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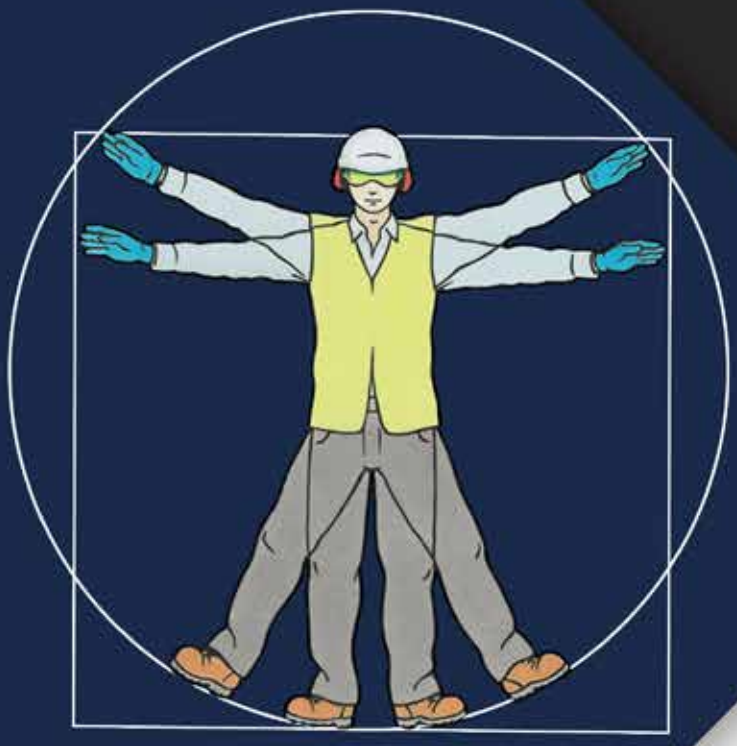
HAND SIGNALS FOR WHEN EXCAVATORS ARE USED AS CRANES

A VOLUNTARY CODE OF PRACTICE



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HAND SIGNALS FOR WHEN EXCAVATORS ARE USED AS CRANES:
A VOLUNTARY CODE OF PRACTICE

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Whilst written principally in a UK context, for the most part, the principles and concepts discussed within this publication hold equal international relevance.

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PREFACE

Modern tracked hydraulic and wheeled excavators (both 180° and 360° models) are widely used throughout the construction and civil engineering industries internationally to undertake earthmoving and site clearance operations for buildings and infrastructure development to support national socio-economic development. Without these versatile machines, the modern digitised 'smart city' economies that proliferate throughout the developed and (increasingly) developing worlds would not be possible. Against this backdrop of inhabiting and working within an increasingly digitised world, it seems ironic that a notable lack of simple hand signals for excavators when operating as cranes continues to cause incidents, accidents and fatalities amongst construction workers and members of the public. This issue is perhaps caused in part by the machine's versatility – made possible by rapid and highly innovative engineering developments that often outstrip the tacit knowledge and formal education/ training of both operators and supervisors of excavators on site. Perhaps some responsibility lies at the door of training providers and accreditation schemes that fail to train operators on basic hand signals – but then again, which signals do they train operators with given a number of international and national standards available? Or perhaps Universities are at fault for not working more closely with industry practitioners to solve real-world problems vis-à-vis blue skies research or fictitious academic pursuits designed purely to publish papers not generate impact? These questions are not intended to be invidious but rather to challenge current thinking and encourage wider research and collaboration between industrialists and academics in order to solve the prevailing problems within the construction and civil engineering industry.

This voluntary code of practice aims to address the issue of poor communication between operator and banksman by providing a set of unequivocal (and in many cases long established) hand signals. Even where other communication devices may be used (such as two-way radio), the basic requirement to communicate using hand signals is essential as technology can, and often does, fail for a variety of reasons.

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Mr Mick Norton, BEM

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LIST OF FIGURES

COLOUR

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COMMONLY USED ACRONYMS

BS	British Standards
BSI	British Standards Institution
CDM	Construction (Design and Management) Regulations
HSE	Health and Safety Executive
ISO	International Organisation for Standardization
LOLER	Lifting Operations and Lifting Equipment Regulations 1998
OEMs	Original Equipment Manufacturers
OPERC	Off-highway Plant and Equipment Research Centre
PUWER	Provision and Use of Work Equipment Regulations 1998
RFID	Radio-Frequency Identification
ROSPA	Royal Society for the Prevention of Accidents
SMR	Supply of Machinery (Safety) Regulations 2008


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INTRODUCTION

The tracked or wheeled hydraulic 360° excavator (as defined in ISO 7315 (ISO, 2009)) and the wheeled 180° excavator are amongst the most widely utilised items of off-highway plant (Edwards et al., 2003). These mobile machines are primarily employed for earth-moving operations (BS EN, 2018) but also operate within diverse working environments including demolition, highways, quarrying, mining and minerals extraction, forestry, agriculture and construction and highways (c.f. Edwards et al., 2019). The excavator's popularity stems from its inherent versatility which is achieved via hydraulic implementation lines that enable various types of attachment to be fitted to the machine's dipper (or stick) to extend machine functionality, for example impact hammers, various bucket specifications, crushing and screening attachments, compaction plates and clamshells or hydraulic grabs (c.f. Edwards et al., 2003; BS EN ISO, 2012).

Excavators are also increasingly being used for performing certain lifting operations on site, hereafter referred to as using excavators as cranes. A purpose-designed lifting point fitted to the excavator is used to allow a freely suspended load to be lifted, moved and positioned. Whilst an excavator should not automatically be the first option considered for a lifting operation, its widespread application for smaller, non-precision and repetitive lifting tasks must be recognised and as such the lifting operation must comply with, and undergo, a thorough examination as required by the Lifting Operations and Lifting Equipment Regulations 1998 (LOLER, 1998).

Despite the excavator's widespread popularity and significant contribution to the built environment and infrastructure development, incidents, accidents and fatalities continue to plague industry. For example, Edwards et al., 2004, report that approximately 40 per cent of all fatal workplace accidents involve pedestrians being struck by a large commercial vehicle. Of these, approximately 30 per cent involve a vehicle that is reversing. Using excavators as cranes adds a further layer of risks to an operation. Some of these are due to incorporation of the lifting process itself, such as failure of the lifting equipment or unplanned detachment of part or all of the load being lifted. Others arise from the fact that excavators are designed primarily as a digging machine, not lifting, so they move differently and more quickly, particularly when turning and slewing; this increases risks such as instability or contact with objects or persons.

Effective communication between site personnel is crucial in mitigating many of the risks that lead to these accidents and incidents. When utilising excavators as cranes, the banksman, signaller or dogman [in Australasia] (hereafter referred to as 'banksman' for convenience) forms an important symbiotic partnership with the machine's operator. The banksman is the person who directs the movement of the machine from the points near where a load is attached and detached – particularly when the excavator operator may not have clear visibility. Communication is often achieved using a combination of mobile telecommunications devices, verbal commands and importantly hand signals. However, despite this essential role, there are at present no international standards available that define and prescribe hand signals for banksmen when excavators are used as cranes to handle objects. Furthermore, there is no universal agreement in operator training courses on what signals should be used in the event that an excavator is utilised as a lifting device. Such a notable gap in current practice literature can lead to poor communication and confusion between the operator and banksman, and to unnecessary incidents, accidents or fatalities occurring.

Given the aforementioned contextual backdrop, this voluntary code of practice seeks to prescribe a set of universally accepted hand signals, specifically designed to train and educate operators and banksmen throughout industry when using excavators as cranes to handle objects. It is anticipated that although such signals alone are not a panacea to curbing incidents and accidents, it is hoped that such will go some way to removing prevailing ambiguity and confusion that can contribute to unsafe acts occurring.

As a final point, please note that OPERC acknowledges that this voluntary code of practice will be subject to periodic review and revision, and that the association is open to receiving constructive advice and guidance from practitioners on subsequent revisions, additions or amendments.

RISKS POSED WHEN EXCAVATORS ARE USED AS CRANES

Although the primary design function of excavators is earthmoving, they are increasingly being utilised to perform lifting activities in a similar mode to mobile cranes. Using the quick hitch mechanism or slings attached to purpose designed, approved lifting points the excavator is used to lift, move and position loads such as pipes, structural beams, bundles of steel, spoil buckets, panels and other construction equipment. When an excavator uses lifting equipment in this manner to undertake a lifting operation, then the procedure must comply with LOLER and according to Regulation 8 must be properly planned, appropriately supervised and carried out in a safe manner.

As excavators are designed first and foremost for digging, not lifting, they behave in a different manner operationally than a crane. Cranes are intended to move slowly and with exact movements so that they are capable of precise lifting and placement, whereas excavators are better suited to the non-precision lifting tasks mentioned above. Excavators move differently to cranes, capable of faster articulation, turning and slewing which means that object handling during lifting operations can pose a number of significant health and safety risks for operators and people working within the vicinity (including banksmen).

