

22 ELEVATING WORK PLATFORMS

Basic Types

There are two basic types of elevating work platforms—boom and scissor. Both types come in

- *on-slab models* for use on smooth hard surfaces such as concrete or pavement
- *rough-terrain models* for use on firm level surfaces such as graded and compacted soil or gravel.

Both types share three major components: base, lifting mechanism, and platform assembly.

Scissor-Type Machines

These are raised and lowered by hydraulic pistons and an expanding scissor mechanism. Platforms are available in various configurations with different capabilities for extension and movement. Some have extendable platforms or platforms that can rotate. Extendable platforms should be retracted before raising or lowering the device. Typical machines are illustrated in Figure 1.1.

On-slab units

- not designed for uneven or sloping ground
- normally have solid rubber tires
- generally powered by rechargeable DC battery
- some powered by internal combustion engine, either gasoline or propane
- most have “pothole protection”—a metal plate lowered close to the ground to afford some protection against inadvertent movement into depressions or debris.

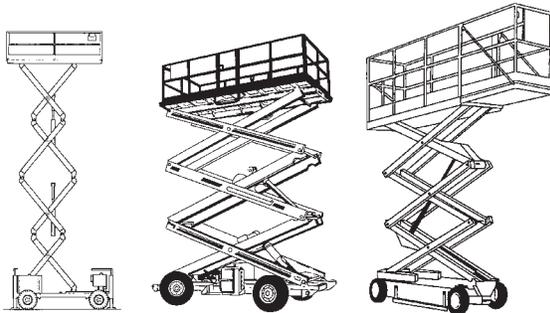


Figure 1.1: Scissor-type powered platforms

Rough-terrain units

- similar in design to on-slab machines
- built to handle rigorous off-slab challenges
- normally have wider wheel bases, larger wheels, and pneumatic tires
- some fitted with outriggers for extra stability
- usually powered by internal combustion engines, gasoline, diesel, or propane
- DC units also available but not common
- lifting mechanism is hydraulic.

Scissor-type machines range in capacity from 500 to several thousand pounds. They are available with platform heights often reaching 15 metres (50 feet) and beyond.

Scissor-type machines must be set up on stable level ground, even with outriggers deployed. A slight imbalance or instability is amplified when the machine is raised.

Figure 1.2 shows one example of controls. Although fixed to the platform, the controls are moveable from one side of the platform to the other. This enables the operator to see the path of travel.

The controls must be oriented correctly so that the operator does not inadvertently move the machine in the wrong direction. Many machines have colour-coded directional arrows on the chassis to aid the operator in moving the machine.

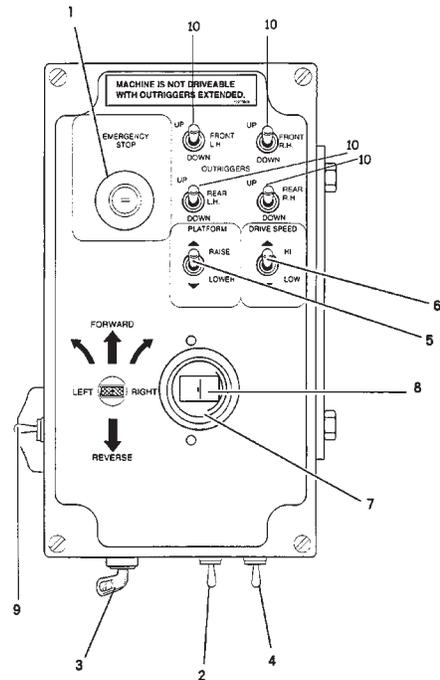


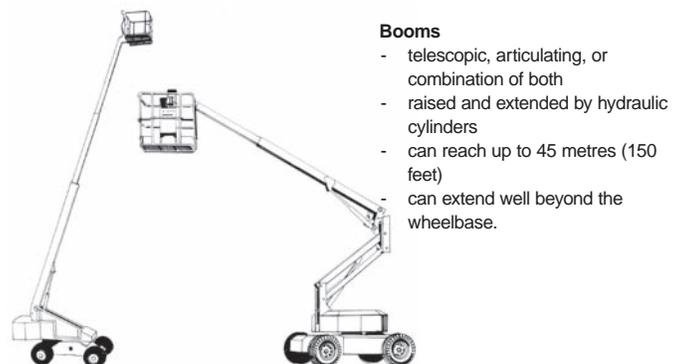
Figure 1.2: Example of controls on scissor-type platforms

