Good practice guideline

Working at height in the offshore wind industry

Second edition

G+ Global Offshore Wind
Health & Safety
Organisation

In partnership with

energy institute

GOOD PRACTICE GUIDELINE: WORKING AT HEIGHT IN THE OFFSHORE WIND INDUSTRY

Second edition

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1 INTRODUCTION

Safe working depends on a combination of:

- Plant:
  - The initial design and long-term condition of structures, workplaces and other assets determine the hazards to which workers will be exposed.
- Processes:
  - The way that work is planned and managed will affect the level of risk to the people involved.
- Place:
  - The characteristics of the working environment, and its hazards.
- People:
  - Decisions made by people, at every level, and in every role within a project or facility, can affect their own safety, and the safety of others around them.

These guidelines address aspects of each of these areas, with a focus on work at height (WAH); other hazards may be mentioned, but are not addressed in detail.

The guidelines are in four parts, based on the scope of work agreed in discussion with the G+ Work at Height Focal Group:

- Life cycle phase checklists:
  - A checklist for each phase (design, construction, commissioning and operation) to prompt those involved to find ways to reduce the requirement for work at height.
- Topic guidance:
  - This adopts a goal-setting approach to five key aspects of WAH;
    - The topics were selected on the basis of:
      - A review of G9 incident data for 2011/2; the more recent G+ data have informed the development of the revised guideline.
      - Workshop discussions with G9/G+ representatives.
      - Surveys to identify areas of concern, conducted amongst G9 representatives, and WAH refresher training candidates at heightec in 2013.
  - For each of the five topics, the guidance addresses:
    - common hazards;
    - PPE and other relevant standards;
    - training, skills and competence;
    - fitness requirements, and
    - responsibilities of those procuring, supervising and undertaking work.
- Flowcharts to support the preparation and review of procedures.
- Supporting information on:
  - Regulatory requirements in the EU and selected nations.
    - The first edition included the UK, Germany, Denmark, Norway, Netherlands and France, all of which have a common baseline of EU directives.
    - This revised edition also considers China, Japan, Taiwan and the USA.
  - Existing guidance on WAH.
  - Equipment and technical standards.
  - Existing fitness standards in wind, oil and gas and maritime sectors.
  - Analysis of G+ member incident data relating to WAH and areas of concern from surveys.

The original guidelines were jointly prepared by heightec and SgurrEnergy, in consultation with the G9 Work at Height Focal Group. The updated guidelines have been prepared by Wood (following the rebranding of SgurrEnergy as Wood Group, which subsequently rebranded as Wood), reviewed by David Thomas (co-author of the original guidelines) of Heightsayfe, again in consultation with the G+ Work at Height Focal Group and industry consultees.

1.1 INTERFACE WITH OTHER G+ GUIDELINES

It is recognised that these guidelines interface with other G+ guidance being prepared. In particular, while dropped objects are a significant hazard with respect to WAH, and were covered in the first edition guidelines, they have been removed from the second edition as they will be covered in separate guidelines.

1.2 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.

2 HIERARCHY OF PROTECTIVE MEASURES FOR WORK AT HEIGHT

All consideration of WAH should start with the hierarchy of protective measures. A lower level on the hierarchy should only be adopted if it is not reasonably practicable to take the approach given in a higher level. Protective measures can either be:

– collective protection, which, when correctly installed and maintained, protects people without requiring them to take any additional actions to ensure safety; or
– personal protection, which depends on the user making correct and consistent use of the equipment.

Collective protection is therefore the preferred approach at each level of the hierarchy.

1. WAH should be avoided wherever it is reasonably practicable to do so, by using an existing safe place of work or permanently installed access platform:
    a. techniques such as using drones for blade inspection may allow sufficient information to be gained on blade condition, without requiring WAH.
2. Where it is not reasonably practicable to avoid working at height, work equipment should be used to prevent falls from occurring:
    a. collective protection, such as providing fixed guardrails, or
    b. personal protection, such as personal fall prevention/work restraint systems.
3. Where it is not reasonably practicable to avoid working at height or to prevent falls from occurring, then work equipment should be used to minimise the distance and consequences of a fall:
    a. collective protection, such as safety nets rigged at high level on a structure, or
    b. personal protection, such as rope access, work positioning, or personal fall arrest system (FAS).
4. Where it is not reasonably practicable to do any of the above, then measures should be taken to minimise the consequences of a fall:
    a. collective protection, such as safety nets rigged at low level.
    b. personal protection, such as the use of Personal Flotation Devices (PFDs, generally in the form of a lifejacket) and immersion suits for work over water.
    c. procedural measures, such as providing suitable incident response, for example having safety vessels standing by when working over water.

Wherever safety depends on the use of work equipment, users must have the necessary competence to use it correctly, and employers should ensure that there is an appropriate level of instruction, supervision, training and other procedural/behavioural controls.

Other forms of work equipment, such as ladders or hop-ups, or the use of signage to guide people away from situations where they could be at risk of a fall from height, do not satisfy these criteria. The use of maintained and secured ladders can only be justified where a risk assessment demonstrates that the use of the preferred approaches set out here is not justified because of the low risk and short duration of use, or existing features on site which cannot be altered.

- The level of risk is the most important factor:
  - The probability of falling can be minimised by limiting the activities that are carried out from a ladder, and ensuring that users maintain three points of contact with the ladder.
  - The potential severity of a fall will depend on the height and location of the work.
- The exposure to the risk can be limited by restricting the duration for which such work equipment is used, such as by ensuring that ladders are only used for tasks with a duration of less than 30 minutes[1].

This guidance document seeks to apply these principles in every situation, for example:

- Design decisions can eliminate work at height for some foreseeable future activities, and minimise the risk for those activities where WAH is unavoidable.
- Selection of rescue methods will determine whether the rescuer is in a position from which a fall cannot occur, or if the rescuer has to rely on an FAS.
- The quality of procedures, and the culture in which work is carried out, will affect the effectiveness of procedural controls.

1 30–minute guideline is from http://www.hse.gov.uk/pubns/indg455.pdf.

3 LIFE CYCLE PHASE GUIDANCE

Purpose:

This guidance provides prompts to assist those involved in planning or undertaking works in a life cycle phase, to find ways to:

- reduce the need to WAH, thereby eliminating the hazard; or, where work at height cannot be avoided, to
- make suitable provision and preparations for safe WAH.

Phases covered:

- Design.
- Construction, up to the point where the offshore structure is physically complete.
  - Decommissioning will involve similar hazards relating to WAH.
- Works over the operating lifetime of the offshore structure, including commissioning and operations and maintenance.

Locations and activities covered:

- Access route from vessel to external platform, and activities on this platform.
- Towers and other structures.
- Nacelle, hub and helicopter hoist operations platform (commonly called a helihoist platform) – but not helicopter hoisting operations.
- External and internal access to blades.

3.1 DESIGN

Key principles:

The designer should undertake hazard identification and risk reduction, concentrating on significant issues within their area of responsibility, and where it interfaces with other work packages. To ensure that such an assessment is effective, and that practical solutions are implemented, it should involve people with direct experience of the activities involved. These solutions should apply the hierarchy of controls to the full life cycle of the wind turbine generator (WTG), for example:

- *Identifying where the design can enable future operating and maintenance tasks to be undertaken without the need to work at height;*
- *Ensuring that there is suitable provision for safe work at height for foreseeable activities during construction, commissioning, O&M and decommissioning phases.*

This section is focused on functional requirements relating to WAH, and does not set out to address other hazards or design considerations. It is intended to be used when specifying, designing or modifying equipment or structures that will involve WAH, but does not create a requirement to modify existing assets.

3.1.1 Common requirements for access equipment

The requirements outlined in this section are relevant to any part of an offshore structure; additional specific requirements should also be addressed for:

- transfer by stepping over from a vessel to a ladder;
- transfer using a walk to work (W2W) gangway to an external platform;
- access to basement;
- access inside foundations;
- access within WTG towers;
- access to the interior and exterior of nacelles;
- nacelle evacuation;
- access to the hub;
- access to blades;
- work on meteorological masts;
- work on foundations, and
- work on offshore substations.

The terminology used in this guideline is defined in Figure 1.

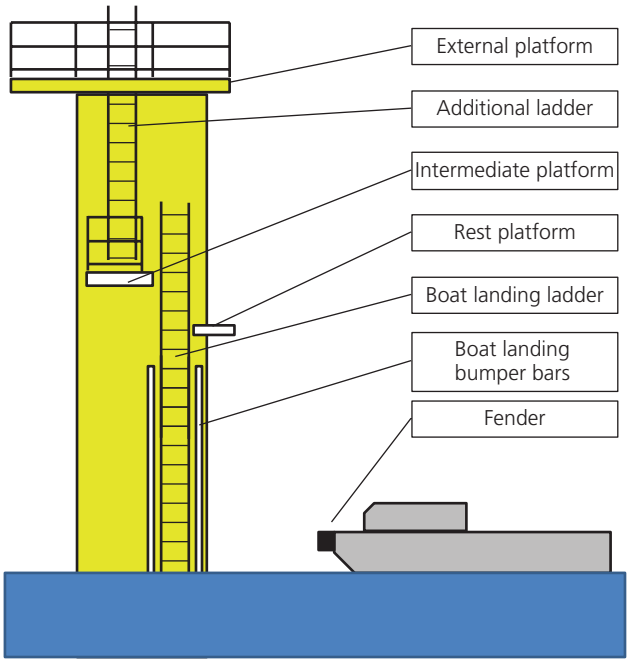

Figure 1: Definitions of access structure components

3.1.1.1 Ladders

Ladder design is generally based on EN ISO 14122-4; the most recent revision of the standard (2016) reflects some wind industry practices, in particular recognising that ladders equipped with fall arresters are appropriate for a 'well-trained user' such as a WTG installer. (The standard continues to recommend staggered flights of caged ladders elsewhere, despite the

findings of research into the fall-arresting effectiveness of ladder safety cages[2,3,4]). There are several areas in which good practice in the wind industry does not match the approaches described in the standard, therefore simply specifying that designs shall comply with the standard may not be sufficient. Different standards are used outside Europe, and may affect working practices.

Key design requirements, based on the standard and industry practice, include:

- The standard requires fall protection to be provided on any ladder where a fall of over 3 m could occur;
  - note the reference to the height of the fall, rather than the length of the ladder.
- The FAS must be mounted in a manner that does not overload any components of the ladder.
- If a fixed FAS is not in use, scaffold hooks with energy-absorbing lanyards will generally be used on a temporary basis. On aluminium ladders, as commonly used inside WTG towers, unless it is clearly indicated that the rungs are of sufficient strength to be used as fall arrest anchors, the scaffold hooks should be connected around the stiles:
  - The dimensions of the stiles on aluminium ladders should therefore be suitable for easy connection of scaffold hooks.
  - The mounting of the ladder, and individual sections thereof, need to have sufficient strength to withstand the load imposed when a fall is arrested.
  - The location of other components, such as cable trays, should avoid obstructing access to the ladder stiles – the standard requires a clearance of 75 mm around stiles.

While fulfilling these requirements enables scaffold hooks to be used, their use should only be a temporary measure, such as when a permanently-installed FAS is out of service, or if undertaking a rescue. They are not a preferred access method.

Areas of difference between the industry good practice and the standard include:

- The standard prefers FAS with a 'rigid anchor line made of rail', and does not mention retractable type fall arresters.
- The 'diamond' profile of rungs made from square bar, as commonly used on boat landing ladders, is not included in the ISO standard.
- The standard only requires the provision of rest platforms if more than one person will use the ladder at the same time. For ladders equipped with an FAS:
  - If the total height is less than 24 m, then a rest platform is to be provided at intervals of no more than 12 m; this can either be a fixed rest platform or movable rest landing, depending on available space.
  - If the total height exceeds 24 m, fixed rest platforms are to be provided at intervals of no more than 24 m, together with additional rest platforms (or movable rest landings) at intervals of no more than 12 m.

2 HSE RR258 *Preliminary investigation into the fall-arresting effectiveness of ladder safety hoops*

3 HSE RR657 *Investigation into the fall-arresting effectiveness of ladder safety hoops, when used in conjunction with various fall-arrest systems*

4 HSE CCID 1-2012 – Safety bulletin – *Hooped ladders and the use of personal fall-arrest systems*

  - The standard specifies that fixed rest platforms are to be designed to allow use by more than one person at once, and to allow users to connect to/disconnect from the FAS from a position of safety, such as within a fully guarded platform with the gate or hatch closed.
  - The design and position of fixed rest platforms should not obstruct the fall path, as, in the event of a fall, this would increase the risk of injury to a falling climber, before they had been stopped by the fall arrest system.

The requirements given in the standard should only be deviated from if justified on the basis of risk assessment, which may take account of factors such as:

- Due to the challenges of corrosion and fouling, movable rest platforms on external ladders (such as on meteorological masts, and especially on boat landing ladders in the splash zone) are unlikely to be practical.
- On boat landings:
  - Rest platforms should not be located in a position where they could present a hazard to crew transfer vessels, or personnel on such vessels, taking account of tidal range, wave motion and foreseeable types of vessel.
  - Retractable type fall arresters, commonly referred to as self-retracting lifelines (SRL) are more appropriate than rigid rails, due to the need to connect/disconnect while on the boat, and the fact that corrosion and fouling would rapidly render rigid rails unusable.

Note that national regulations may impose different requirements, which take precedence over standards.

3.1.1.2 Transition between ladders and platforms

Key principle:

The detailed design should enable a climber to maintain continuous attachment, whenever they are at risk of falling, and ensure good ergonomics.

Where a ladder terminates at a platform, suitable handholds should be provided (or the ladder should continue) above floor level to enable safe climbing until the climber can step over onto the floor.
Suitable arrangements are needed for the transition from ladder FAS to the platform:

- Disconnection from the ladder FAS should be done from a place of safety – standing on the platform, with the hatch/gate closed; if this is not possible:
  - A designated anchor point should be provided for the attachment of an energy-absorbing lanyard, if it is necessary to detach from the ladder FAS while still on the ladder or next to an open hatch. Correct positioning of the anchor point is important:
    - The anchor point should be readily accessible to the climber, and be placed as high as possible in order to minimise the free fall distance.
    - Its position should ensure that the lanyard will not pass over any sharp edges, as these could cause failure in the event of a fall.
    - The lanyard should not have to pass through a closed hatch.

3.1.1.3 Hatches and guardrails/gates

Key principle:

There must be protection against people and objects falling through openings in floors.

The exact solution to be employed depends on the specific situation, and should not introduce other significant hazards.

Ladder openings can either be protected by hatches or guardrails and gates – or a combination of these in some situations:

- if a hatch is in a location where people are likely to need to walk over it, then it should be flush with the floor when closed; however
- if there is no need to walk over the hatch, and there is a risk of objects on the platform falling through the open hatch, then providing toe plates around the hatch opening can reduce the risk of objects dropping through the hatch.

This is shown in Figure 2.

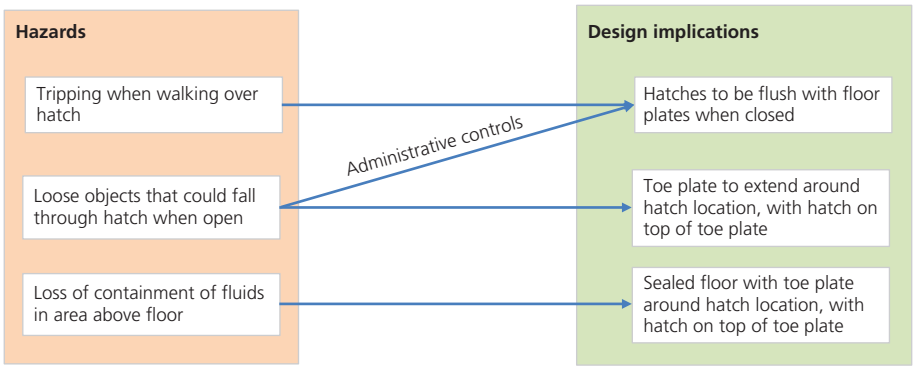

Figure 2: Factors affecting decisions regarding flush or raised hatches

Administrative controls of falling object risk could include improved housekeeping and use of tool lanyards, both of which reduce the probability of a loose object being present on the floor adjacent to the hatch.

It is common practice for ladder hatches in WTGs to be of self-closing type; however, there are conflicting requirements in standards:

- EN 50308:2004 states that hatches shall have two stable positions (open and closed);
- EN ISO 14122-4:2016 states that opening hatches shall be manual, without excessive force being required, and that hatches shall allow safe passage of the operator whilst in the open position, and be self-closing.
  - Allowing 'safe passage' implies that:
    - Hatches should not slam shut, as this can cause injury.
    - If it is necessary to hold hatches open while climbing through, this should not be so awkward that the probability of a fall is increased.

Decisions about the selection of hatches (self-closing or capable of staying open) or guardrails and gates should take account of the activities to be carried out in the vicinity of the hatch:

– If there are situations where people are regularly working between two levels, and/or passing equipment or components between two levels, then it may be more appropriate to protect the opening with guardrails and a self-closing gate.
– If the ladder FAS is an SRL, then a closed hatch might interfere with its operation.
– If it is foreseen that a casualty could be rescued through the hatch, then the presence of self-closing hatches could impede this, potentially requiring additional personnel to undertake the rescue.

The decision to specify self-closing hatches should be based on an assessment of the risks that they introduce, as well as those that they mitigate. The self-closing mechanism should be robust, and not easily defeated.

Decision criteria to determine whether to use hatches or gates are illustrated in Figure 3.

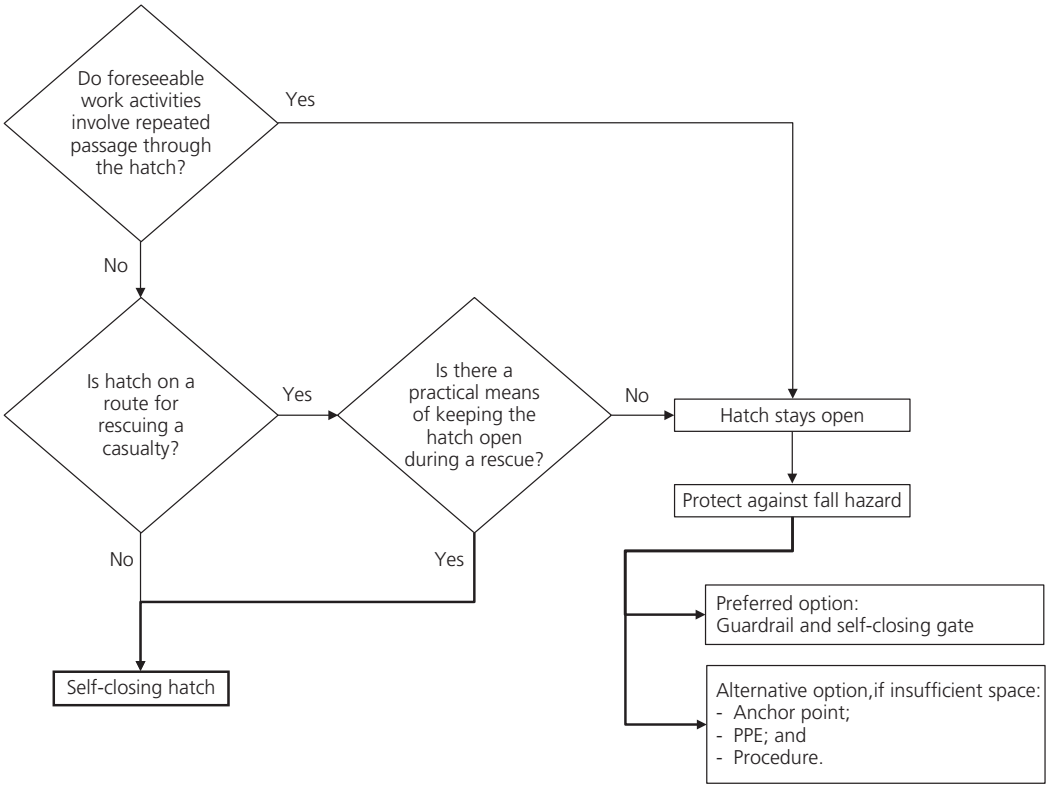

Figure 3: Decision criteria for hatches/gates

Hatches should always be sufficiently strong that they can:

– be safely walked on, and
– withstand other reasonably foreseeable loads that could be placed on them, during expected work activities in their location.

The detail design of hatches should ensure that, when closed, they will remain securely in place even if a hinge fails, such as by having the hatch supported along two opposite edges, and located to prevent lateral movement.

3.1.1.4 Anchor systems

When personal fall protection equipment is being used, it has to be connected to an anchor system. This transmits the load from the fall protection equipment to the structure. Any point at which personal fall protection equipment is intended to be connected to an anchor system is an anchor point. An anchor point may either be part of a component that is permanently attached to a structure (commonly referred to as a structural anchor) or it may be part of an anchor device (that is removable).

Anchor systems and the structures to which they are attached must be unquestionably reliable:

– Designated permanent anchor systems should be designed, inspected, maintained and their location and limitations on use clearly identified.
– If an anchor system is to be established using other means of connection to the structure, then this should only be undertaken by personnel who are competent to determine that the system is unquestionably reliable.
– The structure must have sufficient strength and stability to withstand the loads that could be imposed by the anchor system.

Note that published standards use a range of different terms for these components.

All designated anchor points should be marked in accordance with EN 795: 2012 or CEN/TS 16415, as appropriate. (Note that CEN/TS 16415 is not a harmonised standard, so does not provide presumption of conformity for CE marking under the PPE Directive.) If neither of these standards applies, then the principles of the marking requirements of EN 365: 2004 should be followed; this requires:

– means of identification, e.g. manufacturer's name, supplier's name or trademark;
– manufacturer's production batch or serial number or other means of traceability;
– model and type/identification;
– number and year of the standard to which the equipment conforms, and
– pictogram or other method to indicate the necessity for users to read the instructions for use.

In addition to the above:

– EN 795: 2012 has an additional requirement to include marking that the anchor shall be for use of one user only, and
– EN 795: 1997 Class C anchors have additional marking requirements for the maximum number of attached workers, the need for energy absorbers and ground clearance requirements.

Clearly, in the case of structural anchor points, not all of the information given here will be appropriate, but it is still essential that the acceptable uses of the structural anchor are indicated to users.

3.1.2 Design requirements for stepping over from a vessel to a ladder

This section addresses the WAH aspects of transfer by stepping over from the bow of a vessel to a ladder on a boat landing structure; the vessel could either be a conventional crew transfer vessel, or a daughter craft. Transfer using a W2W gangway is considered separately. Other access methods, such as lifting people using personnel transfer baskets on cranes, are not considered here, but may also present risks relating to WAH. The selection of access methods and equipment should be subject to risk assessment, and apply the hierarchy of protective measures for WAH.

3.1.2.1 Boat landing structure

Key principle:

Fall arrest systems should be used during transfer, and the combination of boat landing design, vessel characteristics and operating procedure should minimise the risk of injury due to falling or crushing/impact against the vessel.

The same level of safety needs to be achieved, irrespective of the type of vessel being used for the transfer.

The design of a boat landing structure must:

- Leave a safe zone between the vessel fender and the boat landing ladder, to eliminate the risk of crushing between the vessel and the ladder:
  - the safe zone should provide:
    - a minimum of 500 mm clearance between the vessel fender and the ladder rungs, and
    - a maximum stepping distance of 650 mm between a suitable and safe non-slip surface on the vessel and the ladder on the boat landing;
  - once the boat landing design has been decided, it will determine the shape of vessel bow/fenders that can safely be used.
- Ensure that the top and bottom of the bumper bars extend beyond the range of vessel bow heights that may be expected, taking account of tidal range, effect of waves, and foreseeable vessel types:
  - Any protrusions from the boat landing structure, such as intermediate platforms, must be sufficiently high to ensure that they do not endanger people on the vessel bow, when the vessel is in the highest foreseeable position on the bumper bars.
  - Any rest platform would also have to be positioned so that it does not interfere with the safety zone between the vessel and the ladder, or create a risk of being hit by a moving vessel.

These considerations are shown in Figures 4 and 5.

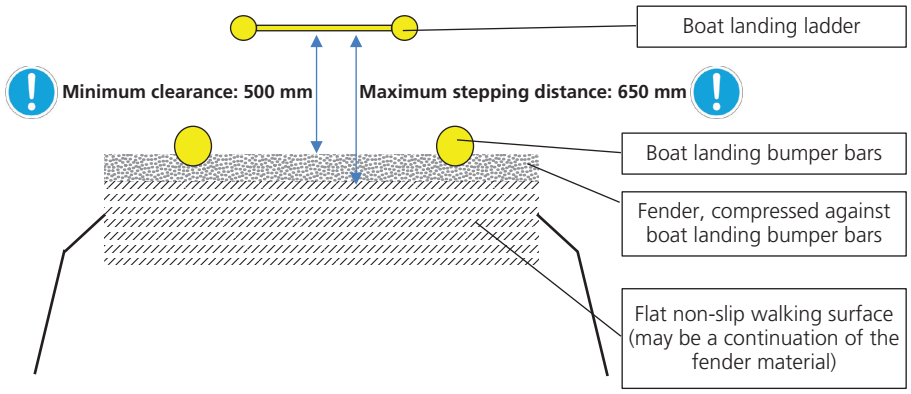

Figure 4: Dimensions of safety clearance and stepping distance

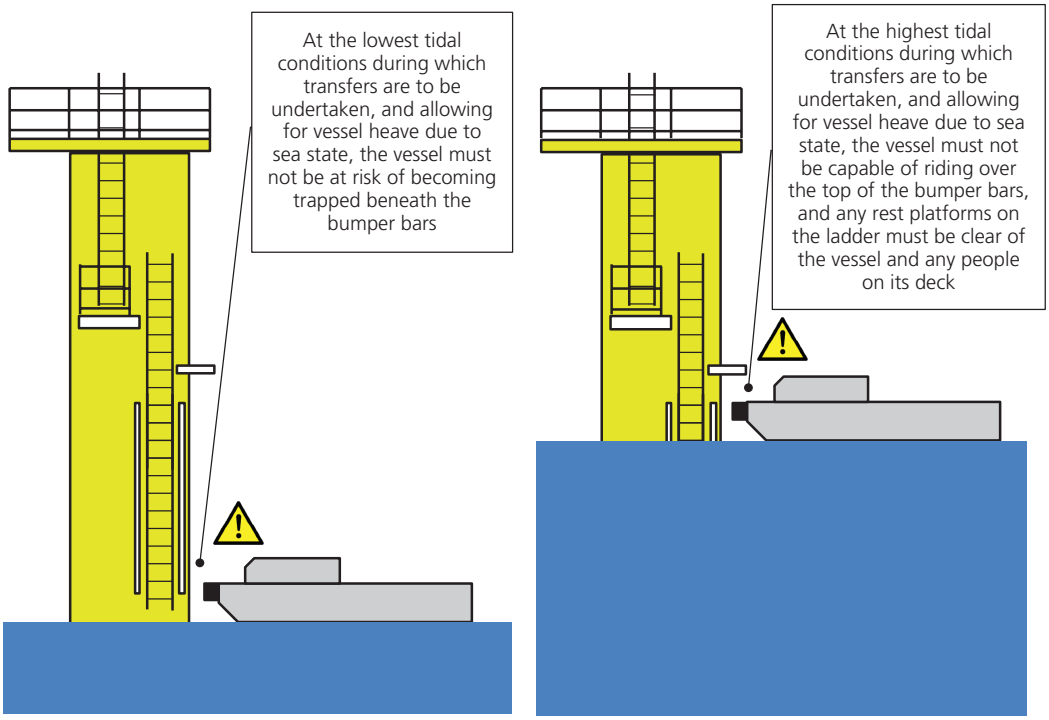

Figure 5: Safety implications of bumper bar height

A suitable FAS, presumed to be an SRL, also known as an 'inertia reel' or 'yo-yo', should be provided on the ladder, to enable attachment before stepping over from vessel; specific requirements include:

- Action of SRL should permit some vessel movement without undesired activation:
  - This may also be affected by details of the procedure used for attachment/ release.
  - When selecting an SRL, data on the lock-on speed should be obtained from the manufacturer, and the corresponding limit on vessel movement determined, to ensure that the SRL will not lock on in conditions under which it is intended that transfers should take place.
- Mounting location of SRL should ensure that:
  - If a climber falls, they remain close to the ladder, in the safety zone (specific issue if access ladder is sloping).
  - There is suitable access for installation and maintenance – ideally working from a safe platform, or by providing designated anchor points if work at height is unavoidable.
  - The SRL will not obstruct climbers, such as by creating a bump hazard, or by impeding ergonomic positioning for climbing and attachment to/from the lifeline.
- A 'tag line' will be needed in order to pull the SRL line down to the climber:
  - The design of the tag line system should both:
    - Avoid creating lengths of slack line, which can catch on the structure and impede climbing or become entangled with the vessel, and
    - Avoid introducing excessive friction, which resists the upward motion of the SRL line while climbing, and can increase the climber's fall distance if tag line friction keeps the connection to the SRL below the climber's harness attachment point when ascending the ladder.
  - The tag line can also be used to ensure that the SRL hook is not allowed to retract in an uncontrolled manner, which can lead to entanglement of the wire, preventing use of the SRL.
- SRLs should not be left extended when not in use.
- The design/connector should allow a person on a vessel to check if the SRL is safe to use, such as by providing visual indication if a fall has previously been arrested.
- Other types of FAS, such as rigid rail systems on ladders, are unlikely to be suitable in the splash zone, due to fouling.

It is important to select a suitable connector for use between the SRL and harness. As connectors with moving parts tend to deteriorate rapidly in the offshore environment, SRLs often have only a plain eye, to which each user attaches.

- Connector between SRL and harness must be secure, but capable of easy and quick one-handed release while wearing gloves, which may be wet and slimy from holding the ladder:
  - This minimises the period during which a climber is on the vessel, but connected to the SRL.
    - Connectors such as triple-locking karabiners can be awkward to disconnect; any delay in detaching from the SRL increases the risk of vessel motion leading to activation of the SRL, and the climber being 'picked up' by the SRL if the vessel moves sharply downwards.

    - Various types of quick connector are available on the market, and may be preferable to karabiners; a suitable connector would:
        - Meet the requirements of EN 362.
        - Be easy to disconnect using one hand.
        - Protect against accidental disconnection while under load, but not prevent deliberate disconnection under partial load, which may be necessary following evacuation into the sea, or if an FAS jams.
- Whatever types of connector are used, the design of the connection system should also allow for recovering from a situation such as one connector jamming in the closed position, to avoid a climber being unable to disconnect for an extended period of time.

Ladder and bumper bar design should minimise protrusions that could cause injury to a climber falling on the ladder (noting that climbing with energy-absorbing lanyards and scaffold hooks will be necessary if the SRL is not in operation, thereby potentially increasing the distance of a fall). For example, the shape and position of the tops of the boat landing bumper bars should minimise the risk of these causing injury to a falling climber.

Given the need for occasional use of scaffold hooks on the ladder, the rungs should be rated for fall arrest, and the surface coating specification should seek to minimise the potential for chipping as a consequence of scaffold hook use. However, scaffold hooks should only be used if the SRL is temporarily out of service, and not as a routine approach.

The potential for ladder/boat landing replacement/repair over the lifetime of the structure should also be considered, such as the provision of flanges or plates to enable future bolted connections.

If transfers during the hours of darkness could be undertaken at any point in the life of the structure, then suitable lighting should be provided on crew transfer vessels and/or the structure:

- The positioning of lights should avoid dazzling personnel transferring or the vessel crew.
- Lights installed on the structure should minimise maintenance requirements, and be positioned to ensure that safe access is available for maintenance.
- Lights should provide an adequate light level, noting that EN 50308 specifies a minimum of 10 lux for guidance lighting in WTG towers.

3.1.2.2 Intermediate platform

Hierarchy of controls for intermediate platform:

1. *Provide a self-closing gate on platform, if this is a practical and reliable approach.*
2. *Prevent falls, by the use of work restraint.*
3. *Minimise distance and consequences of falls, by using energy-absorbing lanyards.*

It is an established practice not to have a gate on this platform, although this deviates from the requirements of ISO 14122-4:2016, which specifies that there shall be a gate at the top of the lower ladder, and a horizontal distance of at least 700 mm between ladders. However, there is the potential for gates to be unreliable in this location, as they may be subject to splash, and potentially to extreme waves, therefore risk assessment might indicate that a gate is not the safest solution. Also, the section (5.6.2.2) of the standard that contains

this requirement mainly pertains to cage ladders, climbed without the use of personal fall protection equipment, therefore the user would not have a harness and lanyards with which to attach to an anchor point. In the absence of a gate, personal protection has to be used: the climber can use work restraint during changeover between ladder FASs; this can either be achieved by:

- use of a work positioning lanyard, attached (and adjusted if necessary) so as to prevent the user from reaching a position from which they could fall; however, if this is set up incorrectly and a fall does occur, there is no shock absorption, or
- use of an energy-absorbing lanyard, attached to a suitable anchor system such that the length of the lanyard prevents the user from reaching a position from which they could fall; even if a fall does occur, the consequences will be reduced through the action of the energy absorber.

As boat landing structures are generally painted yellow, the standard practice of marking anchor points in yellow may not provide the contrast that is needed for ease of identification; a contrasting background, applied to the structure around the anchor, could overcome this concern. Alternatively, if all secondary steelwork (such as guard rails or ladder rungs) that could potentially be used as an anchor system is suitably rated and maintained, then a separate designated anchor point may not be necessary.

3.1.2.3 Additional ladders

FASs on any additional ladders between the boat landing and the external platform should be capable of reliable operation in an exposed location, although will not be subject to marine fouling:

- usage will be simplified if the FASs on all ladders have the same means of attachment to the climber;
- if an SRL is used on additional ladders:
  - a tag line will be needed;
  - the design should avoid the potential for the tag line to catch on the structure (as per the boat landing ladder), and
  - this SRL does not need to tolerate vessel movement, so may not be interchangeable with the SRL on the boat landing ladder – if physically similar SRLs with different characteristics are in use, then they should be clearly identified to avoid errors in installation/servicing.

3.1.2.4 External platform

Key principle:

The design of the external platform should:
- *provide safe access to all required positions and to/from ladders;*
- *enable safe transfer of materials, and*
- *minimise the risk of objects dropping onto a vessel below.*

The design of the external platform should:

- Take account of required working positions around the tower, both when complete and during construction.
- Safeguard the ladder access point with suitable guardrails and an access gate:

  - Ensure that the guardrail/gate design provides sufficient protection against objects dropping from the platform, as this could endanger a person below.
  - The risk of user errors can be minimised if all ladder – platform transitions are similar, for example, always stepping sideways between the ladder and platform, rather than sometimes stepping forward between the ladder stiles.
- Ensure that people on the platform can work safely if sections of perimeter guardrail can be opened/removed (such as for crane operation, casualty evacuation or use of a W2W gangway), e.g.:
  - design the opening so that when the guardrail is open, it prevents access to the opening, thereby maintaining collective protection;
  - provide temporary guard rails to maintain a safe working area while the perimeter guardrail is open, or
  - provide a suitable anchor system so that all personnel involved in the lifting operation can be in work restraint and cannot reach the open edge.[5]
- Ensure that the design of the platform crane (generally a davit crane) minimises the need to work at height when rigging, operating, inspecting and maintaining it:
  - If the crane jib is to be used to anchor the casualty evacuation system, the anchor points on the crane need to be suitably rated, taking account of the fact that if a lifting system includes a pulley, suspended from a lifting eye, then this will almost double the force on the lifting eye, compared to a hoist attached at the same point.
  - When designing the casualty evacuation system, ensure that:
    - It can be rigged quickly, ideally by one person – or is always in place.
    - Its design is simple, in order to minimise the risk of errors in assembly leading to danger.
    - It can be operated by people at platform level.
    - It provides sufficient clearance to manoeuvre a casualty over/through opening in guardrail.
    - If it is necessary to lift the casualty from the platform floor level, prior to lowering to the vessel (for example, in order to lift the casualty over the guardrail), then there must be safe access to the lifting/lowering system.
- Minimise risks associated with accessing any equipment items that are mounted over the side of the platform guardrail, such as aids to navigation:
  - Identify their maintenance requirements, and how these can be minimised, e.g. LED lighting in place of fluorescent lamps.
  - Mount over-side equipment so that it can be brought inboard easily for servicing, eliminating the need to work outside the guardrail.
- Provide suitable platform lighting, if night-time use is expected;
- Ensure that material selection, surface coating and corrosion allowance for all external safety-related components and structures, such as ladders, guardrails, anchor points and supporting steelwork, are suitable for offshore use.

5 The Work Equipment Directive 2009/104/EC, Annex 2, Article 4.1.5 states that '*When the performance of a particular task requires the temporary removal of a collective safeguard designed to prevent falls, effective compensatory safety measures must be taken. The task may not be performed until such measures have been taken. Once the particular task has been finished, either definitively or temporarily, the collective safeguards to prevent falls must be reinstalled*.' It is therefore permissible to open guard rails for the transfer of loads, provided that the compensatory safety measures are effective.

3.1.3 Design requirements for access from W2W gangway

W2W gangways can either be active, motion-compensated systems, which use sensors and actuators to hold the position of the end of the gangway relative to the offshore structure, or passive systems that grip onto the offshore structure, but allow for some vessel movement. Motion-compensated W2W gangways are most commonly used for transferring between large vessels (such as service and operation vessels, or hotel ships) and an external platform of an offshore structure, although some types of motion-compensated gangway are designed for use on crew transfer vessels (CTVs), whereas passive gangways are more commonly used between CTVs and ladders.

The purpose of W2W gangways is to eliminate the risk of falling that is present in transfers that involve stepping over between a CTV and a boat landing ladder. Achieving this requires:

- A suitable landing area, with gates that can be opened to provide direct access between the gangway and the platform, and without excessive gaps between the gangway and the fixed guard rails. (ISO 14122-3:2016 specifies a gap of 50–120 mm between the vertical ends of adjacent guard rail sections, which may be taken as a guide for acceptable gaps between guard rails and gangways.)
  - The orientation of the landing area(s) should take account of prevailing metocean conditions, so as to maximise accessibility:
    - this generally involves allowing the vessel to be orientated with its bow into the waves or currents.
  - The design of the gates should allow a person on the gangway to open them at the start of the transfer, and close them before the gangway is retracted:
    - Note that an emergency retraction of the gangway may result in gates being left open, which would create a hazard for any personnel accessing the structure by other means afterwards.
    - If personnel have to be in a location in which open gates create a fall hazard, suitable personal protection (such as working in restraint, or with fall arrest) should be used.
- If platforms do not have suitable gated landings to allow level access from a gangway, then it may be possible to set up the gangway above the level of the platform guard rail. If this approach is adopted, it should not give rise to a risk of falling (either onto the floor of the external platform, or over the guard rail) when transferring between gangway and platform levels.
  - If achieving safe transfers in this manner requires the end of the gangway to reach down to platform level, inside a fixed guard rail, then the implications of this in the event of emergency retraction must be checked – it is important that the gangway can retract cleanly, without fouling on the guard rail.

Industry standards and guidance provide further information on design requirements, vessel selection, integration of W2W with vessels, training and competence requirements.

3.1.4 Access to basement

In WTGs where the transformer and/or switchgear are located in the basement beneath the entrance area, safe access should be provided to this area. Considerations include:

- Detail design of hatches and guardrails/gates.
- Ladders should have an FAS, and suitably-located anchor points should enable safe attachment to/detachment from the FAS.

