

OPERATIONAL SAFETY OF WORK PLATFORMS

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Abstract: *Elevating work platforms are used for work in places that are not easily accessible, and with their design and subsequently appropriate design craftsmanship they ensure safe work in construction and assembly operations, inspections of street lighting and many other activities. The mobile elevating work platforms that are manufactured today, with their level of construction, quality of workmanship and ever-improving built-in safety features, create safer working conditions at heights and thus a quieter and safer working environment not only for the workers themselves but also for their employers. The paper analyzes the dangers and threats when working with platforms and the requirements for operators working with this equipment. Subsequently, risks are identified using the risk-assessment methods in the standards TNI ISO / TR 14121-2 Safety of Machinery. Risk assessment. Part 2: Practical guidance and examples of methods. In the conclusion is a proposal of corrective measures that can improve safety when working with elevating work platforms.*

Key words: MOBILE ELEVATING WORK PLATFORMS, OPERATIONAL SAFETY, FUNCTIONAL STRUCTURE, RISK

1. Introduction

Work at heights ranks in terms of work safety among the most dangerous types of work and potential work injuries among the most serious. Thus, claims for occupational safety and health naturally grow as a result. A basic technological safety requirement when performing construction assembly works is to protect workers in places where there is the danger of falling from a height. At present mobile elevating work platforms are becoming ever more popular and are commonly used with work at heights.

Selected basic concepts:

Mobile elevating work platform: [10]

- ✓ a mobile machine intended for the transport of persons to a workplace, where they will perform work activities from the work platform under the conditions that persons get on and off the work platform at a determined access point from the level of the terrain or from the undercarriage and which is made up minimally of work platform with controls, telescopic construction and an undercarriage.

Work platform:

- ✓ an enclosed platform or basket, which can be moved while loaded into the required work position and from which it is possible to erect, repair, inspect or perform similar work.

Elevating platform with transport of the operator:

- ✓ an elevating platform, on the surface of which the operator enters for loading and unloading or on which the operator may be transported, for which the platform is equipped with controls.

Operator:

- ✓ the person trained for safe operation of an elevating platform according to the manufacturer's instructions.

Remote controlling:

- ✓ a control connected by a cable which is not located on the elevating platform itself [1].

Prohibited area:

- ✓ a space which is reserved only for a person authorised to be in it and which is not accessible to the public.

Nominal loading capacity:

- ✓ the loading capacity which the equipment lifts when used according to the operating instructions, as guaranteed by the manufacturer [1].

Protective cover:

- ✓ a part of the machine used especially for protection by means of physical blockage.

Safety position:

- ✓ state when the elevating platform or part of the elevating platform is sufficiently secured against entry, thus preventing any threat to persons or cargo.

Emergency stop control:

- ✓ a part of the emergency stopping equipment, which after activation of the incorporated manual control (trigger switch) sends an emergency stop signal.

Description of a work platform:

With respect to the range and various types of performed work the offer of elevating platforms on the market is broad and diverse. Construction of the platforms is intended for specific work environments and use in practice, and thus they are engineered in different forms, versions and sizes. With regard to the mentioned facts it is evident that for good selection of elevating platforms their size or type with regard to their planned use (activities performed and their range) also has a key influence on their effective use.



Fig. 1 Vertical mast platform lift on its own wheeled chassis

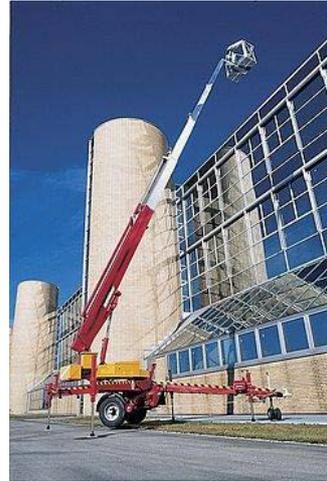


Fig. 4 Trailer telescoping platform lift [1]



Fig. 2 A scissor platform lift on its own wheeled chassis [1]



Fig. 5 Articulated – telescoping platform lift on an automobile chassis



Fig. 3 Articulated platform lift on its own wheeled chassis [2]



Fig. 6 Platform on its own belted chassis [3]

2. Categorizing of mobile elevating work platforms by functional structure

Lifting equipment as an element of a person-machine-environment system can be evaluated as an integrated machine system whose individual functional structures cannot be assessed separately. Most important is the fact that after launch of the system into operation, risks associated with its operation are evident. In relation

to this, it is necessary to start from the fact that it is necessary to ensure an identical technical level not only in the lifting equipment system but also from the fact that the platform must, as a part of a material flow system, correspond to the technical level of the whole technological process [4].

