Health and Safety
With Offshore Wind Farms

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Abstract
Health and Safety must undeniably be the key focus when implementing marine renewable energy projects. Project promoters and contractors are called on to implement strong occupational health and safety policies, procedures and features, from design through to construction, commissioning, operation, maintenance and decommissioning.

The purpose is to avoid accidents and injuries to workers, to comply with regulations, and to demonstrate that marine renewable energy is not only an environment-friendly solution, but a sector with a clear safety focus as well.

Many risks have to be considered:
- construction site (ports and factories): working at height, electrical risks, fire, explosion, handling, crushing, falls, chemical risks, hoisting, occupational stress, etc.
- Transport of staff and materials (road transport) from home, factories and offices to ports: road hazards
- Sea transport and specific works at sea: vessel compliance, subsea works, saline atmosphere, survival at sea, etc.
- Construction and maintenance: working in confined spaces, working at height, electrical risks, handling, machine conformity, etc.
- Others

Keywords: health, management, offshore wind farms, regulations, safety

I. INTRODUCTION
The dangers and risks to be taken into account concern:
- the safety of installations (machinery and equipment),
- the occupational safety and health of workers.

Many rules, regulations and standards need to be considered. Effective policies and procedures need to be implemented:
- Safety design: CSPS (according to French regulations) or CDM (Construction Design and Management), risk assessment, offshore standards, wind farm standards, vessel conception, etc.
- Training of personnel: GWO - Basic Safety Training: first aid, survival at sea, fire awareness, HSE, etc.
- Occupational Health and Safety Management: safety procedures, safety instructions, external providers, purchasing management, etc.
- Health and Safety Management System: ISO 45001, ISO 26000, etc.
- Collective and Personal Protective Equipment

II. RESEARCH ELABORATION
From the offshore wind farm design stage, engineers and developers must ensure the safety and health of facilities and workers are integrated into projects, both for their teams and for their suppliers and partners. They must follow certain general principles of prevention:
- Risk avoidance
- Risk assessment
- Risk combating at source
- Integration of regulatory and other requirements
- Consideration of relevant international offshore standards
- Adaptation of work to individual needs
- Consideration of technological evolution
- Replacing hazardous aspects with less hazardous aspects
- Health & safety management
- Plan prevention
- Prioritization of collective protection measures
- Appropriate instructions given to employees.
Two types of risks and hazards must be taken into account:
- Risks related to installations and to offshore wind turbine equipment (offshore and onshore),
- Risks related to actions of company staff and staff of their suppliers: occupational health and safety

A. Regulations

i. Labour Code – Health & safety

- Workers:

The “French code du travail” [1] includes in its part "Health and Safety at work", most of the applicable regulatory requirements, including the transcription of European directives and the integration of decrees.

For example: Labour Code: Working at height:

Art R-4323-59: Guardrails;
Art R-4323-61: PPE;
Art R-4323-63: Prohibitions and justifications;
and the decree of 21 December 2004 which specifies the conditions of verification for scaffolding. Also the circular of 27 June 2005 and circular DGT No. 8 of 16 April 2009.
Obligations to place a guardrail at a height between one metre and 1.10 m ... Prohibition to use a ladder as a workstation, except under certain conditions, etc.

For example: Labour Code: Occupational risk assessment (“document unique”):
Arts. R. 4121-1 ff.
and Circular No. 6 of the French Labour Relations Directorate of April 18, 2002
Obligations to prepare risk assessment, to identify risks, to prioritize risks and to define preventive measures.

- Work equipment: Design

French regulations devote a complete chapter to the field of project design.
Wind turbines must be considered as working equipment within the meaning of French regulations. Indeed, in labour code [1], 2 chapters are devoted to the integration of security in design. One chapter deals with workplaces (building) and another concerns work equipment (machine). It is this second chapter that concerns among other things safety in the design of wind turbines.
The rules for integrating security can be found in Annex 1 of Art. R 4312-1 [1]. These rules are a transcript of Directive 2006/42 / EC, known as the Machine Directive.

ii. Labour Code – CSPS


These texts established the obligation for the Client to appoint a natural or legal person in charge of coordinating the risks impacting the health and safety of workers through co-activity between companies in the design and implementation phases.

- Application to offshore wind farms:

Construction sites are divided into 3 categories according to the number of man/days of work for the duration of the construction site.
- Category 1: construction site more than 10,000 man/days
- Category 2: site between 500 and 10,000 man/days
- Category 3: site of less than 500 man/days.

