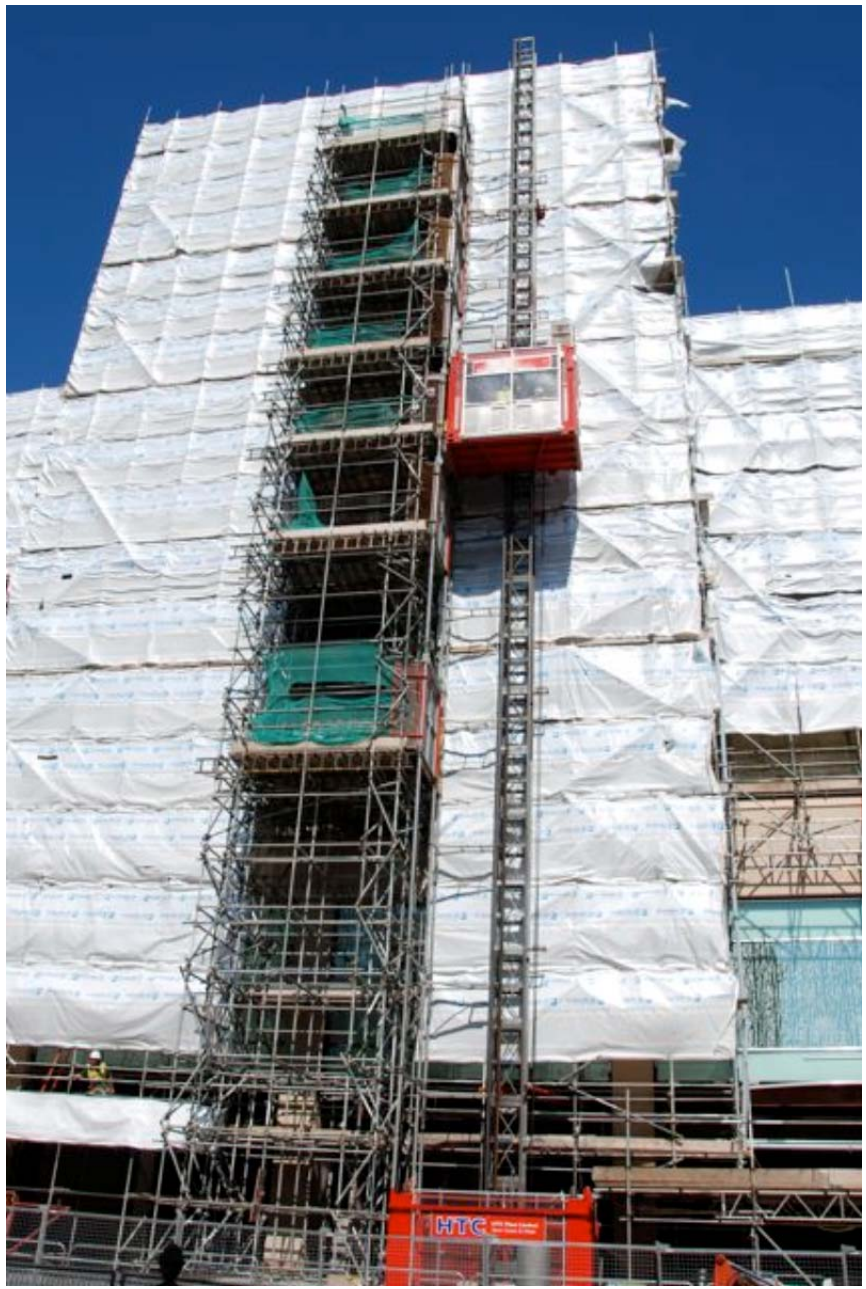
Construction OS&H

Vertical movement



Summary

Common hazards with vertical movement
Cranes
Hoists
Vertical distribution of concrete
Falls of materials

What are the common hazards with vertical movement?

Methods of vertical movement which are often used on construction projects should not give rise to any hazards.

Spend 10 minutes thinking about why hazards arise, and list ten possible causes.

