Steel fabrication in the offshore wind industry

A good practice guidance for developers

G+ Global Offshore Wind
Health & Safety
Organisation

In partnership with energy institute

STEEL FABRICATION IN THE OFFSHORE WIND INDUSTRY – A GOOD PRACTICE GUIDANCE FOR DEVELOPERS

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1 INTRODUCTION

1.1 PURPOSE OF THE DOCUMENT

Steel is the obvious crucial element in offshore wind projects, as it is used in a major part of a wind farm, from the wind turbine generator to its foundation and the plant's substation. It faces challenging conditions, with harsh and irregular loadings, in a corrosive environment. Material strength and durability are therefore critical to support the intended design life of a project, as such, steel fabrication requirements are typically very strict to ensure that the design achieved meets the project targets. Though there is a solid basis of guidelines and standards guiding the steel fabrication steps specifically for the offshore wind sector, there is a room for improvement of the health and safety (H&S) standards that ensure safe working during such fabrication.

This document aims to present a set of formal, practical, and relevant good practice guidelines. It is intended for project developers, and addresses the major challenges in H&S during steel fabrication for offshore wind. The objective is to create a common set of guidelines to improve H&S in the industry and reduce the unfortunate rise in fatalities at the time of writing this document.

For clarity, the scope of this study covers:

- Fabrication, which begins from receipt of steel and considers all welding activities up to the inspection and acceptance of welds.
- Preparation of steel for coating (e.g. water jetting, blasting and coating).
- Mechanical completion (e.g. assembly and installation of internal platforms, internal ladders and fixings (excludes electrical)).
- Loadout, which includes upending of components and may include loading onto the transportation vessel and preparing sea fastenings.

It is recognised that many of the hazards identified within the document may be applicable to other scopes, and this guidance will be updated to cover other types of fabrication in future revisions. Fabrication of floating wind foundations may also bring other risks which have not been identified within the scope of the current document.

Throughout this document the term 'fabrication' shall mean all the scopes listed above. This document also uses the term 'developer' as the entity that plans, develops and executes the offshore wind project, and the term 'contractor' as the contractor(s) in consideration or engaged by the developer to manufacture and supply the offshore wind foundation components. Although this document is intended for developers, the successful implementation of offshore wind projects is dependent on the fruitful collaboration with the contractor.

The document focuses on primary steel fabrication, where primary steel is that which makes up the can sections of monopiles, transition pieces (TPs) and jacket legs. Conversely, secondary steel is typically that of boat landings and external platforms. Tertiary steel can be considered fittings such as rails, ladders, etc. While considered within general hazards, it is recognised that many of the secondary and tertiary elements are outsourced and fall under management of subcontractors.

This document is aimed at addressing major health and safety challenges during fabrication. It does not cover sustainability or environmental considerations. Guidance on these topics can be found, for example, at IPIECA's sustainable supply chains initiative. IPIECA is the global oil and gas association for advancing environmental and social performance across the energy transition, and thought the initiative was developed for oil and gas the principles are largely transferrable. Resources are available through: https://www.ipieca.org/work/sustainability/sustainable-supply-chains.

Nor does it cover broader working conditions and human rights issues, which can have significant impact on health and safety outcomes. Guidance on these topics can be found, for example, in the Building Responsibly principles, freely available from https://www.building-responsibly.org/. Building Responsibly is a group of leading engineering and construction companies working together to raise the bar in promoting the rights and welfare of workers in the engineering and construction industry.

This document is organised in six (6) main sections: following this introduction (section 1), section 2 outlines three key leads seen as relevant ways to address some of the most critical challenges when considering safety in steel fabrication. Section 3 then delves into the enabling activities and human aspects that are crucial to fostering a robust safety culture throughout the primary steel fabrication process. Finally, the hazardous activities specific to monopile, jackets and transition piece fabrication are covered in section 4, section 5 and Section 6 respectively; providing comprehensive guidance at various phases of the fabrication process. It should be noted that elements of these sections (4, 5 and 6) are intentionally repetitive when covering hazards present in the different fabrication scopes. This is so that the sections can be used independently.

Appendix A to Appendix H then provide detailed guidance on addressing key hazardous activities during the design and fabrication phases. These recommendations are intended primarily for the attention of the developer, who holds the responsibility for overseeing these phases. Some best practices may pertain to considerations that the developer should include in their employer requirements, while others directly align with the developer's responsibilities. By adhering to these best practices, developers can proactively mitigate risks, promote a culture of safety, and contribute to a successful and safe execution of their projects.

Finally, Appendix I lists the references used in this document.

1.2 INTERFACE WITH OTHER G+ GUIDELINES

It is recognised that these guidelines interface with other G+ guidance already issued or under preparation. In particular, guidelines on work at height (WAH) and dropped objects are covered in detail in separate guidelines (see [ref. 1]).

1.3 STANDARDS

Where these guidelines contain references to standards, then these are to the editions that were current at the date of drafting. Where it is known that a standard is undergoing major revision, this is noted, but the revised requirements are not referenced.

Prior to the first issue of this good practice guidance document, the industry has often referred to the *Fabrication site construction safety recommended practices* from the International Association of Oil and Gas Producers (IOGP, specifically IOGP 597 *Enabling activities* and IOGP 577 *Hazardous activities*, see [ref. 2] and [ref. 3]) as a means to develop their own H&S in steel fabrication standard. To facilitate the implementation of this new guidance specific to offshore wind steel fabrication, the general structure and terminology of the recommendations provided here has been aligned at a high level with the guidance offered within the IOGP documents.

2 THREE KEY LEADS FOR IMPROVING SAFETY

When considering the industry's current experience, some key risk categories can be brought out as critical challenges to address to improve safety in steel fabrication. This section outlines three initial leads for consideration that should be prioritised:

– Integrating fabrication considerations in the design.
– Clarifying H&S requirements from the procurement and contractual phase.
– Accounting for cultural differences.

Each of these aspects is further developed in the following subsections.

2.1 INTEGRATING FABRICATION CONSIDERATIONS IN THE DESIGN

Improving H&S in steel fabrication for offshore wind can begin well before the first steel plate is being manufactured. In particular, it is generally recognised that lessons learnt during fabrication should feed into future design. For example, means to safely implement passive control measures such as netting can be considered in the design.

From the perspective of the contractors, opportunities should be provided for them to contribute input into projects. This approach would enable designs to better address production challenges and help design out hazards, rather than relying on controls during fabrication.

This becomes even more essential when progressing toward the XXL generation of monopiles. The size of these foundations exacerbates existing challenges, and creates a number of new ones in terms of handling, space availability, or equipment. Consideration should be given to the contractors' restrictions in order to ensure safe fabrication.

In general, it is critical to adopt suitable safe-by-design principles (see [ref. 8] for guidance on applying safe-by-design) to reduce personnel risks, and every step of the fabrication process should be considered in the design to account for both fabrication and logistical challenges, such as multiple lifts or transportation, ergonomics, access/egress, loadout capability/capacity (roll-on roll-off (RORO), onshore crane or vessel crane. Risk management can be used early in the design process to then emphasise H&S throughout the fabrication process. Including input from those directly involved in fabrication helps to better understand challenges and design for production. This approach not only improves safety but also introduces cost savings and operational efficiencies.

2.2 CLARIFYING H&S REQUIREMENTS AT PROCUREMENT AND CONTRACT STAGES

To date, the procurement process has been primarily driven by cost and availability, with H&S being considered but more treated as a determining factor in contract awards. Even results of specific audits covering quality and H&S rarely impact the final decision to award the scope of work. More commonly it is seen that a stringent set of contractual H&S requirements are placed on the contractor in an attempt to ensure H&S performance. However, this approach can result in the developer being required to adopt a less effective, reactive and sometimes more controlling approach to minimise potential incidents. It should be recognised that the developer has a responsibility to identify potential challenges and work with the contractor to improve the overall H&S standard.

While costs and availability are indeed critical factors with direct impact on the feasibility of a project, it should be considered that a lower sale price can reduce the available capital for focusing on H&S. Additionally, focussing on capacity and/or availability does not give reassurance that H&S performance will be acceptable, and it is imperative that suppliers are also selected based on how they propose to manage H&S. Consideration could be given to ringfencing the H&S budget during tender, meaning that all contractors participating in the tender phase are required to specify and guarantee a minimum H&S budget that is then safeguarded from potential compromise resulting from competitive bidding. Implementing such an approach would not preclude developers from requiring H&S resources beyond this minimum (e.g. to close gaps identified during contractor evaluation stages or if they deem it insufficient).

When considering historic data, some of the more notable trends identified as part of the investigation and subsequent reporting process include poor situational awareness, failure to identify and manage simultaneous operations (SIMOPs), and lack of supervision. It is recognised that the use of transient workforces makes it challenging to establish and develop safety culture. Beyond managing contractors via the enforcement of contractual H&S requirements and monitored with client representatives (CRs) who have a relevant H&S background, the responsibility to ensure a positive and safe working environment should be clarified from the contract set-up between the project developers and their contractors.

Tools and methods for conducting detailed root cause analysis (RCA) should, in practice, greatly reduce the likelihood of recurrence. Incident reports should provide detailed and effective corrective and preventative actions. However, it is commonly observed that initial incident investigations lack detail and are unlikely to identify the true root cause. When clarifying H&S requirements during contract set up, it should be considered to specify a recognised incident investigation methodology and evidence of training for that methodology.

The impact of the procurement and contracting models should be considered, alternative approaches could be investigated to ensure that H&S performance is suitably accounted for compared to cost and capacity, and that H&S requirements are clearly stated.

2.3 ACCOUNTING FOR CULTURAL DIFFERENCES

This guidance document considers culture to mean the values, beliefs, systems of language, communication, and practices that people share and that can be used to define them as a collective. In the context of H&S, it is essentially the aspects related to risk that are shared within an organisation, and that can be promoted by individual learning on one hand, but even more importantly by senior management, enforcement of realistic practices for handling hazards, continuous organisational learning, and care and concern shared across the workforce.

It is generally recognised that awarding projects to yards that have a limited H&S culture, with limited budget and resource for improving or putting focus on such culture, will represent an accrued risk for unplanned events and additional challenges for that project. Changing culture requires acceptance and understanding of those involved as to why change is required and is a process that typically spans over a much longer time frame than a single project.

Industry feedback suggests that developer commitment and contributions towards the enhancement of project safety go a long way and a collaborative approach is well received. Consideration for how this continues upon project completion should also be considered.

An efficient mitigation measure could be to clearly specify H&S requirements from the procurement phase (see also 2.2) so that the H&S aspects are stated contractually. This is particularly so when pre-qualification investigations evidence significant risks due to lesser H&S culture. Early engagement (e.g. from the design stage – see also 2.1) and support should also be considered, ensuring streamlined communication between the parties, particularly relevant in a context where a rapidly changing industry transforms process requirements.

Finally, the cultural differences between countries and between organisation mindsets (project developer vs. fabrication yard), although positive in many different aspects, can negatively impact H&S. Language or reference barriers, differences in leadership behaviours and expectations, differences in training, miscommunication, environments or organisations that are poorly inclusive, can lead to conflicts, stress and ultimately to H&S incidents. Open communication between parties, with clear channels and respectful approaches to cultural differences, are essential, and the leadership of developers is a key aspect of it.

3 ENABLING ACTIVITIES AND HUMAN ASPECTS

The success of safety initiatives within the offshore wind industry starts with recognising and managing the human and organisational factors that contribute to overall safety performance. This section delves into the enabling activities and human aspects that are crucial to fostering a robust safety culture throughout the primary steel fabrication process. In particular, the following aspects are covered:

- Roles and responsibilities (3.1):
  - Provides guidance on establishing accountability, ensuring that every team member has a clear understanding of the different roles in promoting and maintaining a safe working environment.
- Standardisation of contractors’ requirements (3.2):
  - Provides guidance on defining contractors' safety requirements, outlining best practices for integrating safety expectations seamlessly into contractual agreements.
- Training and awareness (3.3):
  - Provides guidance on developing comprehensive training programs, ensuring that all personnel are equipped with the necessary skills and knowledge to identify and mitigate potential hazards.
- Incident reporting and investigation (3.4):
  - Provides guidance on establishing incident reporting mechanisms and conducting thorough investigations to uncover root causes, ultimately informing preventive measures.
- Compliance and auditing (3.5):
  - Provides guidance on defining strategies for ensuring ongoing compliance with safety requirements through regular audits and a proactive approach.
- Continuous improvement (3.6):
  - Provides guidance on implementing a culture of continuous improvement, considering lessons learned.

3.1 ROLES AND RESPONSIBILITIES

This section describes the roles and responsibilities of key project stakeholders (outlined in 3.1.1) in ensuring a culture of safety, considering the various relevant phases of the project lifecycle, from the design, through tendering activities, and up to fabrication execution.

3.1.2 to 3.1.4 describe these roles and responsibilities in more detail from the developer’s perspective. The contractor roles, while listed in Figure 1, are not described in detail due to the complexity of organisational structures. The positions listed should be considered ‘likely’ positions that exist within a contractor organisation and are suggested interfaces for the developer to work with during each phase.

3.1.1 Role involvement per phase

Figure 1 outlines the different key roles and high-level hierarchy of reporting from the different phases.

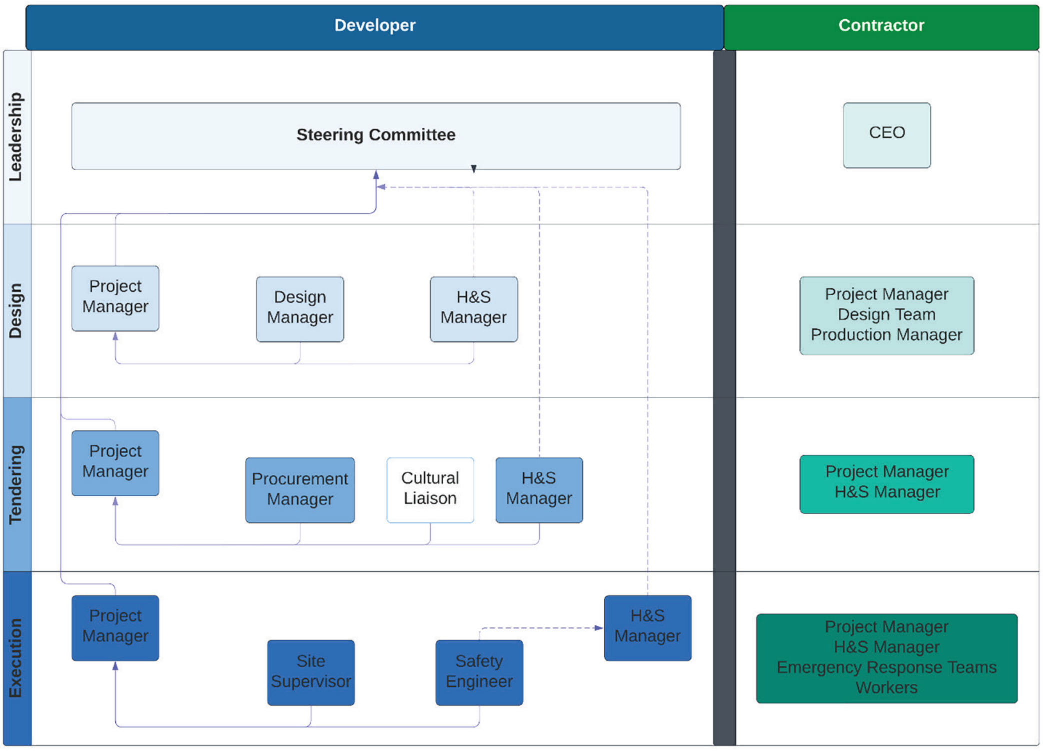

Figure 1: Example key H&S roles per project phase

While the roles and responsibilities outlined in this section serve as comprehensive guidelines, it should be acknowledged that the project specificities, including its scale, location, and specific requirements, may necessitate tailored approaches to safety management.

Leadership is key to developing and maintaining a safe work environment. For each phase it should be recognised that the leadership and direction provided from the developer's steering committee and that of the contractor's senior management plays a vital role in how other stakeholders of the project engage and embrace the values set out.

It is strongly recommended that project stakeholders engage in a thorough review and discussion regularly and from an early stage to define roles and responsibilities that align with the unique characteristics of the project. Such collaborative effort ensures that safety considerations are intricately woven into the fabric of the project's design, tendering and execution strategies. By customising these guidelines based on project-specific considerations, the project can cultivate a safety culture that is not only robust but tailored to the distinctive requirements of the offshore wind initiative.

3.1.2 During design

The project developer should appoint relevant personnel to the following roles during the design phase:

Project manager:

- Role:
  - Overall responsibility for project safety.
  - Develop and communicate the project's safety objectives.
  - Allocate resources for safety initiatives.
  - Oversee the implementation of safety policies and procedures.
- Responsibilities:
  - Integrate safety parameters into project feasibility studies.
  - Establish preliminary safety goals for the fabrication phase.
  - Ensure that safety considerations (including lessons learned, industry and local environment, relevant standards and regulation, etc.) are incorporated into design specifications.
  - Collaborate with designers to address safety concerns in the project layout.
  - Ensure risk register is managed and any issues are tracked and mitigated.

Design manager:

- Role:
  - Integrate safety features into project designs.
  - Ensure product interfaces are considered across all components.
- Responsibilities:
  - Consider risk assessments from the project's concept phase.
  - Define safety measures in alignment with project constraints.
  - Design structures with inherent safety measures.
  - Host or attend safe by design workshops.
  - Consider fabrication safety in the selection of materials and construction methods.

