

## *Translation*

# *Principles of testing and certification of conductor cars*

*Edition: 2019-02*

Principles of testing  
Conductor cars  
GS-ET -01

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**GS-ET 01**

## **Preliminary remarks**

These Principles of testing serve as verification that the requirements of the German Product Safety Act (ProdSG) and the 9th provision of the ProdSG have been complied with.

These principles will be revised and supplemented periodically in consideration of knowledge gained in the area of occupational health and safety, as well as technical progress. The most recent edition shall always be binding for the tests conducted by the testing and certification body of the committee for electrical engineering in DGUV TEST.

### **Changes with respect to Issue 2012-06:**

- **Fundamental revision**

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## 1 General

### 1.1 Scope of application

These Principles of testing serve as a basis for the testing and certification of conductor cars, with and without built-in power drives, used for inspecting active overhead power lines.

### 1.2 Technical rules

#### 1.2.1 Harmonized standards

DIN EN ISO 13857 (2008-06)	Safety of machinery - Safety distances to prevent hazard zones being reached by upper and lower limbs
DIN EN ISO 13849-2 (2013-03)	Safety of machinery - Safety-related parts of control systems - Part 2: Validation
DIN EN ISO 13732-1 (2008-12)	Ergonomics of the thermal environment - Methods for the assessment of human responses to contact with surfaces - Part 1: Hot surfaces
DIN EN ISO 12100 (2011-03)	Safety of machinery; General principles for design - Risk assessment and risk reduction
DIN EN ISO 4413 (2011-04)	Hydraulic fluid power - General rules and safety requirements for systems and their components
DIN EN 60204-1 (2007-06)	Safety of machinery; Electrical equipment of machines - Part 1: General requirements
DIN EN 1808 (2015-08) Revision 1 (2017-06)	Safety requirements for suspended access equipment - Design calculations, stability criteria, construction - Examinations and tests
DIN EN 349 (2008-09)	Safety of machinery; Minimum gaps to avoid crushing of parts of the human body



DIN EN 354  
 (2010-11)                      Personal fall protection equipment - Lanyards

DIN EN 280  
 (2016-04)                      Mobile elevating work platforms - Design calculations -  
 Stability criteria - Construction - Safety - Examinations  
 and tests

### 1.2.2 European standards

DIN EN ISO 10042  
 (2019-01)                      Welding - Arc-welded joints in aluminium and its  
 alloys - Quality levels for imperfections

DIN EN ISO 9606-2  
 (2005-03)                      Qualification test of welders - Fusion welding - Part  
 2: Aluminium and aluminium alloys

DIN EN 50374  
 (2005-02)                      Conductor cars

DIN EN 1999-1-1  
 (2014-03)  
 / NA: (2018-03)                      Eurocode 9: Design of aluminium structures -  
 Part 1-1: General structural rules

DIN EN 1011-4  
 (2001-02)                      Welding - Recommendations for welding of metallic  
 materials -  
 Part 4: Arc welding of aluminium and aluminium  
 alloys

DIN EN 1032  
 (2009-02)                      Mechanical vibration -  
 Testing of mobile machinery in order to determine the  
 vibration emission value

### 1.2.3 International standards

ISO 1219-1  
 (2012-06)  
 AMD 1: (2016-04)                      Fluid power systems and components - Graphic  
 symbols and circuit diagrams;  
 Part 1: Graphic symbols for conventional use and  
 data-processing applications

ISO 1219-2  
 (2012-09)                      Fluid power systems and components - Graphic  
 symbols and circuit diagrams;  
 Part 2: Circuit diagrams

#### 1.2.4 National standards

DIN 45635-1 (1984-04)	Measurement of noise emitted by machines; airborne noise emission; enveloping surface method; basic method, divided into 3 grades of accuracy
DIN 45635-11 (1987-01)	Measurement of noise emitted by machines; airborne noise emission; enveloping surface method; Internal combustion engines.

The normative references listed in these Principles of testing always relate to the edition version as listed in this section.

### 1.3 Validity

GS-ET-01, Principles of testing, Edition 2019-02, is to be applied as of Mar. 01, 2019 and replaces Edition 2012-06.

## 2 Terms

### 2.1 Conductor cars

Conductor cars are working platforms, which serve as movable workstations on active overhead power lines. They are hung onto and driven along the conductor or suspension cables stretched between masts, using tackle or a built-in power drive.

### 2.2 Control elements

Items of work equipment, whose operation affect a change in the flow or position of information, energy and/or material. They can also serve component positioning.

### 2.3 Load-bearing structure

Elements used to ensure that all forces generated during the intended and practical application will be absorbed.

## **2.4 Chassis**

The chassis is comprised of the:

- drive unit, if applicable
- swivel and locking elements
- fall protection devices
- axles/shafts with wheels
- equipment for braking and securing the conductor car

## **2.5 Guide axle**

The guide axle is comprised of the:

- swivel and locking elements
- axles
- guide roller/s (free running)

## **2.6 Drive brakes**

Drive brakes are used to decelerate the conductor car and bring it to a complete stop.

## **2.7 Holding brakes**

Holding brakes are used for fixing the conductor car in one location on a conductor line or earth cable.

## **2.8 Fall protection devices**

Fall protection devices in the context of these Principles of testing are provisions foreseen to prevent the crashing of a conductor car.

## **2.9 Attachment options**

Attachment options in the context of these Principles of testing serve to establish a load-bearing connection between the conductor car and the personal protection equipment to protect against falling (PPEaf).

## **2.10 Fastening equipment**

An arrangement of individual parts with one or more stationary or moveable attachment points, which facilitate engagement of the conductor car.

## **2.11 Test log**

The test log serves to document any testing performed.