Many of the hazards which arise have these causes

- Poor mechanical design (breaks in use, not powerful enough, components fracture or malfunction)
- Poor functional design (not properly designed for the stated purpose)
- Incorrectly erected or installed
- Poor workplace design
- Signalling systems (manual, mechanical, electronic) malfunction
- Misuse (not used as designed)
- Used in the wrong circumstances (eg ground collapses under a crane)
- Loads insecurely attached
- Release of pressure (concrete pumps)
- Poor maintenance (breaks or emits noxious gases)

These cause the following hazards

- Falling machinery or parts of machinery
- Falling loads
- Crushing due to impact of moving or toppling plant and equipment
- Impact from release of pressure (eg concrete exploding from hose failure)
- Falling from plant and equipment
- Falls caused by swinging loads, plant and equipment
- Limbs or bodies caught in machinery
- Electrocution
- Physiological damage through vibration
- Poor ergonomics
- Physiological and psychological damage through repetitive work
- Stress caused by poor environment

Other hazards

These are, of course, just some of the main hazards, there are many more which are specific to particular projects.

Each project must be assessed specifically and all hazards taken into account.

Cranes

Before a crane is used on site, consider all the factors that affect its safe use:

- The weight, size and type of load it will have to lift
- The maximum reach or radius required of it; restrictions on use such as overhead power lines, the state of the site and the type of ground
- Crane operators and signallers must be over the age of 18, and trained and sufficiently experienced

General considerations for cranes (1)