- The hatch should be positioned so that:
  - It is not on a main access route to/from the tower entrance, as this increases the risk of a person falling into the open hatch.
  - It is not obstructed by the lowest stopping point of the lift, to avoid a situation where if power is lost, access to the basement is impeded by the lift resting on the access hatch.
    - If this cannot be achieved by design, then procedural measures will be necessary to ensure that the lift is not left parked over the hatch.
- Provision for rescuing a casualty upwards, from the basement to the entrance level, including both the selection of a suitable rescue system and provision of anchor points in the required locations.

3.1.5 Access inside foundations

As the section of a monopile foundation between the airtight hatch and the water level may have a hazardous atmosphere, access to this area should be minimised, both through design decisions, and through adoption of techniques such as remote inspection systems, where it is reasonably practicable to do so. If access cannot be avoided, then in addition to the considerations for accessing the basement, the principal concerns with respect to WAH are:

- Condition of ladder, handrails and platforms may be uncertain, due to corrosion and infrequent access; until their load bearing capacity has been verified, climbers should be protected against falling by attachment to a suitable anchor point above the sealed hatch level.
- There is no permanent lighting in this area; climbing and other movement in limited light may increase the risk of slips/falls occurring.
- The sealed hatch will generally be much heavier than a standard hatch, so suitable arrangements for moving and securing it will be necessary.

Rescues from foundation areas may involve hauling the casualty upwards, over a distance of 10–20 m; suitable equipment needs to be available, together with people who are competent in its use.

3.1.6 WTG tower

Key principle:

Within WTG towers, the order of preference for access between levels is:

1. *Lift, as this minimises fatigue and eliminates exposure to the risk of falling.*
2. *Ladder with climb-assist system, which reduces fatigue, and a compatible permanently installed FAS if the climb-assist system does not include the functions of an FAS.*
3. *Ladder with permanently installed FAS, which, when used correctly, in conjunction with suitable platform design, minimises the risk of falling.*
4. *Ladder with temporary FAS, installed in such a way as to minimise the number of changeovers between systems; this reduces the risk of falling, but in many cases, temporary systems have poorer ergonomics than permanent systems.*
5. *Ladder used with scaffold hooks and lanyards, as this increases worker fatigue and has a greater potential for hazardous errors, compared to any of the above systems, therefore should only be undertaken in exceptional situations, where none of the preferred approaches is available.*

Given that the lift is the preferred means of access, its reliability and safety are key to risk reduction. However, given that ladders will be used whenever the lift is unavailable, their detailed design and integration with platforms still needs to provide a safe means of access.

3.1.6.1 Lift

Key principle:

Lifts reduce risks related to climbing, but other hazards need to be addressed:
- *The integration of the lift and tower should protect against falling and mechanical hazards created by movement of the lift.*
- *There should be suitable provision for escape and rescue in the event of a fault on the lift.*
- *Safety systems on the lift, such as overspeed protection, should be reliable and ideally fail-safe.*

Ensure that lift design, and integration with platforms/landings, fulfil the Essential Health and Safety Requirements (EHSRs) of the Machinery Directive, taking account of the state of the art[6]. In particular:

- Protect people from fall hazards:
  - Landing gates should be interlocked with the carrier, so that they can only be opened when the carrier is stopped at the landing, and the carrier cannot depart until the gate is locked closed.
    - If the lift runs on the ladder, a safe means of access to the ladder will be necessary – either an override for the interlocked gates, or separate self-closing access gates.
    - People should not have to climb over guard rails to access the ladder.
  - Provide door locking system on carrier, so that the door cannot be opened between landings in normal circumstances;
- Protect people from mechanical hazards created by the moving lift:
  - Guardrails around the opening can normally achieve this at intermediate platforms.
  - Barriers at top and bottom platforms should have mesh infill, to prevent body parts entering the travel zone, and hence may have to be full height.
  - If there are other circumstances or locations in which people could be put at risk by the movement of the lift, then suitable protective measures should be implemented, such as the use of trip plates over the full area of the top and bottom of the lift, and/or a full length emergency stop cord. Such measures are particularly important for ladder-guided lifts, given that people will be in the travel zone of the lift while climbing.
- Provide emergency stop controls at carrier control stations:
  - required at bottom, recommended at top, and
  - must be clearly identified as relating to the lift alone.

[6] Annex 1 of the Machinery Directive states that '*The essential health and safety requirements laid down in this Annex are mandatory; However, taking into account the state of the art, it may not be possible to meet the objectives set by them. In that event, the machinery must, as far as possible, be designed and constructed with the purpose of approaching these objectives*'. The Guide to Application of the Machinery Directive 2006/42/EC states that '*In order to correspond to the state of the art, the technical solutions adopted to fulfil the EHSRs must employ the most effective technical means that are available at the time for a cost which is reasonable taking account of the total cost of the category of machinery concerned and the risk reduction required.*' The state of the art for lifts has been determined by a working group under the Machinery Directive – see European Risk Observatory Report *Occupational safety and health in the wind energy sector*, p29.

- Ensure that the design allows for foreseeable emergency situations:
  - Interlocks on the landing gates and carrier door should be capable of being overridden in case of emergency;
    - However, the ability to override interlocks in an emergency should not result in a design in which interlocks are routinely defeated for convenience.
    - Safe emergency egress from the lift would also require provision of suitable anchor points, and ensuring that the lift is sufficiently close to the ladder to enable access.
  - Provide a means of controlling the carrier from outside, in the event of incapacity of the person inside.
- Provide a means of lowering the carrier safely, from inside, in the event of breakdown or loss of power or motor failure.
- Provide a means of observation between landings, such as a window or removable panel, to enable safe inspection of the suspension ropes from within the carrier with the door closed.

Beyond the published state of the art, further learning has been gained from the experience of G+ members and other WTG operators:

- Reliability of the overspeed prevention system is critical:
  - Ideally this should fail safe, or as a minimum, there should be clear indication that the overspeed protection is not in a healthy state;
  - Relying on detailed daily inspections before use, or physical tests that cause the lift to slip on its drive mechanism, is not satisfactory.
    - If any pre-use checks are required, then it should be safe and practical to undertake them.
- Any limits on the use of manual descent devices need to be clearly established, and appropriate for the application.
  - If their use is limited, then it should also be evident.
- All components in the emergency stop/trip plate circuit (including switches, relays and contactors) need to be of a suitable reliability level, to minimise the risk of the lift not stopping when required.
- In addition to the risk of being struck by the moving lift, the risk of entrapment should also be considered, taking account of typical personal protective equipment (PPE) for work at height such as lanyards; the layout of the lift, landings and barriers should minimise the probability of this occurring, and emergency stop systems should allow the lift to be stopped easily should this occur.

3.1.6.2 Design for rescue

Key principle:

The WTG design should enable foreseeable rescues to be undertaken safely and swiftly:
- *Design decisions regarding access to equipment that has to be serviced will determine the complexity of potential rescues.*
- *The complexity of potential rescues, considering the full rescue path, may determine the safe minimum size of a working party.*
- *Rescue methods should aim to allow rescuers to remain in a safe location.*

Suitable anchor points should be in place throughout the structure, to enable rescue equipment to be set up. Depending on the means of evacuation in an emergency, it may be necessary to move a casualty on a stretcher/spine board from any location in the WTG to either a vessel at the boat landing, or onto the helihoist platform, so rescue routes should be defined on this basis. A stretcher should generally be transported so that the casualty remains horizontal, and should only be inclined where necessary to pass through restricted openings on the rescue path. The effect of transporting a casualty at angles other than horizontal will depend on their condition, and the duration of transport in this manner.

At the design stage, specifications should be prepared to define the rescue equipment that should be:

– present within the WTG or other offshore structure;
– carried by personnel at all times, or for specific activities, and
– available nearby, perhaps kept on the access vessel.

Storage areas should be clearly designated, so that equipment is easily located when needed, and any missing equipment is obvious.

It may be possible to use the lift aperture in platforms as an effective rescue path for moving a stretcher-borne casualty between levels in the tower, provided that it is of suitable size for an inclined stretcher to be guided through:

– it avoids the complication of lowering a casualty through self-closing ladder hatches, if fitted, and
– it enables one member of the rescue team to monitor/guide the casualty as they are being lowered.

Suitable anchor points should be provided to enable this route to be used, and the lift should be isolated when this route is in use.

Other openings in the structure that may be part of a rescue path, such as between the nacelle, yaw deck and tower, need to be of sufficient size to allow a stretcher-borne casualty to be passed through. Provision of an effective internal rescue route can reduce the need for casualties to be lowered outside the tower.

3.1.6.3 Internal intermediate platforms

Internal intermediate platforms should provide safe access to all tower joint flanges and related cable joints, both for initial assembly and subsequent inspections and maintenance.

Openings for the ladder or lift must be suitably protected; the exact method depends on the location, but should take account of the requirements for the transition between the ladder and platform and ladder hatches. The lift opening should be protected by guardrails and an interlocked gate. If the position of the lift opening impedes safe access to the tower flange bolts, then suitable work equipment should be provided so that flange bolts can be accessed safely (considering risks of falling from height, falling objects and ergonomics) during construction and any subsequent maintenance activities.

3.1.6.4 Yaw deck

In addition to these design requirements for intermediate platforms, the route from the yaw deck to the nacelle should enable safe climbing, with good ergonomics, and suitably-positioned anchor points.

- If the design of the route allows an FAS (such as an SRL) to be installed and used effectively, then this further reduces the risk from falling:
  - If the height of a fall could exceed 3 m (according to EN ISO 14122-4:2016), then fall protection is required; this is particularly important if a person could fall through any openings in the yaw deck; however
  - Even if the fall height would be less than 3 m, the risk should be assessed and reduced as low as reasonably practicable, and
- Climbing may be easier if the ladder is inclined from vertical, by up to 15°, provided this does not interfere with safe operation of an FAS.

The platform design should also take account of the requirements for the transition between the ladder and platform and ladder hatches.

3.1.7 Nacelle – interior

The internal design of the nacelle should:

- Provide solid flooring, without openings or trip hazards, as far as possible throughout the nacelle.
- Provide safe access between levels within the nacelle.
- Minimise the need to work at height inside the nacelle, by locating components in locations that are accessible from permanent walkways. Where working above the main floor level cannot be avoided:
  - The preferred option is passive fall protection – guardrails, gates, hatches; if this is not possible then:
    - provide anchor points for fall protection equipment,
    - provide non-slip surfaces, or
    - if portable ladders are to be used, ensure that they can be securely located in the required positions.
- Provide for safe working adjacent to temporary openings that give rise to a risk of falling from height:
  - Routine tasks such as hoisting operations with the onboard service crane should not expose people to a risk of falling from the nacelle.
  - If major component exchanges, such as gearbox replacement, create an opening that could allow a fall to a lower level, then there should be provision for working in restraint.
- Provide guardrails or anchor points if the yaw – nacelle hatch has to be open for transfer of equipment/materials.
- Avoid sharp edges – these are an immediate direct hazard to people, but can also create serious latent hazards if sharp edges damage PPE such as harnesses or lanyards.
- Minimise the risk of loose objects, such as fasteners or hand tools, dropping through gaps in the nacelle flooring, and endangering people below – either inside or outside the tower.
- Enable the rescue of a casualty from any location that they would need to access in order to perform work.

3.1.8 Nacelle – exterior

Key principle:

Equipment should be specified and located to avoid the need to work at height.

Where access to the exterior of the nacelle is essential, the design should provide safe access.

- If a helihoist platform is fitted, this can provide safe access to instruments, aviation lights etc.:
  - The platform should be designed to be maintenance free, to avoid introducing future work at height requirements.
  - Design requirements with respect to safe helihoist operation are defined by national aviation authorities, and may therefore differ between jurisdictions.
- If the nacelle roof has to be used for access, then the design should:
  - provide good access – walking surfaces should be:
    - clearly defined, with durable non-slip finishes;
    - sloping at a sufficient angle to shed water, without being steep enough to increase the risk of slipping, and
    - free from accessible fragile surfaces (such as skylights).
  - If it is not reasonably practicable to provide safe working areas with guardrails to prevent falls, then sufficient anchor points should be provided in suitable locations, depending on whether they are intended to be used for restraint or for fall arrest:
    - the spacing of anchor points will determine the length of lanyard that is needed, to enable continuous attachment while moving between anchor points on the roof:
      - in general, shorter energy-absorbing lanyards are preferable, as they reduce the distance of a fall.
    - anchor points must be of sufficient strength for their intended purpose; on the nacelle roof, this will generally be achieved by attaching the anchor points to the underlying structure, rather than composite panels.

3.1.9 Nacelle evacuation

Key principle:

The combination of boat landing design, work equipment, PPE and procedure should take account of the whole evacuation requirement, including:
- *time and locations available for evacuation in the event of a foreseeable fire scenario;*
- *number of people who may be present, and*
- *where people are likely to land, and how they will be recovered to a vessel.*

Fundamentally, it is not acceptable to have a situation in which people are present in any location from which their evacuation in the event of a fire will result in landing in the sea, without suitable protection from drowning, or means of being located.

In the event of a fire that prevents egress down the tower, emergency evacuation generally involves external descent from the nacelle, potentially resulting in landing in the sea. In the event of a serious fire, vessels may be unable to approach the boat landing, in which case

entry into the sea may be necessary. In such situations, it will be necessary to use PPE to protect from drowning (PFD, personal locator beacon (PLB) and possibly an immersion suit). If this is foreseeable, then such PPE should be available at working locations. Having the PPE available could be achieved by approaches such as:

– providing single-use immersion suits in sealed packs in the nacelle;
– bringing vessel transfer PPE to the nacelle on arrival; or
– a combination of these approaches, particularly for items such as PLBs.

The exact approach to be taken will depend on assessment of risks at a site, including consideration of the ability to descend from the nacelle to the external platform, sea temperature and potential time to rescue the person(s) from the water. It should be noted that the time to recover person(s) from the sea in this situation may be longer than if a person falls overboard from a vessel, as the vessel will be further away, and will not have immediate visual contact with the person(s).

The nacelle evacuation requirements will be a key factor in specifying a suitable rescue and evacuation system.

3.1.10 Hub

The design should provide safe internal access between the nacelle and hub, ideally without involving WAH. The entrance/hatch opening to the hub needs to be large enough to ensure safe access and egress, with sufficient anchor points on both sides if the access route involves WAH. Both the hatch itself, and adjacent equipment, should provide a path through which an immobile casualty can be rescued on a spine board or stretcher.

Provision for safe working should also consider work involving major components, such as blade installation or pitch bearing exchange; if these tasks cannot be completed from a safe location, from which collective protection ensures that a person cannot fall, then suitable anchor points should be provided.

Anchor points and any additional equipment that is needed for rescue from the hub should also be provided.

Where hatches have to be opened to gain access to the hub, the hatch and its fastenings should be designed to avoid creating a falling object hazard; hinged external hatches should be capable of being fastened in the open position, so that they do not blow shut in the wind.

3.1.11 Blade access

Key principle:

– *Minimise the need for blade access, by using techniques such as drone inspections, where appropriate.*
– *Design for safe use of rope access techniques for blade access.*

Provision should be made for future internal and external blade inspection/repair activities. When selecting blade access methods, the hierarchy of protective measures should be applied, including determining whether the task objectives can be achieved without the need for WAH, such as by the use of drones for inspections. As a minimum, given the foreseeable need to use rope access techniques, the design should:

- allow rope access teams to attach to the system in a place of safety;
- avoid ropes passing over sharp edges, and
- provide separate anchor points for working and back-up ropes.

Anchor points for external blade access are generally either inside or on top of the nacelle. During rope access work, the ropes move slightly in response to the climber's movement, which can result in localised wear due to fretting, it is therefore extremely important that the route taken by the ropes does not pass over any sharp or rough edges.

Where hatches are used to gain access to the interior of blades, the hatch and its fastenings should be designed to avoid creating a falling object hazard, which could either endanger people beneath, or lead to loose components such as fastenings being left inside the blade.

Internal blade access will generally be carried out with the blade locked in a horizontal orientation, so, provided the integrity of the blade is assured (for example, by carrying out an external inspection), there is no risk of falling. If the integrity of the blade were uncertain, internal access would be a very high risk operation. In general, access should not extend into the downward-sloping section of the blade. A suitable rescue plan should also be in place, taking account of how to retrieve a casualty from any position in the blade, and in particular how to manoeuvre them back into the hub; the position and size of the access hatch between the hub and blade will greatly affect the ease of such a rescue.

3.1.12 Meteorological masts

Key principles:

- *Consider whether suitable measurement data can be obtained without the need for an offshore mast;*
- *design for safe access, safe lifting of components and to minimise falling object risk, and*
- *ensure that existing masts remain safe to climb.*

Meteorological masts are high lattice structures, with instruments installed on the mast structure, and on retractable booms. Design decisions that will influence the safety of WAH include:

- Whether the required data can be obtained by other means, such as Lidar, thereby eliminating the need to work at height on a meteorological mast.
- Should it be decided to install a meteorological mast, the risks can be reduced by:
  - provision of fixed fall arrest on access ladder;
  - provision of suitable working platforms at levels where work will be necessary during installation, commissioning and maintenance activities;
  - provision of designated anchor points, and
  - ensuring that there is safe access to all items of equipment that may need to be maintained or exchanged over the working life of the mast.

As meteorological masts are open structures, any falling objects present a hazard to people on the external platform below; the risk can be reduced by:

– Design of reliable fastening arrangements.
– Permanent secondary attachment of components that may need to be released or adjusted during maintenance activities.
– Provision of suitable lifting or attachment points on components that may need to be removed for maintenance.
– If it is foreseeable that people may need to be present on the external platform level while others are working on the mast (for example, checking signals from instruments), then the design should provide a safe location on the platform for this work to be carried out.

Given that existing meteorological masts may only occasionally be climbed, and taking account of the exposed nature of these structures and the history of fatigue issues affecting some masts, the integrity of masts should be confirmed prior to climbing. This might involve reviewing previous inspection records, or even carrying out a drone survey to allow a visual check of any areas of concern.

If a mast is no longer being used for measurement purposes, it should still be maintained in safe condition for climbing, given the need to access aviation lights, and potentially also to climb in preparation for lifting operations as part of eventual decommissioning and removal.

3.1.13 Work on foundations

Structures such as transition pieces and jackets may require inspection and maintenance work to be carried out between the external platform and the sea surface; decisions about access methods should always take account of the hierarchy of protective measures for work at height. While most of these structures will involve vertical access from the external platform downwards, areas such as the underside of offshore substations may also need to be accessed. Access should be considered at the design stage, such as by providing fixed working platforms for locations where routine access is foreseeable, and considering how to enable safe use of rope access in areas that will only be accessed very infrequently, taking account of factors such as:

– where ropes could be anchored;
– the route that ropes will take from the anchor locations to the climbers below, and
– how access would be gained from the external platform.

Temporary access platforms such as scaffolding may be appropriate in some locations.

Design decisions will also determine the ease with which foreseeable tasks, such as boat landing structure repair, can be carried out.

Rope access work may also be necessary inside monopile foundations, below the airtight hatch, with the added complexity of working in a potentially hazardous atmosphere.

3.1.14 Offshore substations

Work on the structure and equipment of substations may involve WAH at any stage of the life cycle. The hierarchy of protective measures for WAH should always be applied; specific practical measures include:

- Minimising the need to work at height by identifying components that may need to be accessed during installation, commissioning and maintenance, and locating these in positions that allow safe access, such as on main working floors or walkways.
- If it is not practical to locate such components in accessible positions, then the designer should consider how safe access will be achieved, such as:
  - Provision of permanent additional platforms/walkways to give access to components that may need to be accessed repeatedly.
  - Ensuring that components that may lead to infrequent WAH can be accessed using standard tower scaffolds (which could potentially be stored in a suitable location on the substation) rather than needing custom-designed scaffolds which would almost certainly need to be brought to the substation when needed.
- If the safety of WAH will rely on the use of PPE to prevent or arrest falls, then the design can enable it to be done safely, such as by providing suitable anchor systems:
  - Anchor points should be provided where required inside substation compartments;
    - however, if the available headroom prevents anchor points from being located at sufficient height to arrest a fall safely, then such anchor points would not enable safe working, so other means of fall protection would be necessary.
  - For external areas that are only expected to be accessed infrequently, decisions about the provision of structural anchor points should balance the benefits that they provide with respect to safe access, against the additional maintenance and inspection requirements and the risk of deterioration in locations exposed to salt spray;
    - it might be more appropriate to identify potential methods and locations where anchor systems could be set up using anchor devices to connect to the structure, and provide calculations showing their suitability for use.

The specification and quality assurance of external components and corrosion protection will determine the extent of likely maintenance requirements over their operating lives, and hence affect the scope and frequency of work at height being required.

3.2 CONSTRUCTION

Key principles:

As construction involves incomplete structures and one-time activities, there are many temporary hazards which will not be present once the structure is complete.

- *Apply the hierarchy of protective measures when determining methods and sequences.*
- *Minimise offshore WAH.*

This section considers WAH during construction activities, both offshore and in port. Decommissioning can also be considered as a construction activity, the safety of which depends not only on the extent to which the structure has been designed for decommissioning, but also on how it has been maintained over its working life, so that it is still in a safe condition for work to be carried out.

3.2.1 Contractor selection

The majority of work in the construction phase is generally undertaken by contractors, therefore the selection of competent contractors and subsequent monitoring is vital to controlling the health and safety risk profile of the phase.

3.2.2 Temporary hazards

The incomplete structure may give rise to temporary hazards, which will not be present on completion, such as openings where cables or equipment are to be inserted. For example:

- Depending on the height of the transition piece (TP) top flange relative to the external platform, after the TP has been installed, but before tower installation, there could be a risk of falling from the external platform into the inside of the TP:
  - the severity of this is further increased if there are large openings in the first platform within the TP:
  - if such a fall hazard exists, it can be mitigated by:
    - providing temporary guardrails/covers so that people cannot fall to a lower level, and
    - if these guardrails/covers have to be removed prior to tower installation, it will be necessary for any personnel on the platform to be working in restraint, so that they cannot fall into the opening.
- Prior to fitting of the hub to the nacelle, or of blades to the hub, there may be large openings in the nacelle, hub or spinner, through which a person could fall;
  - the risks presented by different erection strategies should be assessed when selecting the approach to be taken;
  - if such openings cannot be avoided:
    - falls can be prevented by working in restraint, and
    - The distance and consequences of a fall can be minimised by the use of energy-absorbing lanyards if people have to work in a position from which they could fall. For this to be a practical solution, anchor points should be provided in suitable locations, sharp edges on openings avoided, and a suitable rescue plan would be required.
- Tower assembly involves inserting and tightening bolts in the tower flanges, therefore safe access is required around the full circumference of each flange.

The risk of falling objects is high during assembly operations; for example, the insertion of bolts into tower flange joints involves handling heavy bolts, washers and nuts directly above ladder and lift openings, which may either be partially closed by hatches, or completely open. This risk must be controlled, for example:

- by providing robust temporary covers over such openings to prevent bolts from falling through, or
- maintaining an exclusion zone, so that no one is present in lower levels of the tower when bolts are being inserted.

3.2.3 Provision of equipment for safe WAH

The planning of construction work should aim to:

- Minimise WAH and offshore work, for example by maximising assembly, installation and acceptance inspections of equipment in the factory and onshore, while tower sections are horizontal and nacelles are at ground level.
- Ensure that anchor points are inspected before first use – this would ideally be done onshore, working from ground level;
  - this reduces offshore inspection work, and provides safe anchor points for use during construction.
- Make preferred means of access such as lifts and permanent ladder FASs available from the earliest possible stage of installation; in any situations where this is not possible:
  - provide temporary FAS on any ladders where the permanent FAS cannot be used until a later stage of installation.
- Ensure that any necessary rescue equipment is always readily available. For example, if people are working in a part-completed tower, they will not have access to any equipment that is stored in the nacelle, which has yet to be installed, so another means of rescue should be available.

In general, the least preferred option is to install and inspect equipment offshore.

3.3 COMMISSIONING AND OPERATIONS AND MAINTENANCE (O&M)

These two phases have been grouped together, as they both take place on a structure that is mechanically complete, so the temporary hazards of work at height on incomplete structures will no longer be present.

3.3.1 Contractor/vessel selection/mobilisation requirements

During the commissioning phase, numerous access vessels are likely to be in use; during the O&M phase, there is more likely to be an established fleet at the site, but with some changeover of vessels and personnel, over time and to support peaks in demand. It is therefore important to have robust processes for vessel selection and mobilisation, taking account of the key hazards to address, and recommended risk controls with respect to transfers from access vessels.

The robustness of processes for selection and management of contractors should be proportionate to the risk that work packages present.

3.3.2 Planning work

Key principle:

Plan tasks so as to minimise the risks from WAH, by applying the hierarchy of protective measures for WAH.

Early planning of foreseeable tasks that could involve WAH can allow strategies to be adopted that reduce the need to work at height, for example:

- Using alternative approaches, such as using a drone for initial inspection tasks, rather than having people working at height.
- Minimising the number of transfers and climbs, for example by:
  - Making effective use of diagnostic systems, to increase the probability of faults being rectified at the first attempt, and the right spares being available.
  - Scheduling inspection work so that full use is made of each offshore visit.
- Minimising the number of different people who have to access each location, by undertaking multi-skill training;
- Using the contracting strategy to reduce the number of times that WAH has to be initiated. For example, if it is known that there is some blade surface damage, a contract that allows for inspection and repair (within agreed limits) in a single visit can result in fewer set-ups than if inspection and repair are undertaken separately;

Where WAH cannot be avoided, tasks should be planned carefully, applying the hierarchy of protective measures to minimise the risk from falls.

Potential situations that need to be considered when planning WAH include:

- Where multiple activities are planned, identifying if one activity creates a falling object risk for others:
  - For example, small components or tools (such as sockets) might drop from the nacelle to a lower area.
  - The need to make effective use of available weather windows for access should be balanced by the risks associated with working at multiple levels on a structure; where this is necessary, planning should include identifying suitable risk control measures.
- Ensuring that if a person were to be incapacitated, a suitable rescue plan is in place:
  - This includes both having sufficient numbers of competent people, and all necessary equipment available.
  - The proposed rescue method must be capable of being carried out safely in any conditions under which the task would be carried out.
  - During the O&M phase, work is more likely to be carried out by small, relatively isolated teams, so each team needs to have the necessary competence to undertake rescues from the locations in which they are working.

There should be robust processes for planning tasks involving WAH.

4 TOPIC GUIDANCE

4.1 INTRODUCTION

This section gives guidance on five topics, which were selected following analysis of G9 member incident data for 2011/12, priority areas of concern identified in a survey conducted by G9 representatives, and a survey of WAH training candidates undergoing recertification at heightec in 2013. Based on this work, the five topics were chosen as:

- activity-specific topics:
  - falling objects (removed from the revised guideline, as separate guidance is being adopted);
  - personnel transfer between:
    - CTV and offshore structures, by means of boat landing and ladder;
    - service and Operation Vessel (SOV) and an external platform, using a motion-compensated 'walk to work' (W2W) gangway, and
    - CTV and SOV.
  - access to working locations;
  - rescue, and
- safe behaviour for WAH.

While behaviour is not exclusively related to WAH, it was the most common immediate cause of the incidents recorded in the G9 and G+ data, so is an essential aspect of safe WAH.

These revised guidelines include analysis of G+ data for 2014-6, which has informed the targeting of revisions and new content.

To avoid repetition, common requirements for training, competence and PPE have been identified, and should be satisfied in addition to the specific requirements for the topics listed.

For each of the four activity-specific topics, the following aspects are covered;

- prerequisites for the activity;
- training and skills;
- roles and responsibilities of clients, employers, contractors, managers, supervisors and individuals for preparation and execution of tasks, and maintaining safety, and
- hazards at particular stages of the activity.

The recommendations given in these sections seek to apply the hierarchy of protective measures, in order to support safe WAH.

The section on behavioural safety considers:

- fundamentals of behavioural safety: types of error, contributory factors and safety culture, and
- specific behaviours for safe WAH.

4.2 COMMON REQUIREMENTS

This section covers the training and competence requirements that are common to most activities involving offshore WAH. These relate both to those who will be directly involved in undertaking the tasks, and to those who will contract for and manage WAH. Competence is necessary in both the specific technical aspects of WAH, and the broader risk perception, communication and supervisory skills that enable safe working.

4.2.1 Baseline training requirements

Key principle:

Every person should receive a level of training that:
- *complies with regulatory requirements in the country where they are working;*
- *complies with recognised industry standards, and*
- *fulfils any additional requirements identified through risk assessment of the work that they are to undertake.*

The minimum standard for anyone undertaking work at height on structures in the offshore wind industry is generally accepted to be:

- Global Wind Organisation (GWO) Work at Height training, and
- GWO Sea Survival Training (SST).

The full GWO Basic Safety Training (BST) syllabus also covers First Aid, Manual Handling and Fire Awareness, and employers may require these modules to have been successfully completed. While this provides a common core syllabus, the GWO acknowledges that legal requirements could set higher standards in some countries, so some country-specific training may still be necessary, although this should not be significant in scope.

On sites where helicopters may be used for transfer, helicopter escape training such as the Offshore Petroleum Industry Training Organisation (OPITO) Helicopter Underwater Escape Training (HUET) will be required; this is also covered as one part of the OPITO Basic Offshore Safety Induction and Emergency Training (BOSIET).

The remit of training standards must be clearly understood, particularly where workers are moving between industries, to ensure that they cover all the competencies required for proposed activities; some key gaps are:

- Transfer between vessels and ladders on boat landings is only covered in the GWO SST, and is not covered in HUET/BOSIET, although these training standards cover other aspects of marine safety and survival. The OPITO standard 'Travel Safely by Boat' also does not cover transfer from a vessel to a ladder.
- HUET and BOSIET do not cover winching from a helicopter, so while they would be valid for transfers in which a helicopter lands on the helideck of a substation or large vessel, further training (Helicopter Hoist Operations Passenger) would be needed for winched transfers; this is generally provided by the helicopter operator.
- If personnel access a WTG by helicopter, then they should also have received the required training for vessel transfer, in case this is required for the return journey.
- GWO WAH provides theoretical and practical training in the basic knowledge and skills to use typical PPE, and work safely and perform basic rescues at height in

WTGs. The training does not cover specific methods used in particular WTG types, nor does it cover advanced rescues, such as from locations with restricted access or where rescue by winching upwards is necessary. As such, additional training may be necessary for working in locations such as hubs.

– Use of standard wind industry fall arrest systems on ladders (including boat landing ladders), and related rescue equipment, is only covered in the GWO WAH syllabus; it is not covered in BOSIET or rope access training standards.

– Structures such as meteorological masts may require different access and rescue techniques to be used, which are not covered in the GWO WAH training standard.

The remits of, and gaps between, these standard qualifications are illustrated in Figure 6.

In addition to the standard competence training, it is essential that suitable site-specific familiarisation is provided in safe systems of work, taking account of site hazards, procedures and equipment. This may identify the need for additional training, relating to hazards other than working at height.

Having successfully completed a training course does not necessarily mean that a person will be competent in all aspects of the course content, so employers should have systems in place to develop and monitor competence, such as accompanying new personnel during their first few transfers to offshore structures.

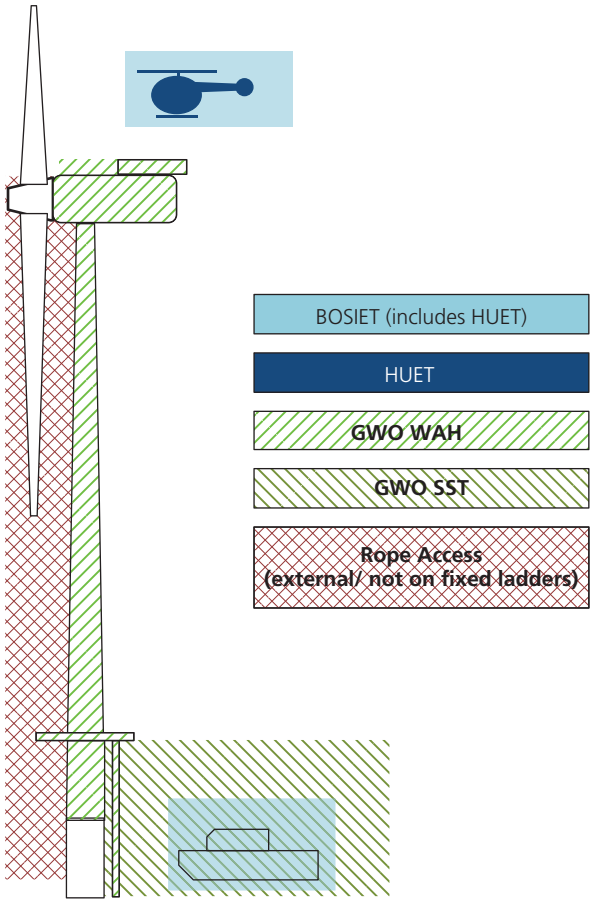

Figure 6: Permitted access zones for different training standards

4.2.2 Fitness

All the activities addressed in these guidelines can involve climbing vertical ladders:

– Transfer from vessels may involve a climb of about 20 m on external ladders, which are subject to marine fouling (which may increase grip strength requirements) and weather.
– If the lift in a WTG is out of service, access to the nacelle will involve an internal climb exceeding 60–100 m for each ascent or descent of the ladder.
– Meteorological masts have external ladders, providing no shelter from the weather, with a height of 85–100 m.

A good level of fitness is necessary for such activities, particularly given the remote locations involved. Fitness should be confirmed prior to transferring from vessels, taking account of the potential for motion sickness to occur during the journey. Various fitness assessment standards are available. Note that even where people have a suitable level of fitness to undertake these climbs without undue difficulty, there may be long-term musculoskeletal effects from regular climbing of vertical ladders, so lifts should be the normal means of access between levels in a tower, with the ladder only being used in exceptional circumstances and subject to additional risk assessment.

4.2.3 Use of anchor systems

Whenever personal fall protection equipment is to be used, it is essential that it is attached to suitable anchor systems. The order of preference for the selection and use of anchor systems can be summarised as:

1. Design provides suitable anchor points, in terms of their strength and location. These could either be on removable anchor devices (to EN 795/CEN TS 16415 etc.) or permanent structural anchors.
2. The planning of work takes account of the need for anchoring, and identifies where it may be necessary to establish additional anchor systems, both for the task being planned and potential rescues. A competent person then verifies the strength of these anchor systems. This verification may include carrying out calculations, inspection and/or testing as required, taking account of the potential direction of load. Other factors affecting their suitability, such as the presence of edges that could damage lanyards or ropes, should also be assessed.
3. If people are to make judgements about setting up anchor systems while carrying out a task, this must be within the limits of their training and competence, and recorded. For example, rope access technicians may have various levels of training in setting up anchor systems, including the identification of suitable locations on a structure and how to set up a system that equalises the load on multiple anchors and provides double protection, but other personnel may not have the necessary competence to make such judgements.

4.2.4 Competence for specific roles

In order for WAH to be undertaken safely, it is important that all parties involved in contracting, organising, planning, managing and supervising the work, have sufficient competence to fulfi their role.

4.2.4.1 Contracting for WAH

Any **employer** (in the contracting sense, distinct from an employer of employees) that appoints contractors to undertake WAH will influence the safety of the work. The precise legal duties on the **employer** depend on which EU member state the work is taking place in, and whether or not the work is being carried out as part of a construction project. However, to ensure that the work is done safely, the **employer** should:

- provide accurate information on the scope of work, the structure and location where it will take place, and any hazards that a competent contractor might not be expected to be aware of;
- select a competent contractor;
- ensure that safe systems of work are in operation, within which the WAH will be undertaken; depending on the situation, this may involve:
  - reviewing how contractors propose to manage the work;
  - managing the site where the work will take place;
  - periodic auditing of contractors, to ensure compliance with agreed procedures;
  - monitoring contractors' working practices, by carrying out safety inspections, and
- ensure that the structure is maintained in a condition that allows safe work at height, for example ensuring the integrity of collective safeguards (such as guardrails) and fall protection equipment such as anchor points.

In order to be able to select competent contractors and review proposed methods, the **employer** needs to have sufficient understanding of how the work should be undertaken. For specialised tasks, such as rope access work, the **employer** may need to obtain assistance from advisers with recognised competence in such activities.

4.2.4.2 Organising, planning and managing offshore WAH

The key competencies that are needed are:

- undertaking suitable and sufficient risk assessments, to identify hazards and necessary precautions:
  - the level of risk will inform the choice of control measures from the different levels on the hierarchy of protective measures;
- selection of suitable techniques and work equipment, both for access and rescue;
  - this selection should apply the hierarchy of fall protection;
- planning of work and preparation of rescue plans, and integration with site Emergency Response Plans;
- understanding of relevant legislative requirements, and
- understanding of the additional challenges that offshore work imposes, such as increased remoteness, effects of weather and sea conditions, limited access, and restricted space.

Management should also select suitable teams to undertake the work, taking account of the level of risk that the work presents, and different levels of competence. The planning of work should avoid creating situations in which time pressure could affect safe working, therefore the progress of tasks should be monitored by working parties and their supervisors to ensure that sufficient time is available, with respect to constraints such as weather/tidal access windows, hours of daylight and availability of CTVs.

The competence to carry out these activities will only come from having breadth and depth of experience in undertaking the activities being considered in the offshore setting, together with suitable training in safety management, and being up-to-date with current techniques and regulations.

4.2.4.3 Supervising WAH

While a work package is in progress, supervisors are responsible for:

- Ensuring that safety management arrangements are in place for the complete scope of work that is to be undertaken by their teams.
- Carrying out pre-work checks to ensure that the correct work equipment is available, including provision of spares/replacements if necessary.
- Carrying out effective pre-work briefings and toolbox talks, to provide information, set expectations and check understanding of hazards, risk controls and safe systems of work.
- Ensuring that work is undertaken in a safe manner and that site rules are being followed.
- Monitoring conditions in the workplace to ensure that housekeeping is of a good standard.

In the offshore wind industry, most workers operate in small self-managed workgroups, with either remote or occasional direct supervision, especially in the O&M phase. Any such workgroup must therefore have sufficient competence and supervisory skills to allow them to manage their work safely. Teams will need to:

- Understand the duties that relevant legislation imposes on their work.
- Be competent in their tasks, and have a clear understanding of the agreed methods or procedures.
- Have an appropriate level of risk-awareness to be able to identify dangerous situations and working practices in the tasks that they are to undertake, and stop the task or take other steps to re-establish safe working.
- Understand the risk assessment and method statement for the work, and ensure that the precautions are implemented effectively and are sufficient for the actual situation faced.

Carrying out these responsibilities will need good communication skills, both to manage the team undertaking the task, and interfaces with clients and other work parties affected. Employers therefore need to:

- Provide training for lead technicians that goes beyond technical and functional knowledge for WAH, and develops the supervisory/leadership competencies listed in this section.
- Consider the level of risk that a task presents, and decide if it is within the capability of a particular team, and whether additional safety management support may be needed for specific tasks.
- Ensure that an effective process is operated for controlling any changes that occur on site, for example by reviewing risk assessments, updating method statements, and communicating changes to all personnel involved in the works.
- Operate an effective induction process for people who are new to a site, with further care being taken to ensure the safety of people who are new to the industry.

