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Guidelines for assessing the safety of circulating monocable passenger ropeways

These Guidelines are not a binding regulation but provides guidance for the parties involved. Their application would be desirable in all countries.
National standards as well as requirements specified by public authorities take precedence over these Guidelines.

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The present Guidelines are based on a reference version in the French language.

1. Foreword

The present Guidelines were drawn up by Expert Committee I under a mandate of the OITAF Management Committee.

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2. Introduction

Regulation (EU) 2016/424 (ex-Directive 2000/9/EC) on cableway installations designed to carry persons as well as the European standards adopted to further define safety requirements for ropeways carrying passengers, establish a framework that is to ensure high safety standards especially for the passengers transported. This is not the only reference framework for achieving these high safety standards, but it is the one used most frequently and, hence, most tried and tested.

There are ropeways that do not live up to such safety standards. Moreover, there are ropeway installations showing symptoms of fatigue, wear and tear that have never been subject to suitable measures.

These cases raise the question whether minimum measures should be taken to raise the safety levels. In the present Guidelines, OITAF wants to address that question out of the conviction that high safety standards of ropeways are a basic condition for the further development of the industry.

3. Objective

The present Guidelines that, in particular, address operators or owners of passenger ropeways have the objective of providing a tool for assessing ropeways to check whether they meet the minimum safety requirements and, if applicable, to propose measures (of a technical or organizational nature) for improving safety and thereby extending their operation.

The Guidelines do not cover any evaluation of the dimensioning of the ropeway and its components.

Likewise, the Guidelines only focus on the risks to which passengers carried are exposed and do not consider any risks for operating or maintenance personnel. Nevertheless, occupational health and safety are important issues that, in general, require specific safety analyses based on the activities to be performed, their frequency and related risks in order to provide for suitable protective and preventive measures covering technical, human and organizational aspects.

The present Guidelines apply to monocable circulating ropeways.

4. Definitions

- Installation

a system made up of one or more subsystems and components, which is designed, constructed, assembled and put into service with the objective of fulfilling one or more specified purposes;

Note: In the case of a ropeway installation the main purpose envisaged is to carry persons.

- Subsystem

a group of components that are functionally and/or spatially related and make it possible to fulfill one or more specified purposes.

- Safety component

basic component, group of components, subcomponent or entire component as well as any device incorporated into an installation for ensuring safety, the failure of which endangers the safety or health of passengers, operating personnel or third parties.

Note: A safety component may also form part of the infrastructure.

- Other components

components that are not relevant to safety.

5. Assessment approach

It is the responsibility of the owner or operator of a ropeway to realize that an assessment of the installation is necessary in line with these Guidelines.

The person put in charge of the assessment has to be a ropeway expert. This expert must have in-depth technical know-how and/or adequate practical experiences.

In practice, it may be necessary to call in specialists from different domains (mechanical or electrotechnical engineering...). In the following, the term "specialist" is to be understood in this sense.

The assessment of a ropeway installation comprises the steps described below:

5.1. History of the installation

At first, data have to be compiled on the establishment of the installation so that the specialist put in charge can identify the special features of the ropeway and its development.

In this phase, important information has to be gathered, such as the year of construction, operating hours of components, passenger statistics (this provides an impression of operating cycles), name of the manufacturer and the design standards applied when the ropeway was built.

Moreover, a dossier should be created that contains the most important drawings, calculations as well as operating and maintenance manuals.

With a view to traceability, information should also be obtained on the most important maintenance activities already performed (regular grip inspections, magnetic rope testing, non-destructive testing after disassembly, etc.), modifications made and on events affecting the installation and its components (incidents, accidents and near misses).

Finally, it makes sense to check whether the ropeway's manufacturer or other organizations have ever issued safety notices on the installation type in question or its components.

This information helps the specialist in getting a first impression of the safety level of the installation.

Annex 1 contains a template for collecting this information.

5.2. Assessment of the status of safety components

It is necessary to assess the status of the installation's safety components.

