Code of conduct for safe use of cranes on windfarm sites

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Contents

1. Introduction.

1.1. This draft will form the basis of a consultative process; the key objective is to develop, ratify and roll out a code of conduct for the safe transit, mobilisation and use of cranes on windfarm sites. This document will apply equally to new or existing sites.

1.2. Compared to any other road going vehicle, heavy cranes are unique in terms of running width, axle loadings and suspension & drivetrain characteristics; many journeys are undertaken on roads with "R" & "L" classifications and, as such, significant planning is required to ensure no incidents are allowed to occur on the public road.

1.3. The same scenario applies to the movement and operation of cranes on our sites; the climate, topography and remote nature of our sites has forged a unique skill set within crane and transport suppliers. These challenges have helped established operators and key stakeholders develop robust risk mitigation strategies but this is not uniform across the industry.

1.4. Each time a crane, or any other element associated with the Irish wind industry, is involved in an incident on a local county council road the news is transmitted nationally, via social media, and creates sensationalist headlines.

1.5. Notwithstanding the obvious potential for injury/fatality, damage to equipment and the public road network and discommoding of local residents our collective reputation is at stake.

2. Legislation.

2.1. The use of mobile cranes is subject to the following statutory or advisory instruments:

2.1.1 Road Traffic Act (2014).

2.1.2 Safety, Health and Welfare at Work, (General Application), Regulations 2007.

2.1.3 BS 7121-1:2006 Code of practice for safe use of cranes, General.

2.1.4 BS 7121-3:2000 Code of practice, mobile cranes.

2.1.5 Lifting Operations and Lifting Equipment Regulations 1998 (LOLER)

2.1.6 Provision and Use of Work Equipment Regulations 1998 (PUWER)

2.2. The movement of cranes, and support vehicles, to site must form part of an approved safe system of work (SSoW); this must be submitted to the client (and/or PSCS) in advance of any works.

2.3. The SSoW must also include provision for the safe movement of cranes on site in road travel order or specific [approved] semi-rigged configurations.

3. Risk mitigation.

3.1. Cooperation:

3.1.1. The successful completion of any cranage operation is contingent upon seamless engagement between all parties involved; this applies equally to new windfarms under construction or simpler component changes on existing sites.

3.1.2. The consultative process will include, directly or indirectly, the following stakeholders:

- Client
- Planners
- Designers
- Turbine supplier
- Civil engineering contractor
- PSCS
- Crane contractor
- O & M contractor

3.1.3. The actions of each party, above, will affect all others and will ultimately influence the conduct & outcome of the specific project.

3.2. Competency

3.2.1. Crane suppliers are normally contracted directly by the turbine manufacturer; each organisation will retain a list of preferred suppliers vetted through formal pre-qualification procedures (PQQ).

3.2.2. The PQQ will measure the competency of the sub-contractor and key personnel within the structure of the company; it is vitally important this auditing process establishes the extent, or involvement of second, or third, tier sub-contractors in any planned or future works.

3.2.3. Key personnel to be identified (below director level):

- EHS manager.
- Appointed Person
- Crane Supervisor
- Crane operator

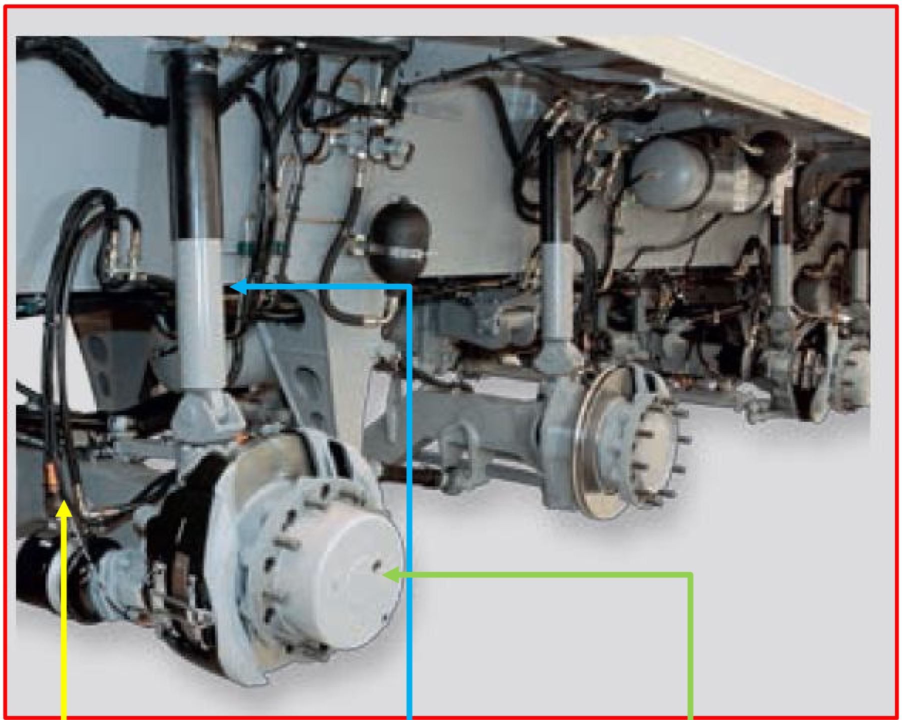
3.2.4. It is well recognised that crane contractors must retain specific competencies to plan and complete safe systems of work; of equal importance is the need for turbine suppliers, client and PSCS to achieve comparable skill levels to ensure the review/approval process is thorough, meaningful and authentic.

