

„Erstellung eines Konzeptes für die EU- weite Migration eines Digitalen Automatischen Kupplungssystems (DAK) für den Schienengüterverkehr“

Anlage 3 zum Schlussbericht DAK Spezifikation und Testkonzept Version 1.01.

(nur auf englisch verfügbar)

für das
Bundesministerium für Verkehr und digitale Infrastruktur
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|----------|----|---|------|---------------------------------------|----|-------|----|----------------------|--|--|--|-------------------------------------|
| AUCO.159 | RE | For new locomotives, the hybrid coupling must be designed so that it is compatible with the installation space in accordance with UIC leaflet 530-1, annex 4a, is decisive for the design of the coupling in westeuropean countries. In easteuropean countries annexe 6a and 6 b are recommended | Muss | Safety, Experience of operators | SB | draft | -- | TIS working group | | | | requirement adapted to AUCO 5 |
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technical Specification automatic coupler for freight wagons/ hybridcoupler for locos (version V1.01)

| ID | Requirement t | Requirement-text | Wertung | Rationale | Product element EN 15380-2 | Status | Change since last release | Source | Comment of owner | Annex to requirement | Requirement t type |
|----------|---------------|---|---------------------------|-----------|----------------------------|--------|---------------------------|-------------------|------------------|----------------------|--------------------|
| AUCO.1 | -- | Automatic couplers | | | | | | | | | |
| AUCO.2 | -- | 1 General requirements for the automatic coupler | | | | | | | | | |
| AUCO.3 | INFO | The AC shall be used exclusively for freight applications. It is not foreseen for passenger applications | Info | General | SB | draft | -- | Shift2Rail | | | General |
| AUCO.4 | RE | Hybrid coupler only The AC shall be compatible with the UIC wagon standard interfaces. | Muss (für Hybridkupplung) | General | SB | draft | -- | Shift2Rail | | | General |
| AUCO.5 | RE | The installation space according to UIC 530-1 annex 4a, is decisive for the design of the coupling in western Europe. For wagons from eastern Europe annexe 6a and 6 b are recommended. | Muss | General | SB | draft | -- | TIS working group | | | General |
| AUCO.171 | RE | No conversions are permitted in this installation space | Muss | General | SB | draft | -- | TIS working group | | | General |
| AUCO.172 | | Force transmission into the underframe shall be in accordance with UIC 530-1, Annex 1 to the tension and compression stops according to Section 5 or Annexes 4 and 6. | Muss | General | SB | draft | -- | TIS working group | | | General |
| AUCO.6 | INFO | The AC shall be temporary compatible with the UIC Screw Coupler. Note: The adapter shall be an "coupler- wagon", at one site with UIC- coupler, at the opposite site with an automatic coupling system | Info | General | SB | draft | -- | Shift2Rail | | | General |
| AUCO.7 | INFO | Exception from this requirement (AUCO 5) can be made for wagons in isolated traffic operations | Info | General | SB | draft | -- | Shift2Rail | | | General |
| AUCO.8 | RE | The coupler assembly shall be as simple as possible, but robust. | Muss | General | SB | draft | -- | Shift2Rail | | | General |
| AUCO.9 | RE | The weight of the coupler shall be minimized. Note: The weight of the AC shall not be more than the UIC-Couplingsystem (2 Buffers, screw-coupler and draw hook inclusive draw-gear) At least the coupler shall weight less equal 370-380 kg . | Muss | General | SB | draft | -- | Shift2Rail | | | General |

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| AUCO.10 | RE | The coupler head shall restrict a strength from 2.000 kN for pressure forces without any plastic deformations. The coupler head shall restrict a strength from - 1.000 kN for draw forces - 2.000 kN for pressure forces without any plastic deformations ($R_p 0,2$). <u>Note:</u> This requirement shall forestalling a destruction of the casing of the coupler head in case of a bounce. A nominal breaking point for loads above 1500 kN should be located in the drawbar. | Muss | General | SB | draft | -- | TIS working group | | | General |
| AUCO.11 | RE | The wagon and the components of it shall fulfill TSI WAG, Chapter 4.2.5 Environmental conditions and at least the temperature class T1 to T3 (45°C to -45°C). | Muss | General | SB | draft | -- | Shift2Rail | | | General |
| AUCO.12 | OR | The automatic coupler shall fulfil the requirements of the energy absorption concept for the wagon, incl. Requirements from to TE22 of RID. | Option | Safety | SB | draft | -- | Shift2Rail | | | Safety |
| AUCO.13 | OR | The automatic coupler shall not cause a climbing of car bodies or a derailment in case of collision up to 150 kN vertical force. | Option, gilt nur für RID-Fahrzeuge | Safety | SB | draft | -- | Shift2Rail | | | Safety |
| AUCO.14 | OR | If the automatic coupler has been exposed to unacceptable load that may have caused a damage to the draw and buffing gear, this damage shall be obviously visible. <u>Note:</u> According to coupling sow's guidance (level 2/4/5) a mechanical or automated solution be used | Option, Anzeige bei Ausschöpfung der max. zulässigen Belastung | Safety, maintainability | SB | draft | -- | Shift2Rail | | | Maintenance, Safety |
| AUCO.15 | -- | 2 Mechanical part | | | | | | | | | |
| AUCO.16 | RE | The design shall minimize the lateral and vertical efforts transmitted to the wagons, during curve negotiation. | Soll | General | SB | draft | -- | Shift2Rail | | | General |
| AUCO.17 | RE | The vertical gathering range in straight tracks: the couplers shall to interact safe with up to 120 mm difference in height in their centre lines in minimum. | Muss | Experience of operators | SB | draft | -- | Shift2Rail | | | General |
| AUCO.18 | RE | The horizontal gathering range of the coupler head will be in the range of 220 mm minimum at each side. | Muss | Experience of operators | SB | draft | -- | Shift2Rail | | | General |
| AUCO.19 | DR | The distance between pivots and the overhang, in order to define the automatic coupler, should be calculated according to the formula given in UIC 530-1. <u>Note1:</u> Automatic couplings need only be connectable up to a track curve radius $R \geq 150$ m. The requirements of UIC leaflet 522 also apply. <u>Note 2:</u> A graphical evaluation of the geometric requirements is permissible. | Soll | Experience of operators | SB | draft | -- | Shift2Rail | | UIC 530-1 | General |
| AUCO.20 | RE | On straight tracks the coupler shall be able to couple automatically without manual intervention. | Muss | Experience of operators | SB | draft | -- | Shift2Rail | | | General |

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| AUCO.21 | DR | Vehicles with automatic coupler shall be coupled with manual intervention on transition curves between straight tracks and curves of a minimum radius of 150 m. | Muss | Experience of operators | SB | draft | -- | Shift2Rail | | | General |
| AUCO.22 | DR | Vehicles with automatic coupler shall be able to couple with manual assistance on reverse curves of a minimum radius of 150m, with a 6 m intermediate straight track. | Muss | Experience of operators | SB | draft | -- | Shift2Rail | | | General |
| AUCO.23 | DR | Vehicles with automatic coupler shall be able to couple without manual assistance on reverse curves of a minimum radius of 190m, without intermediate straight track. | Muss | Experience of operators | SB | draft | -- | Shift2Rail | | | General |
| AUCO.24 | DR | Vehicles with automatic coupler shall allow running on ramps with a maximum inclination of 1/16 when coupled. The practicability of ferryboat ramps with a crease corner from at most 2°30' and a curve radius of 150 m is to be proved. <u>Note:</u> used only by inclinations in the coupled state; no coupling with these inclinations | Muss | Experience of operators | SB | draft | -- | Shift2Rail | | | General |
| AUCO.25 | DR | proper coupling must be ensured a) in straight track between 2km/h and minimum 7km/h b) in curve radius 150m up to 5 km/h c) in s-bow 190m with 6 m straight track up to 5 km/h d) in s-bow 120 m with 20m straight track up to 5 km/h | Muss | Experience of operators | | draft | -- | GATX | | | General |
| AUCO.26 | RE | The automatic coupler shall be mechanical and pneumatical compatible with the coupling type "?". <u>Note:</u> The coupling must be compatible within the coupling family. | Muss | Notification to one type of automatic coupler gives a possibility to let turn freight car everywhere in | SB | draft | -- | EuroSpec automatic coupler type 10 | | | General |
| AUCO.27 | RE | It shall be possible, by means of a manual operation at the lateral sides of the vehicle, to set the locking mechanism in a position in which the heads remain uncoupled until the vehicles separate and they are ready revert to the coupled position, after separation of the vehicles. It shall also be possible to keep the locking mechanism in the uncoupled position, to prevent undesired coupling, at the hump. | Muss | Safety, Operating conditions for the personnel, Experience of operators | SB | draft | -- | Shift2Rail | | | General |
| AUCO.28 | RE | In event of failure of the horizontal or vertical support the coupler head shall not fall down and reach the track. | Muss | Safety | SB | draft | -- | EuroSpec automatic coupler type 10 | | | Safety |
| AUCO.29 | RE | The main pin of the coupler head shall be lubricated/greased. | Muss | Avoidance of self-lubricating bearings for the main pin because of bad experiences | SB | draft | -- | EuroSpec automatic coupler type 10 | | | Maintenance |

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|---------|------|---|------|---|----|-------|----|------------------------------------|--------|--------------------|
| AUCO.30 | DR | The coupling height is 1040 +5/-15 mm from the top of rail (TOR) according to TSI CR. | Muss | Usability | - | draft | -- | Shift2Rail / TSI CR | TSI CR | General, Operation |
| AUCO.31 | RE | The automatic coupler shall work unrestricted and reliably under all operational conditions, e.g. rain, pollution, washing water, snow, ice and particularly in hot summers as well as in cold winters. These conditions shall not have any influence on the function of the coupler. | Muss | Reduce maintenance costs, reliability for life time | SB | draft | -- | Shift2Rail | | General |
| AUCO.32 | RE | Manual Uncoupling shall be possible without external tooling:- | Muss | Use in case of malfunction, during maintenance, in case of emergency / rescue | SB | draft | -- | Shift2Rail | | Operation |
| AUCO.33 | RE | Manual uncoupling shall be possible by one person with a maximum manual tractive power (tension load) of 200 ... 250 N on the coupler's handle. | Muss | Operating condition | SB | draft | -- | EuroSpec automatic coupler type 10 | | Operation |
| AUCO.34 | RE | The manual uncoupling device shall be visible and accessible. | Muss | Operating conditions for the personnel, feasibility in maintenance | SB | draft | -- | Shift2Rail | | Operation |
| AUCO.35 | RE | The coupler head shall resist a strength from - 1.000 kN for draw forces - 2.000 kN for pressure forces without any plastic deformations (R_{p0.2}). <u>Note:</u> In case of overload, the coupling head should not be damaged. A nominal breaking point for loads above 1500 kN should be located in the drawbar. | Muss | Safety, acc. to EN 12663 2, | SB | draft | -- | Shift2Rail | | Strength |
| AUCO.36 | RE | The automatic coupling shall have a long-term firmness for tractive powers and compressive forces of 270 ... 290 kN in service. The actual force is only for prototype coupler. Real forces will be kind during 2020 (TIS value on long value is under construction) <u>Note:</u> Value comes from IGW testing, real this could be 450 kN in relation to the current maximum tractive forces of existing lokos. In the future, higher continuous loads are also possible if locomotives are operated to realise a higher tractive power (e.g.6-axle locos). | Muss | Safety | | draft | -- | | | |
| AUCO.37 | RE | The automatic coupling shall have an "buffer position" for shunting operation. | Muss | Experience of operators | | | | | | General |
| AUCO.38 | INFO | The "buffer position" allows disengagement and re-injection during manoeuvring without a new coupling process. | Info | | | | | | | |
| AUCO.39 | RE | The change from the " buffer position " to the "ready for automatic coupling" position must be possible manually from outside the borderline of the vehicle. | Muss | Experience of operators | | | | | | General |