If the installation is relatively new, at least a visual inspection of all the safety components has to be performed in order to identify any deficiencies or defects (wear and tear, corrosion, deformation, cracks, fractures, etc.).

If the installation is old and has never been checked in detail or if the latest checks were carried out too long ago (e.g. more than 15 years ago), the safety components, in particular those subject to fatigue stress, have to undergo non-destructive testing, as a rule after disassembling.

The checks commonly used for ropeways are visual inspections, magnetic particle testing, dye penetration testing and ultrasonic testing. The specialist in charge of the assessment should define the test method to be used for the individual components. For each of those checks, the person carrying out tests needs to have the requisite skills and qualifications.

Note: Subsequently, such checks have to be repeated at intervals to be defined in line with the operating conditions (operating speed, load conditions, annual operating hours), the installation's ambient conditions (humidity, wind, frost, etc.) and the findings obtained in the checks performed for the assessment. The specialist in charge of the assessment lays down the suitable testing intervals.

This phase has to be prepared and planned in conjunction with the assessment of the individual subsystems described in the next chapter and the modification or replacement measures that may result from it.

If deficiencies are found, suitable measures have to be defined. The processes used for repairs must be laid down by specialists. After each repair, a new check is required.

The checks and repairs performed have to be documented.

5.3. Assessment of subsystems and safety components

The present Guidelines divide a ropeway installation into the following subsystems:

- TS0 Configuration of the installation
- TS1 Ropes and rope connections
- TS2 Drives and brakes

- TS3 Mechanical equipment (tensioning, stations, line)
- TS4 Vehicles
- TS5 Electrotechnical devices
- TS6 Rescue equipment
- TS7 Infrastructure (stations and line)
- TS8 Environs of the installation
- TS9 Operating and maintenance provisions

For the individual subsystems, Annex 2 defines a scheme for assessing individual components and/or aspects that may be addressed by improvement measures.

The measures described in Annex 2 are based on experiences and findings implemented at existing ropeway installations located in various European countries to raise the level of safety. Annex 2 does not claim to be exhaustive, but rather is intended to serve as a basis and tool.

The present Guidelines do not define priorities for the measures to be taken.

5.4. Program of measures to improve safety

Based on the preceding findings and the recommendations made by the specialist, the owner or operator defines a program of measures to improve the safety of the ropeway installation.

The establishment of this program of measures has to take account of the following principles for raising the safety level in the order given:

- technical measures,
- protective measures,
- organizational measures.

The owner or operator of the installation is responsible for planning and effectively implementing the program of measures.

It is recommended:

- to formally lay down the action plan in a single document,
- to document the measures implemented to ensure traceability, and
- to archive this documentation together with the dossier and related technical justifications..

It has to be ensured that the measures to be taken do not give rise to any new risks (e.g. insufficiently free movement of components, excessive increase in stress).

6. Summary of the approach

The following flowchart gives an overview of the approach.

Actors	Action	Relevant parts of the Guidelines
Owner / operator	Decision to carry out an assessment in order to improve the safety standard of an installation	
Operator specialist	History of the installation	See 4.1 and Annex 1
Specialist Inspector	Assessment of the status of safety components	See 4.2
Specialist	Assessment of subsystems and safety components	See 4.3 and Annex 2
Owner operator specialist	Definition and planning of improvement measures	See 4.4
Owner operator specialist manufacturer	Implementation of improvements	See 4.4
Owner operator specialist manufacturer	Documentation and archiving	See 4.4

Annex 1
Template for recording the history of the installation

Year of construction:
Manufacturer:
Operating hours:
Design regulations applied:
Major maintenance work already performed (regular grip inspections, magnetic rope testing, non-destructive testing of disassembled components...)
Modifications made:
Events affecting the installation and its components (incidents, near misses and accidents):
Safety notices issued by the manufacturer or other organizations for the type of installation or its components, if applicable:
Documents to be supplied: • main plans, • calculations, • operating and maintenance manuals.

