

## 1.0 Introduction

Cranes frequently work on construction sites where the signaller is out of sight of the crane operator ('blind'-lifting) and standard hand signals cannot be used. To enable communication between the signaller and the crane operator, radios are used. The incorrect choice and use of radios can lead to problems which could interfere with the clear communication vital for safe lifting operations, such as:

- a) loss of signal and thus communication, resulting in the loss of control of the lifting operation;
- b) interference from radios on adjacent sites, which can result in the loss of communication or directions being given to the wrong crane operator; and
- c) misunderstanding between the crane operator and the signaller, leading to problems such as a) a load being lifted before the slinger has their hands clear, b) a load colliding with the building structure or c) a load being lowered before people are clear of the landing area.

## 2.0 Radio Specification

To avoid loss of signal and interference, the correct radio equipment for the application should be selected, considering:

### a) Signal coverage

The radio system selected should deliver good signal strength to all the areas serviced by the crane. It is possible that building structure under construction may reduce the coverage.

**NOTE:** *If signal strength is too low, there is a risk of signal loss but if it is too high, it is likely to cause interference with adjacent sites. When working 'blind', the structure could cause signal loss for which a remotely positioned repeater to boost and extend the transmission may be required. As the size and shape of the building under construction changes signal, coverage may deteriorate.*

Signal coverage should be checked when the radio system is first installed and at the beginning of each shift before lifting operations are commenced. Lifting operations should not commence until adequate signal strength has been confirmed.

### b) Frequency/channel Allocation

A dedicated frequency/channel should be allocated for communication between the crane and slinger/signaller for each crane in use at the site. To avert problems with inadvertent communication with the incorrect crane, it is recommended that the numbering system for the cranes and channels should be the same (See **Table 1**).

It is recommended that when radios are procured, they are set up by the radio supplier to allow access only to channels required by that radio. Access to other channels should be blocked to prevent communications taking place on the incorrect channel.

It is recommended that separate channels are allocated to trades on site such as steelwork erectors, mechanical and electrical installers. This helps prevent the channels allocated for crane communication being used for other purposes.

On handsets where access to more than one channel is to be provided (Appointed Person, Working Crane Supervisor/Coordinator), it is recommended that a voice announcement is made when the channel selected by the user is changed.

	Radio Type	Communication	'Crash' Radio
<b>Tower crane 1</b>			
Operator – Tower crane 1	Cab	Channel 1	Channel 13
Slinger/Signaller - Tower crane 1	Handset	Channel 1	No access
Slinger/Signaller – Tower crane 1	Handset	Channel 1	No access
<b>Tower crane 2</b>			
Operator – Tower crane 2	Cab	Channel 2	Channel 13
Slinger/Signaller - Tower crane 2	Handset	Channel 2	No access
Slinger/Signaller – Tower crane 2	Handset	Channel 2	No access
<b>Tower crane 3</b>			
Operator – Tower crane 3	Cab	Channel 3	Channel 13
Slinger/Signaller - Tower crane 3	Handset	Channel 3	No access
Slinger/Signaller– Tower crane 3	Handset	Channel 3	No access
<b>Lifting management and supervision</b>			
Appointed Person	Handset	Channel 1, 2, 3	Channel 13
Working crane Supervisor/Coordinator	Handset	Channel 1, 2, 3	No access

Table 1: Example of radio and channel allocation

c) 'Crash' radios

On sites where there is more than one crane and there is a risk of collision, then a separate independent 'crash' emergency radio should be provided in each crane cab. The crash radio system should be set up on a dedicated channel that is separate to any other channels in use at the site. Access to the dedicated channel should be restricted to crane operators and the site's appointed person.

d) Durability

Radio handsets should be water resistant, dust resistant, and shock resistant.

e) Security

Radios and microphones used by the signalers should be fitted with security tethers that can be used to attach the radio to the slinger, holster or their clothing.

f) Ease of use

Radios used by the slingers should be capable used by persons wearing gloves. Consideration should be given to separate microphones.

g) Hands-free controls

Radios systems fitted to tower crane cabs should be fitted with hands-free controls. Separate foot controls should be provided for normal and crash radio systems.

**NOTE:** A hands-free radio systems allow the crane operator to fully concentrate on crane operations, whilst maintaining contact with the lifting team - critical for safe lifting operations.

h) Timed out cut off feature

Radios may be supplied with a feature that cuts off further communication at a set time after the call function has been continuously selected. This time is often set at 60 seconds. If this feature is enabled/present, arrangements should be put in place for lifts that may take several minutes to complete.

i) Noise reducing microphones

Noise reduction microphones help ensure that communications can be heard regardless of background noise.

j) Charging and battery life

Adequate arrangements should be made so that handset batteries are charged at the end of a shift and that spare charged batteries are always available mid-shift on sites where the cranes are used intensively.