Specific risks encountered when using excavators as cranes include the following:

Failure in lifting accessories/ equipment (including lifting chains or synthetic slings, hooks and eyebolts) – these can become damaged, or fail, due to factors such as: the safe working load (SWL) being exceeded; natural wear and tear (where the rate of deterioration can increase in adverse prevailing operational conditions); and/ or damage caused by incorrect usage, for example repeated physical contact with the machine can cause 'fraying' of synthetic slings, or a load that is not freely suspended can result in mechanical failure of the master link due to additional stresses occurring within the steel (for a more detailed explanation refer to Edwards and Holt, 2010). For this reason, daily pre-checks and periodic thorough inspection (normally every six months) are critical (refer to: HSE, 2008).

Unplanned detachment of load – this may happen if the load is not correctly prepared and adequately secured, for example: by failing to properly secure materials lifted on pallets or incorrectly slinging a multiple load; using inappropriate lifting points or accessories; failing to ensure that the safety catch on the lifting hook is closed; or using damaged slings, chains or other equipment. A falling load may damage building materials (thus incurring unexpected additional costs), damage nearby property and/or injure pedestrians and workers in the near vicinity.

Machine lateral and longitudinal instability – there are several factors of a lifting operation which, if not given careful consideration, could result in the machine exceeding its balance 'tipping' point through lateral instability (overturning the machine across the tracks/ tyres) or longitudinal instability (overturning a machine along and in front of the tracks/ tyres) (refer to ISO, 2007), including:

- working on weak, compressible or slippery ground conditions or working on inclined or uneven surfaces; operations should preferably be conducted on a firm, level hardstanding.
- the unpredictable effect of the load, depending on its size or nature, for example: a non-uniform load where the centre of gravity is offset from the lifting point and/or may change during movement; or a load that is light but has a large surface area which may result in a significant wind load.
- slewing the suspended load, particularly at speed, which can add 'additional forces' of inertia (over and above the load being handled) - for a more complete description of these additional forces, please refer to the work of Edwards et al. (2019).
- travelling, in a lift and carry operation, which can also increase the effects from the load compared to a static lift, for example as the load swings while being carried. Load radius charts, in the majority, detail information for static lifting only; incorporation of dynamic forces from travelling or slewing can reduce the SWL. Travelling should be over short distances only and the load should be as near to ground level as possible.

Object/person struck by machine load, boom or other part / struck by vehicle object or pedestrian contact – this may be due to restricted visibility during the lift operation, for example: when undertaking a blind lift, where the operator cannot directly see the load during part of the operation; operating in a tight space where there will be blind spots; reversing; lifting over an obstacle; operating where the boom is raised and a large load is being lifted, particularly where the cab is offset from the centre line of the machine. Another factor could be rapid movements - to keep the lifting operation controlled the machine should be operated with slow speed and in some models a 'lift mode' is incorporated.

The banksman is at particular risk as they must enter the operational area of the excavator to attach or detach the load, which is contrary to normal control measures of excluding persons from the working area. The banksman must only enter this zone when the machine hydraulics are isolated using the safety lever to prevent inadvertent operation of the controls, the machine is immobilised using the parking brake so it cannot physically move and the engine switched off.

THE ROLE OF THE BANKSMAN

When utilising an excavator as a crane, the role of the banksman is to direct the operator during the lifting operation, essentially acting as their eyes and ears on the ground. This definition is deceptively simple, because the banksman's job requires great skill, competence and attentiveness in ensuring that the operation is conducted safely – the following are the main duties involved:

- Conducting pre-use/post-use checks and visual inspection of lifting accessories and equipment and ensuring that the load does not cause damage to them during the lifting operation.
- Ensuring loads are: attached and detached correctly, safely, securely and using appropriate lifting points and accessories, such as cages and slings; and lifted directly up with the hoist rope vertical and the hook centred over the load and free to move.
- Guiding the safe movement of the excavator using a prearranged system of communication with the operator.
- Carefully observing, both prior to and during the operation, factors that can affect the safety of the lift, such as: ground conditions, weather conditions, load swing, machine speed, obstructions affecting the lift, blind spots, personnel in the vicinity, etc.

In consideration of the specific risks of using excavators as cranes outlined previously and the inherent potential of these to cause serious injury or fatality, it is clear that the banksman's duties play a critical role in mitigation of these risks. Effective communication between the banksman and operator is therefore imperative. Indeed, an efficient triumvirate between man (both operator and banksman) and machine constitutes a pre-requisite requirement of achieving safe, productive, and hence profitable, site operations.

Communication with the operator can take several forms: *physical*, by the use of barriers or cones; *audible*, using alarms or verbal instructions over headsets or radios; and *visual*, such as lights or signs, or a system of hand signals. The predominant communication methods between banksman and operator are either verbal instruction over a communication device or a visual system of hand signals. However, verbal communication is not always possible on site (even when equipped with modern digital communication devices) and hence there has been a historical reliance upon hand signals. The issue with hand signals is that they can potentially be ambiguous and thus misinterpreted. It is essential therefore that the hand signals employed when using excavators as cranes are simple to make and are communicated precisely and clearly in order that the operator can easily understand and act on them. In doing so, many of the risks posed can be mitigated and/ or eliminated by effective communication.

International Standards

In the absence of an international standard or universally adopted system for a banksman's hand signals when directing an excavator being utilised in lifting operations, this document provides a voluntary code of practice (VCOP) for a set of agreed and accepted hand signals. Three main British/International standards have contributed towards the development of this VCOP, namely:

i) BS 7121 – Code of practice for safe use of cranes. Mobile cranes (BS, 2016);

ii) BS ISO 16715 – Cranes. Hand signals used with cranes (BS, 2014); and

iii) BS 6736 – Code of practice for hand signalling for use in agricultural operations (BS, 1986).

Unlike BS 6736 and BS ISO 16715, BS 7121 is frequently referred to within the construction and civil engineering industry and yet the other two standards are equally helpful and informative. However, there are several significant differences between these standards that can lead to misunderstanding (refer to Appendix A). For example, the 'stop' signal in BS 6736 is the 'emergency stop' signal in BS 7121 whilst the 'emergency stop' signal in BS ISO 16715 is a completely different signal again. Whilst some differences in hand signals may be apparent between the agricultural sector and the construction and civil engineering sector, the hand signals indicated in both BS 7121 and BS ISO 16715 relate to cranes – so some element of consistency should be apparent. These differences are most likely due to historical developments of standards but nonetheless they are confusing, particularly as an excavator operator and banksman must agree the hand signals to be used before any lifting operation commences.

This VCOP aims therefore to provide a clear, uniform set of hand signals to be implemented when excavators are used as cranes, divided into four thematic categories, namely: i) general hand signals; ii) vertical movement; iii) horizontal movement; and iv) equipment specific signals. As well as the hand signals themselves, the procedures related to these signals that need to be observed both before and during a lifting operation are also essential – these procedures are outlined next, followed by images and text that describe the set of hand signals.

GENERAL REQUIREMENTS FOR THE USE OF HAND SIGNALS

When operating an excavator as a crane, the following general requirements must apply:

Preliminaries

- The operator and banksman should formally introduce themselves to each other before the lifting operation commences.
- Both the operator and banksman should be fully trained and deemed competent to undertake their respective jobs.
- The banksman should be uniquely identifiable to the operator during operation, using high visibility clothing of a specific, agreed colour.
- Both the banksman and operator must be fully conversant with, and agreed on, the hand signals to be used during lifting operations.
- All site personnel should know the hand signal for ‘emergency stop’.
- When the appointed person or lift planner recommends verbal communication, they must consider the lift complexity, the skill of the operator and banksman and the operational limitations/ capabilities of the excavator.
- For direct voice communication, both operator and banksman should agree on the key commands to be used during lifting operations – such commands should be expressed using the operator’s terminology (e.g. dipper in, dipper out).
- Where radio communications are to be used to augment hand signals, the chosen radio channel should be kept clear of all other communications and the banksman should be given a clear and unique call sign that must precede all communications given - the operator must not respond to any command that is not preceded by the given call sign.
- All wireless communication devices must be fully charged and tested to ensure that they are in full working order before the lifting operation commences.