Annex 2

Assessment scheme

TS1 Ropes and rope connections

NO.	COMPONENT	NECESSARY CHECK	RECOMMENDED MEASURES
1.1	Carrying-hauling rope	Has the proper status of the carrying-hauling rope been checked?	No specific measures (apart for visual inspections and magnetic rope testing)

TS2 Drives and brakes

NO.	COMPONENT	NECESSARY CHECK	RECOMMENDED MEASURES
2.1	Brake	Are the braking systems redundant and do they act reliably?	Need for 2 independent brakes (service brake and safety brake) with at least the safety brake located at the drive bullwheel. Installation of a deceleration monitoring device for the service brake with actuation of the safety brake in case of insufficient deceleration.
2.2	Safety brake	Has the reliability of the safety brake been demonstrated?	The safety brake has to work even when energy supply fails (positive action). In case of brakes kept open hydraulically, the solenoid valves applying the brakes have to be redundant. Contrary to the general principles set out in clause 4.4 of the present Guidelines, the electric valves may not be duplicated provided that the engagement of the safety brake is checked and documented daily.
2.3	Cleanness of the brake surface of the safety brake	Do suitable measures prevent that hydraulic oil soils the braking surfaces of the drive bullwheel?	Install splash guards or jacketed hoses. Replace hydraulic hoses after the end of their recommended service life.
2.4	Bullwheels	If the bullwheels are mounted on a shaft or rotating axle, have measures been taken to consider the resulting fatigue stress for the shaft or axle?	This requires: 1) either proof by calculation of the fatigue resistance of the shaft or rotating axle, or 2) a cage assembly catching the bullwheel. This cage assembly must be designed so that it keeps the bullwheel largely in its position in case the shaft or axle fails so that the derailment of the rope is prevented.
2.5	Drive bullwheels	Is the position of the drive bullwheels monitored?	Installation of a device monitoring the position of the bullwheels.

TS 3.1 – Rope tensioning equipment

NO.	COMPONENT	NECESSARY CHECK	RECOMMENDED MEASURES
3.1.1	Hydraulic tensioning devices	Is the permitted rope tension guaranteed and monitored?	Set up: - monitoring of minimum rope tension (monitoring of pressure or tension) to ensure friction, - monitoring of maximum rope tension (monitoring of pressure or tension) or installation of a pressure limiter to ensure the safety coefficient of the rope.
3.1.2	Counterweight tensioning devices	Are the end positions of the tensioning device monitored?	The two end positions of the counterweight have to be monitored.
3.1.3	Tensioning devices in general	Are the end positions of the tension carriage monitored?	The two end positions of the tension carriage have to be monitored.

TS 3.2 - Mechanical equipment in the stations

NO.	COMPONENT	NECESSARY CHECK	RECOMMENDED MEASURES
3.2.1	Installations with detachable grips – attachment / detachment	Have measures been taken to prevent the consequences of deficient attachment/detachment of the grips when they exit/enter the stations?	Precautions have to be taken to bring to a halt, without risk to users, carriers that are deficiently attached to the rope at the moment of departure and carriers that are deficiently detached from the rope at the moment of arrival and to prevent the carriers from falling. Therefore, deficient attachment/detachment has to be detected automatically. Moreover, a device has to be in place that prevents a carrier that is not correctly attached to the rope from leaving the station (e.g. device for the forced attachment of the grip or for holding back the carrier before departing). Otherwise, the length and inclination of the adjoining rope span has to be designed so as to prevent the carrier from sliding along the line.
3.2.2	Installations with detachable grips – prevention of collisions of carriers in the station	Have measures been taken to prevent the risk of carrier collisions in the station?	Sensors have to be provided that detect whether a carrier got stuck while traveling through the station and trigger a stop, at least on the acceleration and deceleration ramps, before the next carrier can collide with the carrier in question. Note 1: In the case of occupied open carriers, the safety distance between the carriers has to be at least 0.5 m after they come to a standstill. Note 2: In the case of closed carriers, the carriers may come in contact with each other after the stop is triggered provided that the impact speed is less than 1 m/s.
3.2.3	Monitoring of gondola boarding	Is proper boarding by passengers monitored at the end of the boarding area?	Gondola lifts have to be equipped with a monitoring device that can detect whether a passenger got stuck on the outside of the doors and stops the installation before the gondola departs.
3.2.4	Monitoring of chairlift unloading	Is a device installed that automatically stops the installation when a passenger fails to unload in due time?	After the unloading area of: - fixed-grip chairlifts; and - detachable chairlifts that do not have a loading area constantly supervised by personnel in the same station, a device has to be provided that automatically stops the installation when a passenger fails to unload. The device has to be as close as possible to the unloading area. Within the distance traveled by the carrier after a stop is triggered, the ground clearance must not exceed 2.5 m.
3.2.5	Return bullwheel	Is the position of the return bullwheel monitored?	Installation of a device monitoring the position of the return bullwheel.