While the roles mentioned above are essential for the design phase, it is important to recognise that additional expertise in H&S can significantly enhance the safety considerations embedded within the design. Therefore, it is strongly recommended to ensure involvement from individuals with experience in both design and H&S domains. This early involvement is critical for identifying and mitigating potential hazards during fabrication, installation and operation. Consideration should also be given to engaging contractors and fabrication specialists early on, as their insight can help reduce hazards in the build phase.

3.1.3 During tendering

The project developer should appoint relevant personnel to the following roles during the tendering phase:

Project manager:

- Role:
  - Overall responsibility for project safety.
  - Develop and communicate the project's safety objectives.
  - Oversee the implementation of safety policies and procedures.
- Responsibilities:
  - Allocate resources for safety initiatives.
  - Ensure that the procurement process aligns with the project's safety goals and objectives.
  - Integrate safety-related budget considerations into the overall project budget.
  - Work with procurement manager to ensure lessons learned from previous projects are considered in procurement phase.

Procurement manager:

- Role:
  - Include safety criteria in the procurement process.
- Responsibilities:
  - Specify safety requirements in contracts with fabrication yards.
  - Evaluate potential suppliers based on their safety track record.
  - Ensure lessons learned from previous projects are considered in procurement phase.

Health and safety manager

- Role:
  - Ensure alignment between safety goals and procurement decisions.
  - Collect relevant lessons learned from previous projects.
- Responsibilities:
  - Review and approve safety plans and supporting documentation from potential contractors.
  - Provide safety expertise during the supplier selection process.
  - Support in conducting audits of contractor locations.

Cultural liaison:

- Role:
  - Support the project stakeholders in understanding cultural differences and provide insights into local customs, traditions, and communication styles.
  - Act as a liaison between contractor and project stakeholders to cultivate relationships and maximise engagement.

  - This role may be integrated into an existing position, such as the safety engineer, or established as a standalone role dedicated to fostering cultural understanding and collaboration.
- Responsibilities:
  - Work with stakeholders through all phases to ensure cultural differences are identified and advise on best practice.
  - Attend key meetings where cultural sensitivity is required (e.g. may be workers union or fishermen local to the fabrication site).
  - Provide guidance and support to project teams on navigating cultural differences and fostering inclusive and effective communication.
  - Offer ongoing training and resources to project personnel on cross-cultural communication and awareness, promoting a culture of inclusivity and respect.
  - Continuously evaluate and adapt strategies for addressing cultural differences, seeking opportunities for enhanced collaboration and relationship-building.

3.1.4 During execution

The project developer should appoint relevant personnel to the following roles during the execution phase, and until project close-out:

Project manager:

- Role:
  - Overall responsibility for project safety.
  - Develop and communicate the project's safety objectives.
  - Oversee the implementation of safety policies and procedures.
- Responsibilities:
  - Allocate budget for H&S resource, equipment and safety initiatives.
  - Work closely with the H&S manager to monitor and enforce safety regulations on-site.
  - Communicate safety expectations and progress to project stakeholders, including fabrication yards and contractors.
  - Provide regular updates on safety performance to the project team.
  - Provide proactive and continuous risk management.

Health and safety manager:

- Role:
  - Oversee safety during the fabrication process.
  - Manage team of safety engineers/coordinators.
- Responsibilities:
  - Ensure project is performing in accordance with H&S policies across all sites.
  - Advise project manager on required resource, tools and equipment.
  - Coordinate H&S matters with all stakeholders.
  - Ensure suitable resource to provide safety training to project personnel.
  - Ensure suitable resource to conduct regular safety inspections and audits.

  - Ensure the mitigation of identified hazards acceptable.
  - Develop and implement process for investigating incidents and near misses, in coordination with site supervisor and relevant stakeholders.

Site supervisor:

- Role:
  - Implement safety measures on the ground.
- Responsibilities:
  - Monitor day-to-day compliance with safety protocols.
  - Conduct safety briefings and toolbox talks.
  - Conduct regular safety inspections.
  - Report incidents and near-misses to relevant stakeholders as defined in H&S plan.

Safety engineer/coordinator:

- Role:
  - Represent specific teams or departments regarding safety matters.
  - Provides support and guidance in H&S specific matters.
- Responsibilities:
  - Act as a liaison between workers and management on safety issues.
  - Conduct regular safety inspections and provide support and expertise to the project team.
  - Ensure safety meetings are being held in accordance with H&S plan, participate and provide input and feedback.
  - Report safety concerns to the management team and work proactively with contractor to address in a practical manner.

Client representative:

- Role:
  - Oversight of safety from the client's perspective.
- Responsibilities:
  - Ensure that safety requirements are included in contracts.
  - Monitor the safety performance of contractors.
  - Collaborate with project management to address safety concerns.

3.2 STANDARDISATION OF CONTRACTORS' REQUIREMENTS

This section addresses the critical aspect of standardising contractors' requirements when tendering the fabrication of primary steel.

Contractors are typically faced with H&S requirements from project developers, due to the variety in backgrounds and experience from the latter, some may be specific for steel fabrication, but others may be more generic. In general, a common approach to standardisation of such agreements will give contractors a better chance to meet one set of standards and build on them.

This guidance aims to highlight developers' responsibilities in minimising conflicts in fabrication standards, understanding the complexities of various regions, and ensuring that safety and project requirements remain fit for purpose.

The section considers the definition of the contractor's safety requirements (3.2.1) and their integration into contractual agreements (3.2.2). Finally, guidance regarding the selection of contractor is provided in 3.2.3.

3.2.1 Defining health and safety requirements

When defining safety requirements, project developers need to establish a robust framework that effectively addresses the unique risks associated with their project. For this purpose, project developers should:

- Ensure early identification and appreciation of production process and any variations to the standard production line:
  - Collaborate with relevant contractors in the early stages to understand if the design presents any significant challenges that require an immediate dialogue. In particular, consider alignment with designer to assess if the design requires changes to the fabrication method and process initially envisaged. Storyboards can be useful tools for understanding the fabrication process and should be requested where available.
- Schedule periodic reviews of safety requirements in collaboration with contractors, adapting them to evolving project needs, technological advancements, and lessons learned. Conduct comprehensive risk assessment:
  - Identify any specific laws or regulation specific to the region and ensure developers' minimum safety requirements make reference to them. When developers' minimum safety requirements are more stringent, they should be included within the employer's requirements.
  - Identify project-specific risks that may influence safety requirements, ensuring that each requirement is tailored to address the unique challenges of the project.
  - Work with contractor to understand if process or equipment changes introduce new hazards in their fabrication process. An example could be new material handling equipment such as rollers, lifting devices, or forklifts. Other examples may be reduced working areas and increased risk of pedestrian injury.
- Align with project objectives:
  - Ensure that the contractor's H&S plan and safety requirements align seamlessly with the broader project objectives and requirements, such as those outlined in the developer's H&S plan. This creates a unified vision for safety within the contractual framework.
  - Ensure that both parties appreciate any changes required and the implications (e.g. training, new personnel, new equipment) and that future requirements take these additions into account.

- Mandate a minimum fixed H&S budget:
  - In tender documents, stipulate a minimum (fixed) cost for H&S management. This ensures that all tendering parties commit equally to H&S expenditures, and price reductions focus on other areas.
- Consider subcontractor management:
  - Layers of subcontract should be no greater than two unless formally agreed.
  - The contractor remains accountable for all subcontracted works. It is recommended to include suitable equivalent articles in subcontracts to meet the requirements of the Contract and an obligation to comply with these requirements.

3.2.2 Integration into contractual agreements

As safety requirements take shape, the focus shifts to seamlessly integrating these specifications into contractual agreements, ensuring clarity, enforceability, and alignment with project objectives within the contractual framework. For this purpose, project developers should, in their contractual agreements:

- Ensure clarity in contract language:
  - Draft safety requirements using clear and unambiguous language within contractual agreements to minimise the risk of misinterpretation.
- Include clear performance metrics:
  - This allows for benchmarking against industry standards, and reduces administrative burden on contractors, making the overall reporting more systematic and efficient.
  - Use measurable H&S performance metrics related to safety expectations, taken from (to the extent possible) recognised metrics found within the industry, enabling effective monitoring and evaluation of contractors' safety compliance.
- Ensure clarity around any specific training requirements for the project:
  - Where specific training requirements are required for the project then they should be captured within contract language. Examples may include specific certification for work at height and rescue.
- Stipulate minimum H&S resource requirements:
  - Ensure H&S resource requirements are clearly defined within the contract. This should include number of resources required, competence levels, and clarity on their location and working hours.
- Include regular safety tours and project audits:
  - Incorporate provisions for periodic H&S audits and safety tours, in order to review contractor conformance to H&S plan and contract.
  - Make clear that site teams will have unobstructed access to all project areas in order to conduct safety tours and audits.
  - Where the project is without an onsite presence, it is important to include a clause requiring access for safety tours and audits within a reasonable time frame.

- Address H&S management of subcontractors:
  - Include provision for limiting levels of subcontracting.
  - Ensure clarity on responsibilities for managing subcontractor activities.
- Emergency response planning (ERP):
  - Develop comprehensive emergency response plans within contractual agreements, outlining the roles and responsibilities of contractors in the event of unforeseen incidents.
  - Ensure the ERP is tested by conducting drills at the earliest opportunity and any lessons learnt are implemented in a timely manner.
- Project reporting:
  - Include provision to include monthly reporting of H&S performance data (see 3.2.1).
  - Ensure that the reporting metrics are standardised to minimise administrative burden on contractor.
  - Ensure clear and detailed requirements for the reporting of incidents throughout the project. This should include reporting of accidents, incidents including unsafe acts, conditions and positive behaviour.
- Incident reporting:
  - Ensure requirements for reporting of incidents are clearly defined, including:
    - Reporting timelines based on incident severity.
    - Clarity on definitions.
    - Persons to notify.
    - Expected minimum investigation outcomes.
- Incentivise safety excellence:
  - Consider integrating safety performance incentives into project contracts to motivate contractors to surpass minimum safety standards, fostering a culture of continuous improvement. Clients could also, for example, reward and celebrate when safe decisions are made, even at the detriment to production schedules. Safe decisions by individuals and organisations should not be contractually disincentivised or even penalised. Examples of incentives could be contributions to the fabricators' personal protective equipment (PPE), equipment, or training.

Established safety organisations, such as the G+ Offshore Wind, can be used to engage with developers and encourage them to share their own experiences with contractors, with a view to share lessons learned and stimulate the standardisation of contractual requirements.

Open dialogue and collaboration between developers and contractors is encouraged to identify areas for safety improvement collaboratively. The contractors should be incentivised to actively participate in safety improvement initiatives and share best practices.

3.2.3 Guidance on selection of contractor

Before engaging with a contractor, thorough pre-selection considerations are essential. To ensure alignment with safety principles, the project developer should, in collaboration with the relevant H&S department where needed:

- Request completion of a Supplier Qualification Questionnaire (SQQ) that includes a specific section for H&S, covering in particular:
  - Certification to ISO namely 45001:2018 or equivalent.
  - Capacity over project duration. In particular, consider other parallel projects that may take up capacity and impact works.
  - Track record of similar projects delivered.
  - Capability considering design (weight and size) and consideration of needs for adjustments or new purchases.
  - Equipment availability and condition.
  - Overall H&S organisation.
  - Number of employees (employed vs subcontracted).
  - Competencies are aligned with project requirements.
  - Languages spoken.
  - H&S performance (consider using G+ incident data for ease of benchmarking).
- Conduct pre-selection audits of potential contractors well in advance of award, with a focus on project specific H&S requirements:
  - Consider the maturity of the contractor's safety culture, for example, assessing if the workforce is aware of what is required from them and their H&S awareness, the contractor's reliance on a transient workforce and how are they integrated into the contractor's culture, and how lessons learned from previous projects have been implemented.
  - Where nonconformities have been identified as part of a pre-selection audit, the developer should consider the effectiveness of the contractor's actions to close-out.
- Evaluate the suitability of the different contractors regarding H&S topics:
  - Define a balanced weighting system to ensure a fair representation of H&S concerns in the assessment, in particular against capacity and price (see also 3.2).
  - If contractor options are limited, for example, due to local content requirements or general availability, flag the limitation within the project risk register and define high-level mitigations.

Where the audit identifies significant nonconformities or concerns, developers should review budget, resource allocation and potential impact to program based on various worst-case scenarios (e.g. equipment failure, serious incident, fatality). As mentioned in 3.2.2, where the tendering phase culminates in the award of a contractor with a low scoring H&S performance, the project developer should consider a level of accountability to mitigate potential performance issues during execution. Possible mitigation measures include allocating a lump sum in the contract to dedicate to H&S resource, having client representatives in place, taking initiative to have safe by design meetings early on including production, and openly discussing challenges that both sides see.

3.3 TRAINING AND AWARENESS

Training is a critical step to ensure that fabrication site personnel have the necessary qualifications and competence to conduct their work safely. This section provides guidance on training and awareness for the offshore wind primary steel fabrication, offering recommendations on responsibilities (3.3.1), topics and methods (3.3.2), and the nuanced consideration of cultural behaviour (3.3.3).

3.3.1 Responsibilities

This section outlines the specific responsibilities of developers and contractors in establishing robust training and awareness programs to enhance safety culture and mitigate risks.

By clarifying the roles split between developers and contractors, stakeholders can collaboratively contribute to fostering a safe and productive work environment throughout all phases of the fabrication process.

- Developers should as early as possible:
  - Ensure a collaborative approach with contractors, ensuring that suitable levels of H&S training and familiarisation are in place for fabrication and assembly activities.
  - Utilise previous project lessons learned and best practices to continually improve the developer's own awareness.
  - Develop a project H&S charter to demonstrate commitment to H&S from the highest level.
  - Ensure timely distribution of project-specific H&S plan and supporting documents to allow for alignment with contractor’s plan.
  - Develop a clear training matrix for project personnel across all phases including those in fabrication yards and load-out areas. Project-specific H&S training or extended induction programmes could be implemented if recognised local standards are not available, and an agreement can be reached between the developer and fabricator.
  - Consider holding, for example, a dedicated safety awareness day where all stakeholders (subcontractors encouraged) attend, H&S expectations are set, and the project charter is reviewed and signed as a commitment from all. This is an opportunity to set the tone and approach to managing safety, for example moving away from the policing approach and more towards behavioural safety and coaching techniques.
  - Ensure the project team undergoes necessary project safety training relevant to location and specific to the hazards they may encounter within that location. This will aid in providing tools to influence and improve safety culture.
  - Ensure there is a dedicated safety engineer/coordinator (see 3.1.4) with the necessary competence who can provide subject matter expertise into the project documentation and ensure that the documents are made specific to the project environment.
  - Ensure there are sufficient H&S resources to monitor contractor performance in each location. This may be permanent client reps or periodic visits with coaching and support.
  - Stay informed about relevant safety regulations and compliance standards.
  - Prepare a project-specific safety induction and ensure all project personnel complete the induction.

- Contractors should:
  - Be able to demonstrate an effective system (documented and traceable) for ensuring personnel are trained and competent for their roles, that the training is current and valid, and at minimum, matches local and client requirements.
  - Demonstrate that they have adequately assessed the project risks and identified any new risks and training needs as a result of change. This should consider new personnel, capacity, equipment as well as critical components, technology, and product.
  - Prepare an H&S plan that aligns with the developer's requirements and expectations.
  - Demonstrate that their personnel have been consulted in the preparation of the risk assessment and can provide evidence that personnel have reviewed and understood the risk assessment and necessary controls.
  - Demonstrate that they engage in continuous improvement programs, providing opportunities for ongoing learning and adaptation to evolving safety standards and best practices.
  - Recognise and address cultural nuances by incorporating cross-cultural training into the safety curriculum, fostering harmonious collaboration between diverse teams.
  - Provide detailed H&S performance metrics to benchmark against others within the sector.

3.3.2 Training and awareness topics

The following provides a list of training and awareness topics that developer should adhere to ensure that the project team has the minimum knowledge required regarding H&S for the project:

- Project charter launch, typically via safety awareness day (see 3.3.1).
- Project specific induction from developer.
- Local legal requirements, such as risk assessment, emergency response (specific training for different scenarios such as rescue from WAH or from confined spaces), hazardous substances, first aid, work at height, maintenance of equipment, PPE, lifting operations, SIMOPs, etc.
- Additional topics required as identified from the gap analysis (see 3.3.1) and risk assessments conducted.
- Emergency response drills. Those should be conducted as early as practicable to prove effectiveness.
- Hazard Identification (HAZID) workshops bringing all stakeholders together to contribute to making high risk activities as safe as reasonably practicable.
- Permit to work training (PTW) where applicable.
- Reporting of incidents, unsafe acts or conditions, and positive behaviours.
- Carry out incident investigation training for relevant personnel. This can be managed internally or externally with a third-party, industry-recognised trainer and will aid in standardising the approach to investigation.
- Follow cultural sensitivity training, recognising the impact of cultural behaviour on safety practices (see also 3.3.3).