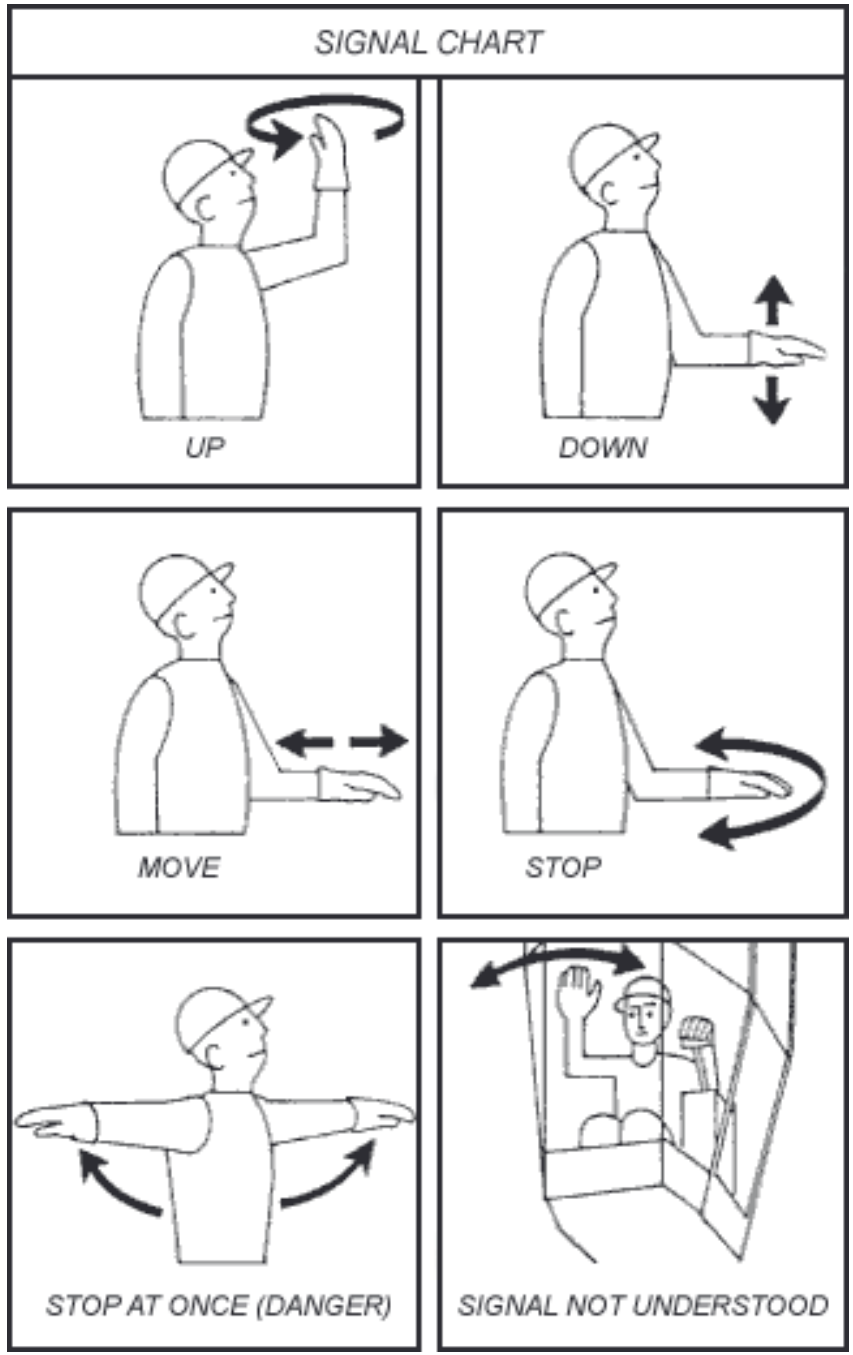
Erection

Skilled workers under the immediate direction of a competent and experienced supervisor should do both the erection and dismantling of cranes. The manufacturers' instructions should be closely followed.

Signalling

There should always be a signaller, or a signalling system such as a telephone, if the crane operator cannot see the load throughout the lift. Hand signals should be clear and distinct, and should follow a recognized code or system.

Crane signals



Safe load indicators

“A modern safe load indicator will give accurate advice to the driver under all conditions.”

Is this statement true or false?

Safe load indicators

All cranes must have an automatic safe load indicator which alerts the operator and warns both the operator and others nearby if the safe load is exceeded.

The safe load indicator is an aid to safe crane operation, but it does not take into account the effect of wind or soft ground conditions.

When lifting a load that is close to the safe working load, the load should be raised a short distance to check the stability of the crane before continuing with the lift.

If a load is allowed to swing or is lowered rapidly, the radius of the jib may be increased unintentionally by flexing of the jib.

If a lift is stopped abruptly, the momentum of the load may cause the safe limit to be exceeded.

Site inspection & maintenance

Cranes are subject to wear and tear which may not be easily detected.

Cranes should be inspected at regular intervals.

The manufacturer’s recommended programmes of operator checks and maintenance should be followed and any damage or defect should be reported to the supervisor.

Particularly susceptible components are wire ropes, brakes and safety devices. The constant contact of wire ropes with the sheaves on the jib accelerates wear. Brakes are in constant use and need to be checked, adjusted or renewed regularly.

Points to remember

If the operator cannot see the load all of the time, a signaller is required.

Beware of exceeding the safe working load when trying to free a stuck load.

Never drag a load with a crane; the friction may cause the safe load to be exceeded

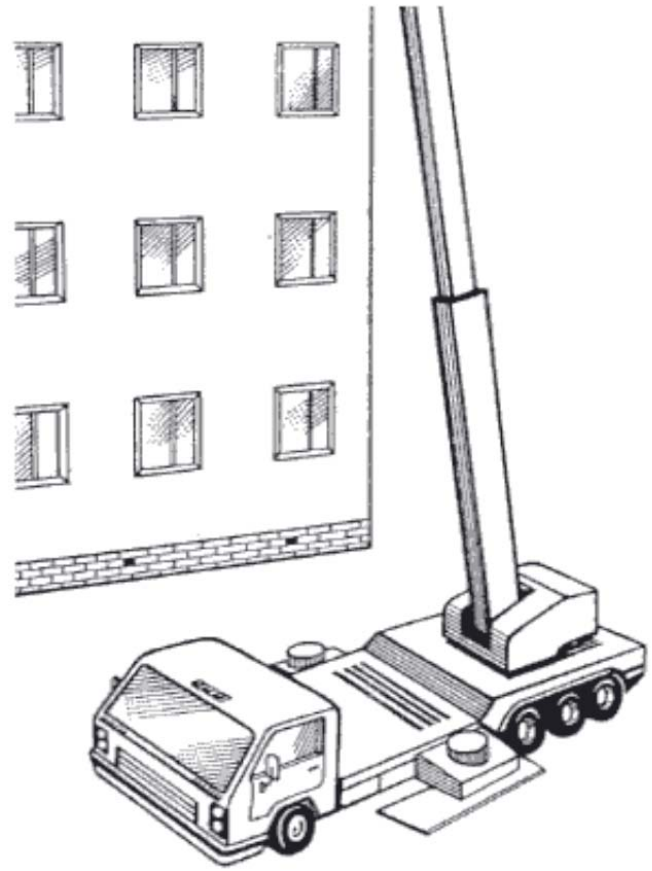
Mobile cranes

There is a huge range of mobile cranes available, but in terms of their safe use they all give rise to similar hazards

Mobile hydraulic crane with outriggers extended

Overturning

A mobile crane works on the basis of balancing overturning forces so it is potentially unstable and is liable to overturn if used on soft ground or on a slope. Rain can soften the ground and sites which are not level impose strains on the crane which may lead to unintentional overloading.