Controls

- | | |
|--------------------------|--------------------------------------|
| 1. Emergency stop button | 6. Drive high range/low range switch |
| 2. Choke | 7. Forward/reverse joystick |
| 3. Stop/start switch | 8. Left/right steer switch |
| 4. Run/idle switch | 9. Traversing deck out/in switch |
| 5. Lift up/down switch | 10. Outriggers up/down switch |

Self-Propelled Boom-Supported Platforms

- normally fitted with rough-terrain undercarriages
- some smaller on-slab units
- platforms have lifting capacity of about 227 kg (500 pounds) or two workers
- lack capacity of scissor-type machines; not intended for lifting materials
- usually powered by an internal combustion engine, gasoline, diesel, or propane.



Booms

- telescopic, articulating, or combination of both
- raised and extended by hydraulic cylinders
- can reach up to 45 metres (150 feet)
- can extend well beyond the wheelbase.

Figure 1.3: Boom-type powered platforms

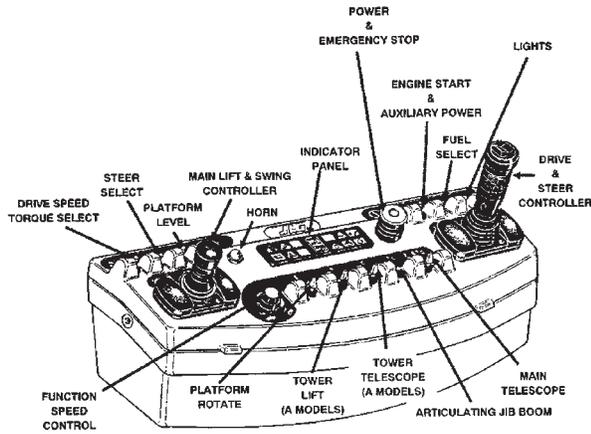


Figure 1.4: Example of boom-machine controls

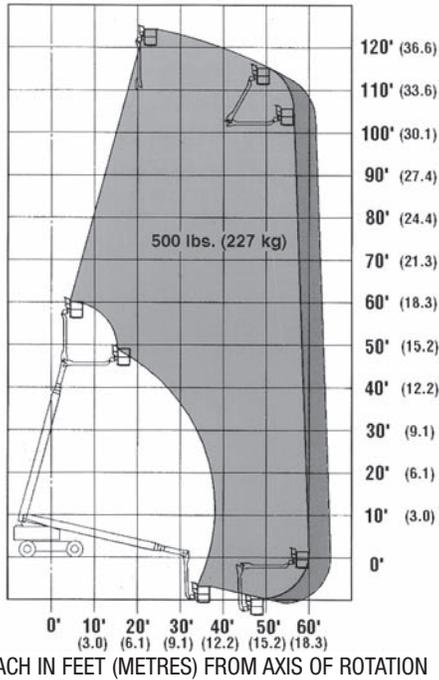


Figure 1.5: Reach chart for a 120-foot (36-metre) machine

Figure 1.4 shows one example of controls for a boom machine. Although controls are fixed in position, the operator may become disoriented by machine rotation and must remain aware of the direction of movement. Many machines have colour-coded directional arrows to help the operator move the machine in the right direction.

As with mobile cranes, stability decreases with length of boom and boom angle as the centre of gravity moves in relation to the platform position. The machine will overturn if the centre of gravity moves outside the machine's base.

Machines come with load charts that show safe operating configurations. Machines with booms long enough to cause overturning at low boom angles are required to have radius-limiting interlocks to prevent operation in unstable configurations.

The reach chart shown in Figure 1.5 indicates the safe operating configurations for a machine with 36 metres (120 feet) of reach operating on a level surface.