This type of project is carried out under various conditions and according to various criteria:
- The CSPS project is carried out on a so-called mobile or temporary site. It is mandatory if at least 2 companies are present simultaneously or not, for the duration of the project (Article L4532-2 of the Labour Code).
- Appendix 1 of the European directive indicates several examples of construction sites that fall within the scope of CSPS projects: Excavation, Earthwork, Construction, Assembly and dismantling of prefabricated elements.
It also gives examples of risks that need to be addressed:
- Work exposing workers to the risk of burial, entrapment or falling from height, particularly aggravated by the nature of the activity or the processes implemented or by the environment of the workstation or the work
- Work exposing workers to a risk of drowning
- Well works, underground earthworks and tunnels
- Well works, underground earthworks and tunnels, etc.

This list shows the importance and the obligation of a CSPS project regarding offshore wind farms.

- CSPS, owner and project manager

The CSPS is appointed by the owner.

During the design phase, the CSPS must anticipate the risks associated with the organization of the project and take into account the effects of the organization chosen in the contracts with the subcontractors. The CSPS must be involved in meetings with the project manager and take into account studies and documents that have an impact on prevention choices. In the implementation phase, the CSPS therefore
ensures the implementation of the measures defined during the design phase and their adaptation.

The client must send the preliminary declaration of work to the inspection and prevention organizations.

- PGCSPS, DIUO and RJC

Right from the offshore wind project design phase, the CSPS begins to draft the General Safety and Health Protection Coordination Plan (PGCSPS) and the Later Work Intervention Record (DIUO) as well as the Coordination Logbook (RJC).

Subcontractors will submit to the project manager and the CSPS their own specific plan for health and safety protection (PPSPS).

The PGC belonging to the Client (Art. L 4532-8) [1] is drafted by the CSPS conception and is adopted throughout the site by CSPS implementation (if differing from design). This document is designed to prevent the risks arising from the interference of the activities of the various parties on the worksite, and must contain:
- Administrative information of interest to the site;
- the measures of general organization for the worksite agreed by the project manager in consultation with the coordinator;
- the practical information specific to the site regarding the rescue and evacuation of workers and the common organizational measures taken in this respect;
- the coordinating measures taken by the coordinator in matters of safety and health.

The Dossier of Subsequent Interventions on the Work (DIUO) is also constituted by the CSPS, under the responsibility of the Owner. It is initiated from the design phase and finalized at the end of the project (Art. R4532-95 to R4532-98) [1]. This document should allow the future operator to optimize, from a health point of view and prevention of occupational risks, the subsequent interventions on wind turbines.

iii. Health & safety European directives

The European Union (EU) Directives and the articles made under the guidelines. They are often translated into their own H & S legislation, e.g. in the labor code.

e.g.
- EU / 89/654 workplaces, 89/655 work equipment, 89/656 EPP, 90/269 manual handling of load
- 2009/26 / EC of 6 April 2009 on marine equipment
- 2009/104 / EC of 16 September 2009 concerning the minimum safety and health requirements for the use of work equipment

- 99/92 / EC of 16 Dec 1999 ATEX and 2014/34 on devices intended to be used in ATEX
- 2001/45 / EC of 27 June 2001 on working at heights
- Directive 2006/42 / EC, known as the Machinery Directive (applied since 31 December 2009)

iv. Offshore international standards and engineering

Different international standards and rules must be taken into account. Here are some examples:
- SOLAS (Safety of Life At Sea): International Convention for the Safety of Life at Sea
- Guidance and Industry best practices:

For example: Guidelines for the G9 Offshore Wind Health & Safety Association "Good practice guidelines for the safe management of small service vessels in the offshore wind industry", January 2018

For example: "Good practice guidelines for working in the offshore wind industry", November 2014.

- EN ISO standards: recommended PPE requirements. For example: EN 420 (gloves), EN 12402-2 (Lifejackets),
- NFPA 101, 70B, etc.

B. Risks and hazards

i. Road safety

The leading cause of death and serious injury for offshore wind projects is road risk.

Indeed, workers travel from their homes or business premises to construction sites (to take vessels in order to travel to the offshore construction area).

Rules need to be remembered: prohibition of use of mobile phone while driving, respect for speed limits, taking into account levels of staff fatigue, etc.

ii. Working at height

The second cause of mortality concerns working at height.

The designer must demonstrate that in some cases the risk at source cannot be eliminated. It is therefore necessary to emphasize collective protection (scaffolding, railing,
machine guards) then the PEE (fall arrest harnesses, lanyards, ropes).

Use of scaffolding requires rules: inspection, design, erection, maintenance and record-keeping. Staff must have received relevant training in working at height.

Fixed ladders in a wind turbine where fall arrest slider systems are fitted.
Fixed ladders on a base section for wind turbine at sea.
Use of portable ladders must meet regulatory requirements [1]

iii. Fire
The design of the wind turbine must incorporate fire risk: fire protection studies, fire and gas detection, sizing of fire extinguishing networks, detection means and extinguishing means (such as automatic fire extinguishing systems, fire tap armed, fire extinguishers, fire hose reels, etc.)

