TIN 010 Tower Crane Anti-collision and Zoning Systems

1.0 Scope

This Technical Information Note deals with the planning, management and use of tower crane anti-collision and zoning systems.

2.0 Definitions

zoning system

a system which slows and restricts the movement of the crane and can be programmed to prohibit the crane hook from entering a prohibited area, such as a railway or an area for which the crane user does not have oversailing rights

anti-collision system

a system fitted to two or more adjacent cranes which prevents a crane colliding with the structure or hoist rope of an adjacent crane

anti-collision radio (also known as a "crash radio")

a radio system comprising a separate radio in each tower crane cab operating on a unique frequency to allow open unimpeded communication between all tower crane operators

approach zone

zone in which the crane motion is automatically slowed and stopped as it reaches the buffer zone

buffer zone (also known as "safety distance")

zone between the approach zone and the prohibited area or adjacent crane structure to allow for mast deflection, adverse wind effects, load size and load swing

3.0 Regulatory Requirements and Guidance

The Approved Code of Practice to Regulation 6 of the Lifting Operations and Lifting Equipment Regulations 1998 (LOLER) says: *"Where two or more items of lifting machinery are used they should be installed or positioned so as to prevent the loads and/or parts of the equipment coming into contact with one another."*

HSE's guidance to Regulation 6 of LOLER says: *"Devices can be fitted onto tower cranes (such as motion limiting and anti-collision devices) that prevent the boom and any counter boom from moving into a potentially dangerous position. Even if such devices are fitted, a safe system of work should always be followed. Crane paths should be planned and clearly defined. Further guidance can be found in the various parts of BS 7121."*

Clause **5.1.3** of BS 7121-5:2019, Code of practice for the safe use of cranes – Tower cranes, states:

"*The crane coordinator should establish the loads to be positioned that day for each crane, taking into account loading and offloading points, and ensure wherever possible that lifting operations have sufficient separation to avoid collision, liaising where necessary with site management and logistics. The use of electronic anti-collision devices should be a secondary aid only to planning and communication (see **9.9.5**).*

Any corresponding instructions from the crane coordinator to the crane operators should be given via the respective signallers. In such circumstances, the slinger-signallers should obtain the agreement of the crane coordinator before carrying out any operation."

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Clause **9.9.5** states that: "*Zoning, radius-limiting and anti collision devices should be fitted where the risk assessment completed as part of the planning process (see 5.2) identifies a risk of cranes and/or the fixed load attachments:*

a) entering or oversailing a prohibited zone;

b) exceeding specified radius; or

c) colliding with fixed structures, other cranes and/or other mobile plant.

*The safe system of work for a tower crane should not rely on the use of electronic aids as the sole means of avoiding collisions. Instead, they should be used as a secondary aid to assist the crane coordinator (see **5.1.3**).*

The functioning of these devices, including calibration checks, should be confirmed during the pre-operational inspections on a daily and weekly basis, and the check should be signed for by the operator.

***NOTE**: Many of the systems allow a check-point to be created, which is then confirmed with the physical location on site. This confirms the correct calibration of the system. This is recorded in the system's memory. Where this is not available, a manual check can be carried out by approaching a boundary on the system and ensuring it activates at the same position on each check."*

Clause **13.2.2** states that: "*For multiple tower crane installations, an anti-collision radio system should be installed, comprising a separate radio in each tower crane cab operating on a unique frequency to allow open unimpeded communication between all tower crane operators, the crane coordinator and anyone with a role in preventing a collision. Unnecessary communication on the anti-collision radio channel should be avoided to ensure it can be used when required.*

***NOTE 1:** In the event of the jib or counter jib of one crane approaching the hoist rope of a higher crane, the operator of the higher crane can immediately warn the operator of the lower crane.*

***NOTE 2:** Guidelines on radio communications for tower cranes are given in Information Sheet RA 195 published by the Office of Communications [27]."*

From this it can be seen that whilst anti-collision systems are a useful aid to the operator, they are **not** the front line of defence, and that the directions of the Crane Coordinator, operator vigilance and the protocols for crash radios (including constant signal reception checks) are essential if collisions between tower cranes and loads are to be prevented.

4.0 Principles of anti-collision systems

Because of the inertia of tower crane components, particularly the jib when slewing, it is not possible to bring a tower crane to a rapid stop from high speed. Consequently, when a crane is approaching the edge of a prohibited zone or the operating area of an adjacent crane, the speed of the motion will automatically be reduced at the start of the "approach zone" to enable the crane to stop without entering the prohibited zone. In addition, a "buffer zone" around the crane is added to allow for - mast deflection, the size of the load, adverse wind effects and any load swing. Points to be borne in mind when considering buffer zones are:

- The system does not know the size of the load;
- The system does not know the deflection of the crane;
- The buffer zone is there to account for the size of the load and deflection, if the load or deflection is larger than the buffer zone there is a potential for collision;
- The system does not know the height of the load, and therefore assumes it to be infinitely tall, so that it is not possible to lift a load over another crane.

These parameters are determined during the initial system set-up on site by a specialist competent technician.

***NOTE:** On some systems the position of the outer limit of the approach zone may vary with approach speed.*

When the system is active, it constantly monitors the position of the crane in relation to fixed obstacles or boundaries for zoning applications, or other cranes for anti-collision applications.

In the case of a zoning application, when approaching an obstacle or boundary, the system monitors the crane's speed against the programmed slowdown value and automatically reduces the speed of the motion to low speed. The crane then continues to operate in low speed until the pre-set minimum buffer distance is achieved and further motion towards the obstacle is prevented. The operator can now only make movements away from, or parallel to, the obstacle in low speed until they leave the buffer and approach zone.