The crane operator must understand the advantages and limitations of outrigger settings and be aware of the dangers of failing to use them.

Use of mobile cranes

Lifting is made more difficult or hazardous by the wind. Make sure that there is adequate clearance for the crane's jib or boom and counterweight from traffic and fixed structures such as buildings, and that no part of the crane or the crane load will be closer than 4m to live overhead power lines.

It is not good practice to travel with a load but if this has to be done it must be controlled very carefully. If the movement is uphill the load will become closer to the crane body, which increases the risk of impact. If the crane is to travel downhill, the effective radius may be increased, so making the effective load heavier.

General advice

Excellent advice on the safety of mobile cranes is provided by the State Pension Insurance Fund of the State of California, USA

www.scif.com/safety/safetymeeting/Article.asp?ArticleID=493

Tower cranes (fixed cranes)

“Eurolift (Tower Cranes) Ltd was fined UK£50,000 plus UK£1,000 costs for breaches of health and safety legislation following the collapse of the tower crane that killed two people.

The men died when the 36m crane collapsed. The accident happened when an unsupervised colleague mistakenly loosened the bolts of the crane they were working on.

The judge said he believed the breach was serious enough to attract a fine in the region of UK£100,000 to UK£200,000. However taking into account the current financial state of the company he imposed a fine of UK£50,000 and ordered it to pay costs of UK£1,000.”

Commonly used tower crane

Tower cranes are very sophisticated items of plant and there is a wide range of types and sizes available. The photo below shows a type of crane commonly in use worldwide.

General safety of tower cranes (1)

To prevent overturning, a tower crane must either be anchored to the ground or securely counterweighted or ballasted. If the crane is rail mounted, remember that the rail tracks cannot be used as an anchor.

Ballast material may be moved so a diagram of the counterweight or ballast should be fixed to the crane, and the ballast should be checked against this whenever the crane is erected, and after bad weather.

Equipment such as slings and chains used with the crane must not clutter accessways or ladders and must be well clear of any machinery in which it may become entangled.

General safety of tower cranes (2)

Loads must be lifted vertically, as any out-of-vertical lifting may result in crane collapse.

Crane manufacturers specify the maximum wind speed at which tower cranes may be safely used.

Cranes on rails should be locked in position in high winds.

Loads having a large surface area should not be lifted in windy conditions.

Tower cranes should not be used with magnets, demolition balls, or for piling or other duties which could impose excessive loadings on the crane structure.

General safety of tower cranes (3)

The crane must be positioned to ensure that the crane jib or boom is free to wind-vane (rotate through 360 degrees) around the tower, so that there are no horizontal wind forces on it when it is not in use.

When the crane is not in use, the hook should be raised to its highest position; the crane should be allowed to wind-vane and the power should be turned off.

When more than one tower crane is used on a site, care must be taken when designing the site layout to ensure that collisions between booms, loads or lifting ropes are avoided. If physical separation cannot be arranged, effective electronic warning devices have to be used.

Hoists

Is there anything unsafe about this hoist set up?

Very close to 3-phase power cables

No cage for the hoisting mechanism, so workers can get caught up in the cable

No gates at top

Not handrail or toe boards on top access platform

(You cannot see it, but there is no cage at the base, so this is a public hazard as well as a site hazard)

Types of hoists

Goods hoists

The goods, or platform, hoist used to raise materials and equipment vertically to successive levels as construction proceeds is probably the most widely used item of mechanical handling equipment.

The principal hazards are of falling down the hoistway from a landing on the platform, being struck by the platform or other moving parts, and being hit by materials falling down the hoist-way.

Passenger hoists

Lifts for the carriage of persons need to be especially constructed and installed for the purpose, with such features as mechanical and electrical interlocking devices on the cage and landing gates. They must be fully enclosed.

Enclosure

A substantial enclosure should be erected at ground level around the hoist-way to a height of at least 2m. It should have suitable gates giving access to the platform.

Concrete pumps

Concrete pump providing concrete in a deep excavation

Use of concrete pumps

Scaffolding carrying a pipe for pumped concrete should be strong enough to support the pipe when filled and all the workers who may be on the scaffold at the same time, with a safety factor of at least 4.