Lifting equipment as a machine system can be divided into six functional structures:

- ✓ the guiding function of the structure,
- ✓ the suspension function of the structure,
- ✓ the moving function of the structure,
- ✓ the strength-load-bearing function of the structure,
- ✓ the safety function of the structure,
- ✓ the controlling-regulation of the structure.

During operation of mobile elevating work platforms these functional structures can be distinguished:

1. Moving function of the structure – the role of this structure is to ensure the mobility, lift and rotation of the platform, a change of position of the boom and additional movements, so that the most effective space is created for its use during work. The moving function of the structure is made up of mechanisms which also ensure the transfer of the power flow to the strength function of the structure [4].



Fig. 7 Moving function of the structure [5]

2. Strength-load-bearing function of the structure – its purpose is to ensure transfer of the external loads influencing the elevating platform. This function at the same time conditions the selection of the material and the form of the load-bearing construction of the elevating platform. At present the construction of this equipment is made from steel – a steel load-bearing construction. The given structure also has a significant impact on stability, which is one of the main safety factors of elevating platforms [4].



Fig. 8 Strength-load-bearing function of the structure [5]

3. Safety function of the structure – its primary task is to ensure safe operation of the elevating platform. This structure must be paramount over other functions of the structure. A component of it is equipment that records the technical status of the machine during operation.



Fig. 9 Safety function of the structure [5]

Standard safety features:

- ✓ double control panel,
- ✓ flow cabling for hydraulic rollers,
- ✓ safety device with destruction of hoses on all rollers,
- ✓ exact horizontal position of the basket in all positions,
- ✓ manual emergency starting,
- ✓ hydraulic and electrical protection against overloading,
- ✓ hydraulic support legs,
- ✓ control signal for all functions,
- ✓ electronic switch when tilting, with a signalling alarm.

4. Controlling-regulation of the structure – the task of this structure is to ensure controlling of the working movements of the elevating platform, such that the loading on its other functional structures is not increased. At present the operator of an elevating platform uses it most often for this purpose. The behaviour of the operator has been the object of several studies, and it acquires, for example, ever greater importance in connection with the expanding use of continuously regulated drives. Two types of controlling of the elevating platform are distinguished – controlling in the basket and remote controlling. This structure in the majority of cases is unable to prevent incorrect usage [8].

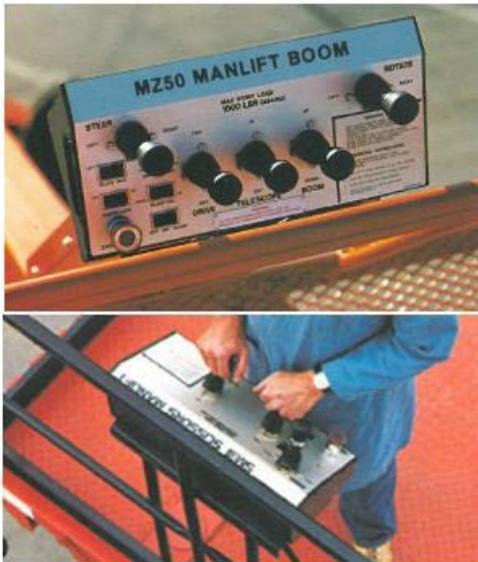


Fig. 10 Control-regulation function of the structure [5]

3. Dangers and risks when operating mobile elevating work platforms

For the exclusion of risks at work with elevating work platforms the operator must follow the relevant instructions and recommendations.

If this is not done, the following risks and threats can arise:

- ✓ fitful controlling of the control stick,
- ✓ overloading of the platform,
- ✓ uncertain relations on the ground,
- ✓ gusts of wind,
- ✓ contact with obstacles on the floor or at height, creating the danger that the machine will begin to move uncontrollably forward, backward, to the side or will tilt over.