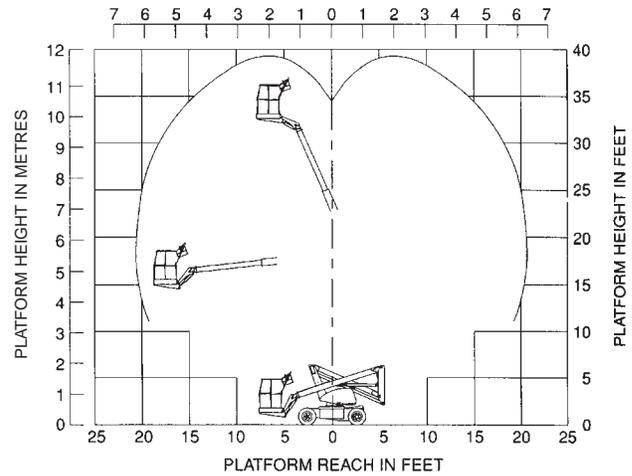


Figure 1.6: Reach diagram for a 10-metre articulating boom platform

The reach diagram in Figure 1.6 shows the safe operating envelope for a 10-metre boom machine.

Notice that the machine does not achieve its maximum height directly overhead. Nor does it achieve its maximum reach at ground level.

Users must be familiar with the operating range of the individual make and model they are using. This knowledge is essential in order to position the machine correctly and reach the work location safely.

Non-Self-Propelled or Push-Arounds

As the name indicates, these units are not self-propelled and must be transported from one location to another with an independent power source or manually in the case of the smaller devices.

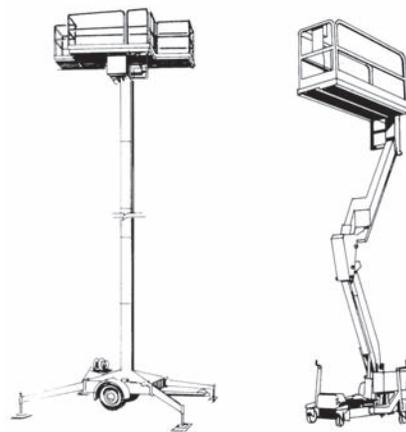


Figure 1.7: Push-around powered platforms

The machines are intended primarily for use on smooth, level, hard surfaces or on-slab conditions. Some trailer-mounted units are available.

Many of these devices can fold up to pass through a standard door and can be transported by pick-up truck. As a result they are suitable for maintenance or renovation work.

Push-Arounds

- Raising mechanism normally powered by gasoline or propane engine or by electric motors, either AC or DC
- normally raised and lowered by hydraulic cylinders
- platform capacities vary from 300 to 1000 pounds or more but are generally less than 500 pounds
- devices with capacity less than 500 pounds are **not recommended** for construction—better suited to maintenance activities
- platforms don't usually exceed 11 metres (36 feet) in height
- as platform is raised, risk of overturning increases
- extra care required when operating at maximum height.

Selection

Elevating work platforms are designed for different uses. It is essential to select the right machine for the job.

Typical Mistakes

- using an on-slab machine on rough terrain
- using a unit undersized with respect to height, reach, and lifting capacity
- lifting large materials that overhang the platform
- using a scissor lift where the reach of a boom-type machine is needed
- extending the platform with planks, ladders, or other devices because the machine can't reach the required height.

Factors to Consider

Capacity – Does the machine have the lifting capacity, the reach, and the height to complete the task?

Surface conditions – Are the surface conditions hard or soft, sloped or level? Will the ground have an effect on the type of machine selected?

Platform size and configuration – Do you need a regular or extendable platform? Is rotation required? Are there space restrictions to consider?

Mobility – Is a boom type better suited than a scissor lift to the task at hand?

Material to be lifted – Will the machine be able to lift the size and weight of material required for the job?

Access – Will the machine be able to travel around the workplace safely? Are there obstructions or depressions that will restrict the use of certain machines?

Operator skill or training – Are the people on site competent to operate the machine? If a propane-powered engine is used, has the operator received propane training?

Work environment – If the work is to be done indoors or in a poorly ventilated area, will an electrically powered machine be required?

Basic Hazards

The following are some basic hazards.

Machine tipping or overturning

Many factors cause instability—sudden stops, depressions, drop-offs, overreaching, overloading, etc. Overturning and tipping result in many fatalities and injuries.

Overriding safety features

Disarming features such as the tilt or level warning and the deadman switch can prevent operators from knowing when they are in a dangerous situation. Overriding the deadman switch has resulted in a fatality; so has malfunction of the tilt warning.

Overhead powerline contact

Contacting overhead wires can cause electrocution. This can happen with any type of machine—and with the loads carried by or overhanging the machine.