On construction sites and in the wind turbine, a smoking policy must be put in place. On building sites, designated smoking areas need to be planned.

iv. Explosion hazard (ATEX)
Art. R 4312-1 of the Labour Code is devoted to explosive atmospheres (ATEX).
The machine is designed and constructed to avoid any risk of explosion caused by the machine itself or by gases, liquids, dusts, vapors and other substances produced or used by the machine. The machine must comply with the provisions of the transposition provisions of the specific Community directives as regards the risks of explosion due to its use in an explosive atmosphere.
This requires the designer to carry out ATEX zoning within the meaning of Art. R. 4216-31 of the Labour Code. The result of this zoning makes it possible to classify and model the potential areas at risk of explosion. This zoning will then allow the installer to integrate compliant and certified equipment to operate in these areas.

v. Electrical hazard - Consignations
Electrical installations must comply with design and verification rules.
Work equipment must be shut down and then secured: consignment and disconnection operations must be incorporated to avoid accidents.
Any de-energized interventions must be subject to a VAT (No Voltage Check)

Stakeholders must have clearances depending on the type of intervention and the areas of tension: B2 / H2, BC / HC ...

vi. Lifting operations
All fixed and portable lifting equipment shall be appropriately certificated and form part of a regular inspection regime.

vii. Confined spaces
Toxic atmosphere, oxygen deficiency, flammable or explosive atmospheres, excessive heat.
This concerns working personnel and people who try to rescue them yet who do not possess the proper training and equipment.
“Danger - confined space - entry to permit holders only”

viii. Crushing
During construction phases and right from the design stage, the risks posed by collisions between vehicles (fork-lift trucks) and pedestrian workers need to be taken into account, as well as falling object hazard.

ix. Slip, trip and fall hazards
This concerns slips, trips, missteps and loss of balance. Such hazards are due to congested spaces, dirty floors, movements that are too fast, transport of objects, insufficient lighting, attention distracted by a task other than moving, etc.

A global analysis of the work situation must be carried out in order to implement preventive measures that combine actions in workspaces, on premises, in physical environments, the organization of the work, and improving employee awareness.

x. Manual handling hazards

xi. Climatic hazards
The design of installations must incorporate the risks related to extreme temperatures, winds and storms, and lightning, etc.

xii. Chemical risks and hazardous substances
Chemicals are used, in particular during maintenance operations: hydraulic oils, lubricating oils, degreasers. Anti-corrosion products are also used.
Safety data sheets must be available. PPEs should be used.

Control for the delivery, storage and use of fuels, oils and chemicals are required on site and on vessels. Control of substances hazardous to health (COSHH) shall be used to determine the necessary controls required to protect human health.

xiii. Ergonomics

For workers with a significant presence in their office, in front of a computer, the workstation ergonomics need to be studied: seat, mouse, distance and alignment screen/view, etc.

This problem must also be taken into account in the design of machines and therefore also of wind turbines. For example, valves and other equipment must be integrated taking into account the available ergonomic data.

xiv. Welfare, quality of life at work – Psychosocial risks, bullying at work

Managers must integrate welfare at work into the management of their teams.

This reduces the psychosocial risks upstream of acute manifestations of stress, violence or exhaustion.

Many actions must be carried out: office layout, team building, entertainment, sport, relaxation, food, etc.

xv. Alcohol and drugs

The company shall have a policy on alcohol and drugs:
- No alcohol or drugs are permitted on premises, on sites and on vessels
- Pre-employment screening (fitness for work)
- Random testing on sites

xvi. Working on vessels

The risks of working "at sea" require basic training such as:
- TIS: Individual Survival Techniques
- BOSIET: Basic Offshore Safety Induction and Emergency Training
- SST (medical): Civic first aid level 1

Other training for certain categories of people:
- BST GWO (Basic Safety Training for Wind Turbines - Global Wind Organization)

xvii. Diving

Personnel engaged in diving must be trained in specific hazards.

xviii. Vibrations

The mechanical vibrations of the tools or devices used can cause joint damage, neurological disorders or traumatic spine. The regulation sets limit values for vibration transmitted to the hands, arms and those transmitted to the whole body. It also sets out obligations for informing workers and monitoring their state of health.

xix. Noise

Chapter 1.5.8 of Annex 1 to Article R4312-1 [1] requires the machinery to be designed and constructed in such a way that the risks arising from the emission of airborne noise are reduced to the lowest level technical progress and the availability of means to reduce noise, particularly at the source. The noise emission level is evaluated against comparative emissions data for similar machines.

The requirement of this chapter covers an assessment of this risk. At the design stage, modeling can be performed to evaluate the sound levels of the entire wind turbine and the parts that compose it. This study will ensure that the future maintainers intervening when the blades of the offshore wind turbine are stopped will not be subjected to sound levels exceeding 87 dB on a day of 8 hours (art. R. 4431-2 of the Labour Code).