TS 3.3 - Mechanical equipment of line structures

NO.	COMPONENT	NECESSARY CHECK	RECOMMENDED MEASURES
3.3.1	Sheave assemblies	Is rope derailment possible towards the ropeway's centerline (inward)?	The sheave assemblies have to be provided with devices preventing derailment towards the ropeway's centerline at both ends of the sheave assemblies. They have to be designed in such a way that the carrying-hauling rope is not damaged as it passes by and the grips cannot get stuck.
3.3.2	Sheave assemblies	How are the consequences of derailment managed?	The sheave assemblies have to be equipped with rope catchers. The rope catchers have to be designed so that minor transverse oscillations of the carriers are not impeded. When the rope is held by the rope catcher, it should not hamper the passage of grips. If this is not the case, alternative measures have to be considered in order to mitigate the risk of derailment or its consequences, e.g. reduction of permitted wind speed for operations.
3.3.3	Sheave assemblies	How are the consequences of derailment managed?	At their leading end, sheave assemblies have to be equipped with safety devices that automatically bring the installation to a halt in case of derailment. Sheave assemblies with more than four sheaves also have to be equipped with such devices at their trailing end. Derailment has to be detected: - when the rope falls into the rope catcher, - when the rope derails beyond the rope catcher.
3.3.4	Sheave assemblies	How are the consequences of the loss of a sheave managed?	It is necessary to put in place anti-rotation stops at 2-sheave rockers or devices detecting whether a rocker tilts after a sheave is lost.

TS4 Vehicles

NO.	COMPONENT	NECESSARY CHECK	RECOMMENDED MEASURES
4.1	Gondola glazing	Is there a risk that glazing panels are dislocated under pressure exerted by passengers?	In gondolas intended to carry exclusively seated passengers, it is recommended to provide a notice requesting passengers to take a seat. In gondolas intended to carry standing passengers where the glazing begins at a height of less than 1 m above the floor, safeguards have to be provided if there is a risk that the glazing can be dislocated even in case of low forces (e.g. fastening by a single seal). The installation of guardrails fulfills the same purpose.
4.2	Gondola doors	Is there a system monitoring the closing and locking of doors?	If there is no automatic monitoring system for gondola doors, operating personnel has to check whether the doors are locked and, if appropriate, locked. Swinging doors absolutely have to be locked.
4.3	Gondolas	Is the maximum capacity or useful load of gondolas known and indicated on a sign?	A sign indicated the maximum number of passengers and the maximum useful load should be posted in the gondolas.
4.4	Buckets (open gondolas)	Are the walls at least 1.10 m high measured from the floor?	Install guardrails at a minimum height of 1.10 m above the floor.
4.5	Chairs	Are restraining bars fitted to the chairs?	Install restraining bars.
4.6	Detachable grips	Is the gripping force monitored during service?	Installation of devices monitoring the gripping force or spring force during service.

TS5 Electrotechnical equipment

The following table lists the minimum safety functions that need to be available in the electrical control system of a circulating monocable ropeway.