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| AUCO.40 | INFO | In case that the vehicle is not in any category acc. to EN 12663-2 the value of the pulling force the automatic coupler has to resist can be adapted to the vehicle strength. | Info | - | - | draft | -- | EuroSpec automatic coupler type 10 | | EN 12663-2 | General |
| AUCO.41 | RE | The casing of the automatic coupler shall resist a compressive force up to 2000 kN without causing any irreparable damage to the coupler head (e.g. cracks or plastic deformation). | Muss | Experience of operators | SB | draft | -- | EuroSpec automatic coupler type 10 | | | Strength |
| AUCO.42 | RE | The pivoting range of the automatic coupler shall be +/- 11° in vertical and +/- 20° in horizontal direction. | Muss | Operating condition | SB | draft | -- | EuroSpec automatic coupler type 10 | | | Operation |
| AUCO.43 | RE | The automatic coupler shall allow the train to operate on slope connections with a radius according to TSI Infrastructure for vertical curves. | Muss | Operating condition | SB | draft | -- | Shift2Rail | | | Operation |
| AUCO.44 | RE | The automatic coupler shall have a centring device. | Muss | Improvement of the ease of use and the reliability of the coupling process | SB | draft | -- | Shift2Rail | | | Operation |
| AUCO.45 | RE | The horizontal support of the automatic coupler shall operate mechanically. | Muss | Use of a reliable design solution | SB | draft | -- | Shift2Rail | | | Operation |
| AUCO.46 | RE | The automatic coupling shall be designed in such a way that it can be used either with cross-beam support or with strut support. | Muss | Use of a reliable design solution | SB | draft | | TIS working group | | | General |
| AUCO.47 | RE | The mechanical connecting elements, horizontal and vertical support of the automatic coupler and its fastening elements shall withstand the operating load during its lifetime./ between 2 heavy maintenance levels. (Note: lifetime 30 years) | Muss | Experience of DB: plastic deformations on two different coupler types | SB | draft | -- | Shift2Rail | | | General |
| AUCO.48 | INFO | For wagons with automatic couplers it shall be possible to drive on rail curves with R =75 m in the coupled state. | Info | Experience of operators | SB | draft | -- | TIS working group | | | General |
| AUCO.49 | RE | The automatic coupler shall stay stable in the uncoupled condition. Appearing relative movements may not lead to the destructions in the vehicle structure | Muss | Safety; to ensure a defined position of the coupler (head) | SB | draft | -- | Shift2Rail | | | Operation |
| AUCO.50 | DR | When using the automatic coupler, connected vehicles shall be able to run through curves with radii $r \geq 120$ m without any restrictions. | Muss | To ensure smooth operation on curves with small radii | SB | draft | -- | Shift2Rail | | | Operation |
| AUCO.51 | DR | When using the automatic coupler, connected vehicles shall be able to run through curves with radii $r \geq 100$ m without any restrictions. | Muss | to ensure smooth operation on curves with small radii | SB | draft | -- | Shift2Rail | | | Operation |

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| AUCO.52 | INFO | When using the automatic coupler, connected vehicles shall be able to run through S-curves with radii $r \geq 150$ m with 6 m intermediate track without any restrictions (according to EN 13803 Kap.6.12, Tab.19) | Info | European standard (EN 13803) | SB | draft | -- | Shift2Rail | | EN 13803-2 | Operation |
| AUCO.53 | INFO | Track conditions are defined in the TSI Infrastructure chapter "Interfaces with the rolling stock subsystems" too. | Info | - | - | -- | -- | | | | - |
| AUCO.173 | RE | For the application of automatic couplers, derailment safety according to EN 15839 shall be demonstrated for each vehicle. | Muss | running safety | SB | draft | | TIS working group | | | Safety |
| AUCO.54 | OR | The automatic coupler shall be equipped with an automatically operated uncoupling device. Note: An automatic uncoupling device is mandatory for DAC 5. Nevertheless, the space provided for this purpose must also be taken into constructional consideration in the case of previous versions. | Option bis DAK 4, ab DAK 5 Muss | Improvement of the ease of use when uncoupling | SB | draft | -- | Shift2Rail | | | Operation |
| AUCO.55 | OR | If there is an uncoupling device: The uncoupling device may be pneumatic or an electrical device. | Option bis DAK 4, ab DAK 5 Muss | | | | under review | EuroSpec automatic coupler type 10 | | | |
| AUCO.174 | RE | If the uncoupling device is a pneumatical device, in according to TSI WAG Annex C9 it's not allowed to take the pressure (air) from the main pipe. | | Safety | SB | draft | -- | TSI WAG | | | Safety |
| AUCO.56 | OR | Uncoupling shall be possible from any active drivers cab. | Option bis DAK 4, ab DAK 5 Muss | Safety | SB | draft | -- | EuroSpec automatic coupler type 10 | | | Operation |
| AUCO.57 | OR | The active driver cab might not be near to the coupler involved into the uncoupling process. | Option bis DAK 4, ab DAK 5 Muss | - | - | -- | -- | | | | - |
| AUCO.58 | OR | If the uncoupling device is not in action it shall be in an neutral situation (ready to couple position). | Option bis DAK 4, ab DAK 5 Muss | Experience of operators | - | draft | -- | Shift2Rail | | | - |
| AUCO.59 | INFO | The active driver cab shall only be located where coupling or uncoupling is going to be executed (local to the coupler involved). | Info bis DAC 4, Muss ab DAC 5) | Safety | SB | draft | -- | EuroSpec automatic coupler type 10 | | | Operation |
| AUCO.60 | OR | The active driver cab is located near to the coupler involved in the uncoupling process. | Option bis DAK 4, ab DAK 5 Muss | - | - | -- | -- | | | | - |

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| AUCO.61 | OR | Locos only Automatic uncoupling shall only be possible when the following conditions occur: -Train speed is 0 km/h; -The brake pipe (BP) pressure is lower than 3,5 bar. and -The operator has activated the automatic/manual uncoupling signal/mechanism. <u>Note:</u> Besides, the logic for the speed recognition does not lie on the wagon, only on the locomotive | Option | Safety, experience of operators | SB | draft | -- | Shift2Rail | | | Operation, Safety |
| AUCO.62 | RE | During the uncoupling process the uncoupling device of the two connected couplers shall work simultaneous. | Muss | Experience of the operators (bad experiences with a certain coupling system) | SB | draft | -- | Shift2Rail | | | Operation |
| AUCO.63 | OR | The contractor shall provide the time required for the replacement of the coupler head including the electrical connections by 2 persons. | Option | Maintenance costs | SB | draft | -- | EuroSpec automatic coupler type 10 | | | Maintenance |
| AUCO.64 | RE | The contractor shall provide the time required for the replacement of the coupler head by 2 persons. | Muss | Maintenance costs | SB | draft | -- | EuroSpec automatic coupler type 10 | | | Maintenance |
| AUCO.65 | RE | The replacement of a coupler head shall be possible within 60 min by 2 persons. | Muss | Maintenance costs | SB | draft | -- | EuroSpec automatic coupler type 10 | | | Maintenance |
| AUCO.66 | RE | The necessary tools, resources and devices for the maintenance and replacement of the automatic coupler or parts of it (including the electrical coupler) shall be agreed with the client. | Muss | Maintenance costs | SB | draft | -- | Shift2Rail | | | Maintenance |
| AUCO.67 | INFO | The use of special tools for maintenance and replacement of the automatic coupler or parts of it shall be avoided. | Info | - | - | -- | -- | | | | - |
| AUCO.68 | RE | Where the use of special tools for maintenance and replacement of the automatic coupler or parts of it is required the customer shall be provided with the detailed information. This document informs about the operation purpose, which measurements have to be made, which values are acceptable (e. g. system technical threshold value) and how the calibration of the special tools has to | Muss | Maintenance costs | SB | draft | -- | Shift2Rail | | | Maintenance |
| AUCO.69 | RE | Related to the ordered wagon types or wagon series the fixing of the coupler head to the coupler, e. g. with a split collar, shall be the same for all couplers regarding dimensions or diameters. | Muss | Maintenance costs | SB | draft | -- | Shift2Rail | | | Maintenance |
| AUCO.70 | OR | The replacement of an uncoupling device shall be possible within 60 min by 1 person. | Option | Maintenance, experience of the operators | SB | draft | -- | EuroSpec automatic coupler type 10 | | | Maintenance |
| AUCO.71 | RE | The contractor shall provide drawings necessary for maintenance, a maintenance manual / file that includes all required actions for the maintenance of the coupler. | Muss | Maintenance planning | SB | draft | -- | EuroSpec automatic coupler type 10 | | | Maintenance |