## **2.12 Conductor cable**

Wire or a combination of wires not insulated from one another, suitable for the conducting of electrical current.

Conductor cables are stretched between two support points along an overhead power line. They can be designed as single strand or bundled (stranded) cables.

## **2.13 Conductor cable configuration**

The arrangement of individual cables on an overhead power line.

Typically: single, double bundle (horizontally/vertically configured), triple bundle or quad bundle cables.

## **2.14 Permissible conductor cable diameters**

The diameter of a conductor cable, which is equal to or lies between the minimum and maximum diameters prescribed by the conductor car manufacturer.

## **2.15 Maximum conductor cable angle of inclination**

The angle of the conductor cable prescribed by the manufacturer, as measured between the conductor cable and the horizontal plane, which is encountered directly in front of the vehicle as it is being driven, (Angle A, Fig. 1).

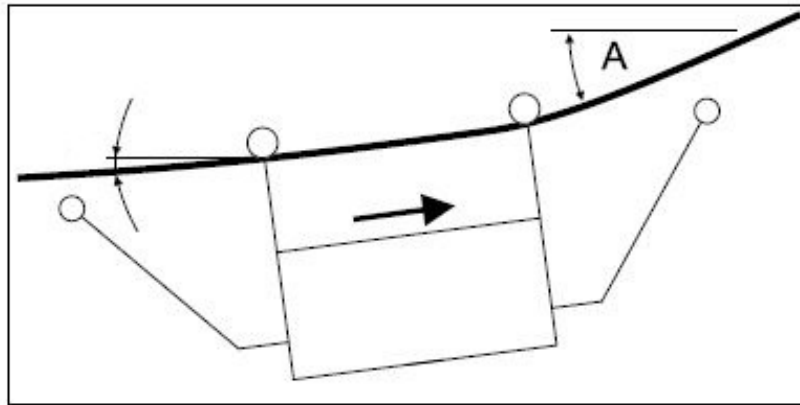


Fig. 1: Maximum conductor cable angle of inclination

### **2.16 Load capacity**

The load as prescribed by the manufacturer, under which the conductor car can be operated as properly intended.

### **2.17 Intended scope of application**

The intended proper usage as prescribed by the manufacturer, including conductor cable configuration.

### **2.18 Rescue equipment**

Equipment foreseen for the rescue of injured persons from a conductor car, which can vary in configuration depending on the rescue concept.

### **2.19 Throw-out mechanism**

Equipment for throwing out a safety line that can be activated by a third person outside the conductor car.

### **2.20 Net for catching assembly parts**

Equipment for retaining assembly parts that can potentially fall out of the car during transport or installation.

### **3 Documents/Prototypes for submission**

#### **3.1 Application documents**

- Application form
- Form: Information related to contract preparation

#### **3.2 Technical documents**

**The following documents must be submitted for technical testing:**

- Instruction manual in the German language
- Parts list(s)
- Technical drawings
- Structural analysis
- Weld seam calculations, if applicable
- Verification of suitability for welders, if applicable
- Verification of strength for a load-bearing structure's interconnection system (e.g. screwed, compressed or bonded joints), if applicable
- Verification of drive shaft fatigue strength for single strand cable operations, if applicable
- Hydraulic diagram, if applicable
- Electrical circuit diagram, if applicable
- Test log
- Data sheet for hydraulic fluid, if applicable
- Data sheet for hydraulic hose lines, if applicable
- Data sheet for fittings, if applicable

The testing facility can request further documentation if deemed necessary.

#### **3.3 Prototype**

As a minimum, a functional conductor car must be available for testing.

## **4 Preparations for testing conductor cars**

### **4.1 Personnel**

Operating personnel and persons who can provide the necessary information related to the construction, configuration and function of the conductor car, as well as those who can perform required installation work (e.g. assembly and disassembly) must be present for testing.

### **4.2 Test track**

The test track must:

- be consistent with the anticipated range of conductor car applications
- feature a conductor cable with an adjustable angle of inclination (incl. spacers and support mast reproductions)
- provide a stretch of track for driving  $15\text{ m} \pm 1\text{ m}$ .

### **4.3 Test loads**

The following test loads must be made available:

- Load capacity
- 1.1-fold load capacity
- 1.5-fold load capacity
- 3-fold load capacity
- $120\text{ kg} \pm 1\text{ kg}$  (e.g. strapped in a sack)

## **5 Requirements and tests**

### **5.1 Technical documents**

#### **5.1.1 Instruction manual**

The Instruction manual must conform to the requirements of DIN EN ISO 12100, Sections 6.4.5.2 and 6.4.5.3.

The language version for which the manufacturer assumes responsibility shall be annotated „Original Instruction Manual“.

The following additional information is required:

#### **A) Minimum information about the product**

- Manufacturer's/authorised representative's name and complete address
- Product designation
- CE-marking
- Type designation
- Year of manufacture
- Information related to the certificate of conformity, mark of conformity or similar, if applicable
- The EC Declaration of Conformity, if applicable, or a rendering of the content found therein if the Machinery Directive is to be considered
- Description of the conductor car, its function, control system and workstations
- Dimensions
- Tare weight
- Load capacity
- Load-bearing structure
- Load-bearing materials
- Chassis
- Tyre pressure, if applicable
- Control system
- Drive configuration
- Drive brakes
- Holding brakes
- Auxiliary brakes, if applicable
- Specifications for the safe recharging of accumulators, if applicable
- Maximum permissible angle of inclination for the conductor cables being inspected
- Minimum and maximum permissible diameters for the conductor cables being inspected
- Special design features
- Design variants
- The A-weighted emission sound pressure level at the workstations  
The A-weighted sound power level emitted by the machinery, if applicable
- The vibration total value for the upper limbs ( $m/s^2$ ) and the highest root mean square value of weighted acceleration to which the whole body is subjected ( $m/s^2$ ), as well as the measurement uncertainties

#### **B) Information related to the deployment location**

- Intended proper usage and information related to foreseeable application / foreseeable faulty application



- Note that the conductor car may be deployed only after the operator is assured that its use is possible without risk to the personnel

It must be particularly noted that:

- masts and conductor cables must possess adequate load-bearing capabilities,
- the permissible conductor cable angle of inclination for the conductor car, with respect to the ambient conditions, must not be exceeded,
- Communication between the persons in the vehicle and the persons on the ground is guaranteed.

