider impact rating and cut rating for hand protection</td></tr>
<tr><td>Hearing protection</td><td>ANSI S3.19
EN 352</td></tr>
<tr><td>Eye protection</td><td>ANSI Z87.1
EN 166</td></tr>
<tr><td>Arc-rated clothing</td><td>ASTM F1506 (clothing)
ASTM F2178 (hoods, eye wear, and face protection)
EN 61482
From commissioning through operations wear Fire Resistant clothing</td></tr>
<tr><td>High-visibility clothing</td><td>EN ISO 20471
ANSI ISEA 107</td></tr>
<tr><td>Personal fall protection systems</td><td>ANSI Z359
There are two situations where a deviation from ANSI Z359.2 may be appropriate in the United States:
A quick connector certified to EN 362 and EN 12275 is commonly used and can be operated while wearing gloves. For this specific application, ACP recognizes the European Norm until the connector can be ANSI certified due to the increased level of safety it provides during offshore transfers.
ANSI recently revised the ANSI/ASSP Z359.14-2021: Safety Requirements for Self-Retracting Devices for Personal Fall Arrest and Rescue Systems standard and revised the maximum locking distance from 54 in. to 42 in. Part of the strategy for using a self-retracting device (SRL) from a crew transfer vessel to a boat landing ladder is to allow for some give and to not lock immediately if the boat moves a little, but also provide fall protection. SRLs that are currently used widely in the offshore wind industry have a maximum locking distance of 54 in., but otherwise conform to ANSI/ASSP Z359.14-2021 and conform to EN 360. At a minimum, the SRL should comply with OSHA 29 CFR 1910.140 and 1926.502. For this specific application, ACP recognizes the European Norm 360 free fall distance of 54 in., however, recommends that SRLs otherwise conform to ANSI/ASSP Z359.14-2021.
EN 365
EN ISO 10333, Part 3</td></tr>
</table>

Type of PPE	Example Standards and Recommended Practices
Life jackets	Performance requirement: 150 Newton for offshore, 275 Newton when worn with personal fall protection equipment SOLAS USCG
Personal locator beacon (PLB) and maritime survivor locating device (MSLD)	MSLD: 47 CFR 95.2989 (RTCM 11901.1) PLB: 47 CFR 95.2989 (RTCM 11010.2) COSPAS-SARSAT C/S T.007
Immersion suit	Minimum performance requirement: Survivability in water temperature of 10 °C/50 °F for at least 1 hour, with no more than a 2 °C drop in core body temperature. SOLAS 1 hour ISO 15027-1 (Class C 0.33 CLO or better) USCG
Helicopter travel immersion suit	ETSO 2C503
Respiratory protection	NIOSH
Electrically protective wear	ASTM F2677 (insulating aprons) ASTM D1501 (rubber insulating sleeves) ASTM D1048 (rubber insulating blankets)
Insulating or insulated hand tools	ASTM F1503
Fiberglass reinforced plastic for live line tools	ASTM F711
Temporary protective grounds	ASTM F855

The following resources provide additional details:

- 29 CFR 1910, Subpart I (Sections 132-140), *Personal Protective Equipment* (OSHA General Industry)
- 29 CFR 1926, Subpart E, *Personal Protective and Life Saving Equipment* (OSHA Construction)
- 33 CFR 142, Subpart B, *Personal Protective Equipment* (USCG)

12 References

Title
ACP 1001-2-202x, *Recommended Practice for Offshore Safety Training and Medical Requirements*
ACP *Offshore Marine Transfer Guidance*
ANSI Z359.2, *Minimum Requirements for a Comprehensive Management Fall Protection Program*
ANSI/ASA S2.70-2006, *Guide for the Measurement and Evaluation of Human Exposure to Vibration Transmitted to the Hand*
ANSI/ASSE A10.4, *Safety Requirements for Personnel Hoists and Employee Elevators on Construction and Demolition Sites*
ANSI/ASSP Z10, *Occupational Health and Safety Management Systems*