C. Health & safety management system

i. QSE System

Companies can set up QSE Management Systems and a sustainable development approach.

These companies can obtain certifications:
- ISO 9001: Quality
- ISO 45001: Safety / health
- ISO 14001: Environment
- ISO 26000: Sustainable Development
ii. ISO 45001 [4]

Companies are encouraged to comply with the requirements of ISO 45001. The leadership of managers and the participation of workers are essential. An S & ST policy needs to be implemented. The company must identify the hazards, assess the risks and opportunities, and determine the legal and other requirements that apply to it. The company must plan actions to achieve its S & ST goals. Documented information, staff awareness and good communication should enable operational activities integrating S & ST. The performance evaluation must allow continuous improvement of the company.

iii. Leadership and management

The management of the company, the managers and all the staff must be involved in taking into account the safety and health of the staff. Management must incorporate the concepts of well-being at work, psychosocial risks, gender equality, non-discrimination, etc., into the hazards and risks.

A written policy must be created. Videos can be recommended.

A ‘moment for safety’ can be introduced: each meeting shall have a ‘moment for safety’ where a project team member delivers a safety message.

iv. Golden rules

The company shall define these rules and communicate to its personal and contractors. For example, instructions: working at height, road safety, crushing, wearing PPE, electrical consignment, lone workers, etc.

Other rules can be introduced: standing by the ramp down a staircase, prohibition to throw a cigarette end on the ground or at sea, etc.

v. Security reviews

During the design of installations, project managers must carry out safety reviews: they shall review the hazards, risks and associated regulations for each sub-project (turbine, mat or floats, equipment, substation, etc.).

An assessment of the proper consideration of hazards and risks and of regulatory and other requirements (international standards) is carried out and documented to prove that safety/health issues have been taken into account.

vi. Personal protection equipment

For onshore and / or offshore works, different PPEs are to be expected depending the identified risks:

- Head protection with chinstrap
- Safety footwear with non-slip-soles and with steel reinforced toes
- Gloves
- Eye protection (glasses)
- Ear protection
- Personal Locator Beacons (PLBS)
- Lifejacket (150N or 275N)
- Survival suits
- Fall arrest harness
- Safety lanyard
- Anti-fall vertical system (attached to the ladder safety rail)
- Headlamp
- Others

vii. Emergency response plans and procedures

Depending on the work areas (onshore site, office, wind turbine, boat, etc.), emergency plans must be implemented:
- Enclosed space evacuation
- Evacuation from the turbine of the wind turbine
- Vessel abandonment procedure
- Medical emergency and evacuation
- Others

viii. Safety equipment

Construction sites (onshore or offshore) must contain safety equipment:
- Alarm systems
- Fire extinguishers
- Fire hose reels
- First aid kits
- Automated External Defibrillator (AED)
- Personal Locator Beacon (PLB)
- Emergency showers
- Eye baths
- Emergency ladders
- Breathing apparatus
- Machine guards
- Interlocks
- Others

ix. Relations with subcontractors

The client must:
- transmit its requirements and guidelines to its subcontractors
- accompany its subcontractors
- audit its subcontractors

Before each intervention, the subcontractors must present the actions they have put in place.

x. Fitness for work

Before hiring and at regular intervals, a medical follow-up must be carried out and adapted to the particular risks of specific people (working at sea, working at height, etc.).

xi. Risks assessments and method statements

For workers, a workplace risk assessment must be carried out. For the design of installations, risk analyses based on Hazard Identification (HAZID) or Failure Modes, Effects and Criticality Analysis (FMECA) methods should be adopted.

xii. Accident, incident and near-misses - Reporting requirements

This concerns accidents at work with stop and without stop (frequency and severity), near-misses, medical treatment injuries, etc.

The Company and its contractors must identify them, notify immediately, and maintain a database. They must be reported to the project director to Project HSE manager or customer. The root cause must be determined and any recurrence must be prevented.

xiii. Training and inductions

Inductions to health / safety and specific risks must be carried out for companies and their subcontractors.

Depending on the type of intervention, training may be required: lifeguard at work, electrical risk training, work at height, training TIS, BOSSIET, GWO BST, etc.

IV. CONCLUSION

Companies with offshore wind farm projects must integrate the hazards and risks that may arise in the different phases of the project from the design stage onwards: design, construction, operation, maintenance and dismantling. This concerns both facilities and workers, including those of subcontractors.

They must also incorporate the applicable regulatory requirements.

For this, safety reviews must be carried out right from the design phase.

Finally, setting up a Health & Safety Management System based on ISO 45001 can be a good decision.

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REFERENCES


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