### **C) Information related to storage and transport**

- Information regarding measures related to long-term decommissioning
- Information regarding suitable load-bearing materials
- Information regarding fastening equipment for load-bearing materials
- Information regarding assembly and disassembly of components and connections
- Information regarding safe transport

### **D) Information related to operations**

- Instruction regarding initial commissioning
- Information regarding operating and auxiliary materials and their usage
- Information regarding the potential use of low-emission fuels with reduced benzene values
- Instruction regarding set-up work: e.g. Alignment of the conductor car for differing conductor cable configurations
- Description of the action of control equipment
- Instruction regarding their actuation
- Measures to take prior to lifting the vehicle onto the conductor cable, incl. proper usage of the load-bearing materials on the conductor car
- Instruction regarding the wearing of personal protective equipment
- Measures to take when hanging the conductor car onto the conductor cable
- Measures to take prior to actuation
- Information regarding the wearing of close-fitting garments:
  - clothing must not possess drawstrings/-cords or other loose-fitting items.
  - hooded clothing should be avoided or must be fastened only with snap fasteners or Velcro.
- Fasteners in the conductor car
- Instruction regarding safe operations and driving along a conductor cable
- Instruction regarding the traversing of cable spacers and support masts
- Information regarding particular safety measures to take during particular operation

- Information regarding normal shutdown and shutdown in case of an emergency
- Information regarding particular hazards and residual risks
- Information regarding actions in the event of a drive brake malfunction
- Instruction regarding troubleshooting and fault rectification during operations
- Instruction regarding letting down from the conductor cable
- Instruction regarding rescue options
- Information regarding the qualification and training of operating personnel

#### **E) Information related to servicing, maintenance and periodic inspections**

- Instruction regarding servicing
- Instruction regarding maintenance
- Instruction regarding repair
- Note: Service, maintenance and repair work may be performed only with the drive unit switched off
- Instruction regarding periodic inspections
- Assessment of the load-bearing connections (e.g. weld seams or screw connections)
- Information and instruction regarding dye-penetration testing, if applicable
- Information regarding the replacement of wearing parts, incl. a spare-parts list
- Information regarding the use of skin protectants and the wearing of protective gloves when working with hydraulic fluids

#### **5.1.2 Parts lists**

The parts lists must agree with the engineering drawings and circuit diagrams.

#### **5.1.3 Electrical diagrams**

Electrical circuit diagrams must conform to the requirements of DIN EN 60204-1, Section 17.6.

#### **5.1.4 Structural analyses, strength and weld seam calculations**

The following documents must be submitted:

- Structural analyses of the load-bearing structure
- Strength calculations for construction connections, if applicable
- Weld seam calculations, if applicable
- Verification of drive shaft fatigue strength for single strand cable operations, if applicable

### 5.1.5 Hydraulic diagram

Hydraulic diagrams must conform to the requirements of ISO 1219-1 / -2.

### 5.1.6 Test log

The test log must clearly reflect the type and scope of the tests performed.

The test log must be structured so that it contains records of, or is possible to record the following data:

- Manufacturer/Supplier
- Operator/Company
- Conductor car designation/Type
- Serial number
- Year of manufacture
- Tare weight
- Load capacity
- Drive rating/Drive configuration
- Drive speed
- Operating pressure, if applicable
- Minimum and maximum diameters of the conductor and earth cables to be inspected
- Maximum angle of inclination of the conductor and earth cable, if applicable, up to which the conductor car can be deployed in dry and wet conditions.
- Testing prior to initial commissioning
- Periodic inspections
- Visual inspection of the load-bearing structure
- Weld seams/dye-penetration testing, if applicable
- Visual inspection of the screw connections on the load-bearing structure, if applicable
- Testing of the drive unit, if applicable
- Testing of the electrical equipment, if applicable
- Testing of the hydraulic equipment, if applicable
- Testing of the control equipment
- Testing of the brakes
- Testing of the safety equipment
- Testing of fall protection devices
- Date of initial commissioning
- Date of testing, results of the testing, signature of the inspector and remarks

### 5.1.7 Sales literature

Sales literature in which the conductor car is described must not contradict the Instruction manual with regard to safety and health aspects.

Sales literature in which the performance characteristics of the conductor car are described must contain the same information as in the Instruction manual with regard to emissions.

#### Tests referenced in Sections 5.1.1 to 5.1.7

Review of the technical documents submitted; check for completeness and plausibility.

## 5.2 Conductor cars

### 5.2.1 Intended proper usage

It must be possible to properly use the conductor car as intended without putting persons at risk.

**Test:** Visual inspection and handling:

The conductor car is to be properly hung onto the test track according to Section 4.2.

The conductor car is to be uniformly loaded up to the permissible load capacity.

The conductor car shall traverse the components along the overhead power line test track (e.g. spacers, support mast reproductions, aircraft warning spheres, etc.) according to Section 4.2. and corresponding to its intended proper usage.

### 5.2.2 Conformity with documentation

Conductor cars must conform to the documentation submitted.