Makeshift extensions

When the machine can't reach the working height desired, don't compensate by using scaffold planks, ladders, blocks of wood, or other makeshift arrangements. Such practices lead to falls and machine instability.

Overloading the platform

EWPs overloaded or loaded unevenly can become unstable and fail. Boom-type machines are especially sensitive to overloading. Always stay within the operating range specified by the manufacturer.

Failure to cordon off

- EWPs have been struck by other construction equipment or oncoming traffic when the work area is not properly marked or cordoned off.
- Workers have been injured when they inadvertently entered an unmarked area and were struck by falling material, tools, or debris.
- In unmarked areas, workers have also been injured by swinging booms and pinched by scissor mechanisms.

Accidental contact

Many EWPs have blind spots. Moving the machine or platform may cause contact with workers or with obstacles. Use a designated signaller on the ground to guide the operator when the path of travel isn't clear or access is tight.

Improper maintenance or modifications

EWPs should be maintained by competent workers in accordance with manufacturer's instructions. No modifications should be made to the machine without the manufacturer's approval.

Improper blocking during maintenance

Failing to block, or improperly blocking the machine, boom, or platform can cause serious crushing injuries and property damage.

Improper access

Don't enter or leave the platform by climbing the scissors or the boom. Don't use extension ladders to gain access. Ladders exert lateral loads on the platform that can cause overturning. For the safest access, lower the machine completely.

Moving with platform raised

Lower the platform before moving the machine unless

- 1) the machine is designed to move with platform raised and
- 2) the supporting surface is smooth and level. Slight dips and drops are amplified when the platform is raised and can cause the machine to overturn.

Improper refuelling

Take care when refuelling. Gasoline, for instance, should be kept in approved containers and dispensed to prevent spills and sparking.

Pinch points

Clothing, fingers, and hands can get caught in scissor mechanisms. As platforms are raised, machines may sway. Workers can be pinched between guardrails and the structure. Position the platform so that work takes place above guardrail height.

Regulations and Responsibilities

The construction regulation (Ontario Regulation 213/91) includes the following requirements:

- Elevating work platforms must be engineered and tested to meet the relevant standard for that equipment [section 144(1)(a)]. Standards include
 - CSA B354.1: non-self-propelled elevating work platforms
 - CSA B354.2: self-propelled elevating work platforms
 - CSA B354.4: boom-type elevating work platforms.
- The devices must be checked each day before use by a trained worker [section 144(3)(b)].
- The owner or supplier must keep a log of all inspections, tests, repairs, modifications, and maintenance [section 145(2)].
- The log must be kept up to date and include names and signatures of persons who performed inspections and other work [section 145(3)].
- A maintenance and inspection tag must be attached near the operator's station and include the date of the last maintenance and inspection and the name and signature of the person who performed the work [section 146].
- Workers must be given oral and written instruction before using the platform for the first time. Instruction must include items to be checked daily before use [section 147].
- All workers on the platform must wear a full body harness or a safety belt attached to the platform while the platform is being moved [section 148(e)].

The health and safety responsibilities of all parties on a construction site are outlined in the "green book"—the *Occupational Health and Safety Act and Regulations for Construction Projects*.

Because elevating work platforms are often rented from an equipment supplier, there is confusion as to the responsibilities of the parties involved. Generally, the responsibilities can be summarized in the following way.

The owner or supplier must ensure that the machine

- is in good condition
- complies with regulations
- is maintained in good condition
- conforms to the appropriate CSA Standard
- includes the correct load rating charts if required.

The employer and supervisor on the project must

- ensure that the operator is competent
- ensure that the machine has the correct load rating capacity for the job
- maintain the equipment and all its protective devices
- maintain a log book for each platform
- ensure that workers use appropriate personal protective equipment
- keep the manufacturer's operating manual on site
- train workers on each class of equipment being used.

The worker or operator of the equipment must

- receive adequate training to be fully competent
- only operate the machine when competent
- operate the machine in a safe manner and as prescribed by the manufacturer and the company's health and safety policy
- inspect the equipment daily before use
- perform function tests before use
- report any defects to the supervisor
- read, understand, and obey the manufacturer's safety rules, including the operating manual and warning decals.

When a defect is reported to the supervisor, the equipment must be taken out of service until the repairs are completed and the equipment is inspected and approved for use.