Title
ANSI/ASSP Z117.1-2022, *Safety Requirements for Entering Confined Spaces*
ANSI/ASSP Z359.14-2021, *Safety Requirements for Self-Retracting Devices for Personal Fall Arrest and Rescue Systems*
ANSI/ISEA 105, *American National Standard for Hand and Arm Protection Classification*
ANSI/ISEA 107, *American National Standard for High-Visibility Safety Apparel*
ANSI/ISEA 121-2018, *American National Standard for Dropped Object Prevention Solutions*
ISEA Z87.1, *American National Standard for Occupational and Educational Personal Eye and Face Protection Devices*
ANSI/ISEA Z89.1, *Personal Protection – Protective Headwear for Industrial Workers*
API Recommended Practice 2D, *Operation and Maintenance of Offshore Cranes*
API Recommended Practice 75W, *Recommended Practice for a Safety and Environmental Management System for Offshore Operations and Assets*
API Recommended Practice 76, *Contractor Safety Management for Oil and Gas Drilling and Production Operations*
ASME P30, *Planning of Load Handling Activities*
ASTM D120, *Standard Specification for Rubber Insulating Gloves*
ASTM D1048, *Standard Specification for Rubber Insulating Blankets*
ASTM F696, *Standard Specification for Leather Protectors for Rubber Insulating Gloves*
ASTM F711, *Standard Specification for Fiberglass-Reinforced Plastic (FRP) Rod and Tube Used in Live Line Tools*
ASTM F1117, *Standard Specification for Dielectric Footwear*
ASTM F1506, *Standard Performance Specification for Flame Resistant and Electric Arc Rated Protective Clothing Worn by Workers Exposed to Flames and Electric Arcs*
ASTM F2178, *Standard Specification for Arc Rated Eye or Face Protective Products*
ASTM F2413, *Standard Specification for Performance Requirements for Protective (Safety) Toe Cap Footwear*
ASTM F2677, *Standard Specification for Electrically Insulating Aprons*
ASTM F855, *Standard Specifications for Temporary Protective Grounds to Be Used on De-energized Electric Power Lines and Equipment*
ASTM F1503, *Standard Practice for Machine/Process Capability Study Procedure* (Withdrawn 2018)
ASTM F2677, *Standard Specification for Electrically Insulating Aprons*
BOEM 2017-063, *Munitions and Explosives of Concern Survey Methodology and In-field Testing for Wind Energy Areas on the Atlantic Outer Continental Shelf*
BOEM 2022-012, *Supporting National Environmental Policy Act Documentation for Offshore Wind Energy Development Related to Munitions and Explosives of Concern and Unexploded Ordinances*
BS EN 352, *Hearing Protectors*
BS EN 362, *Personal Protective Equipment Against Falls from a Height – Connectors*
BS EN 397, *Industrial Protective Helmets*
BS EN 12275, *Mountaineering Equipment. Connectors. Safety Requirements and Test Methods*