3.3. Planning - Technical aspects/crane carrier characteristics

3.3.1. Most cranes featured on Irish windfarm sites are of the all-terrain type; the crane superstructure is mounted on a specialist carrier fitted with large profile tyres, typically 445/95-R25 (1600-R25) and a proprietary hydra-pneumatic suspension system designed to ensure uniform loadings on each axle during transit.

3.3.2. The suspension system forms an integral part of the stability of the crane whether it is moving on the public highway in road travel order, moving rigged or semi-rigged on site or mobilised and engaged in lifting operations.

3.3.3. When travelling on the road the suspension actively monitors the loading on each wheel and adjusts this accordingly to maintain uniformity; see image below:



Axle / Suspension cylinder / wheel hub

3.3.4. It is essential that the suspension system is well maintained & operates correctly for, without it, the braking system will have limited functionality.

3.3.5. Cranes do not rely solely on the hub brakes to slow or control the speed of the carrier, there are a number of additional systems employed, the principal one being an electromagnetic (or eddy-type) retarder mounted on the main prop-shaft.

3.3.6. When the suspension system malfunctions and is not remediated the retarding force will be applied unevenly and, in a worst case scenario, there is a potential for a single wheel to "lock up" whilst others remain unchecked.

3.3.7. Where this occurs on steep gradients it is unlikely the conventional braking system will stop the crane and an accident will ensue.

3.3.8. These anomalies also affect the gradability of the crane when negotiating road gradients; related directly (but oppositely) to reduced braking efficiency, there is potential for increased % wheel-slip and complete loss of traction in some cases.

3.3.9. The suspension system also controls the stability and vertical alignment of the crane carrier; this is important when travelling on roads with significant cross-falls and limiting the extent to which the carrier will move laterally on slippery road conditions.

3.4. Planning – crane axle loadings

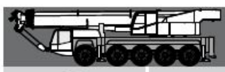
3.4.1. Crane manufacturers issue guidelines on the axle-loads displayed by each specific crane model.

3.4.2. The axle load is determined by the weight of the base machine, complement of counterweight mounted/fixed on the superstructure and/or the crane deck and any boom enhancement devices or accessories carried on the boom casing.

3.4.3. Using the example below (Terex AC140-C) we see how axle load is varied with counterweight levels, additional winches and fly-jib.

SPECIFICATIONS **AC 140 COMPACT**

Technische Daten · Caractéristiques · Dati tecnici · Datos técnicos · Especificações · Технические характеристики



	Total						2	
< 10,0 t	on request · auf Anfrage · sur demande · su richiesta · bajo demanda · a pedido · по заявке							X
12,0 t	60,0 t	10 x 8 x 8	445/95R25	63-3-21	8,2 t	–	–	–
12,0 t	60,0 t	10 x 8 x 8	445/95R25	32-1-21	6,3 t	17 m	–	–
12,0 t	60,0 t	10 x 8 x 8	445/95R25	63-3-21	5,0 t	17 m	X	–
13,5 t	65,0 t	10 x 8 x 8	445/95R25	63-3-21	10,8 t	17 m	–	–
16,5 t	82,0 t	10 x 8 x 8	445/95R25	63-3-21	27,2 t*	17 m	–	–

* Optional · Option · Option · Opzionale · Opcional · Opcional · Опция

3.4.4. Note that 12t/axle is only achieved with 6.3t of counterweight and the bi-fold fly-jib mounted on the carrier.

3.4.5. Most cranes in this class are typically driven to conventional construction sites with 22.5t of counterweight *and* the bi-fold fly-jib with a resultant axle load in excess of 15t/axle.