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| AUCO.72 | RE | The contractor shall provide the time required for the maintenance and the different maintenance steps of the automatic coupler (including electrical and data connections). | Nuss | Maintenance planning | SB | draft | -- | EuroSpec automatic coupler type 10 | | | Maintenance |
| AUCO.73 | RE | The automatic coupler shall reach a reliability of "Z" %, based on the operating time between the manufacturing and the first complete overhaul or between two complete overhauls. <u>Note:</u> The verification of the achieved percentage regarding | Muss | Maintenance costs | SB | draft | -- | Shift2Rail | | | Operation, Reliability |
| AUCO.74 | RE | The automatic coupler shall reach a reliability in the way that it will reach an operational reliability level of "Y" breakdowns per million km. <u>Note:</u> "Y" and the verification of the achieved reliability level (e. g. minor, major, significant) has to be defined and harmonised with the customer. | Muss | Maintenance costs | SB | draft | -- | EuroSpec automatic coupler type 10 | | | Operation, Reliability |
| AUCO.75 | RE | The main parts of the automatic coupler (e.g. coupler head, draw and buffing gear, pivot anchor) shall be connected with connecting elements to be solved simply (e.g. screws and nuts). | Muss | Reduction of work during maintenance | SB | draft | -- | Shift2Rail | | | Maintenance |
| AUCO.76 | OR | The automatic coupler, especially the coupler head, shall be equipped with a top protection against rain, washing water, windscreen cleaning agents, or snow and ice. | Option | Experience of operators | SB | draft | -- | EuroSpec automatic coupler type 10 | | | Operation |
| AUCO.77 | RE | The greasing of automatic coupler parts shall be possible without dismounting any main parts, e.g. coupler head, draw bar, electrical coupler, draw and buffing gear, pivot anchor, centring device. The greasing intervall shall be 6 years. | Soll | Experience of operators | SB | draft | -- | Shift2Rail | | | Maintenance |
| AUCO.78 | RE | The coupler head, coupler shank (draw bar), draw and buffing gear, electric coupler, centring device and connecting elements shall be indelibly marked with the supplier's brand, the date of manufacturing and the serial | Muss | Experience of operators | SB | draft | -- | Shift2Rail | | | Maintenance |
| AUCO.79 | RE | The system for manual uncoupling shall work without malfunction or destruction of any parts - except for wearing parts, e. g. cable pull - during the whole life time of the coupler/ between 2 heavy maintenances. | Muss | Experience of operators | SB | draft | -- | Shift2Rail | | | Maintenance |
| AUCO.80 | RE | The manual uncoupling system shall withstand an operating force of at least 2000 N without any measurable plastic deformation during its whole life time. The direction of the force should be in the same direction as the uncoupling system is operated. The application of the force should be where the hand of the operator activates the uncoupling system. | Muss | Experience of operators | SB | draft | -- | EuroSpec automatic coupler type 10 | | | Maintenance |
| AUCO.81 | -- | 3 Energy absorption system | | | | | | | | | |
| AUCO.82 | RE | The draw bar (draw and buffing gear) shall be equipped with a reversible elastic element for energy absorption. | Muss | Experience of operators | SB | draft | -- | Shift2Rail | | | Damage prevention |
| AUCO.83 | RE | The elastic energy absorption system shall endure a life cycle test analogous to EN 15551, Chapter 5.5 and Annex C. <u>Note</u> The values given in EN 15551 stand for a buffer and must be doubled with regard to the requirements for an | Muss | Experience of operators | SB | draft | -- | Shift2Rail | | EN 15551 | Reliability |

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| AUCO.97 | RE | The automatic coupler shall be pneumatically compatible with the coupling type "Y". | Muss | To offer interoperability between different vehicles, to reduce number of different adaptors; | SB | draft | -- | | | | Operation |
| AUCO.98 | INFO | Regarding other coupler types further information has to be provided by the operator. | Info | - | - | draft | -- | EuroSpec automatic coupler type 10 | | | - |
| AUCO.99 | RE | The pneumatic connection of the automatic coupler shall be done automatically after or simultaneously to the mechanical connection. | Muss | Experience of operators | SB | draft | -- | Shift2Rail | | | Safety |
| AUCO.100 | RE | The disconnection of the pneumatic connection shall be done automatically before or simultaneously to the mechanical uncoupling. | Muss | Experience of operators | SB | draft | -- | Shift2Rail | | | Safety |
| AUCO.101 | RE | If the automatic coupler is unintentionally disconnected, an emergency braking of the train shall be initiated. | Muss | General, Safety | SB | draft | -- | EuroSpec automatic coupler type 10 | | | Safety |
| AUCO.102 | RE | The diameter of the pipe lines inside the automatic coupler shall be 5/4 ". | Muss | Experience of operators | SB | draft | -- | EuroSpec automatic coupler type 10 | | EN 16019 | Safety |
| AUCO.103 | RE | The brake pipe valve shall be directly mechanically activated by working of the mechanical coupling device of | Muss | | SB | draft | -- | Shift2Rail | | | Safety |
| AUCO.104 | RE | When not in use, the air pipes must be protected against the penetration of dirt and humidity. | Muss | Experience of operators | SB | draft | | TIS working group | | | Safety |
| AUCO.105 | -- | 5 Electrical and data connections of the automatic coupler (mechanical part) | | - | - | -- | -- | | | | - |
| AUCO.106 | RE | The electrical coupler shall have the protection class IP 54/55 (during coupled and uncoupled condition). | Muss | Acc. to EN 60529 no rain water is allowed to reach the | SB | draft | -- | EuroSpec automatic coupler type 10 | | | Reliability, Safety |
| AUCO.107 | RE | The electrical coupler shall fulfil the requirements according to EN 50124-1 regarding clearances and creepage distances for equipment. | Muss | Acc. to EN 50124-1 | SB | draft | -- | EuroSpec automatic coupler type 10 | | EN 50124-1 | Reliability, Safety |
| AUCO.108 | RE | Single contacts of the electrical coupler shall be replaceable from the front without removing or replacing the complete electrical coupler. | Muss | Experience of operators | SB | draft | -- | EuroSpec automatic coupler type 10 | | | Maintenance |
| AUCO.109 | RE | The electrical contacts of the automatic coupler shall ensure the connection of control signal lines, data bus lines, lines for transmitting signals and voltage between coupled vehicles and between the train and the loco(s). <i>Note:</i> Actually the voltage is to be limited to 110 V with a current of 50 amperes. | Muss | Safety, experience of operators | SB | draft | -- | EuroSpec automatic coupler type 10 | | | Operation, Safety |
| AUCO.110 | INFO | The signal transfer between the couplings can also be realised as a WiFi, NFC or via bluetooth. | Info | | | | | | | | |

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| AUCO.111 | RE | The mechanical, pneumatic and electrical connections shall be made within a period of 10 seconds. | Muss | Experience of operators | SB | draft | -- | EuroSpec automatic coupler type 10 | | | Operation |
| AUCO.112 | RE | The electrical coupling shall be made within a certain period of time (2 to 6 seconds), after a complete mechanical and pneumatic coupling has been made. | Muss | Experience of operators | SB | draft | -- | EuroSpec automatic coupler type 10 | | | Operation |
| AUCO.113 | INFO | The maximum time expended for these connections does not impair any other vehicle functions, e. g. of the TCMS. | Info | - | - | draft | -- | | | | - |
| AUCO.114 | RE | The mechanical and pneumatic uncoupling shall be made within a certain period of time (2 to 6 seconds), after a complete electrical uncoupling has been made. | Muss | Experience of operators | SB | draft | -- | EuroSpec automatic coupler type 10 | | | |
| AUCO.115 | RE | The connection and separation of the mechanical and electrical connection shall be done automatically (without additional activities by the operating personnel). | Muss | Experience of operators | SB | draft | -- | EuroSpec automatic coupler type 10 | | | Operation |
| AUCO.116 | OR | If the electrical/ data coupler is separate from the mechanical coupler: The electrical coupler shall automatically move to the back position (uncoupling position) only if it is operated by the automatic uncoupling device. Alternative: The electric connecting component should go after separation to a parking position. | Option | - | - | draft | -- | EuroSpec automatic coupler type 10 | | | - |
| AUCO.117 | RE | Locos only: The electrical coupler shall have a "mechanical isolation switch". | Muss | Experience of operators | SB | draft | -- | EuroSpec automatic coupler type 10 | | | Maintenance |
| AUCO.118 | INFO | Locos only: The "mechanical isolation switch" is used for the manual separation or isolation of the electrical coupler and is activated by the maintenance personnel. | Info | - | - | -- | -- | | | | - |
| AUCO.119 | OR | Only for electrical coupler separate from the mechanical coupler: If the "mechanical isolation switch" of the electrical coupler is used (activation of the switch) the electrical coupler shall stay steady and shall not automatically move. If the "mechanical isolation switch" of the electrical coupler is used again (deactivation of the switch) the electrical coupler shall stay in the current position as well (no automatic movement). | Option | Experience of operators | SB | draft | -- | EuroSpec automatic coupler type 10 | | | Maintenance |
| AUCO.120 | OR | Only for electrical coupler separate from the mechanical coupler: If the "mechanical isolation switch" of the electrical coupler has been activated the electrical coupler shall offer the possibility to be moved manually. | Option | Experience of operators | SB | draft | -- | EuroSpec automatic coupler type 10 | | | Maintenance |
| AUCO.121 | RE | Locos only: The position or the state of the "mechanical isolation switch" shall be visible to the maintenance personal outside of the vehicle. | Muss (Locos only) | Safety, experience of operators | SB | draft | -- | EuroSpec automatic coupler type 10 | | | Maintenance |
| AUCO.122 | INFO | The electrical coupler shall have an "electrical isolation switch" that is used by the operating personnel. Note: The electrical isolation switch is part of the delivery of the vehicles manufacturer. | Info | - | - | draft | -- | | | | Operation |

| | | | | | | | | | | | |
|----------|------|---|--------|---|----|-------|----|------------------------------------|--|--|------------------------|
| AUCO.123 | INFO | The "electrical isolation switch" is used for the electrical separation or isolation of the electrical coupler and is activated by the operating personnel. | Info | - | - | draft | -- | | | | - |
| AUCO.124 | INFO | The "electrical isolation switch" for the operating personnel shall be located in a cab (adjacent to the coupler). <i>Note:</i> The electrical isolation switch is part of the delivery of the vehicles manufacturer . | Info | - | - | draft | -- | | | | Operation |
| AUCO.125 | OR | The "electrical isolation switch" shall be operated from the active cab and shall switch off all current to the (corresponding) electrical coupler, including cables and connectors. | Option | Experience of operators | SB | draft | -- | EuroSpec automatic coupler type 10 | | | Operation |
| AUCO.126 | RE | The "electrical isolation switch" shall offer the possibility to be locked and secured against unauthorised unlocking. | Muss | Experience of operators | SB | draft | -- | EuroSpec automatic coupler type 10 | | | Operation |
| AUCO.127 | INFO | Further information about the number of contacts, the contact arrangement and the contact assignments shall be given in the specification module "Vehicle control system". | Info | - | - | -- | -- | | | | - |
| AUCO.128 | INFO | The train manufacturer shall provide the coupler manufacturer with all required information regarding the number and arrangement of contacts that have to be connected by the electrical coupler. | Info | - | - | -- | -- | | | | - |
| AUCO.129 | INFO | Further information about environmental conditions shall be given in the specification module "System specification" of the technical requirement specification. | Info | - | - | draft | -- | | | | - |
| AUCO.130 | RE | The electrical contacts of the automatic coupler shall not be damaged during normal operation (when electrical coupling and/or uncoupling is successful as well as unsuccessful). | Muss | Experience of operators | SB | draft | -- | EuroSpec automatic coupler type 10 | | | Maintenance, Operation |
| AUCO.131 | RE | Checking and adjusting the position of the electrical coupler shall be required a maximum once at 6 years. | Muss | Experience of operators; reduction of work in maintenance | SB | draft | -- | EuroSpec automatic coupler type 10 | | | Maintenance |
| AUCO.132 | RE | The train bus bar (main power line between wagons and between train and loco) shall be coupled by the automatic coupler. | Muss | Innovation | SB | draft | -- | EuroSpec automatic coupler type 10 | | | General |
| AUCO.133 | RE | The electrical coupler shall be equipped with a protection of the pins against influences from outside (when the electrical coupler is not connected to another one). | Muss | Experience of operators; protection against humidity and dirt | SB | draft | -- | EuroSpec automatic coupler type 10 | | | Soiling prevention |
| AUCO.134 | RE | The potential interferences between the seals and the protection or between the seals and the body of the electrical coupler shall not generate any disturbance to the protection. | Muss | Bad experiences of operators with covers that did not open or close properly because of problems with | SB | draft | -- | EuroSpec automatic coupler type 10 | | | Operation |
| AUCO.135 | RE | In case of a collision the protection shall prevent the electrical coupler from making short circuits. | Muss | Safety | SB | draft | -- | EuroSpec automatic coupler type 10 | | | Safety |