4.2.5 WAH on vessels

WAH on vessels is subject to the requirements of the same EU directive[7] as work at height on land or on fixed structures, so similar standards should be maintained, even if the work is being undertaken by the crew of the vessel, under the direction of the master, in the course of normal ship-board activities. As vessel crew members do not work on offshore wind farm structures, they are not expected to have GWO training.

Employers should set clear expectations for the standards of safety that are expected in relation to WAH on vessels, and ensure that all personnel involved have suitable training and competence for the tasks that they are expected to undertake. Unless specific training is provided, and competence demonstrated, vessel crew should not be expected to transfer to offshore structures, participate in rescues on these structures, or become involved in the operation of SRLs or other FAS for transfer. Access arrangements to vessels in ports should also be assessed, to ensure that technicians and crew all have safe means of vessel access and rescue available.

4.2.6 Baseline PPE requirements

These guidelines assume that all personnel involved in WAH will have the following PPE available as a minimum, and be competent in its use:

- personal fall protection (further guidance on standards is in Annex D.4.2);
  - full body harness (EN 361) with work positioning belt (EN 358);
  - energy-absorbing lanyards with energy absorber (EN 354 and EN 355);
  - work positioning lanyard (EN 358);
  - fall arrest slider (EN 353-1) compatible with the fixed rail/wire installed in the tower (if accessing locations above tower entrance), and
- Safety helmet – note that there are several different standards, depending on the hazards that the helmet is to protect against.

These fall protection equipment standards do not generally define limits on the user's mass; the instructions for use should be consulted.

Note that energy-absorbing lanyards can have either stretchable energy-absorbing webbing, or separate energy-absorbing element(s); compatibility with the rescue kits on a site should be checked.

Additional PPE will be needed for specific activities, or to protect from other workplace hazards, not related to WAH. Selection, care and inspection of PPE should take account of the potential for accelerated degradation in the offshore environment.

4.2.6.1 Appropriate use of energy-absorbing lanyards

Some types of energy-absorbing lanyard can be used to provide work restraint (only if this is specified in the instructions for use); the user should always be aware of the lanyard's extended length, in order to prevent them reaching a position from which they could fall. Energy-absorbing lanyards should not be used as a deliberate means of suspension – for example, they should not be used in a situation where a work positioning lanyard should be used to support the user.

7 Directive 2009/104/EC: Minimum health and safety requirements for the use of work equipment by workers at work, Annex 2, Section 4.

Note that EN 363 defines a restraint system as being a system that restricts the movement of the user, so that he/she is prevented from reaching areas where a fall from a height could occur; such a system is not intended to arrest a fall from a height, nor is it intended for work in situations where the user needs support from the body holding device (e.g. to prevent him/her from slipping or falling).

4.2.7 Maintenance of equipment for WAH

Key principle:

The purpose of inspecting equipment for WAH is to ensure that health and safety conditions are maintained and that deterioration liable to result in dangerous situations can be detected and remedied in good time. This objective should drive the scope and frequency of inspection and maintenance activities.

The EU Work Equipment Directive provides a common baseline requirement; Article 4(2) states:

'*In order to ensure that health and safety conditions are maintained and that deterioration liable to result in dangerous situations can be detected and remedied in good time, the employer shall ensure that work equipment exposed to conditions causing such deterioration is subject to:*

(a) periodic inspections and, where appropriate, testing by competent persons within the meaning of national laws and/or practices;

(b) special inspections by competent persons within the meaning of national laws and/or practices each time that exceptional circumstances which are liable to jeopardise the safety of the work equipment have occurred, such as modification work, accidents, natural phenomena or prolonged periods of inactivity.'

As the Directive refers to national laws, requirements vary between member states.

In practical terms, sustaining the safety of work at height over the lifetime of an offshore wind farm depends on certain maintenance actions being carried out:

- Access ladder fouling should be minimised by operating an effective cleaning programme, taking account of the tidal range at a site.
- Structural integrity should be assured by a risk-based inspection programme.
- All PPE, anchor points and fall arrest systems should be subject to pre-use checks (by users) and periodic inspection (by competent persons), in order to ensure that they remain in a safe condition for use.

4.2.7.1 Inspection of personal fall protection equipment

Formal inspection procedures should be put in place by employers to ensure that personal fall protection equipment is subject to a detailed inspection at intervals that satisfy national regulations and take account of the potential rate of deterioration of the equipment, considering its usage and the working environment.[8] In practice, this generally involves several levels of inspection:

8 Practical guidance is available in HSE INDG367: *Inspecting fall arrest equipment made from webbing or rope*, although legislative references are specific to the UK.

- Equipment should be subjected to detailed inspections (which would be known as 'thorough examination' for lifting equipment) by a competent person in accordance with a predetermined regime.
- Interim inspections might be needed between detailed inspections in situations where the risk assessment has identified a hazard that could cause significant deterioration in the equipment, such as items that are subject to high levels of wear and tear or contamination, including the effects of the marine environment.
- Users should carry out a pre-use check before each use, and should have the necessary level of competence to do so.
- In all cases, damaged equipment should be taken out of service immediately:
  - If it has arrested a fall, then it should be securely stored in case further investigation is needed in future – local regulations or company policies may dictate the period of retention.
  - Otherwise, defective items should be properly disposed of, to ensure that they are not reused.

Records of detailed and interim inspections should be kept, as required under national regulations; while there is no requirement to record the completion of pre-use checks, employers should ensure that these vital checks are carried out effectively.

4.2.7.2 Competent person

EN 365 specifies that the competent person for periodic examination must:

- Be knowledgeable of manufacturer's current periodic examination requirements, recommendations and instructions for the specific model of component, sub-system or system.
- Be capable of identifying and assessing the significance of defects.
- Initiate the corrective action to be taken for defects and have the necessary skills and resources to do so.

Depending on the degree of complexity or innovation, or whether safety-critical knowledge is needed to conduct the examinations, this knowledge may need to take the form of training from the manufacturer or an authorised representative; such training may need periodic refreshment to take account of modifications and upgrades.

National regulations and guidance may specify requirements for the independence and impartiality of the competent person, and in particular, whether or not they are required to be from an external company. If in-house inspectors fulfil the role of competent person, then they must be sufficiently independent and impartial to allow objective decisions to be made, and have the authority to ensure that examinations are properly carried out and that the necessary recommendations arising from them are made. As a general principle, the competent person for inspection should not be the same person who undertakes routine maintenance, in order to ensure that a person is not inspecting their own work.

4.2.7.3 Inspection of rescue kits

Rescue or evacuation devices (other than a self-rescue device) are classified as lifting equipment rather than PPE, but should be inspected in the same way as other equipment for WAH[9]. The default period for thorough examination (the equivalent of 'detailed inspection' for other WAH equipment) is defined in national regulations. For example, in the UK, the default interval is six months, although – subject to a written scheme of examination drawn up by a competent person – this period might be longer, such as for equipment that has not been used and has been stored correctly.

Equipment should in any case be inspected at least once a year; for a hermetically sealed rescue kit, the scope of the inspection may be limited to verifying the integrity of the seal, until a defined lifetime has been reached. Rescue kits should also be inspected by a competent person after use for a rescue or evacuation, and repacked in readiness for further use. Specific guidance on the scope or interval of inspections should be obtained from the manufacturer or supplier.

4.2.7.4 Inspection of anchor systems

EN 365 includes a recommendation that the periodic examination frequency for PPE shall not be less than once every 12 months. However, inspection intervals are defined in national regulations and guidance, and may vary according to the purpose of the anchor system. For example, in the UK, the default period for thorough examination of equipment and accessories used for lifting and lowering people (e.g. those used for rope access, davits or designed specifically for emergency evacuation) is six months, although – subject to a written scheme of examination drawn up by a competent person – this period might be longer, subject to risk assessment.

The scope and frequency of inspections should take account of the frequency of usage, loading, condition and the environment, and whether proof load testing at periodic intervals is required, in order to assess the integrity of the anchor system. Manufacturers of anchor devices should be consulted for advice. For anchor systems subject to particularly intensive use, risk assessment may indicate a need to inspect more frequently than the legal minimum.

As inspections may include proof load testing, a suitable test method should be defined by the designer/manufacturer of the structure to which the anchor system is attached, taking account of the full load path from anchor points to the load-bearing structure. If structural anchors are fixed into composite materials such as GRP nacelle covers (rather than metallic structural elements) then a normal pull test may not be appropriate, as it might damage the composite, or might only demonstrate that the anchor system is securely fixed into an insert within the composite, without showing that the insert itself was secure in the composite, and that the section of composite was adequately secured to the structure.

4.2.7.5 Maintenance of lifts

Key principle:

If lifts have safety-critical components that do not fail safe, then maintenance and inspection are the main barriers to hazardous situations occurring.

9 Practical guidance is available in HSE INDG422 *Thorough examination of lifting equipment: A simple guide for employers*, although legislative references are specific to the UK

It is important that the correct scope and schedule of maintenance is undertaken on lifts, to ensure their safe and reliable operation. Achieving this depends on information being provided by the manufacturers of main lift components (such as the drive unit and overspeed prevention (fall arrest) systems), passed on by the lift supplier and WTG manufacturer, and reviewed to take account of the way in which the equipment is used. Product updates should also be communicated, if they can affect maintenance requirements.

The frequency of maintenance should reflect how often lifts are used, rather than simply being undertaken after a fixed time interval. The scope of maintenance should aim to prevent and/or detect deterioration of safety-critical components, before such deterioration becomes hazardous. Techniques such as Failure Mode and Effects Analysis (FMEA) may be useful in developing maintenance plans. The extent to which lifts are designed for maintenance will affect the efficiency and safety of lift maintenance, considering aspects such as access to components and provision for suspension wire inspection from within the lift carrier.

Maintenance should be undertaken by competent personnel, who have been trained in the specific requirements of the lift and its main components. Effective record keeping is important; it should be possible to determine if unusual or accelerated wear has occurred since maintenance was last undertaken. In the event that scheduled maintenance detects a level of deterioration that was potentially hazardous, then this should be investigated further, particularly if other lifts of the same type could be affected.

The scheduling of lift maintenance should aim to ensure that lifts are available when maintenance campaigns are planned on WTGs. Scheduled lift maintenance should be backed up by pre-use checks; however, the scope of these checks should be reasonable, and the methods used should not put people at risk, nor accelerate component wear.

Procedures need to be in place for managing situations in which lifts are not available for use, considering aspects such as

– setting limits on climbing, and
– planning of work, to allow for the increased time and effort required to reach the nacelle.

4.3 FALLING OR DROPPED OBJECTS

G+ has decided to adopt the DROPS guidance in relation to falling objects, therefore the G+ website should be consulted for current guidance on this topic.

4.4 TRANSFER BY STEPPING OVER BETWEEN VESSELS AND OFFSHORE STRUCTURES

Key principle:

The aim should be to ensure that people do not fall into the sea or become trapped between the vessel and any part of the offshore structure during transfers, through a combination of having a suitable design of boat landing, vessel selection, operating procedures, training and competence. Residual risks from falling should be mitigated by using suitable protective equipment.

This section covers personnel transfer from the deck of a CTV or daughter craft to the external platform on the TP, or equivalent position on other offshore structures. It is assumed that this transfer involves stepping from the vessel onto a stationary vertical (or near vertical) boat landing ladder, then climbing to the external platform on the offshore structure, with the operation being reversed for transfer back to the vessel. Although floating WTGs are not fixed to the seabed, transfers to these should be equally safe as to a bottom-fixed WTG, therefore the hazards and protective measures in this situation can be applied. This section covers:

– PPE requirements;
– supervisory/task management arrangements;
– training and skills, and
– potential hazards at each stage of the transfer process.

Other types of transfer may also occur, including:

– transfers between CTVs and larger vessels (such as hotel ships or SOVs), and
– transfers between larger vessels and platforms on offshore structures using W2W gangways.

The risk from falling objects during transfer also needs to be addressed in any transfers at height.

While some daughter craft may be significantly smaller than many CTVs, and may also have different hull forms, the same level of safety should be achieved, therefore the requirements described in the following sections are not significantly different.

4.4.1 PPE requirements for transfer

This PPE is additional to the baseline PPE required for WAH in offshore wind. The key hazards and associated PPE are:

– falling: mitigated by the use of FAS during transfer, and
– drowning: mitigated by the use of PFDs, personal locator beacons and immersion suits.

As transfer can involve using multiple items of PPE, compatibility must be checked to ensure that the combination of PPE will function effectively.

4.4.1.1 Protection against drowning: PFD

As transfer involves moving around on the deck of a vessel, and stepping over water, a PFD must be worn, providing at least 275 N of buoyancy – note that 150 N PFDs do not prevent casualties being submerged in 1,2 m near-breaking waves[10], which are within normal offshore wind transfer conditions. PFDs with automatic inflation are generally used; hydrostatic triggering of inflation avoids the potential for unintentional inflation, which can occur due to moisture ingress on PFDs that are simply triggered by the presence of water. (Note that PFDs for use in helicopters must not inflate automatically, so this can affect PPE provision on sites that use both vessel and helicopter access.) PFDs should have spray hoods, to minimise inhalation of water from waves and spray, which can lead to drowning.

10 HSE Offshore Technology Report OTO 95 038 – *Review of Probable Survival Times for Immersion in the North Sea*, p12.

4.4.1.2 Protection against drowning: casualty location

Key principle:

Personal Locator Beacons (PLBs) can assist in locating a casualty who is in the water. Several types are available, with different functions, therefore correct selection is important. PLBs must be compatible with systems used on the site where they are to be used, to ensure that a casualty can be located effectively and without delay.

PLBs are generally integrated into PFDs, which has several benefits:

– it avoids an inappropriately mounted PLB interfering with the inflation of the PFD;
– it ensures that the PLB antenna is correctly positioned;
– it ensures that the PLB cannot be mislaid or dropped, as long as the PFD is worn, and
– the inflated PFD will not obstruct the casualty's access to the PLB in case manual activation is required.

PLBs can work in several different ways:

– Homing signals can be transmitted on 121,5 MHz; rescuers can use this to determine the direction of the casualty's location, but not its distance.
– ID and location information can be transmitted on 406 MHz to the COPSAS – SARSAT satellite network. The information from the satellites is transmitted to a mission control centre, which verifies that the signal is from a genuine distress call (rather than an accidental activation) before passing information to the nearest rescue control centre, which will broadcast emergency information to vessels and activate emergency response resources such as Search and Rescue (SAR). However, this verification stage typically takes about 60 minutes. This method is therefore of little benefit in situations where potential rescuers (such as CTVs) are already close to the casualty.
– Personal Automatic Identification System (AIS) beacons: these transmit the casualty's location and identity number, which will be displayed as a Search and Rescue Transponder (SART) icon on AIS-enabled chart plotters, on any vessel within a range of about four miles. AIS cannot be used to raise an alert, but this method is a useful means of tracking the position of casualties after an alert has been raised by other methods.
– Beacons with VHF Digital Selective Calling (VHF DSC) broadcast a DSC Distress alert (Mayday), which can be received by all standard VHF DSC marine radios within range, together with an ID number and GPS coordinates of the casualty. The coordinates are refreshed every five minutes, therefore this can also be an effective method of tracking casualties.

Given the range of types available, for a PLB to provide the expected level of protection, it must be compatible with the systems in use at the site where it is to be used.

4.4.1.3 Protection against drowning: use of immersion suits

Where the preventive measures leave a significant residual risk of a person falling into the sea, immersion suits may be necessary, particularly in cold water and rough sea conditions. This decision should be based on risk assessment, considering:

– Probability of falling into the sea, which is affected by:

  - Use of an FAS during transfer.
  - Detail design of vessel bow – guardrails and anchor points at suitable positions and heights.
  - Condition of the deck and ladder surfaces.
  - Sea state – rougher seas increase the risk of sudden vessel movement, and the direction of the wind and waves can also alter their effect on the vessel.
  - Capability of the vessel to maintain its position against the bumper bars in the prevailing sea state.
  - Interface between vessel and boat landing.
- Sea temperature:
  - low sea temperatures reduce the casualty's survival time.
- Sea state: rougher seas will:
  - increase the probability of falling into the sea, if the vessel starts to move relative to the structure;
  - increase the time to recover the casualty;
  - increase the risk of the casualty inhaling water, and
  - reduce the casualty's survival time.
- Ability to recover the casualty from the water, which is affected by:
  - Vessel(s) and crew performance in prevailing sea conditions.
  - Position of the casualty: if the waves take them between the hulls of a catamaran, or inside the framework of a jacket foundation, then the risk to the casualty is increased, and recovery may be delayed.

A range of types of immersion suit is available, to protect against different hazards; in particular, different levels of thermal insulation are available (ISO 15027-1:2012 S*uit performance levels* A-D). If a person falls into the sea during transfer between a vessel and an offshore structure, then it should be the case that:

- a highly-manoeuvrable crew transfer vessel is present;
- the crew and passengers are trained and competent in their roles in Man Overboard (MOB) recovery in the prevailing sea conditions, and
- it is immediately known that a person is overboard; therefore
- the rescue time should be short (significantly less than 30 minutes).

If these conditions are met, then the main risk to people falling into the sea would come from cold shock and water inhalation (which can lead to drowning within minutes of immersion) rather than hypothermia (which has a slower onset). Therefore, if an immersion suit is to be worn for transfer, it would only need to keep the casualty's body and clothing dry, rather than having to provide protection against gradual cooling, which could result in hypothermia during a long period of immersion. An insulated immersion suit would therefore be unnecessary[11,12]. Further, as the immersion suit is to be used for climbing, the restricted

11 The Danish Maritime Authority specifies that 'In Danish ships, immersion suits shall be of a type with built-in insulation and buoyancy' – see DMA website. This conflicts with the UK MCA's Workboat Code (section 13.5.3), which specifically permits non-insulated immersion suits. National regulations must be complied with.

12 IMCA SEL 025 Guidance on the Transfer of Personnel to and from Offshore Vessels and Structures states '*It is not possible to accurately establish at what water temperature cold water shock occurs to a person who unexpectedly enters the water. Some experts state that this can occur at a water temperature of below 10 °C, others say it can happen when the water temperature is below 15 °C. Clearly there is no consensus. As there are a number of physiological factors that can influence cold water shock, it is difficult to define a set temperature. Thus it is recommended that an assessment of the risks associated with the work activity is undertaken, including, for example; sea state, current, weather, height of transfer, vessel type, fitness of person being transferred, estimated time to recover the person from the water, etc. to identify the correct PPE (thermal protection) required, to ensure the safety of the person, should they fall in the water.*'

movement or reduced dexterity of an insulated suit could increase the risk of falling. Even with an uninsulated suit, there can be a risk of overheating (hyperthermia) if climbing in warm ambient conditions. However, if transferring by helicopter, insulated immersion suits may be required to provide protection in the event of ditching in a location remote from vessels and structures.

Decisions about the wearing of immersion suits, and the type to be used, must be based on detailed risk assessment, considering all relevant factors. An illustration of this is given in Table 1, but should not be taken as being exhaustive. National health and safety regulators may also define decision-making criteria, for example in the Netherlands, immersion suits are to be worn when transferring if the sea temperature is under 12 °C.[13]

Table 1: Factors influencing decisions about wearing of immersion suits for transfer

Note: this table is not a risk assessment, and the values (particularly for sea temperature) are not absolute. Clear decision-making criteria should be established, taking account of these and other relevant factors. It is the combination of different factors, rather than any one factor in isolation, that determines the risk to people, and selection of PPE.

Risk factor	**Condition (Green/yellow/red shading indicates increasing severity)**		
Sea temperature	Benign (e.g. >15 °C)	Cold (e.g. <15 °C)	Cold (e.g. <15 °C)
Sea state	Calm/smooth	Moderate – approaching limits for transfer	Moderate – approaching limits for transfer
Light	Daylight	Daylight	Poor/dark
Visibility	Good	Good	Limited
Current/wind	Minimal, will not cause casualty to drift	Some effect – casualty may drift slowly	May cause casualty to drift significantly
Vessel capability	Highly manoeuvrable	Highly manoeuvrable	Limited vessel manoeuvrability
Other vessels	Present nearby, could assist	In area, could come to assist	May take some time to respond
Expected casualty recovery time	Very quick – a few minutes	Quick – definitely within 30 minutes	Potential for delay
Likely outcome	**Immersion suit may not be required if <u>all</u> of the above criteria are met**	**Lightweight immersion suit may be appropriate**	**Insulated immersion suit required if <u>any</u> of the risk-increasing factors are present**

4.4.1.4 Compatibility and suitability of immersion suits, PFDs and harnesses

The combination of immersion suit and PFD must be compatible with each other:

13 See http://windenergiebedrijven.dearbocatalogus.nl/nl/arbo/offshore/322/2837/278/4926/6113.

- The buoyancy of an immersion suit will tend to raise the wearer's legs, counteracting the action of the PFD and resulting in a horizontal position in the water, thereby reducing the clearance of the casualty's face above the water, and increasing the risk of drowning by water inhalation.
- ISO 15027-1:2012 requires manufacturers of immersion suits to state which type(s) of PFD the suit is compatible with.

The immersion suit and PFD also need to be suitable for climbing:

- They need to be compatible with the harness, such as ensuring that the attachment point remains accessible and the harness can be properly adjusted – slack leg loops can cause injury in the event of a fall.
- The collar of the suit/PFD should not prevent the climber from looking up, when wearing a helmet.
- Immersion suits should be lightweight and flexible, so as not to impede movement.

4.4.1.5 Other PPE for transfer

Suitable clothing and PPE for transfer should include:

- Gloves must provide good grip on wet/slippery ladder, protect hands, maintain dexterity for attaching to/detaching from FAS, and not be degraded by salt water:
  - the integrated gloves on some immersion suits are unsuitable for ladder climbing and use of FAS.
- Footwear must be well-fitted, with good grip:
  - Bulky integrated boots may impede climbing.
  - Thick integrated waterproof socks, worn inside normal safety footwear, can also impede climbing – either use an immersion suit with ankle seals (although these are easily damaged), or thin integrated socks that fit comfortably in normal safety footwear.
- Clothes worn under the immersion suit should provide sufficient insulation for prevailing weather conditions, given that the immersion suit itself is not insulated.

4.4.1.6 Protection against falling: SRL on boat landing ladder

Transferring from the bow of a vessel to a boat landing ladder presents a risk of falling, either when stepping over or when climbing the ladder. Attachment to an SRL before stepping from the vessel to the ladder, and remaining attached while stepping from the ladder to the vessel, can ensure that people do not fall into the sea. However, there are concerns about how SRLs interact with heaving vessels, as this can lead to people being 'picked up' if the vessel suddenly moves down. Specific hazards and protective measures are reviewed in Table 2. The following conditions need to be satisfied in order to enable safe transfer with continuous attachment:

- transfer is taking place in suitable conditions, defined as:
  - vessel is holding steady position against boat landing;
  - speed and distance of any vessel movement should be much less than SRL lock-on limits:
    - when selecting an SRL, the specifier should identify the range and speed of vessel movement that will be within acceptable limits for transfer procedure, and ensure that the SRL will not lock on within these limits; this may involve obtaining information on lock-on characteristics from the SRL manufacturer;
    - data on the speed and range of bow movement can be captured using accelerometers, to quantify the demands on the SRL;

- vessel and ladder/boat landing are compatible, i.e. sufficient safety zone to prevent crushing;
- design and operation of SRL allows for limited vessel movement without activation:
  - if an operating procedure is proposed that involves manually introducing slack into the system, then this should be checked with the SRL manufacturer, to ensure that it does not increase the height of a fall to the extent that the energy absorption capacity of the SRL is exceeded;
    - note that the test method for retractable type fall arresters certified to EN 360 includes the introduction of 600 mm of line that is not under tension, with the 100 kg test mass being dropped from a starting position such that its top is level with the bottom of the tensioned section of line.
- Connector between SRL and harness should enable easy one-handed connection/ removal, while wearing gloves:
  - this minimises the time during which a person is connected to the SRL, while still on the vessel.

If considering a transfer in conditions that impede continuous attachment, note that such sea conditions will also:

- increase the probability of falling into the sea;
- increase the recovery time of the casualty, and
- reduce the survival time of the casualty.

4.4.2 Supervisory/working arrangements

4.4.2.1 Responsibilities of clients and vessel charterers

The **client** will generally be responsible for the design/specification of boat landing structures. As the boat landing interfaces with the vessel, relevant information on its design needs to be communicated to any party who will be selecting and chartering crew transfer vessels, to ensure compatibility in terms of factors such as bow profile, bow height, and imposed loadings on bumper bars (both in planned operation and foreseeable potential impacts). If smaller vessels, such as some types of daughter craft, are introduced to a site, several potential effects of the lower bow height need to be checked:

- The bumper bars need to extend far enough down that the lower vessel can still safely push against them.
- It should still be possible to attach to/detach from the FAS safely while standing at the bow of the vessel.
- Marine fouling may need to be cleaned from further down the bumper bars and ladder than when using a conventional CTV.

At a site level, suitable systems need to be in place for personnel tracking and marine co-ordination; the responsibility for this will be determined by the contractual arrangements at the relevant stage of project development.

4.4.2.2 Roles of supervisors, vessel captain, deckhand and passengers

In addition to their general responsibilities for the safety of their teams, when transfer operations are taking place, supervisors should specifically ensure that PPE 'buddy checks' are carried out.

The vessel captain has overall responsibility for the safety of the vessel and all personnel aboard; specific duties generally include:

- ensuring that vessel safety briefings are carried out;
- safe navigation of the vessel;
- carrying out communications check with the platform party before or immediately after transfer to structure;
- establishing safe positioning of the vessel against the boat landing;
- authorising transfer, based on stable positioning of vessel, and
- maintaining weather watch, and notifying the marine co-ordinator/working parties of how this can affect offshore work.

The deckhand has a key role on crew transfer vessels, with responsibilities generally including:

- Ensuring the safety of personnel on board the vessel and during transfers, including carrying out induction/briefings and managing the movement of personnel between areas of the vessel.
- When a climber is descending the boat landing ladder, the deckhand counts down the remaining rungs and tells the climber when to step back onto the vessel.
- Assisting the climber back onto the vessel.
- Should the site procedure assign any other responsibilities to the deckhand, then training and competence assessment in these tasks will be necessary, and the responsibility interfaces will have to be agreed between the different employers involved. Typical activities at this interface include:
  - confirming that climbers' PPE is correctly fitted for transfer;
  - carrying out pre-use checks on the ladder SRL;
  - pulling down the SRL and attaching/offering it to climbers;
  - assisting with disconnection from the SRL, and
  - assisting with recovery of injured personnel being lowered to vessel deck, with or without a stretcher, from the external platform, hub or other levels of an offshore structure.

As can be seen from this list, the deckhand may have many important and simultaneous responsibilities; these must be realistic, to avoid creating overload. The responsibilities of the master and deckhand must be clear and appropriate, particularly as:

- The master is in a position to see the coming waves, and predict how the vessel is about to move, whereas the deckhand is more likely only to be seeing how the vessel is moving, which may be too late for giving correct instructions to climbers.
- The master has access to the vessel PA system, so may be able to communicate to the climber more effectively than the deckhand, even though the deckhand is closer.

Personnel being transported on vessels also have specific responsibilities, including:

- compliance with vessel safety policies and instructions;
- wearing correct PPE, ensuring that it is properly fitted, within its inspection date and in good condition;

- carrying out 'buddy checks' prior to transfer;
- confirming correct operation of ladder FAS;
- deciding if transfer is within personal capabilities, at the time of transfer, and communicating this decision, and then
- transferring without delay onto ladder, once attached to FAS.

4.4.2.3 Procedural arrangements

Clear decision criteria must be in place for conditions under which transfer can take place. This is not as simple as setting a wave height limit; other important variables are:

- the wave direction (relative to the vessel);
- vessel performance – different vessels may have different levels of movement in similar conditions, and
- the condition of the ladder, especially the level of contamination or presence of ice, which can affect the ease of climbing.

There should also be suitable arrangements in case of problems arising:

- a rescue plan must be in place, and all personnel (both vessel crew and WTG team) must be familiar with the plan and competent to fulfil their roles – regular practice is necessary in order to combat skill fade:
  - this includes rescue from any position on the ladder, and from the sea;
- effective personnel tracking, marine coordination and emergency response systems must be operated, so that the locations of all personnel and vessels are known at all times.

When reviewing decisions about whether conditions were suitable for transfer, or investigating incidents that occur during transfer, the use of vessel CCTV can provide evidence of the situation that faced the personnel involved, and the actions taken, and can also be useful in sharing lessons learned.

4.4.3 Training and skills

4.4.3.1 Standard qualifications

Personnel being transferred should have fulfilled the baseline training requirements.

The master and deckhand have key responsibilities in enabling safe transfer. While there are recognised qualifications for vessel masters and deckhands/crew, and some of the qualifications are specific to workboat personnel and typical workboat operations, there are no recognised assessment criteria relating to transfer of personnel onto offshore structures. In the absence of such qualifications, **employers** will have to conduct their own assessment of competence.

4.4.3.2 Site-specific requirements

In addition to standard training that is needed to work on any site, some site-specific training and familiarisation is necessary, such as:

- training in detailed transfer procedure – take account of vessel/ladder/FAS interfaces;

- training for deckhand and vessel master: roles in procedure, use of FAS and roles in ladder rescue situation;
- MOB training for master, deckhand and WTG personnel (if vessel crew is just master and deckhand, then the WTG personnel may need to assist in any rescue of the deckhand);
  - regular practice should be carried out – including:
    - practice in darkness if transfers are ever carried out in the dark;
    - practice in realistic sea conditions, at the limit allowed for transfer;
    - utilising MOB tracking systems as well as visual contact, and
- training in site emergency arrangements.

4.4.4 Hazards during specific activities

Table 2 identifies some of the principal hazards, relating to WAH, that may be present in a typical transfer process, and recommends measures that can be taken to reduce the associated risks. In cases where the basis for the recommendations may not be obvious, this is outlined in the relevant column. This table could be used as an input to a hazard identification and risk assessment process, but is not a comprehensive risk assessment on its own.

14 IMO guidance on wearing immersion suits in totally enclosed lifeboats is given as Annex A of: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/440770/MGN_396.pdf

Table 2: Hazards during transfers by stepping over to boat landing ladder

Activity	Hazard	Recommended risk control	Basis of recommendations
Movement on vessel prior to start of transfer process	Slip/fall on vessel or overboard	**Prevention:** – Housekeeping: keep walkways clear of obstructions and free from contamination (especially oils/greases) – Use suitable footwear – non-slip soles, and avoid oil contamination – Vessel design: provide suitable walkways, guardrails and anchor points – Suitable area for donning immersion suit and harness – best not to wear immersion suit for duration of passage on vessel – Do not move around on vessel unless essential **Mitigation:** – Do not leave cabin unless wearing PFD, PLB and immersion suit (depending on sea conditions)	Wearing immersion suits during passage can lead to overheating[14], increased risk of seasickness, and sweating reducing thermal efficiency of clothing worn beneath suit
Transfer from vessel to boat landing ladder	Fall into sea, between vessel and boat landing ladder	**Prevention:** – Combination of detail design of vessel and operating procedure should ensure that no person is in a location from which they could fall into sea – i.e. remain within guardrails until stepping forward to attach to ladder FAS (presumed to be an SRL)	

Table 2: Hazards during transfers by stepping over to boat landing ladder (continued)

Activity	Hazard	Recommended risk control	Basis of recommendations
Transfer from vessel to boat landing ladder (continued)	Fall into sea, between vessel and boat landing ladder (continued)	– Deckhand to remain within area protected by guardrails, or wear a harness and be in work restraint, so that he/she cannot fall overboard. For this to be effective, the anchor point on the vessel may need to be higher than the attachment point on the deckhand's harness – this should be checked when selecting a vessel. If effective work restraint is not possible, then a fall arrest lanyard should be attached to a suitably rated anchor point; the risk assessment should also consider the potential position of the deckhand if suspended, to ensure he/she will not be suspended in front of the vessel fender, which would introduce a risk of crushing. The position of the anchor point should not impede the deckhand from moving back from the bow, such as if an object falls from the person transferring. Use of a combined harness/PFD may be beneficial – Each person should confirm fitness to transfer and climb, prior to transfer commencing, taking account of seasickness etc	

Table 2: Hazards during transfers by stepping over to boat landing ladder (continued)

Activity	Hazard	Recommended risk control	Basis of recommendations
Transfer from vessel to boat landing ladder (continued)	Fall into sea, between vessel and boat landing ladder (continued)	**Prevention:** – Attach to SRL before stepping off vessel	Recommendation to attach to SRL before stepping off vessel is based on: – Transfer taking place in suitable conditions – vessel holding steady position against boat landing – speed and distance of any movement should be much less than SRL lock-on limits – Vessel and ladder/boat landing are compatible, i.e. sufficient safety zone to prevent crushing – Design and operation of SRL allows for limited vessel movement without activation – Connector between SRL and harness allowing easy one-handed connection/ removal, while wearing gloves
		Prevention: – Do not climb ladder if iced/severely fouled – Ensure ladder is regularly cleaned at low tide – Use suitable footwear and gloves to provide good grip – Maintain continuous attachment during climbing (ladder SRL, or scaffold hooks/ lanyards if SRL not available)	

Table 2: Hazards during transfers by stepping over to boat landing ladder (continued)

Activity	Hazard	Recommended risk control	Basis of recommendations
Transfer from vessel to boat landing ladder (continued)	Fall into sea, between vessel and boat landing ladder (continued)	**Mitigation:** – Always wear a suitable PFD during transfer	
		Mitigation: – Do not attach any bags to harness or body – Ensure harness (and all other PPE such as PFD, immersion suit) is correctly fitted – carry out buddy check before going on deck	Bags can result in: – Climbing being impeded, increasing the probability of a fall – Added weight (casualty floats lower in water, increasing risk of drowning due to water inhalation), or – Added buoyancy in wrong position relative to casualty's centre of mass (casualty may not self-right to bring face out of water, increasing risk of drowning)
		Mitigation: – Ensure casualty's position can be located – PLB and light to be worn on (preferably integrated with) PFD	Locating PLB on PFD ensures that it is always in the same location on the person, irrespective of whether an immersion suit is worn, and ensures that the inflated PFD does not obstruct access to a PLB worn on the immersion suit. However, the PLB mounting arrangement must be compatible with the inflated PFD – manufacturer approval may be needed

Table 2: Hazards during transfers by stepping over to boat landing ladder (continued)

Activity	Hazard	Recommended risk control	Basis of recommendations
Transfer from vessel to boat landing ladder (continued)	Fall into sea, between vessel and boat landing ladder (continued)	**Mitigation:** – Wear suitable immersion suit when conditions require	
	Fall between vessel and boat landing ladder, remaining attached to either, resulting in impact with, or crushing between, vessel and boat landing ladder/ bumper bars	**Prevention:** – Only attempt transfers in suitable conditions **Mitigation:** – Eliminate risk of crushing between vessel bow and boat landing ladder by ensuring vessel and boat landing structure are compatible – after arresting a fall, the FAS should suspend the climber in the safety zone, formed by the bumper bars – include in vessel specifications and surveys – Step over from vessel to ladder as soon as attached to SRL/detach immediately after stepover from ladder to vessel – Use FAS so that if a fall occurs, casualty remains in safety zone between ladder and vessel – If deckhand is attached to vessel, they should be in restraint, so that they cannot be suspended over bow fender – this may require the provision of an anchor point above harness dorsal attachment point height – Vessel master to monitor transfers, and manoeuvre vessel to safe position in the event of a failed transfer	

Table 2: Hazards during transfers by stepping over to boat landing ladder (continued)

Activity	Hazard	Recommended risk control	Basis of recommendations
Transfer from vessel to boat landing ladder (continued)	'Picked up' by SRL due to vessel movement	**Prevention:** – Only attempt transfers in suitable conditions – Step over from vessel to ladder as soon as attached to SRL/detach immediately after stepover from ladder to vessel – Design and operation of SRL allows for limited vessel movement without activation – If the procedure involves the deckhand introducing slack into the system prior to connection, then this must not exceed the allowable limits for the type of SRL	
Climbing boat landing ladder	Slip/loss of grip on ladder, leading to fall, resulting in injury of climber and/or deckhand	**Mitigation:** – Climber to be attached to SRL while climbing	
Transfer from boat landing ladder to additional ladder(s) of TP/jacket	Fall from height during transfer between FAS	**Mitigation:** – Attach to designated anchor point while transferring between FAS	
Climbing additional ladder(s) of TP/jacket	Slip/loss of grip on ladder, leading to fall	**Mitigation:** – Attached to FAS while climbing	
Work on external platform	Fall from height	**Prevention:** – Do not leave any unprotected edges on completion of any tasks that require opening of hatches or guardrails – Work in restraint, to prevent falls if hatches or guardrails have to be opened (e.g. open section of guardrail for lifting loads to/from external platform)	

Table 2: Hazards during transfers by stepping over to boat landing ladder (continued)

Activity	Hazard	Recommended risk control	Basis of recommendations
Transfer from boat landing ladder back to vessel	Fall from ladder (Other hazards and risk controls are the same as for transfer from vessel to boat landing ladder – see above)	**Prevention:** – Clarity of deckhand and master's roles – Count climber down last few steps, and then instruct when to step back – Having a standard communication protocol can help to avoid misunderstanding e.g. '4-3-2-1-Yes' (avoid words that could be misheard, such as 'step/stop', 'go/no'.) – Vessel PA can help with audibility – Deckhand to be ready to assist climber in establishing stable position on vessel and detaching from SRL	

4.5 TRANSFERS USING WALK TO WORK GANGWAYS

The use of W2W gangways for access from a vessel to the external platform of an offshore structure aims to eliminate the hazards relating to WAH and immersion in the sea which have to be considered when stepping over to a ladder. However, other hazards exist when using this transfer method, therefore the risks need to be assessed and minimised; a key part of this is to ensure that there is an appropriate design of the interface between the gangway and the platform. Some of the key hazards to consider, and potential protective measures, are reviewed in the following sections.

4.5.1 Gangway operation

The gangway needs to be installed on a suitable vessel, with appropriate positioning capability to hold station with the required accuracy under anticipated operating conditions, taking account of wind, waves and currents.

The gangway needs to be properly integrated with the vessel, including aspects such as:

– positioning for maximum stability;
– set-up of dynamic positioning (DP) systems to keep the base of the gangway in a stationary position, and
– power supply arrangements, to minimise the probability of an interruption.

In preparation for transfer, there need to be clear procedures for vessel and gangway operation, particularly in relation to the roles of the DP and gangway operators in establishing and maintaining gangway positioning, and providing early warning of positioning limits being reached, which could result in the gangway retracting.

If a W2W gangway is correctly integrated, maintained and operated, then the probability of emergency retraction is minimised. However, personnel undertaking transfers still need to be trained in correct use of the gangway under normal conditions, and how to respond in the event of emergency retraction occurring.

4.5.2 Hazards during specific activities

Table 3 identifies some of the principal hazards, relating to WAH, that may be present in a typical transfer process, and recommends measures that can be taken to reduce the associated risks. In cases where the basis for the recommendations may not be obvious, this is outlined in the relevant column. This table could be used as an input to a hazard identification and risk assessment process, but is not a comprehensive risk assessment on its own.