**Test:** Compare the technical documents to the construction model of the conductor car.

### 5.2.3 Control elements

Control elements must be readily accessible, self-evident, clearly legible and durably marked

Control elements must be arranged in such a manner that they are protected against unintentional activation, the operator has sufficient freedom of movement and the stretch of cable to be inspected can be clearly seen.

Control elements used for navigating along the conductor line must be designed in such a manner that they are stationary and self-resetting.

**Test:** Visual inspection and handling

### 5.2.4 Type plate

The conductor car must have a type plate containing at least the following information:

- Company name and full address of the manufacturer and representatives, if applicable
- Machine designation, such as “Conductor car“ (if the Machinery Directive applies)
- Type or design series
- Serial number, if applicable
- Year of manufacture
- Tare weight
- Load capacity
- Rated power (kW) of the drive unit (may also be specified on the unit’s type plate)
- Minimum and maximum diameters of the conductor cables to be inspected
- Maximum angle of inclination of the conductor cable, up to which the conductor car can be deployed in dry conditions
- Maximum angle of inclination of the conductor cable, up to which the conductor car can be deployed in wet conditions
- Tyre pressure, if applicable
- CE-marking (using the same technology as set forth in the manufacturer’s specifications), if applicable, if the Machinery Directive applies

All inscriptions must be clearly legible and durably marked

### 5.2.5 Safety and warning signs

The following safety signs must be permanently affixed at clearly visible locations on the conductor car:

- Use safety gear
- Wear close-fitting garments
- Wear ear protection, if applicable

Warning signs directing attention to potential residual risks that can't otherwise be prevented by design features or avoided through the use of protective equipment must be located at the danger points.

### Tests referenced in Sections 5.2.3 to 5.2.5:

Check the markings for completeness and plausibility. Wipe test: Rub using two cotton cloths, one soaked in water and the other in a test fluid<sup>\*)</sup> for 15 s each.

The markings must remain clearly legible following the test. It must not be possible to easily remove the marking labels, nor should they be wrinkled or creased.

<sup>\*)</sup>The chemical product with the trade name "n-Hexan for analysis", which fulfils the requirements for the test fluid defined in DIN EN 60335-1 and DIN EN 62368-1, should be used as test fluid.

### 5.2.6 Protection against falling

Conductor cars must be outfitted with side guards to protect persons or safeguard objects from falling off the vehicle. Comparable protection must also be available for the front and rear sections. In this context, the drive axles/shafts and guide axles could provide this protection, if appropriate.

Side guards must be comprised of:

- Handrails  $\geq 1.00$  m in height (floor panels to the upper edge)
- Knee railing at a height, at which the slipping through of persons is not to be anticipated (e.g.  $\leq 0.50$  m clearance between the skirting boards and the knee railing, or between the knee railing and the hand rails).
- Skirting boards at a height of  $\geq 0.15$  m

The skirting boards must rest on the floor without a clearance so that objects on the floor cannot fall out of the vehicle.

If the conductor car is to be used optionally on two- or four-conductor bundles, then the conductor cables, themselves, can partially fulfil the side guard function.

If the conductor car is to be used on cable bundles where the operator is located outside the bundle, itself, then chains or other elements can take over the upper side guard function.

**Test:** Visually inspect and measure the clearances

### 5.2.7 Emission sound pressure level / Sound power level

Conductor cars must not exceed the emission sound pressure or sound power levels under any operating condition as prescribed in the Instruction manual.

**Test:** Measurements are to be made at idle and at full load.  
Measurements are to be made according to DIN 45635, Part 1 and, if applicable, DIN 45635, Part 11 (if an internal combustion engine is in use).

### 5.2.8 Vibrations

Conductor cars must never exceed the vibration total value as specified in the Instruction manual for the upper limbs or the highest root mean square value of weighted acceleration to which the whole body is subjected under any operating condition.

**Test:** Measurements are to be carried out on a conductor car hung onto the conductor cable, with the drive unit at full load and at the maximum speed according to DIN EN 1032.

Vibration values, such as required in Sec. 5.1.1, A, must be measured at that section of the conductor car, which would transfer the greatest amount of vibration into the body (normally through the floor panels) or into the hands/arms. If the conductor car is configured for sitting, then a measurement should also be made at this installation according to DIN EN 1032.

### 5.2.9 Load-bearing structure

Measurement of the load-bearing structure is based upon DIN EN 1999-1-1. Load-bearing parts and parts that serve a safety function must be calculated on the load side to reflect at least a 3-fold safety factor over the static loading anticipated in the most unfavourable operational conditions. On the material side, a 1.1-fold safety factor based on the yield point (0.2% of the yield strength) must be considered.

Verification of fatigue strength for the drive shaft with the maximum load must be provided, especially for single strand cable applications, using a minimum safety factor of 1.1 based on the fatigue strength value for the respective materials used.

**Test:** Plausibility check of the structural analyses and fatigue strength verifications submitted.

Practical testing takes place on the most unfavourable cable configuration as prescribed for the conductor car's scope of application.

The conductor car is to be properly hung onto the horizontal conductor cable mock-up.

The outer overlying swivel arm is subsequently swung as far out from the conductor car as functionally possible with the test load. By opening the drive axles/shafts, the most unfavourable operational condition for the conductor car is produced (the vehicle is hung on a drive axle/shaft and on the outer axle of the swivel arm on the opposite side).