Stability and Tipping

In general, EWPs are well manufactured and are safe to use within their specific limitations. As with any equipment or tool, there are do's and don'ts to follow.

One of the most dangerous hazards in operating EWPs is tipping over. This can be caused by one or several of the following factors:

- sudden movement of the unit or parts of the unit when elevated
- sudden stopping when elevated
- overloading or uneven loading of the platform
- travelling or operating on a slope or uneven terrain
- changing the weight distribution of the machine by replacing parts with others of a different weight or adding attachments not approved by the manufacturer
- holes or drop-offs in the floor surface causing one wheel to drop suddenly
- operating the equipment in windy conditions (refer to the operator's manual for safe operating conditions).

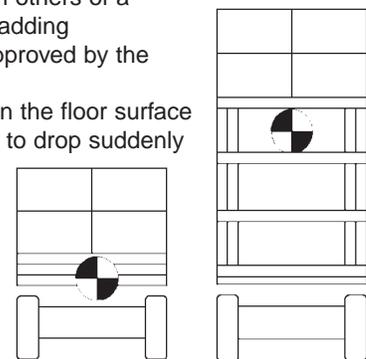


Figure 4.1 Centre of gravity on scissor lifts

It is important that users understand what makes a platform stable and what causes it to overturn. To understand stability, one must understand the concept of centre of gravity, tipping axis (or tipping point), and forces that shift the centre of gravity.

Stability is resistance against tipping over. Stability

depends on the location of the centre of gravity in relation to the tipping axis.

Centre of Gravity

Every object has a centre of gravity. It is the point where the object's weight would be evenly distributed or balanced. If a support is placed under that point, the object would be perfectly balanced.

The centre of gravity is usually located where the mass is mostly concentrated. However, the location doesn't always remain the same. Any action that changes the machine's configuration—such as raising the platform, extending the boom, or travelling on a slope—can change the location of the centre of gravity.

Figure 4.1 shows how raising a scissor-type platform affects the centre of gravity.

Tipping Axis and Area of Stability

When an EWP turns over, it tips around an axis or point. This is called the tipping axis or tipping point. EWPs typically have four tipping axes – front, back, left, and right.

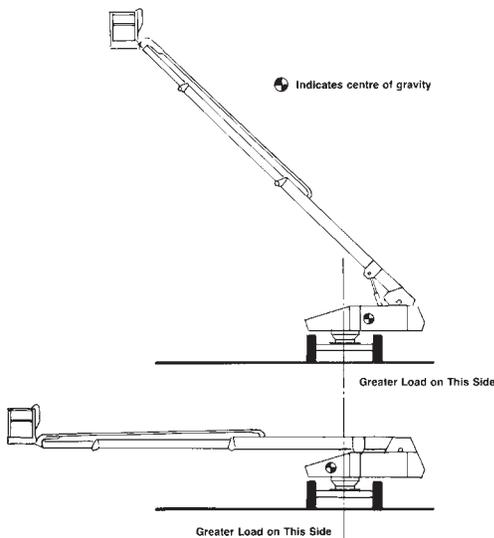


Figure 4.2: Centre of gravity for a boom-supported machine

Each EWP has its own area of stability. This varies from platform to platform and from model to model. In most cases, the area of stability is bound by the four tipping axes (or the four tires or outriggers). The platform is stable as long as the centre of gravity remains inside the area of stability. This is the key to safe operation.

Figure 4.2 shows how lowering the boom angle affects the centre of gravity. In this example the centre of gravity moves towards the platform but remains inside the area of stability.

When the centre of gravity shifts beyond the area of stability, the machine will tip over. Some factors that can cause a shift beyond the stability area are overloading, moving on excessively sloped ground, a sudden drop of one wheel, and shock loading.

Raising the platform also raises the EWP's centre of gravity.

When a scissor lift is situated on a slope, and the platform is raised, the platform's centre of gravity will move toward the tipping axis. If the centre of gravity moves beyond the tipping axis, the platform will overturn.