Table 3: Hazards during W2W transfers

Activity	Hazard	Recommended risk control	Basis of recommendations
Initial positioning of gangway	End of gangway moving relative to offshore structure resulting in open gap or collision between gangway and structure	**Prevention:** – Clear procedures for vessel positioning and gangway operation – No personnel to be on gangway until it has established a fixed position and is confirmed to be safe for use – Gangway to be positioned under the control of a remote operator – Establish an exclusion zone around the position of the interface between the gangway and the offshore structure, so that if people are already on the structure, they are not at risk from movement of the gangway	
Opening/closing of gangway access gates on structure	Fall from height	**Prevention:** – Design of gates to enable opening/closing from a safe location **Mitigation:** – Use PPE to prevent falls if it is necessary to approach open gates – If the risk of falls cannot be eliminated, then minimise the consequences: position of opening should not create the risk of a fall onto lower parts of the structure, and wear PFD and PLB for protection in the event of falling into the sea	Common industry practice is to require the wearing of PFDs during W2W transfers, to provide protection in the unlikely event of a fall into the sea However, if a fall could result in a person hitting lower parts of the structure (such as jacket legs, boat landings or concrete foundations), then this would result in severe injury, therefore the location at which the gangway connects with the structure should be selected so as to avoid this hazard

Table 3: Hazards during W2W transfers (continued)

Activity	Hazard	Recommended risk control	Basis of recommendations
Emergency retraction of gangway	Fall from height	**Prevention:** – Minimise number of emergency retractions by ensuring that the gangway and vessel are suitable for use under foreseeable transfer conditions, and are suitably operated and maintained **Mitigation:** – Alarm to warn users prior to retraction occurring, so that any person undertaking a transfer can avoid being at the outer end of the gangway when it retracts – If the risk of falls cannot be eliminated, then minimise the consequences: the position where the gangway meets the platform should not create the risk of a fall onto lower parts of the structure, and wear PFD and PLB for protection in the event of falling into the sea – Train users how to respond to the alarm – procedure may differ between vessels, so provide briefing on the vessel and carry out periodic drills. A typical response is to move away from the end of the gangway (either onto external platform, or further onto the gangway, and if remaining on the gangway, adopt a braced position to avoid slipping when the gangway rises to a steeper gradient – If an emergency retraction occurs, investigate why it happened and use the learning to reduce future occurrences	Common industry practice is to require the wearing of PFDs during W2W transfers, to provide protection in the unlikely event of a fall into the sea However, if a fall could result in a person hitting lower parts of the structure (such as jacket legs, boat landings or concrete foundations), then this would result in severe injury, therefore the location at which the gangway connects with the structure should be selected to avoid this hazard

Table 3: Hazards during W2W transfers (continued)

Activity	Hazard	Recommended risk control	Basis of recommendations
Emergency retraction of gangway (continued)	Entrapment in/crushing between moving parts	**Prevention:** – Design to avoid creating shear/crush hazards where gangway sections move relative to each other – Safe hand-holds to be provided throughout gangway **Mitigation:** – Alarm to warn users prior to retraction occurring, so that any person undertaking transfers can be ready for sudden movement – Procedure for response when the alarm is given – Training (gangway-specific induction) and warning signs and markings to warn users of any residual risks and show how to avoid them	
	Trip/stumble when stepping between moving sections of gangway	**Prevention:** – Gangway/vessel suitability to minimise relative movement – Design to minimise height difference between moving sections – Flooring to have clear markings and non-slip surfaces – Safe hand-holds to be provided throughout gangway **Mitigation:** – Procedure for response in the event of a person falling over – Gangway operator to monitor personnel transferring	

Table 3: Hazards during W2W transfers (continued)

Activity	Hazard	Recommended risk control	Basis of recommendations
Emergency retraction of gangway (continued)	Uncontrolled movement of load being transferred along gangway if gangway luffs to a steep angle	**Prevention:** – Transfer loads using crane, rather than gangway – Do not carry heavy objects by hand while transferring **Mitigation:** – People to be positioned at side of load which will be higher in the event of emergency retraction, and no personnel to be at other side, so that if the emergency retraction alarm sounds, they can safely let go of the load and brace with both hands. (e.g. person is always at WTG side of load, either pushing or pulling), if the gangway will slope up towards the WTG during emergency retraction	
Gates left open following (emergency) gangway retraction	Fall from height	**Prevention:** – Minimise number of emergency retractions (see above) **Mitigation:** – Procedure/operational restriction to inform teams accessing structure by other methods (such as CTV or helicopter) that gates may have been left open – Routine hazard-spotting checks on arrival at structure – Use PPE to prevent falls when closing open gates	

Table 3: Hazards during W2W transfers (continued)

Activity	Hazard	Recommended risk control	Basis of recommendations
Accessing platform without gates	Fall from height due to climbing over guard rail	**Prevention:** – Fit gates to all structures that will be accessed using W2W **Mitigation:** – Modify end of gangway to enable climbing between gangway level and platform floor without risk of falling. This must not interfere with the emergency retraction function	

4.6 TRANSFERS BETWEEN VESSELS

This section considers transfer between CTVs or daughter craft and large vessels such as hotel ships, construction vessels or SOVs. Several different types of transfer can be undertaken; the hierarchy of protective measures for WAH should be used when assessing different transfer options.

4.6.1 Level step-over

Some hotel vessels or SOVs are equipped so as to enable a CTV to push on amidships, adjacent to a shipside door, allowing level (or near-level) transfer, without any climbing being involved. As this minimises the risk of a fall from height, it is a preferred solution.

4.6.2 Transfer using a pilot ladder

The use of pilot ladders, involving free-climbing up to 9 m up a vertical rope/wooden ladder against the side of a ship, is recognised to be a high-risk approach – the International Marine Pilots' Association describes pilot transfer at sea as 'a treacherous part of the vital task needed to maintain a continuous service', and has led campaigns to improve the safety of pilot transfer.

While such transfers are mainly carried out by free-climbing, in the UK, the MCA states that, for personnel who are not experienced in such transfers, '*when the ship is not alongside a berth:… For transfers using a pilot ladder, it is advisable to use a safety harness (or a marine rescue strop). It is to be noted that these could be dangerous in a swell as precision timing and communications between the person on the ladder and the person tending the rescue strop would be required.*'[15] The purpose of this appears to be to ease recovery in the event of the person falling into the water (hence minimising the consequences of a fall), rather than trying to reduce the distance of a fall (by providing fall arrest).

At an international level, the baseline regulatory requirements for pilot transfers are defined in SOLAS (Chapter V, Regulation 23 and Annex 21). While regulations permit pilots to transfer in this manner, it should not be used by other personnel offshore due to the high level of risk.

4.6.3 Transfer by stepping over onto a boat landing ladder

Some large vessels have purpose-designed boat landings, which CTVs can push against, allowing personnel to step over to the ladder and climb up to the deck, in a similar manner to accessing an offshore structure. The design of the boat landing should satisfy the same requirements as landings on offshore structures, with respect to key safety features such as step-over distance, protection against falling and against risks caused by vessel movement. This includes the provision of an FAS; given that this is a modified application of the standard approach used when transferring to fixed offshore structures, vessel-specific hazard identification should be undertaken to identify any additional hazards, so that these can be eliminated or mitigated.

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The optimal position for a boat landing depends on the type of vessel, and the circumstances under which transfers are to be undertaken:

– the larger vessel may be at anchor, under way, or holding position using DP;
– if the boat landing is positioned to allow beam-on transfers, then this can be used to create a lee-side, giving more sheltered conditions, or
– if the boat landing is at the stern, with the intention of carrying out transfers while under way at low speed, then in the event of a climber falling into the sea, they will fall into the propeller wash of the larger vessel, and are also likely to pass beneath the CTV, potentially passing very close to its propellers.

The means of positioning of the larger vessel needs to be suitable to allow for the push-on force of the CTV, which can exert a bollard push force in the order of 5–10 tonnes. Careful coordination between the two vessels will be necessary, both to ensure that sufficient force is applied to avoid relative movement of the vessels at the boat landing, and to avoid the larger vessel being pushed out of position.

Transfers to boat landings on vessels should maintain the same level of safety as transferring to an offshore structure, and should therefore only take place under conditions that permit safe transfer while continuously attached to an FAS; these include limiting the allowable extent of relative movement between the vessels.

4.6.3.1 Hazards during specific activities

Table 4 identifies some of the principal hazards that may be present in a typical transfer process between vessels, and recommends measures that can be taken to reduce the associated risks. These risks are additional to those present in transfers between CTVs and fixed structures. In cases where the basis for the recommendations may not be obvious, this is outlined in the relevant column. This table could be used as an input to a hazard identification and risk assessment process, but is not a comprehensive risk assessment on its own.

Table 4: Hazards during vessel to vessel transfers

Activity	Hazard	Recommended risk control	Basis of recommendations
Transfer beam-on	Larger vessel pushed out of position	**Prevention:** – Coordination of vessels – in particular, if using DP, the DP operator needs to be ready to respond to a CTV push-on – Limitation of allowable thrust to be applied by CTV, but force must still be sufficient to avoid relative movement of the CTV bow and the boat landing **Mitigation:** – Undertake transfers at a location where some loss of station-keeping is not hazardous – No simultaneous operations involving the larger vessel, such as lifting or gangway transfers, while the CTV transfer is in progress	
Transfer at stern, under way	Fall into water, with additional hazard of propeller wash of larger vessel, which could result in being swept under CTV, with potential exposure to CTV propellers Recovery will also be more challenging, as the vessel will be moving relative to a casualty who is in the water, which may make it more difficult to maintain visual contact with the casualty	**Prevention:** – Use FAS on boat landing to prevent a person who falls during transfer from entering the water **Mitigation:** – Procedure: CTV to stop propellers if a person falls when not attached to the FAS. (Note that this will immediately result in relative movement of the CTV against the boat landing, so may not be appropriate if a person falls and is suspended by the FAS.)	– Design of boat landing, and compatibility with bow of CTV, provides a safe space where the climber can be suspended without risk of impact against the CTV – FAS will arrest a fall from bow height sufficiently quickly that a person suspended by the FAS is largely clear of the water. This should be checked, particularly if the transfer procedure introduces some slack into the system

4.7 ACCESS TO WORKING LOCATIONS

This section covers access from the external platform on the TP (or equivalent location on jacket/offshore substation) to locations where work is to be carried out, such as the WTG tower, basement, nacelle, hub or roof, as well as working areas on substations or meteorological masts. Specific hazards and recommended risk controls relating to access to these locations are given in the following sections and in Table 5, together with considerations for the use of rope access techniques.

As a fundamental principle, prior to any location being accessed, a suitable rescue plan must be in place, and the common training, competence and PPE requirements that apply to all activities should also be satisfied.

4.7.1 Wearing of PPE while working

Any decisions to remove items of PPE when working in a particular location should be based on an assessment of the potential consequences of doing so, as well as the potential for PPE to be damaged in some locations. For example, when considering whether harnesses are required for work in a specific location such as a nacelle, relevant considerations include:

- characteristics of the location: are people at risk of a fall from height? If so, harnesses should be worn and continuous attachment should be maintained;
- task being undertaken: would wearing a harness impede work, or could the work lead to the harness being damaged? If so, consider removing harness, provided that removal will not impede rescue;
  - if the person were to be incapacitated, would rescue be impeded if they were not wearing a harness? Is a rescue harness ('nappy') available in the rescue kit?;
  - if the rescue plan for a task or location assumes that a casualty will be wearing a harness, and no rescue harness is available, then harnesses should be worn at all times when in such locations;
- moving machinery: the potential for entrapment should be eliminated by having appropriate guarding in place, or if that is not practicable, by having robust procedures to ensure that exposed moving parts are prevented from moving. If a task presents a residual risk of entrapment, then a risk assessment may determine that lanyards should be removed from harnesses in order to reduce this risk. Harness removal may also be specified; however, if a person is going to be sufficiently close to moving machinery that wearing a properly fitted harness presents a risk of entrapment, then harness removal alone is unlikely to be sufficient mitigation.

Even if these criteria for harness removal are satisfied, harnesses should still be kept immediately available, as they are essential for emergency evacuation.

4.7.2 Hazards during specific activities

Table 5 identifies some of the principal hazards, relating to WAH, that may be present in the course of obtaining access to a working location, and recommends measures that can be taken to reduce the associated risks. In cases where the basis for the recommendations may not be obvious, this is outlined in the relevant column. This table could be used as an input to a hazard identification and risk assessment process, but is not a comprehensive risk assessment on its own.

Table 5: Hazards in accessing working locations

Activity	Hazard	Recommended risk control	Basis of recommendations
All areas	Slippery surfaces/ contamination of footwear due to leakage of oils, bird fouling etc., leading to slip/fall	**Prevention:** – Design: ensure full containment of any potential spillages – Housekeeping: thorough cleaning of affected surfaces after any spillages/contamination	
Changeover from access/climbing PPE to working PPE	Potential for slip/fall (on same level) if changing in unsuitable location	**Prevention:** – Ensure suitable space is available and clear of other obstructions and tripping hazards	
	Error in refitting PPE	**Mitigation:** – Carry out 'buddy check' after refitting harness, prior to resuming WAH	
	Insufficient PPE worn	**Prevention:** – Define clear PPE requirements for locations and tasks	
	Damage to PPE (e.g. immersion suit seals) leading to latent defect	**Prevention:** – Take care when removing PPE – Provide designated storage location/receptacle **Mitigation:** – Carry out effective pre-use checks on PPE	
	PPE not available in the event of emergency escape being necessary	**Prevention:** – Ensure that necessary PPE (harness, immersion suit, PFD, PLB) is kept in vicinity of worker at all times, so that it is available without delay when needed	

Table 5: Hazards in accessing working locations (continued)

Activity	Hazard	Recommended risk control	Basis of recommendations
Access inside WTG tower – climbing ladder	Use of ladder – immediate hazard of fall from height	**Prevention:** – Minimise use of ladder by ensuring lift is available: – Commission lift at earliest opportunity after erection – Ensure periodic inspections and certification of lift are carried out as required to keep lift available for use **Mitigation:** – Anchor points and FAS to be inspected prior to WTG offshore assembly (to the extent possible), and any remaining items inspected immediately after assembly in order to enable safe use – Periodic inspection should take place thereafter	
	Use of ladder – exhaustion from multiple climbs, possible longer-term musculoskeletal disorders (MSDs)	**Prevention:** – Consider setting limit on daily /weekly climbing height – Ensure technicians have suitable fitness to minimise risk – Avoid combination of ladder climbing and other tasks that can increase risk of MSDs (e.g. prolonged kneeling) – Provide training in efficient climbing techniques	Precautionary approach, as there are insufficient data in the industry to quantify the problem. There is emerging evidence that efficient climbing technique reduces fatigue
	Fall from height while climbing	**Mitigation:** – Correct use of ladder FAS and compatible harness	

Table 5: Hazards in accessing working locations (continued)

Activity	Hazard	Recommended risk control	Basis of recommendations
Access inside WTG tower – climbing ladder (continued)	Starting to climb section of ladder and forgetting to attach to ladder FAS	**Prevention:** – Use lift whenever available – All personnel should stay alert and observe each other's actions – Provide appropriate safety signage – Training and competence of personnel	Hierarchy of controls: closed hatch/gate provides a safe working location (prevention), which is preferable to using energy-absorbing lanyard (mitigation)
	Slip while climbing ladder	**Mitigation:** – Keep ladder and walkways clean of oil spillages, bird fouling etc	Contaminated footwear increases risk of slipping, even when walking on a clean surface
Transfer between ladder and tower platforms	Fall from height	Design of transition should either: 1. Allow the climber to pass through hatch or gate, and close it, before detaching from FAS (**prevention** – preferred option), or 2. Provide an anchor point in a suitable location for an energy-absorbing lanyard to reduce the distance and consequences of a fall after detaching from ladder FAS (**mitigation**) – Anchor point should be above climber, but still accessible from ladder – Lanyard should be as short as possible, to minimise free fall distance – Lanyard should not pass over sharp edges between anchor point and climber Within a WTG, there should be consistent orientation of ladder to landing area (e.g. all ladders project through floor and have side access to platform – not mixed with some ladders having front access/egress between guardrails)	Hierarchy of controls: closed hatch/gate provides a safe working location (prevention), which is preferable to using energy-absorbing lanyard (mitigation) Location of anchor points determines the safety and practicality of using them Consistent orientation minimises the probability of human errors

Table 5: Hazards in accessing working locations (continued)

Activity	Hazard	Recommended risk control	Basis of recommendations
	Falling object	**Prevention:** – All removable parts of FAS should remain securely attached to harness throughout transition to platform – Hatches to be self-closing, or separated from platform by a guard rail and self-closing gate	
	Fall through open hatch	**Prevention:** – Hatches to be self-closing, or separated from platform by a guard rail and self-closing gate – Communicate with others present before opening hatch	
Climbing through hatch	Injury due to action of hatch	**Prevention:** – Ensure that hatches are as light as possible, consistent with strength requirements – Avoid sharp edges on hatches – Avoid creating trapping/crush points in locations where climbers may be expected to have their hands/fingers	
Standing on hatch	Fall from height due to failure of hatch/hinges	**Prevention:** – Hatches should be designed so that failure of a hinge does not allow the hatch to drop through the opening – Users should check condition, report any concerns – If concerns are raised, steps should be taken to prevent use of the hatch until it has been made safe	Hinges are the most likely failure location on a hatch, and critical structural elements such as hinge pins may not be visible to users

Table 5: Hazards in accessing working locations (continued)

Activity	Hazard	Recommended risk control	Basis of recommendations
Transfer from yaw deck to nacelle	Fall from height (nacelle ladder to yaw deck, or lower level if there are openings in the yaw deck)	**Prevention:** – Design ladder for good ergonomic access to minimise risk of slip/fall; provide FAS **Mitigation:** – Attach to FAS/anchor points when climbing between yaw deck and nacelle	
Access inside WTG tower – using lift (normal operation)	Fall from lift landing area	**Prevention:** – Lift access to be protected by gates, interlocked so that they can only be opened when lift is at landing – If the lift runs on the ladder, access should be provided through an alternative, self-closing gate, or through interlocked gate by means of an override – it should not be necessary to climb over guardrails	
	Lift stops and will not restart	**Prevention:** Lift design to enable controlled lowering without the need for power **Mitigation:** Lift design and integration into tower must provide safe means of escape to ladder in event of mechanical blockage of lift. Key requirements are: – Anchor point in suitable location in lift – Lift location to be sufficiently close to ladder to enable safe step-over, while maintaining continuous attachment – Energy-absorbing lanyard length must be sufficient to enable escape from lift to ladder	

Table 5: Hazards in accessing working locations (continued)

Activity	Hazard	Recommended risk control	Basis of recommendations
Access inside WTG tower – using lift (normal operation) (continued)	Injury to personnel on a platform due to contact with moving lift	**Prevention:** – Guard landings to prevent contact between persons on landing, and the lift. However, this may not be practical (due to need for access to lift area for evacuation/escape/climbing ladder), in which case the full area of the base and top of the lift should be interlocked to stop it if it makes contact with any obstruction	Essential Health and Safety Requirements of Machinery Directive
	Lift falls due to suspension wire failure	**Prevention:** – Design to include back-up system (e.g. second wire and reliable (preferably fail-safe) overspeed protection system); – Effective inspections required – lift design should enable thorough visual inspection of suspension wires to be done safely from inside the lift, and also enable physical access for measurement of wear; – Manufacturer to specify inspection criteria, and design life (hours/number of times used) of critical components	
Working in nacelle	Fall from height through openings created by work being carried out (e.g. during major component exchange, or use of service crane)	**Prevention:** Task risk assessment should consider if openings are created; if so, either: – Establish exclusion zone in area with unprotected edge, or – Provide temporary edge protection, or – Work in restraint when in area with unprotected edge	

Table 5: Hazards in accessing working locations (continued)

Activity	Hazard	Recommended risk control	Basis of recommendations
Access to hub/spinner	Fall from height when using external access route	**Prevention:** – Design: new WTGs to have access route that provides safe internal access to hub **Mitigation:** – Procedure: On existing WTGs where external access is required: follow procedure: use restraint/fall arrest PPE if accessing exterior of hub	
Working in hub/spinner (normal maintenance tasks)	Fall from height within hub (e.g. into blade)	**Prevention:** – Design of working locations should not expose people to risk of falling to a lower level **Mitigation:** – Attach to anchor points if a fall hazard exists – Ensure blade hatches are securely closed	
Working in hub/ spinner (during blade installation or exchange)	Fall from height through hole that blade normally fills	**Prevention:** – Hub/spinner design should enable personnel access for blade insertion/fastening without being at risk of falling from hub/spinner **Mitigation:** – Attach to anchor points where a fall hazard exists – High level of supervision required for high risk task	

Table 5: Hazards in accessing working locations (continued)

Activity	Hazard	Recommended risk control	Basis of recommendations

Work on top of nacelle	Fall from height over edge of nacelle	**Prevention:**
		Identify how work on top of nacelle can be avoided – specify high-reliability equipment, consider mounting arrangements – can access be provided from inside nacelle?
		– Minimise work near edges of nacelle
		– Provide high anchor points at any locations where people have to stand
		– Helihoist platform can eliminate the need to work on unprotected roof area
		– Position anchor points/rails to prevent falls (work in restraint) and minimise the need to transfer between isolated anchor points
		– Condition of surfaces to be accessed:
		  – non-slip finish
		  – free from ice
		– Ensure that footwear is in good condition and free from oil/grease contamination;
		– Work within weather limits – e.g. wind speed, absence of lightning
		– Ensure that a valid inspection method is available for the anchor points
		Mitigation:
		Provision for rescue – method must be compatible with PPE	

Table 5: Hazards in accessing working locations (continued)

Activity	Hazard	Recommended risk control	Basis of recommendations
Access beneath sealed hatch to foundations	Oxygen depletion or other hazardous atmosphere	**Prevention:** Restrict access e.g. lock hatch and provide clear 'access prohibited' signs **Mitigation:** Procedures to be implemented for any access, potentially including atmospheric monitoring, ventilation, use of respiratory protective equipment	
	Fall from platform inside TP	**Prevention:** Ensure that platform design includes provision of suitable guardrails	
	Fall due to condition of access ladder/platform/ guardrails – potential for high corrosion rates if in contact with salt water	**Prevention:** Remain attached to designated anchor point above foundation area until condition of structures is verified (also likely to be required as part of safe working in confined space)	
	Complex rescue	**Mitigation:** Detailed rescue plan, considering the height through which a casualty may have to be raised, atmospheric hazards, work equipment requirements, competence requirements and number of people required to undertake a rescue	

Table 5: Hazards in accessing working locations (continued)

Activity	Hazard	Recommended risk control	Basis of recommendations
Work on meteorological mast	Initial access is by climbing external ladder; some tasks may require work positioning or rope access techniques	**Mitigation:** Design: – Provide FAS on ladder; – Provide suitable platforms at levels where work is to be carried out – Provide structural anchor points where necessary (e.g. in locations where structural members are either too large for the use of scaffold hooks, or too slender to have sufficient strength to arrest a fall without damage) Training: – Additional or alternative training (compared to standard WTG WAH training) may be necessary, to take account of different rescue methods, and any additional hazards such as radio frequency (RF) radiation Rescue: – Ensure that a suitable rescue plan is implemented, and that the necessary personnel and equipment are present	
Rope access work	Fall from height	**Prevention:** – Rope access work to be planned, supervised and undertaken by competent specialists – Apply principle of 'double protection' to eliminate risk from single point failures – WTG rotor and yaw to be locked as required	
Work inside blades	Fall from height	**Prevention:** – Ensure blade is locked in horizontal position for internal access – Ensure blade integrity is sufficient for safe access	

Table 5: Hazards in accessing working locations (continued)

Activity	Hazard	Recommended risk control	Basis of recommendations
Work between underside of external platform, and surface of sea	Fall from height into sea	**Prevention:** – Design to provide for needs of future rope access work – Rope access work to be planned, supervised and undertaken by competent specialists – Apply principle of 'double protection' to eliminate risk from single point failures **Mitigation:** – Wear PPE to protect against drowning (PFD, immersion suit, PLB etc) – Vessel to be on standby to retrieve any personnel who fall into sea	
WAH on transition piece platform prior to installation of tower	Fall from TP external platform into open top of TP – additional hazard if top internal platform of TP has openings	**Prevention:** Design to consider relative heights of internal and external TP platforms Procedure: – Eliminate fall hazard by keeping openings covered – only remove covers immediately before WTG tower is lifted into position; – Work in restraint if covers are removed and a fall hazard exists	

4.7.3 Use of rope access

Key principle:

Rope access is a work positioning technique, which allows specialised technicians to work in difficult locations at height for which there is no permanent or temporary platform or ladder access.

The fundamental working principle is that any technician working suspended from a rope access system will always be attached to at least two, independently anchored ropes, one of which is taking the technician's weight (the working rope), and the other is a back-up (the 'safety-rope'), that will prevent a hazardous fall if the working rope fails.

The safety of rope access work is highly dependent on the competence of the personnel involved in planning, undertaking and supervising the work.

Rope access is a work positioning technique, used for gaining access to difficult locations at height. It is defined in ISO 22846 *Personal equipment for protection against falls – Rope access systems* as a:

> '*technique using ropes, normally incorporating two separately secured systems, one as a means of getting access and the other as back-up security, used with a harness in combination with other devices, for getting to and from the place of work and for work positioning*'.

The standard also defines the two ropes as the:

– Working line, which is 'used primarily for suspension, work positioning or restraint for both descending and ascending'.
– Safety line (also known as the 'back-up rope' or 'back-up line'), 'provided as a safeguard to protect against a fall if the user slips or the primary support (e.g. the working line), anchor or positioning mechanism fails'.

ISO 22846-1 defines fundamental principles for a system of work, while ISO 22846-2 defines a code of practice, considering aspects such as:

– management and planning;
– competence of individuals and work teams;
– equipment selection, use and maintenance, and
– organisation and execution of work.

The industry has an excellent safety record, and clear standards are set by its trade associations, including:

– Industrial Rope Access Trade Association (IRATA International), based in the UK but with member companies worldwide;
– Society of Professional Rope Access Technicians (SPRAT), USA;
– Fach- und Interessenverband für seilunterstützte Arbeitstechniken (FISAT), Germany, and
– Samarbeidsorganet For Tilkomstteknikk (SOFT), Norway.

Each of these associations publishes codes of practice (with ISO 22846 as a baseline), and sets competence standards for technicians (of various different levels) and supervisors. ISO 22846

states that rope access personnel should be assessed against the '*competence levels set by the peak body administering rope access in the jurisdiction where the rope access work is to be carried out*', and that the assessment is undertaken by assessors who are independent of the candidate, their employer and the training organisation. Despite the common baseline, there are differences between the associations' training syllabi, and the hours of experience that have to be achieved to reach a particular level, therefore a technician qualified under one association's system may have to complete a conversion course in order to be recognised under another system. The associations also differ in aspects such as auditing of member companies and requirements for incident reporting.

In addition to the standards, it is important that technicians and supervisors appreciate the differences that offshore work brings, compared to more conventional situations.

While many tasks undertaken by WTG technicians involve WAH in order to gain access to the place of work, in rope access, the work is undertaken while working at height, supported by the rope access system. Undertaking the rope access work will therefore be a core competence of rope access technicians, in addition to their competence in the task that they will be undertaking, such as inspection and/or repair of blades and structures.

The fundamental principles of safe rope access are described in ISO 22846 and association codes of practice such as the IRATA International Code of Practice (ICOP). In addition to always working from at least two, independently anchored ropes, other general principles of rope access include:

- Planning and management of work:
  - Work should be planned and managed by a person whose competence has been demonstrated through obtaining a rope access qualification of the appropriate level, such as a rope access supervisor.
  - The risks involved in a work package must be assessed.
  - All practicable measures should be taken to avoid injury due to impact with structures; this may include routing the suspension ropes away from edges that could cause damage.
- Undertaking and supervising work:
  - Employers should ensure that technicians have suitable physical capability and health to undertake the work.
  - Technicians must have appropriate training and competence for the task and any potential rescues; the different grades of technicians' qualifications determine the levels of complexity of tasks and rescues for which they are competent.
  - Work should be carried out under appropriate supervision, taking account of the place of work and level of risk; rope access supervisors should therefore be competent in:
    - rope access techniques;
    - organising and/or carrying out rescues, and
    - safe management of the work site;
- Provision and use of equipment:
  - Back-up devices must always be used, and be capable of safely arresting a fall, without catastrophic damage to the device or the safety rope; this is achieved through a combination of the design and operation of the back-up device – keeping it as high as possible on the safety rope, to minimise the fall factor (ratio of fall length to rope length).
  - Descender devices should fail to safe, i.e. they lock onto the rope if the user either lets go, or squeezes too hard.

  - Equipment should be subject to pre-use inspection and periodic thorough examination.
  - Technicians should be competent to determine when equipment should be withdrawn from use.
  - Equipment should be procured with full traceability to the manufacturer, and properly stored and maintained.
  - Other PPE should be used, as appropriate to the location and task:
    - if working in the splash zone, then immersion suits and PFDs will generally be required.
- Methods of work:
  - Technicians should connect to the rope access systems in a location where there is no risk of a fall from height, or use other means of protection.
  - Technicians should always be connected, through their harness, to both the working and safety ropes, even if using a work seat.
  - The ropes should be set up to avoid inadvertent descent off the bottom of the rope, such as by tying a stopper knot in each rope.
  - The minimum size of a rope access team is two technicians, one of whom should be a competent supervisor.
  - An effective communication system must be in place; if necessary, equipment such as radios may be used (and should, of course, be prevented from being dropped).
- Emergencies:
  - A rescue plan, specific to the intended work, should always be in place. Rescues should be practised periodically, based on an assessment of the risks that work presents;
  - While technicians are trained in how to recover themselves, in some situations they may have to rescue each other, or be assisted by an on-site rescue team. Planning for rescues should be assessed prior to contract award;
    - Until rope access technicians have set up their rope system on a WTG, their means of evacuation/rescue from the nacelle would be the same as for wind turbine technicians, therefore rope access technicians may also need to be competent in the use of typical WTG evacuation equipment. This is not covered in standard rope access training syllabi.
  - As rescues generally involve descent, then if working over water, the rescue may involve retrieval from the sea:
    - planning should ensure that a vessel is standing by if required for a rescue, and that technicians have suitable PPE.
- Protection of others:
  - suitable exclusion zones should be established, and
  - in some locations, it may be necessary to have a look-out to protect against ropes being damaged.

Employers can also define their own training and competence standards for rope access, potentially focusing on a limited range of tasks and access arrangements; however, this would not conform to ISO 22846 (as it would not be subject to a rope access association).

4.7.3.1 Application

Rope access is typically used if work has to be carried out in locations where it is not practical to use permanent or temporary fixed access solutions, such as:

- external inspection and maintenance of blades or tower sections;
- work on foundation structures, below the level of the lowest platform, or
- repair/replacement of ladder sections.

4.8 RESCUE AND EVACUATION FROM WORKING LOCATIONS

This section covers the rescue of a casualty, who may be conscious or unconscious, from any working location on an offshore structure, to the vessel or helihoist platform. It also considers provision for evacuation, such as in the event of a fire.

The terms rescue and evacuation are defined as:

- rescue: the recovery of a casualty by another person, either remotely or directly, in some cases with multiple phases:
  - the initial stage of rescue brings the casualty from being in immediate danger (such as being suspended after a fall) to a safe location where their condition can be stabilised; followed by
  - rescue to a means of transport (vessel or helicopter) and thereafter to a safe location where all necessary treatment can be given;
- evacuation: carried out by a stranded user to escape a remote/hazardous situation, may also be termed 'escape'.

Key principle:

It is essential that, should a person become injured or incapacitated in any location on an offshore structure, they can be rescued to a place of safety without undue delay; no persons should ever be in a location from which this cannot be achieved.

Effective preparation for rescue involves ensuring that structures are designed, work is planned, and suitable equipment and training are provided, to accommodate potential rescue scenarios.

Preferred approaches:

If a casualty is unable to self-evacuate, the preferred order of approaches for achieving a safe and rapid rescue is:

- Lowering a remote casualty.
- Raising a remote casualty (less preferred as this is likely to take more time and effort than lowering).
- Rescuing a casualty by descent (less preferred as it requires the rescuer to leave a safe location and descend with the casualty.)

4.8.1 Providing suitable rescue and evacuation equipment

Key principle:

Rescue kits must be suitable for use in their intended location, taking account of the:

- *types of rescue that may be necessary;*
- *locations from which people may need to be rescued;*
- *heights through which a casualty may be raised or lowered;*
- *number of people who may need to evacuate using the kit(s);*
- *types of anchor system to which the kit may need to be attached;*
- *ability to set the kit up while remaining in a safe location;*
- *time available for evacuation;*
- *location where people may land, and*
- *range of PPE that may be in use.*

4.8.1.1 Specifying suitable rescue kits

As a minimum, a rescue kit should consist of:

- a suitable length of rope for the location:
  - the height of the structure determines the length of rope that will be needed, although sufficient allowance must be made for deviations, use of pulley systems etc., which can increase the length that is needed;
    - however, excessive length can increase the time taken between descents, if it becomes necessary to pull excess length through, and/or tie knots in the rope to provide loops for attachment;
- means of attaching the kit to the structure:
  - the potential to establish anchor systems on the structure should be assessed. While designated anchor points are suitable for connection of standard karabiners, if anchor systems are to be attached to locations such as structural beams and lifting eyes on major components, slings and additional connectors may be necessary – however, the system should still be sufficiently simple to enable quick and reliable set-up;
  - the descender should be capable of easy and secure attachment to the structure above the emergency evacuation location, without having to use textile slings, as these could be weakened by high temperatures in the event of a fire;
- means of attaching the rope to the casualty, taking account of the PPE being used; for example:
  - the sewn fabric attachment points on some types of harness tend to flatten when under load, making it impossible to insert a second karabiner to rescue a suspended casualty;
  - if the rescue kit relies on attaching to the casualty, and then cutting their lanyard/rope, then this would not work if the casualty were suspended on an all-metal system;
  - if the rescue plan is based on the expectation that the rescue system will be attached to a dorsal D-ring attachment point on the casualty's harness, then any personnel on site whose harnesses did not have this attachment point, could not be rescued in the expected manner;
  - some rescue kits use 'rope grabs' to engage with energy absorbing lanyards, but these may not work on some types of lanyard, in which case it would be necessary to engage with a connector, requiring different rescue equipment;
  - when some types of energy-absorbing lanyard are deployed, they expose 'rescue loops', which are intended to be used to connect the casualty to the rescue system. However, these are not present on all lanyards, and are not visible until deployed, therefore if the rescue plan is relying on using such loops, there must be control of the types of lanyard being used at a location;
  - if there are any locations in which technicians are permitted not to wear harnesses, then the rescue kit will require a rescue harness that can be fitted to an incapacitated casualty;
  - for evacuation, it is important that the arrangements for attachment to the harness are compatible with the PFD:
    - it must be possible to attach to/detach from the rope while wearing the PFD – this can be difficult after a PFD has inflated, especially if two people have descended together, and if the action of waves or currents creates a slight tension on the connection;

- a device for controlled raising/lowering of the casualty, known as a descender;
  - if there is a requirement to lift the casualty (e.g. over a handrail or other obstructions) to allow them to be lowered, then it will be essential that the descender can also be used to raise a casualty;
  - while most descenders are suitable for raising casualties through short distances, rescue from locations such as basements and foundations may require the use of a dedicated rescue winch;
  - the number of descenders should be sufficient to allow all personnel who may be in a location to complete evacuation safely within the time available under foreseeable fire scenarios; the descent energy rating of the descender should be checked, and
  - the minimum ambient operating temperature of the descender should also be checked, to ensure that it is suitable for foreseeable conditions under which people would be working at the project location, as performance cannot be guaranteed if used outside design limits.

Specific working locations may need additional rescue equipment, such as stretchers that are suitably designed and rated for raising or lowering a suspended casualty.

4.8.1.2 Descent energy rating

Descenders control the rate of descent by limiting the speed of the rope, and in doing so, are subject to frictional heating. Any given descender has a limit on the descent energy that it can absorb prior to needing servicing; this limit determines its descent energy class. The descent energy is the product of the weight of the people on each descent, the height of descent and the number of descents. EN 341 defines four descent energy classes, of which Class A is the highest rating, while Class D devices are only suitable for a single descent.

The information supplied by the manufacturer must include the maximum rated load, minimum rated load and maximum descent height of the descender device. It should be noted that these figures may be mutually exclusive, i.e. the maximum rated load may not necessarily be achieved over the maximum descent height.

4.8.1.3 Location of rescue kits

Rescue and evacuation equipment tends to be supplied as complete kits that are either permanently located in the work area or taken to site by the work team. These kits are stored in a sealed bag or other container. It is important to ensure that the kits permanently located on site are capable of accommodating the types of rescue that may be carried out. Sufficient kits should be provided for the number of people present in a location, taking account of the time required to escape and the time available for people to complete their escape; if additional people are to be present in a location (such as when carrying out major component exchange), it may be necessary to provide additional temporary rescue kits.

Rescue equipment should always be in a location that allows it to be used promptly, to minimise harm to a casualty. For example, it is important that a suspended casualty can be rescued as quickly as possible to an initial place of safety (such as the next platform beneath them), even if additional equipment will then be needed for subsequent stages of rescue to a vessel or the helihoist platform.

4.8.1.4 Personal evacuation kits

Personal evacuation kits generally consist of a descender, which is attached to the user's harness, and which runs down a rope that has been secured to a suitable anchor. This

contrasts with most evacuation systems, in which the descender is anchored, and the rope runs through it. Additional care needs to be taken if it is proposed to use a personal evacuation kit:

– if the rope is anchored in a location at elevated temperature, such as may occur in the event of a fire, it will have a longer duration of exposure to heat than if the descender is anchored in the same location, and the rope runs through it. Ropes with enhanced heat resistance, made from materials such as aramid fibres, can mitigate this issue. The requirements set out for descenders in EN 341 do not specify that descenders should be suitable for use in elevated temperatures; manufacturers have to state a minimum temperature for use, but no maximum, or
– if the anchored rope comes into contact with an edge (which is not good practice, but is a foreseeable occurrence, especially in a hastily-rigged evacuation situation), then any abrasion will be concentrated on the section of rope that is rubbing on the edge, which gives a higher probability of rope damage than if a moving rope is passing over the edge. The ropes in personal evacuation kits are generally much thinner than in conventional systems, which may further increase their vulnerability to abrasion. This risk can be mitigated by suitable placement of anchors for evacuation, and careful routing/protection of ropes when preparing to evacuate.

4.8.2 Safe rescue methods

The rescue method should be capable of being set up and used in the work location without putting the operator at risk, for example by avoiding the need to lean over handrails to operate a descender device.

In all normal WAH situations, back-up systems are used; for example, work positioning requires the use of a back-up system – a work positioning lanyard would be backed up with an energy-absorbing lanyard. Rescues are the only time that a person will deliberately be supported by a single rope with no back-up, so it is vital that the equipment is in good condition, correctly assembled and operated. During training, however, it is essential that the casualty (and, on occasion, the rescuer) has a back-up system.

4.8.3 Maintenance and inspection of a rescue system

In addition to periodic thorough examination, a rescue kit should be checked:

– On delivery to/installation on the site: the contents should be verified as being correct; in the case of a sealed kit, this may be limited to checking the documentation/ contents list.
– Prior to starting work: the location of the kit should be checked, to ensure that it is present and sealed; if not sealed, a visual and tactile pre-use inspection should be carried out to ensure that the equipment is in good condition – in an emergency, there might not be time to do this.

During the pre-use check, should a piece of rescue equipment be found to be damaged or malfunctioning then it should be replaced before allowing the work to continue; having spare kits available in-field can ensure that work can proceed safely. An operational restriction should be put in place if the kit has to be removed from its normal location.