| | | | | | | | | | | | |
|----------|----|---|------|--|----|-------|----|------------------------------------|--|---------|-------------|
| AUCO.136 | RE | The contact resistance for energy transmission and ep brake must be less than 5 mOhms (7 mOhms including reserve over lifetime). Info: This includes the transition from the line of one wagon through the coupling and into the line of the following wagon. | Muss | Reduction of power losses at the coupler interfaces to provide sufficient power over | SB | draft | | | | | Operation |
| AUCO.137 | RE | The contact resistance for data transmission must be less than 25 mOhms. Info: This includes the transition from the line of one wagon through the coupling and into the line of the | Muss | Provide reliable signal transfer between two | SB | draft | | | | | Operation |
| AUCO.138 | RE | The insulation resistance between the electrical power contacts (110 V level) and coupler ground shall be at least 800 MOhms. | Muss | Provide sufficient isolation resistance in the whole train configuration | SB | draft | | | | | Operation |
| AUCO.139 | RE | The dielectric withstand test is to be conducted with 1500 V according to EN 50155 (for operating voltages of 72 V to 125 V DC). | Muss | Fulfillment of EN 50155 | SB | draft | | | | | Operation |
| AUCO.140 | -- | 6 Safety | | | | | | | | | |
| AUCO.141 | RE | The entire automatic coupler shall be earthed according to UIC 533. | Muss | Safety | SB | draft | -- | EuroSpec automatic coupler type 10 | | UIC 533 | Safety |
| AUCO.142 | RE | The occurrence of an unintentional mechanical disconnection without working of the brake on the hauled train or / and the leading train shall not exceed 10 ⁹ per operation hour. | Muss | Safety and risk analyses | SB | draft | -- | EuroSpec automatic coupler type 10 | | | Safety |
| AUCO.143 | RE | The occurrence of unintentional uncoupling shall not exceed 10 ⁶ per operating hour. | Muss | Safety and risk analyses | SB | draft | -- | EuroSpec automatic coupler type 10 | | | Safety |
| AUCO.144 | -- | 7 General requirements (part of the system requirement specification) | | | | | | | | | |
| AUCO.145 | RE | Each attachment point at the coupler where there is made a mechanical connection (e.g. by bolts or screws) shall not be secured by a locking plate. | Muss | Maintainability | SB | draft | -- | EuroSpec automatic coupler type 10 | | | Maintenance |
| AUCO.146 | RE | Attachment points at couplers shall be secured e. g. by the use of self-locking nuts. | Muss | - | - | draft | -- | | | | - |
| AUCO.147 | RE | The coupler and the spring device should operate for a period of at least six years without requiring maintenance. This does not include ordinary day-to-day maintenance to be carried out during service hours, such as greasing and cleaning of the parts subject to particularly heavy wear. | Muss | Maintainability | SB | draft | -- | EuroSpec automatic coupler type 10 | | | Maintenance |
| AUCO.148 | RE | X % (e.g.: 98%) at least of the DAK must be produced with recyclable materials | Muss | Environment | SB | draft | | TIS working group | | | |

| | | | | | | | | | | | | |
|----------|------|---|------|---------------------------------|----|-------|----|-------------------|--|----------|--|--|
| AUCO.149 | INFO | It will happen during a long period, because of the workshops capacities and availabilities. This means that we will start to replace first the couplers of block trains, and of the locomotives. But what about the isolated railcars, and what about the engines owned by the private sidings which move the railcars at our client's plants? It could be interesting also to ask for the development of a specific tool able to connect (in particular conditions of | Info | | | | -- | | | | | |
| AUCO.150 | | 8 Hybrid coupler (special case) | | | | | | | | | | |
| AUCO.151 | INFO | Hybrid couplings (Hyco) represent a special design of the couplings. | Info | basic requirement | SB | draft | -- | TIS working group | | | | |
| AUCO.152 | INFO | They allow coupling not only to the automatic coupling as well to the conventional UIC coupling system. | Info | basic requirement | SB | draft | -- | TIS working group | | | | |
| AUCO.153 | INFO | Hybrid couplings should only be used on locomotives. | Info | basic requirement | SB | draft | -- | TIS working group | | | | |
| AUCO.154 | RE | The hybrid coupling shall, in the 'automatic coupling' position, fulfil all the requirements of the automatic coupling, in particular the requirements for safety, passable track geometry and strength. | Muss | Safety | SB | draft | -- | TIS working group | | | | |
| AUCO.155 | RE | If the connective element is a draw hook The draw hook of the hybrid coupling for connection to the UIC coupling shall fulfil the requirements for the 1.5 MN draw hook in accordance with EN 15566. | Muss | Safety | SB | draft | -- | TIS working group | | EN 15566 | | |
| AUCO.156 | RE | If the connective element is a screw coupler The screw coupler of the hybrid coupling for connection to the UIC coupling shall fulfil the requirements for the 1.5 MN screw coupler in accordance with EN 15566. | Muss | Safety | SB | draft | -- | TIS working group | | EN 15566 | | |
| AUCO.157 | RE | The used buffers shall fulfil the requirements for category "C" buffers for freight wagons according to EN 15551. | Muss | Safety | SB | draft | -- | TIS working group | | EN 15551 | | |
| AUCO.158 | RE | The hybrid coupling must be able to be mounted on/ into the underframe of the existing locomotive without major structural changes to the vehicle structure. | Muss | Safety, Experience of operators | SB | draft | -- | TIS working group | | | | |
| AUCO.159 | RE | For new locomotives, the hybrid coupling must be designed so that it is compatible with the installation space in accordance with UIC leaflet 530-1, annex 4a, is decisive for the design of the coupling in westeuropean countries. In easteuropean countries annexe 6a and 6 b are recommended. | Muss | Safety, Experience of operators | SB | draft | -- | TIS working group | | | | |
| AUCO.160 | RE | If the automatic coupling function is not required, the automatic coupling head shall not affect the function of the UIC coupling point. | Muss | Safety, Experience of operators | SB | draft | -- | TIS working group | | | | |
| AUCO.161 | RE | If the automatic coupling function is not required, the automatic coupling shall be secured against unintentional movement. | Muss | Safety, Experience of operators | SB | draft | -- | TIS working group | | | | |
| AUCO.162 | RE | If the automatic coupling function is not in use, the spaces to be respected according to the clearance gauge according Chapter 4.2.2 of TSI CR/ EN 16839 shall not be | Muss | Safety | SB | draft | -- | TIS working group | | | | |
| AUCO.163 | RE | The hybrid coupling shall be designed in such way that, when it is used or when changing from automatic coupling mode to UIC coupling mode, the physical strain on the operator is kept to a minimum (e.g. 150...170 N). | Muss | Experience of operators | SB | draft | -- | TIS working group | | | | |

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|-----------------|----|--|--------|--|----|-------|----|-------------------|--|--|--|--|
| AUCO.164 | OR | The change between the operating modes may take place via pneumatic, electrical or mechanical activation. | Option | Experience of operators | | draft | -- | TIS working group | | | | |
| AUCO.165 | RE | If components to be carried on the vehicle are required for mode change, their single weight shall not exceed 25 kg. | Muss | Compliance with work safety and health regulations | SB | draft | -- | TIS working group | | | | |
| AUCO.166 | RE | The mode change does not require any tools (e.g. wrench, pincer, hammer...). | Muss | Experience of operators | SB | draft | -- | TIS working group | | | | |
| AUCO.167 | RE | When using the UIC coupling point the pneumatic connection between the vehicles shall be made manually. | Muss | Experience of operators | SB | draft | -- | TIS working group | | | | |
| AUCO.168 | RE | The pneumatic connection between the vehicles with different coupling systems shall be made via a UIC/TSI compliant interface. | Muss | Experience of operators | SB | draft | -- | TIS working group | | | | |
| AUCO.169 | RE | When the UIC coupling point use the electrical and signal connections between the vehicles this shall be made manually. | Muss | Experience of operators | SB | draft | -- | TIS working group | | | | |
| AUCO.170 | OR | The connection for the electrical signal transmission between the rolling stock shall be made via a UIC/TSI compliant interface. | Option | Experience of operators | SB | draft | -- | TIS working group | | | | |

Tests with the digital automatic coupling (DAC) by the operator V1.00

| Sequence no. | Name of test | Requirement type | Tests performed | Requirements covered | Results expected | Results achieved, by manufacture | Free text field | additional comments | |
|-----------------------|---|------------------|--|----------------------|---|----------------------------------|-----------------|--|---|
| Tests on single wagon | | | | | | | | | |
| 1 | Weighing the coupling to determine its net mass | Mandatory | | AUCO.9 | Total weight of a coupling ≤ 380 kg | | | | |
| | | | | | | | | | |
| 2 | Coupling of the automatic coupling against a UIC coupling point (side buffers and screw coupling) without the use of adapters (special test for the hybrid coupler of | Mandatory | Coupling test for the automatic coupling with a vehicle with buffers and screw coupling without the use of adapters | | A coupling can be achieved without an special adapter | | | | |
| 2.1. | Creating buffer contact on a straight track (only locos with dual mode coupler) | Mandatory | | | | | | | |
| | | | | | | | | | |
| 3 | Coupling tests with couplings of the same type under the following conditions (before the tests begin, the couplings are equipped with sensors to record compressive and tensile forces, distances and acceleration measurements) | Mandatory | | | | | | All tests from chapter 3 and 4 shall be carried out in the vehicle combination full-full, empty-full and empty-empty. | |
| 3.1 | On straight track | | | | | | | | |
| 3.1.1 | At v= 2 km/h | Mandatory | | | | | | | |
| | Wagon empty | Mandatory | | | | | | | |
| | Wagon fully loaded | Mandatory | | | | | | | |
| 3.1.2 | with v= 4 km/h | Mandatory | | | | | | | |
| | Wagon empty | Mandatory | | | | | | | |
| | Wagon fully loaded | Mandatory | | | | | | | |
| 3.1.3 | with v= 6 km/h | Mandatory | | | | | | | |
| | Wagon empty | Mandatory | | | | | | | |
| | Wagon fully loaded | Mandatory | | | | | | | |
| 3.1.4 | with v= 8 km/h | Mandatory | | | | | | | |
| | Wagon empty | Mandatory | | | | | | | |
| | Wagon fully loaded | Mandatory | | | | | | | |
| 3.1.5 | with v= 10 km/h | Mandatory | | | | | | | |
| | Wagon empty | Mandatory | | | | | | | Attention: the max. speed depended from maximum force level of 2.000 kN for which wagons are designed. Based on requirement for standard buffer test (max. 3.000kN/wagon end) force shall not become higher than 3.000 kN |
| | Wagon 50% loaded | Mandatory | | | | | | | |
| | Wagon fully loaded | Mandatory | | | | | | | |