During lifting operations

- The banksman must be situated in a safe position and preferably outside of the operational area of the machine's fully extended boom, dipper and attachment.
- The banksman must face the operator when signalling and be clearly visible to them.
- The banksman must maintain a clear line of sight with the excavator operator at all times.
- The banksman must have direct sight of the load and lifting equipment at all times during the lifting operation and have adequate visibility of the load path.
- The communication between operator and banksman must be continuous throughout the duration of the lifting operation.
- The operator must not respond to any hand signals (or other communication) that are not clearly understood and should seek additional clarification.
- Hand signals and any additional voice instructions should only be given by the identified banksman – with the exception of an emergency stop which can be given by any person, at any time, if a perilous circumstance is spotted.
- If other instructions are required (other than the agreed hand signals), then the lifting operation should be stopped.
- Where there is any concern about the safety of, or the need to halt, the lifting operation, all movement (and therefore, the lifting operation) should be stopped until the issue has been resolved to the mutual satisfaction of both the operator and the banksman.

GENERAL HAND SIGNALS

Figure 1 | Start operations

START

Purpose

To notify the operator to commence operations and follow signalling instructions.

Stance

Fully extend both arms horizontally to the side of the body at shoulder height: hands closed into fists, palms facing forwards.

Figure 2 | Stop operations

STOP

Purpose

To stop all motions, stop an individual motion or punctuate between motions.

The stop operation does not mean to isolate the machine but rather to stop that particular operation which may form part of a wider sequence of operations being undertaken.

E.g. a lifting operation may include: raise the load – stop – slew in the direction indicated – stop – lower the load – stop.

Stance

Raise right arm to shoulder height at the side of the body, elbow bent at 90° with forearm pointing upwards: hand open, palm facing forwards. Hold left arm down against the side of the body.

NOTE: the final stop in a sequence 'may' require the machine to be isolated and for tracked vis-à-vis wheel machines, the isolation sequence is very different. For tracked excavators, the operator must: i) take their feet off the tracking pedals; ii) lower all equipment to the ground; iii) engage the safety lock lever to isolate all hydraulics; iv) isolate the machine (switch off the engine and isolate); and v) conduct a visual check to make sure the machine is safe. For wheeled excavators the operator must: i) bring machine to a stop; ii) apply park brake; iii) lower all equipment to the ground; iv) engage the safety lock lever to isolate all hydraulics; v) switch off the machine and isolate machine electrics/batteries; and vi) conduct a visual check to make sure the machine is safe.

Figure 3 | Cease operations

END

Purpose

To notify the operator to end operations, to stop following signalling instructions and isolate the machine.

Stance

Place both hands together in front of the body at chest height, elbows bent: hands open and touching together, palms facing each other.

Figure 4 | Emergency stop

DANGER

Purpose

Cease all operations **IMMEDIATELY** and isolate the machine. Note that **ANYONE** can give this signal if they observe a dangerous situation arising.

Stance

Raise both arms horizontally to the side of the body at shoulder height, elbows bent at 90° with forearms pointing upwards: hands open, palms facing forwards.

VERTICAL MOVEMENT

Figure 5 | Raise at a steady rate

RAISE STEADY

Purpose

To raise/lift the load/equipment at a steady rate.

Stance

Raise right arm to shoulder height at the side of the body, elbow bent at 90° with forearm pointing upwards: hand closed, palm facing forwards, index finger pointing upwards. Hold left arm down against the side of the body. Make small horizontal, circular movements with the right forearm in a 'cone like' fashion. The speed of the hand rotation will vary the hoisting speed of the excavator.

Figure 6 | Raise slowly

SMALL MOVEMENT

Purpose

To indicate a small movement of either the travelling machine or of the slewing / movement of the arm geometry.

Stance

Hold left arm down against the side of the body: hand open, palm flat against the hip. Raise right arm to shoulder height at the side of the body, elbow bent at 90° with forearm pointing upwards: hand closed, palm facing forwards. Repeatedly open and close right hand.

Figure 7 | Lower at a steady rate

LOWER STEADY

Purpose

To lower the load/equipment at a steady rate – hoist down.

Stance

Extend right arm at 45° to the side of the body: hand closed, index finger pointing downwards. Hold left arm down against the side of the body. Make small circular movements with the right forearm in a 'cone like' fashion. The speed of the hand rotation will vary the lowering speed of the excavator.

Figure 8 | Lower slowly

LOWER SLOW

Purpose

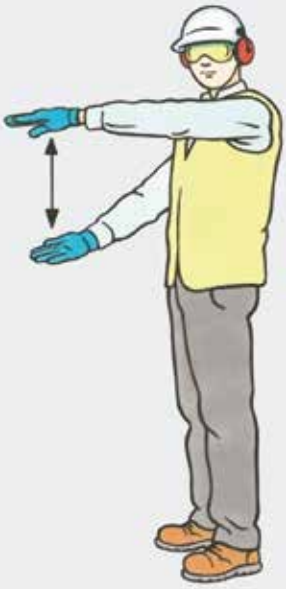
To lower the load/equipment at a slow rate – hoist down.

Stance

Extend left arm diagonally across the front of the body: hand open, palm facing upwards, motionless. Raise right arm to shoulder height at the side of the body, elbow bent with forearm pointing downwards: hand closed, index finger pointing downwards at left hand.

Figure 9 | Indicate vertical distance

VERTICAL DISTANCE



Purpose

To indicate the vertical distance that the load or equipment must be raised or lowered.

Stance

Turn body slightly to the side. Extend both arms horizontally in front of the body: hands open, palms flat and facing each other. Position arms so that the distance between the palms reflects the vertical distance.

HORIZONTAL MOVEMENT

Figure 10 | Travel/slew in the right direction

MOVE RIGHT

Purpose

To travel or slew to the operator's right direction.

Stance

Fully extend left arm horizontally at shoulder height to the side of the body: hand open, palm flat and facing downwards. Bend right arm and place hand on body at chest level: hand open, palm flat against body.

Figure 11 | Travel/slew in the left direction

MOVE LEFT

Purpose

To travel or slew to the operator's left direction.

Stance

Fully extend right arm horizontally at shoulder height to the side of the body: hand open, palm flat and facing downwards. Bend left arm and place hand on body at chest level: hand open, palm flat against body.

Figure 12 | Travel away from the banksman

TRAVEL BACKWARDS

Purpose

To travel backwards away from the banksman. Applicable to both wheeled or tracked motions.

Stance

Place both arms at the side of the body, elbows bent: hands open, palms facing downwards. Move forearms together in slow vertical up and down movements away from the body. Repeat until the travel destination is reached.

Figure 13 | Travel towards the banksman

TRAVEL FORWARDS

Purpose

To travel forwards towards the banksman. Applicable to both wheeled or tracked motions.

Stance

Place both arms at the side of the body, elbows bent: hands open, palms facing upwards. Move forearms together in slow vertical up and down movements towards the body. Repeat until the travel destination is reached.

Figure 14 | Travel on both crawler tracks

TRAVEL – BOTH TRACKS

Purpose

To travel forwards or backwards to continue operations.

Stance

Place both hands in front of the body at chest height, elbows bent: hands closed into fists, palms facing body. Rotate fists (forwards or backwards) to indicate the direction of travel.

Figure 15 | Travel on one crawler track

TRAVEL – ONE TRACK

Purpose

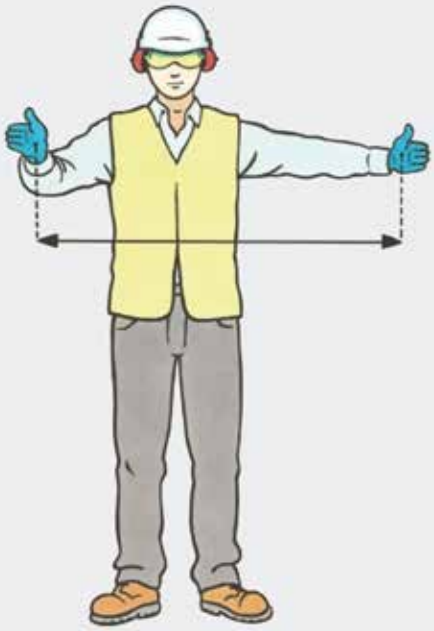
To travel forwards or backwards on one track to move the positioning of the machine to the left or the right.

Stance

Raise left or right arm (to indicate the side of the track which should be locked) to shoulder height at the side of the body, elbow bent at 90° with forearm pointing upwards: hand closed, palm facing forwards. Place the other hand in front of the body at chest height: hand closed into fist, palm facing body. Rotate fist in front of chest (forwards or backwards) to indicate the direction of travel on the other side of the track.

Figure 16 | Indicate horizontal distance

HORIZONTAL DISTANCE



Purpose

To indicate the horizontal distance that the machine or arm geometry needs to travel.

Stance

Extend arms at the front of the body at chest height: hands open, palms facing each other. Position arms so that the distance between the palms indicates the horizontal distance.

Figure 17 | Inching or dead slow

DEAD SLOW

Purpose

To perform the operation or move the machine at a dead slow pace.

Stance

Place both hands together in front of the body at chest height, elbows bent: hands open, palms facing each other. Rub palms together in a circular motion.