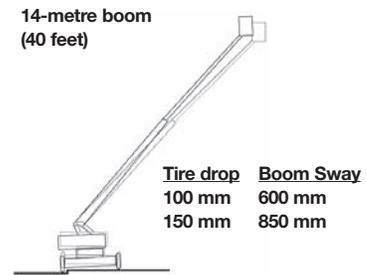


Figure 4.3: Effect of uneven ground on boom sway

Boom-supported EWPs work in the same way. When the boom is extended outward, the centre of gravity moves outwards towards the tipping axis. The EWP will overturn if the boom is extended such that the centre of gravity moves beyond the axis. Boom-type machines have an interlocking system that prevents the machine from moving into an unstable configuration.

Factors Affecting Stability

Dynamic Forces

Dynamic forces are forces generated by movement or change of movement. For example, applying the brakes suddenly or travelling too fast around corners can cause instability – as in a car or van. Sudden stops while raising or lowering the platform can also cause instability.

Travelling

Travelling the platform over rough or uneven ground can also cause instability. Figure 4.3 shows how a tire dropping 100 mm can cause the boom to sway 600 mm. It is important to lower the platform fully or to retract telescoping sections while travelling, particularly on uneven surfaces.

Equipment Inspection

All components which bear directly on the safe operation of the EWP and can change from day to day must be inspected daily. Inspection is mostly visual – done in a quick but thorough manner.

Users must check the operator's manual for a complete list of pre-operational checks.

Minimum Requirements

Before climbing into the platform, check

- ✓ Tires for proper pressure and wheels for loose or missing lug nuts
- ✓ Steer cylinder, linkage, and tie rods for loose or missing parts, damage, and leaks
- ✓ Hydraulic hoses, lift cylinder(s), and connections for leaks or loose connections (for example, a small pool of hydraulic fluid)
- ✓ Fuel supply – adequate fuel, filler cap in place, no damage, leaks, or spills

- ✓ Hydraulic oil for leaks and fluid level, battery for fluid level and state of charge
- ✓ Proper connection of all quick-disconnect hoses
- ✓ Structural components for damage, broken parts, cracks in welds, including scissor arms, outrigger arms, and pads
- ✓ Ladder or steps for damage and debris (ladder must be firmly secured to the platform and relatively free of grease, mud and dirt)
- ✓ Beacon and warning lights for missing and defective lenses or caps
- ✓ Ground controls (manual and powered)—including emergency stop switch and platform lower/lift switch—for proper function and damaged and missing control sticks/switches
- ✓ Decals and warning signs to make sure they're clean, legible, and conspicuous.

On the platform, check

- ✓ Platform assembly for loose and missing parts, missing or loose lock pins and bolts
- ✓ Platform floor for structural damage, holes, or cracked welds and any dirt, grease, or oil that can create a hazard
- ✓ Operator's manual to make sure it's in place
- ✓ Extendable platform deck for ease of extension/retraction and proper function of locking position of platform
- ✓ Guardrails to make sure they're in place
- ✓ Access gate for ease of movement, missing parts, latch, and locking capabilities
- ✓ All fall protection anchorage points
- ✓ All control mechanisms for broken or missing parts
- ✓ All emergency controls for proper function—stopping, descending, master OFF switch
- ✓ All safety devices such as tilt and motion alarms for malfunction
- ✓ Swivels for freedom of rotation
- ✓ Scissors for smooth movement up and down
- ✓ Brakes for stopping capabilities
- ✓ Horn for proper function.

Manuals, Signs, and Decals

Section 144(8) of the construction regulation (Ontario Regulation 213/91) specifies the signs that are required on an EWP.

Signs clearly visible to the operator at the controls must indicate

- the rated working load
- all limiting operating conditions, including the use of outriggers, stabilizers, and extendable axles
- the specific firm level surface conditions required for use in the elevated position
- such warnings as may be specified by the manufacturer
- other than for a boom-type elevating work platform, the direction of machine movement for each operating control
- the name and number of the National Standards of Canada standard to which the platform was designed and
- the name and address of the owner.

In addition to the above, the CSA standards for EWPs require the following signs:

- the make, model, serial number, and manufacturer's name and address
- the maximum platform height
- the maximum travel height, if not equal to the maximum platform height
- the nominal voltage rating of the batteries, if battery-powered
- a warning to study the operating manual before using the equipment
- a notice outlining the required inspections
- diagrams or description of the various configurations in which the platform can be used
- the capacity in each configuration
- a statement as to whether or not the platform is insulated
- warnings against replacing, without the manufacturer's consent, components critical to the machine's stability—for example, batteries or ballasted tires with lighter weight components (the minimum weights of such components must be specified).