| Sequence no. | Name of test | Requirement type | Tests performed | Requirements covered | Results expected | Results achieved, by manufacture | Free text field | additional comments | | |
|--------------|--|------------------|---|----------------------|--|----------------------------------|-----------------|---|--|--|
| 3.1.6 | At v= 12 km/h (simulated impact running down from the hump without a rail brake) | Mandatory | Coupling tests with identical coupling types, 5 test attempts per requirement | AUCO 10 to 36 | Coupling provides a reliable connection under the defined track geometries, boundary conditions and speeds, including electrical connection of the contacts. | | | Attention: the max. speed depended from maximum force level of 2.000 kN for which wagons are designed. Based on requirement for standard buffer test (max. 3.000kN/wagon end) force shall not become higher than 3.000 kN | | |
| | Wagon empty | Mandatory | | | | | | | | |
| | Wagon fully loaded | Mandatory | | | | | | | | |
| 3.2 | In curved track R 190 m | | | | | | | | | |
| 3.2.1 | At v= 2 km/h | Mandatory | | | | | | | | |
| | Wagon empty | Mandatory | | | | | | | | |
| | Wagon fully loaded | Mandatory | | | | | | | | |
| 3.2.2 | At v= 4 km/h | Mandatory | | | | | | | | |
| | Wagon empty | Mandatory | | | | | | | | |
| | Wagon fully loaded | Mandatory | | | | | | | | |
| 3.2.3 | with v= 6 km/h | Mandatory | | | | | | | | |
| | Wagon empty | Mandatory | | | | | | | | |
| | Wagon fully loaded | Mandatory | | | | | | | | |
| 3.2.4 | At v= 8 km/h | Mandatory | | | | | | | | |
| | Wagon empty | Mandatory | | | | | | | | |
| | Wagon fully loaded | Mandatory | | | | | | | | |
| 3.3 | Curved track R 150 m, manual alignment of the couplings permitted | | | | | | | | | |
| 3.3.1 | At v= 2 km/h | Mandatory | | | | | | | | |
| | Wagon empty | Mandatory | | | | | | | | |
| | Wagon fully loaded | Mandatory | | | | | | | | |
| 3.3.2 | with v= 4 km/h | Mandatory | | | | | | | | |
| | Wagon empty | Mandatory | | | | | | | | |
| | Wagon fully loaded | Mandatory | | | | | | | | |
| 3.3.3 | At v= 6 km/h | Mandatory | | | | | | | | |
| | Wagon empty | Mandatory | | | | | | | | |
| | Wagon fully loaded | Mandatory | | | | | | | | |
| 3.3.4 | At v= 8 km/h | Mandatory | | | | | | | | |
| | Wagon empty | Mandatory | | | | | | | | |
| | Wagon fully loaded | Mandatory | | | | | | | | |
| 3.4 | S-curve 190 m | | | | | | | | | |
| 3.4.1 | with v= 2 km/h | Mandatory | | | | | | | | |

| Sequence no. | Name of test | Requirement type | Tests performed | Requirements covered | Results expected | Results achieved, by manufacture | Free text field | additional comments |
|--------------|--|------------------|-----------------|----------------------|------------------|----------------------------------|-----------------|---------------------|
| | Wagon empty | Mandatory | | | | | | |
| | Wagon fully loaded | Mandatory | | | | | | |
| 3.4.2 | At v= 4 km/h | Mandatory | | | | | | |
| | Wagon empty | Mandatory | | | | | | |
| | Wagon fully loaded | Mandatory | | | | | | |
| 3.5 | S-curve 150 m, manual alignment of the couplings permitted | | | | | | | |
| 3.5.1 | At v= 2 km/h | Mandatory | | | | | | |
| | Wagon empty | Mandatory | | | | | | |
| | Wagon fully loaded | Mandatory | | | | | | |
| 3.5.2 | At v= 4 km/h | Mandatory | | | | | | |
| | Wagon empty | Mandatory | | | | | | |
| | Wagon fully loaded | Mandatory | | | | | | |
| 3.6 | S-curve 150 m, with 6 m intermediate straight, manual alignment of the couplings permitted | | | | | | | |
| 3.6.1 | At v= 2 km/h | Mandatory | | | | | | |
| | Wagon empty | Mandatory | | | | | | |
| | Wagon fully loaded | Mandatory | | | | | | |
| 3.6.2 | At v= 4 km/h | Mandatory | | | | | | |
| | Wagon empty | Mandatory | | | | | | |
| | Wagon fully loaded | Mandatory | | | | | | |
| | | | | | | | | |
| 4 | Running on various track geometries in the coupled state | | | | | | | |
| 4.1 | Passage through curved track 190 m, | | | | | | | |
| | Wagon empty | Mandatory | | | | | | |
| | Wagon fully loaded | Mandatory | | | | | | |
| 4.2 | Passage through curved track 190 m, pushed | | | | | | | |
| | Wagon empty | Mandatory | | | | | | |
| | Wagon fully loaded | Mandatory | | | | | | |
| 4.3 | Passage through curved track 150 m, | | | | | | | |
| | Wagon empty | Mandatory | | | | | | |
| | Wagon fully loaded | Mandatory | | | | | | |
| 4.4 | Passage through curved track 150 m, pushed | | | | | | | |
| | Wagon empty | Mandatory | | | | | | |
| | Wagon fully loaded | Mandatory | | | | | | |
| 4.5 | Passage through S-curve 190 m, pulled | | | | | | | |
| | Wagon empty | Mandatory | | | | | | |
| | Wagon fully loaded | Mandatory | | | | | | |
| 4.6 | Passage through S-curve 190 m, pushed | | | | | | | |
| | Wagon empty | Mandatory | | | | | | |
| | Wagon fully loaded | Mandatory | | | | | | |
| 4.7 | Passage through S-curve 150 m, pulled | | | | | | | |
| | Wagon empty | Mandatory | | | | | | |
| | Wagon fully loaded | Mandatory | | | | | | |
| 4.8 | Passage through S-curve 150 m, pushed | | | | | | | |
| | Wagon empty | Mandatory | | | | | | |
| | Wagon fully loaded | Mandatory | | | | | | |
| 4.9 | Passage through S-curve 150 m with 6 m intermediate straight, pulled | | | | | | | |
| | Wagon empty | Mandatory | | | | | | |
| | Wagon fully loaded | Mandatory | | | | | | |

Running on the track geometries in the coupled state with identical coupling types, 5 test attempts per requirement

AUCO 10 to 36

Able to run on the described track geometries without restriction, as both a pulled and pushed unit.

Electrical connection is stable and uninterrupted under all conditions.

| Sequence no. | Name of test | Requirement type | Tests performed | Requirements covered | Results expected | Results achieved, by manufacture | Free text field | additional comments |
|--------------|---|--|---|---|--|--|-----------------|---------------------|
| 8. | Impact tests to determine the strength of the coupling head and the forces and accelerations occurring in the vehicle | Mandatory | Proof of required strength against plastic deformation of the coupling head and the acceleration that occurs in the vehicle as well as the forces acting on the vehicle-coupling interface, 5 test attempts per requirement, Measurement of the acceleration impact on the electric coupler (test concept chapter 2.3.4). | AUCO 902 to 92 | Complies with the specified requirements | | | |
| 8.1. | Determination of the maximum forces occurring in the coupling head at an impact speed of 8 km/h and 90t against | Mandatory | | | Force occurring in the coupling head ≤ 2000 kN | | | |
| 8.2. | Determination of the maximum forces occurring in the connection between the coupling head and the base frame at an impact speed of 8 km/h and 90t against 80t | Mandatory | | | Force occurring at the interface to the base frame ≤ 2000 kN | | | |
| | | | | | | | | |
| 9. | electrical connections | | | | | | | |
| 9.1 | Contact resistance per coupler interface (chapter 2.2.1 in testing concept) | Determination of contact resistance of all coupler contacts in coupled state. | | Contact resistance below the specified value (refer to the testing concept and / or manufacturer specification) | | | | |
| 9.2 | Isolation resistance (chapter 2.2.6 in testing concept) | Determination of isolation resistance of all coupler contacts to the coupler ground. | | Isolation resistance above the specified value (refer to the testing concept and / or manufacturer specification) | | | | |
| 9.3 | Data transfer between wagons (chapter 2.2.3 in testing concept) | Determination of communication capability of the coupler, including the hard-wired CAN communication, powerline communication and radio communication. | | Successful data transfer according to the specifications. | | These tests will be defined and executed by OWITA. | | |
| 9.4 | Power transfer along the train (chapter 2.2.2) | successful power transfer along several wagons (up to 12) | | refer to testing specification | | | | |
| 9.5 | Data transfer along the train (chapter 2.2.4) | Test of successful data transfer along several wagons (up to 12) | | refer to testing specification | | These tests will be defined and executed by OWITA. | | |
| | | | | | | | | |
| 10. | Test dismantling/assembly of the coupling head by 2 persons | Mandatory | Test dismantling/assembly of the coupling head by 2 persons in a workshop | AUCO 52 to 62 | Coupling head can replaced by 2 persons within 60 minutes, no special tools required (except lifting equipment). | | | |
| 11. | Test dismantling/assembly of the automatic coupling equipment by 1 person in 60 minutes (if available) | Mandatory | Test dismantling/assembly of the automatic coupling equipment by 1 person in 60 minutes in a workshop | AUCO 62 | Replacement of automatic decoupling equipment by 1 person in 60 minutes, no special tools required. | | | |

| Sequence no. | Name of test | Requirement type | Tests performed | Requirements covered | Results expected | Results achieved, by manufacture | Free text field | additional comments |
|--------------|--|---|---|--|---|----------------------------------|-----------------|---------------------|
| 11.1 | Test replacement of the electric contacts (chapter 2.2.10 in the electric testing concept) | Test exchange of single contacts from the front without removing / replacing the complete electric coupler. | AUCO. 108 | Test exchange of single contacts from the front using only the manufacturer-specified tools and successfully executed within the time specified by the manufacturer. | | | | |
| 12. | Final examination of the coupling | Mandatory | | | | | | |
| 12.1. | Measurement of the couplings | Mandatory | Separate protocols must be produced for these measurements based on the manufacturer's data. | | No dimensional changes outside the manufacturing tolerance range | | | |
| 12.1.1. | Inspection of the main dimensions of the coupling | Mandatory | | | No dimensional changes outside the manufacturing tolerance range | | | |
| 12.1.2. | Inspection of the functional dimensions | Mandatory | | | No dimensional changes outside the manufacturing tolerance range | | | |
| 12.1.3. | Recording the actual characteristic curve for the damping unit | Mandatory | | | Permissible deviation from the target characteristic curve within | | | |
| 12.2. | Inspection for damage visible to the naked eye, e.g. breaks, plastic deformations, fractures, cracks in the visible area of the | Mandatory | Separate protocols must be produced for these inspections. Guidelines for the assessment and admissibility of the recorded properties after the completion of the test must be agreed separately with the manufacturer. Professional supervision can be provided by DB Systemtechnik GmbH, TT.TVE 31(2). | | | | | |
| 12.3. | Step-by-step disassembly of the couplings into the main subassemblies with inspection for damage visible to the naked eye, e.g. breaks, plastic deformation, fractures, cracks, abrasions together with manufacturer | Mandatory | | | | | | |
| 12.3.1. | Measurement of components from 12.2. | Mandatory | | | | | | |
| 12.3.2. | NDT inspection of parts in the load path from 8.2 (optional) | Mandatory | | | | | | |
| 12.8 | Test lubrication during service | Mandatory | Test lubrication of all possible lubrication positions by 1 people. | | Wear elements can be lubricated by 1 people within 2 minutes without any special tools. | | | |