EQUIPMENT SPECIFIC SIGNALS

Figure 18 | Crowd out dipper

CROWD OUT

Purpose

To indicate that the dipper (or stick) should move out and away from the machine.

Stance

Hold right arm down against the side of the body. Fully extend left arm horizontally in front of the body: hand closed into fist, thumb extended. Rotate arm to move thumb from horizontal position to pointing downwards.

Figure 19 | Crowd in dipper

CROWD IN

Purpose

To indicate that the dipper (or stick) should move in and towards the machine.

Stance

Hold right arm down against the side of the body. Fully extend left arm horizontally in front of the body: hand closed into fist, thumb extended. Rotate arm to move thumb from horizontal position to pointing upwards.

Figure 20 | Boom section in

RAISE BOOM

Purpose

To indicate that the boom must be raised in towards the body of the machine.

Stance

Extend right arm upwards and place hand on head: hand open, palm flat on head. Fully extend left arm horizontally to the side of the body at shoulder height: hand closed into a fist, thumb extended and pointing upwards. Make small upward movements with the thumb.

NOTE: Tap the head with the right hand before giving the signal, to indicate that the main boom section will be required to go up or down.

Figure 21 | Boom section down

LOWER BOOM

Purpose

To indicate that the boom must be lowered.

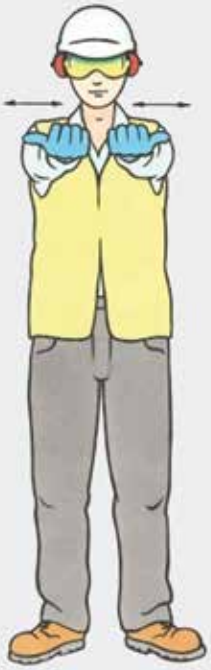
Stance

Extend right arm upwards and place hand on head: hand open, palm flat on head. Fully extend left arm horizontally to the side of the body at shoulder height: hand closed into a fist, thumb extended and pointing downwards. Make small downward movements with the thumb.

NOTE: Tap the head with the right hand before giving the signal, to indicate that the main boom section will be required to go up or down.

Figure 22 | Hydraulic extension of dipper *(180° machine)*

EXTEND DIPPER



Purpose

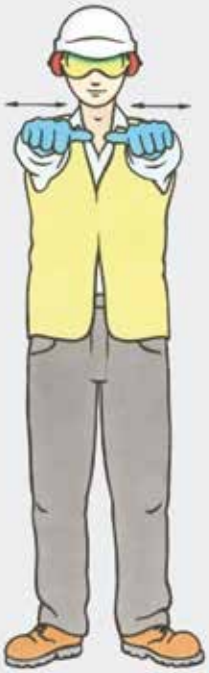
To extend the dipper, telescope out.

Stance

Fully extend both arms in front of the body at shoulder height: hands closed into fists, palms facing **UP**wards with thumbs extended and pointing **AWAY** from each other.

Figure 23 | Hydraulic retraction of dipper *(180° machine)*

RETRACT DIPPER



Purpose

To retract the dipper, telescope in.

Stance

Fully extend both arms in front of the body at shoulder height: hands closed into fists, palms facing **DOWN**wards with thumbs extended and pointing **TOWARDS** from each other.

CONCLUDING SUMMARY

Maintaining efficient and effective communication within the workplace is essential to preserving the health, safety and welfare of workers as well as to increasing production rates (commensurate with augmented profitability rates) on construction and civil engineering sites. The palpable benefits of good communication are myriad but fundamentally it ensures that: the roles and duties of workers are clearly understood; incipient or perilous hazards can be warned against; unsafe practices are avoided; opportunities to promote critical emergency response(s) as and when required are provided; and opportunities to learn about, and from, the concerns and hazards that workers encounter are made available.

In a technological age where digital solutions are treated as the panacea to health, safety and well-being problems confronting the construction and civil engineering sector, there is a growing realisation that the fundamentals underpinning a safe system of working (e.g. a competent workforce coupled with safe machine and safe site) must be preserved and adhered to. In addition, it is apparent that technology complements and does not replace basic operator and banksman skills and competencies. Of these professional skills and competencies, the need to effectively communicate using hand signals is imperative to preserving the safety of a lifting operation when excavators are used as cranes. It is perplexing that to date a common set of banksman signals for this common operation have not henceforth been developed. Instead, a mismatch of different signals (largely for cranes and often inappropriate for excavators) and interpretations of these prevail.

Against this contextual setting, it is hoped that in the short term this new voluntary code of practice provides a basic set of hand signals that can be used to train and educate both banksmen and operators as well as generate further development of signals used – perhaps including new signals for attachments and other operations undertaken. In the longer term, the publication may spark much needed debate in this area and constitute the basis for future international standards development.


mini STORAGE SYSTEMS 731

REFERENCES & BIBLIOGRAPHY

BS (1986) BS6736 - Code of Practice for Hand Signalling for Use in Agricultural Operations, London: British Standard Institution (BSI). ISBN: 978 0 580 15396 7.

BS EN ISO (2012) BS EN ISO 6165:2012 - Earth-moving machinery. Basic types. Identification and terms and definitions, London: British Standards Institution (BSI). ISBN: 978 0 580 66594 3.

BS (2014) BS ISO 16715 - Cranes - Hand Signals Used with Cranes, London: British Standard Institution (BSI). ISBN: 978 0 580 78928 1.

BS (2016) BS 7121 - Code of Practice for Safe Use of Cranes, London: British Standard Institution (BSI). ISBN: 978 0 580 89630 9.

BS EN (2018) BS EN 474-1:2006+A5:2018, Earth-moving machinery. Safety. General requirements, London: British Standards Institution. ISBN: 978 0 580 95583 9.

CDM (2015) Statutory Instrument 2015 No. 51 The Construction (Design and Management) Regulations 2015. London: Her Majesty's Stationery Office. ISBN: 978 0 11 112781 0. Available via: http://www.legislation.gov.uk/uksi/2015/51/pdfs/uksi_20150051_en.pdf [Acessed: June 2019].

Edwards, D. J., Harris, F. and McCaffer, R. (2003) Management of Off-highway Plant and Equipment, Spon Press: London. ISBN: 978 0 415 25128 1.

Edwards, D. J., Loxton, N. and Robinson, B. (2004) A practical guide to enhancing the all-round awareness of plant operators. Off-highway Plant and Equipment Research Centre. ISBN: 978 0 947 97426 1.

Edwards, D. J. and Holt, G. D. (2010) Case Study Analysis of Risk from Using Excavators as Cranes. Automation in Construction. Vol. 19, No. 2, pp. 127-133. DOI: https://doi.org/10.1016/j.autcon.2009.12.013

Edwards, D. J. and Love, P. E. D. (2016) A Systemic Risk Maintenance Model for Machinery, Accident, Analysis and Prevention. Vol. 93, pp. 319-329.

Edwards, D. J., Pärn, E. A., Love, P. E. D. and El-Gohary, H. (2017) Machinery, manumission and economic machinations. Journal of Business Research, 70, pp. 391-394. DOI: https://doi.org/10.1016/j.jbusres.2016.08.012

Edwards, D. J., Pärn, E. A., Sing, C. P. and Thwala, W. D. (2019) Risk of excavators overturning: determining horizontal centrifugal force when slewing freely suspended loads, Engineering, Construction and Architectural Management. DOI: https://doi.org/10.1108/ECAM-03-2018-0125

HASWA (1974). The Health and Safety at Work etc Act 1974. (Elizabeth II 1974. Chapter 37), London: Her Majesty's Stationary Office.

HSE (2008) Thorough examination of lifting equipment: A simple guide for employers, INDG 422. London: HSE Books. ISBN: 978 0 7176 6305 7.

ISO (2007) ISO 10567 - Earth-moving machinery -- Hydraulic excavators -- Lift capacity, International Organisation for Standardization: Geneva.Junior, J.A.G.

ISO (2009) ISO 7135 - Earth-moving Machinery: Hydraulic Excavators - Terminology and Commercial Specifications, International Organisation for Standardization: Geneva.Junior, J.A.G.

LOLER (1998) Safe Use of Lifting Equipment: Lifting Operations and Lifting Equipment Regulations 1998. Approved Code of Practice and Guidance L113, 2nd Ed. Published 2014 (with amendments 2018) Revised. ISBN: 978 0 7176 6586 0

OJEU (2006) Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery, and amending Directive 95/16/EC (recast) (Text with EEA relevance), Official Journal of the European Union (OJEU). Available via: https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:157:0024:0086:EN:PDF [Accessed: June 2019].

PUWER (1998) Safe Use of Work Equipment: Provision and Use of Work Equipment Regulations 1998. Approved Code of Practice and Guidance L22. Revised. HSE Books, ISBN: 978 0 7176 6619 5.