4.8.4 Training for rescue

Training must be provided for employees who will carry out a rescue if needed. Given the different variations of rescue kits that are available, employee training should take account of the potential rescue situations that may arise, and the equipment that will be used on site. This training must also be carried out by a competent person.

Formal refresher training must also be undertaken to ensure that the employee's knowledge of the rescue equipment and techniques remains current. Further, where possible there should also be a level of local refresher training; for example, during bad weather days, drills using the equipment could be carried out by the workforce.

4.8.5 First aid

Personnel should possess an appropriate level of first aid training for the task being carried out, and the location of the workplace. The number of employees on site who will be trained in first aid, and their level of training, should be based on an assessment of the work area, the tasks being undertaken and the potential injuries that may be sustained. Given the isolated nature of offshore WTGs, and the need to ensure that first aid can be provided, without delay, to any injured person, this will generally mean that every work party should include at least two first aiders.

Basic emergency first aid covers the initial care of a casualty who may be:

- unconscious and or in seizure;
- suffering from internal or external bleeding;
- in shock;
- choking; or
- have sustained a fracture or spinal injury.

For WAH, additional training may be required for a first aider to:

- fit a neck collar, and/or
- move the casualty onto a spinal board and stretcher, and prepare for the next stage of the rescue.

Decisions about the number of first aiders, their level of training, additional medical support and provision of first aid/medical facilities and equipment should be based on a thorough assessment of first aid requirements, and integrated with the site emergency response arrangements, which will determine how long it may take for further help to arrive. The GWO BST First Aid module provides a common baseline level of training, but further training may be needed, depending on the outcome of the assessment.

4.8.6 Planning rescues

A rescue plan must be in place prior to any work at height being carried out. The plan must be specific to the works and included in the safe system of work for each location. Typical components of a rescue plan include:

- details and the location of the rescue equipment that is in place;
- limitations of the rescue system, such as:
  - configuration of the system;

  - maximum weight;
  - weather restrictions such as high winds, and
  - requirements for additional resources, such as extra personnel or equipment, to be brought to the structure;
- identification of the anchor systems to be used to attach to the structure;
- rescue paths on/in the structure, and
- communications arrangements, within the site and with external support.

A rescue plan also needs to take account of the range of potential injuries and medical conditions that may affect a casualty.

A casualty in an offshore WTG may either have to be lowered to the external platform, and from there to a vessel, or raised to the helihoist platform for evacuation by helicopter. Rescue routes may either be inside or outside the tower:

- External rescue routes should be as close as possible to the tower, to minimise the effect of wind, which could otherwise cause a stretcher-borne casualty to spin.
- Internal rescue routes allow greater monitoring of the casualty's condition, although no real opportunity for intervention between platform levels.

Internal lowering is only a viable option if the design of tower platforms allows an inclined stretcher to be lowered through the openings in intermediate platforms.

Alternatively, if the casualty is to be evacuated by helicopter, then a suitable route and lifting equipment will be necessary in order to bring the casualty to the helihoist platform for winching and evacuation by a suitable helicopter.

Offshore meteorological (met) masts have different rescue requirements to WTGs; for example, platforms within the mast may prevent internal lowering, and helicopters may not be able to access met mast platforms, due to the obstructions presented by the booms of the mast. For these reasons, working parties on met masts must be competent in the specific rescue techniques that may be required.

New rescue plans should be tested, to ensure that the arrangements work as expected, and full briefing on the plans should be provided to all who may be involved. The weather limits for external rescue methods should be established, as these will determine the working limits for the relevant locations on a structure. Periodic drills should be carried out, to maintain familiarity with the methods and support reviews of the plans.

4.8.7 Supervisory/working arrangements

4.8.7.1 Employers' responsibilities

Employers need to ensure they have sufficient competence within their organisation to:

- Assess the competence of all contractors being used.
  - This assessment should be based on a review of the contractors' competence training, safety performance and culture.
- Review safety documentation to ensure that all work at height is properly planned and that these plans include suitable preparation for emergency situations and rescues.

If an **employer** recognises that it does not have the necessary competence to fulfil these responsibilities, then external competent advisers should be consulted, particularly for specialised areas of WAH, such as the planning of rescues.

4.8.7.2 Roles of contractors

- ensure the supervisor on site has the competence to carry out their duties;
- assess the risks related to WAH, in order to minimise the requirement for rescue;
- provide suitable rescue equipment for the workforce;
- include rescue in the planning of all works;
- include rescue equipment in the project's equipment maintenance schedule, and
- ensure that the workforce has been trained in the rescue systems that are in place.

4.8.7.3 Roles of supervisors

- Ensure that the correct rescue kits are in place, taking account of the tasks that are to be carried out, and their locations.
- Coordinate any rescue on site if required, including liaison with additional support from other parts of the site, or external resources.

4.8.8 Hazards during specific activities

Table 6 identifies some of the principal hazards, relating to WAH that may be present during typical rescue activities, and recommends measures that can be taken to reduce the associated risks. In cases where the basis for the recommendations may not be obvious, this is outlined in the relevant column. This table could be used as an input to a hazard identification and risk assessment process, but is not a comprehensive risk assessment on its own.

Table 6: Hazards in rescue activities

Stage	Hazard	Recommended risk control	Basis of recommendations
Identify that a rescue is required to be carried out on site	Delay in recognition that a rescue is needed, leading to casualty's condition deteriorating	**Prevention:** – Ensure that personnel working at height are within sight of each other – teams should avoid getting too spread out	
Initiating rescue	Inadequate assessment of situation and hazards, or unfamiliarity with rescue plan, leading to: – Delays in rescuing the casualty – Additional injury being sustained by casualty, or – Rescue team being endangered during rescue – Delays in receiving additional help	**Prevention:** – Maintain familiarity with rescue plans – both technicians and support functions must be ready to respond correctly – Ensure effective communications systems are always available – Train and coach personnel in rescue techniques and wider hazard identification skills	

Table 6: Hazards in rescue activities (continued)

Stage	Hazard	Recommended risk control	Basis of recommendations
Initiating rescue (continued)	Rescue equipment not available/not suitable/ not functional, leading to delay in rescue	**Prevention:** – Ensure that rescue equipment is regularly inspected – Check rescue equipment is available at start of work – Carry out periodic drills using actual rescue kit and PPE as used on site – check for any compatibility problems	
Carrying out rescue	Errors made in operation of rescue kit, leading to harm to the casualty or rescue team	**Prevention:** – Ensure that all personnel have thorough training, suitable site equipment familiarisation and regular refresher training/drills – Ensure that training is appropriate to the locations where people are working – meteorological masts may require different techniques to WTGs, hubs may need different techniques to nacelles	
	Unsuitable weather conditions for rescue, leading to harm to the casualty or rescue team	**Prevention:** – Ensure that work only takes place in conditions under which a rescue could be carried out safely – Assess the weather-tolerance of rescue techniques by carrying out practices (using weighted dummy – not real people) in realistic conditions and from actual working heights	
After initial stage of rescue	Miscommunication delaying evacuation	**Prevention:** – Rescue plan should include emergency contact information	

Table 6: Hazards in rescue activities (continued)

Stage	Hazard	Recommended risk control	Basis of recommendations
After initial stage of rescue (continued)	Incorrect treatment of casualty (e.g. failure to recognise and treat suspension intolerance)	**Prevention:** – First aid training of personnel must be sufficient to identify and treat foreseeable injuries that could be sustained on site – First aiders may also benefit from being able to access medical advice by radio	

4.9 TEMPORARY ACCESS PLATFORMS

Key principle:

If access is required to locations that do not have permanent access platforms, then in some situations the most appropriate means of access may be a temporary access platform. It is important to select a suitable type, taking into account the task and location, and the complexities of offshore working, and then make sure that is erected by competent personnel and subject to an appropriate scope and frequency of inspections.

Several types of temporary access platform are available, including:

– Scaffolding, for which the most suitable type for a given task and location should be selected.
– Custom-designed fabricated access platforms, which may be necessary to reach specific locations. Their design should generally match standards for permanent platforms, with any restrictions on their use, such as limits on occupancy or loading, being clearly indicated.
– Standard access platforms or step-ups, which should be carefully selected for their proposed use.

The rest of this section focuses on scaffolding.

4.9.1 Common requirements for scaffolding

Several different types of scaffolding are available, although there are some common requirements that apply to all types, summarised in Table 7.

Table 7: Common requirements for scaffolding

Aspect	Common requirements
Edge protection	Edges should be protected by (as a minimum) top and intermediate guardrails and a toe board of a height suitable to prevent people or materials from falling, typically at least 100 mm. The heights of the guardrails are defined in national regulations
Competence	Scaffolding should only be selected, designed, erected, modified, inspected and dismantled by competent personnel This is of critical importance with respect to maximising the use of collective protection during erection and dismantling, as the sequence of working will determine whether the part-complete scaffold provides collective protection, or if scaffolders are reliant on PPE to mitigate the risk of falling
Inspections	To ensure continued stability and structural integrity is maintained it is strongly recommended that stagings and temporary platforms be inspected by a competent person at the following frequencies: – Upon completion of construction and before first use – At regular scheduled intervals after the date of construction – After all authorised changes and before first use – In the event of an incident that may cause the stability of the structure to be suspect, such as – after periods of adverse weather – if struck by some form of transportation vehicle or suspended load – if there is suspicion of unauthorised changes to the structure
Records of inspection	A record of inspection must be displayed on the staging as being either safe for use, or not to be used Records should be retained on site for as long as the staging is being used Records should be retained on site for three months after the staging has been dismantled. Records are to be retained at the project owner's offices when the project is complete

4.9.2 Types of scaffold platform

Table 8: Types of scaffold platform

Platform type	Description	Features (advantages/disadvantages)	
Tube and fitting	A system of metal tubes of various lengths which are secured using friction clamps Working platforms are provided using timber scaffold boards The metal tubes and fittings may be manufactured from mild steel, stainless steel or aluminium. Tubes of the same outside diameter may have a range of different wall thicknesses	+	Friction clamps may be set at any position along the tubes, which makes the technique very adaptable and allows for scaffolds to be assembled in complex shapes or restricted spaces The friction clamps may be used to secure the staging to the structure without the requirement to install any form of permanent fixtures Load bearing capabilities of the staging may be increased by reducing bay lengths and/or adding additional support poles A staging may be constructed to provide a safe working platform suspended underneath a structure, when designed by a competent engineer Stainless or galvanised steel components provide some corrosion resistance, which is important for usage in the offshore environment
		–	System requires a large number of separate components, which include different types of friction clamps, some of which are not load bearing. The large number of loose parts increases the risk of dropped objects during erection and dismantling With the exception of the more basic standard stagings, all large or complex stagings must be designed by a competent engineer The spacing and strength of ties to the structure is important to the safety of the scaffold The placement of sheeting, netting or other materials is likely to increase wind loads on the structure, so should be considered during design Timber boards are prone to weathering and warping, and splinter if not maintained Corrosion can affect integrity and cause threaded components to seize if used for extended periods in exposed locations offshore Tools and equipment may be left inside any open tube ends and may fall out during changes or dismantling

Table 8: Types of scaffold platform (continued)

Platform type	Description	Features (advantages/disadvantages)	
System staging	A system of interconnecting metal poles with dedicated securable connection points set at fixed intervals along their length. A second set of fixed length metal bars are designed to fit into the connection points and lock in place Working platforms are provided using metal plates which are designed to connect onto the metal bars locking into place	+	The system is quick to assemble due to the fixed lengths of the poles The fixed lengths and standardised connections may be fitted at any location throughout the staging Significant reduction in the quantity of small loose fittings, which reduces dropped object risk
		–	Unsuitable for any form of suspended staging: components are designed to interlock but are only load bearing with respect to downward vertical loads The load limits are not adjustable as the staging bay length is fixed, which will fix the load bearing capacity The fixed lengths of the components may prevent use of a system if they do not fit in with the size or shape of the work area
Mobile access platforms	A system of pre-set manufactured sections designed to interconnect into a working platform of fixed dimensions The height of the working platform may be adjusted by installing a limited number of additional sections	+	The platform is quick to assemble, normally manufactured from lightweight materials such as aluminium. Some GRP systems are available, which avoid the corrosion issues that can affect metallic scaffolding Can be fitted with wheels to enable movement of the platform within rooms or compartments without being disassembled; however, people should not be on the platform during movement, and the wheels must be locked before use Access to the working platform is via an integral ladder which accesses the platform from within the structure, thus ensuring that climbing takes place within the structure May be dismantled and stored locally in relatively small spaces All of the required connection components are fixed to the staging sections so cannot be lost/dropped

Table 8: Types of scaffold platform (continued)

Platform type	Description	Features (advantages/disadvantages)	
		–	The ratio of height to base dimensions is typically restricted to 3:1, with respect to either the dimensions of the base, or the dimensions of additional supporting outriggers, if fitted May topple if not correctly constructed and supported Requires a flat level surface to ensure stability of the platform Load bearing capacity is fixed The fixed lengths of the components may prevent use of a mobile access platform if they do not fit in with the size or shape of the work area
Bamboo scaffolds (generally only used in certain Asian countries)	A system comprising two sizes of bamboo poles which are secured into a structure to provide a working platform together with nylon strips. In some cases the scaffold is secured to the structure using anchor bolts	+	Lightweight components which may be easily manually handled Components are sourced locally, at relatively low cost Easily adapted to suit the structure Quicker to assemble and dismantle compared to steel scaffolds Not susceptible to corrosion
		–	The bamboo is susceptible to weakening and damage from the wind and rain Requires highly trained, skilled and experienced operatives to install and maintain Bamboo has to grow and mature for at least three years before being harvested and processed into the required lengths. It is not manufactured to any recognised standard nor is it subjected to testing and/or certification

4.10 SAFE BEHAVIOUR FOR WAH

Key principle:

Incident data show that behavioural failures were the most common immediate cause of incidents involving WAH. However, it is important to understand the underlying causes of these failures, which include how design and safety culture can influence behaviour.

All parties involved in a project or workplace have responsibilities for influencing behaviour, and certain specific behaviours can encourage safe WAH.

4.10.1 Definition

Behavioural safety covers all non-technical aspects of safety, and determines how work will actually be undertaken, which may differ from how it might be expected to be undertaken according to the safety management system.

4.10.2 Introduction: importance and approach

Analysis of G9 and G+ incident data showed that behavioural failures were an immediate cause of around 60 % of the recorded incidents during WAH, rather than equipment or design issues. This is a common situation: the UK HSE notes that '*up to 80 % of accidents may be attributed, at least in part, to the actions or omissions of people*'[16]. However, this does not mean that the accidents are entirely caused by the individual involved; the same guidance goes on to state '*Many accidents are blamed on the actions or omissions of an individual who was directly involved in operational or maintenance work. This typical but short-sighted response ignores the fundamental failures which led to the accident. These are usually rooted deeper in the organisation's design, management and decision-making functions*.'

4.10.3 Contributory factors

The risk from behavioural errors is affected by the combination of three major groups of factors:

– The job or task, and its physical and mental match with the person carrying it out.
– The individual: their competence, attitude, skills, habits, risk perception and personality.
– The organisation, which influences group and individual behaviour, through its culture, leadership, resources, work patterns, communications and contractual arrangements.

It is not realistic to expect an individual technician or vessel crew member to change the culture of an organisation, whether that be their direct employer, or an **employer**, but rather, the organisation is likely to affect the behaviour of individuals.

The **employer** has a key role, as they:

– set the objectives, in terms of design standards, safety, cost and schedule;
– appoint the main contractor(s), and
– have a role in monitoring how the work is carried out.

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The exact legal duties will depend on the nature of the work, and which regulations apply. Further details on the responsibilities of **employers**, contractors/employers and individuals are given in the appendices.

4.10.3.1 Design considerations

Decisions made during the design phase will determine how effectively the highest levels of the hierarchy of protective measures are applied, and the residual risks that will rely on safe behaviour for mitigation. The design also affects the level of effort that will be needed in order to work safely, for example:

- if a competent worker has to undertake a task at height, and suitable anchor points are available, they are very likely to use them; however
- if no suitable anchor points are available, then the worker has to stop the job, which many workers will hesitate to do, unless there is a strong safety culture on the site;
  - this introduces the temptation for a worker to improvise or take a shortcut, potentially putting themselves or others at risk.

4.10.3.2 Life cycle phase effects

During the construction phase, the duration of a typical work package will often be too short for major changes in safety culture and behaviour to be achieved; however, there are various ways in which **employers** can influence the safety culture of a project, such as:

- establishing a strong project safety culture, and then selecting contractors whose own safety culture is compatible, or
- entering into long-term partnering arrangements with selected contractors, so that a safety culture can be developed and brought to a number of different projects over time.

Employment practices can also affect the development of a safety culture: if a high proportion of the workforce is on short-term contracts, or there is a high turnover of personnel, the potential for development of a shared culture will be reduced.

In the O&M phase, there are likely to be long-term relationships between **employers** and contractors, and a higher proportion of the workforce will be permanent (either employed by a contractor, or by the owner/operator), giving greater opportunity for safety culture development. Given that the O&M phase has the greatest reliance on small self-managed workgroups, the reliance on safe behaviour is at its greatest, but so is the potential for development of a strong safety culture. Various tools are available to support safety culture assessment and improvement.

4.10.4 Specific behaviours for safe WAH

All those involved with WAH, in any capacity, should seek to apply the hierarchy of protective measures, the first of which is to avoid WAH.

These principles should be applied to the design of equipment and workplaces, and the planning and execution of work. In order to ensure that these are effective, all personnel involved in organising, planning, supervising and undertaking WAH must be competent for their role, including both competence in the task and potential rescues, and the ability to identify, communicate and mitigate hazards.

In situations where it is necessary to work at height, the specific safety-related duties and behaviours of employers and employees are set out in Table 9 – note that, in this context, the term 'employer' refers to anyone who employs people, rather than the defined term **employer** in a contractual context.

Table 9: Employer and employee's duties in relation to safe WAH

Stage	Employer's duties	Employee's duties
Planning the work	– Hazard identification and risk assessment – Select fall protection system according to hierarchy of protective measures – Ensure that the work involved in installation, use and dismantling of an FAS does not expose people to greater risks than would be the case if it were not used – Ensure that work is properly planned and supervised, so that risks are minimised – Ensure that the plan is communicated effectively, e.g. through clear and accurate procedures and effective briefing/toolbox talks – Plan the response to potential emergencies and rescue, and ensure that arrangements are put in place for these situations – Selection of rescue methods should minimise risk to both the rescuer and the casualty – Establish effective communication systems within the team that is undertaking the task, and with other workgroups as necessary – Ensure that work is only carried out in suitable weather conditions – Ensure that work is assigned to people with suitable training and competence to carry it out safely – Consult with employees and/or their representatives	– Read and understand method statements – Participate in briefings/toolbox talks, and understand and apply their content – Be familiar with appropriate rescue and emergency procedures for the work being undertaken

Table 9: Employer and employee's duties in relation to safe WAH (continued)

Stage	Employer's duties	Employee's duties

Equipment selection	– Ensure that equipment is procured from reputable sources, with a verifiable supply chain back to the equipment manufacturer, in order to avoid counterfeit products
	– Ensure that any equipment designed, supplied or installed by others is fit for the purpose for which it will be used in the intended work, for example:
	  – Equipment has been installed in accordance with the manufacturer's instructions
	  – The strength of supporting structures has been shown to be sufficient
	  – Equipment conforms to relevant standards
	  – All components in a fall protection system have adequate static and dynamic strength and appropriate factors of safety
	  – The combination of components in a system is compatible
	– Select access and egress methods that are appropriate to the distance, duration and frequency of access
	– Ensure that work equipment (such as tools) can be used without risk of being dropped
		– Use equipment in accordance with manufacturer's instructions
		– Ensure that markings on equipment are legible, so that items can be identified correctly

Training	– Ensure that all personnel have the necessary competence for their roles, based on recognised industry standards (where available) or internal assessment where necessary
	  – Provide suitable refresher training to avoid 'skill fade' in infrequent tasks such as rescues
	– Provide relevant site-specific inductions and training;
	  – Ensure that trainers are competent
		– Work in accordance with training and additional information provided
		– Understand and work within personal limits of competence and the remit of the training received

Table 9: Employer and employee's duties in relation to safe work at height (continued)

Stage	Employer's duties	Employee's duties
Use of equipment	– Provide instructions and training for correct use of equipment – Ensure that anchor systems are unquestionably reliable in terms of strength and stability – Ensure that anchor locations minimise the distance and consequence of falls, including the potential for a swinging fall – Ensure that exclusion zones are established or other protection provided against falling objects as necessary	– PPE should be worn and used correctly, according to the work situation and conditions – Connect to fall protection systems while in a safe location, where there is no risk of a fall from height. – Ensure that tools, work equipment and activities do not endanger safety of WAH – e.g. beware of cutting tools, sparks from grinding, or chemicals, damaging personal fall protection equipment – Ensure that personal fall protection systems are not exposed to rough or sharp edges, as these can damage ropes and lanyards – Ensure that work equipment is secured at all times to prevent it from falling – Establish and comply with exclusion zones – Check that there is sufficient clearance to enable a fall to be arrested before contact is made with obstructions – Remain alert to unexpected hazards or deviations from the intended plan

Inspection and maintenance	– Ensure that equipment is subject to pre-use checks and periodic inspections by a competent person
	  – ensure that defective equipment is withdrawn
	  – keep appropriate records of inspection, and ensure that they are available
	– Operate an effective quarantine system for defective or suspect equipment
	– Ensure that equipment is stored properly
	– Ensure that equipment is maintained in a safe state
	– Comply with manufacturer's advice on obsolescence
		– Carry out pre-use checks, and put suspect equipment into quarantine – do not attempt to repair

Table 9: Employer and employee's duties in relation to safe WAH (continued)

Stage	Employer's duties	Employee's duties

Supervision and reporting	– Ensure that safety is given the highest priority when work is being undertaken: encourage employees to stop if they have any doubts about the safety of a situation or action, and support the review of their concerns
	– Ensure that there is effective supervision
	  – Additional supervision may be necessary for inexperienced workers, or when high risk tasks are taking place
	  – Do not condone unsafe acts or behaviour – always intervene when such situations are observed
	– Encourage the reporting of hazardous observations, near hits etc.
	  – Ensure that lessons are learned and implemented effectively
	– Ensure that incidents and accidents are investigated thoroughly
	  – Ensure that both immediate and underlying causes are identified and addressed.
		– Stop if unsure about the safety of an action or situation, and review before proceeding further
		– Report hazardous observations, incidents, accidents etc.
		– Do not ignore unsafe acts or behaviour – always intervene when such situations are observed

5 FLOWCHARTS: PREPARATION/REVIEW OF OPERATIONAL PROCEDURES

This section outlines a process that can be used to support the development of 'operational procedures' or 'work instructions' for offshore tasks involving WAH. These documents define both the technical and safety management steps to take in the execution of a task, and would form part of a safe system of work, supported by the risk assessment and method statement for the programme of works as a whole.

Four stages are outlined:

– preparation: defining the task, determining if a procedure is appropriate, and how it should be prepared;
– writing the procedure;
– implementing the procedure, including training of relevant personnel, and
– reviewing the procedure.

Before relying on procedures to control a risk, it is important to apply the hierarchy of protective measures for WAH, to determine whether a procedural control is appropriate. Procedures are susceptible to a range of human factors, and the quality of procedures and documentation is important to minimising errors and violations.[17]

5.1 PREPARATORY STEPS

This stage considers the purpose of the procedure, initial risk assessment, and deciding how the procedure should be prepared, including deciding who should be involved in its preparation.

17 Useful guidance is available at http://www.hse.gov.uk/humanfactors/topics/procedures.htm.

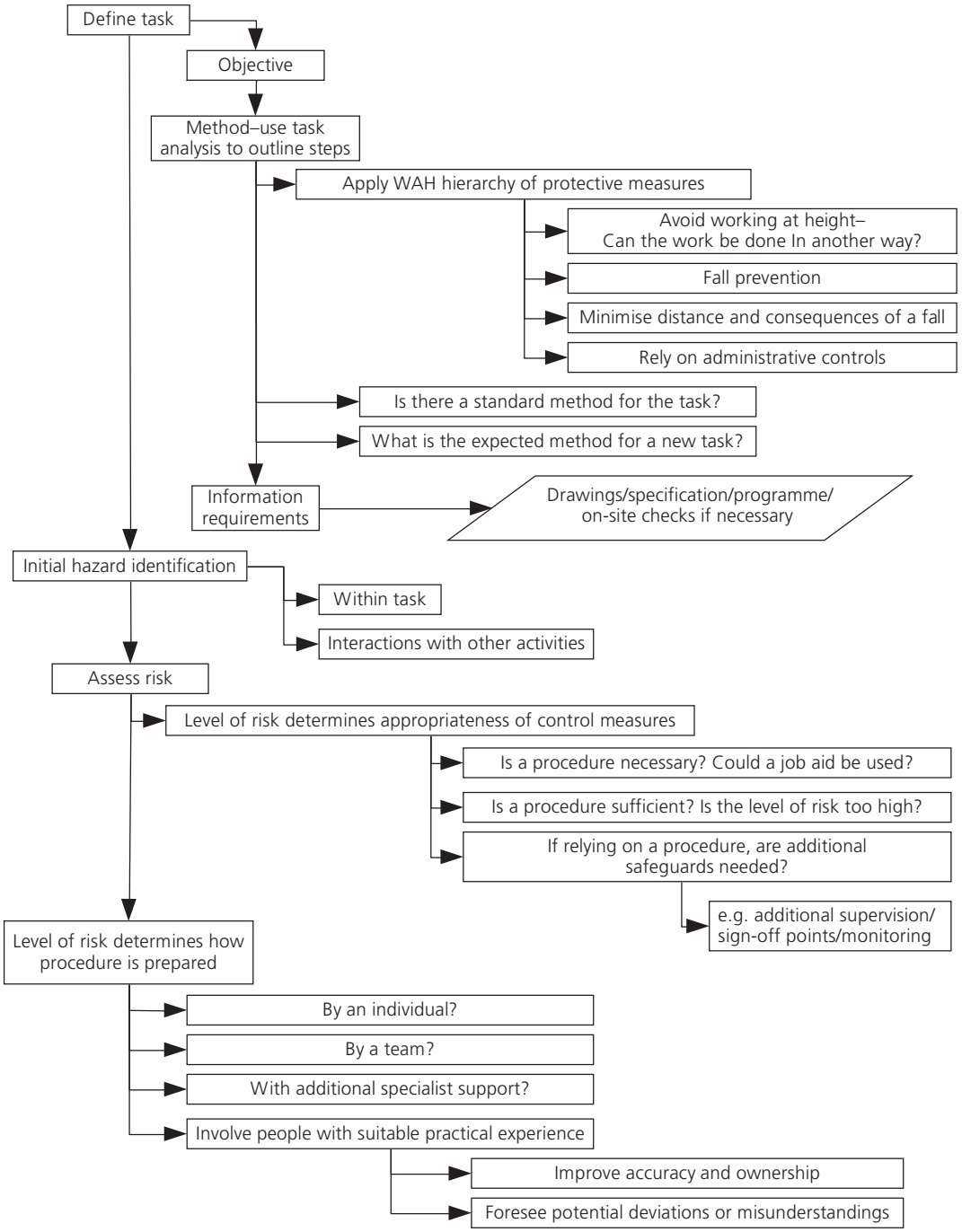


Figure 7: Flowchart for preparation before writing procedures for WAH

5.2 WRITING THE PROCEDURE

The aim of this stage is to produce a procedure that is readily understood, accurate, and provides the users with sufficient information about the task, the hazards involved, and how the hazards will be managed.

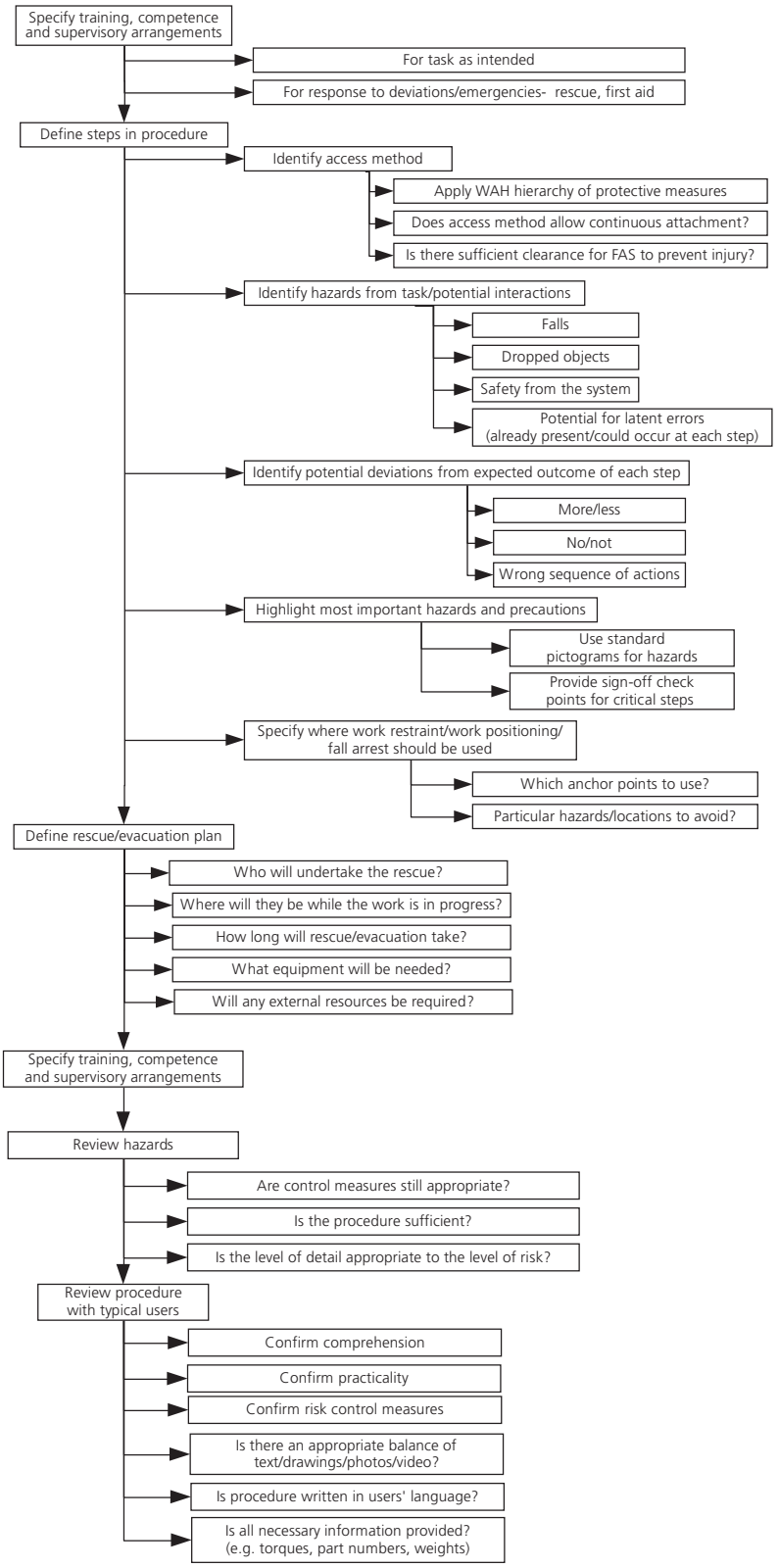


Figure 8: Flowchart for writing procedures for WAH

5.3 IMPLEMENTATION OF THE PROCEDURE

Effective implementation of procedures is essential, to ensure that tasks are performed consistently and correctly, risk assessments are valid, and risk control measures are effective.

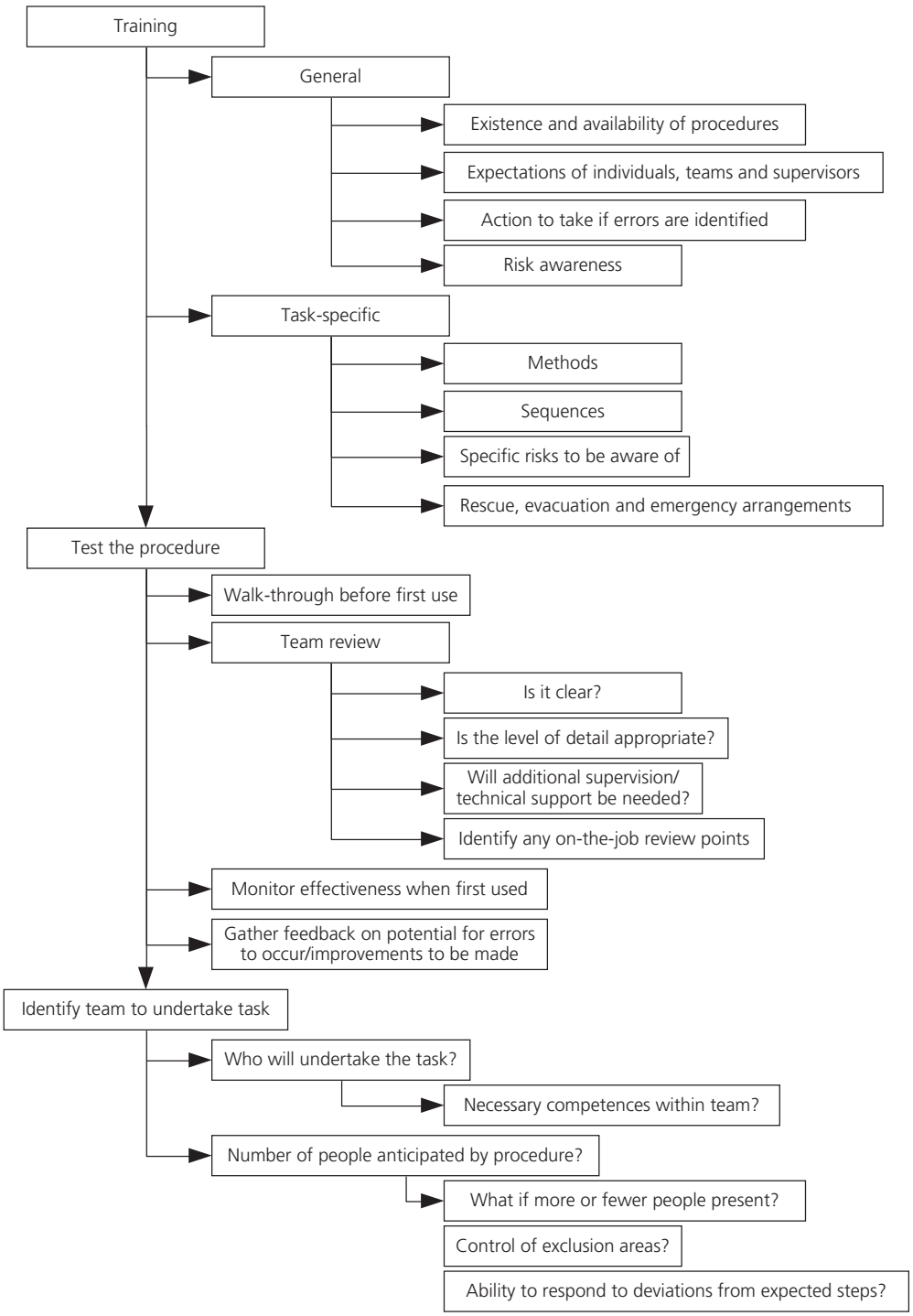


Figure 9: Flowchart for implementation of procedures for WAH

5.4 REVIEW OF PROCEDURES

Compliance with procedures is most readily achieved if procedures are accurate, efficient and practical. Operation of an effective review system allows for procedures to be improved, based on the learning from identified errors, incidents or hazardous observations, and the availability of improved methods or tools.

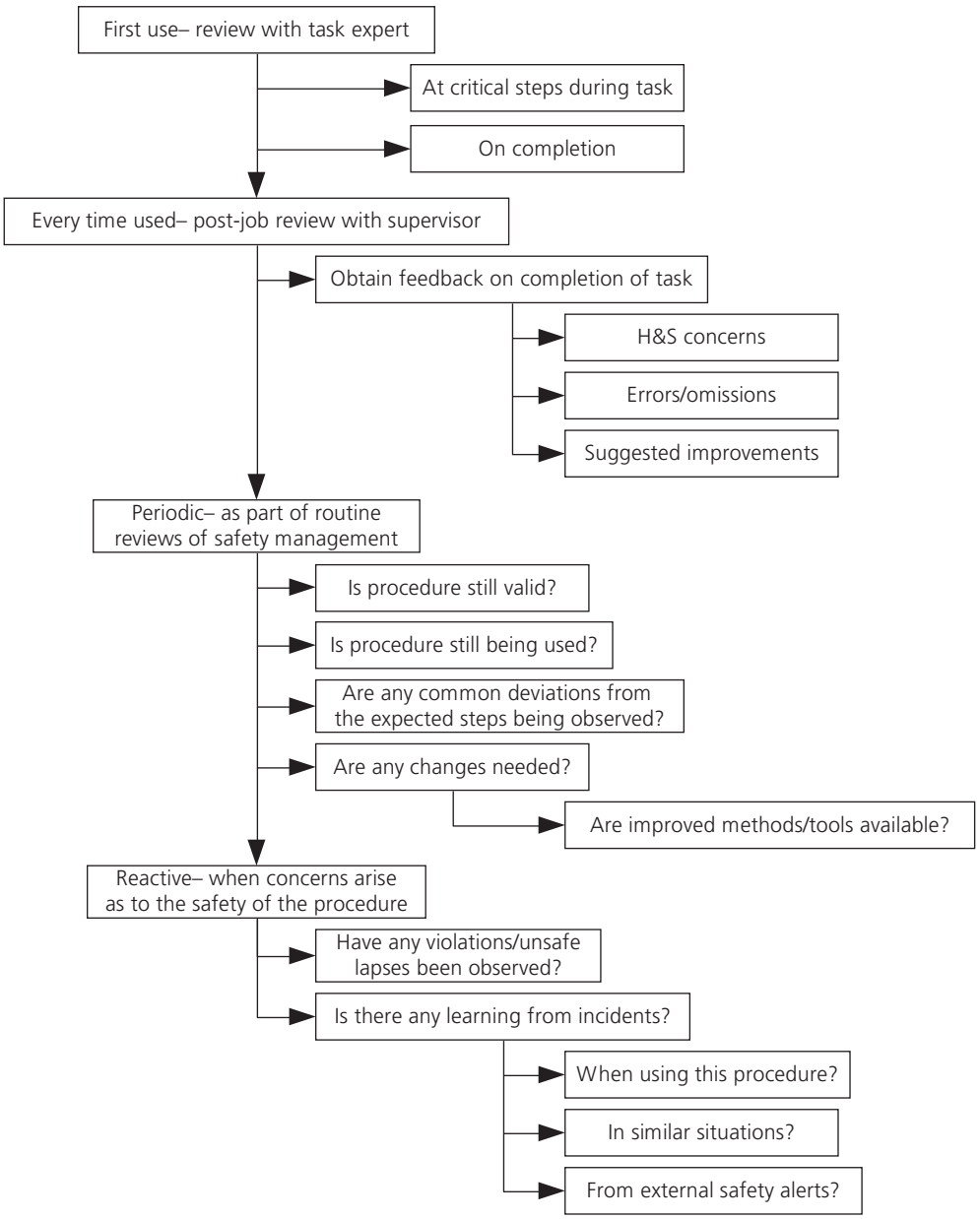


Figure 10: Flowchart for review of procedures for WAH

ANNEX A
EU DIRECTIVE AND NATIONAL REGULATIONS

The regulatory content of these guidelines is based on the regulatory regime within the EU; however, the broader content of the guidelines, such as hazards and good practices, could apply in any regulatory regime.