3.3.3 Cultural behaviour awareness

The success of safety training and awareness initiatives is typically tied to an understanding of cultural behaviour within the entities involved. Cultural nuances influence learning, communication, and the adoption of safety practices. To ensure that safety practices are understood and embraced across diverse cultural landscapes, developers and contractors alike should:

- Appoint cultural liaisons:
  - It is advised, as early as possible, to appoint cultural liaisons (see 3.1.3) within the project team who can act as bridges between different cultural groups, facilitating understanding and cooperation, particularly in safety-related matters.
- Get baseline of safety culture maturity:
  - There are many models for establishing a company's safety maturity level. It is recommended when conducting pre-selection audit (see 3.2.3) to develop a scoring system that will aid in assessing the contractor's maturity level in relation to the chosen matrix.
- Customise safety training:
  - Customise safety training programs to account for cultural nuances, making the content relatable and ensuring that safety practices resonate with individuals from various cultural backgrounds, and complement adequately the specific knowledge and awareness of the region.
  - Discuss behavioural safety programs, also known as behaviour-based safety or behaviour modification. They can be contractor or developer led and should have active participation from all parties with top management leading the way (see 3.4.1) and taking initiative to engage on all levels. This type of training and approach aims to improve safety by changing the behaviour. It should be designed so that it focuses on observing and reinforcing safe or unsafe behaviours in the workplace.
- Foster diversity awareness:
  - Cultural awareness and sensitivity are a key aspect to consider when working in regions with diverse backgrounds. Training to recognise and respect the customs, traditions, and social norms of different cultures should be provided. Training should encourage individuals to be open-minded and non-judgmental when interacting with individuals.
  - Language barriers can often pose challenges in cross-cultural communication. It is recommended to minimise complex language, support instructions with graphics, encourage patience with non-native speakers, and make use of translators or translation tools to develop native language project documents.
  - It should be recognised that nonverbal communication plays a significant role in cross-cultural interactions. Gestures, facial expressions, and body language can have different meanings across cultures. Training and familiarisation of these nuances and adapting nonverbal cues will help avoid misinterpretations or misunderstandings.
  - Building trust is vital for effective cross-cultural communication. Training in active listening skills can help to demonstrate respect for other perspectives. Active listening requires the practice of empathy and encourages awareness of our own bias and enables an open-minded approach when communicating.

3.4 INCIDENT AND OBSERVATION REPORTING AND INVESTIGATION

Robust incident and observation (unsafe acts or conditions) reporting, and investigation processes are cornerstones for a proactive and effective safety culture within the offshore wind fabrication industry. This section outlines the essential steps recommended for reporting and investigating incidents and observations, in 3.4.1 and 3.4.2 respectively.

3.4.1 Reporting process

To ensure the project builds a positive culture towards the reporting of incidents and observations the developer should follow the key steps below:

- Strong and visible leadership commitment:
  - Emphasise from the highest level (project owner, project manager, etc.) the importance of reporting incidents and observations towards unsafe behaviour to all workers, and ensure prompt feedback and action where required.
  - Prepare a project policy that clearly states the commitment from key positions (see 3.1.4) within the project. Ensure it is visible and clear for all personnel working on the project.
  - Ensure that the project charter includes a strong emphasis on the importance of transparent reporting of incidents and observations.
- Establish clear reporting channels and effective reporting system:
  - Establish clear procedures and channels for reporting incidents, unsafe acts/conditions or positive behaviours promptly and in alignment with recognised industry standards.
  - Have clarity on severity and actions for each category. All incidents and observations should be subject to investigation and the severity of the event should dictate the level of investigation required.
  - Define clear process to follow upon occurrence of an incident or observations. For observations, the process should describe what to report, how to report, when to report, what to expect, and the next steps/actions for those that receive the report. For incidents, the process should describe the initial measures to make the area safe, issue initial notification and/or collect photographs and necessary witness statements.
  - Ensure that the system established is suitable for the different work environments. Example may be that a reporting tool is downloadable to mobile phones, however in some areas (e.g. painting areas), there may be rules against mobile phone use, and the reporting tool should be adjusted.
  - Consider accessibility of any software, to ensure that the system established is fully accessible to everyone of all abilities.
  - Provide anonymous reporting options to encourage open disclosure of incidents, unsafe acts/conditions or positive behaviours, assuring team members that their comments will be treated confidentially and without fear of reprisal.
  - Ensure there is an effective feedback loop to the individual or area reporting the incident or observation. Failure to provide feedback can discourage future reporting.
  - Provide training on the use of incident reporting systems, ensuring that all team members are apt at utilising the tools available for timely and accurate reporting.

- Immediate reporting protocols:
  - Emphasise the importance of immediate incident reporting once safe to do so, enabling timely investigation and effective immediate controls. Delays or failure to report can result in more serious events occurring and missed opportunities to learn.
- Standardised templates:
  - Use standardised reporting templates that capture essential information uniformly. This ensures consistency and facilitates a comprehensive review of incidents.
  - Consider accessibility when preparing templates, e.g. colour impairment, dyslexia, language, etc.

3.4.2 Investigating process

Once an incident or an observation has been reported, it is of paramount importance that it is properly reviewed and, where required, investigated. A sign of a strong safety culture is the investigation and follow up of all occurrences so that effective correction and preventative measures can be implemented. A systematic approach to incident investigation should be followed, encouraging multidisciplinary collaboration for a thorough analysis and prevention of recurrence, as follows:

- Competent investigation teams:
  - Where appropriate, form multidisciplinary investigation teams comprising individuals with diverse expertise, ensuring a comprehensive analysis of incidents from various perspectives.
- Root Cause Analysis:
  - Where procedure dictates, conduct thorough RCA to identify the true root cause of the incident and minimise likelihood of it reoccurring.
  - This analysis serves as a foundation for effective corrective and preventive actions.
  - Suitable industry-recognised investigation tools should be considered. An example of this could be the Energy Institute's Tripod Lite (see [ref. 5]), or the more detailed Tripod Beta (see [ref. 6]).
  - For observations, it should be noted that the requirement for conducting a thorough RCA can be dependent on the severity or frequency of submission. The end goal of conducting such analysis being essentially to minimise likelihood of observations leading to an incident. It is strongly encouraged to proactively address trends coming from the reporting of observations to prevent future incidents.
- Documentation:
  - Establish protocols for the meticulous documentation and archiving of evidence during investigations, ensuring the integrity and accuracy of the investigative process.
  - Use standardised investigation reporting templates that capture essential information uniformly. This ensures consistency and facilitates a comprehensive review of incidents.
  - Align investigation and reporting procedures with recognised industry standards.
  - Provide training on the use of investigation tools, ensuring that all team members are adept at using them for timely and accurate reporting.

- Follow up and verifying effectiveness:
  - Incident investigations should be recognised and promoted as invaluable learning opportunities for the entire project team. Where learnings are identified, it is important to consider:
    - How will the learnings be communicated?
    - What short-term checks will be in place?
    - What long-term checks will be in place?
    - How will these be sustained?
    - Have they made a positive difference?
    - How is this known?

    This verification process can be confirmed as part of safety tours, audits or general follow up.
  - Learnings from investigations should be communicated in an open and transparent manner and shared with industry recognised organisations who are working collectively to reduce incidents in the sector.
  - For observations, providing feedback is vital to maintaining and improving the reporting culture. Consider how feedback is provided. Examples could be via newsletter, push notifications via mobile app, poster campaigns.
  - Consider employee recognition programs where immediate verbal feedback and recognition is provided by key project members or management. This will enforce the values set out within the H&S policy and charter and encourage more participation when individuals see action and recognition.

3.5 COMPLIANCE AND AUDITING

This section outlines key considerations throughout the execution phase (3.5.1 upon kick-off and 3.5.2 during execution). Additionally, it outlines robust auditing procedures aimed at meticulously verifying safety compliance during the fabrication process (3.5.3).

3.5.1 Compliance prior to execution

Upon award and prior to commencing fabrication, the following steps are critical to help ensure alignment with safety principles:

- Hold a project kick-off meeting with key stakeholders to ensure understanding of project requirements.
- Verify that actions identified as part of the pre-selection audit have been closed or have suitable and realistic close-out dates agreed.
- Ensure that the project risk register includes all concerns from the selection process, with clear owners and mitigations assigned.
- If required, conduct a follow up audit to ensure suitable and effective close-out of nonconformities or concerns identified in preselection audit.
- As per contract, review contractor's H&S plan, as well as relevant supporting documentation to demonstrate control of hazards during fabrication. This should be carried out in line with the timelines defined in the document review clause.
- Establish an effective document management system, including review and approval process, to ensure control over contractor-submitted documents.

3.5.2 Compliance during execution

Once in the execution phase, maintaining safety compliance becomes paramount. Continuous monitoring by means of data review, regular safety tours, and audits are key to upholding safety standards throughout the fabrication process. Project developers should:

- Ensure a continuous monitoring:
  - Implement continuous monitoring mechanisms to track safety performance during execution (see 3.6.1 and 3.6.2).
  - Ensure regular reporting for prompt identification of deviations from safety standards, allowing for immediate intervention and where necessary corrective action.
  - Consider an onsite presence (see 3.1.4) whereby H&S monitoring and verification of implementation can be witnessed in real time. This provides an opportunity to develop relationship with contractor and provide coaching to better practice. Where necessary it allows for early intervention of nonconformities to project plan and contract requirements.
- Regular safety tours:
  - Standardise the categories and criteria to be measured within reports to facilitate the monitoring of improvements or trends.
  - Engage with workers to understand their behaviour; these tours are opportunities for observations, not policing.
  - Promptly provide specific positive feedback when applicable to reinforce desired behaviour.
  - Where behaviour needs to be corrected, provide feedback in an objective manner and without adding personal opinions or interpretations.
  - In general, aim for a 4:1 ratio of positive to corrective feedback.
- Regular safety audits (see also 3.5.3):
  - Conduct regular safety audits throughout the fabrication process.
  - Involve key project personnel (see 3.1.4) to demonstrate commitment to safety.
  - These audits serve as a proactive measure to verify compliance to project H&S plan, identify potential risks, and foster a culture of continual improvement.
  - Actions identified as part of the audit should be tracked through to close-out.

3.5.3 Auditing procedures

Robust auditing procedures are critical to ensure the effectiveness of safety measures. To enable a systematic and effective verification of safety compliance, the project developer should:

- Prepare a clear and project-specific audit plan:
  - Prepare an audit plan that clearly defines the areas and activities of focus. The purpose should be to demonstrate effectiveness of process and procedures specific to the project needs.
  - Pay attention to special processes and newly defined procedures that may be required as part of the scope. (e.g. working at height, lifting and hoisting, confined space, logistics of sections).
- Objective safety auditing criteria and checklists:

  - Develop objective auditing criteria and checklists specifically tailored to assess compliance.
  - This ensures a standardised and systematic approach, leaving no room for ambiguity.
- Multidisciplinary audit teams:
  - Consider forming multidisciplinary audit teams comprising safety experts, quality assurance professionals, and project managers. The positions are all linked and failures in one discipline can result in a knock-on effect to the others, therefore this approach can save cost and give a more holistic view of overall project performance.
  - This collaborative approach brings diverse perspectives to the auditing process, enhancing its effectiveness.
- Documentation and reporting:
  - Establish clear protocols for documentation and reporting of audit findings.
  - Transparent communication of results facilitates swift corrective actions and provides valuable insights for continuous improvement.
- Follow up and close-out:
  - Ensure the actions proposed by the contractor are realistic, timely, and effective.
  - Continue to track open items until close-out, and ensure a mechanism is in place to evaluate the effectiveness of the close out action.
  - Any nonconformities identified as part of the audit process that have the potential for significant impact to project should be captured within the project risk register.

3.6 CONTINUOUS IMPROVEMENT

Continuous improvement first requires the systematic collection and analysis of safety performance data. Guidance for these steps is outlined in 3.6.1 and 3.6.2, respectively. Actionable steps for implementing lessons learned are then proposed in 3.6.3, with the aim of fostering a culture of continuous improvement that transcends individual projects.

3.6.1 Collecting safety performance data

Effectively navigating safety improvement requires a foundation of reliable data. To ensure real-time data capture, and foster cultural feedback mechanisms to enrich the safety performance dataset, project developers should:

- Define comprehensive safety performance metrics throughout the project lifecycle. This includes incident categories and frequency rates, and adherence to safety protocols, providing a holistic view of safety performance. Those metrics should, to the extent possible, be taken from recognised metrics found within the industry (see 3.2.2).
- Implement real-time data capture mechanisms to ensure the timely availability of safety performance data. This facilitates proactive decision-making and intervention in response to emerging trends or potential risks.

- Define a requirement for the monthly reporting of the selected H&S performance metrics, enabling effective monitoring and evaluation of contractors' safety compliance.
- Establish cultural feedback mechanisms that encourage contractors to share observations and insights related to safety.

3.6.2 Analysing safety performance data

Analysing safety performance data is key to uncovering systemic factors, draw lessons learned and enable continuous improvement. When analysing data, project developers should:

- Segment safety performance data based on project phases, work areas, and contractors. Such a granular approach enables targeted analysis, revealing specific areas for improvement.
- Regularly benchmark safety performance data against industry standards and best practices. This comparative analysis identifies areas of excellence and opportunities for enhancement, driving a continuous improvement mindset.
- Prioritise RCA for incidents, going beyond immediate causes to uncover underlying systemic factors (see also 3.4). Such analysis informs the development of preventive measures and procedural enhancements.

3.6.3 Implementing lessons learned

Lessons are only truly 'learned' if and when they are sustainably applied. This subsection recommends structured lessons learned sessions, actionable improvement plans, and knowledge transfer mechanisms to ensure that insights gleaned from one project contribute to the improvement of the entire industry.

- Conduct structured lessons learned sessions at key project milestones, involving all relevant stakeholders and exploring the analysed data. Such collaborative approach ensures a diverse range of perspectives and insights.
- A detailed review of incidents and their root cause should be conducted to provide input into lessons learned and identify opportunity for systemic improvement (see roles and responsibilities in 3.1.3).
- Translate lessons learned into actionable improvement plans with clear timelines and responsibilities. This helps to ensure that identified areas for enhancement are systematically addressed in subsequent projects.
- Establish mechanisms to transfer knowledge and share lessons learned across projects, teams and contractors. This cross-pollination of insights contributes to industry-wide improvement and the evolution of best practices.

4 MONOPILES – HAZARDOUS ACTIVITIES

This section delves into the hazardous activities specific to monopile fabrication and provides comprehensive guidance at various phases of the fabrication process. From initial tendering to project close-out, each subsection addresses critical aspects of safety management, focusing specifically on the unique challenges of monopile fabrication. Following an introductory overview of monopiles, outlining their function and structural characteristics relevant to fabrication (4.1), the common hazards encountered during the fabrication of monopiles are reviewed (4.2). Key considerations and safety protocols for monopile fabrication are then outlined, as follows:

- At tendering phase (4.3):
  - Offers guidance on setting safety performance expectations, evaluating contractors' capabilities, and incorporating safety requirements into tender documents during the pre-contract phase.
- At execution phase (4.4):
  - Details safety requirements and procedures to be implemented during the execution phase of monopile fabrication, including monitoring compliance, defining safety roles, and conducting regular safety audits.
- At close-out phase (4.5):
  - Outlines protocols for reviewing safety documentation, assessing safety performance, and identifying opportunities for continuous improvement during the project close-out phase.

4.1 OVERVIEW OF MONOPILE

At a high-level, a monopile can be described as a tubular steel structure installed in the seabed (see Figure 2), designed to provide both axial and lateral resistance. The length of the monopile is normally kept as short as possible, meaning that after installation, only a few metres of monopile will be seen above the mean water line. On top of the monopile, a TP is typically installed, housing the secondary steel attachments (e.g. platforms) and the interface with the wind turbine generator (WTG) tower – see also section 6. The connection between the monopile and the TP can be either bolted or grouted.

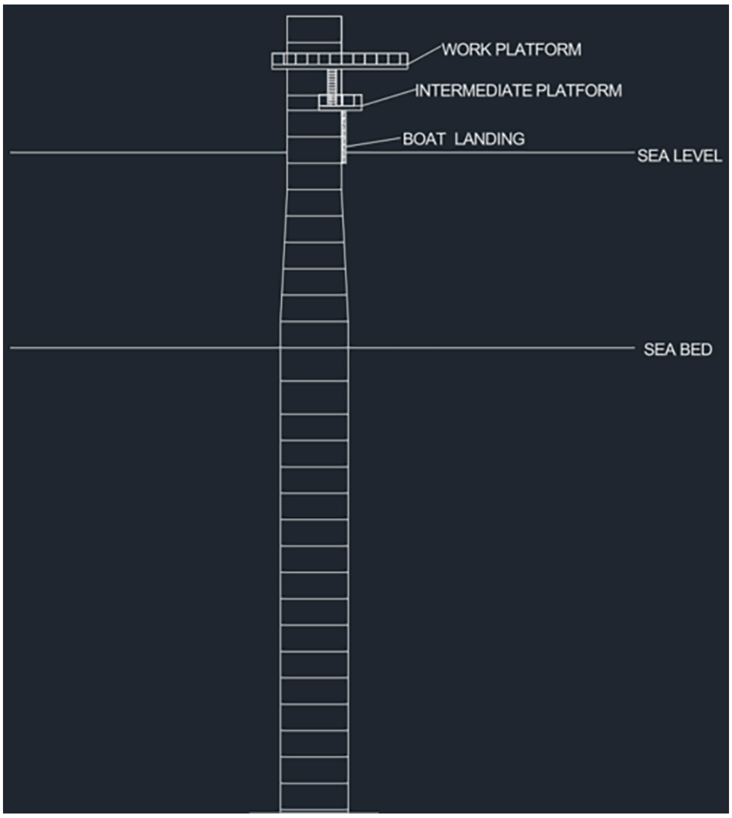

Figure 2: Example of XXL monopile schematics

Monopiles were traditionally considered only applicable for relatively shallow water depths (e.g. less than 30 m). However, in recent years the development of larger diameter 'XL' monopiles has enabled their installation in deeper waters, supporting larger turbines. The use of monopiles in up to 40–50 m water depth is currently under consideration, in the assumption that suitable soils are present. The monopile's primary function is to anchor and support the towering wind turbine structures. With such a crucial role, meticulous design and fabrication are critical to ensure enduring structural integrity.