**NOTE:** Multiple battery changes may be necessary each working shift when cranes are in continuous use.

### 3.0 Radio frequencies, channels, coverage, and license requirements

Two types of radio system for two-way communication on construction sites, are available. Low output power private mobile network (PMR) radios - which can be used without and licence - or higher output power radios - which require a licence from Ofcom.

#### 3.1 Licence-free PMR 446 Radios

Low output power radios that use a European system called PMR 446 do not require a licence. These radios are purchased, pre-programmed off the shelf and are limited to a maximum of 500 mW effective radiated power. They cannot legally use a repeater to extend their range.

In comparison, licenced radios operate at between 3 - 5 watt effective radiated power and offer significantly improved coverage. PMR446 radios have low level of encryption and a shared pool of frequencies, therefore the chances of interference - particularly in busy city centres - will be dramatically increased.

For the reasons described above, licence free PMR 446 radios should not be used for communications on tower cranes.

#### 3.2 Licenced Radio Systems

More powerful radios work on VHF and UHF radio frequency bands, which are assigned to a user by Ofcom. To obtain a licence on one of these frequencies, an application needs to be made to Ofcom. The benefits of a licensed frequency radio systems include:

- greater range;
- less interference from other users;
- ability to use repeaters to extend coverage in areas with a low signal strength;
- enhanced features and accessories available on the radio sets making them better suited for use on construction sites.

Licences are allocated to businesses only on a case-by-case basis. Once a licence has been issued, radios can be purchased. The supplier needs to see a copy of the licence to program the radio channels to the correct frequencies before shipping.

**NOTE:** Sufficient time must be allowed for an application to Ofcom to be submitted and approved. The radio/tower crane supplier should be able to advise users on typical time frames.

#### 3.3 Additional Guidance

Additional guidance is given in Ofcom's Information Sheets:

- Business Radio – Guidance note Business Radio frequencies and tower cranes – January 2016:  
[https://www.ofcom.org.uk/data/assets/pdf\\_file/0021/83604/guidance\\_note\\_for\\_tower\\_cranes.pdf](https://www.ofcom.org.uk/data/assets/pdf_file/0021/83604/guidance_note_for_tower_cranes.pdf)
- Business Radio - Analogue and Digital PMR446 Information Sheet - Feb 2018:  
[https://www.ofcom.org.uk/data/assets/pdf\\_file/0025/85156/ir\\_2009\\_analogue\\_and\\_digit\\_a1.pdf](https://www.ofcom.org.uk/data/assets/pdf_file/0025/85156/ir_2009_analogue_and_digit_a1.pdf)

### 3.4 Analogue versus Digital Radios

Radios are available with Analogue and Digital communication systems. Key benefits of Digital radios over Analogue radios include:

- Better audio quality – *crisper audio, which offers greater coverage;*
- Encryption – *higher level of encryption offering less interference;*
- Better audio/range performance - *voice quality tends to be better;*
- Better spectrum efficiency – *more channels are available than with digital radios;*
- Better battery life - *there is typically a 20-25% battery saving in digital mode;*
- Availability of enhanced features - *such as ‘Man’-down alarm, Lone Worker alarm, GSM 3G and 4G connectivity, text messaging and WiFi connections.*

Historically analogue radios have been cheaper to purchase or rent than digital radios. Over recent years the differential cost however has reduced.

### 3.5 Digital Cellular Radios with WiFi

Digital radios are available that offer WiFi and cellular (GSM/3G/4G/5G) connectivity. These function much like a regular radio system except that when radio signal strength is poor, WiFi or a cellular mobile phone network can be used instead. Each of the radios will require a SIM card and a suitable contract to connect to cellular phone networks.

To maximise coverage, it is recommended that the SIM card and contract selected does not restrict connection to a single network provider. This allows the radios to automatically connect to the strongest available network provider at different locations at the site.

These radios can provide improved coverage, range, and functionality to standard UHF/VHF radios.

## 4.0 Recording of Voice Communications

It is recommended that radio systems used on tower cranes are provided with systems that record all voice communications. The information may be stored on a local computer, server or remotely in the ‘Cloud’. The recording of voice communications assists with the monitoring, training of radio users and investigation of incidents. It is essential that the crane operators and signallers are told that the radio system will record all voice communications and the reason why the recordings are being made.