Tests with the digital automatic coupling (DAC) by the operator V1.00

| Sequence no. | Name of test | Requirement type | Tests performed | Requirements covered | Results expected | Achieved results | Free text field |
|---------------------------------|--|------------------|---|--|--|------------------|-----------------|
| Tests on the demonstrator train | | | | | | | |
| 1. | Coupling procedures with couplings of the same type under the following conditions (before the tests begin, the couplings are equipped with sensors to record compressive and tensile forces, distances and acceleration measurements, couplings at the coupling point are of the same type) | Mandatory | Coupling tests with couplings of the same type, 5 test attempts per requirement, train constellation with mixed loads | AUCO 17, AUCO 19 to 32, AUCO 103 to 105, AUCO 118 to 123 | Coupling provides a reliable connection under the defined track geometries, boundary conditions and speeds | | |
| 1.1. | On straight track | Mandatory | | | | | |
| 1.1.1. | At v= 2 km/h | Mandatory | | | | | |
| 1.1.2. | At v= 4 km/h | Mandatory | | | | | |
| 1.1.3. | At v= 6 km/h | Mandatory | | | | | |
| 1.1.4. | At v= 8 km/h | Mandatory | | | | | |
| 1.2. | In curved track R 190 m | Mandatory | | | | | |
| 1.2.1. | At v= 2 km/h | Mandatory | | | | | |
| 1.2.2. | At v= 4 km/h | Mandatory | | | | | |
| 1.3. | Curved track R 150 m, prior manual alignment of the couplings permitted | Mandatory | | | | | |
| 1.3.1. | At v= 2 km/h | Mandatory | | | | | |
| 1.3.2. | At v= 4 km/h | Mandatory | | | | | |
| 1.4. | S-curve 190 m | Mandatory | | | | | |
| 1.4.1. | At v= 2 km/h | Mandatory | | | | | |
| 1.4.2. | At v= 4 km/h | Mandatory | | | | | |
| 1.5. | S-curve 150 m, prior manual alignment of the couplings permitted | Mandatory | | | | | |
| 1.5.1. | At v= 2 km/h | Mandatory | | | | | |
| 1.5.2. | At v= 4 km/h | Mandatory | | | | | |
| 1.6. | S-curve 150 m, with 6 m intermediate straight, manual alignment of the couplings permitted, coupling in the | Mandatory | Running on track geometries as a train, 5 test attempts per requirement, train constellation with mixed loads | AUCO 16 to 23, AUCO37 and 38, AUCO 43 to 46 | Able to run on the described track geometries without restriction, as both a pulled and pushed unit | | |
| 1.6.1. | At v= 2 km/h | Mandatory | | | | | |
| 1.6.2. | At v= 4 km/h | Mandatory | | | | | |
| 2. | Running on various track geometries as a train | Mandatory | | | | | |
| 2.1. | Passage through curved track 190 m, | Mandatory | | | | | |
| 2.2. | Passage through curved track 190 m, pushed | Mandatory | | | | | |
| 2.3. | Passage through curved track 150 m, | Mandatory | | | | | |
| 2.4. | Passage through curved track 150 m, pushed | Mandatory | | | | | |
| 2.5. | Passage through S-curve 190 m, pulled | Mandatory | | | | | |
| 2.6. | Passage through S-curve 190 m, pushed | Mandatory | | | | | |
| 2.7. | Passage through S-curve 150 m, pulled | Mandatory | | | | | |
| 2.8. | Passage through S-curve 150 m, pushed | Mandatory | | | | | |
| 2.9. | Passage through S-curve 150 m with 6 m intermediate straight, pulled | Mandatory | | | | | |
| 2.10. | Passage through S-curve 150 m with 6 m intermediate straight, pushed | Mandatory | | | | | |
| 2.11. | Passage through curved track 100 m, | Mandatory | | | | | |
| 2.12. | Passage through curved track 100 m, | Mandatory | | | | | |

| | | | | | | | | | |
|---------|---|-----------|---|---------------------|---|--|--|--|--|
| 2.14. | Navigating a ramp with 3°20' pitch, pulled | Mandatory | | | | | | | |
| 2.15. | Navigating a ramp with 3°20' pitch, pushed | Mandatory | | | | | | | |
| 2.16. | Navigating a ramp with 3°20' pitch and overlapping with a 120 m curved track, | Mandatory | | | | | | | |
| 2.17. | Navigating a ramp with 3°20' pitch and overlapping with a 120 m curved track, pushed | Mandatory | | | | | | | |
| 2.18. | Creating buffer contact on a straight track | Mandatory | | | | | | | |
| | | | | | | | | | |
| 3. | Coupling under defined real climatic | Mandatory | | | | | | | |
| 3.1. | Coupling in cold conditions | Mandatory | Proof of ability to couple under defined climatic conditions, 5 tests per requirement, testing performed under real environmental conditions Deviations from prescribed temperatures and conditions must be recorded. | AUCO 10 and AUCO 29 | Coupling reliably creates a connection under the defined climatic conditions at the first attempt | | | | |
| 3.1.1. | Coupling at 0°C, dry | Mandatory | | | | | | | |
| 3.1.2. | Coupling at 0°C, spray | Mandatory | | | | | | | |
| 3.1.6. | Coupling at -10°C, covered in snow, dry | Mandatory | | | | | | | |
| 3.1.7. | Coupling at -10°C, covered in snow, coupling iced, layer thickness 5 mm | Mandatory | | | | | | | |
| 3.1.10. | Coupling at -20°C, covered in snow, dry | Mandatory | | | | | | | |
| 3.1.11. | Coupling at -20°C, covered in snow, coupling iced, layer thickness 5 mm | Mandatory | | | | | | | |
| 3.1.12. | Coupling at -25°C, covered in snow, dry | Mandatory | | | | | | | |
| 3.1.13. | Coupling at -25°C, covered in snow, coupling iced, layer thickness 5 mm | Mandatory | | | | | | | |
| | | | | | | | | | |
| 3.2. | Coupling in warm conditions | Mandatory | | | | | | | |
| 3.4.9. | Coupling at 40°C, dry | Mandatory | | | | | | | |
| 3.4.10. | Coupling at 45°C, dry | Target | | | | | | | |
| | | | | | | | | | |
| 4. | Measurement of the response speed when braking/releasing brakes | Mandatory | | | | | | | |
| 4.1. | Measurement of the brake wave propagation speed when applying/releasing brakes within a wagon group with the same type of coupling. | Mandatory | Proof of the brake response time in accordance with UIC 544-1 and brake wave propagation time in accordance with EN 14198, 5 test attempts each | AUCO 106 | Compliance with the specified brake wave propagation/response times | | | | |
| 4.2. | Measurement of the brake wave propagation speed when applying/releasing brakes throughout the train. The measurement must be taken at the last wagon in the train. The length of the train must be specified [in | Mandatory | | | | | | | |
| | | | | | | | | | |
| 5. | Recording the operating force of the manual decoupling equipment This test can be combined with the coupling tests from Sequence no. 1. | Mandatory | Proof of compliance with the permissible operating force, 5 tests each | AUCO 31 | The specified release force of the manual decoupling equipment remains within the range 150 ... 170 N | | | | |
| | | | | | | | | | |

| | | | | | | | |
|------|---|-----------|---|---------------|---|--|--|
| 6. | Impact tests to determine the strength of the coupling head and the forces and accelerations occurring in the vehicle | Mandatory | | | Complies with the specified requirements | | |
| 6.1. | Determination of the maximum forces occurring in the coupling head at an impact speed of 8 km/h between a loaded wagon group and a non-braked wagon group standing on the track. | Mandatory | Proof of required strength against plastic deformation of the coupling head and the acceleration that occurs in the vehicle as well as the forces acting on the vehicle-coupling interface, 5 test attempts per requirement, tests to be performed in accordance with DIN EN 15551:2017, Table E3 Test No. 3 to 5 from Categories B and C | AUCO 92 to 96 | Force occurring in the coupling head ≤ 2000 kN | | |
| 6.2. | Determination of the maximum forces occurring in the connection between the coupling head and the base frame at an impact speed of 8 km/h between a loaded wagon group and a non-braked wagon group standing on the track. | Mandatory | | | Force occurring at the interface to the base frame ≤ 1500 kN | | |
| 6.3. | Determination of the maximum accelerations occurring in the vehicle at an impact speed of 8km/h and 90t against 80 | Mandatory | | | Acceleration $\leq 2g$ | | |
| 6.4. | Determination of the maximum forces occurring in the coupling head at an impact speed of 12 km/h between a loaded wagon group and a non-braked wagon group standing on the track. | Mandatory | | | Force occurring in the coupling head ≤ 2000 kN | | |
| 6.5. | Determination of the maximum forces occurring in the connection between the coupling head and the base frame at an impact speed of 12 km/h between a fully loaded wagon group and a non-braked fully loaded wagon group standing on the | Mandatory | | | Force occurring at the interface to the base frame ≤ 1500 kN | | |
| 6.6. | Determination of the maximum accelerations occurring in the vehicle at an impact speed of 12km/h between a fully loaded wagon group and a non-braked fully loaded wagon group standing on the track. | Mandatory | | | Acceleration $\leq 3g$ | | |
| | | | | | | | |
| 7. | Free tests | | | | | | |
| 7.1 | Überwachung der Kräfte an der Kupplung und an der Schnittstelle Kupplung/ Fahrzeugstruktur im Fahrbetrieb | | | | | | |
| 7.2 | Kuppeln/ Entkuppeln der Fahrzeuge im Rahmen des Fahrzeugumlaufs, Zielstellung sind 20 Kuppel/ Entkuppelvorgänge je Kuppelstelle und Woche | | | | | | |