Pipes for carrying pumped concrete should be:

•Securely anchored at the ends and at curves

•Provided near the top with air release valves

•Securely attached to the pump nozzle by a bolted collar or equivalent means

Safety and concrete pumps

Moving concrete by pumping is a specialist process, and must be done by fully-trained and competent people, using properly maintained equipment used in a well-planned way.

Despite the specialised nature of concrete pumping, basic safe operation can be achieved by applying the general processes and procedures of Construction OS&H: for example, working with the pumping specialist to identify hazards, developing a safe working method, and briefing everyone involved carefully.

Hazards & concrete pumps (1)

Mobile pumps are large vehicles and need care when driving to and from the site and manoeuvring into position.

Mobile pumps are subject to the same types of forces as mobile cranes and so must be sited in the same way.

All mobile pumps work with high pressures, so the pump itself and the pipes and hoses must be carefully maintained, positioned and held securely in place.

Concrete for pumping is poured into a hopper and drawn forward by powerful pumping mechanisms. This hopper must be covered by a strong and well-fixed grill to prevent any part of a human body getting into it.

Examples of injuries from concrete pumps from Australia (1)

“Two serious accidents, one fatal, in Sydney in June 1994 involving concrete placing boom pumps highlighted the need to follow the safety recommendations in the WorkCover Authority's Codes of Practice on Pumping Concrete and Construction and Testing of Concrete Pumps.

The first accident occurred when a boom pump operator stood on the hopper grate of his machine and his leg slipped through the grate. His leg became entangled in the auger of the pump and his left leg was severed below the knee.

Investigation revealed the hopper grate bars at each end of the grate were wider than the 70mm recommended by WorkCover Codes of Practice.

Examples of injuries from concrete pumps from Australia (2)

WorkCover recommends that all pump operators should:

- Never stand on the hopper grate of concrete placing pumps.
- Always ensure the grate complies with the recommendations of the WorkCover Authority.
- Always ensure that grates are in good condition and not unduly worn or damaged.

Concrete Placing Pumps. Safety Alert No: 4024.
Date of Issue: 22 November 1994]

Examples of injuries from concrete pumps from Australia (3)

The second accident involved the collapse of the boom of a concrete placing boom pump, which hit the pump line operator on the head and inflicted fatal injuries. Investigation revealed that a failure of the pedestal-to-hydraulic ram connection caused the boom to collapse.

Recommendations:

A regular and thorough maintenance program be undertaken by pump owners and operators in accordance with WorkCover's Codes of Practice.

Operators and concreters should avoid standing or working under the elevated boom as much as possible.

When working on a construction site, workers should always remember to wear head protection.

Fixed concrete pump serving large building in Dar es Salaam

Hazards & concrete pumps (2)

Emptying and cleaning the pipeline can cause explosive pressures if not done carefully.

There must be safe workplaces for those using the pump, including safe means of access and egress.