**Note:** *Digital cellular radios provide improved recording facilities over conventional radios.*

## 5.0 Radio Protocol, Calls Signs and Standard Commands

Poor radio discipline and failure to follow protocols can lead to lifting incidents. To avoid misunderstandings between the crane operator and signaller:

- a) a full radio check between all users must take place prior to commencing lifting operations;
- b) to ensure the full message is understood when using the radio - always press, pause and then speak;
- c) both parties should have a sufficient command of a common language (normally English) so that clear, unambiguous communication can take place;
- d) a clear, unique call sign should be allocated to each signaller and crane operator;
- e) each message should be preceded by the call sign;
- f) the crane operator should not respond to any command (other than “Stop”) that is not preceded by the call sign;

- g) voice commands should only be given by one person, normally the signaller, at any one time;
- h) voice commands should be given using the signals as in **Table 2** and;
- i) voice commands should be acknowledged and repeated by the operator to demonstrate that the message has been received and understood.

Standard Voice Commands for Lifting Operations		
	Command	Crane Type
1	“Take the weight”	All
	“Hoist”	
	“Hoist Slowly”	
2	“Lower” (see Note 1 below)	All
	“Lower Slowly”	
3	“Slew Left” (see Note 2 below)	All
	“Slew Right” (see Note 2 below)	
4	“Trolley In”	Trolley Jib
	“Trolley Out”	
5	“Jib Up”	Luffing jib tower cranes, mobile cranes, and crawler cranes
	“Jib Down”	
6	“Extend Jib”	Mobile and some self-erecting cranes
	“Retract Jib”	
7	“Travel Forward” (see Note 3 below)	All travelling cranes
	“Travel Backward” (see Note 3 below)	
8	“Stop”	All
	“Stop Now” (Emergency Stop)	
<b>NOTE 1:</b>	<i>When fine positioning control is required, the person giving the signal should repeat the command continuously for as long as motion is required “Lower slowly, Lower, Lower, Lower, Lower, Lower, Lower, Lower, Stop”. As long as the crane operator can hear the command, they will know that the radio is working. If the commands cease before the final “Stop”, they will know that communication has broken down and should stop the operation.</i>	
<b>NOTE 2:</b>	<i>Left and Right are defined from the viewpoint of an operator sitting in a cab looking down at the load. This also applies when a crane is being operated using remote controls.</i>	
<b>NOTE 3:</b>	<i>In the case of a travelling tower crane, “Forwards” and “Backwards” should be clearly designated by signs on the tower crane track that are visible to both the signaller and the operator. If the signaller cannot see the track, they must be provided with a site plan indicating the designated directions.</i>	

**Table 2: Standard voice commands for lifting operations**

## 6.0 Communication Between Signaller and Operator

Prior to lifting, the signaller should:

- a) check the radio and ensure communication is clear prior to commencing lifting;
- b) inform the operator of the task to be completed;

- c) inform operator the location of the load that is to be lifted;
- d) inform the operator of the weight of the load;
- e) inform operator of proximity hazards relevant to the lifting area;
- f) inform the operator of the expected load path;
- g) inform the operator of where the load is to be landed.

During the lifting operation, the signaller should provide regular updates to the to the operator as to the position of the load relative to the intended landing position.

Examples of communication as the load is lowered:

- a) **“Lower”** (*always checking visually for hazards and you are in a safe position*);
- b) **“20m to go keep lowering”** (*make sure the area is clear*);
- c) **“Keep lowering”** (*you are in a safe position*);
- d) **“10m to go, keep lowering”** (*the operator is slowing down*);
- e) **“5m to go, keep lowering”** (*bearers are in position*);
- f) **“2m to go, keep lowering”** (*ensuring the load is in full control*);
- g) **“1m to go, keep lowering”** (*the operator is in slowest speed*);
- h) **“Load landed”** (*ensure load is in correct position*);
- i) **“Stop”**.

## 7.0 Training and Monitoring of Radio Users

All radio users should be trained and familiar with the radios and communication protocols that they will be required to use. The training should include instruction on:

- Radio controls and features;
- Changing channels (if required);
- Checking radio coverage and function;
- Battery charging and exchange;
- Radio etiquette, protocols, call signs and standard commands;

**Note:** *This should include listening to recordings of good and bad good communications.*

- Avoiding unnecessary non-task specific communication (i.e. chatting, gossip and banter);
- How to provide continuous feedback to the crane operator during extended movements on movement of the load/hook;
- How to advise that tag lines, slings have been removed from a load and that the hook can be raised;
- Listening to examples of good communication.

**NOTE:** *Current Slinger/Signaller and Tower Crane Operator training courses may not include comprehensive training in the use of radio protocol, calls signs and standard commands.*

The appointed person for the site should periodically check live radio communications and recordings to confirm that radio users are adhering to the site agreed radio protocol, call signs and standard commands. Feedback should be provided to improve communication.