| | | | | | | | | |
|--------|--|-----------|--|---------------|---|--|--|---|
| | | | | | | | | |
| 8. | Test dismantling (after testing of the demonstrator train has been completed) | | | | | | | |
| 8.1. | Test dismantling/assembly of the coupling head by 2 persons | | Test dismantling/assembly of the coupling head by 2 persons | AUCO 52 to 63 | Coupling head can be replaced by 2 persons within 60 minutes, no special tools required (except lifting equipment). | | | |
| 8.2. | Test dismantling/assembly of the automatic coupling equipment by 1 person in 60 minutes (if available) | | Test dismantling/assembly of the automatic coupling equipment by 1 person in 60 minutes | AUCO 63 | Replacement of automatic decoupling equipment by 1 person in 60 minutes, no special tools required. | | | |
| | | | | | | | | |
| 9. | Final examination of the coupling | | | | | | | |
| 9.1. | Inspection for damage visible to the naked eye, e.g. breaks, plastic deformations, fractures, cracks in the visible area of the couplings | Mandatory | <p>Separate protocols must be produced for these inspections. Guidelines for the assessment of recorded properties and damage after the completion of the test must be agreed separately with the manufacturer. If the dismantling and evaluation of the couplings cannot be performed by the manufacturer, an authorised workshop of DB AG (e.g. for Voith Product --> factory in Kassel, SA3 derivative > factory in Paderborn) must be commissioned to perform the work. Professional supervision can be provided by TT.TVE 31(2).</p> | | | | | |
| 9.2. | Step-by-step disassembly of the couplings into the individual parts with inspection for damage visible to the naked eye, e.g. breaks, plastic deformation, fractures, cracks, abrasions together with manufacturer | Mandatory | | | | | | |
| 9.2.1. | Measurement of components from 8.2. | Mandatory | | | | | | |
| 9.2.2. | NDT inspection of parts in the load path from 8.2 (optional) | Mandatory | | | | | | |
| 9.2.3. | Recording the actual characteristic curve for the damping unit | Mandatory | | | | | | Permissible deviation from the target characteristic curve within the range of \pm -20% |

Test instructions

Functional testing of an automatic coupling for rail freight transport at an ambient temperature of +40°C and in increments down to -25°C

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10.08.2019

Approved:

Descriptors: AK-Güt, DAC

1. Objectives

- Functional testing of the coupling head (with e-contact coupling) and air coupling of the automatic coupling for freight trains at ambient temperatures from +40°C to -25°C
- Prove the mechanical, pneumatic and electrical automatic and manual decoupling functions operate

2. Test setup

- Two automatic couplings, or at least the corresponding coupling heads, are set up in a climate test
- Selected contacts of the e-contact coupling are connected to the electrical continuity test
- The pneumatic air supply is connected to the air coupling

3. Method

3.1. Tests at +40°C

- The couplings are ready to be coupled

| Temperatur | Duration of heating |
|------------|---------------------|
| +40°C | at least 4 h |

- The couplings must be coupled and decoupled 6 consecutive times
- After coupling, a continuity test must be performed on the air coupling and the selected contacts in the e-contact coupling
- Check the display of the coupling state
- The decoupling must be performed 5x automatically and 1x manually

3.1.1. Tests at +40°C ambient temperature and 90% humidity

- The couplings are ready to be coupled
- Enrichment of the air humidity to 90%

| Temperatur | Humidity overlay |
|------------|------------------|
| +40°C | at least 1 h |

- Immediately before and during the mechanical, pneumatic and electrical coupling test, the coupling is a sprinkled with water using spray nozzles

- The couplings must be coupled and decoupled 6 consecutive times

- After coupling, a continuity test must be performed on the air coupling and the selected contacts in the e-contact coupling

- Check the display of the coupling state

- The decoupling must be performed 5x automatically and 1x manually. The sprinkler must be turned off before manual decoupling.

After this phase of the test, the humidity in the climate test stand must be reduced until the couplings and their components are dry. Then incrementally reduce the temperature in the climatic test stand to -25°C for tests 3.2 to

3.2. Tests at 0°C

- The couplings are ready to be coupled

| Temperatur | Duration of cooling |
|------------|---------------------|
| 0°C | at least 4 h |

- Using a spray bottle, create a layer of ice (approx. 1 mm thick) on the coupling, repair flaws in this layer caused by the coupling tests

- The couplings must be coupled and decoupled 6 consecutive times

- After coupling, a continuity test must be performed on the air coupling and the selected contacts in the e-contact coupling
- Check the display of the coupling state
- The decoupling must be performed 5x automatically and 1x manually

3.3. Tests at -5°C

- The couplings are ready to be coupled

| Temperatur | Duration of cooling |
|------------|---------------------|
| -5°C | at least 2 h |

- Using a spray bottle, create a layer of ice (approx. 3-5 mm thick) on the coupling, repair flaws in this layer caused by the coupling tests
- The couplings must be coupled and decoupled 6 consecutive times
- After coupling, a continuity test must be performed on the air coupling and the selected contacts in the e-contact coupling
- Check the display of the coupling state
- The decoupling must be performed 5x automatically and 1x manually

3.4. Tests at -10°C

- The couplings are ready to be coupled

| Temperatur | Duration of cooling |
|------------|---------------------|
| -10°C | at least 2 h |

- Using a spray bottle, create a layer of ice (approx. 3-5 mm thick) on the coupling, repair flaws in this layer caused by the coupling tests
- The couplings must be coupled and decoupled 6 consecutive times
- After coupling, a continuity test must be performed on the air coupling and the selected contacts in the e-contact coupling
- Check the display of the coupling state
- The decoupling must be performed 5x automatically and 1x manually

3.5. Tests at -15°C

- The couplings are ready to be coupled

| Temperatur | Duration of cooling |
|------------|---------------------|
| -15°C | at least 2 h |

- Using a spray bottle, create a layer of ice (approx. 3-5 mm thick) on the coupling, repair flaws in this layer caused by the coupling tests
- The couplings must be coupled and decoupled 6 consecutive times
- After coupling, a continuity test must be performed on the air coupling and the selected contacts in the e-contact coupling
- Check the display of the coupling state
- The decoupling must be performed 5x automatically and 1x manually

3.6. Tests at -20°C

- The couplings are ready to be coupled

| | |
|------------|---------------------|
| Temperatur | Duration of cooling |
| -20°C | at least 2 h |

- Using a spray bottle, create a layer of ice (approx. 3-5 mm thick) on the coupling, repair flaws in this layer caused by the coupling tests
- The couplings must be coupled and decoupled 6 consecutive times
- After coupling, a continuity test must be performed on the air coupling and the selected contacts in the e-contact coupling

- Check the display of the coupling state
- The decoupling must be performed 5x automatically and 1x manually

3.7. Tests at -25°C

- The couplings are ready to be coupled

| Temperatur | Duration of cooling |
|------------|---------------------|
| -25°C | at least 2 h |

- Using a spray bottle, create a layer of ice (approx. 3-5 mm thick) on the coupling, repair flaws in this layer caused by the coupling tests
- The couplings must be coupled and decoupled 6 consecutive times
- After coupling, a continuity test must be performed on the air coupling and the selected contacts in the e-contact coupling
- Check the display of the coupling state
- The decoupling must be performed 5x automatically and 1x manually

3.6. Tests at -20°C

- The couplings are ready to be coupled

| Temperatur | Duration of cooling |
|------------|---------------------|
| -20°C | at least 2 h |

- Using a spray bottle, create a layer of ice (approx. 3-5 mm thick) on the coupling, repair flaws in this layer caused by the coupling tests
- The couplings must be coupled and decoupled 6 consecutive times
- After coupling, a continuity test must be performed on the air coupling and the selected contacts in the e-contact coupling
- Check the display of the coupling state
- The decoupling must be performed 5x automatically and 1x manually

3.7. Tests at -25°C

- The couplings are ready to be coupled

| Temperatur | Duration of cooling |
|------------|---------------------|
| -25°C | at least 2 h |

- Using a spray bottle, create a layer of ice (approx. 3-5 mm thick) on the coupling, repair flaws in this layer caused by the coupling tests
- The couplings must be coupled and decoupled 6 consecutive times

- After coupling, a continuity test must be performed on the air coupling and the selected contacts in the e-contact coupling
- Check the display of the coupling state
- The decoupling must be performed 5x automatically and 1x manually

Tests with digital automatic coupling (DAC)

In the digital automatic coupling (DAC) project, automatic freight car couplings are provided for test purposes by the currently designated manufacturers for testing on individual cars. The vehicle types serving as test carriers are to be selected and named. At present, a total of 4 couplings per manufacturer is assumed for single wagon testing.

The couplings are to be tested for compliance with technical requirements under almost real conditions in order to test the functionality of each type of coupling. For the time being it is assumed that the mechanical and pneumatic functionality will be tested. On the automatic couplings there are E contact couplings which are used for tests of the interaction of the mechanical component and the E contact coupling and for continuity measurements as well as functional tests.

Conditions linked to track geometries are tested in real driving tests. Conditions that are linked to climatic requirements are tested both in a climatic chamber and later at the demonstrator train.

For the single wagon test, freight cars are equipped with the automatic coupling and a train is assembled from these cars. Each of the freight cars, with exception of the end cars, will be equipped with an automatic coupler from the participating manufacturers at both ends of the car. The couplings are mounted in such a way that similar couplings are opposite each other and can be coupled.

At one end of the end cars there is an automatic coupling, while the UIC interface (side buffer, screw coupling and draw hook) is retained at the other end of the car. This guarantees the possibility of coupling to the traction units.

The attached test requirements are derived from the requirements and bundled, because partly several specifications from the SPEC AK Güt EUROPA can be tested in the same way. The reference to the specifications is made by a corresponding reference to the specification number (e.g. AUCO.XYZ). AUCO stands for "automatic coupler".



Structure of the test overview

The test overview is structured in tabular form and divided into tests on the single wagon.

The test concept for demonstrator train is under development.

| current no. | test designation | test execution | covered requirements | bided result | reached result | result complied | free text field |
|--|------------------|----------------|----------------------|--------------|----------------|-----------------|-----------------|
| Tests on single wagon / demonstrator train | | | | | | | |

Running number indicates the sequential number of the test

| | |
|-------------------------------------|--|
| Test name | names the test |
| test execution covered requirements | describes the test and, if necessary, the number of individual tests reference to the request number from the "SPEC AK Güt EUROPE Requirements (e.g. AUCO XYZ) |
| bided results | describe the bided result |
| reached result | describe the reached result of the automatic coupling |
| result complied | marked in the columns with |
| |  fully met |
| |  for not fulfilled to be marked. |

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If a requirement is only partially fulfilled, it shall be considered as "not fulfilled" in the assessment. The results achieved in the corresponding test(s) shall be documented.

Free text field

here insert further additions/ information

Tests on single wagons/
demonstrator train

serves to differentiate between single car test and test on the demonstrator train. However, the test requirements are listed in different documents.