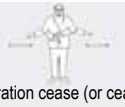
Riaz, Z., Edwards, D. J. and Thorpe, A. (2006) SightSafety: A hybrid information and communication technology system for reducing vehicle/pedestrian collisions. Automation in Construction, 15(6), pp. 719 - 728. DOI: https://doi.org/10.1016/j.autcon.2005.09.004

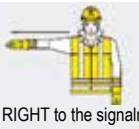
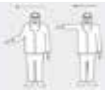
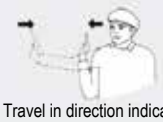
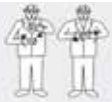
OTHER SOURCES OF INFORMATION

OEMs often provide the very latest (and arguably the best) sources of information regarding the safe operation of their equipment and compatible ancillary components, but invaluable additional support can be gained from:

- British Safety Council (www.britsafe.org)
- Construction Plant Hire Association (www.cpa.uk.net)
- Health and Safety Executive (HSE) (www.hse.gov.uk)
- Hire Association Europe (www.hae.org.uk)
- Off-highway Plant and Research Centre (OPERC) (www.operc.com)
- The Royal Society for the Prevention of Accidents (ROSPA) (www.rospa.com).

APPENDIX A: COMPARISON OF HAND SIGNALS BETWEEN STANDARDS

	The Health and Safety (Safety signs and signals) Regulations 1996	BS ISO 16715:2014 Cranes – Hand signals used with cranes	BS 7121-1:2016 Code of practice for safe use of cranes – Part 1: General	BS 6736: 1986 Hand signalling for use in agricultural operations	Hand signals for when excavators are used as cranes: a voluntary code of practice (OPERC)
GENERAL HAND SIGNALS					
START	 START – Attention – Start of command	 Operations start	 Operations start (Follow my instructions)		 START – Start operations
STOP	 STOP – Interruption – End of movement	 Stop (stop normally)	 Stop	 Stop	 STOP – Stop operations
EMERGENCY STOP	 DANGER – Emergency stop	 Emergency stop (stop quickly)	 Emergency stop		 DANGER – Emergency stop
CEASE OPERATION	 END of the operation	 Cease operation (stop following my instructions)	 Operation cease (or cease to follow my instructions)	 Operation cease	 END – Cease operations
VERTICAL MOVEMENT					
RAISE	 RAISE	 Raise/lift the load at a steady rate	 Hoist		 RAISE STEADY Raise at a steady rate
RAISE SLOWLY		 Raise slowly	 Inch the load	 Raise	 SMALL MOVEMENT Raise slowly
LOWER	 LOWER	 Lower the load at a steady rate	 Lower	 Lower	 LOWER STEADY Lower at a steady rate
LOWER SLOWLY		 Lower slowly	 Lower slowly		 LOWER SLOW Lower slowly
VERTICAL DISTANCE	 VERTICAL DISTANCE	 Indicating vertical distance			 VERTICAL DISTANCE Indicate vertical distance

	The Health and Safety (Safety signs and signals) Regulations 1996	BS ISO 16715:2014 Cranes – Hand signals used with cranes	BS 7121-1:2016 Code of practice for safe use of cranes – Part 1: General	BS 6736: 1986 Hand signalling for use in agricultural operations	Hand signals for when excavators are used as cranes: a voluntary code of practice -OPERC
HORIZONTAL MOVEMENT					
MOVE RIGHT	 LEFT to the signalman	 Travelling/slewing in the direction indicated	 Slew/Travel in direction indicated	 Travel in direction indicated	 MOVE RIGHT Travel/slew in right direction
MOVE LEFT	 RIGHT to the signalman	 Travelling/slewing in the direction indicated	 Slew/Travel in direction indicated	 Travel in direction indicated	 MOVE LEFT Travel/slew in left direction
TRAVEL BACKWARDS	 MOVE BACKWARDS	 Travelling away from me	 Travel from me Signal with both hands	 Move away from me	 TRAVEL BACKWARDS Travel away from banksman
TRAVEL FORWARDS	 MOVE FORWARDS	 Travelling towards me	 Travel to me Signal with both hands	 Move toward me, follow me	 TRAVEL FORWARDS Travel towards the banksman
TRAVEL ON BOTH TRACKS		 Travel of both crawler tracks			 TRAVEL – BOTH TRACKS Travel on both crawler tracks
TRAVEL ON ONE TRACK		 Travel of one crawler track			 TRAVEL – ONE TRACK Travel on one crawler track
HORIZONTAL DISTANCE	 HORIZONTAL DISTANCE	 Indicating horizontal distance		 This far to go	 HORIZONTAL DISTANCE Indicate horizontal distance
DEAD SLOW		 Inching or dead slow			 DEAD SLOW Inching or dead slow