3.5. <u>Route analysis</u>

3.5.1. Where a defined route to site exists it is important that road width, bearing capacity and running surface are examined and the axle-load determined accordingly.

3.5.2. Such advance analysis is critical in ensuring cranes can enter and exit the site in a safe manner; the client, O & M operator and/or turbine manufacturer must clearly indicate the target axle load and advise the crane supplier accordingly.

3.5.3. On established (or older) sites the condition of local road network deserves special attention given that some, if not all, county council's now have very limited resources allocated to road maintenance.

3.5.4. This factor alone is causing the significant deterioration on the running surface and the potential for road failure, especially after extended cold periods, cannot be ignored.

3.5.5. Route surveys must identify all features that are likely to affect the crane whilst travelling to site, this must include:

- ***Mean road width.***

- ***Extended portions of road with no passing places.***

- ***Ref: above, location of schools and private dwellings likely to be affected*.**

- ***Bridges, culverts etc.***

- ***Overhead lines.***

- ***Overhanging trees, foliage encroaching on road edge.***

- ***Extended linear cracks on road running surface*.**

- ***Undulating surface, excessive settlement.***

- ***Deep ditches parallel to road edge.***

3.6. **Preventative measures**

3.6.1. Many older, established, windfarm sites are located in remote areas with poor local road infrastructure; for this reason alone it is important that the approved route to site is clearly highlighted to the crane contractor and a traffic management plan is compiled with control measures included.

3.6.2. The SSoW must refer to the specific axle load achieved by the crane; consideration must be given to targeting 12t/axle as a standard for all sites and, more especially, when accessing remote sites with problematic access routes.

3.6.3. Occasionally the road envelope is severely curtailed thereby limiting any scope for road widening or reinforcement; in such cases temporary works e.g. steel plates must be used.

3.6.4. Whilst such procedures reduce the risk profile they do affect people living along the route; the SSoW must include measures to reduce the impact on the public i.e. road being blocked during deployment/removal of steel plating and risk posed by sharp, projecting edges.

3.6.5. The client must assist in this process by liaising with local householders and the county council in advance of all such works.

3.7. **Information sharing**

3.7.1. Where certain roads are identified as being high risk it is vital that such information is collated, retained and circulated to ensure incidents are prevented from occurring.

3.7.2. It is incumbent upon all stakeholders to engage effectively and share experiences and lessons learned; the images below are a stark reminder of the risk burden applied to crane movements.

3.7.3. Note that, in the first image the full complement of counterweight present on the crane deck and superstructure and, in the second image, the support plates are carried on the rearward deck of the crane; both should have been removed.

3.8. **Risk analysis & methodology**

3.8.1. It is an unfortunate fact that much of the experience we have gleaned over the last 20 years and, more significantly, in the last 10 has been hard earned; for this reason it is vital that frontline personnel are given clear, *simple & concise* instructions on the procedures to be followed.

3.8.2. Operator behaviour is an important factor in most incidents involving cranes being driven on the public or site roads; the culture among a group of operators is influenced by the attitude of company directors/management.

3.8.3. There are a number of basic protocols to be enacted as control measures:

- Maintaining full concentration at all times, not being distracted.

- Driving to suit the road & weather conditions, speed limit will be the third aspect if the first two are considered carefully.

- Not using mobile phones whilst driving.

- Ensuring crane is in good working order & reporting faults.

- Driving on the road centreline and maintaining adequate distance from road edge, see image below:

3.8.4. The crane operator must also be provided with the following before leaving for site:

- Map showing precise route to site.
- Clear indication of location of site entrance.
- Additional measures required on route to site.
- Permissible axle loading on site.
- Map of site.
- Drawing of typical crane hardstand arrangement.