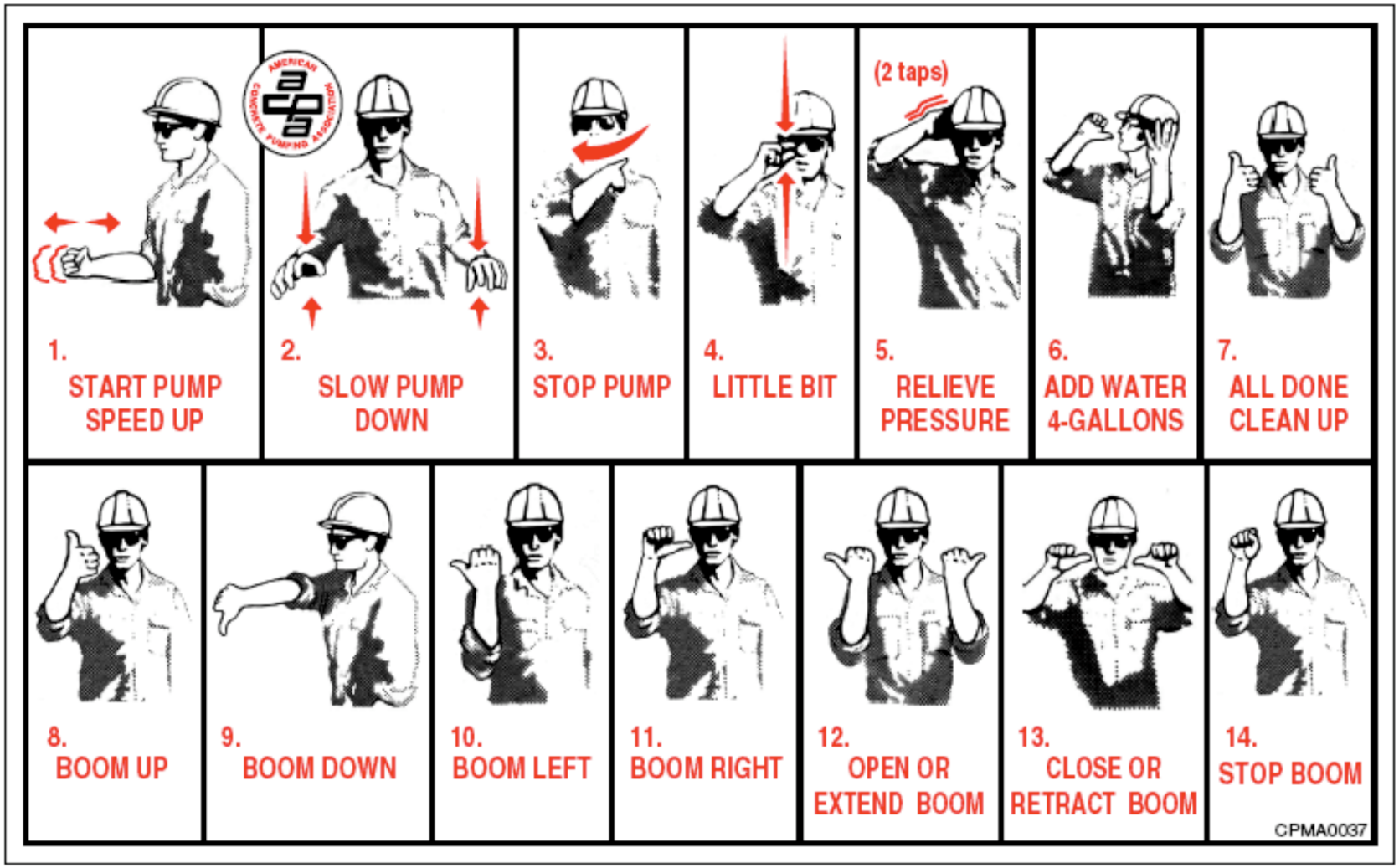
Handling the discharge pipe can give rise to strong forces so can cause muscular and impact injuries.

Concrete is a corrosive substance to human skin, so good PPE must be provided.

Visibility & signaling

It is often the case that the pump operator cannot see the end of the pumping hose, so a banks-man is required.

Pumping signals



Hazards of falling materials, tools & equipment

Every effort must be made to prevent these incidents, primarily by:

- Planning all activities carefully
- Keeping all plant and equipment in a condition that is safe to use
- Installing all plant and equipment securely
- Making sure that loads are attached properly and that no part of the load can become detached
- Keeping all working platforms tidy, so reducing the likelihood of loose tools and material being dislodged and falling

Skip or pump?

A four-storey building has a concrete frame, floors, services shafts and shear walls. It is 25 x 20 metres in plan. There is adequate access directly from the road for large vehicles and good hard standing.

There will be one tower crane on site but this cannot service all the concrete placement as well as the other lifting requirements. A decision has to be made to provide another tower crane, and to use either crane to place the concrete with a skip; or to place the remaining concrete with a mobile pump, to be hired as needed.

The costs will be very similar, so the decision comes down to a comparison of safety and health factors. What are the main factors?

Skip or pump?

The tower crane driver will be able to see the placing team, pump operator probably won't.

Cleaning out the pump may be less safe than cleaning out a skip.

The tower crane and skip may be more sensitive to wind.

Pumping may be marginally safer for the concrete crew when on a scaffolding for walls and columns because skips tend to swing about more.

Concrete pipelines work at high pressure, so (although very rare) there is a risk of bursting, which can be very dangerous.

Safety nets, sheeting and fans

The photo shows a building that has been carefully sheeted to prevent falling objects landing in the street, and also a solid fan to catch falling objects.

[The sheeting also improves working conditions in bad weather.]