Test execution and period

Single car tests

According to the schedule of the DAC project, the single car tests will be carried in 2020.

For the tests, the vehicles are to be used both unloaded and fully loaded.

The test end for the single wagons is planned for the 1st quarter of 2021.

The couplers are to be tested with the vehicles, as far as possible, on tracks and in a climate chamber. The test period is planned for the 2nd and 3rd quarter of 2020, as the evaluation of the results is to be incorporated into the couplers which will be procured for the demonstrator train, if possible.

Objective: To prove the functionality of the DAC to potential operators

Construction of the test train

With the single wagon test the following basic conditions are to be considered:

- Test of coupling systems DAC type 4 (Schwab, 2x system "Scharfenberg"®, SA3) from four different manufacturers,
- with these four coupling systems DAC four same carriage groups by three freight cars in each case are to be equipped as follows (a total of twelve carriages),
- Carriages 1 in front: Screw coupling (because of incompatibility of the different coupling systems)
- Carriages 1 behind: DAC (of the respective manufacturer)
- Carriages 2 in front and behind: DAC
- Carriages 3 in front: DAC
- Carriages 3 behind: Screw coupling

Static tests

In the absence of a complete coverage of the test requirements by standards/regulations of technology, the following specifications are to be used for this purpose and tests are to be carried out by analogy:

- DIN EN 15551, Annex D
- UIC 522 (2) approval automatic coupling
- MB 523 technical conditions for automatic couplers
- UIC 530 (1) constructive measures underframe quality for automatic couplers

Dynamic tests

- DIN EN 15551, Annex E
- DIN EN 15566, Annex A
- MB 524 (1) Spring apparatus for automatic freight couplers 1978-01-01 incl. modification 1 to 6 d
- MB 530 (2) Freight wagon driving safety

During the dynamic tests, forces, accelerations and displacements occurring both at the coupling itself and at the interface between coupling and vehicle structure shall be recorded and documented.

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As a minimum, measuring points for the force measurement shall be provided:

- clutch lock
- coupling head casing/ housing
- connection coupling head housing - coupling arm
- coupling clutch/ arm
- connection clutch arm - spring mechanism / damping device
- connection of spring system/damping device to the vehicle structure.

As a minimum, measuring points for acceleration absorption shall be provided:

- coupling head
- connection coupling - vehicle structure
- vehicle structure (underframe of the wagon)
- electric coupler

As a minimum, measuring points for distance measurements shall be provided:

- coupling clutch/ arm with regard to horizontal and vertical deflection
- spring mechanism/ damping device regards to maximum strokes in tension and shock direction
- electric coupler actuation (conformity with allowed timespan for completed acutation)

Tests on pneumatics / brakes

The tests for the pneumatic connection and effectiveness of the brake are concerned both with maintaining the functionality and adherence to braking and release times. The form basis for carrying out the corresponding tests are:

- EN 14198
- EN 15355
- EN 15611
- UIC 540
- UIC 544 (1)

Tests on the E contact coupling

Freight wagons must be equipped with electric and electronic components. Single wagon tests will be executed on wagons which are part of the test train described above (four different types of automatic couplers, three wagon variants per coupler type). The electric interfaces of the provided automatic couplers shall comply with the requirements defined in the document "Requirements for the electrical contacts in the coupling" in its latest version.

Tests on the data communication shall be planned, executed and evaluated separate. They are not part of this document.

Testing overview single wagons

The following tests shall be carried out

1. Contact resistance per coupler interface

This test shall be executed in standstill on one coupler interface (two wagons), with the respective contacts being electrically isolated from the wagon circuits. See test specification sequence 9.1.

2. Insulation resistance of the power net

This test shall be executed on the power net (110 V circuit) on a wagon decoupled from other wagons, with all respective contacts of the power net being short-circuited, and the insulation resistance shall be measured against wagon ground. See test specification sequence 9.2.

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3. *Contact formation during coupling*

Target of this test is to show successful electric contact formation during coupling and stable electric contacts in the coupled state. The tests shall be executed in conjunction with the mechanical tests of the coupler, test specification sequences 3, 4, and 5.

During the tests at different temperatures (sequence 5), the requirement concerning the allowed timespan for completed acutation of the electric coupler shall be verified.

4. *Field test of coupling shock*

Test of coupling shock (accelerations in three dimension) on the e-coupler during coupling and operation. See test specification sequence 9.4.

5. *Power transfer along the train*

In this test, the transfer of electric power from the locomotive to the last freight car shall be shown in a configuration of all 12 cars (three cars for each of the four automatic coupler types). Power transfer shall take place via electric couplers, connection cables at the screw couplers and the wiring on the cars. See test specification sequence 9.5

6. *Test of the electromagnetic compatibility*

Test shall demonstrate compliance of the electric and electronic equipment of the freight car with admissible electromagnetic emission. During these tests, the power transfer along the train shall be working as well as data transmission, especially over the wireless channels.

7. *Charging and discharging of the buffer battery*

This test shall demonstrate the functionality of the buffer batteries on each car. It shall verify the ability to charge the batteries from the power net, maintain electric functionality upon disconnection and recharge the batteries upon recovery of the power supply. See test specification sequence 9.6.

8. *Replacement of electric contacts*

This test shall verify that an exchange of single contacts in the electric coupler is possible with reasonable effort. Contacts shall be exchangeable from the front without removing or replacing the complete electric coupler. See test specification sequence 11.1.

Coupling tests in different track geometries

The coupling tests shall be performed 5 times per test. The following vehicle combinations shall be selected:

- wagon fully loaded with wagon empty
- wagon fully loaded with wagon fully loaded
- wagon empty with wagon empty.

1. *Coupling on straight track*

Both vehicles to be coupled are facing each other on a straight track. The distance between the couplings must be at least 2 m. Exceptions are coupling speeds above 4 km/h. Here the distance is to be selected so that the specified speed is reached when the couplings meet.

The passive-coupling vehicle stands free and is not braked; the active-coupling vehicle is pushed onto the passive-coupling vehicle at the specified speeds.

TIS working group digital automatic coupler

2. *coupling in curves without an intermediate straight line*

a. Single curve

Both vehicles to be coupled are positioned in the track curve. The distance between the couplings must be at least 2 m. Exceptions are coupling speeds above 4 km/h. Here the distance shall be selected so that the specified speed is reached when the couplings meet.

The passive coupling vehicle is free standing and not braked, the active coupling vehicle is pushed onto the passive coupling vehicle at the specified speeds. The passive-coupling vehicle is positioned in such a way that the coupling plane is in the transition from the straight track to the curved track.

b. S- curve

Both vehicles to be coupled are positioned in the track curve. The distance between the couplings must be at least 2 m. Exceptions are coupling speeds above 4 km/h. In this case, the distance shall be selected so that the specified speed is reached when the couplings meet.

The passive coupling vehicle is free standing and not braked, the active coupling vehicle is pushed onto the passive coupling vehicle at the specified speeds.

The position of the coupler is to be selected so that it is in the transition from the track curve to the opposite curve.

3. *coupling in S-curves with intermediate straight*

Both vehicles to be coupled are positioned in the track curve. The distance between the couplings must be at least 2 m. Exceptions are coupling speeds above 4 km/h. Here the distance shall be selected so that the specified speed is reached when the couplings meet.

The actively coupling vehicle is pushed on at the specified speed.

The passive coupling vehicle is positioned in such a way that the coupling position is in the middle of the intermediate straight.

Impact tests

The impact tests are carried out to assess the behaviour of the vehicles at different impact speeds. These tests are carried out 5 times in all combinations of loading conditions. The aim is to absorb the forces occurring at the specified measuring points and to determine accelerations acting on the vehicle and the load from recorded force and travel data.

The overrun test at 12 km/h, which is intended to simulate a shunting impact with failed track brakes and non-existent brake shoes, is to be carried out as the last test series.

Documentation of the results

The performance and results of all tests shall be documented in the form of a report. The specific test conditions shall also be addressed.

The recorded data shall be clearly summarized and presented in a corresponding tabular form. Achieved minimum and maximum values shall be highlighted in different colors. In addition, the data shall be presented in graphical form over the entire test procedure.

The partners of the TIS working group "Project DAK" are to be included.

These partners will accompany the tests, at least temporarily.

A joint evaluation of the test results based on the documentation to be prepared is planned.

Additional information

documentation to be provided by the manufacturer (minimum scope)

- Assembly instructions on the vehicle/interface definition (including details of relevant tightening torques)
- Operating instructions for the component, including permissible tensile and compressive forces (Rp0.2), minimum coupling speed, total weight, partial weights of the individual assemblies, designed swivel angles horizontally and vertically, designed spring deflections for compression and tension, design of energy absorption ...
- Maintenance documentation for service / maintenance in operation
- complete documentation of the product, including strength certificates (test protocols, alternatively FEM calculations, test certificates etc.) of the safety-relevant components lying in the force flow, material specifications, manufacturing certificates (e.g. welding design test part I and part II, approval certificates of the subcontractors, material certificates)

Demonstrator Train (Preview)

The demonstrator train is formed from 24 wagons. Besides, all wagons are equipped with the same coupling type. Aim position is to simulate a real operational service by this train. In the demonstrator train the same types of car are used, like in the single carriage test, however, on the suitable aim number increased, i.e., the number of the vehicles is doubled.

Aim position of the demonstrator train is also to be used in all European climate areas.

With the demonstrator train, experiments are carried out in circulation with the target to simulate a real service.

The "climate tests" under wintry conditions occur in winter, mainly in northern countries (e.g., Sweden).

During the European circulation coupling and uncoupling should be carried out. Aim position is to realise 10.000 coupling-/uncouplings.

Besides, the demonstrator train is to be equipped completely with measuring equipment and at every coupler place the following data are to be generated:

- Strength effect with coupling processes on the coupling head, coupling rod, damping equipment and interface coupling vehicle structure
- Recording accelerations in the named areas with the coupling-/uncoupling
- Recording active forces and accelerations under service

The recorded data are to be processed in tabular form. Besides, minimum values and maximum values are to be marked, in addition, in colour.

In addition, a graphic representation, in each case separate is to be generated from the data table for forces, accelerations and ways.

In parallel with recording the precalled identity values a test of the electric equipment and the data connections occurs. In addition there exists a separate description.

The electric tests on the demonstrator train shall demonstrate the reliability and availability of the electric coupler and the electric power supply including the buffer batteries. During the field tests with the demonstrator train, relevant electrical parameters will be monitored and recorded. The values are given in the test specification, chapter 2.3.2. Data shall be readily accessible, ideally via mobile connection with the traction vehicle.

In addition to the continuously measured values, recurring tests have been specified:

- Contact resistance per coupler interface
- Isolation resistance of the electric coupler
- Power transfer along the train
- Charging and discharging behaviour of the buffer battery

Additional tests concerning the communication functionality and equipment are planned. They will be executed and realized separate.