Considering the monopile specificities, health and safety challenges during fabrication may involve, for example:

– Working at height: The increasing diameters of monopiles raise challenges associated with working at significant heights during fabrication.
– Welding of large cans: Welding large cans, integral components of monopiles, poses challenges related material handling and welding safety.
– Handling, lifting, and transport of large cans: The sheer size and weight of monopile components necessitate careful handling, lifting, and transport to prevent accidents and ensure the well-being of workers.
– Material handling and storage: Safely managing and storing materials, including steel plates and components, requires meticulous planning and execution to prevent injuries and damage.
– Grit blasting and coating: The increasing size and weight of monopiles adds to the complexity and is likely to require modifications to equipment within the facilities.

4.2 TYPICAL HAZARDS ASSOCIATED TO MONOPILE FABRICATION

Fabricating monopiles for offshore wind projects involves a range of complex processes, machinery, and activities, each presenting its own set of potential hazards. Understanding and mitigating these hazards is paramount to ensuring the safety and well-being of workers, protecting the environment, and maintaining the integrity of the fabrication process. This provides an overview of the typical hazards associated with monopile fabrication. Each of these are further described in the appendices included at the end of the document:

- Working at height:
  - Challenges:
    - While monopiles are typically fabricated in the horizontal position, the need to access seams and welds for preparation, welding or inspection at height is increasing with can diameter.
    - Means to work at height vary, access is typically via scaffold, mobile elevated platforms, and in some limited cases ladders each with their own individual risks.
    - The cylindrical shape of the monopile often implies that the typical means to WAH will leave gaps between the access platform and the monopile. This creates a risk for falls from height and dropped objects, which should be carefully considered in the risk assessment.
  - Mitigation:
    - Apply hierarchy of controls (see [ref. 4]) to ensure that the most suitable mean of access is provided.
    - Consider SIMOPs when planning work at height to prevent any work below or risk collision with those working at height.
    - Ensure all workers have a basic understanding of work at height and are able to demonstrate competence. This is particularly important to transient workforces, newly hired, and/or young workers.
    - Consider the potential for falls from height when planning work and ensure a suitable means to rescue the worker is in place before work starts.
    - While dropped objects should not be considered an inherent hazard of a working environment, there should be a suitable system put in place to identify, prevent, and manage the risks associated with dropped objects.
    - Consider the working environment when planning work at height, the hazards associated with work at height indoors in a sheltered and controlled environment greatly differ to those that are exposed to the elements.
- Welding of large cans:
  - Challenges:
    - The footprint of larger equipment and components may impact available space and increase risk of injury or require changes to fabrication process.
    - Welding process and repairs produce toxic fumes as well as fire risk.
  - Mitigation:
    - Design and optimise for automated welding processes to reduce exposure to hazards.
    - Ensure suitable familiarisation and training is provided, in particular for new equipment for material handling such as rollers, lift equipment, plant.

    - Ensure suitable extraction, ventilation, and respiratory protective equipment (RPE) is provided free of cost to the worker.
    - Ensure fire management plan is updated to consider changes to floor layout or additional hazards.
- Handling, lifting, and transport of large plate, cans and sections:
  - Challenges:
    - As a result of increasing weight and diameter, all handling, lifting and transportation activities present new potential hazards and need to be assessed.
    - Crush injuries may occur where workers become caught between moving components, or if components shift unexpectedly. Proper procedures for securing loads and maintaining clear work areas and movement paths are essential to prevent crush hazards.
    - Current plant and equipment may be working closer to their working load limits due to increased weight and diameter.
    - Handling, lifting and transportation operations can in some cases be conducted in challenging environmental conditions if outside, such as wind or limited visibility, which can impact safety and operational efficiency.
  - Mitigation:
    - Optimise the fabrication process for minimal handling of can and sections. Relevant lift plans or transport plans should be in place for each component move.
    - Schedule suitable familiarisation and training for new equipment and plant prior to scheduled works.
    - Assess access roads and hardstands to ensure they are within accepted load bearing capacities prior to transport.
    - Ensure that all lifts throughout the project are risk assessed by a competent person, and managed by lift plan or associated documentation for lifting appliance and accessories.
    - Define upper and lower operating limits for plant and equipment, such as high winds, rough seas (if working over water), or thunderstorms, including planning for the safe suspension of activities when required to prevent accidents and ensure the safety of personnel and equipment.
    - Ensure that documentation is provided well in advance for review.
- Manual handling of tools and equipment:
  - Challenges:
    - As part of fabrication, there are numerous occasions where personnel will be required to manually handle tools and equipment, often in restricted spaces (e.g. welder sets, consumables). This can lead to musculoskeletal injuries if proper handling techniques are not followed, or if workers are required to perform repetitive or awkward manual tasks over extended periods.
  - Mitigation:
    - Apply hierarchy of controls (see [ref. 4]), eliminating the need for the loads, tools or equipment to be moved wherever possible, and minimising manual handling.

    - Ensure personnel are trained in the necessary manual handling techniques and the aids that can be used.
    - Where possible, have tools and equipment lifted and moved using lifting aids. There should be sufficient resources available to support this.
    - Ensure all tools and equipment are suitable for the task and the worker.
- Material handling and storage:
  - Challenges:
    - Storage areas will require a larger footprint and potentially new supports to allow for storing of larger components.
  - Mitigation:
    - Access to stored components for inspection need to be considered, increased diameter and height introduce additional hazards for access.
    - Implementing organised material storage practices, providing proper training for material handlers, and regularly inspecting storage facilities for safety compliance.
- Grit blasting and coating:
  - Challenges:
    - Grit blasting generates airborne particles and contaminants such as heavy metals, which can pose respiratory hazards to workers.
    - Grit blasting equipment produces high levels of noise and vibration, which can lead to hearing loss and musculoskeletal disorders. Noise exposure levels are likely to exceed the recommended values permitted per region.
    - Workers may come into contact with hazardous chemicals during the coating process, leading to respiratory problems, skin irritation, burns, or other health issues.
  - Mitigation:
    - Explore means to eliminate exposure to the worker, e.g. through automation.
    - Due to the combustible nature of paints and coatings, ensure access to areas is controlled and entry limited to trained personnel.
    - Provide specific RPE, free of cost to the worker, and adequate ventilation for accessing grit blasting and coating areas.
    - Ensure that there are suitable controls in place for measuring noise and hand arm vibration syndrome (HAVS), and that appropriate mitigations are applied to prevent prolonged exposure, compliant with local regulation and/or minimum developer's requirements.
    - Introduce access control protocols to prevent unauthorised entry to areas where blasting and coating is ongoing.
- High-pressure water jetting:
  - Challenges:
    - Typically, the objective of high-pressure water jetting is to remove unwanted materials adhering to a substrate. When the stream of water impacts the material, it becomes loosened from the substrate and creates flying debris.
    - High-pressure water jetting produces high levels of noise and vibration, which can lead to hearing loss and musculoskeletal disorders. Noise exposure levels are likely to exceed the recommended values permitted per region.

    - Due to the high-pressure element of water jetting it carries the risk of high-pressure injuries to the body as well as the added hazard of involving contaminated water.
  - Mitigation:
    - Explore means to eliminate exposure to the worker, e.g. through automation.
    - Ensure work zones for high-pressure jetting are cordoned off from pedestrians and access controlled.
    - Ensure all workers operating high-pressure equipment are trained and competent to do so.
    - Provide suitable PPE including heavy duty overalls, face protection and gloves free of cost to the user and ensure it is used during high-pressure jetting operations.
    - Establish and maintain adequate controls for noise exposure.
    - Ensure whip checks are in place on all high-pressure hoses, and that equipment is properly maintained.

4.3 SAFETY GUIDANCE AT TENDERING PHASE

Prior to the commencement of monopile fabrication, it is essential to establish robust safety protocols and performance expectations during the tendering phase.

The following points summarise the recommended steps to ensure that the key hazardous activities relevant to the project are identified and that suitable safety considerations are integrated seamlessly into the tendering process:

- Assess contractors' capabilities and suitability for the project specificities:
  - Ensure open communication with designer and contractors regarding design challenges and opportunities, and the fabrication process.
  - Conduct gap analysis to identify the risks and opportunities specific to the project for each potential contractor, and identify relevant mitigation measures or contingencies where appropriate, e.g. in case of poor H&S scoring (see also 3.5).
  - Require contractors to submit comprehensive H&S plans and procedures specifically tailored to monopile fabrication (including detailed protocols for managing relevant hazards).
  - Request examples of fabrication method statements in order to identify potential hazards or challenges in production.
- Specify safety performance requirements:
  - In the tender documents, articulate clear safety performance expectations for contractors involved in monopile fabrication (see also 3.2).
  - Emphasise adherence to industry best practices and regulatory standards, with a focus on addressing key hazards (see also 4.2).
- Evaluate safety records and capabilities:

  - During the pre-contract selection process, assess contractors' safety records, certifications, and demonstrated capabilities in managing safety during monopile fabrication projects (see also 3.5).
  - Prioritise contractors with a proven track record of implementing effective safety measures and maintaining high safety standards in similar projects.

4.4 SAFETY GUIDANCE AT EXECUTION PHASE

During the execution phase, the objective is to implement safety measures and monitor compliance throughout the phase to mitigate risks effectively.

The following points outline the recommended steps to ensure that safety procedures, compliance monitoring, and roles and responsibilities are in place to mitigate the key hazardous activities during the execution phase:

- Include detailed safety requirements in the contract:
  - Ensure that the contract includes comprehensive safety requirements and procedures specific to monopile fabrication (see 3.2).
  - This should encompass detailed protocols for welding, material handling, equipment operation, and emergency response, tailored to the unique challenges of monopile fabrication (see 4.2).
- Monitor, coach and where necessary enforce safety compliance:
  - Implement robust monitoring mechanisms to ensure ongoing safety compliance throughout the fabrication process.
  - Conduct regular safety audits and inspections to identify potential hazards, assess safety performance, and address any non-compliance issues promptly (see 3.5).
  - Prioritise measures to mitigate key risks, e.g. associated with WAH, handling of large steel components, welding operations and grit blasting and coating (see 4.2).
- Define roles and responsibilities for safety management:
  - Clearly define the organisational structure and interfaces of project stakeholders, including contractors, subcontractors, and project managers, in managing safety during the execution phase of monopile fabrication (see 3.1.4).
  - Establish protocols for incident reporting, near-miss reporting, and safety communication channels to facilitate effective safety management (see 3.4).

4.5 SAFETY GUIDANCE AT CLOSE-OUT PHASE

When nearing completion, the H&S attention shifts towards the review of safety performance.

The following points summarise the recommended steps to follow to ensure that thorough safety assessments are conducted, safety documentation are evaluated, and opportunities for continuous improvement on the key hazardous activities are identified during the close-out phase of monopile fabrication projects:

- Review safety documentation and records:
  - Conduct a comprehensive review of the safety documentation and records provided by the contractor at the close-out phase of the project.
  - This should include a thorough examination of incident reports, safety performance data, and any corrective actions implemented during the fabrication process.
- Assess effectiveness of safety measures:
  - Evaluate the effectiveness of safety measures implemented during monopile fabrication, identifying areas of success and areas for improvement.
  - Analyse incident trends, near-miss reports, and safety performance metrics to inform future safety initiatives and strategies for monopile fabrication projects.
- Ensure comprehensive handover process:
  - Ensure that the handover process includes the transfer of all safety-related documentation and records to the project owner or operator for future reference.
  - This should include detailed safety manuals, training materials, and incident investigation reports to support ongoing safety management efforts and facilitate continuous improvement in monopile fabrication safety.
  - Ensure lessons learned from the project are documented and shared with key stakeholders such as procurements team, designers and relevant safety organisations via workgroups.

5 JACKETS – HAZARDOUS ACTIVITIES

This section delves into the hazardous activities specific to jacket fabrication and provides comprehensive guidance at various phases of the fabrication process. From initial tendering to project close-out, each subsection addresses critical aspects of safety management, focusing specifically on the unique challenges of jacket fabrication. Following an introductory overview of jackets, outlining their function and structural characteristics relevant to fabrication (5.1), the common hazards encountered during the fabrication of jackets are reviewed (5.2). Key considerations and safety protocols for jacket fabrication are then outlined, as following:

- At tendering phase (5.3):
  - Offers guidance on setting safety performance expectations, evaluating contractors' capabilities, and incorporating safety requirements into tender documents during the pre-contract phase.
- At execution phase (5.4):
  - Details safety requirements and procedures to be implemented during the execution phase of jacket fabrication, including monitoring compliance, defining safety roles, and conducting regular safety audits.
- At close-out phase (5.5):
  - Outlines protocols for reviewing safety documentation, assessing safety performance, and identifying opportunities for continuous improvement during the project close-out phase.

5.1 OVERVIEW OF JACKETS

Jacket foundations are typically space frame substructures that aim to provide the required strength and stiffness in transitional water depths. Typically, such foundations are three- or four-legged triangulated structures made of circular steel tubes (see Figure 3). A TP is installed on top of the structure, typically in the form of a plated structure designed with a large centre steel tube for connection with the tower (see also section 6). The structure is typically anchored into the seabed by 'pin piles' installed at each leg, although suction bucket anchors can also be considered.

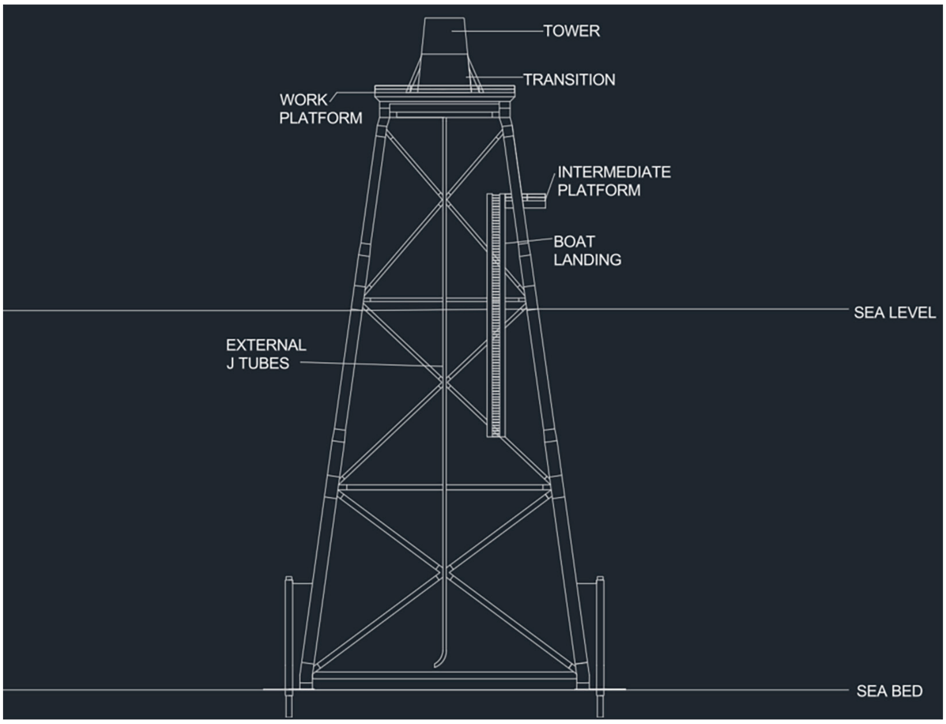

Figure 3: Example jacket schematics

Like monopiles, the jacket's primary function is to anchor and support the towering wind turbine structures. With such a crucial role, meticulous design and fabrication are critical to ensure enduring structural integrity. In general, jacket foundations have been used for transitional water depths where monopile foundations would be deemed unfeasible due to e.g. manufacturing limitations or a lack of suitable installation vessels. Extensively used in the offshore oil and gas industry, jacket foundations feature a long track record, providing a degree of confidence to developers. As developers are increasingly pursuing sites with deeper waters, jackets may become more common as an offshore wind foundation type.

From a fabrication perspective jackets require significant capacity from yards and planning. Jackets are made up of pin piles, tubulars and x braces as well as a TP, which is assembled prior to loadout. Working at height is unavoidable during assembly of lower jacket to upper jacket and TP. However, with careful planning, hazards associated with this type of work can be mitigated significantly. The following section describes in more details the typical hazards associated with jackets fabrication, covering in particular:

– Working at height: the construction of jackets often involves working at significant heights, which poses risks of falls for workers involved in, e.g. welding, coating or assembly tasks.
– SIMOPs: coordinating SIMOPs (such as welding, lifting operations, material handling, and assembly tasks) presents risks of collision, interference, and worker exposure to multiple hazards simultaneously.
– Assembly of tubulars: the assembly process involves aligning, fitting, and welding individual tubulars, which can be complex and hazardous, especially when working at height or in confined spaces.

- Handling, lifting, and transport of large components and sections: jackets consist of large steel structures that require heavy lifting and handling during fabrication. This presents risks of crane accidents, equipment failures, and worker injuries related to lifting operations.
- Material handling and storage: moving and storing large jacket components within the fabrication yard requires specialised equipment and procedures to prevent accidents, collisions, and injuries to workers.
- Grit blasting and coating: grid blasting and coating application present risks of exposure to airborne contaminants, such as dust and toxic fumes, as well as hazards associated with handling abrasive materials and working at height.