APPENDIX B: HAND SIGNALS – BLACK AND WHITE

Figure 24 | Start operations

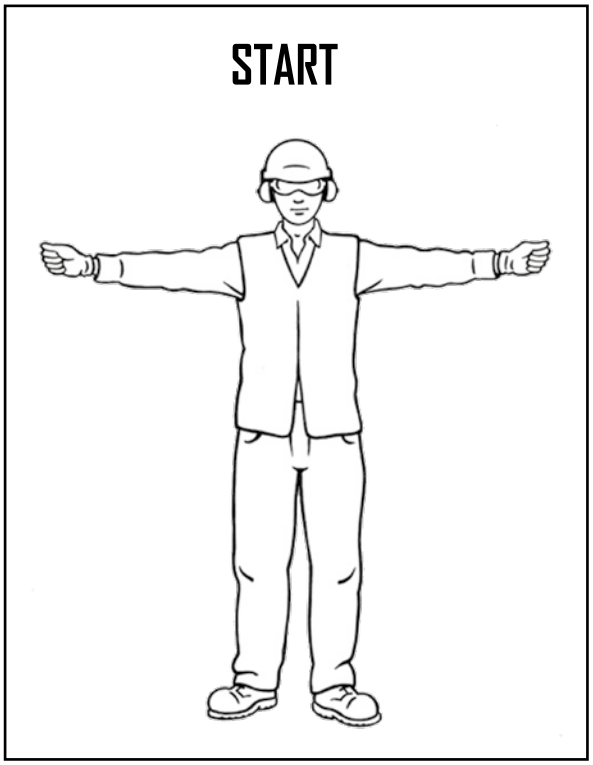


Figure 25 | Stop operations

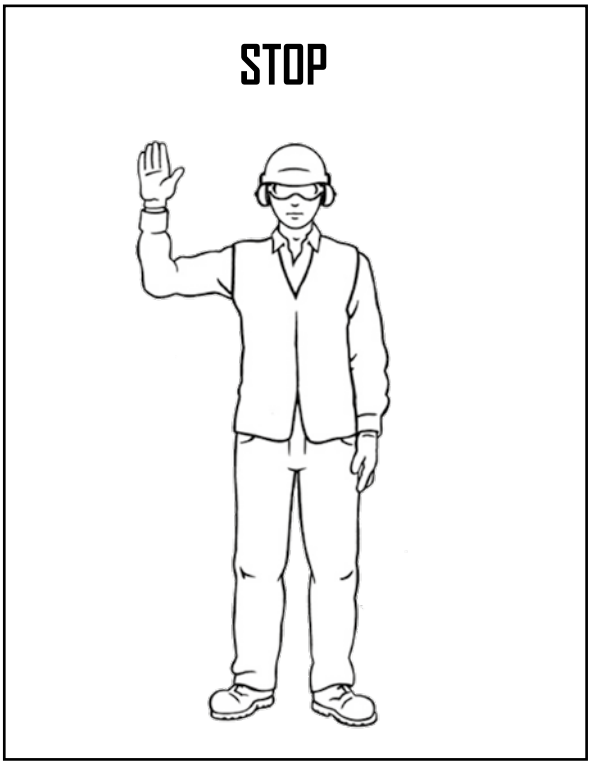


Figure 26 | Cease operations

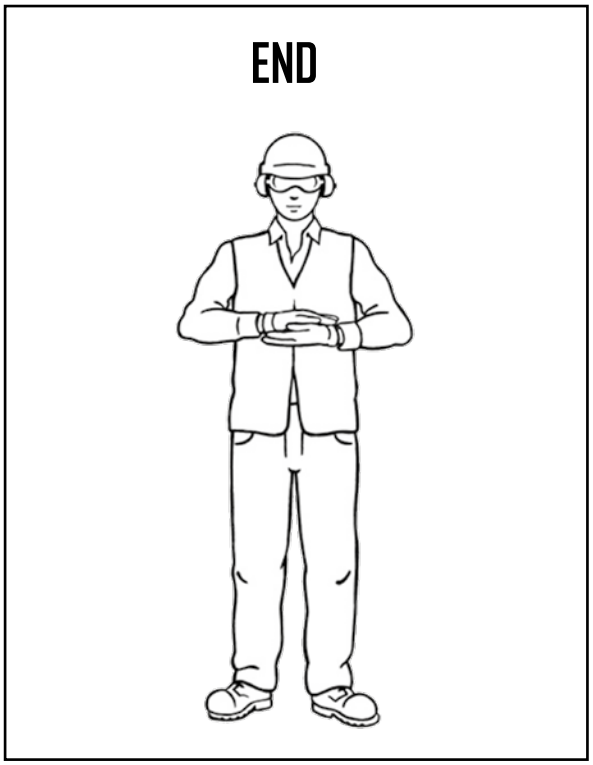


Figure 27 | Emergency stop

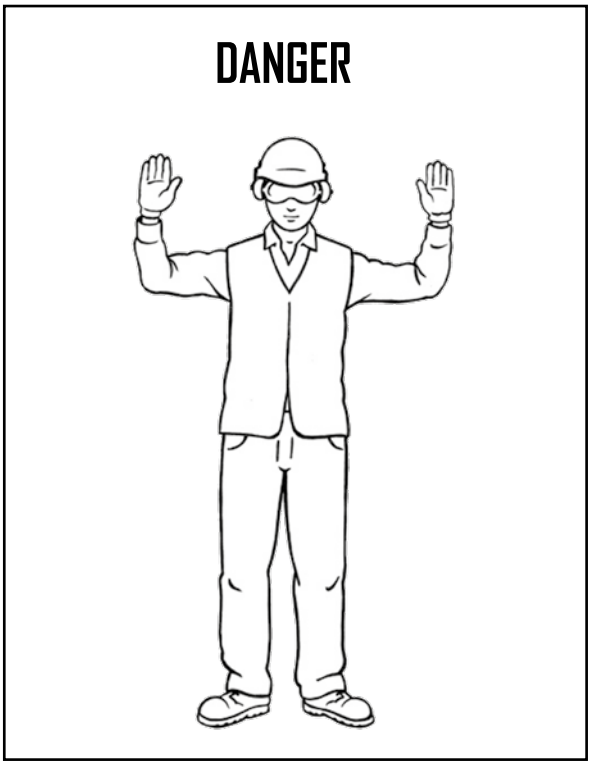


Figure 28 | Raise at a steady rate

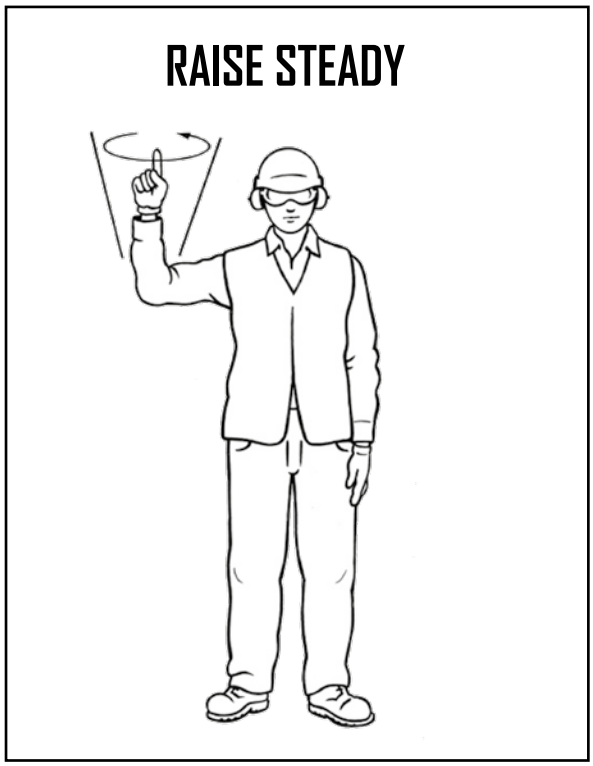


Figure 29 | Raise slowly

Figure 30 | Lower at a steady rate

Figure 31 | Lower slowly

APPENDIX B: HAND SIGNALS – BLACK AND WHITE

Figure 32 | Indicate vertical distance