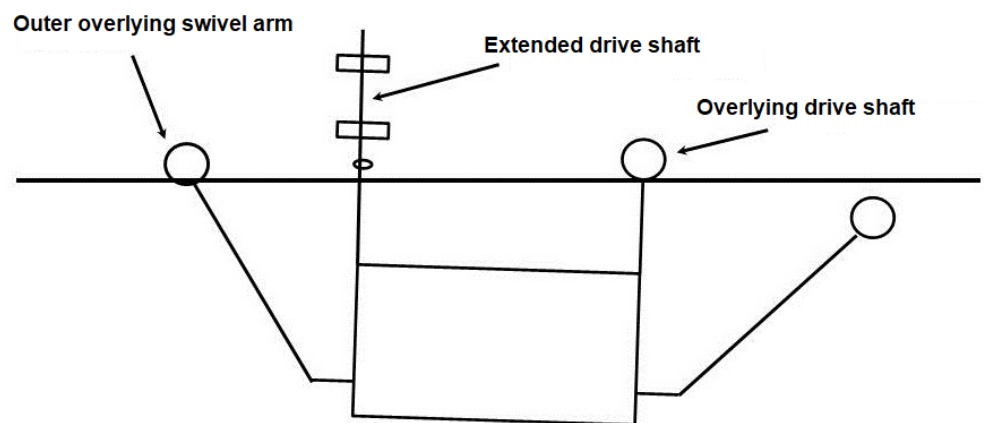


Fig. 2 Test setup for the load-bearing structure

The conductor car is then to be subjected to 3-fold the load capacity with the load distributed uniformly across the floor panels.

The load is applied for 5 minutes.

There must be no permanent deformation of the loaded sections and the rollers must still be „free running“.



### 5.2.9.1 Weld seam joints

The constructive design and configuration of the weld seams must comply with the requirements of DIN EN 1011-4. In so doing, all weld seams must at least conform to Evaluation Group C (medium) according to DIN EN ISO 10042.

**Test:** Visual inspection of the weld seam joints

### 5.2.9.2 Screw connections

Screw connections on the load-bearing structure must be secured to prevent loosening.

**Test:** Visual inspection

### 5.2.10 Chassis

The chassis must be outfitted with equipment to protect the conductor car from falling.

**Test:** The conductor car is to be properly hung onto the test track with swivel arms (if available) opened according to Section 4.2, and then uniformly loaded to 1.5-fold the load capacity. If multi-conductor bundles with conductors arranged above/underneath each other are present, then the lower guide axles should be opened, as well.

The drive axle/shaft on the side corresponding to the conductor car centre of gravity is then opened abruptly.

The fall protection devices must function reliably.

### 5.2.11 Wheels

If the conductor car is to be driven manually when traversing spacers or support masts, then the wheels within reach of the operator's hands must be outfitted with equipment to protect against injury.

If wheels with grooves or flanks can be interchanged for different cable diameters or configurations, then the applicable cable diameters and configurations must be clearly legible and durably marked on the respective wheels.

**Test:** Visual inspection, handling and wipe test according to Sec. 5.2.5

### 5.2.12 Cable guides for single core and double core bundled (vertical) conductor cables

In order to counteract a possible displacement of the cable when accessing single core and double core bundled (vertical) conductors, the maximum permissible conductor cable must ingress the drive wheel/guide roller to at least one third its diameter.

**Test:** Determination of ingress depth based on design specifications.

### 5.2.13 Braking system

#### 5.2.13.1 Drive brakes

Conductor cars must be configured with at least one drive brake acting upon each drive axle/shaft.

Drive brakes must be capable of stopping the conductor car as quickly as possible.

On horizontally arranged conductor cables, the drive brakes must be applied uniformly to both cables.

Drive and holding brakes must be designed in such a manner that the cables will not be damaged with proper usage.

Drive brake control elements must be easily accessible with proper usage.

**Test:** Testing is performed on a conductor cable configuration commensurate with proper usage. Testing is to be carried out on a new conductor with the maximum permissible cable cross-section in a dry as well as wet state.

The conductor car is to be properly hung onto the prepared test track at the corresponding maximum angles of inclination for dry and wet conductor cables. The conductor car should be fixed in place.

A load 1.1-fold the capacity is distributed uniformly across the floor panels.

The conductor car is then driven downwards along the test track at maximum drive speed, with the drive brakes actuated at the maximum speed to bring it to a stop.

The distance travelled between the point at which the brakes are actuated and the point at which the conductor car comes to a standstill shall be measured.

The distance measured must remain below 3000 mm under both ambient conditions (dry/wet).

### 5.2.13.2 Drive brake reliability

Drive brakes must be designed in such a manner that, in the event of a malfunction, a hazardous condition cannot occur (single fault security).

**Test:** Validation according to DIN EN ISO 13849-2

### 5.2.13.3 Holding brakes

A conductor car must be outfitted with at least one effective holding brake system with consideration given to its intended proper usage.

Control elements for the holding brakes must be easily accessible with proper usage.

Holding brakes must be capable of holding the conductor car at any position.

Holding brakes must be applied directly to the conductor cable.

Holding brakes must be designed in such a manner that the conductor cable cannot be damaged with proper usage.

**Test:** Testing is performed on a conductor configuration commensurate with proper usage. Testing is to be carried out on a new, dry as well as wet conductor with the maximum permissible cable cross-section. The conductor car is to be properly hung onto the prepared test track at the maximum angle of inclination specified for the dry or wet conductor cable, and then subjected to 1.5-fold the load capacity, distributed uniformly across the floor panels.

The holding brake is to be properly actuated.

The holding brake should be released, if possible, to relieve the drive axle/shaft on the opposite side.

The distance travelled between the point at which the brakes were actuated, and the point reached after 2 min has passed shall be measured.

The distance measured must remain below 50 mm under both ambient conditions (dry/wet).