NO.	SAFETY FUNCTION	CF	CD/GD	NOTES
Rope speed				
5.1	Redundant measurement of rope speed with deviations between the two values being monitored	X	X	Redundancy may also be achieved by using the motor speed.
5.2	Monitoring of deviations between the target value and actual value of rope speed.	X	X	Rope speed may be measured also indirectly by means of the motor speed if, additionally, there is a comparison between motor speed and rope speed.
5.3	Monitoring of the direction of travel / stop (no unintentional change in the direction of travel)	X	X	
5.4	Monitoring of overspeed	X	X	Limit value that may set to a maximum of 110% of nominal speed.
Drives and brakes				
5.5	Reliable engagement of the safety brake	X	X	The related electrical control has to be provided twice (redundant) and must ensure positive action (engagement of the safety brake when the installation's energy supply fails). Contrary to the general principles set out in clause 4.4 of the present Guidelines, the control may not be duplicated provided that the engagement of the safety brake is checked and documented daily. Note: This alternative is also laid down for the solenoid valves used to apply the safety brake in TS2.
5.6	Monitoring of deceleration in case of an electric stop	X	X	If it is provided and used as an emergency stop for certain safety functions.
5.7	Monitoring of deceleration after engaging the service brake	X	X	
5.8	Monitoring of the safety brake lock	X	X	This function is required if the safety brake can be locked when it is open. The locking of the safety brake has to trigger a stop using the service brake and switch off the main drive.

NO.	SAFETY FUNCTION	CF	CD/GD	NOTES
5.9	Preventing the simultaneous, unintentional engagement of all braking system at full brake power	X	X	The simultaneous engagement of all brakes is permitted provided that: - the deceleration resulting from the simultaneous engagement of all brakes cannot exceed 2.5 m/s ² , and - tests show that ropes are not lifted from the towers and carriers cannot collide with line structures or ropes in such cases.
5.10	No release of the service brake upon actuation of the safety brake during standstills (below minimum speed)	X	X	
5.11	Monitoring of the brake position	X	X	Monitoring when the installation stands still, starts to move and is in motion
5.12	Safe torque interruption	X	X	By means or redundancy or a safety function of the speed variator (like a safe-torque-off function)
5.13	Overload monitoring at the drive motor	X	X	
5.14	Monitoring of the position of bullwheels in drive and return stations	X	X	
Safety line				
5.15	Safety monitoring at towers	X	X	Note: The safeguards needed at towers are detailed in TS3.3. These monitoring devices also have to work during operations with the emergency drive. Alternatively, a visual and acoustic signal can be issued at the place where the emergency drive is operated.
Control				
5.16	No unintentional startup	X	X	Loss of the "ready" indication after a maximum of 30 s
5.17	Electric stop or emergency stop button in drive and return stations	X	X	If it is provided and used as a stop or emergency stop for certain safety functions. Stop button to be reset manually

NO.	SAFETY FUNCTION	CF	CD/GD	NOTES
5.18	Emergency stop button for actuating the service brake in drive and return stations	X	X	Stop button to be reset manually
5.19	Emergency stop button for actuating the safety brake in drive and return stations	X	X	Stop button with two contacts (with discordant contact states, at least in the drive station) to be reset manually and provided with a padlock (for the stop button at the control panel in the drive station). Alternatively to stop buttons two contacts, a daily functional test may be performed for the emergency stop buttons actuating the safety brake.
Tensioning device				
5.20	Monitoring of rope tension	X	X	Monitoring of the minimum value (pressure or force); for details, see TS 3.1 When a counterweight is used, the two end positions have to be monitored.
5.21	Monitoring of the end positions of the tension carriage.	X	X	The two end positions of the tension carriage have to be monitored.
Other requirements				
5.22	Insulation monitoring if potential is not grounded	X	X	Only if 24 volts are insulated.
Carriers with detachable grips				
5.23	Monitoring of carriage transport in the station		X	For further details, see TS 3.2
5.24	Monitoring of the attachment and detachment of grips		X	
5.25	Monitoring of the gripping force or spring force of the grips		X	At least in one station
5.26	Monitoring of the closing and locking of gondola doors		X	Under certain conditions, monitoring is not necessary (for further details, see TS 4). Monitoring is required if old gondolas are replaced by new ones that are provided with closing and locking mechanisms.
5.27	Monitoring of proper loading at the end of the loading areas of gondola lifts		X	For details, see TS 3.2.3 In the case of gondola lifts, by means of entry barriers at the end of the boarding area.