5.2 TYPICAL HAZARDS ASSOCIATED TO JACKET FABRICATION

Fabricating jackets for offshore wind projects involves a range of complex processes, machinery, and activities, each presenting its own set of potential hazards. Understanding and mitigating these hazards is key to ensuring the safety and well-being of workers, protecting the environment, and maintaining the integrity of the fabrication process. The following provides an overview of the typical hazards associated with jacket fabrication. Each of these are further described in the appendices included at the end of the document:

- Working at height:
  - Challenges:
    - WAH is extensively required for assembling/welding the multiple components that constitute a jacket, such as pin piles, buckets, tubulars into x-braces and TP. As jackets are typically upended and welded in sections, the potential height of a fall is even greater.
    - The means of working at height vary; access is typically via scaffolding, mobile elevated platforms, and, in some cases, ladders, each with its own set of risks.
    - As fabrication progresses, the likelihood of workers being at different levels (above/below each other) increases and must be managed.
  - Mitigation:
    - Apply hierarchy of controls (see [ref. 4]) to ensure that the most suitable means of access is provided.
    - Consider SIMOPs when planning work at height to prevent any work below or the risk of collision with those working at height.
    - Ensure all workers have a basic understanding of work at height and are able to demonstrate their competence. This is particularly important to transient workforces, newly hired, and/or young workers.
    - Consider the potential for falls from height when planning work and ensure a suitable means to rescue the worker is in place before work starts.
    - While dropped objects should not be considered an inherent hazard of a working environment, there should be a suitable system put in place to identify, prevent, and manage the risks associated with dropped objects.
    - Consider the working environment when planning work at height as the hazards associated with WAH indoors in a sheltered and controlled environment (e.g. during fabrication) greatly differ from those that are exposed to the elements (e.g. potentially during loadout).

- Simultaneous operation:
  - Challenges:
    - SIMOPs is a significant hazard throughout most of the jacket fabrication process, as it involves the joining of a multitude of components (pin piles, buckets, tubulars into x-braces and TP), often combined with lifting operations or work at height.
    - The operation space is often limited, increasing the risk of collisions, entanglements, and other incidents during SIMOPs if proper spatial planning and communication protocols are not in place.
    - SIMOPs can involve the use of heavy plant, equipment and machinery, such as cranes, winches, and power tools, which can pose crush, entrapment, and struck-by hazards if not operated correctly or if safety protocols are not followed.
    - Coordinating multiple operations, such as welding, lifting, and assembly, on a single jacket structure requires careful planning, clear coordination and effective communication to prevent conflicts and ensure that each activity proceeds safely and efficiently.
    - Communication may be hampered by noise, distance, and the use of PPE.
  - Mitigations:
    - It should be recognised that during fabrication, the schedule can often impact decisions in fabrication process. Prevent SIMOPs such as WAH and lifting operations while work is occurring underneath, prioritising critical tasks, and ensuring that each operation has adequate space, resources, and time to be completed safely.
    - When simultaneous work on different levels cannot be avoided, install passive control measures (physical barriers preventing access, nettings, toe boards, etc.) to prevent WAH or dropped-objects incidents impacting workers in the area immediately under.
    - Introduce access control procedures and PTW for all complex works involving SIMOPs. This should ensure that all workers involved in SIMOPs are aware of their roles, responsibilities, and the status of other ongoing activities.
    - Consider the communication methods between those working simultaneously to facilitate real-time communication between workers.
    - Carry out regular inspections of access at height equipment. Concerns should then be raised via the project's incident or observation reporting system depending on the severity of the finding.
- Handling, lifting, and transport of large components and sections:
  - Challenges:
    - As a result of increasing weight and diameter, all handling, lifting and transportation activities present new potential hazards and need to be assessed.
    - Crush injuries may occur where workers become caught between moving components, or if components shift unexpectedly. Proper procedures for securing loads and maintaining clear work areas are essential to prevent crush hazards.
    - Current plant and equipment may be working closer to its working load limits due to increased weight and diameter.

    - Lifting of upper and lower jacket sections as well as complete jackets means lifts of significant weight and are likely subcontracted lifts, which introduces additional hazards that require managing.
    - Handling, lifting and transportation operations can in some cases be conducted in challenging environmental conditions if outside, such as wind or limited visibility, which can impact safety and operational efficiency.
  - Mitigation:
    - Implement engineering controls to minimise risks, such as designing jackets with lifting points or structural features optimised for safe handling and transportation.
    - Where possible, automate the handling of plates and pipes to involve minimum handling from personnel.
    - Schedule suitable familiarisation and training for new equipment and plant prior to scheduled works.
    - Access roads and hardstands should be assessed to ensure they are within accepted load bearing capacities prior to transport.
    - Ensure that all lifts throughout the project are assessed by a competent person and managed by lift plan or associated documentation for lifting appliance and accessories.
    - Define upper and lower operating limits for plant and equipment, such as high winds, rough seas (if working over water), or thunderstorms, considering, e.g. suspension of activities when required to prevent accidents and ensure the safety of personnel and equipment.
    - Ensure that documentation is provided well in advance for review.
- Manual handling of tools and equipment:
  - Challenges:
    - As part of fabrication there are numerous occasions where personnel will be required to manually handle tools and equipment, often in restricted spaces (e.g. welder sets, consumables). This can lead to musculoskeletal injuries if proper handling techniques are not followed, or if workers are required to perform repetitive or awkward handling tasks over extended periods.
  - Mitigation:
    - Apply hierarchy of controls (see [ref. 4]), and where possible eliminate the need for the loads, tools or equipment to be moved wherever possible, and minimise manual handling.
    - Ensure personnel are trained in the necessary manual handling techniques and the aids that can be used.
    - Where possible, have tools and equipment lifted and moved using lifting aids. There should be sufficient resources available to support this.
- Ensure all tools and equipment are suitable for the task and the worker. Material handling and storage:
  - Challenges:
    - Storage areas will require a larger footprint and potentially new supports to allow for storing of components.

    - Workers required to manually handle materials are exposed to musculoskeletal injuries if proper handling techniques are not followed, or if workers are required to perform repetitive or awkward handling tasks over extended periods.
  - Mitigation:
    - Ensure the storage plan is realistic and hazards associated with storage of components are identified.
    - Implement ergonomic material handling processes and workstations to minimise strain and fatigue on workers.
    - Implement clear traffic management plans and designated pedestrian walkways to separate vehicle and pedestrian traffic within the fabrication yard.
    - Ensure supports are available and inspected and compliant with project requirements.
- Grit blasting and coating:
  - Challenges:
    - Grit blasting generates airborne particles and contaminants such as heavy metals, which can pose respiratory hazards to workers.
    - Grit blasting equipment produces high levels of noise and vibration, which can lead to hearing loss and musculoskeletal disorders. Noise exposure levels are likely to exceed the recommended values permitted per region.
    - Workers may come into contact with hazardous chemicals during the coating process, leading to respiratory problems, skin irritation, burns, or other health issues.
  - Mitigation:
    - Explore means to eliminate exposure to the worker, e.g. through automation.
    - Due to the combustible nature of paints and coatings, access to areas should be controlled and limited to trained personnel.
    - Provide specific RPE free of charge to the worker and adequate ventilation for accessing grit blasting and coating areas.
    - Ensure that there are suitable controls in place for measuring noise and HAVS, and that appropriate mitigations are applied to prevent prolonged exposure, compliant with local regulation and/or minimum developer's requirements.
    - Introduce access control protocols to prevent unauthorised entry to areas where blasting and coating is ongoing.
- High-pressure water jetting:
  - Challenges:
    - Typically, the objective of high-pressure water jetting is to remove unwanted materials adhering to a substrate. When the stream of water impacts the material, it becomes loosened from the substrate and creates flying debris.
    - High-pressure water jetting produces high levels of noise and vibration, which can lead to hearing loss and musculoskeletal disorders. Noise exposure levels are likely to exceed the recommended values permitted per region.

    - Due to the high-pressure element of water jetting it carries the risk of high-pressure injuries to the body as well as the added hazard of involving contaminated water.
  - Mitigation:
    - Explore means to eliminate exposure to the worker, e.g. through automation.
    - Work zones for high pressure jetting should be cordoned off from pedestrians and access controlled.
    - Ensure all workers operating high-pressure equipment are trained and competent to do so.
    - Provide suitable PPE free of cost to the worker, including heavy duty overalls, face protection and gloves, and ensure it is used during high-pressure jetting operations.
    - Establish and maintain adequate controls for noise exposure.
    - Ensure whip checks are in place on all high-pressure hoses, and that equipment is properly maintained.
- Confined Space:
  - Challenges:
    - Jacket leg design may require access for welds, inspection or repair and may fit criteria for confined space.
    - Confined spaces in offshore wind jackets often have limited ventilation, which can result in poor air quality. Workers may be at risk of asphyxiation or exposure to toxic substances if adequate ventilation measures are not in place.
    - Confined spaces typically have limited entry and exit points, which can pose challenges in case of emergencies or the need for evacuation. Entrapment or entanglement hazards may also arise due to narrow passageways or obstructed pathways within the confined space.
    - Confined spaces in offshore wind jackets may contain physical hazards such as sharp edges, protruding objects, uneven surfaces, or moving machinery. These hazards increase the risk of injury to workers entering or working within the confined space, especially if visibility is limited or if they are working in tight or awkward positions.
  - Mitigation:
    - Ensure fabrication process is considered in its entirety and that confined space is considered throughout all phases, i.e. welding, inspection, repair, coating.
    - Where confined space is identified, have a suitable safe system of work in place prior to start of works (e.g. ventilation systems, atmospheric monitoring, etc.).
    - Ensure the confined space entry considers rescue and that an effective rescue plan is in place prior to start of works.

5.3 SAFETY GUIDANCE AT TENDERING PHASE

Prior to the commencement of jacket fabrication, it is essential to establish robust safety protocols and performance expectations during the tendering phase.

The following points summarise the recommended steps to follow to ensure that the key hazardous activities relevant to the project are identified and that suitable safety considerations are integrated seamlessly into the tendering process:

- Assess contractor's capabilities and suitability for the project specificities:
  - Ensure open communication with designer and contractors regarding design challenges, opportunities and the fabrication process.
  - Conduct gap analysis to identify the risks and opportunities specific to the project for each potential contractor, and identify relevant mitigation measures or contingencies where appropriate, e.g. in case of poor H&S scoring (see also 3.5).
  - Require contractors to submit comprehensive H&S plans and procedures specifically tailored to jacket fabrication (including detailed protocols for managing relevant hazards).
  - Request examples of fabrication method statement in order to identify potential hazards or challenges in production.
- Specify safety performance requirements:
  - In the tender documents, articulate clear safety performance expectations for contractors involved in jacket fabrication (see also 3.2).
  - Emphasise adherence to industry best practices and regulatory standards, with a focus on addressing key relevant hazards (see also 5.2).
- Evaluate safety records and capabilities:
  - During the pre-contract selection process, assess contractors' safety records, certifications, and demonstrated capabilities in managing safety during jacket fabrication projects (see also 3.5).
  - Prioritise contractors with a proven track record of implementing effective safety measures and maintaining high safety standards in similar projects.

5.4 SAFETY GUIDANCE AT EXECUTION PHASE

During the execution phase, the objective is to implement safety measures and monitor compliance throughout the phase to mitigate risks effectively.

The following points outline the recommended steps to ensure that safety procedures, compliance monitoring, and roles and responsibilities are in place to mitigate the key hazardous activities during the execution phase:

- Include detailed safety requirements in the contract:
  - Ensure that the contract includes comprehensive safety requirements and procedures specific to jacket fabrication (see 3.2).
  - This should encompass detailed protocols for welding, material handling, equipment operation, and emergency response, tailored to the unique challenges of jacket fabrication (see 5.2).

- Monitor, coach and where necessary enforce safety compliance:
  - Implement robust monitoring mechanisms to ensure ongoing safety compliance throughout the fabrication process.
  - Conduct regular safety audits and inspections to identify potential hazards, assess safety performance, and address any non-compliance issues promptly (see 3.5).
  - Prioritise measures to mitigate relevant risks, e.g. associated with WAH, handling of large steel components, welding operations and grit blasting and coating (see 5.2).
- Define roles and responsibilities for safety management:
  - Clearly define the organisational structure and interfaces of project stakeholders, including contractors, subcontractors, and project managers, in managing safety during the execution phase of jacket fabrication (see 3.1.4).
  - Establish protocols for incident reporting, near-miss reporting, and safety communication channels to facilitate effective safety management (see 3.4).

5.5 SAFETY GUIDANCE AT CLOSE-OUT PHASE

When nearing completion, the H&S attention shifts towards the review of safety performance.

The following points summarise the recommended steps to follow to ensure that thorough safety assessments are conducted, safety documentation are evaluated, and opportunities for continuous improvement on the key hazardous activities are identified during the close-out phase of jacket fabrication projects:

- Review safety documentation and records:
  - Conduct a comprehensive review of the safety documentation and records provided by the contractor at the close-out phase of the project.
  - This should include a thorough examination of incident reports, safety performance data, and any corrective actions implemented during the fabrication process.
- Assess effectiveness of safety measures:
  - Evaluate the effectiveness of safety measures implemented during jacket fabrication, identifying areas of success and areas for improvement.
  - Analyse incident trends, near-miss reports, and safety performance metrics to inform future safety initiatives and strategies for jacket fabrication projects.
- Ensure comprehensive handover process:
  - Ensure that the handover process includes the transfer of all safety-related documentation and records to the project owner or operator for future reference.
  - This should include detailed safety manuals, training materials, and incident investigation reports to support ongoing safety management efforts and facilitate continuous improvement in jacket fabrication safety.
  - Ensure lessons learned from the project are documented and shared with key stakeholders such as procurements team, designers and relevant safety organisations via workgroups.

6 TRANSITION PIECES – HAZARDOUS ACTIVITIES

This section delves into the hazardous activities specific to TP fabrication and provides guidance at various phases of the fabrication process. From initial tendering to project close-out, each subsection addresses critical aspects of safety management, focusing specifically on the unique challenges of TP fabrication. Following an introductory overview of TPs, outlining their function and structural characteristics relevant to fabrication (6.1), the common hazards encountered during the fabrication of TPs are reviewed (6.2). Key considerations and safety protocols for TP fabrication are then outlined, as following:

- At tendering phase (6.3):
  - Offers guidance on setting safety performance expectations, evaluating contractors' capabilities, and incorporating safety requirements into tender documents during the pre-contract phase.
- At execution phase (6.4):
  - Details safety requirements and procedures to be implemented during the execution phase of TP fabrication, including monitoring compliance, defining safety roles, and conducting regular safety audits.
- At close-out phase (6.5):
  - Outlines protocols for reviewing safety documentation, assessing safety performance, and identifying opportunities for continuous improvement during the project close-out phase.

6.1 OVERVIEW OF TRANSITION PIECES

TPs serve as crucial components in offshore wind turbine installations, bridging the gap between the foundation and the tower structure (see Figure 4). TPs are designed to provide a seamless connection between the offshore foundation and the towering WTG structure, while ensuring structural support and stability to the WTG.

From a fabrication perspective, TPs demand significant capacity and expertise from fabrication yards, requiring meticulous planning and execution. The assembly of transition pieces involves intricate processes, including the integration and internal fit-out of various elements. These tasks often involve working at height, handling heavy components, and conducting complex welding and assembly operations.

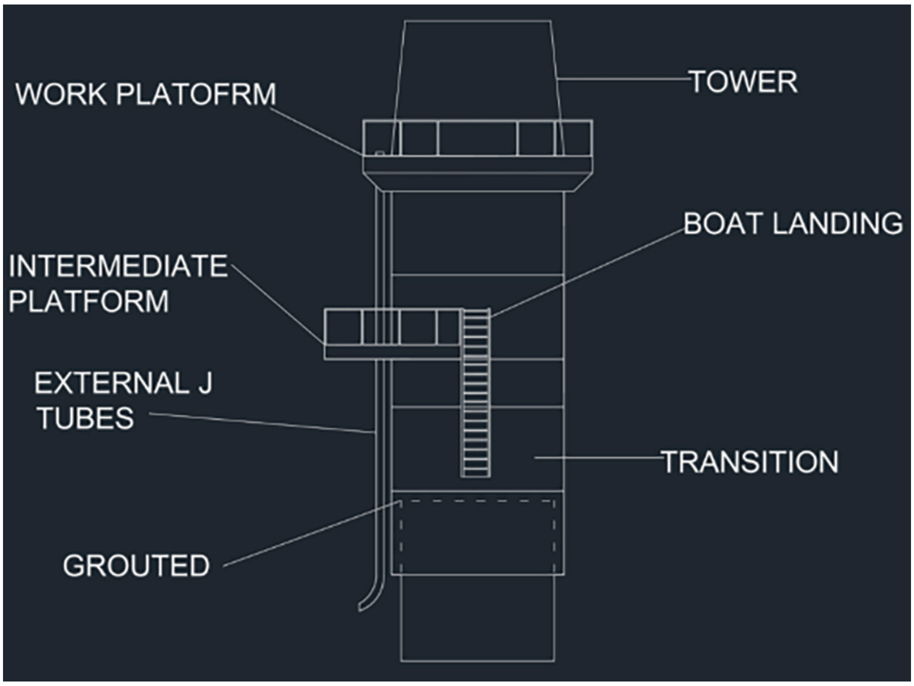

Figure 4: Example TP schematics

In the fabrication yard, the assembly of TPs is a complex undertaking that necessitates careful consideration of safety protocols and risk mitigation strategies. Workers engaged in tasks such as welding, coating, assembly, and fit-out operations face inherent risks associated with working at height, handling large components, and exposure to hazardous materials.

The following section delves into the typical hazards associated with TP fabrication, providing detailed insights into key risk areas and offering guidance on implementing effective safety measures. Specifically, the section covers hazards such as working at height, welding simultaneous operations, assembly of tubulars, handling and lifting of components, handling, lifting, transport and storage, grit blasting and coating application, confined space, internal fit-out, and assembly and upending.