This section provides an overview of the EU directive relating to WAH, and the national regulations of six countries. It should be noted that the powers and responsibilities for health and safety regulation and enforcement lie with national governments, who will regulate on the basis of their national regulations, therefore compliance with local requirements is essential.

A.1 THE DIRECTIVE

EU legislation on WAH is contained in Directive 2009/104/EC '*concerning the minimum safety and health requirements for the use of work equipment by workers at work*', otherwise known as the Work Equipment Directive, which is the second individual directive made under the Framework Directive. There is no directive relating exclusively to WAH.

As the directive defines the minimum requirements, governments are free to apply higher standards in their national regulations; in particular, the directive does not define WAH; this is contained in (or omitted from) regulations. The resulting differences in national regulations can be a source of confusion and conflict in a multi-national workplace.

A.2 RELEVANT CONTENT OF THE DIRECTIVE

Key parts of the directive are summarised in Table A.1; direct quotations are in italics, and key points are emphasised in bold. It should be noted that where the directive mentions ladders, the provisions generally relate to portable, rather than fixed, ladders.

Table A.1: EU Directive requirements for WAH

Section	Summary of provision
Article 3	Employer to **ensure that work equipment is suitable for the work**, and safe to use. If risks cannot be eliminated, they shall be minimised
Article 4	Employer to ensure that work equipment complies with the requirements of Annex 1, and that it is **properly maintained**
Article 5	Employer to **ensure that necessary inspections are carried out** in order to maintain health and safety conditions
Article 8	Employer to **provide adequate information/instructions to enable safe use** of work equipment
Article 9	Employer to **ensure that workers have the necessary training**

Table A.1: EU Directive requirements for WAH (continued)

Section	Summary of provision
Annex 1	Specifies minimum requirements in relation to a range of different risks Specific requirements apply to certain groups of equipment; in particular Section 3.2.4 *gives the requirements for* **work equipment for lifting or moving workers**, which includes both permanently-installed lifts and temporary equipment such as man-baskets
Annex 2	Section 4 of the annex contains the specific requirements for '*work equipment provided for temporary work at height*', including: **If … temporary work at a height cannot be carried out safely and under appropriate ergonomic conditions from a suitable surface, the work equipment most suitable to ensure and maintain safe working conditions must be selected. Collective protection measures must be given priority over personal protection measures** *The most* **appropriate means of access** *to temporary workplaces at a height must be selected according to the frequency of passage, the height to be negotiated and the duration of use. The choice made must permit evacuation in the event of imminent danger. Passage in either direction between a means of access and platforms, decks or gangways must not give rise to any additional risks of falling* **Ladders** *may be used as work stations for work at a height only under circumstances in which, …, the use of other, safer work equipment is not justified because of the low level of risk and by reason of either the short duration of use or existing features on site that the employer cannot alter* **Rope access and positioning techniques** *may be used only under circumstances where the risk assessment indicates that the work can be performed safely and where the use of other, safer work equipment is not justified* *Depending on the type of work equipment selected on the basis of the foregoing, the appropriate measures for minimising the risks to workers inherent in that type of equipment must be determined. If necessary, provision must be made for the installation of* **safeguards to prevent falls.** *These must be of suitable configuration and sufficient strength to prevent or arrest falls from a height and, as far as possible, to preclude injury to workers. Collective safeguards to prevent falls may be interrupted only at points of ladder or stairway access* *When the performance of a particular task requires the* **temporary removal of a collective safeguard designed to prevent falls, effective compensatory safety measures must be taken.** *The task may not be performed until such measures have been taken. Once the particular task has been finished, either definitively or temporarily, the collective safeguards to prevent falls must be reinstalled* *Temporary work at a height may be carried out only when the* **weather conditions** *do not jeopardise the safety and health of workers*

Table A.1: EU Directive requirements for WAH (continued)

Section	Summary of provision
Annex 2 (continued)	Section 4.2 covers the use of **(portable) ladders** Section 4.3 covers the use of **scaffolding**; selected key provisions include: *When a note of the calculations for the scaffolding selected is not available or the note does not cover the structural arrangements contemplated,* **strength and stability calculations must be carried out unless the scaffolding is assembled in conformity with a generally recognised standard configuration** *Depending on the complexity of the scaffolding chosen, an* **assembly, use and dismantling plan** *must be drawn up by a competent person. This may be in the form of a standard plan, supplemented by items relating to specific details of the scaffolding in question* *The* **bearing components of scaffolding must be prevented from slipping** *… Steps must be taken to* **ensure that the scaffolding is stable**. *Wheeled scaffolding must be prevented by appropriate devices from moving accidentally during work at a height* *The dimensions, form and layout of scaffolding decks must be* **appropriate to the nature of the work to be performed and suitable for the loads to be carried, and must permit work and passage in safety.** *Scaffolding decks must be assembled in such a way that their components cannot move in normal use. There must be no dangerous gap between the deck components and the vertical collective safeguards designed to prevent falls* **When parts of a scaffolding are not ready for use, for example during assembly, dismantling or alteration, they must be marked with general warning signs** *… and must be suitably delimited by physical means preventing access to the danger zone* **Scaffolding may be assembled, dismantled or significantly altered only under the supervision of a competent person and by workers who have received appropriate and specific training in the operations envisaged …** *The person supervising and the workers concerned must have available the assembly and dismantling plan … including any instructions which it may contain* Note that the Directive does not specify particular inspection arrangements for scaffolding – this is defined in national regulations and codes of practice

Table A.1: EU Directive requirements for WAH (continued)

Section	Summary of provision
Annex 2 (continued)	Section 4.4: *Specific provisions regarding the use of* **rope access and positioning techniques:** *The use of rope access and positioning techniques must comply with the following conditions:* *(a)* **the system must comprise at least two separately anchored ropes, one as a means of access, descent and support (work rope) and the other as backup** *(security rope);* *(b) workers must be provided with and use an appropriate harness and must be connected by it to the security rope;* *(c) the work rope must be equipped with safe means of ascent and descent and have a self-locking system to prevent the user falling should he lose control of his movements. The security rope must be equipped with a mobile fall prevention system which follows the movements of the worker;* *(d)* **the tools and other accessories to be used by a worker must be secured to the worker's harness or seat** *or by some other appropriate means;* *(e) the* **work must be properly planned and supervised,** *so that a worker can be rescued immediately in an emergency;* *(f) in accordance with Article 9, the* **workers concerned must receive adequate training specific to the operations envisaged, in particular rescue procedures** *In exceptional circumstances where, in view of the assessment of risks, the use of a second rope would make the work more dangerous, the use of a single rope may be permitted, provided that appropriate measures have been taken to ensure safety in accordance with national legislation and/or practice*

The European Commission has published non-binding guidance to good practice for the application of the directive, 'How to choose the most appropriate work equipment for performing temporary work at height'.

A.3 REVIEW OF SELECTED NATIONAL WORK AT HEIGHT REGULATIONS

The regulations pertaining to WAH were reviewed for six countries: Great Britain and Northern Ireland, Denmark, Germany, Norway, the Netherlands and France. Key guidance documents were also identified, although the lists given in this section are not exhaustive. The guidance documents are listed for information, but have not been reviewed in detail.

A.3.1 Great Britain and Northern Ireland

- Legal framework:
  - Health and Safety at Work etc. Act 1974 (HSWA)/Health and Safety at Work (Northern Ireland) Order 1978.
  - Work at Height Regulations 2005 (WAHR)/Work at Height Regulations (Northern Ireland) 2005.
  - Apply to work throughout the GB EEZ[18].
- Definition of work at height:
  - '*work in any place, including a place at or below ground level*' and '*obtaining access to or egress from such place while at work, except by a staircase in a permanent workplace, where*' … '*a person could fall a distance liable to cause personal injury*'.
- Regulators:
  - Health and Safety Executive.
  - Health and Safety Executive of Northern Ireland.
- Guidance:
  - Extensive range of guidance published by HSE and trade associations, many of which were used as references in the drafting of this guideline.
  - Key codes of practice and specifications that are not covered in EN standards have been published as British Standards.

Table A.2: British standards relating to WAH

Standard	Subject	Comments
BS 7883: 2005	*Code of practice for the design, selection, installation, use and maintenance of anchor devices conforming to EN 795*	Current, but does not take account of the revision of EN 795 and publication of TS 16415. (Under revision)
BS 7955: 1999	*Containment nets and sheets on construction works – specification for performance and test methods*	Note that the puncture resistance test involves dropping a 1 kg steel sphere (ø63 mm) onto a net from a height of 2 m. This indicates the limitations of nets for providing protection against falling objects when heights typically encountered in WTGs are considered – any such net would need to be rigged close below the level from which the object might be dropped

18 HSWA and specific regulations are extended offshore through the Application Outside Great Britain Order 2013.

Table A.2: British standards relating to WAH (continued)

Standard	Subject	Comments
BS 7985: 2013	*Code of practice for the use of rope access methods for industrial purposes. Recommendations and guidance supplementary to BS ISO 22846*	Provides recommendations and guidance which supplement BS ISO 22846-1 and -2
BS 8411: 2007	*Code of practice for safety nets on construction sites and other works*	Provides guidance on the use, selection and specification of personnel safety nets (due to be revised)
BS 8437: 2005 +A1: 2012	*Code of practice for selection, use and maintenance of personal fall protection systems and equipment for use in the workplace*	Detailed guidance on a wide range of aspects of personal fall protection, including: – Basic principles – Selection of systems, including restraint, work positioning and fall arrest – Rescues, including planning and equipment requirements – Equipment, including correct and incorrect usage – Advantages and disadvantages of different design details, for example, different closing and locking mechanisms on connectors, or different attachment points on harnesses – Inspection, care and maintenance of equipment, including information on modes of deterioration – Safe methods of work, including method statements, working practices, clothing and protective equipment, and hazards to be aware of – Anchoring, including designated anchor points, anchoring to structures, anchoring more than one person, and the different requirements for anchors used for restraint and for fall arrest – Testing of harness comfort and adjustability – Suggested inspection checklists for a range of different types of equipment. – Calculation of free space requirements for different types of FAS

Table A.2: British standards relating to WAH (continued)

Standard	Subject	Comments
BS 8437: 2005 +A1: 2012 (continued)		– Properties of artificial fibres used in fall-protection PPE – Effect of wind speed on working times While legislative references are UK-specific, and some are out of date, the principles contained in the guidance could be applied anywhere
BS 8454: 2006	*Code of practice for the delivery of training and education for work at height and rescue*	The standard gives recommendations and guidance on the delivery of formal training and education for work at height, whether that training is provided internally or externally, at a training centre or in the workplace. It covers roles, facilities, management system, personnel, equipment, first aid provision, courses and assessment, delivery of training, and certification of trainees It includes the requirement that, if any person is to be suspended on a single line, for example when using equipment for personal evacuation or rescue after a fall, an additional safety system should be used. This ensures that persons being trained are not put at unnecessary risk It does not specify course content
BS 8610: 2017	*Personal fall protection equipment – anchor systems – specification*	Testing of anchors under this standard takes place in the substrate into which it is installed (as set out by the manufacturer). It includes methods for testing of permanently installed anchors

A.3.2 Denmark

– Legal framework: Working Environment Act.
  – Matches directive – no height specified.
  – EU Directives are applied to Danish ships, and foreign ships carrying out construction work in Danish waters for a period of 14 days or more[19].

19 See chapter VI, Annex 3 of the Executive Order 1246 of 11/12/2009 for the requirements, and § 1 Stk. 4 in the introduction for the application to foreign-flagged vessels.

- Regulator:
  - Working Environment Authority (*Arbejdstilsynet*).
    - Enforcement guidance refers to 2 m; implies that action should only be taken if there are particular hazards, or height >2 m.
- Key points:
  - Extensive guidance on roof and ladder work.
  - Use of fall protection is limited to tasks of duration less than four man-hours.
  - Lifting equipment to be used for lifting people has to be registered with Labour Inspectorate.
  - Guidance for roof work allows work to be carried out on flat roofs up to 3,5 m high with no edge protection.

Table A.3: Danish regulations and guidance

Title	Translation/content
Lov om arbejdsmiljø 7. September 2010	The Danish Working Environment Act, 7. September 2010
Bekendtgørelse om anvendelse af tekniske hjælpemidler – Arbejdstilsynets bekendtgørelse nr. 1109 af 15. december 1992	Executive order on the use of work equipment – 1109 – 15. December 1992
Bilag til bekendtgørelse nr. 1109 af 15. december 1992 om anvendelse af tekniske hjælpemidler	Annex to executive order no. 1109 of 15 December 1992 on the use of work equipment (section 6 of annex covers work equipment provided for temporary work at height)
Bekendtgørelse om arbejdets udførelse – Arbejdstilsynets bekendtgørelse nr. 559 af 17. juni 2004	Executive order on the performance of work – 559 – 17. June 2004
Bekendtgørelse om brug af personlige værnemidler – Arbejdstilsynets bekendtgørelse nr. 1706 af 15. december 2010	Executive order on use of personal protective equipment – 1706 – 15. December 2010
Ulykker ved fald til lavere niveau	Guidance on prevention of injuries from falls to a lower level
At-vejledning D.5.5-3 Faldsikring	Guidance on fall protection (PPE)
At-vejledning 2.4.3 Arbejde i højden fra reb	Guidance on work at height from rope
At-vejledning B.3.1.1-3 om krav til og brug af transportable stiger	Guidance on the use of portable ladders
Transportable personløftere med arbejdsstandplads (At-meddelelse nr. 2.04.3)	Mobile elevating work platforms
Stilladsarbejde	Guidance on scaffolding

A.3.3 Germany

- Legal framework:
  - Occupational Safety and Health Act (*Arbeitsschutzgesetz – ArbSchG*), Industrial Safety ordinance (*Betriebssicherheitsverordnung – BetrSichV*).
  - ArbSchG applies throughout German EEZ[20], although BetrSichV only applies to German ships.
  - Matches directive, no height specified.
  - Statutory AWMF medical examination required for work at height.
- Regulators:
  - Gewerbeaussichtsamt: each Bundesland (state) has its own Gewerbeaussichtsämter (inspectorates), which are responsible for enforcement of labour, environmental and consumer regulations. Structures and responsibilities vary between states.
  - German Social Accident Insurance (Deutsche Gesetzliche Unfallversicherung (DGUV)) is the umbrella association of the accident insurance institutions for the industrial (BG) and public sectors.
  - There are multiple Professional Associations (BG) for different sectors, several of which are relevant to offshore wind, such as:
    - Construction, BG Bau.
    - Power generation is covered by BG-ETEM.
  - The functions of BGs include:
    - Publishing guidance which sets out how to comply with the duties under regulations.
    - Providing statutory health insurance and occupational health services.
  - Federal Institute for Occupational Safety and Health (Bundesanstalt für Arbeitsschutz und Arbeitsmedizin (BAuA)) carries out research, development and knowledge transfer and provides policy advice.
    - Publishes Technical Rules for Occupational Safety (Technische Regeln für Betriebssicherheit (TRBS)).
- Extensive and detailed guidance:
  - workplace guidelines.
  - technical rules for occupational safety, and
  - BG rules, regulations, information.
- Rope access trade association FISAT – Fach- und Interessenverband für seilunterstützte Arbeitstechniken has its own Level 1–3 certifications for rope access technicians and supervisors.

Table A.4: German regulations and guidance

Title	Translation
Arbeitsschutzgesetz – ArbSchG	Occupational safety and health act
Betriebssicherheitsverordnung – BetrSichV	Industrial safety ordinance
Technische Regel für Betriebssicherheit 2101 *TRBS 1201 Prüfungen von Arbeitsmitteln und überwachungsbedürftigen Anlagen*	Technical rule for occupational safety 2121 Inspection of work equipment and equipment that is required to be monitored

20 ArbSchG Article 1(1), BetrSichV Article 1(4). Neither link will open

Table A.4: German regulations and guidance (continued)

Title	Translation
Technische Regel für Betriebssicherheit 2121 *Gefährdung von Personen durch Absturz – Allgemeine Anforderungen*	Technical Rule for Occupational Safety 2121 Risk to people from falling: General requirements
Technische Regel für Betriebssicherheit 2121 Teil 1 *Gefährdungen von Personen durch Absturz – Bereitstellung und Benutzung von Gerüsten*	Technical Rule for Occupational Safety 2121 Part 1 Risk to people from falling: Provision and use of scaffolding
Technische Regel für Betriebssicherheit 2121 Teil 3 *Gefährdungen von Personen durch Absturz – Bereitstellung und Benutzung von Zugangs- und Positionierungsverfahren unter Zuhilfenahme von Seilen*	Technical Rule for Occupational Safety 2121 Part 3 Risk to people from falling: Provision and use of rope access and positioning techniques
Technische Regel für Betriebssicherheit 2121 Teil 4 *Gefährdungen von Personen durch Absturz – Heben von Personen mit hierfür nicht vorgesehenen Arbeitsmitteln*	Technical Rule for Occupational Safety 2121 Part 4 Risk to people from falling: lifting of people using work equipment not designed for lifting people
DGUV Information 201–018 (BGI 772) Handbetriebene Arbeitssitze	Rope access
Arbeitsmedizinische Eignungsuntersuchungen für Arbeitnehmer auf Offshore-Windenergieanlagen und Offshore-Installationen	Guidance on the AWMF medical fitness assessment for workers on offshore WTGs and installations
DGUV Grundsatz 312–906 BGG 906 *Auswahl, Ausbildung und Befähigungsnachweis von Sachkundigen für persönliche Schutzausrüstungen gegen Absturz*	Selection, training and certification of competent persons for (inspection of) personal fall protection equipment
DGUV Regel 112–198 BGR/GUV-R 198 *Benutzung von persönlichen Schutzausrüstungen gegen Absturz*	Use of personal fall protection equipment
DGUV Regel 112–199 BGR/GUV-R 199 *Retten aus Höhen und Tiefen mit persönlichen Absturzschutzausrüstungen*	Rescue from height and depth using personal fall protection equipment
DGUV Information 212–870 BGI 870 Haltegurte und Verbindungsmittel für Haltegurte	Work positioning belts and connectors
DGUV Information 208–019 BGI 720 Sicherer Umgang mit fahrbaren Hubarbeitsbühnen	Safe use of MEWPs

Table A.4: German regulations and guidance (continued)

Title	Translation
DGUV Regel 101–005 Hochziehbare Personenaufnahmemittel	Suspended access equipment
DGUV Information 203–007 BGI 657 Windenergieanlagen	Wind turbines
DGUV Erste Hilfe in Offshore-Windparks	First aid on offshore wind farms. (Note that this goes well beyond the scope of GWO Basic Safety Training.)
FISAT – Fach- und Interessenverband für seilunterstützte Arbeitstechniken	German Association for Rope Access – Level 1, 2, 3 certifications

A.3.4 Norway

Norway is a member of the European Economic Area, and has therefore adopted the requirements of many EU directives and European standards.

- Legal framework:
  - Working Environment Act:
    - Applies to oil and gas activities in Norwegian Territorial Sea and continental shelf – not explicitly applied to other activities, and does not apply to shipping.
  - Work at height is regulated in the 'Regulations for the execution of work', chapter 17.
  - Similar to Directive, although some differences in relation to ladders – sets limits of 4 m, 6 m depending on type.
- Regulator:
  - Norwegian Labour Inspectorate.
  - Industrial Safety Organisation is the supervisory authority for industrial safety.
- Guidance:
  - Very limited guidance from regulators.
  - Employers are responsible for working out how to fulfil duties:
    - Detailed guidance published by major firms, or groups of firms such as the oil and gas initiative 'Working together for Safety' (SfS).
- Norwegian Standards match EN.
- Rope access trade association: SOFT – Samarbeidsorganet for tilkomstteknikk, which has two certification levels: Class A (Advanced, within which are levels 1–3 and Safety Supervisor) and Class B (Basic), defined in standard NS 9600.

Table A.5: Norwegian regulations and guidance

Title	Translation/content
Lov om arbeidsmiljø, arbeidstid og stillingsvern mv. (arbeidsmiljøloven)	Working Environment Act
Forskrift om utførelse av arbeid, bruk av arbeidsutstyr og tilhørende tekniske krav *Kapittel 17. Arbeid i høyden*	Regulations for the execution of work, the use of work equipment and associated technical requirements Chapter 17 – work at height

A.3.5 The Netherlands

- Legal framework:
  - Working Conditions Act, Decree, Regulations and Annexes apply to:
    - activities within the EEZ on assets placed in the EEZ.
    - vessels under the Dutch flag in any location, and
    - all activities within the 12 miles zone.
  - Amendment to Working Conditions Decree matches the Directive; however, Article 3.16 of Decree refers to 2,5 m as the height above which protective measures are needed.
- Regulator:
  - Inspectorate SZW;
  - Offshore (outside 12 miles) the regulator is Staatstoezicht op de Mijnen (SodM) (State regulator of mining).
- Guidance:
  - Arbocatalogus (Work Catalogues) document how employers and unions in a sector have agreed to implement regulations.
    - There is a specific Arbocatalogus for offshore wind, which specifies detailed protective measures for a wide range of tasks in offshore wind. The measures are listed according to whether they are the responsibility of the employer or employee.

Table A.6: Dutch regulations and guidance

Title	Translation/content
Arbeidsomstandighedenwet (Arbowet)	Working Conditions Act (translation)
Besluit tot Wijziging van het Arbeidsomstandighedenbesluit) *Staatsblad, 2004-06-29, No. 279, pp. 1–5*	Decree Amending the Working Conditions Decree, adding provisions regulating the use of work equipment for temporary work at height
Arbocatalogus – Risico: Vallen van hoogte	Work catalogue: Risk: falling from height
Arbocatalogus – Risico: Letsel door vallende voorwerpen	Work catalogue: Risk: Injury from falling objects
PBM: persoonlijke valbeveiliging	Personal fall protection advice
Algemene informatie over het risico valgevaar	General information on the risk of falls
Arbouw-advies Veilig werken op hoogte	Advice on safe work at height

A.3.6 France

- Legal framework:
  - Code of Work, not explicitly extended throughout EEZ.
  - Relevant articles match Directive, height not defined.
- Regulator:
  - Ministry of Labour.

- Guidance:
  - Key publication bodies are:
    - INRS (l'Institut National de Recherche et de Sécurité) – National Institute for Safety Research.
    - CNAMTS (Caisse nationale de l'assurance maladie des travailleurs salariés) – National Fund for Employees' Health Insurance.

Table A.7: French regulations and guidance

Title	Translation/content
Code du travail, Articles R4323-58 – R44323-90	Transposes directive into French law
INRS – La prévention des chutes de hauteur	Prevention of falls from height (brochure)
INRS – Prévention des risques de chutes de hauteur	Prevention of risk of falling from height
INRS – Plates-formes élévatrices mobiles de personnel	MEWPs
INRS – Principales vérifications périodiques	Principles of periodic inspection (not limited to PPE)
INRS – Repérer les situations de travail en hauteur, prévenir les risques	Guidance on risk prevention in work at height (website)
CNAMTS – Utilisation des systems d'arrêt de chutes	Recommendations on use of fall arrest systems
CNAMTS – Utilisation de plates-formes élévatrices mobiles de personnes (PEMP)	Recommendations on use of MEWPs
CNAMTS – Dispositifs d'ancrage pour les équipements de protection individuelle contre les chutes de hauteur	Recommendation on anchor devices for use with personal fall protection equipment
SYNAMAP Guide d'installation des dispositifs d'ancrage permanent selon la norme EN 795 pour les EPI contre les chutes de hauteur	SYNAMAP (PPE manufacturers' and distributors' association) guidance on installation of EN 795 anchor points – last revised in 2004, so not in line with latest revision of standard

ANNEX B
WORK AT HEIGHT REGULATIONS OUTSIDE EUROPE

Offshore wind is growing in numerous countries outside Europe. While the hazards are common to all jurisdictions, there are differences in regulatory requirements and technical standards. This section provides an overview of regulatory requirements and standards in China, Japan, Taiwan and the United States of America (USA).

B.1 CHINA

B.1.1 Legal framework

The fundamental regulations are defined in Article 27 of Safe Production Law of People's Republic of China (PRC). The contents of the article are:

- Special operating personnel of industrial and business entities must complete appropriate safety training before starting work, in accordance with the relevant provisions of the State.
- The scope of 'Special Operating Personnel' is defined by the department of the State Council responsible for industrial safety supervision and management, in conjunction with other relevant departments of the State Council.

There is no specific legislation for WAH. However, relevant regulations are detailed in the officially issued administrative regulation named 'Special Operating Personnel Safety Training and Examination Regulations'. The key items include:

- WAH is defined as being any work over 2,0 m. Two main types are identified as erecting and dismantling scaffolding, and general installation, maintenance and demolition work.
- All WAH personnel must be provided with suitable and sufficient training and must be certified as having passed the assessment held after the training.
- All WAH personnel must satisfy the following conditions:
  - Minimum of 18 years old, and below the state retirement age;
  - Satisfactory medical examination, considering conditions such as heart disease, epilepsy, Meniere's disease (which causes episodes of vertigo), vertigo, hysteria, tremors, paralysis, psychosis, dementia, blood pressure, vision, hearing, grip strength, standing balance and other relevant physical conditions;
  - Education level: Junior high school and above.
- Specific safety-related knowledge and skills.

B.1.2 Regulator

The national (state) regulator is the State Administration of Work Safety (SAWS), which is a ministerial level organisation of the State Council. However local government, at or above the county level (i.e. city level and province level) has corresponding organisations responsible for supervision and administration of industrial safety within their respective areas. Administrative procedures may vary between different local government bodies,

but as they must all conform to the state-level law and regulations, the differences should be relatively minor. These various regulatory bodies are listed on the Chinasafety website (in Chinese).

B.1.3 Guidance

Table B.1: WAH guidance in China

Title	Translation/content
SAWS web page	Links to numerous resources relating to safety regulations and policies (in Chinese)
China Electricity Council rules for work at height in WTGs	Specific guidance, including training, health requirements, size of working party, wind speed limits for access, use of PPE, use of fall arrest systems, rules for working in nacelles and hubs, emergency escape

B.1.4 Technical standards

The national standardisation body in China is Standardization Administration of China (SAC), which issues all the national standards with serial numbers beginning with GB. Industry standards are accredited by standardization agencies of the relevant administrative departments of the State Council, and have serial numbers beginning with JG, DL, etc., which are abbreviations of the industry sector titles in Chinese. A selection of relevant standards is given in Table B.2.

Warning note: while the titles of many of these standards are identical to European standards, there may be differences in technical requirements, and the Chinese standards may not have been updated to match the current versions of European standards. For example, EN 353-1 was revised in 2014, to address significant safety issues in the earlier (2002) edition, while the corresponding Chinese standard GB 24542 was issued in 2009.

Table B.2: Technical standards for WAH in China

Standard	Title (Chinese)	Translation/key content
DL/T 796	风力发电场安全规程	Safety regulations for wind farms. This defines the basic requirements in terms of wind farm personnel, environment and safe working, safety requirements for WTG installation, commissioning, maintenance and emergency response
DL 5009.2	电力建设安全工作规程 第2部分 电力线路	Specification for safe operation of electric power construction, part 2: power lines
DL/T 1147	电力高处作业防坠器	Electric power industry WAH fall protection
GB 2811	安全帽	Safety helmets
GB 6095	安全带	Safety harnesses
GB 4053.1	固定式钢直梯安全技术条件	Technical safety requirements for fixed steel vertical ladders

Table B.2: Technical standards for WAH in China (continued)

Standard	Title (Chinese)	Translation/key content
GB 4053.2	固定式钢斜梯安全技术条件	Technical safety requirements for fixed steel angled ladders
GB 7059	便携式木梯安全要求	Portable wooden ladders – safety requirements
GB 12142	便携式金属梯安全要求	Portable metal ladders – safety requirements
GB/T 23468	坠落防护装备安全使用规范	Code of practice for safe use of fall protection equipment
GB/T 23469	坠落防护 连接器	Personal fall protection equipment – Connectors
GB/T 24537	坠落防护 带柔性导轨的自锁器	Personal fall protection equipment – Guided type fall arrester including a flexible anchor line
GB/T 23538	坠落防护 缓冲器	Personal fall protection equipment – Energy absorbers
GB 24542	坠落防护 带刚性导轨的自锁器	Personal fall protection equipment – Guided type fall arrester including a rigid anchor line
GB 24543	坠落防护 安全绳	Personal fall protection equipment – Lanyards
GB 24544	坠落防护 速差自控器	Personal fall protection equipment – Retractable type fall arrester
GB 30862	坠落防护 挂点装置	Personal fall protection equipment – Anchor devices
GB/T 3608	高处作业分级	Classification of WAH. This defines WAH, how height is to be calculated and the corresponding classes
JB/T 11699	高处作业吊篮安装、拆卸、使用技术规程	WAH basket: technical procedures for assembly, disassembly and use
JGJ 80	建筑施工高处作业安全技术规范	WAH Safety – technical Code for Building Construction

Key requirements from these industry standards include, but are not limited to:

- If work gives rise to a risk of falling from a height of 2 m and above, guardrails or a safety net should be installed.
- Personnel undertaking WAH shall be equipped with suitable PPE, and shall use it correctly.
- Climbing facilities shall be reliable and of sufficient strength. Tread load should not exceed 1,1 kN; when special work is to be conducted on a ladder, it shall be designed for the purpose. (Note: 1,1 kN is lower than the tread load specification of 1,5 kN in ISO 14122-4).
- Two workers shall not be on the same ladder at the same time.
- Ladders must not be erected on the platform of a scaffold.
- Portable ladders should be used at an angle of 75° above horizontal; steps shall not be missing, and shall be spaced at 300 mm.
- Fixed ladders of less than 3 m do not require fall protection, above this height fall protection should be provided; the regulations indicate that the use of a cage ladder fulfils this requirement if the height is less than 8 m; for greater heights, separate ladder flights or stairs should be provided.

B.2 JAPAN

B.2.1 Legal framework

The two most relevant Acts are:

- Labour Standards Act (Act No. 49 of April 7, 1947), which defines working conditions in Japan.
- Industrial Safety and Health Act (Act No. 57 of June 8, 1972), which aims to secure, in conjunction with the Labour Standards Act, the safety and health of workers in workplaces, as well as to facilitate the establishment of a comfortable working environment by promoting comprehensive and systematic measures to prevent industrial accidents, such as:
  - Taking measures for the establishment of standards for hazard prevention;
  - Clearly assigning responsibilities for safety and health management, and
  - Promotion of voluntary activities with a view to preventing industrial accidents.

There is no specific legislation for WAH; however, the Ordinance on Industrial Safety and Hygiene, made under the Industrial Safety and Health Act, defines certain specific requirements, including:

- WAH is defined as being any work over 2,0 m; this definition should be applied when interpreting the following requirements, in relation to work at height:
- The employer is required to provide employees with health and safety training appropriate to their work. (Article 59 of Industrial Safety and Health Act).
- The employer is obliged to provide a safe working platform, by installation of scaffolding or by other methods, if working at height, and when there is a risk of danger due to falling. When it is difficult to provide a safe working platform, the employer is obliged to implement other measures, such as the use of nets or safety harnesses, to protect workers from dangers due to falling. (Article 518 of Ordinance on Industrial Safety and Hygiene).
- When rope access work is to be carried out, the employer is obliged to provide workers with a 'lifeline' (secondary rope) and to prepare a method statement for the work to be implemented. As the use of a lifeline is a new requirement, not all personnel may be familiar with working in this way. The employer is also obliged to appoint a supervisor for the rope access work, to ensure its safe conduct. The ropes, harness and anchor points are to be inspected prior to undertaking the work, and workers are to receive safety training on rope access work, of a minimum of seven hours duration, and including certain specific modules. The working conditions for the rope access work (i.e. site conditions, anchor points or ground conditions under the working position) are required to be recorded and retained. (Revised Article 518 of Ordinance on Industrial Safety and Hygiene).
  - Note that Article 518 was revised in 2016, and as of October 2017, there is still a transitionary period in which a lifeline is not required to be used if the following conditions are satisfied:
    - the main rope is fixed at robust anchorages with more than two anchor points, and
    - a rope protection device is in place at any point, below the third anchor, at which the rope could become damaged while in use.
- The employer is obliged to provide protective measures such as guard rails and covers in workplaces at height of 2 m and where workers may be at risk of falling, such as at

the edge of platforms and at openings. When it is difficult to provide guard rails, or if they have to be temporarily removed in order to perform work activities, the employer is obliged to implement alternative protective measures such as provision of safety netting or the requirement to use personal fall protection equipment. (Article 519 of Ordinance on Industrial Safety and Hygiene). Workers are obliged to comply with safety instructions, such as the requirement to wear harnesses in specific locations. (Article 520 of Ordinance on Industrial Safety and Hygiene).

– When work is being carried out at height, and where the use of personal fall protection equipment is required, the employer shall provide reliable anchor systems and inspect equipment and facilities. (Article 521 of Ordinance on Industrial Safety and Hygiene).
– The employer shall ensure that work is not undertaken at height during adverse weather, specifically strong wind (10 minute average exceeding 10 m/s), heavy rain (greater than 50 mm/minute), or heavy snow (over 0,25 m). (Article 522 of Ordinance on Industrial Safety and Hygiene).
– When carrying out work at a place having a height or a depth exceeding 1,5 m, the employer is obliged to provide safe access facilities, although there are some exceptions for situations in which it is particularly difficult to provide such facilities. (Article 526 of Ordinance on Industrial Safety and Hygiene).
– The employer shall not allow workers to enter locations where there is a risk of falling. (Article 530 of Ordinance on Industrial Safety and Hygiene).

B.2.2 Regulator

The Ministry of Health, Labour and Welfare works to promote the improvement of the working environment, employment security, and human resource development. In cases where workers are injured due to occupational injuries, the employer is obliged to report the incident to the labour standards inspection office, which is a division of this ministry.

B.2.3 Guidance

Table B.3: WAH guidance in Japan

Title	Translation/content
http://www.mhlw.go.jp/new-info/kobetu/roudou/gyousei/anzen/dl/140526-1-0.pdf	Work standard manual for safety equipment for fall prevention
http://www.mhlw.go.jp/file/06-Seisakujouhou-11300000-Roudoukijunkyokuanzeneiseibu/0000104440.pdf	Revision of the ordinance on industrial safety and hygiene for rope access work
http://www.mhlw.go.jp/new-info/kobetu/roudou/gyousei/anzen/dl/170131-1.pdf	Use of full body harness
http://www.kensaibou.or.jp	Japan Construction Industry Occupational Accident Prevention Association web page, with links to resources relating to safe work at height

B.2.4 Technical standards

The main standards body in Japan is the Japanese Industrial Standards Committee (JISC), which charters Japanese Industrial Standards (JIS). JISC is an active member of ISO and IEC, therefore JIS are aligned with these international standards, and state the extent of any deviations. In many areas, Japan uses ISO standards without modification. A selection of relevant standards isgiven in Table B.4.

Warning note:

– ISO standards for fall protection have not had substantive updates for around 10 years, and are currently undergoing a five-yearly review, so even though their titles may be identical to European standards, their requirements may differ.

– Japanese standards may impose different strength requirements for components such as harnesses, lanyards and connectors, compared to European standards.

Table B.4: Technical standards for WAH in Japan

Standard	Title/scope
JISA4302	Safety testing standard for a lift
JIST8165	Safety harnesses, lanyards and energy absorbers, connectors, based on ISO 10333, but with some modifications
JISB9713	Parts 1–4 are identical to the corresponding parts of ISO 14122:2001 Safety of Machinery – permanent means of access to machinery
JIST8101	Safety shoes
JIST8131	Safety helmet
JIS T 8165	Safety belt (corresponds to ISO 10333-1)
ISO 10333-3:2000	Personal Fall-Arrest Systems – Part 3: Self-Retracting Lifelines
ISO 10333-4:2002	Personal Fall-Arrest Systems – Part 4: Vertical Rails and Vertical Lifelines Incorporating a Sliding-Type Fall Arrester

B.3 TAIWAN

B.3.1 Legal framework

There is no specific legislation for WAH. The basic regulations are defined in the Occupational Safety and Health Act. Relevant requirements include:

– Article 19: employers shall not have workers working in high ambient temperatures for more than six hours per day; employers shall reduce working hours for workers performing various work activities, including WAH, activities involving high levels of physical exertion, or other specially hazardous tasks, and give appropriate rest periods during working hours.

– Article 6: employers shall provide the necessary safety and health equipment and measures that comply with regulations, with respect to the risks of injuries posed by falling, falling objects, or collapse at the job site.

- Article 20: employers shall conduct pre-employment physical examinations, and general health examinations for current workers.
- Article 32: Employers shall provide workers with all safety and health education and training that is necessary for them to perform their duties and minimise the risk of accidents.

Specific regulations included in several administrative regulations have some content relevant to WAH, including:

- Standard for protective measures for work involving elevated operations (高架作業勞工保護措施標準), updated 25 June 2014.
- Construction safety and health facility standard (營造安全衛生設施標準), updated 26 June 2014.
- Labour health protection rules (劳工健康保护规则), updated 23 March 2016.
- Occupational safety and health education and training rules (职业安全卫生教育训练规则), updated 22 September 2016.
- Occupational safety and health facility rules (職業安全衛生設施規則), updated 1 July 2014.

The key items include:

- The term 'elevated operations' (namely WAH) is defined as being work:
  - At or above a height of 2 m, with necessary protective measures, other than a work platform with guardrails etc., or
  - At or above a height of 5 m with necessary safety measures against falling, including a work platform with guardrails etc.
- Employers should reduce working hours for personnel working at height.
  - Following every two hours of continuous working, the employer should give rest breaks, according to the height at which the work is being done:
    - If working between 2–5 m, a break of at least 20 minutes.
    - If working between 5–20 m, a break of at least 25 minutes.
    - If working above 20 m, a break of at least 35 minutes.
  - The regulations allow these breaks to be adjusted, such as by adjusting overall working hours, or adopting other protective measures, to accommodate emergency maintenance work or other special cases.
  - The rest breaks should be taken at ground level or on a safe working platform.
- The employer shall not permit WAH if a worker is affected by alcohol, is medically unfit, affected by mental health conditions that could impair safety, or if the worker feels unfit for the task, or is affected by other conditions that may be specified in regulations.
- Employers are required to define fall prevention plans for WAH, and to provide appropriate protective equipment.
- The employer should have suitable scaffolding erected for construction work at a height exceeding 2 m, where ladders and MEWPs are unsuitable.
- Physical health examinations should be undertaken by doctors, on behalf of the employer; conditions considered unsuitable for WAH include: epilepsy, mental or nervous system diseases, hypertension, cardiovascular disease, anaemia, impaired balance, colour blindness, poor vision, hearing impairment and musculoskeletal conditions;

- Safety training is required for WAH, including but not limited to:
  - a summary of relevant health and safety related laws and regulations;
  - occupational safety and health concepts and practices;
  - regular inspections (before, during and after the work);
  - standard operating procedures, and
  - emergency response, including regular knowledge and practice in fire-fighting and first aid.
- New employees or workers are required to have specific training before starting work; for general work, it should not be less than three hours, but for construction work, an additional 3 hours is required.
- For work being undertaken at a height exceeding 2 m, and where there is a risk of falling, employers should make sure that workers use safety harnesses, helmets and other necessary PPE. The type of harness should be appropriate for the work being done, and comply with national standards.