Title
BS EN 13463-1, *Non-Electrical Equipment for Use in Potentially Explosive Atmospheres – Basic Method and Requirements*
BS EN 50365, *Electrically Insulating Helmets for Use on Low and Medium Voltage Installations*
BSI 7121, *Code of Practice for the Safe Use of Cranes*
Carbon Trust, *Guidance for Geophysical Surveying for Unexploded Ordnance and Boulders Supporting Cable Installation*
14 *CFR* Part 5, *Safety Management Systems*
14 *CFR* Part 133, *Rotorcraft External-Load Operations*
14 *CFR* Part 135, *Operating Requirements*
29 *CFR* 1910, *Occupational Safety and Health Standards*
29 *CFR* 1910, Subpart I (Sections 132-140), *Personal Protective Equipment*
29 *CFR* 1910, Subpart D (Section 21-30), *Walking Working Surfaces*, 1910.22 and 29
29 *CFR* 1910, Subpart L, *Fire Protection*
29 *CFR* 1910, Subpart S, *Electrical*, 1910.269, 1910.303, 1910.22
29 *CFR* 1910, Subpart T, *Commercial Diving Operations*
29 *CFR* 1910.23, *Ladders*
29 *CFR* 1910.27, *Scaffolds and Rope Descent Systems*
29 *CFR* 1910.28, *Duty to Have Fall Protection and Falling Object Protection*
29 *CFR* 1910.29, *Fall Protection Systems and Falling Object Protection – Criteria and Practices*
29 *CFR* 1910.38, *Emergency Action Plans*
29 *CFR* 1910.39, *Fire Prevention Plans*
29 *CFR* 1910.95, *Occupational Noise Exposure*
29 *CFR* 1910.140, *Personal Fall Protection Systems*
29 *CFR* 1910.146, *Permit Required Confined Spaces*
29 CFR 1910.147, *Control of Hazardous Energy*
29 *CFR* 1910.179, *Overhead and Gantry Cranes*
29 *CFR* 1910.1200, *Hazard Communication*
29 *CFR* 1926, *Construction*
29 *CFR* 1926, Subpart AA, *Confined Spaces in Construction*
29 *CFR* 1926, Subpart E, *Personal Protective and Life Saving Equipment*
29 *CFR* 1926, Subpart F, *Fire Protection and Prevention*
29 *CFR* 1926, Subpart I, *Tools – Hand and Power*
29 *CFR* 1926, Subpart K, *Electrical*
29 *CFR* 1926, Subpart M, *Fall Protection*
29 *CFR* 1926, Subpart X, *Stairways and Ladders*
29 *CFR* 1926, Subpart Y, *Diving*
29 *CFR* 1926.24, *Fire Protection and Prevention*

Title
29 *CFR* 1926.52, *Occupational Noise Exposure*
33 *CFR* 142, Subpart B, *Personal Protective Equipment*
33 *CFR* 142.87, *Guarding of Deck Openings*
33 *CFR* 145.01, *Portable and Semi-Portable Fire Extinguishers*
33 *CFR* 145.10, *Location, Number and Installation of Fire Extinguishers*
33 *CFR* Chapter 1, *Coast Guard, Department of Homeland Security*
33 *CFR* Subchapter N, *Outer Continental Shelf Activities*
46 *CFR* Subchapters L, T, I, or J
46 *CFR* 197, *Commercial Diving Operations*
49 *CFR*, Subchapter C, *Hazardous Materials Regulations*, Part 176 *Carriage by Vessel*
49 *CFR* 171.22-25, *Authorization and Requirements for the Use of International Transport Standards and Regulations*
Ciria, *Assessment and Management of Unexploded Ordnance (UXO) Risk in the Marine Environment* (C754)
DIN EN 166, *Personal Eye Protection – Specifications*
DIN EN 388, *Protective Gloves Against Mechanical Risks*
DNV-RP N101, *Risk Management in Marine and Subsea Operations*
DNV-ST-N001, *Marine Operations and Marine Warranty*, Edition 2023-12
EI 3442, *Good Practice Guidelines for Safety Helicopter Operations*
EI, *Wind Turbine Safety Rules* (WTSR) (for low-voltage work)
EI, *Wind Turbine Safety Rules* (WTSR) (for high-voltage work), expected September 2025
EN 362, *Personal Protective Equipment Against Falls from a Height – Connectors*
EN 365, *Personal Protective Equipment Against Falls from a Height – General Requirements for Instructions for Use, Maintenance, Periodic Examination, Repair, Marking and Packaging*
EN 60903, *Standard: Electrical Insulating Gloves*
EN ISO 20345, *Personal Protective Equipment – Safety Footwear*
EN ISO 20471, *High Visibility Clothing – Test Methods and Requirements*
European Parliament and the Council, Directive 2006/42/EC on Machinery, 17 May 2006
European Parliament and the Council, Directive 2013/35/EU, 26 June 2013
Federal Aviation Administration Advisory Circular 120-92D, *Safety Management Systems for Aviation Service Providers*
Federal Aviation Administration Order 8020.11D, *Aircraft Accident and Incident Notification, Investigation and Reporting*
Fugro Marine Services, *Munitions and Explosives of Concern Desktop Study*
Global Wind Organisation, *Basic Safety Training Standard*, V19, Wind Training Standards, May 2025
G+ Good Practice Guideline, *Offshore Wind Farm Transfer*
G+ Good Practice Guideline, *Severe Weather Preparedness* (in production, with publication planned for November 2025), Energy Institute