6.2 TYPICAL HAZARDS ASSOCIATED TO TRANSITION PIECE FABRICATION

Fabricating transition piece for offshore wind projects involves a range of complex processes, machinery, and activities, each presenting its own set of potential hazards. Understanding and mitigating these hazards is key to ensuring the safety and well-being of workers, protecting the environment, and maintaining the integrity of the fabrication process. The bullets below provides an overview of the typical hazards associated with TP fabrication. Each of these are further described in the appendices included at the end of the document:

- Working at height:
  - Challenges:
    - While transition pieces are typically fabricated in the horizontal position, the need to access seams and welds for preparation, fit up, welding or inspection at height is increasing with can diameter.

    - Means to work at height vary: access is typically via scaffold, mobile elevated platforms, and in some limited cases, ladders, each with their own individual risks.
    - The cylindrical shape of the TP often implies that the typical means to WAH will leave gaps between the access platform and the TP, i.e. risk for falls from height and dropped objects, and should be considered in the assessment.
  - Mitigation:
    - Apply hierarchy of controls (see [ref. 4]) to ensure that the most suitable mean of access is provided.
    - SIMOPs should be considered when working at height to prevent any work below or risk collision with those working at height.
    - All workers should have a basic understanding of work at height and should be able to demonstrate competence. This is particularly important to transient workforces, newly hired, and/or young workers.
    - Falls from height must be considered in planning and a suitable means to rescue the worker should be in place prior to starting the works.
    - While dropped objects should not be considered an inherent hazard of a working environment, there should be a suitable system put in place to identify, prevent, and manage the risks associated with dropped objects.
    - Working environment should be considered when working at height as the hazards associated with WAH indoors in a sheltered and controlled environment greatly differ to those that are exposed to the elements.
- Complex welding and joining of sections and secondary steel components:
  - Challenges:
    - The footprint of larger equipment and components may impact available space and increase risk of injury or require changes to fabrication process.
    - Welding process and repairs produce toxic fumes as well as fire risk.
    - Installation of secondary steel components can present a challenge for welding if design has not considered buildability.
  - Mitigation:
    - Fabrication method statement to be clear on how transition piece will be built and any additional hazards identified.
    - Where possible, design and optimise for automated welding processes to reduce exposure to hazards.
    - Ensure suitable familiarisation and training is provided, in particular for new equipment for material handling such as rollers, lift equipment, plant.
    - Ensure suitable extraction, ventilation, and respiratory protective equipment is provided free of cost to the worker.
    - Ensure fire management plan is updated to consider changes to floor layout or additional hazards.
- Handling, lifting, and transport of large plate, cans and sections:
  - Challenges:
    - As a result of increasing weight and diameter, all handling, lifting and transportation activities present new potential hazards and need to be assessed.

    - Crush injuries may occur where workers become caught between moving components or if components shift unexpectedly. Proper procedures for securing loads and maintaining clear work areas are essential to prevent crush hazards.
    - Current plant and equipment may be working closer to its working load limits due to increased weight and diameter.
    - Handling, lifting and transportation operations can in some cases be conducted in challenging environmental conditions if outside, such as wind or limited visibility, which can impact safety and operational efficiency.
  - Mitigation:
    - Where possible, the handling of plates, cans and sections should be automated and involve minimum handling from personnel. Relevant lift plans or transport plans should be in place for each component move.
    - Schedule suitable familiarisation and training for new equipment and plant prior to scheduled works.
    - Access roads and hardstands should be assessed to ensure they are within accepted load bearing capacities prior to transport.
    - Ensure that all lifts throughout the project are assessed by a competent person, and managed by lift plan or associated documentation for lifting appliance and accessories.
    - Define upper and lower operating limits for plant and equipment, such as high winds, rough seas (if working over water), or thunderstorms, considering, e.g. suspension of activities when required to prevent accidents and ensure the safety of personnel and equipment.
    - Ensure that documentation is provided well in advance for review.
- Manual handling of tools and equipment:
  - Challenges:
    - As part of fabrication, there are numerous occasions where personnel will be required to manually handle tools and equipment, often in restricted spaces (e.g. welder sets, consumables). This can lead to musculoskeletal injuries if proper handling techniques are not followed, or if workers are required to perform repetitive or awkward handling tasks over extended periods.
  - Mitigation:
    - Apply hierarchy of controls (see [ref. 4]), and where possible eliminate the need for the loads, tools or equipment to be moved wherever possible, and minimise manual handling.
    - Ensure personnel are trained in the necessary manual handling techniques and the aids that can be used.
    - Where possible, have tools and equipment lifted and moved using lifting aids. There should be sufficient resources available to support this.
- Ensure all tools and equipment are suitable for the task and the worker. Material handling and storage:
  - Challenges:
    - Storage areas will require a larger footprint and potentially new supports to allow for storing of components.

    - Design dictates if transition piece will be stored horizontally or vertically for installation of internal platform and requires assessing for hazards.
  - Mitigation:
    - Consider access for inspection of stored components. Increased diameter and height introduce additional hazards for access.
    - Implement organised material storage practices, providing proper training for material handlers, and regularly inspecting storage facilities for safety compliance.
    - If transition piece is stored vertically, then access to various levels will be at height and require a means to control and manage entry.
- Grit blasting and coating:
  - Challenges:
    - Grit blasting generates airborne particles and contaminants such as heavy metals, which can pose respiratory hazards to workers.
    - Grit blasting equipment produces high levels of noise and vibration, which can lead to hearing loss and musculoskeletal disorders. Noise exposure levels are likely to exceed the recommended values permitted per region.
    - Workers may come into contact with hazardous chemicals during the coating process, leading to respiratory problems, skin irritation, burns, or other health issues.
  - Mitigation:
    - Explore means to eliminate exposure to workers, e.g. through automation.
    - Due to the combustible nature of paints and coatings, access to areas should be controlled and limited to trained personnel.
    - Specific RPE and adequate ventilation should be provided free of cost to the worker for accessing grit blasting and coating areas.
    - Ensure that there are suitable controls in place for measuring noise and HAVS, and that appropriate mitigations are applied to prevent prolonged exposure, compliant with local regulation and/or minimum developer's requirements.
    - Introduce access control protocols to prevent unauthorised entry to areas where blasting and coating is ongoing.
- High-pressure water jetting:
  - Challenges:
    - Typically, the objective of high-pressure water jetting is to remove unwanted materials adhering to a substrate. When the stream of water impacts the material, it becomes loosened from the substrate and creates flying debris.
    - High-pressure water jetting produces high levels of noise and vibration, which can lead to hearing loss and musculoskeletal disorders. Noise exposure levels are likely to exceed the recommended values permitted per region.
    - Due to the high-pressure element of water jetting it carries the risk of high-pressure injuries to the body as well as the added hazard of involving contaminated water.
  - Mitigation:
    - Explore means to eliminate the exposure to the workers, e.g. through automation.

    - Work zones for high-pressure jetting should be cordoned off from pedestrians and access controlled.
    - Ensure all workers operating high-pressure equipment are trained and competent to do so.
    - Provide suitable PPE free of cost to the worker, including heavy duty overalls, face protection and gloves, and ensure it used during operation high pressure jetting operations
    - Establish and maintain adequate controls for noise exposure.
    - Ensure whip checks are in place on all high-pressure hoses, and that equipment is properly maintained.
- Confined space:
  - Challenges:
    - TP design may require access for welds, inspection or repair and may fit criteria for confined space.
  - Mitigation:
    - Ensure fabrication process is considered in its entirety and that confined space is considered throughout all phases, i.e. welding, inspection, repair, coating.
    - Where confined space is identified, have a suitable safe system of work in place prior to start of works.
    - Ensure the confined space entry permit considers rescue and that an effective rescue plan is in place prior to start of works.
- Internal fit out and assembly:
  - Challenges:
    - Mechanical completion type works with multiple components for installation and typically differing in design project to project.
    - Installation method changes depending on transition piece storage position, i.e. horizontal or vertical.
    - Use of plant and mechanical lifting aids for lower weight but sometimes complex lifts.
    - Torquing of bolts and fasteners can result in exposure to prolonged vibration and HAVS.
    - Increased likelihood of SIMOPs due to various fit out tasks and remedial actions at this stage.
  - Mitigation:
    - Ensure focus on mechanical completion works, and conduct thorough review of installation methodology for all components.
    - Ensure necessary lift plans or method statements are in place prior to start of mechanical completion type works.
    - If third party contractors are involved, ensure they are inducted to project requirements and supporting documentation is submitted in advance.
    - Ensure that there are suitable controls in place for measuring HAVS, and that appropriate mitigations are applied to prevent prolonged exposure, compliant with local regulation and/or minimum developer's requirements.
    - Introduce access control procedures and PTW for all complex works involving SIMOPs. This will ensure that all workers involved in SIMOPs are aware of their roles, responsibilities, and the status of other ongoing activities.

- Upending:
  - Challenges:
    - Typically, a tandem lift to upend from horizontal position, which meets the classification of a complex lift.
    - Common to use a third-party contractor for upending of TPs, which can add another layer of complexity for managing activities.
    - Once upended, the towers will require access control procedures.
    - Various workers will require access to the transition piece for completion works, with risk of SIMOPs.
    - Lift plans and heavy lift documentation may fall out of knowledge area of project personnel and rely on competence of lift company's appointed person.
  - Mitigation:
    - Use of competent heavy lift contractor to ensure necessary competence in lifting operations and planning.
    - Ensure project has a competent person internally to review lift plans or consider hiring third-party lift specialist.
    - Ensure suitable access control procedures are in place and effective.
    - Ensure suitable rescue plan is in place for various scenarios in newly upended transition piece.

6.3 SAFETY GUIDANCE AT TENDERING PHASE

Prior to the commencement of TP fabrication, it is essential to establish robust safety protocols and performance expectations during the tendering phase.

The following points summarise the recommended steps to follow to ensure that the key hazardous activities relevant to the project are identified and that suitable safety considerations are integrated seamlessly into the tendering process:

- Assess contractors capabilities and suitability for the project specificities:
  - Ensure open communication with designer and contractors regarding design challenges, opportunities, and the fabrication process.
  - Conduct gap analysis to identify the risks and opportunities specific to the project for each potential contractor, and identify relevant mitigation measures or contingencies where appropriate, e.g. in case of poor H&S scoring (see also 3.5).
  - Require contractors to submit comprehensive H&S plans and procedures specifically tailored to TP fabrication (including detailed protocols for managing relevant hazards).
  - Request examples of fabrication method statement in order to identify potential hazards or challenges in production.
- Specify safety performance requirements:
  - In the tender documents, articulate clear safety performance expectations for contractors involved in TP fabrication (see also 3.2).
  - Emphasise adherence to industry best practices and regulatory standards, with a focus on addressing key relevant hazards (see also 6.2).

- Evaluate safety records and capabilities:
  - During the pre-contract selection process, assess contractors' safety records, certifications, and demonstrated capabilities in managing safety during TP fabrication projects (see also 3.5).
  - Prioritise contractors with a proven track record of implementing effective safety measures and maintaining high safety standards in similar projects.

6.4 SAFETY GUIDANCE AT EXECUTION PHASE

During the execution phase, the objective is to implement safety measures and monitor compliance throughout the phase to mitigate risks effectively.

The following points outline the recommended steps to ensure that safety procedures, compliance monitoring, and roles and responsibilities are in place to mitigate the key hazardous activities during the execution phase:

- Include detailed safety requirements in the contract:
  - Ensure that the contract includes comprehensive safety requirements and procedures specific to TP fabrication (see 3.2).
  - This should encompass detailed protocols for welding, material handling, equipment operation, and emergency response, tailored to the unique challenges of TP fabrication (see 6.2).
- Monitor, coach and, where necessary, enforce safety compliance:
  - Implement robust monitoring mechanisms to ensure ongoing safety compliance throughout the fabrication process.
  - Conduct regular safety audits and inspections to identify potential hazards, assess safety performance, and address any non-compliance issues promptly (see 3.5).
  - Prioritise measures to mitigate relevant risks, e.g. associated with working at height, handling of large steel components, welding operations, and grit blasting and coating (see 6.2).
- Define roles and responsibilities for safety management:
  - Clearly define the organisational structure and interfaces of project stakeholders, including contractors, subcontractors, and project managers, in managing safety during the execution phase of TP fabrication (see 3.1.4).
  - Establish protocols for incident reporting, near-miss reporting, and safety communication channels to facilitate effective safety management (see 3.4).

6.5 SAFETY GUIDANCE AT CLOSE-OUT PHASE

When nearing completion, the H&S attention shifts towards the review of safety performance.

The following points summarise the recommended steps to follow to ensure that thorough safety assessments are conducted, safety documentation are evaluated, and opportunities for continuous improvement on the key hazardous activities are identified during the close-out phase of TP fabrication projects:

- Review safety documentation and records:
  - Conduct a comprehensive review of the safety documentation and records provided by the contractor at the close-out phase of the project.
  - This should include a thorough examination of incident reports, safety performance data, and any corrective actions implemented during the fabrication process.
- Assess effectiveness of safety measures:
  - Evaluate the effectiveness of safety measures implemented during TP fabrication, identifying areas of success and areas for improvement.
  - Analyse incident trends, near-miss reports, and safety performance metrics to inform future safety initiatives and strategies for TP fabrication projects.
- Ensure comprehensive handover process:
  - Ensure that the handover process includes the transfer of all safety-related documentation and records to the project owner or operator for future reference.
  - This should include detailed safety manuals, training materials, and incident investigation reports to support ongoing safety management efforts and facilitate continuous improvement in TP fabrication safety.
  - Ensure lessons learned from the project are documented and shared with key stakeholders such as procurements team, designers and relevant safety organisations via workgroups.

APPENDIX A
CONFINED SPACES

A.1 DESCRIPTION

A confined space is an enclosed or largely enclosed space that is not designed or constructed for continuous human occupancy, has limited or restricted means for entry or exit, and where there is risk of injury or illness from hazardous substances or conditions.

Risk factors associated with confined spaces may include the presence of flammable gases or vapours, which pose risks of fire or explosion; oxygen deficiency, which can cause loss of consciousness or asphyxiation; toxic chemicals; and physical hazards such as crushing, entanglement, engulfment, or impact injuries.

Examples of confined spaces commonly encountered during fabrication include, but are not limited to, pipes, tubulars or airtight platforms. Workers engaged in tasks such as welding, non-destructive testing (NDT), quality inspection, or repair within these spaces face increased risks and must adhere to stringent safety protocols to mitigate potential dangers.

During construction, it is critical that confined spaces are considered and comprehensively addressed throughout fabrication process. This includes implementing appropriate safety measures, conducting thorough risk assessments, providing adequate training for personnel, and ensuring proper ventilation and atmospheric monitoring to safeguard workers' health and well-being. The following subsections provide guidance to address this hazard from design to fabrication phases.

A.2 BEST PRACTICES FOR DESIGN PHASE

During the design phase of offshore wind component steel fabrication, understanding the specific fabrication processes of contractors is essential to inform design decisions aimed at minimising the need for confined space entry.

This section presents best practices and recommendations to address confined space hazards at the design phase, emphasising proactive measures to optimise safety and efficiency throughout the fabrication process:

- Risk assessment and mitigation:
  - Conduct risk assessments during the design phase with the view to eliminate confined space where possible, considering hierarchy of control (see [ref. 4]).
  - Establish mechanisms for collecting feedback, incident reports, and near-miss data related to confined space during fabrication activities.
  - Use this information to identify opportunities for improvement and refine design elements to enhance safety performance over time.
- Design for safe access:
  - Optimise the design to reduce the need for workers to enter confined spaces during fabrication and assembly activities. Confined spaces can be created from various scenarios, some examples could be the need to carry out welding, inspection, or NDT inside a component, the blasting or coating of a component or a need to access an airtight platform.

  - Incorporate safe access points and openings into the structure to facilitate entry and exit from confined spaces.
  - Ensure that access points are adequately sized, positioned, and equipped with safety features such as ladders, platforms, or stairways.
  - Integrate monitoring and testing equipment into the design to continuously assess the conditions inside confined spaces.
- Ventilation and air quality:
  - Design ventilation systems to ensure adequate airflow and ventilation within confined spaces.
  - Consider natural ventilation, mechanical ventilation, or air exchange systems to prevent the buildup of hazardous gases, vapours, or airborne contaminants.
- Emergency rescue and evacuation:
  - Incorporate emergency rescue and evacuation procedures into the design of confined spaces.
  - Designate rescue access points, install anchor points for rescue equipment, and provide means for rapid extraction or evacuation of workers in case of emergencies.
- Training and awareness:
  - Ensure that designers, engineers, and other stakeholders involved in the design process receive training on confined space hazards and safety measures.
  - Promote awareness of confined space risks and best practices for safe design and operation among all project stakeholders.

A.3 BEST PRACTICES FOR FABRICATION PHASE

Efficiently managing confined space hazards during the fabrication phase is paramount to ensuring the safety of workers involved in offshore wind component steel fabrication. This section outlines best practices and strategies to mitigate confined space risks during the fabrication phase, emphasising proactive measures to safeguard workers and minimise the need for confined space entry wherever possible:

- Entry control and permitting:
  - Implement entry control measures and PTW systems to regulate access to confined spaces.
  - Develop clear procedures for obtaining permits, conducting pre-entry checks, and ensuring that only authorised personnel enter confined spaces.
- Lighting and visibility:
  - Provide adequate lighting inside confined spaces to ensure visibility and safety for workers.
  - Design lighting fixtures that are suitable for the confined environment.
- Communication systems:
  - A watchperson is always in place prior to and during entry to a confined space to maintain communication.
  - Install communication systems, such as two-way radios or intercoms, to maintain communication between workers inside confined spaces and personnel outside.