B.3.2 Regulator

The national (state) regulator is the Occupational Safety and Health Administration (OSHA) of the Ministry of Labour, which is a ministerial level organisation of the Taiwanese government. However, note that national regulations allocate responsibility for some aspects of labour and employment law enforcement to local government at the county or city level (nine cities and 13 counties[21]).

B.3.3 Guidance

Table B.5: WAH guidance in Taiwan

Link	Summary
http://www.osha.gov.tw/1106/1251/10159/?CatType=10171	SAWS web page with links to numerous resources relating to safety regulations and policies
http://www.cnsonline.com.tw/?node=result&typeof=common&locale=zh_TW	Official database online service with links to national standards with regard to WAH
http://law.moj.gov.tw/Eng/index.aspx	Laws and Regulations Database of Taiwan

B.3.4 Technical standards

The state standardisation body in Taiwan is the Bureau of Standards, Metrology and Inspection (BSMI), under the Ministry of Economic Affairs of the Taiwanese government. A selection of relevant standards is given in Table B.6. Taiwanese standards are entitled 'Chinese National Standard', CNS, but are made independently of standards in the People's Republic of China.

Warning note:

- Taiwan is not a current member of ISO, therefore although the parts and titles of CNS 14253 match ISO 10333, the actual requirements may differ.

21 See http://www.osha.gov.tw/1106/1164/1165/1465/10084/ for further details.

– ISO standards for fall protection have not had substantive updates for around 10 years, and are currently undergoing a five-yearly review, so even though their titles may be identical to EN standards, their requirements may differ.
– Taiwan does not recognise EN standards.

Table B.6: Technical standards for WAH in Taiwan

Standard	Title
CNS 7534	*Personal protective equipment for work positioning and prevention of falls from a height – Belts for work positioning and restraint and work positioning lanyards*
CNS 6701	*Safety Belts (fasten type)* 安全帶（緊身型）
CNS 7535	*Personal protective equipment against fall from a height – Test methods*
CNS14253-1: 2014	*Personal fall-arrest systems – Part 1: Full-body harnesses*
CNS14253-2: 2014	*Personal fall-arrest systems – Part 2: Lanyards and energy absorbers*
CNS14253-3: 2014	*Personal fall-arrest systems – Part 3: Self-retracting lifelines*
CNS14253-4: 2014	*Personal fall-arrest systems – Part 4: Vertical rails and vertical lifelines incorporating a sliding-type fall arrester*
CNS14253-5: 2014	*Personal fall-arrest systems – Part 5: Connectors with self-closing and self-locking gates*
CNS14253-6	*Personal fall-arrest systems – Part 6: System performance tests*
CNS14252: 2012	*Safety nets*
CNS1336: 2017	*Industrial protective helmets*
CNS4750: 2014	*Tubular steel scaffolds*

B.4 USA

B.4.1 Legal framework

Regulations (commonly known as 'Standards' are defined in 29 Code of Federal Regulations (CFR). The two most relevant parts are:

– part 1910 Occupational Safety and Health Standards, which defines general occupational health and safety regulations, and
– part 1926 Safety and Health Regulations for Construction, which defines specific regulations for construction.

There is no specific legislation for WAH, the requirements are listed as individual statements throughout parts 1910 and 1926. The requirements are defined in imperial units, but are given here in metric for convenience. Key requirements include:

– WAH is defined as being any work over 1,8 m, although protective measures are specified in some situations for work over 1,2 m.

- All personnel working at height must be provided with suitable and sufficient training, which should include using any required work equipment, safety equipment and/or personal fall protection systems.
- Ladders of less than 7,3 m do not require fall protection; above this height fall protection must be provided. OSHA 1910.21 states that cages are not ladder safety (fall protection) systems, and OSHA 1910.28 even sets a timetable for provision of personal fall arrest or ladder safety systems on existing cage ladders by 2036.
- The performance requirements for anchor points, harness and lanyard components differ from those in European standards, and are sometimes higher; some key specification requirements are listed in TableB.7.
- The standards list four risk control options for all work at height – but note these are not a hierarchy:
  - guardrail systems;
  - safety nets;
  - 'travel restraint' systems (i.e. work restraint), and
  - personal fall protection systems.
- Means of access to elevated working areas is included throughout the standards, with reference to these risk control options.
- There are regulations for 26 different named types of scaffolds, all of which are defined and controlled in Subpart L of 1926.
- PPE is mentioned in a number of sections throughout 1910; it is also specifically covered in Subpart I of 1910, which includes fall prevention systems.

Table B.7: Key equipment specification requirements from USA regulations

Equipment or component	Key specification requirements
Lanyards and vertical lifelines	22 kN minimum breaking strength
Self-retracting lanyards	Fall distance limit 0,61 m Able to withstand 13,3 kN minimum tensile load
D-rings, snap hooks and carabiners	Without failure: 16 kN minimum tensile load Gate strength 16 kN minimum tensile load in all directions
Anchor points and anchorages	Capable of supporting at least 22,2 kN for each employee attached
Fall arrest equipment	Limit maximum arresting force on the user to 8 kN Shall be rigged to limit the free fall to a maximum of 1,8 m (and not contacting lower levels) and then bring the employee to a complete stop and limit the maximum deceleration distance the employee travels to 1,1 m Have sufficient strength to withstand twice the potential impact load of the operative free falling a distance of 1,8 m, or the free fall distance permitted by the system

Table B.7: Key equipment specification requirements from USA regulations (continued)

Equipment or component	Key specification requirements
Positioning device system	These are to be rigged such that an employee cannot free fall more than 0,6 m, and shall be secured to an anchorage capable of supporting at least twice the potential impact load of an employee's fall or 13,3 kN, whichever is greater
Fixed ladders	Ladder safety devices may be used on ladders over 20 feet in unbroken length in place of cage protection. No landing platform is required

B.4.2 Regulator

The national (federal) regulator is the Occupational Safety and Health Administration (OSHA). However, 27 states and territories (include nine of the mainland coastal states) operate their own OSHA-approved workplace safety and health regulatory systems, known as 'plans'. These may include standards and other procedures, which are not always identical to the federal requirements, but must be at least as effective. The OSHA website provides further explanation, and a map showing the status of each state.

The Bureau of Ocean Energy Management also requires the submission of a Safety Management System, and conducts both scheduled and unscheduled inspections.

B.4.3 Guidance

OSHA publishes various guidance documents in relation to WAH, including:

– Information on fall protection in construction.
– OSHA web page with links to numerous resources relating to safe WAH.

B.4.4 Technical standards

The main standards body in the USA is the American National Standards Institute (ANSI), which charters Accredited Standards Committees (ASC) and accredits certain other bodies to develop standards, such as the American Society of Safety Engineers (ASSE) and American Society for Testing and Materials (ASTM). A selection of relevant standards is given in Table B.8. Note that some of these standards may impose higher loading requirements than equivalent European standards.

Table B.8: Technical standards for WAH in USA

Standard	Title
ANSI/ASSE A1264.1-2017	*Safety requirements for workplace walking/working surfaces and their access; workplace floor, wall and roof openings; stairs and guardrail systems*
ANSI/ASSE A10.8-2011	*Scaffolding safety requirements*
ANSI/ASSE A10.32	*Personal fall protection used in construction and demolition operations*

Table B.8: Technical standards for WAH in USA (continued)

Standard	Title
ANSI ASC A14.1-2007	*American National Standards for Ladders – Wood – Safety Requirements*
ANSI ASC A14.2-2007	*American National Standards for Ladders – Portable Metal – Safety Requirements*
ANSI ASC A14.3-2008	*American National Standards for Ladders – Fixed – Safety Requirements*
ANSI ASC A14.5-2007	*American National Standards for Ladders – Portable Reinforced – Plastic Safety Requirements*
ANSI/ASSE Z359.0-2012	*Definition and Nomenclature Used for Fall Protection and Fall Arrest*
ANSI/ASSE Z359.1-2016	*The Fall Protection Code*
ANSI/ASSE Z359.2-2007	*Minimum Requirements for a Comprehensive Managed Fall Protection Program*
ANSI/ASSE Z359.3-2017	*Safety Requirements for Lanyards and Positioning Lanyards*
ANSI/ASSE Z359.4-2007	*Safety Requirements for Assisted-Rescue and Self-Rescue Systems, Subsystems and Components*
ANSI/ASSE Z359.6-2009	*Specifications and Design Requirements for Active Fall Protection Systems*
ANSI/ASSE Z359.7-2011	*Qualification and Verification Testing of Fall Protection Products*
ANSI/ASSE Z359.11-2014	*Safety Requirements for Full Body Harnesses*
ANSI/ASSE Z359.12-2009	*Connecting Components for Personal Fall Arrest System*
ANSI/ASSE Z359.13-2009	*Personal Energy Absorbers and Energy Absorbing Lanyards*
ANSI/ASSE Z359.14-2012	*Safety Requirements for Self-Retracting Devices for Personal Fall Arrest and Rescue Systems*
ANSI/ASSE Z359.15-2014	*Safety Requirements for Single Anchor Lifelines and Fall Arresters for Personal Fall Arrest and Rescue Systems*
ANSI/ASSE Z359.16	*Safety Requirements for Climbing Ladder Fall Arrest Systems*
ANSI/ ASSE Z359.18	*Safety Requirements for Anchorage Connectors for Active Fall Protection Systems*
ANSI/ASSE Z459.1-201x	*Standard being drafted: Safety Requirements for Rope Access Systems*
ASTM F887-11	*Standard Specifications for Personal Climbing Equipment*

ANNEX C
REVIEW OF SELECTED EXISTING WORK AT HEIGHT GUIDANCE

Table C.1: Review of existing WAH guidance

Document	Scope and industry relevance	Comments
Work At Height Safety Association (WAHSA) Practical Guidance Note (PGN) PGN01 (formerly TGN01) – Consideration for the use of personal fall protection equipment	Document provides brief guidance on considerations when selecting WAH equipment including: – suitability – condition – traceability – compatibility – security – anchorages – fit – age of equipment – clearance – selection	Document is very basic, providing headings and a brief overview on considerations Document could not be used on its own, as it does not go into detail and offers no specific information on manufacturing standards
WAHSA Technical Guidance Note (TGN) TGN01 (Formerly TGN02) – Guidance on the selection, use, maintenance and inspection of retractable type fall arresters	Document provides detailed information on: – the function of a fall arrester – applicable standards – when a fall arrestor should be used – safety concerns when using fall arrester – checks to be made if intending to use a fall arrester – pre-use checks to be carried out on the fall arrester – inspection and servicing frequencies of a fall arrester – cleaning, storage and maintenance of a fall arrester – training and rescue when using a fall arrester	The document makes reference to suitable clearance distance but does not provide any information on how to determine this clearance or where to find this information
WAHSA PGN02 (formerly TGN03) – Guidance on inspecting personal fall protection equipment	Provides guidance on the interpretation of regulation 12 of the Work at Height Regulations 2005 Areas covered include: – the UK legal requirements for inspection – practical reasons for inspection – details on inspection frequencies and regimes – competence requirements of inspectors – record keeping – withdrawing equipment from use Document also references relevant British Standards, UK regulations and HSE guidance	Document is fairly high level and does not offer detail on actual inspection criteria

Table C.1: Review of existing WAH guidance (continued)

Document	Scope and industry relevance	Comments
WAHSA TGN02 (formerly TGN04) – Guidance on the use of single and twin energy absorbing lanyards	Provides information on the use of energy-absorbing lanyards. Areas covered in the guidance include: – The function of energy-absorbing lanyards – Correct and incorrect methods of attaching an energy-absorbing lanyard – Differences between a single lanyard double lanyards and twin lanyards – Information on acceptable lanyard life – Information on acceptable user weight – Training recommendations The guidance also references other documents in the WAHSA guidance note series, standards, codes of practice, UK regulations and HSE guidance	
WAHSA PGN03 (formerly TGN05) – Guidance on rescue during work at height	Provides guidance on emergency planning and the provision of rescue resources for WAH: – the legislative requirements for emergency planning – considerations for rescue – types of casualty rescue – procedures for casualty recovery – medical implications of suspension – overview of rescue equipment and its inspection including relevant standards – first aid	
WAHSA TGN03 (formerly TGN06) – Guidance on inspecting eyebolts used for personal fall protection purposes	Document provides guidance on carrying out examination on class A1 anchor devices as per BS 7883:2005. Areas covered in the guidance include: – background to the guidance – definition of class A1 anchor devices – periodic examination requirements – competence for inspection – examination reports – labelling – marking of eyebolts – test equipment	Terminology is not aligned with current edition of product standards
WAHSA PGN06 – Guidance on CE Marking	Document provides guidance on why different items of equipment for WAH are/are not CE marked	

Table C.1: Review of existing WAH guidance (continued)

Document	Scope and industry relevance	Comments
RenewableUK Offshore Wind and Marine Energy Health and Safety Guidelines 2014	Document provides health and safety guidance based on existing UK health and safety legislation and emerging good practice, and consists of three parts covering: A – Health and Safety Management B – The Offshore Project Life cycle C – Offshore Hazards and Activities Section C-24 presents a detailed examination of work at height offshore, including: – Direct WAH health and safety risks – Commercial and operational risks relating to WAH – Relevance of WAH to the key life cycle phases of an offshore project – The regulatory requirements of work at height offshore – Identifying opportunities to effectively manage offshore WAH risks – Considerations when carrying out reviews or managing changes	The work at height section does not go into any technical detail, only comprising one section of the wide-ranging overall guidance
GWO Basic Safety Training	The WAH module of this training standard specifies the requirements for the GWO's basic two-day work at height course and one-day refresher Its purpose is stated by the GWO as being to provide 'the necessary basic knowledge and skills through theoretical and practical training to use basic PPE and perform safe work at heights and safe and comprehensive basic rescue from heights in a remote wind turbine environment'	It does not address the specific training and knowledge requirements for complex rescues from locations with restricted access, or locations from which the casualty cannot be lowered to safety. However, it provides the basic training that serves as a foundation for more advanced training to address specific situations
IRATA – Application of rope access methods in the construction, inspection, repair and maintenance of wind turbines	Guidance document for work in and on wind turbines located both onshore and offshore. Document is designed to supplement the IRATA ICoP and provides an overview of: – Planning and management of rope access work on turbines – Potential hazards when working offshore – Overview of competence and training requirements – Care and maintenance of equipment – Emergency procedures	Applicable to rope access works only

Table C.1: Review of existing WAH guidance (continued)

Document	Scope and industry relevance	Comments
IRATA – International Code of Practice (ICoP)	International voluntary code of practice gives definitions, recommendations and guidance on the use of IRATA International rope access methods. Document consists of five parts that provide detailed information on: Part 1: Document scope, terms and definitions, principles and controls Part 2: Detailed guidance on: – planning and management – objective – planning – pre-work analysis – risk assessment – safety method statement – procedures and personnel in place before work begins – competence – training – managers and supervisors – selection of equipment – inspection and care of equipment – primary rope access systems Part 3: Informative annexes Part 4: Legislation Part 5: Bibliography and further reading	Covers areas applicable to rope access operations only and does not cover certain line rescue techniques Note that rope access does not include fall arrest
HSE HSG150 – Health and safety in construction	Health and safety guidance aimed at everyone involved in construction work, providing information on various aspects of site safety. Document contains an extensive section on WAH which covers: – the WAH hierarchy of control, including practical examples of its use – selecting appropriate access equipment – steps to take before WAH – overview of safe working platforms – WAH equipment inspection and reports – types of scaffolding and their components – types of mobile access equipment – suspended access equipment – safety nets – rope access equipment and techniques	

Table C.1: Review of existing WAH guidance (continued)

Document	Scope and industry relevance	Comments
HSE work at height solutions – register at: http://webcommunities.hse.gov.uk	Website providing public question and answers covering various topics including falls from height, including: – Selection and use of equipment – Industries with prominent WAH risks – Industry-specific tasks and how to manage WAH risks	Although information offered can be used in the offshore wind industry, very little wind industry-specific questions are available
Step Change in Safety – Best practice guide to manriding safety 2002 and manriding checklist	Guidance document covering best practice information for manriding operations in the oil and gas industry. Areas covered include: – top 10 alternatives to manriding – training and competence – manriding hand signals – manriding competence task list – pre-manriding checklist – manriding register – participating companies	Updated in 2016, free to members, now focused on drill floor activities. Available for purchase from Step Change in Safety website
National Access and Scaffolding Confederation (NASC) – SG4:15 Preventing falls in scaffolding operations	Safety guidance for scaffolding operations, with a focus on maximising collective protection for scaffolders through the establishment and correct use of a 'scaffolders' safe zone'. Although a UK publication, it focuses on safe working techniques that could be applied elsewhere	SG4 has contributed to NASC members achieving an 82 % reduction in injuries due to falls from height from 1999 to 2014

ANNEX D
GUIDANCE ON TECHNICAL AND EQUIPMENT STANDARDS

This appendix lists the principal standards relevant to WAH, together with comments that provide information on their current status, any current areas of concern about their content, or common areas of confusion.

Additional introductory information is given in D.1 and D.2 respectively, on CE marking and environmental effects on equipment performance, as this is only partially addressed in the standards.

D.1 CE MARKING

The CE mark is only permitted to be applied to products that fulfil the 'basic' or 'essential' health and safety requirements of an EU directive or regulation on the supply of new products. For a product to bear the CE mark, it must either:

– fulfil the requirements of a harmonised EN standard, i.e. a standard that carries the presumption of conformity to the appropriate directive, or
– be assessed (on the basis of its technical file and type testing) against the requirements of the appropriate directive or regulation.

The definitive list of harmonised standards is published in the Official Journal of the EU; information is also available on the European Commission Enterprise and Industry website.

For typical equipment used in offshore wind, relevant legislation includes the:

– PPE Regulation 2016/425, which supersedes the PPE Directive, 89/686/EEC, and
– Machinery Directive 2006/42/EC (this includes WTGs, lifts in WTGs, and lifting accessories).

The Construction Products Regulation 305/2011 is mainly concerned with basic requirements of normal construction products (such as their structural and thermal performance), rather than the characteristics of specialised components such as anchor points. However, as anchor points that are permanently fixed to a structure are excluded from the scope of the PPE Directive, a new standard is being prepared under this regulation.

The PPE Directive is being superseded by the PPE Regulation 2016/425; however, the essential health and safety requirements are largely unchanged.

Health and safety directives, such as the Work Equipment Directive, which impose duties on employers in relation to the provision and use of work equipment, do not contain any provisions relating to CE marking.

There are several different situations in which an item of equipment cannot bear a CE mark; the safety implications of products without the CE mark are discussed in Table D.1. It should be noted that there is no single recognised marking that indicates that an equipment item conforms to a non-harmonised standard.

Table D.1: Safety implications of products without the CE mark

Reason for absence of CE mark	Probable safety implications	Example
The equipment conforms to applicable EN or national standards, but is of a class of equipment that is not subject to a directive	Safe, based on the standard	Rescue lifting device to EN 1496:2017
There is no applicable standard	Safety depends on design, testing and product quality	Lifting bag[23]
The equipment conforms to a standard that does not satisfy the health and safety requirements of a relevant directive	Unsafe	Fall arrester to EN 353-1: 2002, without having passed the additional testing requirements
The equipment does not conform to applicable standards	Unsafe	Connectors that have not been sourced through an appropriate supply chain, and are of unknown origin and performance

D.2 ENVIRONMENTAL EFFECTS ON EQUIPMENT PERFORMANCE

Testing requirements in the standards may include carrying out performance tests in a range of ambient temperatures, and in both wet and dry conditions.

Certain standards listed in the following sections include corrosion testing, such as by undertaking a neutral salt spray test in accordance with EN ISO 9227; however, this does not necessarily imply suitability for use in a marine environment – particularly in challenging locations such as the splash zone. Information on suitability for such use, and any additional requirements for care and inspection, should be obtained from the manufacturer.

D.3 STANDARDS CURRENTLY IN DEVELOPMENT

Certain key standards, which will affect WAH in offshore wind, are currently in development:

– IEC TS 61400-30 Wind turbines – Part 30: Safety of Wind Turbine Generator Systems (WTGs) – General principles for design is forecast to be published in 2019.

– EN 81–44 Lifts in wind turbines is currently in development. This will be a new harmonised standard under the Machinery Directive and will therefore form the basis of CE marking of future types of lift[22]. There is no confirmed timeline for its publication.

22 Lifting accessories are subject to the Machinery Directive, but lifting bags are not classified as lifting accessories (in contrast to items such as textile slings). See Machinery Working Group publication *Classification of equipment used for lifting loads with lifting machinery* for details of equipment classification.

D.4 SUMMARY OF STANDARDS

The standards summarised in this section are grouped into:

– Codes of practice, which define principles and methods for carrying out work, specifying and using equipment, delivering training, and terminology.
– PPE and other safety equipment standards, which define the performance and testing requirements for these types of equipment. With respect to safety helmets, several different standards can apply, depending on which hazards the helmet is to protect against.
– Design standards for safety aspects of WTGs and means of access between levels.

Table D.4.1: Codes of practice and general requirements

Standard	Subject	Comments
ISO 22846-1: 2003	*Personal equipment for protection against falls. Rope access systems. Fundamental principles for a system of work*	Provides the fundamental principles for a safe system of work in industrial rope access; the IRATA ICOP adopts these
ISO 22846-2: 2012	*Personal equipment for protection against falls. Rope access systems. Code of practice*	Does not cover the 'quality' aspects provided by trade association, e.g. IRATA; the IRATA ICOP provides much more detail
EN 363: 2008	*Personal fall protection equipment. Personal fall protection systems*	Describes fall protection systems, built up from the components in product standards (e.g. anchor point + lanyard + harness)
EN 364: 1993	*Personal protective equipment against falls from a height. Test methods*	Contains information on test facilities and equipment, as well as methodology (Note: As new standards are produced, the methodologies are being superseded). More applicable to manufacturers and notified bodies
EN 365: 2004	*Personal protective equipment against falls from a height. General requirements for instructions for use, maintenance, periodic examination, repair, marking and packaging*	Primarily (not exclusively) aimed at manufacturers

Table D.4.2: PPE and other safety equipment standards

Key:
PPE?: indicates whether or not the standard relates to PPE.
PoC?: indicates whether conformity to the requirements of the standard provides Presumption of Conformity to the basic requirements of the PPE Directive. (Note that there will be a transition to the new PPE Regulation 2016/425).

Standard	PPE?	PoC?	Subject	Comments
EN 1868: 1997	N/A	N/A	*Personal protective equipment against falls from a height. List of equivalent terms*	Informative document, rather than normative – lists terms in multiple languages, e.g. English, German, French
EN 341: 2011	No	No	*Personal fall protection equipment. Descender devices for rescue*	Includes both automatic (Type 1) and manually operated (Type 2) descender devices: Type 1 devices (such as constant rate descenders) do not require any intervention by the user to control their speed, once their descent has started; Type 2 devices have a braking system that requires user intervention, and therefore travel with the user down a fixed rope The standard includes four classes of descender, according to whether they are for multiple descents (Classes A to C) or one descent only (Class D). Each of classes A to C has a different descent energy rating, which determines the limit on the product of weight, height of descent and number of descents that the device can control
EN 353-1: 2002	Yes	No	*Personal protective equipment against falls from a height. Guided type fall arresters including a rigid anchor line*	Presumption of conformity was withdrawn due to safety concerns in relation to the effectiveness of these devices in the event of a person falling backwards or sideways. Additional testing was introduced through the Co-ordination of Notified Bodies for the PPE Directive Recommendation for Use sheet CNB/P/11.073, and the standard was superseded in 2014. Any affected systems should have been upgraded – in most cases, this involved replacement/modification of sliders and end stops. If using an FAS certified to this standard, then these points should be checked

Table D.4.2: PPE and other safety equipment standards (continued)

Standard	PPE?	PoC?	Subject	Comments
EN 353-1: 2014	Yes	Yes	*Personal fall protection equipment – Guided type fall arresters including an anchor line*	The revised standard addresses the shortcomings in the 2002 edition, and regains the presumption of conformity, thereby eliminating the need to undertake additional tests beyond those contained in the standard The scope and the requirements are based on the philosophy that a guided type fall arrester including a rigid anchor line is rated to sustain the maximum dynamic load generated in a fall from a height by the mass of one person, including any equipment carried. The standard provides requirements and test methods for such fall arresters, used in personal fall protection systems in accordance with EN 363 Annex B provides details of significant technical changes between this document and the previous edition EN 353-1:2002
EN 353-2: 2002	Yes	Yes	*Personal protective equipment against falls from a height. Guided type fall arresters including a flexible anchor line*	Flexible anchor line is a synthetic fibre or wire rope, attached only at an upper anchor point – most commonly used on a temporary basis, prior to installation/commissioning of a permanent FAS The condition/age of the rope can affect the effectiveness of the 'rope grab' element of this type of FAS; testing is always done on new rope (including under conditions of heat, cold and wet, and optionally with dust or oil contamination)
EN 354: 2010	Yes	Yes	*Personal fall protection equipment. Lanyards*	This standard relates to restraint lanyards – by definition, must not be able to get to the fall hazard, as these lanyards do not provide any shock absorption – Standard does not include requirements or testing of resistance to UV and abrasion, but does include testing in wet/cold conditions, and for slippage of the adjusting mechanism – Do not 'choke' the lanyard unless the manufacturer permits this (and has been tested accordingly)

Table D.4.2: PPE and other safety equipment standards (continued)

Standard	PPE?	PoC?	Subject	Comments
EN 355: 2002	Yes	Yes	*Personal protective equipment against falls from a height. Energy absorbers*	To minimise the distance and consequences of a fall: – Attach lanyard as high as possible (consistent with the tasks to be carried out) – Use the shortest possible lanyard that can reach the available anchor points (maximum available is 2 m, shorter is preferable) – Ensure that there is sufficient clearance for the lanyard to arrest potential falls – Always attach above body's centre of gravity, and centrally – never use a side attachment point for fall arrest – Beware of pendulum falls – user may swing into obstruction; also risk of lanyard being damaged/cut if it slides along a sharp/rough edge while user is swinging – Do not extend the fall height, for example by adding additional slings or karabiners to the system – Stow carefully when not in use – long lanyards are a tripping hazard Standard covers different types: – Single leg, for attachment to a fixed or mobile anchor point – Twin-tailed ('y-shaped') lanyard with single energy absorber – enables continuous attachment while moving around – but don't clip spare leg back to harness, as energy absorber will be bypassed – Two single-legged energy absorbers – don't clip both legs to the same anchor (except momentarily whilst traversing) – the forces to extend each of the lanyards add together, risking injury Standard test is with 100 kg mass; check min/max user weights in instructions. Energy absorbers start to deploy at 2 kN, so users should avoid exerting a shock load Note that lanyards need to be compatible with the rescue kit: if the rescue kit includes a rope grab, it must be capable of engagement with the lanyards – webbing-type lanyards are incompatible with most rope grabs

Table D.4.2: PPE and other safety equipment standards (continued)

Standard	PPE?	PoC?	Subject	Comments
EN 358: 2000	Yes	Yes	*Personal protective equipment for work positioning and prevention of falls from a height. Belts for work positioning and restraint and work positioning lanyards*	a) Standard covers both the belt and the lanyard b) Assess back support ('comfort') as per BS 8437

EN 360: 2002	Yes	Yes	*Personal protective equipment against falls from a height. Retractable type fall arresters*	– Should not use over edge
				– Avoid pendulum falls – risk of swinging into obstruction, or rope being damaged/cut as it runs along edge
				– Use in the correct plane, i.e. an overhead anchor point is generally required – there is no test to prove the 'cone of influence'
				– Don't leave anchor line extended – use a tag line
				– Check path of cable is not impeded
				– Consider whether the following features are required:
				  – Swivel hook
				  – Fall arrest indicator
				  – Short webbing attachment strop
				  – Retraction brake
				  – Integral rescue lifting device (option on larger blocks)
				  – Tolerance of some movement before starting to engage, to allow use from vessel at boat landing on offshore structure – but note that there is no standard test/specification for this feature
				  – Suitability for wet, dusty, cold and icy conditions
				  – If using with horizontal anchor lines, check if 'ratchet bounce' is an issue
				  – Need to be able to achieve the 'lock on' speed – ensure that obstructions in fall path will not prevent this
				– Standard is currently being revised; the main changes expected are in test and marking requirements

Table D.4.2: PPE and other safety equipment standards (continued)

Standard	PPE?	PoC?	Subject	Comments
EN 361: 2002	Yes	Yes	*Personal protective equipment against falls from a height. Full body harnesses*	– Assess 'comfort' e.g. leg loops for climbing – Good fit is important, e.g. adjustability – Care with choice of connector(s) for front attachment point: webbing loops can close up during rescue (versus a D-ring) and cross-gate loading should be considered – Instructions for use will specify how attachment points are to be used, and how to ensure compatibility – The standard allows for attachment to fall arrest systems at the front (sternal) or back (dorsal) positions; however, note that if fall arrest lanyards are attached to the dorsal attachment point, they will have to be longer than if they were attached at the front, thereby increasing the distance of any fall – When working in work positioning/restraint, always attach to both sides of work positioning belt, otherwise the load will not transfer to the sub-pelvic straps of the harness, risking injury to internal organs
EN 362: 2004	Yes	Yes	*Personal protective equipment against falls from a height. Connectors*	Standard covers – Screwlink connectors, for locations that are used infrequently – Basic connectors (such as karabiners) – Termination connectors (such as scaffold hooks) – Self-closing, manual locking and self-locking types of gate Usage: – Consider the alignment of any connectors – Consider 'roll out' – Keep loading to 'spine' – use of wide strops can distribute the load further away from the spine, increasing the stress on the connector – Consider whether a 'captive' connection is required?

Table D.4.2: PPE and other safety equipment standards (continued)

Standard	PPE?	PoC?	Subject	Comments
EN 795: 2012	Some	No	*Personal fall protection equipment. Anchor devices*	EN 795 anchor points are only for single users – for multi-user anchor points see PD CEN/TS 16415: 2013 For exclusions see Scope, e.g. the standard does not cover 'structural' anchors EN 795 and TS 16415 do not cover anchor systems that are not intended to be removed from the structure, and therefore may not strictly apply to most anchor systems in WTGs; however, the test methodology is still a valid approach Type C: 'Horizontal' is defined as +/– 15° – must ensure that attachment to the system is done in a point of safety Check anchor loads resulting from 'vector' forces Note that anchor devices that are permanently fixed to a structure (Types A, C and D in this standard) are not classified as PPE, and therefore cannot be CE marked under the PPE Directive, under which this standard is harmonised. Regulatory work is in progress to address this, potentially allowing CE marking in future under the Construction Products Regulations
EN 813: 2008	Yes	Yes	*Personal fall protection equipment. Sit harnesses*	Consider adequacy of back support and comfort of leg loops
EN 1263: 2014	No	No	*Safety nets:* *1 – Safety requirements, test methods;* *2 – Safety requirements for the positioning limits*	Specifications for the manufacture, testing and installation/positioning of safety nets for fall arrest. Only applicable to nets exceeding 35 m^2 area and shortest side at least 5 m. The maximum permissible fall height into these nets is 6 m from the working level to the net, reduced to 3 m if the fall would be within 2 m of the edge of the net. (Positioning requirements are amended in Denmark, to comply with national regulations)
EN 1496: 2017	No	No	*Personal fall protection equipment. Rescue lifting devices*	New revision of standard. No substantive changes with respect to device performance. Compliance with this standard does not allow application of the CE mark
EN 1497: 2007	Yes	Yes	*Personal fall protection equipment. Rescue harnesses*	

Table D.4.2: PPE and other safety equipment standards (continued)

Standard	PPE?	PoC?	Subject	Comments
EN 1498: 2006	No	No	*Personal fall protection equipment. Rescue loops*	May not be as appropriate (comfort) as a 'nappy' rescue harness, but useful in restricted access areas
EN 1891: 1998	Yes	Yes	*Personal protective equipment for the prevention of falls from a height. Low stretch kernmantel ropes*	Standard rope is Type A – low stretch ('semi-static')
EN 12841: 2006	Yes	Yes	*Personal fall protection equipment. Rope access systems. Rope adjustment devices*	Back-up devices (Type B): Opinion has been expressed that part of the standard is flawed. Standard is currently under revision
PD CEN/TS 16415: 2013	No	No	*Personal fall protection equipment. Anchor devices. Recommendations for anchor devices for use by more than one person simultaneously*	EN 795 and TS16415 do not cover anchor systems that are not intended to be removed from the structure, and therefore may not strictly apply to most anchor systems in WTGs; however, the test methodology is still a valid approach
EN 397:2012 +A1:2012	Yes	Yes	*Industrial safety helmets*	See comparison of safety helmet standards for further details
EN 12492:2012	Yes	Yes	*Mountaineering equipment. Helmets for mountaineers. Safety requirements and test methods*	Commonly used in wind industry, but are generally incompatible with PPE such as ear defenders, face visors etc See comparison of safety helmet standards for further details
EN 14052:2012 +A1:2012	Yes	Yes	*High performance industrial helmets*	New standard – fulfils site safety helmet requirement but also meets climbing requirements, close fitting, no peak, undergo impact testing across top and sides of helmet, 2-point chin strap retention strap system, able to mount head torch and other PPE (depending on design) See comparison of safety helmet standards for further details

Table D.4.3: Comparison of safety helmet standards

Standard	EN 397	EN 12492	EN 14052
Title of standard	*Industrial safety helmets*	*Mountaineering equipment. Helmets for mountaineers*	*High performance industrial helmets*
Purpose	Protect the wearer against **falling objects** and consequential brain injury and skull fracture	Protect the upper part of a wearer's head against **hazards which might occur during activities carried out by mountaineers**	**Greater protection from falling objects,** protection from off-crown impacts and protection from penetration by a flat blade striker It also includes a **retention system** that meets mandatory requirements for system **release force** and system **effectiveness**
Mandatory requirements	**Shock absorption** (**vertical**), resistance to penetration, flame resistance, **chin strap strength and release** and label	**Shock absorption, (vertical, front, side, and rear)**, resistance to penetration, **retention system strength and effectiveness** (roll off) and label	**Shock absorption at the crown and a range of angles**, resistance to penetration, **retention system strength, release and effectiveness**, flame resistance and label
Optional requirements	Very low temperature (–20 °C or –30 °C), very high temperature (+150 °C), electrical properties (up to 440 V ac), lateral deformation and molten metal splash		Performance at lower temperatures, performance at higher temperature, resistance to radiant heat, electrical properties and molten metal splash
Shock absorption	A **5 kg** striker (with a hemispherical surface) is dropped onto the helmet from a height of **1 m** The maximum transmitted force cannot exceed **5 kN**	**5 kg hemispherical striker** is dropped from a height of **2 m**, at **top** A **5 kg flat striker** is dropped from a height of **500 mm, at the front, rear and sides** The transmitted force cannot exceed **10 kN**	**Crown impact**: **100 J** (**5 kg dropped 2,04 m**). **Off-crown impacts: 50 J (5 kg dropped 1,02 m)** with the headform inclined at **angles of 15°, 30°, 45° and 60°** The force transmitted shall not exceed **5 kN** for an impact to the crown and the deceleration of the striker shall not exceed 300 *g* for off-crown impacts

Table D.4.3: Comparison of safety helmet standards (continued)

Standard	EN 397	EN 12492	EN 14052
Penetration	A **3 kg pointed cone striker** is dropped from a height of **1 m**, onto an area **at the crown** of the helmet. The striker must not contact with the headform underneath the helmet	A **3 kg pointed cone striker** is dropped from a height of **1 m**. The striker must not contact with the headform underneath the helmet. Tests can be carried out on **any point around the shell** of the helmet	A **1 kg flat blade striker** is dropped **2,5 m** (**crown** impacts) and **2 m** (**off-crown** impacts), with no contact between the striker and headform allowed
Chin strap/ retention system	Chin strap is optional. If fitted, it must have a minimum width of 10 mm, when untensioned. The standard requires that the **anchorage shall withstand no less than 150 N, but break at no more than 250 N**	Chin strap can **withstand a sustained load of 500 N** for two minutes, with <25 mm of movement of the helmet. There is **no specified breaking force for the strap** **Basic testing of retention system effectiveness**	Chin strap is optional, but manufacturer may specify it as an essential part of retention system. **Must release at a force of no less than 150 N and no more than 250 N. Additional testing of retention system effectiveness**, using test headform and people carrying out specified exercises
Warnings in text of standard		Mountaineers' helmets are fitted with a retention system to retain the helmet on the head. However, there may be a foreseeable risk that helmets could become trapped and thereby cause a **risk of strangulation**	No requirements concerning **mechanical rigidity**, as no valid test method was recognised by the technical committee

Nothing in EN 397 would prevent a manufacturer from offering a helmet with a shell that also passed all or some of the additional testing requirements in EN 12492, combined with a chin strap that released as required under EN 397; such a helmet could only be certified to EN 397, but could be accompanied by information stating the additional type testing of the shell that had been undertaken. Users should ensure that they read the instructions for PPE, and use it as intended, taking account of any warnings or limitations.

Table D.4.4: Design standards

Standard	PoC?	Subject	Comments
EN ISO 14122:2016	Yes*	*Safety of machinery – Permanent means of access to machinery* ** – Note that this is a harmonised standard, giving presumption of conformity in relation to certain essential Health and Safety requirements of the Machinery Directive*	Standard is in four parts: Part 1: Choice of a fixed means of access between two levels; Part 2: Working platforms and walkways Part 3: Stairways, stepladders and guard-rails Part 4: Fixed ladders While the standard provides detailed and useful design requirements, some of its provisions conflict with current understanding of safe design (for example, the standard prefers the use of hoop ladders to fall arrest systems)
PD CEN/TS 16415: 2013	No	*Personal fall protection equipment* *Anchor devices. Recommendations for anchor devices for use by more than one person simultaneously*	EN 795 and TS 16415 do not cover anchor systems that are not intended to be removed from the structure, and therefore may not strictly apply to most anchor systems in WTGs; however, the test methodology is still a valid approach
EN 50308:2004	No	*Wind turbines — Protective measures — Requirements for design, operation and maintenance*	Refers to EN ISO 14122 for walkways, climbing facilities such as ladders Specifies anchor points in detail, 20 kN for safety lines/10 kN per person (min 20 kN) for emergency descent points Specifies ladders to be 'safeguarded by an anti-fall device comprising an anchorage line and fall-protection mechanism or a climbing cage (shaped structure) if the vertical height exceeds 3,0 m, although allows for omission of cage if ladder is within 0,8 m of WTG wall, and climber has back to wall Shortcomings of the standard are widely recognised; a revised draft was released in 2013, but was not adopted. Note that PD IEC/TS 61400-30 Ed.1.0 Wind turbines. Part 30: *Safety of Wind Turbine Generator Systems (WTGs) – General principles for design* is currently being developed

Table D.4.5: Walk to work gangway standards

Title	Description
DNVGL-ST0358 Certification of offshore gangways for personnel transfer (download)	Generic certification standard, applicable to all types of offshore gangway. Scope of standard includes structural, functional, safety and procedural aspects, and can be used to certify a gangway as a standalone unit, prior to installation on a vessel
Gangway access to offshore facilities *Walk-to-Work (W2W) – industry guidance*	The 'W2W Joint Industry Project' led by DNV GL developed this comprehensive industry guidance document to assist offshore facility operators in achieving safe and efficient personnel transfers to/from their facilities via a gangway system Key parts of the guidance include: – Vessel and gangway selection – Gangway mobilisation onto a vessel, including risk management, performance prediction, procedures, workforce engagement, training and competence – Gangway operation The guidance also addresses aspects specific to offshore wind Can be downloaded after submitting a request on DNVGL website

ANNEX E
REVIEW OF FITNESS STANDARDS

A detailed review was carried out of the following standards:

- RenewableUK Medical Fitness to Work – Wind Turbines.
  - Guidelines for near offshore and land based projects.
- Oil and Gas UK (OGUK) – Medical Aspects of Fitness for Work Offshore;
  - Guidelines for examining physicians.
- UK Maritime and Coastguard Agency (MCA) ENG1 Certification process.
- Energy Institute (EI) publication 'A recommended fitness standard for the oil and gas industry'.