According to valid provisions on high-tension lines, persons and equipment for elevating persons may not operate closer to electrical outdoor power lines than safety zones permit. If doing work requires a smaller distance from power lines, it is necessary to agree with the operator or owner of the distribution network on a method of execution. For example, the safe distance for power lines in the range of 1000 volts of one-way voltage within a town is for mobile elevating work platforms in non-insulated configurations minimally 1 meter from the lines of the outermost line and from parts under voltage. The safe distance from the power lines for railways of both voltage systems is 2 meters from the lines. In the case of need of a work platform at a distance smaller than 2 meters, it is necessary to fulfil the requirements given in technical standards [6].

During storms the use of mobile elevating work platforms is prohibited. In environments threatened by explosion or fire, such as, for example, the charging of accumulators in a closed space with simultaneous activity of the platform, filling the fuel tank in the vicinity of an open flame, contact with heated parts of a motor, using equipment with oil leaking from the hydraulic system, the danger of explosion or burning arises. Persons may not move in the work space of a machine, and in the case that solid barriers are located there, the operator must prevent

dangerous collisions with a moving part of the machine. Therefore, before each use the operator must unconditionally inspect whether persons are moving in a dangerous work space and ensure that no dangerous collision will occur. In order to limit the threat of a fall or injury, dangerous manoeuvres cannot be made, safety and signalization elements cannot be taken out of operation, and it is prohibited to sit and climb on the railings during movement, and the like [7].

- **Danger of shock from electric current**

A work platform is not electrically insulated, and therefore it does not ensure protection in the case of contact with electric current or being in its vicinity [13].



Fig. 11 Prohibition on nearing power lines [6]

- **Danger of tilting over**

The weight of persons, equipment and material on a platform cannot exceed the load-capacity of that platform. The weight of supplements and accessories, such as, e.g. pipe holders, sheet metal and welding aggregates, which decrease the nominal load-capacity of the platform, must be included in the total loading of the platform. The boom cannot be lifted nor disengaged if the machine is not standing on a solid and even surface [6].

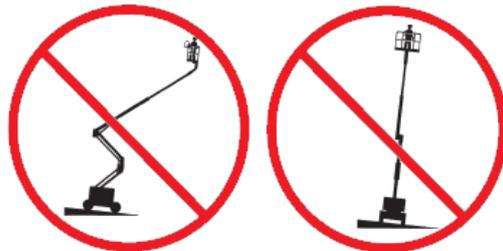


Fig. 12 Prohibition of lifting the boom on an uneven surface [6]



Fig. 13 Prohibition on operating in strong wind and prohibition on moving through unsuitable terrain [6]



Fig. 14 Prohibition on pulling/pushing objects outside the platform [6]



Fig. 15 Prohibition of lifting loads and prohibition on overloading of a platform [6]

4. Identification of threats

When assessing the risks of any machine a fundamental step is the systematic identification of threats which are adequately foreseeable, that is determining situations in which during the performance of planned or unplanned operations, a person may be exposed to a dangerous situation which could also lead to endangerment of his life or health. The design engineer must take into consideration all types of threats which can occur at the individual stages of the equipment lifespan, in particular with:

- ✓ assembling, installation and transport of the machine,
- ✓ putting it into operation,
- ✓ use and maintenance,
- ✓ taking out of operation, disassembling and disposing of the machine [8].

The types of threats, their sources and potential consequences are listed in Table 1.

Tab. 1 Examples of types of threats, their sources and potential consequences [9]

	Type, or group	Examples of threats	
		Source	Potential consequences
1.	Mechanical threats	Accelerating, slowing	Collision, fall from a height
		Angular parts	Cutting oneself
		Collision of the platform with a solid part	Striking, contusion, fall
		Falling objects	collision
		Starting of the platform	Smashing of the operator's hand
		Unstablensness of the machine	Collision, being thrown off, fall,

			smashing
		Course, slippery surface	Slipping, tripping, fall
		Unstable terrain	Overturning, fall of the platform
2.	Electrical threats	Live parts	Shock by electrical current
		Electromagnetic factors	Biochemical changes, breakdown of brain activity
3.	Thermal threats	Hot or cold objects or material	Dehydration, burning, freezing
		Explosion	Burning, contusions
		Radiance from a heat source	Injuries caused radiance from heat source
4.	Vibration threats	Moving equipment	Stress, headache
		Wearing down of parts	Inattention
5.	Ergonomic threats	Position	Dizziness, pain in the legs
		Limited space	Discomfort, mental fatigue
		Work strain	Hand pain
6.	Threats associated with the environment in which the machine is used	snow	Slipping, fall
		temperature	Dehydration, seizure, catching cold
		rain	Illness, discomfort
		wind	Turning over, fall of the platform