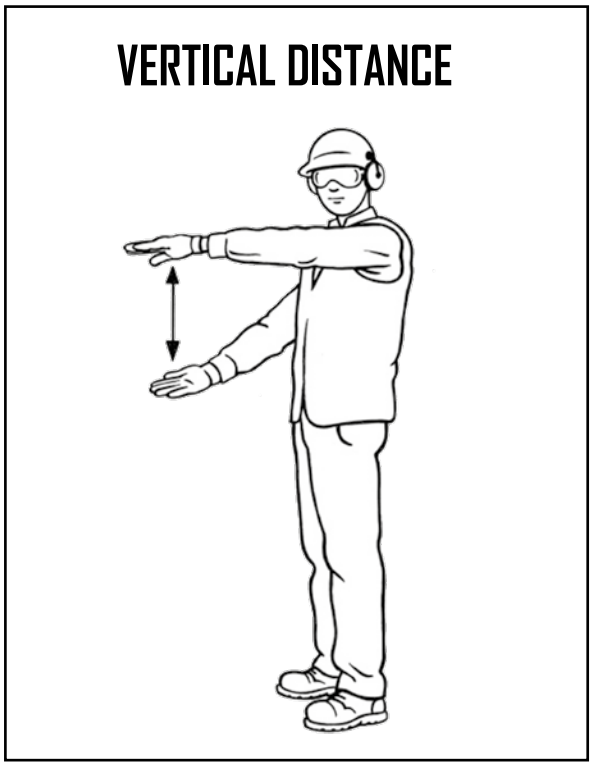


Figure 33 | Travel/slew in the right direction

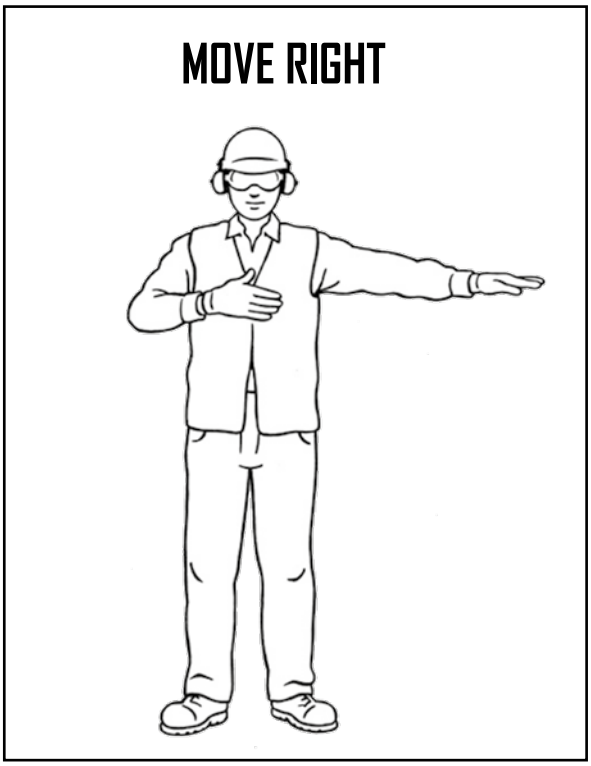


Figure 34 | Travel/slew in the left direction

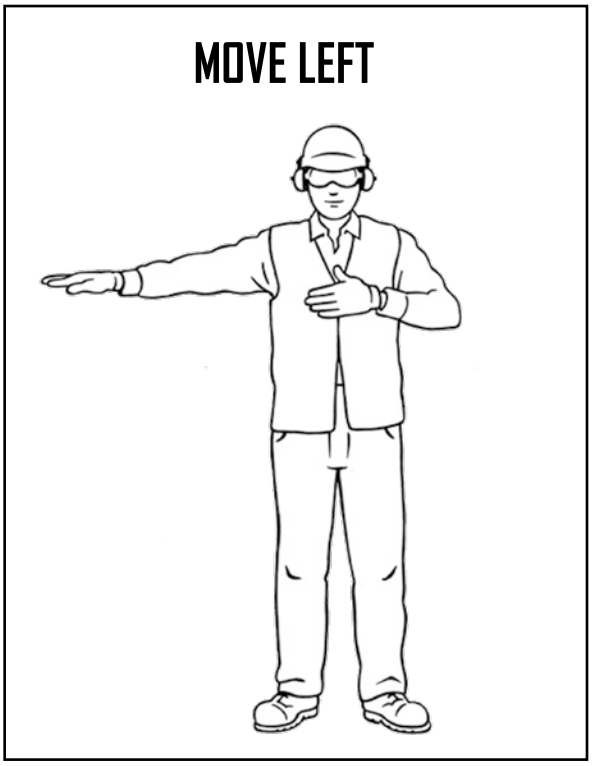


Figure 35 | Travel away from the banksman

Figure 36 | Travel towards the banksman

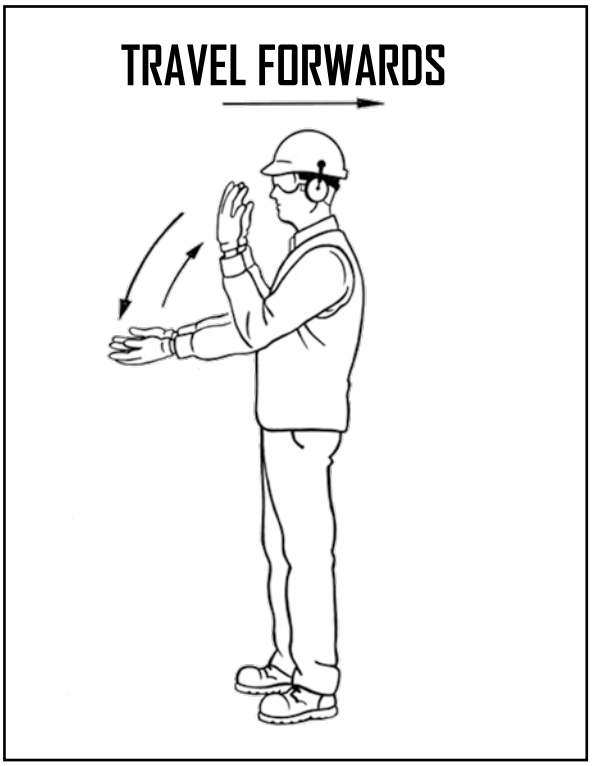


Figure 37 | Travel on both crawler tracks

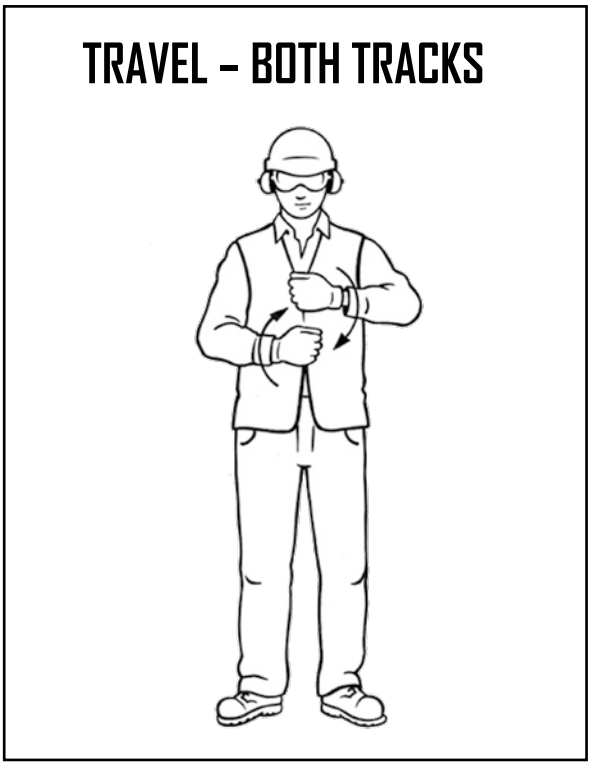


Figure 38 | Travel on one crawler track

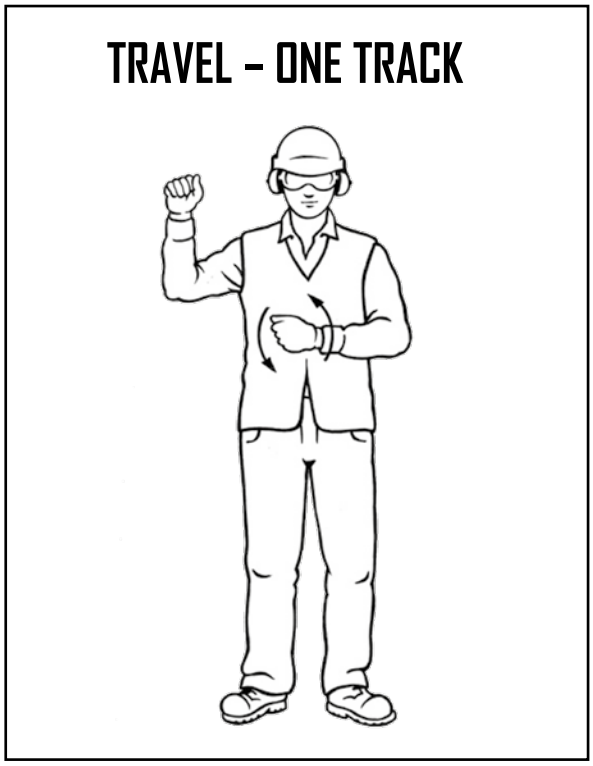
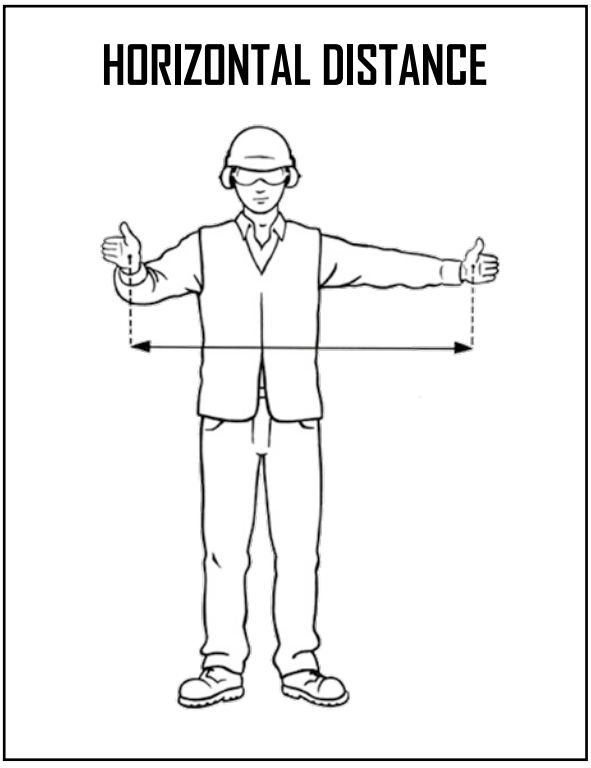