Figure 5.1

Many of these signs are vital to the operation of the machine and the protection of workers. All signs and decals must be kept clear of dust and grease so they can be easily read. Torn or damaged signs must be replaced. A typical warning sign is shown in Figure 5.1.

CSA standards also require that the manufacturer provide a manual containing the following information:

- description, specifications, and capacities of the platform
- the operating pressure of the hydraulic or pneumatic system that is part of the work platform
- instructions regarding operation and maintenance, including recommended daily, weekly, and monthly inspection checklists
- information on replacement parts.

The manual must be stored on the platform in a weather-proof storage container.

Safe Practices

Specific Requirements

For the specific EWP they will use, operators must be familiar with

- the manufacturer's operating manual
- the manufacturer's warning and caution signs on the machine
- the location of all emergency controls and emergency procedures
- the daily maintenance checks to perform.

General Guidelines

- Always check for overhead powerlines before moving the machine or operating the platform. You must observe the minimum permitted distances from overhead powerlines (see table, next column). When equipment operates within reach of (and could therefore encroach on) the minimum distance from a powerline, make arrangements with the owner of the utility to have the powerline de-energized. Otherwise, the constructor is required to have written procedures in place to prevent equipment from encroaching on the minimum distance. Copies of the procedures must be available for every employer on the project. See section 188 of the Construction Regulation for further requirements.
- Allow for movement or sway of the lines as well as the platform. Be aware of overhanging tools or equipment.

Voltage Rating of Powerline	Minimum Distance
750 to 150,000 volts	3 metres (10 feet)
150,001 to 250,000 volts	4.5 metres (15 feet)
over 250,000 volts	6 metres (20 feet)

- Wear a full body harness and tie off to a designated tie-off point while the machine is moving.
- Do not leave the machine unattended without locking it or otherwise preventing unauthorized use.
- Don't load the platform above its rated working load (RWL). Wherever possible, keep the load below 2/3 of the RWL.
- Make sure that all controls are clearly labeled with action and direction.
- Keep guardrails in good condition and ensure that the gate is securely closed before moving the platform.
- Shut off power and insert the required blocking before maintenance or servicing.
- Deploy stabilizers or outriggers according to the manufacturer's instructions.
- Don't remove guardrails while the platform is raised.
- Position the boom in the direction of travel where possible.
- Keep ground personnel away from the machine and out from under the platform.
- Don't access the platform by walking on the boom.
- Don't try to push or move the machine by telescoping the boom.
- Do not use the machine as a ground for welding.
- Don't use a boom-supported platform as a crane.

- Don't operate the equipment in windy conditions. For safe wind speeds refer to the operator's manual for the specific make and model you are using.
- Do not place the boom or platform against any structure to steady either the platform or the structure.
- Secure loads and tools on the platform so that machine movement won't dislodge them.
- Make sure that extension cords are long enough for the full platform height and won't get pinched or severed by the scissor mechanism.
- Use three-point contact and proper climbing techniques when mounting or dismounting from the machine (Figure 6.1).

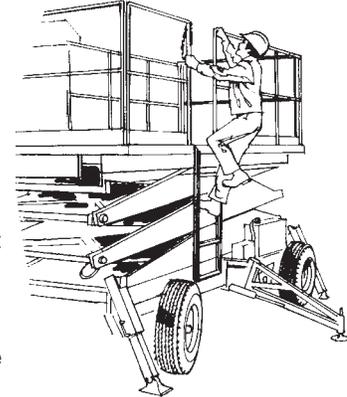


Figure 6.1: Three-point contact

Never operate equipment on which you have not been trained or which you are not comfortable operating. The safety of you and others on site depends on the competent, knowledgeable operation of equipment.

Work Area Inspection

Before operating the EWP, check the work area for

- ✓ drop-offs or holes in the ground
- ✓ slopes
- ✓ bumps or floor obstructions
- ✓ debris
- ✓ overhead obstructions
- ✓ overhead wires, powerlines, or other electrical conductors
- ✓ hazardous atmospheres
- ✓ adequate operating surface—ground or floor
- ✓ sufficient ground or floor support to withstand all forces imposed by the platform in every operating configuration
- ✓ wind and weather conditions.