#### 5.2.14 Floor covering

Floor covering selected for the conductor car must be slip-resistant and must feature drainage openings for moisture and liquids.  
The openings must be designed so that a ball with a  $\varnothing 15$  mm will not fall through.

**Test:** Visual inspection and measurement

#### 5.2.15 Protection against persons falling

##### 5.2.15.1 Attachment options

Conductor cars must be outfitted with at least one PPEaf attachment option for each person provided for in the conductor car's intended proper usage. They must be clearly legible and durably marked. Attachment options must be capable of withstanding all anticipated loads.

**Test:** Visual inspection, handling and wipe test according to Sec. 5.2.5

Load testing:

The conductor car is to be properly hung onto the test track corresponding to the most unfavourable cable configuration according to Section 4.2.

A test load of  $120 \text{ kg} \pm 1 \text{ kg}$  (e.g. strapped in a sack) shall be fastened to the attachment point using a 2 m long connecting element (e.g. synthetic fibre rope according to DIN EN 354), without a fall impact absorber at the attachment point. The test load is then allowed to fall from a height of 1 m above the attachment point.

In this manner, a free fall distance of 3 m is realized, whereby the load must not contact the ground during the test.

The attachment option must not break off.

##### 5.2.15.2 Side guards

Side guards on the conductor car must be dimensioned in such a manner that they will withstand the loads anticipated under normal operating conditions. Railings must be configured so that they will withstand a combined force of 500 N, multiplied by the number of persons permitted in the conductor car.

**Test:** The force must be applied at the most unfavourable location in the most unfavourable direction for a duration of 5 min.

There must be no indication of permanent deformation found on the side guards.

### 5.2.16 Fastening equipment for tow ropes

Fastening equipment for tow ropes must be available on the conductor car's load-bearing structure. These devices must be able to withstand the anticipated load conditions and must be clearly legible and durably marked.

**Test:** Visual inspection and wipe test according to Sec. 5.2.5

Testing of the fastening equipment:

A force of 10 kN shall be applied to the tow rope fastening equipment. The load must be completely absorbed by the fastening equipment. The force should be applied for 5 min  $\pm$  10 s.

There must be no permanent deformation of the fastening equipment.

### 5.2.17 Fastening equipment for raising and lowering

Conductor cars must be outfitted with fastening equipment for being raised to and lowered from the overhead power line. These must be dimensioned to be able to withstand the anticipated operating loads. Fastening equipment must be clearly legible and durably marked.

**Test:** Visual inspection and wipe test according to Sec. 5.2.5

Testing of the fastening equipment:

The conductor car is to be properly prepared for being raised up to the overhead power line. 3-fold the load capacity is to be distributed uniformly across the floor panels. The conductor car is to be raised for 2 min  $\pm$  10 s to a height that prevents it from contacting the ground during the test, by means of suitable load bearing materials attached to the marked fastening equipment.

There must be no permanent deformation of the fastening equipment.

## 5.2.18 Mechanical hazards

### 5.2.18.1 Entanglement points

Teeth, chains and V-belt drives must be completely covered or enclosed. Rotating parts on the drive axles/shafts must have a clearance of  $\leq 4$  mm or  $\geq 25$  mm between the stationary parts arranged axially on the conductor car.

Stationary parts arranged above the wheels and guide rollers on the conductor car must have a clearance of  $\geq 120$  mm.

If the safety clearances can't be maintained because of functional considerations, then the points of entanglement should be secured with stationary separating guards insofar as this is functionally possible. Fastening equipment for separating guards must be detachable solely by means of a tool. The fastening equipment must remain connected to the safeguards or the conductor car upon removal of the safeguard.

If the separating guards can't be used due to functional considerations, then the danger points must be reduced to a minimum.

Warning signs should be placed near the danger point and information identifying these residual risks should be included in the Instruction manual.

**Test:** Visual inspection, measurement and wipe test according to Sec. 5.2.5

### 5.2.18.2 Entrapment points

Wheels and guide rollers must not have any protruding parts.

Rotating parts must be outfitted with stationary protection devices covering the upper section of the drive axles/shafts at least to the midsection – insofar as functionally possible - over the entire length. Fastening equipment for separating guards must be detachable solely by means of a tool. The fastening equipment must remain connected to the safeguards or the conductor car upon removal of the safeguard.

**Note:** Cable inclination angles can occur on the front and rear sides of the vehicle that must be considered when dimensioning the protective coverings.

**Test:** Visual inspection and measurement

### **5.2.19 Hydraulic equipment**

The hydraulic equipment must comply with the requirements of DIN EN ISO 4413.

**Test:** In accordance with DIN EN ISO 4413

### **5.2.20 Electrical equipment**

The electrical equipment must comply with the requirements of DIN EN 60204-1.

**Test:** Visual inspection and measurement

### **5.2.21 Batteries**

If batteries are used to start and to drive the conductor car, then the battery compartment must be designed and constructed in such a manner that the battery is protected against external mechanical influences. In the event of battery damage (e.g. bursting), operating personnel must be sufficiently protected.

The conductor car must be designed and constructed in such a manner that the battery can be easily disconnected with the aid of prescribed and easily accessible tooling.

Battery poles must be protected against the risk of short circuiting.

Rechargeable batteries must feature a suitable method of charge management or must employ a recharging unit that incorporates charge management. Reference to the charging process should be included in the Instruction manual.

**Test:** Visual inspection.

### **5.2.22 Conductor car floor space**

The accessible floor space of the conductor car must be at least 0.25 m<sup>2</sup>/ person, whereby the shortest side may not be smaller than 0.5 m.

**Test:** Visual inspection and measurement

### 5.2.23 Drive unit

If internal combustion engines are used to drive the conductor car, then all potentially hot components (touchable surfaces with temperatures > limit value according to DIN EN ISO 13732-1) accessible by operating personnel must be arranged so that contact is not possible.