Sources of threats when working with a work platform and the potential consequences following from them are depicted in Table 2.

Tab. 2 Threats with images

Threat	Threat
 <p>Source Work at height Potential consequences: Fall from a height</p>	 <p>Source Live parts under voltage Potential consequences: Shock by elec. current</p>
 <p>Source Moving parts Potential consequences: Collision, contusion</p>	 <p>Source Charging of the accumulator Potential consequences: Explosion</p>
 <p>Source Unstable platform Potential consequences: Tipping over of the platform</p>	 <p>Source Inexpert operator Potential consequences: Collision, tipping over</p>
 <p>Source Dangerous behaviour Potential consequences: Fall from a height, collision</p>	 <p>Source Unevenness of surface Potential consequences: Tipping over of the platform,</p>

Tab. 3 The most serious risks when working with a work platform [9]

Dangerous situation/threat	Possible damage to OSH/Negative consequence	Seriousness S1/S2	Frequency F1/F2	Possible prevention P1/P2	Risk a-e	Proposed measures
Work at a height						
Collision, fall from height due to sudden acceleration / slowing of the machine	Broken bones, tearing wounds, internal bleeding, death of a worker	S2	F1	P1	C	<ul style="list-style-type: none"> to inform operators about the dangers and safety system of the work, which should be observed to organize regular training for the lift platform operator selection of a suitable type of platform with sufficiently high railings Use of safety belt / rope
Work at height						
Tipping over, fall of the platform due to instability of terrain	Broken bones, tearing wounds, death of a worker	S2	F1	P1	C	<ul style="list-style-type: none"> using a platform only on a solid and flat foundation extension and failure of supports on the floor against movement of the elevating platform design of signalization equipment

Tipping over of the platform due to strong wind	Broken bones, tearing wounds, death of a worker	S 2	F 1	P 1	C	<ul style="list-style-type: none"> • observing of set max. safety speed of wind for platform operation • not overloading the platform by crew or material • not extending the surface of the platform <ul style="list-style-type: none"> • design of signalization equipment
Lightning						
Strike by lightning with work on the platform	Burns, death	S 2	F 1	P 1	C	<ul style="list-style-type: none"> • observing the prohibition on use of the platform during a storm • finishing work and lowering the platform in the area of lightning and thunder
Electrical current						
Threat of shock by electrical current due to contact with live parts	Burns, death	S 2	F 1	P 1	C	<ul style="list-style-type: none"> • observing the prohibition on use of lifting platforms with unprotected electric cables • inspection of el. mains before starting to use a

					C	<ul style="list-style-type: none"> platform • disconnecting el. energy with work on el. cables • observing the principles of work safety
Natural factors						
Threats from heat, cold, rain	Dehydration, dizziness, catching cold	S 1	F 2	P 2	C	<ul style="list-style-type: none"> • ensuring sufficient amount of fluids • increasing the number of breaks in extreme weather • selection of suitable clothing according to the weather
Charging of an accumulator						
Threat of explosion when charging an accumulator	Burns, tearing wounds, contusions, death	S 2	F 1	P 1	C	<ul style="list-style-type: none"> • regular inspection and maintenance work on platform • observing safety procedures during maintenance and charging of the accumulator • training of operator
Handling the platform						
Threat of crushing the operator when handling the platform	Contusions of upper limbs and other parts of the body, broken bones	S 2	F 1	P 1	C	<ul style="list-style-type: none"> • improving communication between workers • observing safety principles • paying increased attention to solid obstacles

5. Conclusion

At present elevating work platforms are irreplaceable in construction and handling technologies. When it comes to work on buildings, assembly works or various actions on above-ground cabling for electrical networks,

accidents that do occur with work at heights are among the most common reasons for serious injury and death. In the following short instructions it is possible to see what can be done in order to minimize risks and successfully manage them.