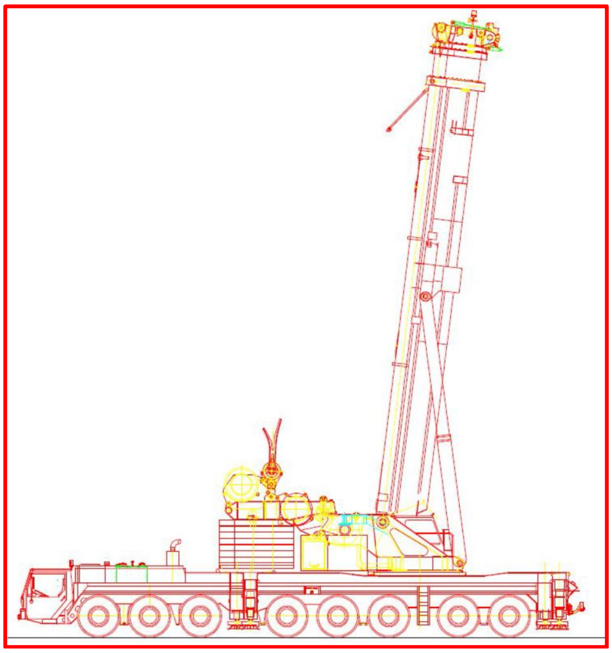
3.9. **Rigged movement of cranes on site.**

3.9.1. All terrain cranes are designed to be moved in rigged, or semi-rigged, configuration on site subject to compliance with certain conditions.

3.9.2. The precise configuration of the crane must be established as follows:

- Counterweight and attachments fixed to crane.
- Orientation of superstructure relative to carrier centre-line.
- Angle of main boom and fly-jib (luffing-jib)
- Out-rigger deployment.
- Pressure levels in suspension circuit.
- Axle locks.

3.9.3. The above data must be incorporated within the SSoW and defined as shown below:



3.9.4. The table below shows the axle-load applicable to the rigged configuration of the crane in item 3.9.3. above:

15.05 Charts for driving with the equipment in place 026933-02

3.4 Guyed telescopic boom T-16.1 (0/0/0)

Note

▶ The associated hook block weight of 3500 kg at the boom head is taken into account in the chart.

445/95 R 25			**10 bar**		
525/80 R 25			**8 bar**		
Boom direction towards the rear					
Folding jib	**Counter-weight**	**Telescopic boom angle to the hori-zontal**	**Support width (min. B)**	**maximum axle load per axle 1 ... 4**	**maximum axle load per axle 5 ... 8**
[m]	**[t]**	**α**	**[m]**	**[t]**	**[t]**
without	165	-	-	-	-
without	135	63° ... 80°	6.25	33	37
without	135	78° ... 80°	6.25	33	33
without	105	53° ... 84°	6.25	29	38
without	105	81° ... 84°	6.25	29	30
without	90	48° ... 84°	6.25	27	38
without	90	84°	6.25	27	28
without	75	42° ... 84°	6.25	24	38
without	75	84°	6.25	24	27
without	60	40° ... 84°	6.25	21	37
without	60	84°	6.25	21	26
without	45	53° ... 84°	6.25	18	33
without	45	84°	6.25	18	25
without	30	64° ... 84°	6.25	16	30
without	30	83° ... 84°	6.25	16	24

15.05 LIEBHERR 31

3.9.5. Note the clear definition of boom angle ***and*** out-rigger deployment.

3.9.6. The proposed strategy must be set against any constraints applicable on site as follows:

- Client specific policy on rigged movement of cranes.
- Axle load limit defined by designer and enforced by PSCS/site management.
- Presence of floating roads.
- Road camber and general condition of running surface.
- Height restrictions / presence of overhead HV lines.
- Obstructions preventing deployment of out-riggers during relocation process.
- Micro-movements on the hardstand & road adjacent to hardstand.
- Requirement for reversing.

3.9.7. There are specific scenarios where cranes must be moved in semi-rigged configurations; this applies to the following crane models:

- Liebherr LG1750, superstructure lifted on by ancillary cranage.

- Liebherr LTM11200-9.1, boom is jacked onto superstructure.

3.9.8. In the above instances, the crane must be partially rigged before being moved into final working position; see image below:

3.9.9. The designer must ensure the hardstand, and the portion of road adjacent to the hardstand is built to withstand the resultant axle loadings.