Exhaust fumes must be discharged away from operating personnel.  
Filler necks for refuelling must be configured outside the proximity of potentially hot components.

The drive unit must be virtually vibration-free when mounted on the conductor car.

**Test:** Visual inspection and measurement

### 5.2.24 Alternative drive

Power-driven conductor cars must be designed in such a manner that, in the event of a malfunction of the power drive, manual procedures are available, or the use of a tow rope is possible.

**Test:** Visual inspection and handling, if applicable

### 5.2.25 Drive speed

The maximum conductor car drive speed must not exceed 6 km/h.

**Test:** The test must be carried out on a power driven conductor car.

The conductor car is to be hung onto a horizontally arranged test track according to Section 4.2 and driven at the maximum drive speed. The speed is to be measured for a driving distance of 10 m at maximum speed.

The speed determined must not be greater than 6 km/h.

### 5.2.26 Fire extinguishers

Conductor cars driven by internal combustion engines must be outfitted with an easily accessible fire extinguisher.

Fire extinguishers must be positioned/affixed in such a manner that, in the event it inadvertently comes loose, it will not fall out of the vehicle.



**Test:** Visual inspection.

### 5.2.27 Stability criteria

Conductor cars must be sufficiently stable.

**Test:** The conductor car should be placed on an even surface inclined at 10°. At the same time, the conductor car must be prepared as follows and positioned on the inclined plane:

- a.) Fold out the drive axles/shafts towards the inclined side.
- b.) Position the vehicle with the heaviest side in the direction of inclination, then open and lower the swivel arm on this side of the vehicle. Completely open the swivel arm on the opposite side, as well, and pivot it towards the vehicle.

The vehicle must not tip over from any position.

### 5.2.28 External materials and properties

**5.2.28.1** Parts that may come in contact with the operator's skin during usage must not be comprised of any dangerous substances.

**Test:** Review of the safety data sheets for the materials used. Use the procedure according to German Product Safety Commission GS 2014:01 PAK to check the amount of polycyclic aromatic hydrocarbon (PAH).

**5.2.28.2** Parts or components accessible by hand must have no sharp corners or edges, or abrasive surfaces that can cause injuries.

**Test:** Visual inspection.

### 5.2.29 Optional equipment

#### 5.2.29.1 Net for catching assembly parts

If a net is used to reduce risk when transiting areas where an increased presence of persons is anticipated, then the following requirements apply:

- The retaining elements for the net must be attached in such a manner that the load-bearing structure will not be compromised.

- The retaining elements and net must be attached in such a manner that they cannot loosen automatically.
- The mesh width of the net must not be larger than 10 x 10 mm.
- The net must not interfere with the operator's visibility.
- The net must not interfere with conductor car when operated as properly intended.

**Test:** Visual inspection and measurement

## **5.2.29.2 Rescue equipment**

### **5.2.29.2.1 General requirements**

- It must be possible for an individual person to safely operate the rescue equipment without creating additional hazards to other persons.
- Fall protection must be assured at all times for both the rescuer as well as the person being rescued.
- Information about the rescue equipment and related accessories must be incorporated into the Instruction manual for the conductor car.

**Test:** Visual inspection and handling

### **5.2.29.2.2 Special requirements related to individual pieces of rescue equipment**

#### **5.2.29.2.2.1 Escape hatch**

- It must be possible to secure the rescue lifting device in position in all situations with the attachment options available. The attachment options can be integral to the conductor car's load-bearing structure.
- The attachment options for the rescue lifting device must possess at least the characteristic load values of the rescue lifting device, itself.

- The dimensions of the escape hatch must be at least 400 x 550 mm, whereby the broader side of the hatch should be aligned with the vehicle's transversal axis.
- The escape hatch must be unlocked solely by means of two independent actuating elements.
- The actuating elements must be designed with sufficient protection against inadvertent actuation.
- Moving parts associated with the escape hatch must be designed to open downwards only.
- Identification and markings: The operating elements for the release of, and attachment options for the rescue lifting device (if a part of the load-bearing structure) must be clearly legible and durably marked.
- It must be annotated in the Instruction manual that the rescue opening must be properly closed if personnel need to access the cage for vehicle recovery purposes.

**Test:** Visual inspection, handling and measurement

Check the markings for completeness and plausibility. Wipe test: Rub using two cotton cloths, one soaked in water and the other in a test fluid<sup>\*)</sup> for 15 s each.

The markings must remain clearly legible following the test. It must not be possible to easily remove the marking labels, nor should they be wrinkled or creased.

<sup>\*)</sup>The chemical product with the trade name "n-Hexan for analysis", which fulfils the requirements for the test fluid defined in DIN EN 60335-1 and DIN EN 62368-1, should be used as test fluid.

- The safety factor for the escape hatch on the load side must be calculated to reflect at least a 3-fold margin over the static loads anticipated in the most unfavourable operating conditions. On the material side, a 1.1-fold safety factor based on the yield point (0.2 % of the yield strength) must be considered.

**Test:** Plausibility check of verification of strength documentation submitted

#### 5.2.29.2.2.2 Rescue tub

- It must be possible to secure the rescue lifting device in position in all situations with the attachment options available. The attachment options can be integral to the conductor car's load-bearing structure.
- The attachment options for the rescue lifting device must possess at least the characteristic load values of the rescue lifting device, itself.
- The rescue tub must be outfitted with equipment, which allow it to be guided into the end position.\*
- The rescue tub must automatically lock into the end position.
- The unlocking mechanism must be designed with sufficient protection against inadvertent actuation.
- The rescue tub must be designed so that, in an extended state, openings in the floor of the conductor car will not ensue that would allow a ball with a  $\varnothing 15$  mm to fall through.
- The rescue tub must be designed so that, at its maximum permissible angle of inclination, loose parts will not slip out of the tub.
- It must be possible to extend the rescue tub out, at least 500 mm over the vehicle side guards.
- A clear width of at least 400 mm must exist between the floor of the rescue tub and the knee railings on the side guards within the travel range of the tub.
- Identification and markings: The operating elements for the release of and handling of the rescue tub, as well as the attachment options for the rescue lifting device (if a part of the load-bearing structure) must be clearly legible and durably marked.