The Summary of medical fitness assessments is given in Table E.1, and covers the approach and criteria that are set out in each of these standards. It should be noted that only the RenewableUK standard has been specifically created for the wind industry; however, this standard does not set out to cover far-offshore wind farms or other situations where people are offshore for more than 24 h at a time.

Of these four publications, the EI standard is entirely focused on fitness assessment; the other three approaches consider a wide range of underlying health issues, as listed in the Summary of aspects of health considered in medical assessments.

In addition to the listed standards, certain countries have statutory medical examination requirements for personnel undertaking WAH; these include:

- Germany:
  - Arbeitsmedizinische Eignungsuntersuchungen für Arbeitnehmer auf Offshore-Windenergieanlagen und Offshore-Installationen (AWMF guideline 002/43) medical has been specifically developed for the assessment of people working on offshore WTGs and other offshore installations. (Note that there is a separate 'G41' medical for onshore WAH).
    - The assessment is undertaken by doctors who specialise in occupational health, and considers a wide range of aspects of health.
    - It includes urine and blood sample analysis, hearing test, electrocardiogram (ECG) tests, and fitness testing (in terms of achieving a specified work rate, in relation to body mass). Additional tests may be carried out if deemed clinically necessary by the doctor.
    - The assessment can take account of relevant factors in the specific offshore workplace where the person will be working, such as the frequency and duration of offshore work, and the medical facilities available.
- Sweden:
  - AFS 2005:6 Art 41–45 defines medical examination requirements for a wide range of areas of work, with specific requirements for WAH:
    - Examination takes place annually, or following a relevant illness or accident.
    - Includes history of diseases or illnesses that can cause sudden loss of consciousness, or other sudden weakness.

- Includes routine physical status with determination of blood pressure and the propensity for orthostatic reaction, assessment of cardiac and pulmonary status, and stress test with ECG monitoring. Frequency of ECG depends on age of candidate:
  - once every five years for persons under 40 years old;
  - biannual for persons between 40 and 50, and
  - annual for persons over 50.

Table E.1: Summary of medical fitness assessments

Body	Purpose/target group	Approach/focus
RUK	Personnel working onshore and offshore, returning to shore within 24 h	Health and fitness in relation to typical WTG tasks
OGUK	Personnel working on installations, up to 200 miles from shore, with a crew of 20–250 persons; typical factors in this work include: Helicopter transfer, two–three week offshore tour of duty Offshore survival and breathing apparatus training required; Offshore medic on installation Evacuation to shore may take four–five hours and could be delayed for two–three days at a time due to weather	Risk assessment in relation to role, which may be specific (or restricted by the outcome of the medical) to a single installation Strong emphasis on underlying health conditions that could present increased risk offshore
MCA	Unrestricted medical certificate allows work anywhere in world, in any role on any type of vessel	Risk assessment, which may lead to an unrestricted certificate, or various levels of restriction (of duration and role) Strong emphasis on underlying health conditions Carried out by doctors appointed by MCA, who should have an understanding of maritime operations
EI	Clearly-defined fitness tests and their application to typical offshore oil and gas roles	Fitness in relation to typical demands of offshore roles Does not consider underlying health conditions

Note that the MCA Chief Medical Adviser is quoted in the RUK medical fitness guidelines as stating in March 2011 that '*The MCA standards should not be used except for the crews of vessels. Employment decisions for wind farm technicians based on these standards will not be valid, may not be safe and could leave the employer open to a legal challenge if a person is denied employment*'.

Shaded cells indicate that the standard considers the listed aspect of health; the actual health standard for each aspect may vary depending on the role for which the candidate is being assessed, and the combination of health issues that an individual presents.

Table E.2: Summary of aspects of health considered in medical assessments

Aspect of health	RUK	OGUK	MCA
Vision			
Hearing			
Cardiovascular system			
Respiratory health			
Locomotor system			
Nervous system			
Diabetes			
Mental state			
Drugs and alcohol			
Skin conditions			
Peripheral circulation			
Obesity			
Physical fitness to climb			
VO_2max: defined minimum value			
Gastrointestinal system			
Musculoskeletal disorders			
Genitourinary disorders			
Diseases of blood-forming organs			
Organ transplants			
Malignant neoplasms			
Infectious diseases			
Dental health			
Allergies and anaphylaxis			
Medications being taken			
Pregnancy			
Specific requirements for emergency response teams			
Specific requirements for crane operators			

E.1 KEY FINDINGS

None of the above standards has been created specifically to address the combination of risks that are present in offshore wind. Both the OGUK and ENG1 standards are based on a risk assessment approach, which relies on the medical practitioner having sufficient understanding of:

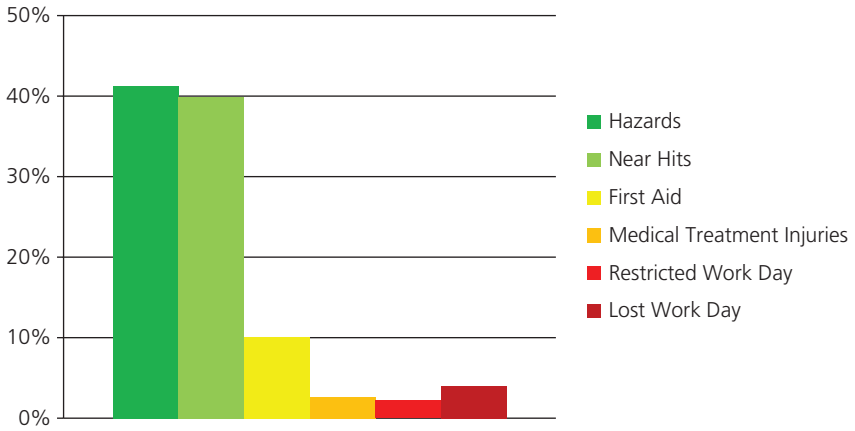
- the demands of a role, and how a person may:
  - be fit to fulfil these demands, or
  - have health issues that may be adversely affected by the demands, and
- the consequences of any health problem occurring when a person is at their place of work, including:
  - the level of medical care (if any) that is immediately available, and
  - the potential duration and challenges of evacuating the casualty to the level of medical care that their condition may demand.

Medical practitioners can only be expected to make valid assessments if they are given sufficient information on the role, and context of the role, for which the person is being assessed. The RUK guidelines could be used to provide such information, although with modifications to reflect the differences in far-offshore and long-duration deployments.

ANNEX F
INCIDENT DATA AND RISK PERCEPTIONS

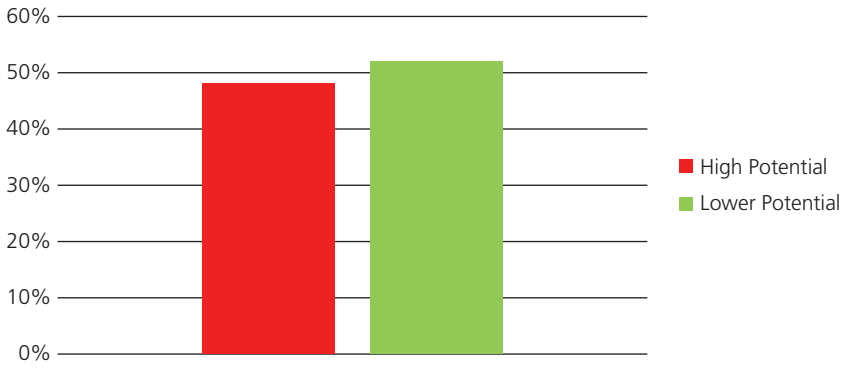
F.1 ANALYSIS OF G+ MEMBER INCIDENT DATA

Prior to development of the original guideline, G9 member incident data from January 2011 to June 2012 were provided for analysis; within this period of 18 months, the nine companies reported a total of 95 incidents. During the drafting of the revised guideline, G+ member incident data for 2014–16 were analysed, as shown in the WAH graphs in this section. The data listed around 240 incidents related to work at height.

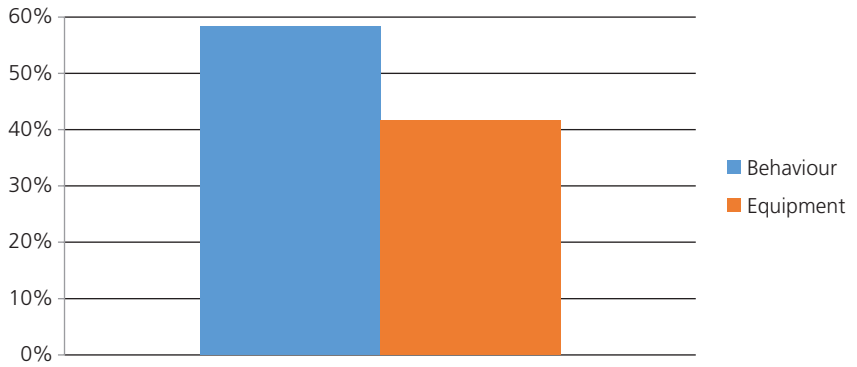


Graph 1: Actual severity of the incidents

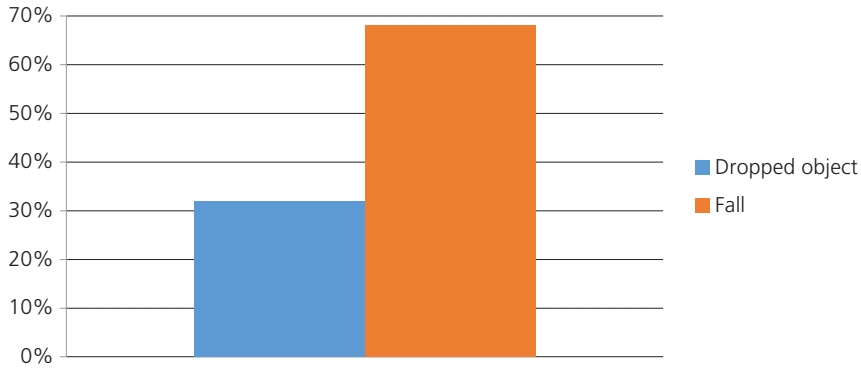
Note that 81 % of reported incidents were in the 'Hazard' or 'Near Hit' categories, in which no actual harm occurred to people. Effective reporting in these categories can help to minimise the number of incidents that result in injury.



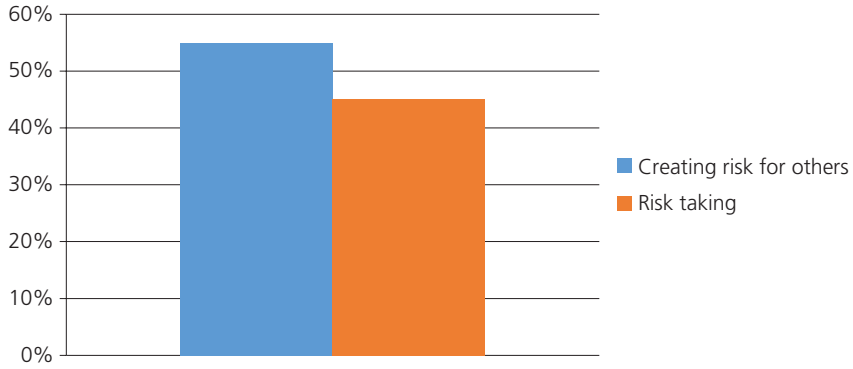
Graph 2: Potential severity of the incidents



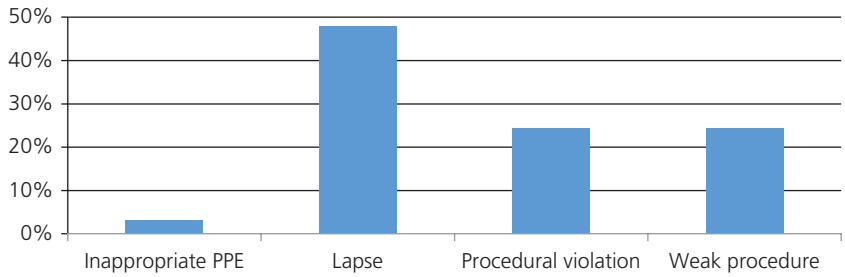
Graph 3: Immediate cause of the incidents



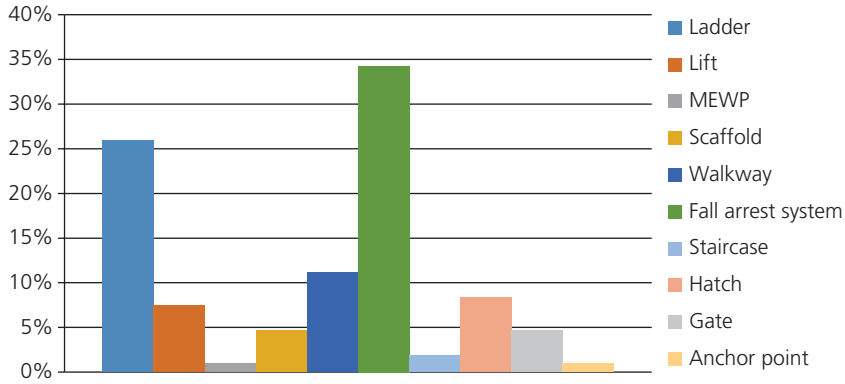
Graph 4: Identified hazard in the incidents



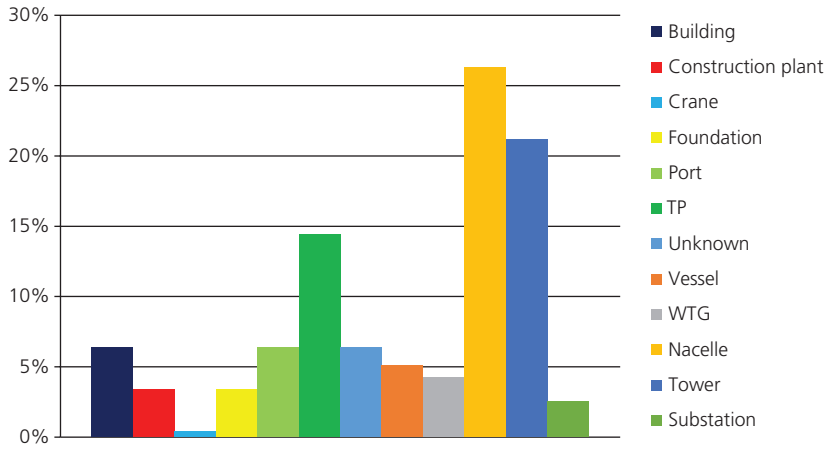
Graph 5: Who was put at risk by behavioural failures



Graph 6: Types of behavioural failure identified



Graph 7: Types of access equipment being used in fall-hazard incidents



Graph 8: Locations of the incidents

F.2 SURVEYS TO IDENTIFY AREAS OF CONCERN

Following a project workshop with G9 representatives during preparation of the first edition guideline, it was agreed that an informal survey should be undertaken to identify areas of concern relating to WAH. Participants in the survey were asked 'What are your top 10 health and safety concerns relating to work at height?' The survey was carried out by:

– G9 representatives asking colleagues/contractors, and
– a questionnaire being offered to candidates at heightec, undertaking WAH revalidation courses for wind turbine climbing; 29 completed questionnaires were received in time for inclusion in this analysis.

This approach allowed the opinions of a wide range of technicians, managers and safety professionals to be taken into account.

The responses were collated, taking account of the rank that participants assigned to their different concerns; the results are given in Table F.1 below. While there was broad agreement in the areas of concern, there are some noteworthy differences in perception:

– The heightec survey was mainly completed by technicians, who expressed higher levels of concern about procedures and rescue provision than the G9 results.
– Conversely, the G9 results had much higher levels of concern about falling objects and behaviour, which may reflect the 'management' perspective of this survey group.

This difference in perception is important, as it will affect the behaviours and priorities of the two groups in seeking to achieve safe WAH. All the priority areas identified by both groups are addressed within sections 3 to 5 of these guidelines.

Table F.1: Ranking of areas of concern from survey data

Topic Group	G9 Rank	heightec Rank
Design	1	2
Falling object	2	6
Vessel transfer	3	3
Procedure	4	1
Behaviour	5	9
PPE	6	8
Maintenance	7	11
Organisation	8	10
Training	9	7
Rescue	10	5
Other		4

The survey has not been updated in the preparation of the revised guideline.

ANNEX G
BEHAVIOURAL SAFETY: BACKGROUND INFORMATION

G.1 SAFETY CULTURE

Safety culture is defined in HSE guidance as:

> '*the product of individual and group values, attitudes, perceptions, competencies, and patterns of behaviour that determine the commitment to, and the style and proficiency of, an organisation's health and safety management.*
>
> *Organisations with a positive safety culture are characterised by communications founded on mutual trust, by shared perceptions of the importance of safety and by confidence in the efficacy of preventive measures*.'[23]

Each organisation on a project will have its own distinct safety culture – in some cases, different workgroups from the same parent company may also have different safety cultures. Safety cultures can be formally assessed using tools such as the Safety Culture Maturity Model[24], which can both be used internally (as a measurement tool to support improvement), and as a means of recognising differences in approach between different organisations that will be working together. Where organisations with different safety cultures work together, significantly different approaches to safety are likely to appear, and will have to be resolved. For example, an organisation with a well-developed safety culture is likely to generate a high number of hazardous observations, whereas an organisation with a weaker safety culture might see this as an indication of problems.

The leadership of an organisation or project will have a major influence, either positive or negative, on its safety culture.

G.2 TYPES OF UNSAFE BEHAVIOUR

There are several different types of unsafe behaviour, with different contributory factors, and requiring different approaches to achieve improvements; these are summarised in Table G.1.

23 HSE Human Factors Common Topic 4: *Safety Culture*

24 Step Change in Safety – 'Changing Minds Guide' Link not working search only found retailers websites

Table G.1: Behavioural faults and contributory factors

Type of error/behavioural fault	Typical contributory factors
Deliberate deviation from procedure – routine	– Procedures are incorrect or impractical (in the opinion of the worker, who has to use them) – Short cuts make it easier to accomplish task, and resulting increased risk is not recognised – Low expectation of getting caught
Deliberate deviation from procedure – situational	– Attempting to meet conflicting or unrealistic demands – Trying to get the job done despite not having all of the necessary/correct resources available
Deliberate deviation from procedure – exceptional	– Abnormal circumstances that cause someone to take actions that deviate from the procedures with which they normally comply
Errors of action – lapses or omission – forgetting a routine action; or slips – doing routine action incorrectly	– High levels of distractions/interruptions/ fatigue – Confusing sequences of tasks – Level of competence of worker
Errors of thinking – following incorrect procedure for the prevailing circumstances e.g. using methods/equipment on one type of WTG that are intended for another type	– Limited understanding of procedures and their application
Errors of thinking – unfamiliar situation leads to wrong course of action being taken e.g. accident occurs, team focuses on immediate rescue/first aid, and fails to initiate wider emergency response plan	– Lack of realistic practice (drills) in handling unfamiliar situations
Latent errors – ineffective training and communication	– Weak processes for briefing teams and for handovers when tasks span more than one shift/period of work – particularly critical where tasks are interrupted by unplanned events such as weather, and the ability to conduct an orderly handover is challenged – Communication challenges increase with multinational workforce, especially when different contractors work together on a project, using systems established by another contractor – Understand scope and remit of training
Latent errors – errors/omissions/lack of clarity in design or procedures	– Insufficient attention being given to preparation of procedures – Personnel operating beyond their competence

G.3 RESPONSIBILITIES FOR BEHAVIOURAL SAFETY

This section considers the roles and responsibilities of **employers**, contractors/employers and individuals, as each group has a different contribution to make. The exact roles may vary depending on contracting arrangements:

- On a construction project being managed by the client, with a multi-contractor approach, the client will have far more extensive responsibilities for the coordination of health and safety than on a project where the client only has the role of an employer, and the responsibility for health and safety coordination is fulfilled by a contractor
  - The EU Temporary or Mobile Construction Sites directive, as incorporated into national regulations such as the Construction (Design and Management) (CDM), defines specific appointments, and their responsibilities for construction projects.
- For work other than construction work, such as the majority of activities during the operations and maintenance phase, the employer is free to adopt a range of organisational models, with different aspects of work and safety management being undertaken by themselves or contractors.

G.4 EMPLOYER'S RESPONSIBILITIES

When an **employer** initiates any package of work, they:

- set the expectations (safety, price and schedule);
- appoint the main contractor(s), and
- have a role in monitoring how the work is carried out.

The exact legal duties will depend on the nature of the work, and which regulations apply. However, certain principles apply to most situations, and are outlined in the following sections.

G.4.1 Setting expectations

The **employer** has to set clear and consistent expectations for contractors. If safety is the priority, then contractor selection should reflect this; if contractor selection is too strongly weighted towards the price, or the project schedule is unrealistic (either in terms of activity durations, or lead time for mobilisation), then this may lead to:

- Lower-priced (and potentially less capable) vessels or sub-contractors being employed.
- People being over-stretched – rushing tasks, trying to do too many tasks at once, working when fatigued, or attempting tasks that are beyond their competence.
- Work starting with inadequate preparation, so necessary resources and safety management arrangements may be missing.
- Work continuing in unsuitable conditions.
- Inadequate monitoring and review of how work is carried out.
- Inadequate readiness and resources to respond effectively to incidents.
- A culture being created where short-cuts are tolerated (as they appear to save time and money).

– Pressure being put on people not to stop work on safety grounds, although this will seldom be stated explicitly.

Any of these factors could encourage unsafe behaviour.

The same expectations should be set for all contractors, for example, vessel crew working at height on the vessel should take similar precautions to those that a wind turbine technician would be expected to take on a similar task. If contractors have a background that does not include wind industry approaches to safe WAH, then additional effort may be necessary to set the expectations and ensure that personnel have appropriate training. Setting these expectations at the start of contractor selection can help to ensure that they are clearly defined as being at the core of the **employer's** requirements, rather than potentially being seen as an afterthought, or an extra cost for which the contractor had not budgeted.

G.4.2 Selection of contractors

The **employer** should assess the safety management capability of contractors, with the exact scope of the assessment reflecting the contractor's role.

- where a contractor will be carrying out work directly on behalf of the employer, key areas of assessment are:
  - how the contractor manages packages of work, such as how they define the scope of work, assess risks, prepare method statements, monitor execution of work, manage handovers between shifts and other teams, manage deviations from the expected method and review tasks on completion:
    - this should include the competence of people involved in preparing, supervising and executing work, and
    - competence assessment should consider both the technical ability to complete the task, and safety-related areas such as risk awareness;
  - the arrangements which the company has made for putting its policy into effect and for discharging its duties, and
  - leading and lagging indicators of safety, including evidence of hazardous observations being recorded and addressed, and jobs stopped if circumstances deviate from those envisaged in the procedure or method statement;
- Where a client is appointing a main contractor (who may also fulfil the functions of a 'project supervisor' and/or 'coordinator for safety and health matters at the project execution stage', as defined in EU Temporary or Mobile Construction Sites directive), the safety performance of the project will be highly dependent on how this contractor manages safety and selects contractors. In these cases, a thorough assessment should be made of this contractor's processes for:
  - Selection of contractors and personnel for key safety-related roles:
    - These processes need to ensure that a consistent level of competence is maintained at every level of subcontracting, particularly as the people who will actually be working at height may be employed by an entity that is several levels down the contracting chain.
  - Preparation and review of risk assessments/method statements and procedures.
  - Preparation of realistic schedules for work.
  - Communication with contractors.
  - Monitoring safe execution of work.
  - Managing deviations from expected situations, including response to incidents and emergencies.

While formal assessment of safety culture may be unrealistic, the **employer** should have an understanding of their own safety culture maturity, and that of their contractors, in order to ensure that they are broadly compatible, and to identify areas where significant differences exist, or improvements are needed.

G.4.3 Ongoing monitoring

Once contractors have been appointed, the **employer** still has a responsibility to ensure that the safety management arrangements are in place throughout the project. The means of doing this will depend on whether the **employer** is managing the work directly, or if a main contractor is managing the work; typical methods include:

- health and safety inspections and audits can be used to monitor whether work is being carried out safely, in accordance with the safety management system and approved procedures;
  - the follow-up to observations will depend on who is responsible for safety management;
- employer's representatives must put forward a consistent message on health and safety, ensuring that cost and schedule considerations do not start to take precedence over safety;
- employer's personnel on site must model the behaviours that the employer is seeking from the contractors, including:
  - respecting the safety management arrangements on a site, whether these have been implemented by the **employer** or a contractor, and not seeking to be exempt from compliance with site rules, and
  - taking appropriate action if they observe a hazardous situation or behaviour.

G.5 EMPLOYER'S RESPONSIBILITIES

This section outlines the responsibilities of contractors or other employers of people. For clarity, the term 'employer' is used throughout, but this should not be confused with the defined term '**employer**' in a contract between companies.

Employers are directly involved in the management of work, and the selection and deployment of people, so have a high level of influence on the behaviour of people undertaking their scope of work.

At the earliest stage of their involvement in a project, employers need to ensure that schedules and budgets are realistic, to enable safe preparation and execution of the work. This is supported by the **client's** duty to apply the general principles of prevention when estimating the period for completing work[25]. In the UK CDM regulations, this duty is explicitly stated as '*the allocation of sufficient time and other resources … to ensure that … the construction work can be carried out so far as is reasonably practicable without risk to the health and safety of any person*'[26]. This duty should balance the **client's** likely desire for the work to be done at the lowest cost and in the shortest timescale.

25 Council Directive 92/57/EEC of 24 June 1992 on the implementation of minimum safety and health requirements at temporary or mobile constructions sites, Article 4 link updated

26 Construction (Design and Management) Regulations 2015, Regulation 4 (1)

The employer's key responsibilities are to:

- identify hazards and assess risks;
- provide a safe system of work;
- ensure that the safe system of work is being operated effectively;
- provide the necessary information, instruction, training and supervision, and
- provide suitable and safe equipment, and ensure that it is used correctly.

Employers need to ensure that workers are competent to:

- undertake the intended task;
- identify and react appropriately to previously unforeseen hazards, and
- respond appropriately to incidents and emergencies affecting their work.

This level of competence goes beyond initial basic training and technical skills, and is about the qualities of being a safe worker:

- placing competent people into teams requires effective selection processes, together with training and development to build the necessary competence; however
- if the contracting environment results in a high proportion of personnel being on short-term contracts, the potential for developing competence will be reduced.

As incidents and emergencies should not be frequent occurrences, the responses should be practised regularly, so that people are ready to respond correctly to real incidents; this should include both the immediate rescue techniques, and site procedures for emergency response.

Deviations from approved procedures/methods will be minimised if:

- Employers ensure that procedures are accurate and practical;
  - This will only be possible if the procedures are prepared by competent people, with sufficient time.
  - In some cases, new procedures may have to be tested in carefully-controlled trial runs, before rolling out procedures to the whole organisation.
  - If situations change, or apparent errors are found in procedures, employers need to ensure that:
    - Workers do not ignore procedures that they consider to be wrong or not applicable, but are clearly empowered to stop the job in such situations.
    - Having stopped the job, workers and site supervisors have effective processes for reviewing procedures, together with clearly-understood boundaries within which they can make changes, and suitable support if further guidance is needed.
  - If workers can see potential improvements to procedures, particularly where these can reduce time and cost, then the operation of an effective suggestion scheme/engagement programme will allow potential improvements to be implemented in a controlled manner, with their risks properly assessed, rather than workers being tempted to take short cuts.
    - This also ensures that improvements are implemented across all relevant workgroups, and on future projects.

- Employers ensure that work is carried out under a suitable level of supervision, taking account of the level of risk that a task involves, and the competence of the people involved.
- Employers establish a 'just' safety culture, in which honest reporting of genuine mistakes is encouraged, but deliberate violations of safety rules are not tolerated.

G.6 INDIVIDUAL RESPONSIBILITIES

While the **employer** and other employers create the working environment, and hence influence behaviour, the final decisions about safe behaviour are taken by individuals.

The key responsibilities of individuals are to:

- Know and work within personal limits of competence.
- Understand and comply with site safety rules and procedures for tasks;
  - this also requires a clear understanding of the application of procedures.
- Stop the task if it cannot be undertaken in accordance with the approved procedure, or if there is a change in circumstances or intent, and inform management.
- Participate in reviews of procedures.
- suggest where procedures can be improved.
- Report deviations from procedures (including formal reporting of deviations as 'hazardous observations', if the deviations increase risk).
- Highlight if the schedule for a task is unrealistic, or resources are inadequate.
- concentrate on the task, and enable others to do so, to minimise the risk of errors.
- Support safe working by co-workers, by looking out for others who are putting themselves at risk through errors or deviations, and intervening in an appropriate manner.
- Participate in incident response drills, and review personal understanding of what to do in a given set of circumstances.

Fulfilling these responsibilities will be easiest in a culture where safety is truly given the highest priority, and there is a high level of trust. In a weak safety culture, a worker who stops a job on safety grounds may be seen as a troublemaker, to the detriment of their employment prospects.

Given that many wind industry tasks are undertaken by small, self-managed workgroups, with remote or occasional direct supervision, the reliance on individual behaviour is higher than in many other industries. Providing training that develops a high level of risk-perception, and the skills to have a 'safety conversation' can help to ensure that individuals can contribute effectively to creating a safe workplace.

G.7 ASSESSMENT AND IMPROVEMENT TOOLS

G.7.1 Safety culture maturity model

Research carried out for the UK HSE has identified five levels of safety culture maturity[27], summarised in Table G.2. It is important to understand the safety culture maturity of an organisation, as this will indicate where the most effective improvements can be made, and which tools to improve behaviour will be most appropriate.

Table G.2: Five levels of safety culture maturity

Level	Title	Characteristics
1	Emerging	Technical and procedural solutions to ensure regulatory compliance Accidents seen as inevitable Low level of interest in safety – not seen as a key business risk – safety department carries primary responsibility for safety
2	Managing	Safety seen as a key business risk, and broad-based management effort is invested in accident prevention Focus on compliance with rules, procedures and engineering controls Management perception that majority of accidents are caused by unsafe behaviour of front-line staff Performance measurement based on lagging indicators, and management involvement is reactive
3	Involving	Relatively low accident rate, but not improving Recognition that accidents are caused by a wide range of factors, and root causes often include management decisions Increasing involvement of front-line staff
4	Cooperating	Health and safety is seen as important, on economic and moral grounds Recognition that accidents are caused by a wide range of factors, and root causes often include management decisions; front-line staff take personal responsibility for their own safety, and others around Significant effort invested in proactive measures to prevent accidents, and non-work accidents are also monitored
5	Continually improving	Prevention of harm is a core value, and all employees see health and safety as being a critical part of their work Excellent safety record, but not complacent Wide range of indicators used to monitor performance and maintain high level of confidence in safety management processes Constantly striving to improve risk management

27 HSE OTO 00049 *Safety culture maturity model:* See also Energy Institute Human Factors Briefing Notes

A range of different tools is available to assess the safety culture maturity of an organisation.

G.7.2 Safety leadership development and behavioural interventions

Moving to a higher level of safety culture maturity involves changes being made throughout an organisation; a high level of trust between and within different levels of the organisation, together with clear management commitment and effective two-way communication, are necessary to create a suitable environment for behavioural change.

Guidance produced by Step Change in Safety[28] summarises a range of safety leadership and behavioural intervention tools, experiences of applying them, and critical success factors identified in the offshore oil and gas industries. The guidance notes that it takes time for individuals and organisations to change their behaviour, and suggests that it may take at least 18 months to reach the next level of maturity. This has implications for offshore wind projects: successful safety culture change involves using a suitable tool (in relation to the current and desired future safety cultures) and sustaining a long-term commitment to the change programme.

28 Step Change in Safety – Changing Minds – *A practical guide for behavioural change in the oil and gas industry.*

ANNEX H
REFERENCES

The documents listed here have been summarised in Annex C, or are referenced in the main text. Additional national laws, guidance and standards are listed in the review of WAH regulations in selected European nations and the review of WAH regulations in selected nations outside Europe.

Advisory Committee for Roofsafety (ACR) (http://www.roofworkadvice.info/)

Advisory Committee for Roofsafety Guidance, *Note for competence and general fitness requirements to work on roofs*, ACR (CP) 005: 2012

Association of the Scientific Medical Societies in Germany (AWMF) (https://www.awmf.org/)

*Arbeitsmedizinische Eignungsuntersuchungen für Arbeitnehmer auf Offshore-Windenergieanlagen und Offshore-Installationen (*AWMF guideline 002/43) – German medical examination for workers on offshore WTGs and installations

Danish Maritime Authority (DMA) (https://www.dma.dk/Sider/default.aspx)

Technical regulation on the construction and equipment, etc. of passenger ships on domestic voyages – Chapter III – Life-saving appliances

Dropped Objects Prevention Scheme (DROPS) (http://www.dropsonline.org/)

Dropped Objects Prevention Scheme Global Resource Centre

HSE (http://www.hse.gov.uk/)

Construction (Design and Management) Regulations 2015 – Guidance

HSE HSG48 *Reducing error and influencing behaviour*

HSE HSG150 – *Health and safety in construction*

HSE Human Factors Common Topic 4: Safety Culture

HSE INDG367: *Inspecting fall arrest equipment made from webbing or rope*

HSE INDG401 – *Working at height – A brief guide*

HSE INDG422 *Thorough examination of lifting equipment: A simple guide for employers*

HSE L101: *Safe work in confined spaces,* Confined Spaces Regulations 1997 Approved Code of Practice, Regulations and guidance (2009 edition)

HSE Offshore Technology Report 2002/021: *Compatibility test protocol for lifejackets and immersion suits on offshore installations*

HSE Offshore Technology Report OTO 00049 *Safety culture maturity model*

HSE Offshore Technology Report OTO 95 038 *Review of probable survival times for immersion in the North Sea*

Energy Institute (EI) (https://publishing.energyinst.org/)

A recommended fitness standard for the oil and gas industry

Human Factors: Briefing notes

EUR-Lex (https://eur-lex.europa.eu/homepage.html)

Council Directive 92/57/EEC of 24 June 1992 on the implementation of minimum safety and health requirements at temporary or mobile construction sites

Classification of equipment used for lifting loads with lifting machinery

Directive 2009/104/EC of the European Parliament and of the Council concerning the minimum safety and health requirements for the use of work equipment by workers at work

European Risk Observatory Report – *Occupational safety and health in the wind energy sector*

Global Wind Organisation (GWO) (http://www.globalwindsafety.org/)

Basic safety training

International Maritime Organisation (IMO) (http://www.imo.org/)

Guidance on wearing immersion suits in totally enclosed lifeboats

Industrial Rope Access Trade Association (IRATA) (https://irata.org/)

IRATA – *Application of rope access methods in the construction, inspection, repair and maintenance of wind turbines*

IRATA *International Code of Practice (ICOP)*

Marine Coastguard Agency (MCA)
(https://www.gov.uk/government/organisations/maritime-and-coastguard-agency)

MCA ENG1 Certification process

MCA Workboat Code

Oil and Gas UK (OGUK) (https://oilandgasuk.co.uk/)

Medical aspects of fitness for work offshore: Guidelines for examining physicians

RenewableUK (https://www.renewableuk.com/)

First Aid needs assessment

RenewableUK *Medical Fitness to Work – Wind Turbines (no longer available online)*

Offshore Wind and Marine Energy Health and Safety Guidelines 2014

Step Change in Safety (https://www.stepchangeinsafety.net/)

Changing Minds – *A practical guide for behavioural change in the oil and gas industry*

Swedish Work Environment Authority (https://www.av.se/)

AFS 2005:6 *Medicinska Kontroller* I Arbetslivet, Articles 41–44 define Swedish medical surveillance requirements for work at height

Work at Height Safety Association (WAHSA) (https://www.wahsa.org.uk/)

Practical Guidance Note (PGN) PGN01 (formerly TGN01) – *Consideration for the use of personal fall protection equipment*

PGN02 (formerly TGN03) – *Guidance on inspecting personal fall protection equipment*

PGN03 (formerly TGN05) – *Guidance on rescue during work at height*

PGN06 – *Guidance on CE Marking*

Technical Guidance Note (TGN) TGN01 (Formerly TGN02) – *Guidance on the selection, use, maintenance and inspection of retractable type fall arresters*

TGN02 (formerly TGN04) – *Guidance on the use of single and twin energy absorbing lanyards*

TGN03 (formerly TGN06) – *Guidance on inspecting eyebolts used for personal fall protection purposes*

ANNEX I
GLOSSARY OF ACRONYMS AND ABBREVIATIONS

AIS	automatic identification system
BOSIET	basic offshore safety induction and emergency training
CDM	Construction (design and management) regulations (implementing the temporary or mobile construction sites directive, 92/57/EEC) in Great Britain.
Client	the client, in the context of work subject to the Temporary or Mobile Construction Sites Directive, 92/57/EEC.
Client	the client or customer of a service provider, in any context other than that of a **Client**
Contractor	a party that carries out work on behalf of an **Employer**.
CTV	Crew Transfer Vessel
Employer	the party that engages contractors or suppliers to provide services or goods
Employer	the party that has line management and health and safety responsibilities for the people whom they employ
EEZ	exclusive economic zone
EI	Energy Institute
FAS	fall arrest system
FISAT	Fach- und Interessenverband für seilunterstützte Arbeitstechniken
g	acceleration due to gravity
GWO	Global Wind Organisation
HSE	Health and Safety Executive
HUET	helicopter underwater escape training
ICOP	International Code of Practice (IRATA publication)
IMCA	International Marine Contractors Association
IRATA	International Rope Access Trade Association
MAT	mobile access tower
MCA	Maritime and Coastguard Agency
MEWP	mobile elevating work platform
MOB	man overboard
MSD	musculoskeletal disorder
OGUK	Oil and Gas UK
OPITO	Offshore Petroleum Industry Training Organisation
PFD	personal flotation device (generally a lifejacket)
PLB	personal locator beacon
PPE	personal protective equipment
RUK	RenewableUK
SAR	search and rescue
SART	search and rescue transponder

SOFT	Samarbeidsorganet for tilkomstteknikk
SOV	service and operations vessel
SPRAT	Society of Professional Rope Access Technicians
SRL	self-retracting lifeline (retractable-type fall arrester)
SST	sea survival training
SWL	safe working load (the maximum load (as determined by a competent person) which an item of lifting equipment may raise, lower or suspend under particular service conditions.)
TP	transition piece
W2W	walk to work
WAH	work at height
WAHSA	Work At Height Safety Association
WLL	working load limit (the maximum load, determined by the manufacturer, that an item of lifting equipment is designed to raise, lower or suspend.)
WTG	wind turbine generator

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