  - Ensure that communication devices are reliable, durable, and compatible with the confined space environment.
- Monitoring and testing:
  - Install gas detectors, atmospheric monitors, and other sensors to monitor air quality, temperature, humidity, and other relevant parameters.
- Emergency equipment and supplies:
  - Include emergency equipment and supplies within or near confined spaces to support rescue and first aid efforts.
  - Provide access to emergency breathing apparatus, rescue harnesses, first aid kits, and other necessary equipment for responding to emergencies.
- Competence and training:
  - Hold pre-entry meetings attended by all personnel involved in confined space entries to review the risk assessment, method statement, and the confined space entry permit to ensure that all measures are implemented, isolation points are in place, and gas detection has been done prior to authorising the work to start and entry into the confined space.
  - Ensure the emergency team is trained, equipped and available for rescue and first aid if required.
  - Carry out and record gas monitoring/atmospheric testing by an authorised gas tester prior to the start of, and during, the work.
  - Ensure that those requesting, issuing and authorising the permit to enter are trained and competent to do so.

APPENDIX B
DROPPED OBJECTS

B.1 DESCRIPTION

A dropped object can be defined as any item (tools, equipment or materials) that falls from its previous position, typically from height, that has the potential to cause injury, death or equipment/environmental damage.

A host of factors can contribute to a dropped object incident, including poorly secured tools and equipment, improper storage practices, insufficient barricading or exclusion zones, and human error. Energy sources such as gravity, wind, heave and mechanical motion can initiate a sequence of events that result in something falling. Corrosion, lack of awareness and inadequate inspection or maintenance can increase the chances of a dropped object. It is important to consider these factors during worksite hazard identification, and workers must be vigilant and proactive in identifying and addressing potential hazards to minimise the risk of dropped objects during fabrication activities.

Examples of scenarios where the dropped objects hazard is more significant in offshore wind fabrication include tasks involving manual handling, overhead work, material transport, and equipment installation or maintenance. Workers involved in these activities must be trained to recognise and mitigate the risks associated with dropped objects effectively.

Dropped objects should not be considered an inherent hazard of a working environment. A system should be put in place to identify, prevent and manage the risks associated with dropped objects. The following subsections provide guidance to address this hazard from design to fabrication phase.

B.2 BEST PRACTICES FOR DESIGN PHASE

During the design phase of offshore wind component steel fabrication, understanding the specific fabrication processes of contractors is essential to inform design decisions aimed at minimising the risks of dropped objects.

This section presents best practices and recommendations to address dropped object hazards at the design phase, emphasising proactive measures to optimise safety and efficiency throughout the fabrication process:

- Risk assessment and mitigation:
  - Conduct risk assessments during the design phase to identify potential hazards related to dropped objects and evaluate the effectiveness of proposed control measures.
  - Consider factors such as work height, material handling methods, and proximity to other workers when assessing drop hazards.
  - Establish mechanisms for collecting feedback, incident reports, and near-miss data related to dropped objects during fabrication activities.
  - Use this information to identify opportunities for improvement and refine design elements to enhance safety performance over time.

- Secure attachment points:
  - Design of primary steel structures (monopiles, jackets, and TPs) to consider work at height during fabrication phase and where feasible include designated attachment points, anchorages, or mounting brackets for securing tools, equipment, and accessories.
  - Ensure that these attachment points are robust, well-positioned, and capable of supporting the intended loads.

B.3 BEST PRACTICES FOR FABRICATION PHASE

Efficiently managing dropped object hazards during the fabrication phase is paramount to ensuring the safety of workers involved in offshore wind component steel fabrication. This section outlines best practices and strategies to mitigate dropped object risks during the fabrication phase, emphasising proactive measures to safeguard workers:

- Plans and procedures:
  - Ensure there is a plan for the prevention of dropped objects for the project site. The plan can include scenarios such as ways to minimise exposure to dropped objects by promoting ground assembly, when possible, preparation for high wind conditions, personal tool inventory, minimisation of any work activities in and around established exclusion zones, and performing dropped object surveys for the removal of potential dropped objects prior to transportation of equipment or modules.
  - Have a dedicated person responsible for the site's dropped object prevention plan.
- Tool and material management:
  - Designate specific areas for storing tools, equipment, and materials to minimise the risk of accidental drops.
  - Incorporate storage solutions such as tool cribs, toolboxes, and material racks that are easily accessible and organised.
  - Ensure equipment, components, and fittings have secure fastenings and retention systems to prevent unintended dislodgement or detachment during fabrication activities.
  - Use methods such as locking pins, safety chains, and tethering devices to secure tools and equipment. Consideration should also be given to securing devices which may become dropped objects themselves.
  - Personnel working in elevated work areas should maintain the highest possible housekeeping standards at all times to reduce the risk of potential dropped objects.
- Guardrails and catchment systems:
  - Incorporate guardrails, barriers and similar around elevated work areas, open edges, and overhead platforms to prevent objects from falling to lower levels.
  - Ensure that guardrails meet relevant safety standards and provide adequate protection for workers and equipment.
  - Install safety netting, debris nets, or catchment systems below elevated work areas to intercept falling objects and prevent them from causing injury or damage.

  - These systems must be able to withstand the anticipated impact loads and securely anchor them to structural elements.
- Clearance and overhead hazards:
  - Evaluate the layout of the fabrication yard to identify potential overhead hazards, such as crane booms, equipment gantries, or protruding structures.
  - Ensure that there is sufficient clearance and overhead space to manoeuvre materials and equipment safely.
- Regular inspections and maintenance:
  - Implement inspection procedures for verifying the condition and integrity of safety features.
  - Ensure that regular inspections and periodic 'Hazard Hunts' are performed at the site to ensure precautions are taken to 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.)
  - Prior to moving components and structures, ensure there is a dropped object sweep performed. For larger structures consider use of drones or camera systems.
- Worker training and awareness:
  - Provide training and awareness programs for workers to educate them about the risks associated with dropped objects and the importance of implementing preventive measures.
  - Consider running specific dropped object campaigns reiterating the importance of drops management.
  - Train workers on proper tool handling techniques, tool securing procedures, and hazard recognition.

APPENDIX C
HOUSEKEEPING

C.1 DESCRIPTION

Housekeeping activities are essential for maintaining a safe and orderly work environment in offshore wind fabrication yards. Effective housekeeping involves the systematic organisation, cleanliness and tidiness of the workplace to minimise hazards and ensure smooth operations. It is also a good indicator of a well-run and disciplined site that has pride in its work and site.

Poor housekeeping practices can lead to various safety and health risks, including slips, trips, falls, dropped objects, fire hazards, chemical exposures, and ergonomic injuries. Examples of housekeeping-related hazards include cluttered walkways, unsecured materials, spills, debris, and inadequate lighting.

To mitigate the risks, comprehensive housekeeping procedures should be implemented, emphasising regular inspections, proper storage of materials, waste disposal, floor cleaning, and maintenance of equipment and facilities. Additionally, workers should receive training on housekeeping best practices and be encouraged to maintain a clean and safe work environment at all times.

The following subsections provide guidance to address this hazard, in particular on the fabrication phase.

C.2 BEST PRACTICES FOR DESIGN PHASE

There are no specific recommendations to be considered for housekeeping at the design stage. Instead, emphasis should be placed on implementing best practices for housekeeping during execution (see Appendix C.3).

C.3 BEST PRACTICES FOR FABRICATION PHASE

Efficiently managing housekeeping during the fabrication phase is key to ensuring the safety of workers involved in offshore wind component steel fabrication. This section outlines best practices and strategies to ensure good housekeeping practices during the fabrication phase, emphasising proactive measures to safeguard workers:

- Leadership and supervision:
  - Site management communicates frequently and reinforces expectations for housekeeping.
  - There are regular walkthroughs and inspections by site management including senior leaders should be used to systematically monitor housekeeping and reinforce commitment to safety.
  - Supervisors verify that their work teams perform housekeeping in alignment with expectations.

- Resource planning:
  - Site management ensures resources and space are available:
    - For the segregation and disposal of scrap, waste, and surplus materials.
    - For storage of material and supplies that considers the flow of personnel, equipment, materials, fire hazards, and clear routes for evacuation, firefighting, and rescue.
  - Site management should ensure that adequate hardware such as waste chutes, bins, hose/cable manifolds, hanging trees for hoses and cables, etc. are made available.
  - Site makes arrangements for removing waste and debris at a frequency that keeps the worksite orderly.
- Training and awareness:
  - All workers are trained and made aware to ensure that stairways, walkways, ladders, scaffold, and gangways are free of material, supplies and obstructions.
  - All workers are trained to ensure that cords, cables, and hoses are protected from damage and kept out of walkways and working surfaces. Where possible they can be elevated on designated hangers to eliminate tripping hazards.
  - Individuals are encouraged to perform housekeeping in their work areas as needed throughout their shift, but at minimum at the end of each shift.
  - All workers are trained to ensure that flammable materials are segregated when stored and used to minimise fire hazards.
  - All workers are trained to ensure that material is kept from being placed in locations where it would be a dropped object hazard.
  - Individuals are encouraged to address unsafe conditions and report them via observation reporting system to identify common trends and failures.

APPENDIX D
LIFTING OPERATIONS

D.1 DESCRIPTION

Hazardous lifting operations typically involve the movement of heavy components or equipment using cranes, hoists, or other lifting devices. These operations pose risks such as structural failure of lifting equipment, dropped objects, entanglement, crushing, or personnel struck by moving loads.

Risk factors associated with lifting operations include inadequate equipment maintenance, improper rigging techniques, overloading, unstable ground conditions, and adverse weather conditions. Workers involved in lifting operations must be trained to identify and mitigate these risks effectively to prevent accidents and injuries.

Examples of lifting operations commonly encountered during offshore wind fabrication include, but are not necessarily limited to, the movement of monopiles, jackets, TPs, and other large structural components. All lifting operations should be planned to ensure that they are carried out safely and that all foreseeable risks are taken into account. Planning should be carried out by the appointed person who has the appropriate knowledge for the lift being undertaken. The outcome of the planning process should be a written lift plan which includes risk assessments, method statements and supporting information, such as a schedule of lifts, drawings and photographs. In addition, workers engaged in tasks such as lifting, rigging, signalling, or supervising must adhere to strict safety protocols and procedures to minimise the likelihood of accidents and ensure the integrity of the lifting operation.

Due to the varying levels of governance on lifting globally it is recommended that the industry works towards standardising terminology used in lifting and agreeing on some minimum standards for lifting. Recommended definitions for routine and non-routine lifts are found in the 'Glossary' section, Appendix J.

The following subsections provide guidance to address this hazard from design to fabrication phase.

D.2 BEST PRACTICES FOR DESIGN PHASE

During the design phase of offshore wind component steel fabrication, understanding the specific fabrication processes of contractors is essential to inform design decisions aimed at minimising the need for lifting.

This section presents best practices and recommendations to address lifting operation hazards at the design phase, emphasising proactive measures to optimise safety and efficiency throughout the fabrication process:

- Risk assessment and mitigation:
  - Conduct risk assessments for lifting operations during the design phase with the view to eliminate or reduce lifting operations as far as practicable, considering hierarchy of control (see [ref. 4]).

  - Consider the gross weight of final product against capabilities of the contractor. If design constraints result in gross weight being greater than contractor's lift capability, then early discussions are encouraged to minimise any impact to project timelines or budgets.
  - Consider factors such as equipment failure, human error, and environmental conditions when assessing lifting risks.
- Structural considerations:
  - Overall, design with the aim to reduce as far as practicable the need to perform multiple lifts.
  - Design the primary steel structures (monopiles, jackets, and transition pieces) with lifting points, attachment points, or lifting lugs incorporated into the structure.
  - Ensure that these lifting points are strategically positioned and adequately reinforced to withstand the anticipated loads during lifting operations.
  - Consider the need for thorough examinations as required by law, including consideration for access to them.
- Load analysis:
  - Conduct thorough load analysis to determine the maximum permissible loads for lifting operations.
  - Consider factors such as structural integrity, material strength, centre of gravity, and dynamic loading effects to ensure safe lifting practices.
- Standardisation of lifting gear:
  - Align (or standardise) the design and specification of lifting gear, such as slings, shackles, and lifting beams, to ensure compatibility with the fabrication yard.
  - Specify the type, capacity, and configuration of lifting gear required for each lifting operation.
- Accessibility and clearance:
  - Align with the fabrication yard layout to ensure it can provide sufficient space, clearance, and accessibility for lifting equipment and cranes to manoeuvre safely.
  - Ensure that there are no obstacles, obstructions, or overhead hazards that could interfere with lifting operations.

D.3 BEST PRACTICES FOR FABRICATION PHASE

Efficiently managing lifting operation hazards during the fabrication phase is paramount to ensuring the safety of workers involved in offshore wind component steel fabrication. This section outlines best practices and strategies to mitigate lifting operation risks during the fabrication phase, emphasising proactive measures to safeguard workers and minimise the need for lifting wherever possible:

- Lifting plans and procedures:
  - A lift plan is required that represents every lift. The detail of the lift plan is scaled based on the level of risk. Generic plans may represent multiple occurrences of routine lifts. Specific plans are needed for non-routine lifts:
    a) For non-routine simple crane and lifting operations, the lift plan is by a person assessed as competent, e.g. a slinger, rigger, person in charge of the lift.

b) For complex/critical/tandem lifting operations, the lift plan is prepared and reviewed by an assured qualified engineer.
c) For heavy lifts, the lift plan is reviewed with input from an assured qualified engineer.
d) Lifting of personnel is carried out in accordance with a specific personnel lift plan.
e) Blind lifts require additional planning and communication before the work starts.
f) Self-fabricated lift points such as trunnions or lift eyes are not used unless they conformance with local regulations.

- Involve experienced rigging engineers, crane operators, and safety personnel in the planning process.
- Nominate one person in the lift team, designated as the 'Person in Charge' of the lifting operation, responsible for ensuring that the lift team has tested and understood the lift plan as well as visual and/or radio communications prior to the lift.

– Clear markings and signage:
  - Clearly mark and identify designated lifting points and load capacities on the primary steel structures.
  - Ensure that the person directing the lift (banksman/signaller/spotter) is easily identifiable.
  - Identify work zone boundaries to prevent contact with overhead hazards such as power lines or fixed structures.
  - Ensure that all people are kept clear of overhead loads and lifting equipment and areas of potential impact including the counter-weight swing radius.
  - Evaluate potential for falling objects and extend the exclusion zone to include deflected falling objects.
– Training and certification:
  - Ensure that personnel involved in lifting operations receive adequate training, certification, and competency assessments for their respective roles.
  - A person 'assessed competent' has been assessed as competent by an industry recognised authority.
  - Provide training on safe lifting practices, rigging techniques, signal communication, and emergency response procedures.
– Pre-lift inspection:
  - Lifting devices and equipment undergo documented verification of inspection, as well as any maintenance required before first use and thereafter, as stipulated by original equipment manufacturer (OEM), guidance or recognised industry practice.
  - Inspection and maintenance activities are carried out by persons assessed and documented as competent. Consider using a third-party lifting company to review lifting documentation and perform verification checks against the contracted lift company. This improves the quality of the review process and ensures suitable competence.
  - Mechanised lifting equipment and rigging apparatus that does not pass visual, periodic, or annual inspections is immediately taken out of service, repaired or destroyed and removed from the site.

  - All lifting devices and equipment are visually examined before use.
  - Colour coding or labelling for lifting accessories are a recommended effective administrative control to ensure inspection of rigging.
- Environmental conditions:
  - If the lift, operational or weather conditions deviate from the agreed lift plan, the activities are stopped safely, and either risk is re-assessed, controls identified and represented in a revised plan, or the lift paused until conditions match the agreed lift plan.
- Lifting of personnel:
  - Manlift/mobile access platforms should be the preferred method for lifting people. Lifting of personnel with cranes is prohibited unless the risk has been demonstrated as being as low as is reasonably practicable (ALARP). Work baskets are designed, certified and used according to recognised international standards. Cranes involved in lifting of personnel are certified for man-riding operations.

APPENDIX E
SIMULTANEOUS OPERATIONS

E.1 DESCRIPTION

SIMOPs is defined as two or more work scopes during project works at site occurring simultaneously in a same or adjacent area which can interfere with one another. This increases the complexity and potential for incidents if not managed diligently.

Several factors contribute to the risk associated with SIMOPs, including the proximity of different work activities, conflicting priorities, limited workspace, and the interdependence of tasks. The dynamic nature of fabrication operations further amplifies these challenges, necessitating proactive measures to ensure the safety and well-being of personnel.

Key examples of SIMOPs in fabrication may include welding activities alongside material handling or lifting operations, blasting and coating operations occurring concurrently with assembly or fit-out tasks, or structural inspections being conducted alongside construction activities. Each of these scenarios requires careful planning, communication, and supervision to minimise the risk of incidents and maintain safe working conditions. These activities can have significant consequences if not managed.

Robust control measures should be established to manage SIMOPs effectively. This includes developing comprehensive work plans and schedules, implementing clear communication protocols, establishing designated work areas, and providing adequate training and supervision for personnel involved in simultaneous tasks. Additionally, ongoing monitoring and review of SIMOPs are crucial to identify emerging hazards, assess the effectiveness of control measures, and make any necessary adjustments to ensure continued safety and operational efficiency.

The following subsections provide guidance on addressing the SIMOPs hazard, in particular throughout the fabrication process.

E.2 BEST PRACTICES FOR DESIGN PHASE

At the design stage, it is recommended that SIMOPs are considered as part of design risk assessment. This information should then be considered in the design risk register to define mitigation measures that identify any adjustments required to ensure continued safety and operational efficiency.