\*To address the problem of an uncontrolled release from/engagement with the end position while the vehicle is in an extremely inclined position.

**Test:** Visual inspection, handling and measurement

Check the markings for completeness and plausibility. Wipe test: Rub using two cotton cloths, one soaked in water and the other in a test fluid<sup>\*)</sup> for 15 s each.

The markings must remain clearly legible following the test. It must not be possible to easily remove the marking labels, nor should they be wrinkled or creased.

<sup>\*)</sup>The chemical product with the trade name "n-Hexan for analysis", which fulfils the requirements for the test fluid defined in DIN EN 60335-1 and DIN EN 62368-1, should be used as test fluid.

- The safety factor for the rescue tub on the load side must be calculated to reflect at least a 3-fold margin over the static loads anticipated in the most unfavourable operating conditions. On the material side, a 1.1-fold safety factor based on the yield point (0.2 % of the yield strength) must be considered.

**Test:** Plausibility check of verification of strength documentation submitted

- A covering beneath the rescue tub must be able to withstand a load of at least 390 kg.

**Test:** Analogous to Sec. 5.2.9, with a test load of 390 kg placed at the most unfavourable location on the covering over a surface area of 350 x 350 mm. Upon visual inspection the covering must show no signs of ripping or tearing.

- The rescue tub must be designed so that, in an extended state, it will withstand a load of 390 kg applied to the outermost location of the tub.

**Test:** Analogous to Sec. 5.2.9, with a test load of 390 kg placed at the outermost location on the rescue tub. There must be no permanent deformation of the loaded section.

### 5.2.29.2.2.3 Accessories

#### Throw-out mechanism

- The throw-out mechanism must be located outside the side guards.

- The throw-out mechanism can be integral to the conductor car's load-bearing structure.
- The throw-out mechanism must be outfitted with a remote release function that can be actuated independently of the personnel within the conductor car.
- The throw-out mechanism must be outfitted with a test function that provides for testing of the release function. The test results must be clearly indicated on the component that is used to generate the release signal.

**Test:** Visual inspection and handling

- Safety-related parts on the throw-out release mechanism must be designed to PLC standards in accordance with DIN EN ISO 13849-1.

**Test:** Validation according to DIN EN 13849-2

- If remote control is used to release the throw-out mechanism, then it must meet the requirements of RED 2014/53/EU.

**Test:** Plausibility check of the technical documentation.

- The attachment options for the escape rope associated with the throw-out mechanism must be connected to the conductor car's load-bearing structure and must be able to accept at least the characteristic load values of the escape rope, itself.
  - The escape rope must be designed as a Kernmantle rope in accordance with DIN EN 1891. Minimum diameter, 10 mm.
  - The rope must be stored in a manner that protects it from environmental influences and which ensures its automatic unreeling upon actuation of the throw-out mechanism.
  - Additional information in the Instruction manual:
    - Useful life of the escape rope
    - Permissible static strength of the escape rope
    - Meanings of the marking on the escape rope
    - Potential material hazards that could affect escape rope capacity

- Identification and marking of the throw-out mechanism:
  - Escape rope length
  - Permissible static strength of the escape rope

**Test:** Visual inspection and handling

Check the markings for completeness and plausibility. Wipe test: Rub using two cotton cloths, one soaked in water and the other in a test fluid<sup>\*)</sup> for 15 s each.

The markings must remain clearly legible following the test. It must not be possible to easily remove the marking labels, nor should they be wrinkled or creased.

<sup>\*)</sup>The chemical product with the trade name "n-Hexan for analysis", which fulfils the requirements for the test fluid defined in DIN EN 60335-1 and DIN EN 62368-1, should be used as test fluid.

## **6 Piece testing**

The tests described in this section should serve to uncover any discernible installation errors and damage related to the conductor car. These tests are to be performed on each conductor car.

### **6.1 Functional test**

The individual operating elements should be tested to determine that they fulfil their proper function.


### **6.2 Visual inspection**

All components should be checked for discernible damage (e.g. Leakage, loose connections, faulty weld seams, etc.).

Affixing of warning signs and notice placards.

Availability of the test log and Instruction manual.

**Annex 1**

 <p><b>DGUV Test</b>  <small>Prüf- und Zertifizierungsstelle      Fachausschuss Elektrotechnik</small></p>	<p><b>Information related to contract preparation</b></p> <p><b>- Conductor cars -</b></p>	<p>Company:</p>
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**Product identification information**

Product description

Type

Product variants available?

Yes  / No

Variant matrix attached?

Yes  / No

**Design specifications**

Manually operated

Yes  / No

Motor operated

Yes  / No

Swivel arm

Yes  / No

**Documentation to be submitted**

*attached*

*will be submitted*

User information

to

Sales literature

to

Drawings

to

Circuit diagram(s)

to

Parts list(s)

to

Weld seam calculations/Structural analyses

to

Braking system validation

to

**Note:** In the interest of prompt order processing, it is essential that the information above be provided in its entirety!

\_\_\_\_\_

Date

\_\_\_\_\_

Name

\_\_\_\_\_

Signature