***NOTE**: Some zoning systems have an option to define the height of an area to avoid. Therefore, it would be possible to pass over a prohibited area as long as the load is above the height limit.*

The proximity of the crane to a prohibited zone will limit its speed, consequently careful placing of loading bays during the planning process is critical.

In the case of an anti-collision application, when the crane approaches another crane using the pre-set approach distance, the anti-collision system cuts slewing and/or trolleying and/or luffing to low speed on both cranes. The cranes then continue to operate in low speed until the buffer zone is reached, when further motion toward the other crane is stopped. Each crane can now only operate in low speed until they leave the influence of the other crane. The system will also prevent the load passing over or alongside a counter-jib of the other crane. In addition, there is a buffer zone around the jib where the ropes cannot enter and an approach zone where both cranes will be limited to low speed:

The system does know the dimensions of the crane, so most systems will allow a load to pass under a counter jib with a buffer zone - but not over the counter jib, as the system does not know the dimensions of the load on the hook.

5.0 Potential issues with anti-collision systems

The approach zones and buffer zones required by anti-collision systems place restrictions on the speed and operational flexibility of tower cranes on multi-crane sites, which may have an impact on productivity. When planning the use of anti-collision systems, the following points should be taken into account:

- An anti-collision system will not prevent collisions with mobile cranes and other high-reach plant;
- When a crane approaches an adjacent crane, both cranes are slowed down when in each other's approach zone;
- The size of the approach and buffer zones should allow the cranes to slow down safely;
- If the buffer zone is too small there is a potential for clash between the cranes;
- The size of the load is critical, the system will not stop a large load over-sailing the boundary – it should be controlled by the slinger/signaller and manipulated with taglines;
- Placing cranes too close to each other will significantly impact crane performance, as their motion speeds will often be limited to low speed;
- The careful placement of loading bays and consideration of offload points is key to efficient lifting;

On very tight sites the only option may be to use the system in passive mode – i.e. audible and visual warnings only. Lifting operations must, however, be carefully managed with a crane supervisor in permanent attendance for every lift. Using the system in passive modes should only be undertaken where no other approach is possible and should only be undertaken following a robust risk assessment and implementation of appropriate control measures.

6.0 Common faults

6.1 Loss of communication

Anti-collision systems on cranes on a multi-crane site communicate with each other via a radio link. For maximum reliability of the anti-collision system this radio link needs to be robust. It is possible to operate the system on open radio frequencies, but as these are often congested with other traffic the signal may be poor resulting in a loss of communication between cranes.

This can be overcome by licencing a dedicated frequency from Ofcom (https://www.ofcom.org.uk/__data/assets/pdf_file/0021/83604/guidance_note_for_tower_cranes.pdf)

If the system loses communication with another crane, either because it is switched off or faulty, most systems assume the crane could be anywhere in its operating radius, preventing any cranes moving within or into the zone, severely impacting lifting operations on site.

NOTE: *Some systems limit the effect of lost communications by expanding the exclusion zone to the maximum slewing/ trolley/luffing swept path.*

6.2 Calibration faults

It is possible for the system sensors to "move" and the system to come out of calibration. This could result in the crane being allowed to enter a zone or collide with another crane.

The risk of this can be minimised by carrying out a daily calibration check. This is carried out by placing the hook block in a fixed known location on site and confirming that the system screen in the crane cab shows the position correctly.

NOTE: *The fixed point should be a location that does not move from day to day such as a gate post or chain store.*

7.0 Modification and Bypassing the system

Access to the system's settings should be strictly controlled as any unauthorised modifications will increase the risk of collisions or prohibited zone infringements. Any changes made to the settings should be approved in advance by the Appointed Person and a record made in the crane file after the system has been tested to verify the changes have been made correctly. Drawing(s) showing the zoning restrictions and anti-collision measures for each crane should be updated and copies provided to the lifting team members on site.

The system should not be disabled (switched off, bypassed) without prior written approval of the appointed person. The appointed person should ensure that all lifting team members (crane supervisors, crane operators, slinger signallers and crane coordinators) on site have been told that the system has been disabled. A record that the system has been bypassed should be made in the crane file.

On older systems where the system can be disabled by a key switch in the operators cab the key should only be issued to the driver when this has been authorised by the Appointed Person. Arrangements should be in place for the system to be restored to normal operation and the key returned when it is no longer required. Similar arrangements should be in place where the system can be disabled remotely via a phone or computer app.

When the system is disabled, it cannot control the operation of the crane to prevent collisions or infringements. In the disabled condition the crane should have an external white light flashing to warn other crane operators and lifting operation managers that the system has been switched off.

8.0 Planning the use of anti-collision systems

As with all lifting operations on site, the use of anti-collision and zoning systems should be adequately and effectively planned at the pre-construction stage. It is essential that those carrying out the planning are familiar with the benefits and limitations of these systems so that the most effective multi-crane layout can be achieved.

Anti-collision and zoning systems will have an impact on lifting operations and should be taken into account by all those planning lifting operations on a construction site. Not using such systems may result in an accident or severe financial penalties (e.g. oversailing railways or a third party's property).

9.0 Training

It is essential that all those involved in any way with tower crane anti-collision systems on construction sites have an adequate understanding of the benefits and limitations of these systems. This does not just include those personnel responsible for installing, setting up, using and maintaining the system.

It also includes other personnel such as those:

- planning the construction process;
- planning the layout of cranes on site;
- planning lifting operations;
- carrying out the thorough examination of tower cranes;
- managing lifting operations.

It is also helpful if those carrying out the procurement of tower cranes are familiar with the principles of anti-collision systems.

Training can be provided by anti-collision system manufacturers and distributors, and some tower crane suppliers. There are also a number of helpful videos available on YouTube which can be found using search term: *'tower crane anti-collision and zoning'.*