Figure 39 | Indicate horizontal distance



APPENDIX B: HAND SIGNALS – BLACK AND WHITE

Figure 40 | Inching or dead slow

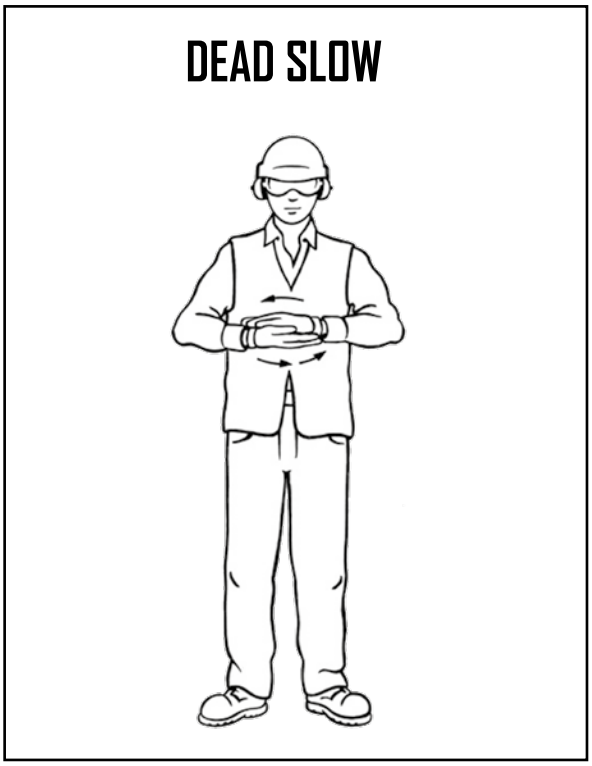


Figure 41 | Crowd out dipper

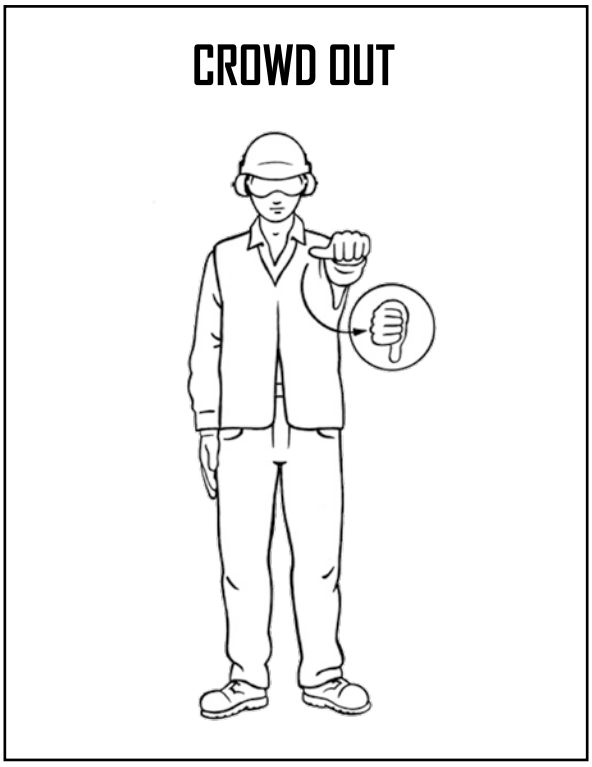


Figure 42 | Crowd in dipper

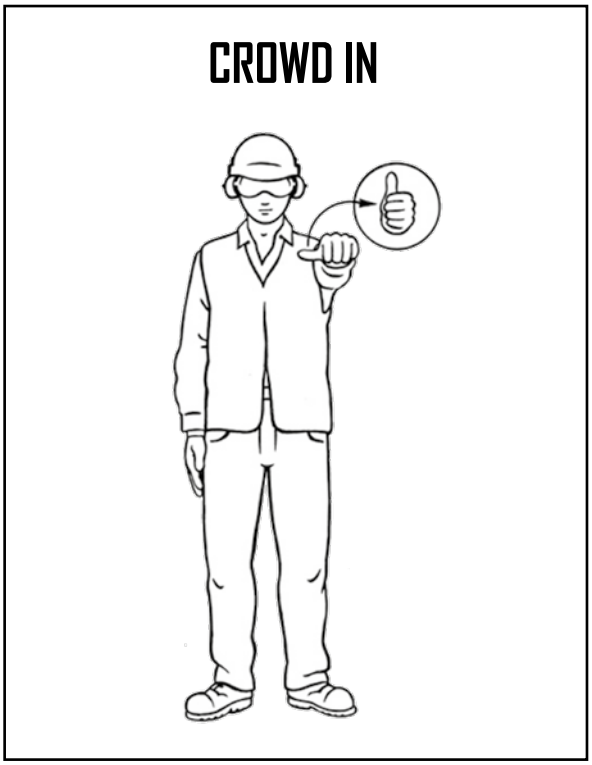


Figure 43 | Boom section in

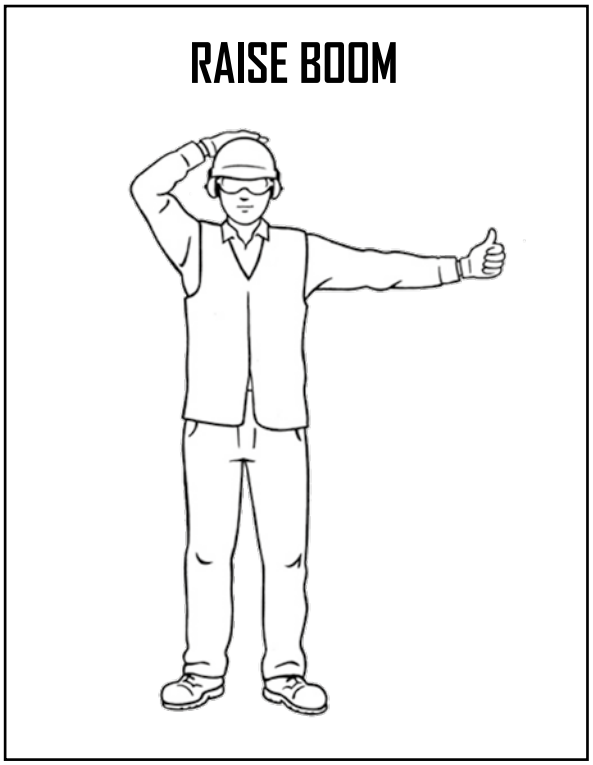


Figure 44 | Boom section down

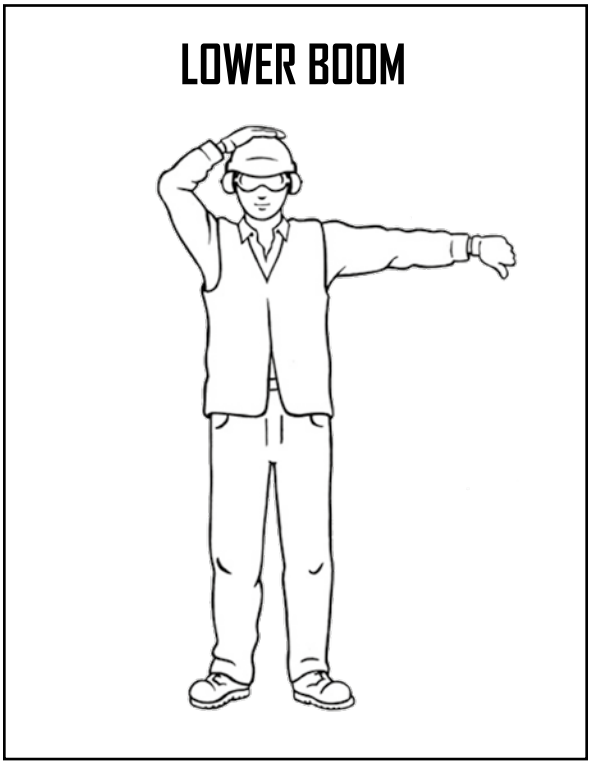


Figure 45 | Hydraulic extension of dipper
(180° machine)

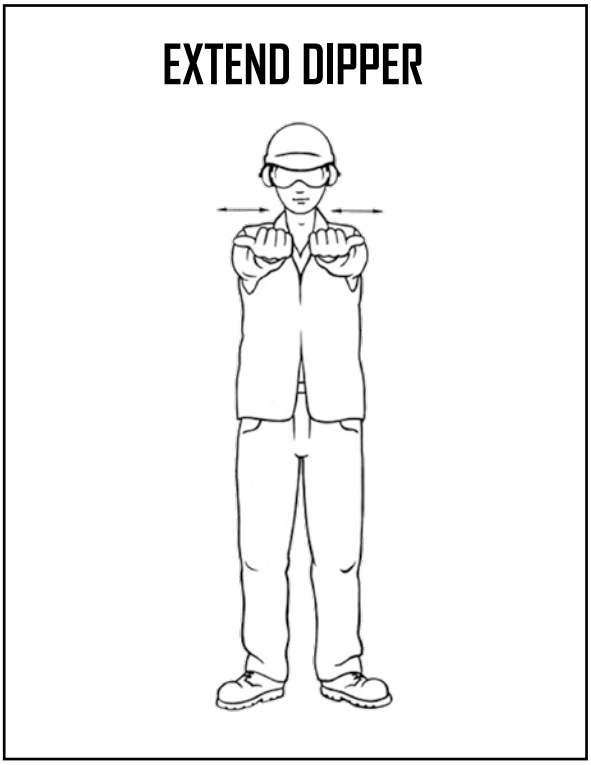
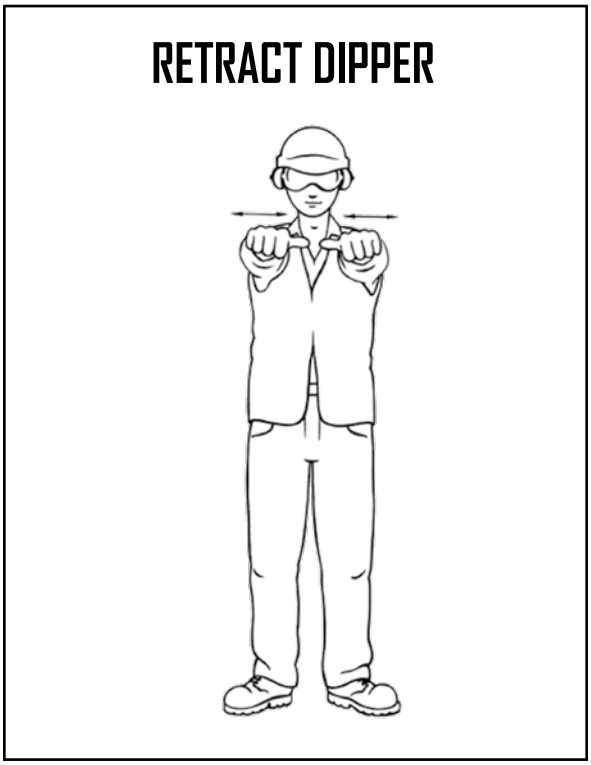


Figure 46 | Hydraulic retraction of dipper
(180° machine)



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