1. Threat of collision, fall from a platform by sudden accelerating/slowing of the machine [9]

A sudden acceleration or slowing of the platform may lead to the collision of the operator with the platform construction, or to a fall of the worker from the working height to the ground, which has in a great many cases very negative consequences in the form of a serious injury, such as broken bones, tearing wounds and in the worst cases ends in death.

Application of the following measures could possibly contribute to improving the current state:

- informing of operators about the dangers and the safety system of work which should be observed,
- organizing of regular training sessions for the operator of elevating work platforms,
- selection of a suitable type of platform with sufficiently high railings so that falls are prevented,
- use of a safety belt/rope which would also prevent a fall from the platform.

2. Threat of tipping over the platform due to instability of the terrain

Work and use of a work platform in unsuitable terrain with an unstable base could lead to tilting, and upon subsequent loss of stability, even the tipping over of the platform. This could lead to serious undesired consequences. In the case of such a situation a devastating injury of even death can easily occur. For prevention of a similar event it is possible to use these proposals:

- use the platform only on a solid and even base,
- spread the telescoping supports and set them onto the floor before starting to lift the platform,
- do not overload the platform with a number of operators or different heavy materials which could lead to tipping over,
- design signalization equipment which would announce a critical tilt of the terrain, or tilting of the platform with a sound or light signal.

3. Threat of the tipping over the platform due to strong wind

Unfavourable wind conditions can also threaten the stability of a platform. A strong wind in connection with other factors has the potential to lead to an unfortunate course of events with subsequent tragic consequences. Measures for this case are:

- observing the set maximum safe speed of the wind for operation of the platform,
- not overloading the platform by the operator or material used,
- with strong wind use telescoping supports for increased equipment stability,
- design of signalization equipment for monitoring the wind.

4. Threat of lightning strike with work on a platform

For safety during operation of a work platform natural factors are also considered, since a great amount of work on platforms is performed outdoors. Among those natural factors are lightning, which is very dangerous during operation of platform, as a possible lightning strike could have fatal consequences. The following measures are proposed for avoiding such situations:

- observing the prohibition on using a platform during storms,
- finishing work and leaving the platform with lightning and thunderstorms nearing.

5. Threat of shock by electric current

Anywhere there is work with electrical equipment or electric current, there is a potential threat. With defective insulation, incorrect maintenance, or in cases when the electric current reaches the external construction of the platform, an operator could be shocked, and this could lead to serious health damage. Shock may also occur in cases not directly related to work with the platform, but when the operator of the platform works on above-ground electrical power lines or with maintenance of public lighting. These proposals are in place in order to successfully avoid this:

- observing the prohibition on using work platforms in the near vicinity of unprotected power lines,
- disconnection of electricity when working on electric power lines,
- observing principles of safety maintenance.

6. Threat from heat, cold, rain or snow

The influences of the external environment are significant factors with operation of work platforms, since their effects cannot be avoided and weather cannot be adapted. The influence of different unfavourable situations, which obviously do not help with comfort and safety of work, may follow from different types of weather. Measures with negative effects of weather are:

- ensuring a sufficient amount of fluids,
- increasing the number of breaks with extreme heat or cold weather,
- selection of suitable clothing according to the weather.

7. Threat of explosion when charging an accumulator

Charging an accumulator also belongs among those activities which have the potential to lead to undesired events, for example, an explosion. This as a consequence could cause serious injuries or even death. Proposals for preventing this happening are:

- regular control and maintenance of the work platform,
- ensuring the observance of safety processes with maintenance and charging of the accumulator
- strict observing of the prohibition on smoking or handling an open flame when charging an accumulator,
- charging of accumulators in well ventilated spaces.

8. Threat of crushing and striking of a platform operator when handling the platform

Operation of a platform can lead to crushing and injuring of workers, when moving or folding up of the equipment, which in the majority of cases leads to devastating injuries. These measures are used for avoiding such cases:

- observing the principles of safe behaviour,
- devoting increased attention to solid barriers,
- improving the method of communication between workers.

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