Title
G+ Good Practice Guideline, *The Safe Management of Small Service Vessels Used in the Offshore Wind Industry*
G+ Integrated Emergency Response
G+ *Integrated Offshore Emergency Response (IOER-R): Good Practice Guidelines for Offshore Renewable Energy Developments*
G+ Manual Handling Case Studies
G+ Safe by Design Workshop Report, *WTG Service Lifts*
G+ *Working at Height in the Offshore Wind Industry*
G+/*DROPS Reliable Securing Booklet for Offshore Wind*, June 2019
Health and Safety Executive, *HSG65 Managing for Health and Safety*
Health and Safety Executive, *Safe Use of Lifting Equipment: Lifting Operations and Lifting Equipment Regulations*
HeliOffshore, *Wind Farm Recommended Practice*
IMCA *Guidance on the Transfer of Personnel to and from Offshore Vessels and Structures*
IMCA C018, *Basic Safety Training Requirements for Vessel Personnel in the Offshore Renewable Energy Sector*
IMCA D014, *International Code of Practice for Offshore Diving*
IMCA D035, *The Selection of Vessels of Opportunity for Diving Operations*
IMCA HSSE 001, *Guidelines for Management of Change*
IMCA LR 006, HSSE 019, *Guidelines for Lifting Operations*
IMCA M103, *Guidelines for the Design and Operation of DP Vessels*
IMCA M119, *Fires in (DP) Vessels*
IMCA M171, *Crane Specification Document*
IMCA M203, *Guidance on Simultaneous Operations*
International Association of Oil and Gas Producers Report 411, *Diving Recommended Practice*
International Association of Oil and Gas Producers Report 423, *HSE Management Guidelines for Working Together in a Contract Environment*
International Association of Oil and Gas Producers Report 690-1, *Safety Management System*
International Civil Aviation Organization Annex 19
ISA/IEC 62443, *Security for Industrial Automation and Control Systems*
ISO 10333-3, *Personal Fall-Arrest Systems – Part 3: Self-Retracting Lifelines*
ISO 12100, *Safety of Machinery – General Principles of Design – Risk Assessment and Risk Reduction*
ISO 15027-1, *Immersion Suits – Part 1: Constant Wear Suits, Requirements Including Safety*
ISO 23932-1, *Fire Safety Engineering: General Principles*
ISO 31000, *Risk Management – Guidelines*, 2018
ISO 45001, *Occupational Health and Safety Management System* (reaffirmed in 2022)
Maritime Institute of Technology and Graduate Studies, *Good Housekeeping and Safe Working Practices for Vessels at Sea*

Title
MGN 372, *Offshore Renewable Energy Installations (OREIs): Guidance to Mariners Operating in the Vicinity of UK*
MGN 654, *Offshore Renewable Energy Installations (OREI) Safety Response*
NEMA SG 10-2019, *Guide to OSHA and NFPA 70E Safety Requirements When Servicing and Maintaining Medium-Voltage Switchgear, Circuit Breakers, and Medium-Voltage Controllers Rated above 1000 V*
NFPA 30, *Flammable and Combustible Liquids Code*
NFPA 70, *National Electrical Code*
NFPA 70E, *Standard for Electrical Safety in the Workplace*
NFPA 850, *Recommended Practice for Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations*
NIOSH, *Applications Manual for the Revised NIOSH Lifting Equation*, September 2021
NIOSH Publication No. 83-110, *Vibration Syndrome*
NIOSH Publication No. 98-126, *Occupational Noise Exposure*
Offshore Energy UK, 2018, *Best Practice Transportation of Project Related Cargo Items: Guidance Note*
Offshore Energy UK, 2020, *Oil & Gas UK Best Practice for the Safe Packing and Handling of Cargo to and from Offshore Locations*, Issue 6
OSHA Factsheet, *Protecting Workers from the Hazards of Abrasive Blasting Materials*
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