NO.	SAFETY FUNCTION	CF	CD/GD	NOTES
5.28	Monitoring of passenger unloading at the end of the unloading area of chairlifts	X	X	For details, see TS 3.2.4

Abbreviations:

CF: Chairlift with fixed grips

CD: Chairlift with detachable grips

GD: Gondola lift with detachable grips

TS6 Rescue system

Verification of the availability and functioning of rescue equipment included in the rescue plan.

Likewise, the availability of personnel required for rescue operations has to be ensured. Otherwise, an agreement has to be signed with a local rescue organization, if there is one.

TS7 Infrastructure

NO.	COMPONENT	NECESSARY CHECK	RECOMMENDED MEASURES
7.1	Rope lifters on towers	Is the maximum force indicated at all the required points of force application?	Verification of the maximum force for each point of force application and provision of a sign indicating the relevant load.

TS8 Environs

NO.	COMPONENT	NECESSARY CHECK	RECOMMENDED MEASURES
8.1	Towers	Are the risks of damage to towers resulting from creeping snow taken into account adequately?	Identification of towers exposed to creeping snow. Provisions to be made for those towers: - either uphill safeguards, or - operational measures ensuring that snow is removed down to a sufficient level (i.e. the level predefined by the dimensions of the tower) or removed completely.
8.2	Stations, towers	Are natural and environmental hazards (avalanches, rockfalls, landslides, falling trees, lightning strikes...) or fire risks taken into account?	It is recommended to take stock of the different risks to which a ropeway is exposed (if such risks exist in the relevant area or have developed there over time). If such risks are found during stocktaking, they should be assessed by specialists and result in the development of an action plan by the operator. This plan should take account of the recommendations made by the specialists.

TS9 Operation

NO.	COMPONENT	NECESSARY CHECK	RECOMMENDED MEASURES
9.1		Has the operator formalized the instructions for the staff and the operational processes for ensuring operational and rescue activities at the installations?	Existing OITAF recommendations can be helpful for these topics, in particular: - Book 9-1: Provisions for special transport cases - Book 9-2 Operation in exceptional circumstances - Books 26 and 26-1: Recommendations for evacuation from ropeways - Book 32: Operations
9.2		Is the installation equipped with devices that help the operator assess winds?	Devices measuring wind speed have to be installed in the section(s) that are most exposed to wind.
9.3		Are the passengers given instructions on how to behave to ensure safe transportation?	Instructions have to be posted in the form of pictograms at the installation. These pictograms have to cover at least the information specified in Book 9 of OITAF. The standard ISO 7010 contains some of those pictograms. Additionally, national standards may be used.
9.4		Are safety distances observed at each point along the line?	Warning signs have to prohibit access to all areas below carriers where, under most unfavorable load conditions, the distance between the ground (with snow cover, if applicable) and the bottom of the carrier is less than: - 1.5 m (inaccessible for persons), - 2.5 m (accessible for persons), - 4 m (snow groomers), - clearance gauges of traffic routes + 1m (road and railway vehicles). Those distances have to be raised by 0.50 m for occupied chairs.
9.5		Are there areas in the stations involving the risk of falls (higher than 1 m or slopes with an inclination of more than 60%) that are not secured by means of handrails or similar safeguards?	Installing safeguards such as handrails or securing areas by means of safety nets. In platform areas facing carriers, it is sufficient to provide signs warning passengers of the danger.
9.6		Is there a detailed maintenance manual?	A maintenance manual has to define the maintenance work and inspections to be performed, in particular for safety components (ropes, carriers, sheave assemblies, structures, etc.). This manual has to specify the type of the checks to be carried out, their intervals and acceptance criteria.