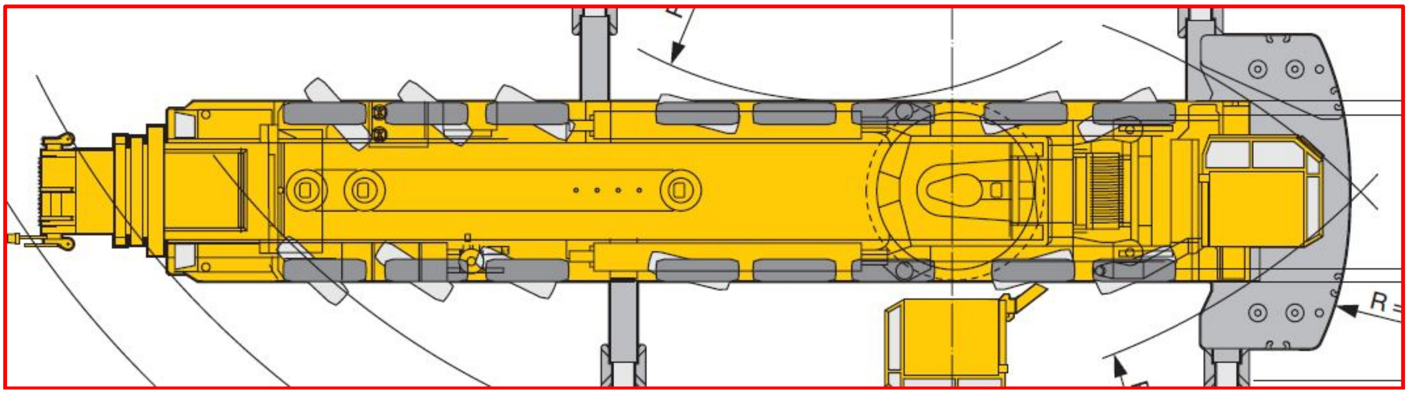
3.10. <u>Reversing cranes on site</u>

3.10.1. Installation planning or turbine repair works must consider the safe movement of cranes on site roads; typical site infrastructure design will include a crane hardstand approx. 40m x 20m and a road running adjacent to that approx. 4 – 5m wide.

3.10.2. A crane hardstand of this size is sufficient to allow any crane carrier to turn around so reversing should only be considered, or required, in exceptional circumstances.

3.10.3. Heavy crane carriers, 200t and upwards, do not perform well when reversing; such manoeuvres are an unfair burden on the operator as the crane will rarely follow the road centre-line. The effect is quite pronounced on floating roads or when a lateral cross-fall is present on the road running surface.

3.10.4. Consider the characteristics of the LTM1500 shown below, the steering angles on the front and rear wheels are, by design, quite different and this influences the extent to which the crane may be controlled whilst reversing:



3.10.5. Note the rear wheels turn to approx. 20° whilst the front wheels turn > 45°.

3.10.6. In certain instances, e.g. floated roads with high water-table levels, the carrier will tend to drift to one side, or the other, whilst reversing so the crane is deviating from the road centre-line.

3.10.7. Where the operator attempts to counter this movement by steering the carrier in the opposite direction, the front of the crane will actually move toward the road edge ***before*** the rear moves away. The net result is the entire carrier drifts toward the edge of the road increasing the risk of rolling off the verge.

3.10.8. The effect is similar when cranes are reversed up a gradient where the road is also sloped laterally to drain water from the running surface; in this scenario the crane will crab sideways with the pull of the lateral slope and the operator will find he must stop every 150 – 200m, drive forward again to regain road centre-line before resuming the reversing manoeuvre.

3.10.9. The motion cannot be countered effectively by steering out whilst reversing, the net effect is still the same and the crane will continue to drift with the lateral road slope.

3.10.10. Furthermore, where the crane is reversed in rigged, or semi-rigged, configuration the effect becomes even more pronounced and the risk of roll-over is markedly increased.

3.10.11. There are circumstances where smaller scale cranage must be reversed e.g. when building a lattice boom on the main crane adjacent to the site road; however, such movements are relatively short i.e. < 30m and are easier to control.

4. Managing incidents.

4.1. Advance planning & preparedness.

4.1.1. Despite our collective and best efforts incidents do occur and measures must be in place to eliminate, or minimise, the risk of injury to the operator.

4.1.2. It is important that the crane operators cabin itself does not present a threat to the operator; what is meant here is that there must be no loose or unsecured items within the cab that are likely strike the operator were the crane to roll off the road verge.

4.1.3. For this reason, toolboxes must not be stored on the floor area of the cab; similarly, fire extinguishers, flasks etc. should not be left loose within the cab. All such items are certain to cause injury to the operator in a worst case scenario and should be fixed/secured firmly or stored in closed compartments.

4.1.4. Crane operators must receive clear instructions on how to behave should the crane turn over; no attempt should be made to jump clear, as with tractors being used on farms, the likelihood of injury is increased where the operator attempts this. The operator must grip the steering wheel firmly until the crane has stopped moving.

4.1.5. Operator should also be trained to free him/herself from the cab when the crane has come to rest; there must be a proprietary device fixed within the cab to break the windscreen should no other means of exit be possible.