E.3 BEST PRACTICES FOR FABRICATION PHASE

Efficiently managing SIMOPs during the fabrication phase is paramount to ensuring the safety of workers involved in offshore wind component steel fabrication. This section outlines best practices and strategies to mitigate SIMOP risks during the fabrication phase, emphasising proactive measures to safeguard workers and ensure where required there are effective controls in place to prevent incident or injury:

- Risk assessment and planning:
  - Plan work to eliminate or minimise SIMOPs.
  - Conduct a comprehensive risk assessment to identify potential conflicts, hazards, and dependencies associated with SIMOPs.
  - Consider factors such as workflow, resource allocation, equipment utilisation, and spatial constraints when planning and scheduling concurrent activities.
- Sequencing and scheduling:
  - Develop a detailed sequencing and scheduling plan that prioritises safety and minimises the likelihood of conflicting activities occurring simultaneously (consider NDT and any remedial works required).
  - Coordinate with project stakeholders to establish clear timelines, milestones, and priorities for each operation, ensuring adequate coordination and communication.
- Work area segregation:
  - Designate separate work areas or zones for different activities to minimise interference and enhance safety.
  - Where SIMOPs cannot be avoided, ensure suitable passive controls are in place such as protective netting or barriers.
- Permit to Work and communication:
  - SIMOPs should be managed via a PTW system, led by one single authority.
  - Competent supervisors, identified in the PTW, with authority on the involved organisations, are available in the work area to manage and oversee SIMOPs activities.
  - Ensure SIMOPs communication sessions are held between affected parties, such as interface meetings and toolbox talks.
  - SIMOPs activities are executed based on the permit conditions. If conditions cannot be met, options include the temporary cancellation of the activity, adjusting timeframes, or introducing specific site controls.
  - Ensure that SIMOPs activities are communicated and visible using permit boards.

APPENDIX F
TRAFFIC MANAGEMENT

F.1 DESCRIPTION

Traffic management is ensuring that construction traffic, which could be any self-propelling vehicle or equipment, such as cars, cranes, fork-lift trucks, mobile elevating platforms or remotely operated vehicles is assessed, and the hazards posed by such movements are identified. The movement of vehicles, machinery, and personnel within fabrication yards presents inherent risks, including the potential for collisions, struck-by incidents, and other accidents.

Key aspects contributing to the traffic management hazard include limited visibility, congested work areas, interaction between different types of vehicles and equipment, and human factors such as distraction or complacency. It is critical that robust traffic management procedures are established to mitigate these risks and maintain a safe working environment.

During construction, specific consideration should be given to the interface between pedestrian and construction traffic, general movement of construction traffic and how it can be safely controlled, and comprehensive traffic management measures should be implemented to control vehicle movement, ensure clear signage and markings, establish speed limits, and designate pedestrian walkways. Adequate training and supervision are also essential to ensure that all personnel understand and adhere to traffic management procedures.

The following subsections provide guidance on addressing the traffic management hazard, in particular throughout the fabrication process, covering topics such as risk assessment, traffic control measures, communication protocols, ongoing monitoring, and review and training.

F.2 BEST PRACTICES FOR DESIGN PHASE

At the design stage, it is recommended that traffic management is considered as part of design risk assessment, analysing likely traffic flow patterns and identifying potential bottlenecks, congestion points, and areas of high vehicle activity. This information should then be considered in the design risk register to define mitigation measures that optimise the layout and ensure smooth traffic movement.

F.3 BEST PRACTICES FOR FABRICATION PHASE

Efficiently managing traffic hazards during the fabrication phase is paramount to ensuring the safety of workers involved in offshore wind component steel fabrication. This section outlines best practices and strategies to mitigate traffic risks during the fabrication phase, emphasising proactive measures to safeguard workers and minimise bottlenecks, congestion points, and areas of high vehicle activity where possible:

- Plans and procedures:
  - Ensure that a plan is developed that captures all the logistical challenges and components to be moved. Challenges and relevant interfaces should be shared with the contractor to feed into their traffic management plan.

  - The plan ensures risks associated with workplace transport are identified and control measures are adopted to ensure the safety of pedestrians or persons at work. The plan considers the following:
    - The layout of the site, the activities carried out, the types of vehicles/mobile equipment used, the competency of operators, and the control measures for subcontractors and delivery drivers.
    - The steps to be taken to prevent vehicle incidents, including detail of site traffic routes for the safe movement of vehicles/equipment and pedestrians, fatigue management, and the requirement for drivers to check that the vehicle being driven is free from hazards before moving the vehicle (a good practice is to perform a 360 walk around).
    - That only authorised/approved persons operate a vehicle/truck/motorised equipment.
  - Consider implementing a one-way systems where design allows. All reversing is done using technology (sensors, cameras, etc.) to eliminate the need for spotters, where this is not possible, a banksman or spotter is required.
  - Emergency response planning should be considered specifically around recovery of plant, actions on impact with pedestrian and or crush/entrapment, the latter requiring time-critical response to maximise chance of a positive outcome.
- Risk assessment and planning:
  - Conduct a comprehensive risk assessment to understand the full range and direction of movement of all plant and mobile equipment.
  - Ensure suitable controls are in place to prevent injury to personnel, damage to equipment and assets, prioritising in accordance with hierarchy of control (see [ref. 4]).
  - Consider the ground bearing capacity of routes to ensure they are suitable for the plant and equipment planned to travel on.
  - Ensure plant and equipment are suitable for the planned route, considering ability to manoeuvre safely and without risk of overturning.
- Training and awareness:
  - All workers are trained in risk awareness on hazards associated with construction traffic interface with emphasis on blind spots and the appropriate use of spotters.
  - All external drivers are briefed on the site's requirements and enforcement of rules.
  - Require all third-party contractors to submit in advance the necessary documentation to satisfy competence and demonstrate suitable controls for hazards identified.
  - Speed limits within the fabrication areas are visible and suitable for the works being carried out.
  - Reflective and high visibility apparel is used by those exposed to operating vehicles.

APPENDIX G
WORKING AT HEIGHTS

G.1 DESCRIPTION

WAH involves tasks performed above ground level, or near an edge, where the risk of falling exists, from an edge, through an opening or fragile surface, or from ground level into a hole or opening in the structure, during assembly, installation, maintenance, or inspection activities. It should be noted that the exact definition varies country to country, so it is key that the developer makes clear their expectations for working at height.

Risk factors associated with WAH include unprotected edges, fragile surfaces, unstable platforms, adverse weather conditions, equipment failure, poor lighting, lack of training, and overloading. These factors increase the likelihood of slips, trips, falls, and other accidents, leading to serious injuries or fatalities if not properly managed.

Examples of work at height include accessing the top of transition pieces via scaffold, conducting tasks on platforms at elevated levels, and accessing hatches or openings in the structure. Workers performing these activities face the risk of falls and must adhere to strict safety protocols and use appropriate fall protection equipment to prevent accidents and injuries.

To mitigate the risks associated with working at height effectively, robust controls must be implemented throughout the design and fabrication processes. This should start with following hierarchy of controls (see [ref. 4]): When it is not possible to work at ground level or in a protect area, fall prevention systems, such as harness tethers restricting movement or temporary railings, are used as first option. Potential second options (such as controlled-access zones or leading-edge procedures) are approved prior to use by the client and site management, fall arrest systems would be the next option. Thorough risk assessments should also be conducted, providing adequate fall protection systems, ensuring stable working platforms, and delivering comprehensive training to workers on safe working practices and equipment usage.

The following subsections provide guidance to address this hazard from design to fabrication phase.

G.2 BEST PRACTICES FOR DESIGN PHASE

During the design phase of offshore wind component steel fabrication, understanding the specific fabrication processes of contractors is essential to inform design decisions aimed at minimising the need for WAH.

This section presents best practices and recommendations to address WAH hazards at the design phase, emphasising proactive measures to optimise safety and efficiency throughout the fabrication process:

- Risk assessment and mitigation:
  - Ensure that the hierarchy of controls (see [ref. 4] are applied throughout design and planning.

  - Conduct risk assessments during the design phase to identify potential hazards related to work at heights and evaluate the effectiveness of proposed control measures.
  - Establish mechanisms for collecting feedback, incident reports, and near-miss data related to work at heights during fabrication activities.
  - Use this information to identify opportunities for improvement and refine design elements to enhance safety performance over time.
- Minimise work at heights:
  - Optimise the design to reduce the need for workers to work at heights during fabrication and assembly activities. Work at heights can be created from various scenarios, some examples could be the need to carry out welding, inspection or the blasting or coating of a component.
  - Enable the installation of safe access and egress routes, such as stairs, ladders, or scaffolding, to facilitate safe movement to and from elevated work areas.
  - Ensure that access points are adequately sized, positioned, and equipped with safety features such as ladders, platforms, or stairways.

G.3 BEST PRACTICES FOR FABRICATION PHASE

Efficiently managing WAH hazards during the fabrication phase is paramount to ensuring the safety of workers involved in offshore wind component steel fabrication. This section outlines best practices and strategies to mitigate WAH risks during the fabrication phase, emphasising proactive measures to safeguard workers and minimise the need for WAH wherever possible:

- Plans and procedures:
  - Where WAH is unavoidable, the implementation of robust fall protection measures is required. This includes passive (e.g. guardrails, netting, covers) and active (e.g. harness, lanyards and restraint systems). Consider how passive controls can be installed as part of the assembly for access (i.e. install netting as part of scaffold erection).
  - Provide a means of accounting for persons working at height when accessing larger assemblies such as upper and lower structures. This can be as simple as a T-card system or digital sign in/out method. This aids various emergency scenarios such as fall from height, confined space, fire, etc. and should be considered during planning.
  - Ensure that all WAH activities have a suitable rescue plan in place and personnel trained and competent to do so.
  - Carry-out pre-work planning to identify the locations of acceptable anchor points to facilitate ease of use, load requirements, and height requirements. If access to height does not provide suitable tie-off points via these means, then work should not go ahead until assessed by a competent person.
- Training and certification:
  - Ensure that all persons exposed to working at height are suitably trained and competent to do so.
  - Rehearse and practice rescue from height as early as practicable to ensure the measures in place are suitable.

  - Ensure that a trained rescue team knowledgeable in suspension trauma and outfitted with fit for purpose emergency rescue equipment is located at the work site.
- Use of mobile elevated work platforms (MEWP's) for access at height:
  - Due to the access needs for many of the components, MEWPs are commonly used and while typically acknowledged as a safer means of access/egress, they do carry some considerable risks that must be considered and appropriately mitigated.
  - Typical hazards to consider when planning include entrapment between parts of the basket and fixed structures, equipment overturning, basket falls, and collisions with pedestrians, overhead structures, power lines, or adjacent vehicles.
  - Other factors to consider when planning are ground conditions, dropped objects, weather, and hazards nearby such as overhead lines or structures that create a restricted space.
  - The emergency response plans require careful consideration, not only for rescue from height but rescue from crush and entrapment. Where possible, MEWPs should have shrouds around controls to prevent accidental contact if fallen onto.
  - See also the guidance and resources available from the International Powered Access [ref. 7]
- Equipment and inspection:
  - Provide, free of charge to the worker, personal fall arrest systems consisting of a full-body harness and tie-off equipment such as dual self-retracting lanyard, dual lanyards with a shock absorber, or other approved devices matched to the fall potential the worker is exposed to. Single hooks are not acceptable.
  - Follow approved procedures to use, maintain, and inspect components of fall protection systems and ladders as per manufacturer's requirements and recommendations, including pre-use inspections.
  - Remove from service and destroy fall protection systems or their components if they do not pass inspections, or if they have been subjected to a fall.

APPENDIX H
WORKING NEAR OR OVER WATER

H.1 DESCRIPTION

Working near or over water entails inherent risks due to the proximity to bodies of water, which can pose significant dangers to workers. This hazard is particularly pronounced during activities such as upending, conducting remedial works and loadout of components, where workers may be exposed to potential fall hazards into the water. The risk factors associated with working near or over water can vary depending on the specific location and conditions of the worksite.

One of the primary risk factors associated with working near or over water is the condition of the quay or harbour where the work is being conducted. Poorly maintained infrastructure, or unmarked edges along the water's edge or on floating platforms can increase the likelihood of accidents, such as slips or trips, leading to falls into the water. In addition, inadequate housekeeping in the vicinity of water edges can create obstacles or hazards that may contribute to accidents. The presence of moving vehicles and machinery in the designated loadout area also poses a significant risk, as it increases the potential for collisions or incidents resulting in falls into the water. Finally, adverse weather conditions, such as high winds, rain, or fog, can exacerbate the risks associated with working near or over water, making surfaces slippery and reducing visibility. These factors increase the likelihood of falls into water, leading to serious injuries or fatalities if not properly managed.

Examples of working near water include tasks performed within a predetermined distance from water edges, whether from land or aboard a floating vessel. Working at height in areas with a potential to fall into water should also be considered. When such activities cannot be avoided, workers performing them face the risk of falling into water and must adhere to strict safety protocols and use the appropriate PPE to prevent accidents and injuries.

The following subsections provide guidance on addressing hazards from working near or over water, throughout the loadout process.

H.2 BEST PRACTICES FOR DESIGN PHASE

At the design stage, it is recommended that working near or over water is considered as part of design risk assessment. This information should then be considered in the design risk register to define mitigation measures that identify any adjustment required to ensure continued safety and operational efficiency.

H.3 BEST PRACTICES FOR FABRICATION PHASE

- Risk assessment and planning:
  - Ensure there is a suitable and comprehensive risk assessment in place to identify potential conflicts, hazards, and dependencies associated with working near or over water.

- Clear marking and lighting:
  - Laws and regulations will vary from region to region, however, the developer must ensure that there are safe working practices in place for work near water. This typically includes a safe working area and a clear delineation from where additional protective measures are required, such as personal floatation device (PFD) and, if environment requires, survival suits.
  - Each part of the dock premises that is being used for 24-hour dock operations should be suitably and adequately lit, and lighting should be properly maintained.
- Safe access and egress:
  - At jetties and quay edges where the edges are unfenced, means should be provided to help people to rescue themselves from drowning, and also provision for other people to rescue those in danger without endangering themselves. The means should include:
    - Handholds on the quayside at water level (at any state of the tide).
    - Ladders on quay walls.
    - Life-saving equipment.
- Operating plant and equipment near within harbour area:
  - Consideration should be given for the implementation of one-way systems where design allows. All reversing is done using technology (sensors, cameras, etc.) to eliminate the need for spotters. Where this is not possible a banksman or spotter is required.
  - Speed limits within the harbour areas are visible and suitable for the works being carried out.
  - Plant and equipment operate at a safe working distance from the quay edge. Where works are required at a proximity that exceeds the safe working distance (e.g. when placing crane matts), additional controls need to be in place.
- Vessel alongside:
  - The risk assessment should consider the risk of crush between vessel and harbour wall introduced by situations of vessel alongside.
  - Access vessels and barges via a gangway that complies with appropriate international standards.
  - The structure of gangways and their fittings allows for regular inspection and maintenance of all parts.
  - Where conducting sea fastening or remedial works on a barge or vessel that has unprotected edges, provisions are made to ensure the safe access/egress and work within that area.
- Emergency response and equipment
  - Life-saving equipment is conspicuous, properly maintained, and provided at appropriate intervals (no greater than 100 m).
  - Life-saving equipment includes lifebuoys, throwing lines and rescue poles. What is suitable life-saving equipment will depend on the circumstances. In some situations, particularly where there is a strong tide or current, a throwing line may be appropriate either in addition to, or in place of, a conventional lifebuoy.
  - Instructions for the use of each piece of life-saving equipment should be given or displayed.
  - The length of the lifeline, where provided, should be adequate for the dock and should be attached to each lifebuoy, or a separate throwing line should be

provided. All such equipment should be kept readily accessible. Draglines are not rescuing equipment.
- Consider use of fast response craft to provide rapid response in the event of a person in the water. Should this not be available then a suitable means of recovery must be identified and appropriately risk-assessed.

- Training and competence:
  - Personnel working near or over water are required to undergo additional inductions covering:
    - Weather operating limits.
    - Hazards associated to work near or over water.
    - PPE requirements.
    - Emergency actions for person in water.
    - Use of plant and equipment within the area.
    - Speed limits and traffic management.
    - Nighttime working.
  - The emergency response plan includes actions on person in the water and cover appropriate actions for recovery. All persons working in this area are trained to act accordingly and have suitable knowledge and skills to do so.
- Weather:
  - Harbour areas have suitable means of monitoring the weather and communicating the information to relevant stakeholders.
  - There is clearly defined weather limitations for all operations within the harbour area.
  - Due to the seasonal variation in temperature and general conditions, appropriate PPE and equipment is considered for work near or over water.

APPENDIX I REFERENCES

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APPENDIX J
GLOSSARY OF ACRONYMS AND ABBREVIATIONS

Abbreviation	Definition
ALARP	as low as is reasonably practicable
CR	client representatives
ERP	emergency response planning
HAVS	hand arm vibration syndrome
HAZID	hazard identification
HMI	human-machine interface
H&S	health and safety
IOGP	International Association of Oil and Gas Producers
ISO	International Organization for Standardization
MEWP	mobile elevated work platform
NDT	non-destructive testing
OEM	original equipment manufacturer
PFD	personal floatation device
PPE	personal protective equipment
PTW	permit to work
RCA	root cause analysis
RORO	roll-on roll-off
RPE	respiratory protective equipment
SIMOPs	simultaneous operations
SQQ	supplier qualification questionnaire
TP	transition piece
WAH	work at height
WTG	wind turbine generator

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