高雄市政府 捷運工程局
KAOHSIUNG MASS RAPID TRANSIT

STADLER

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General Technical Specification

L-4561_KHYL

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Table of Revision

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_	First Version	21.08.2023	Bilgeri Lucas	Basaras Mikel	Schöfnagl Peter
a	Second Version	07.09.2023	Bilgeri Lucas	Basaras Mikel	Schöfnagl Peter
b	Third version: Update Train Layout Drawing Update Design Representation Update Acronyms and Abbreviations Update Applicable Documents Update Watertightness Update Mechanical Requirements Update Electrical Requirements Update RAM	05.03.2024	Bilgeri Lucas	Basaras Mikel	Schöfnagl Peter
c	Safety Requirements added by Applicable Documents and refered to in Chapter 6	06.03.24	Bilgeri Lucas	Basaras Mikel	Hudec Marek
d					

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1 Introduction

1.1 General Information

Stadler Rail is a Swiss rail car manufacturer, best known for constructing high quality passenger trains. Throughout several decades of experience, Stadler has developed rail car concepts which will allow the operator to provide its passengers with an entirely new, comfortable, safe and highly reliable as well as sustainable metro rail cars.

This general technical specification includes major technical requirements for a new metro-rail car, which will operate in Kaohsiung, Taiwan.

The units will be operated by KMRT (Kaohsiung Mass Rapid Transit).

For developing and designing this metro-line/car, the requirements 12.03.2024mentioned in this document have to be met by Stadler AG and the considered potential supplier (from here on, referred as SU) must comply with them in order to participate in this project.

As it contains technical requirements on a general basis, this document is only exhaustive in combination with additional system-specific specifications and other documents. So, for designing systems and components for this project, detailed system-specific requirements have to be met too.

Figure 1: Exterior Trainset Design Representation

1.2 Unit Configuration

The scope of delivery are twenty-five (25) vehicles in total, consisting of 3 (three) coaches/cars per train (EMU).

The composition for the new fleet consists of two motorized end cars (A and B respectively) and one trailer middle car (C). The three cars are connected to each other by semi-permanent couplers and form an operative unit for automatic driving (GoA4) under unattended, automatic control mode through an Operation Control Center (OCC). Multiple coupled trainset operation is not foreseen as a normal service mode. Rescue coupling can be performed in any section of the track, main line or depot.

The length of the composition is 56 m and offers a capacity of 474 passengers including standees (5 persons per m^2. The trainset fulfils the latest requirements regarding safety, comfort, operability and maintenance.

Each car is equipped with three electrically controlled exterior double-leaf sliding doors on each side (total nine doors on each train side). The entrances are designed to enable level boarding by passengers to the spacious and clearly arranged passenger area.

The motorized cars A and B have one area that offer a proper, safe place for persons in wheelchairs and are equipped with a dedicated zone for manual driving.

The crash energy management is designed according to EN 15227, category C-II, whereas the fire protection measures are defined by the EN 45545. All onboard equipment will comply with impact forces, time and frequencies as defined in IEC 61373.

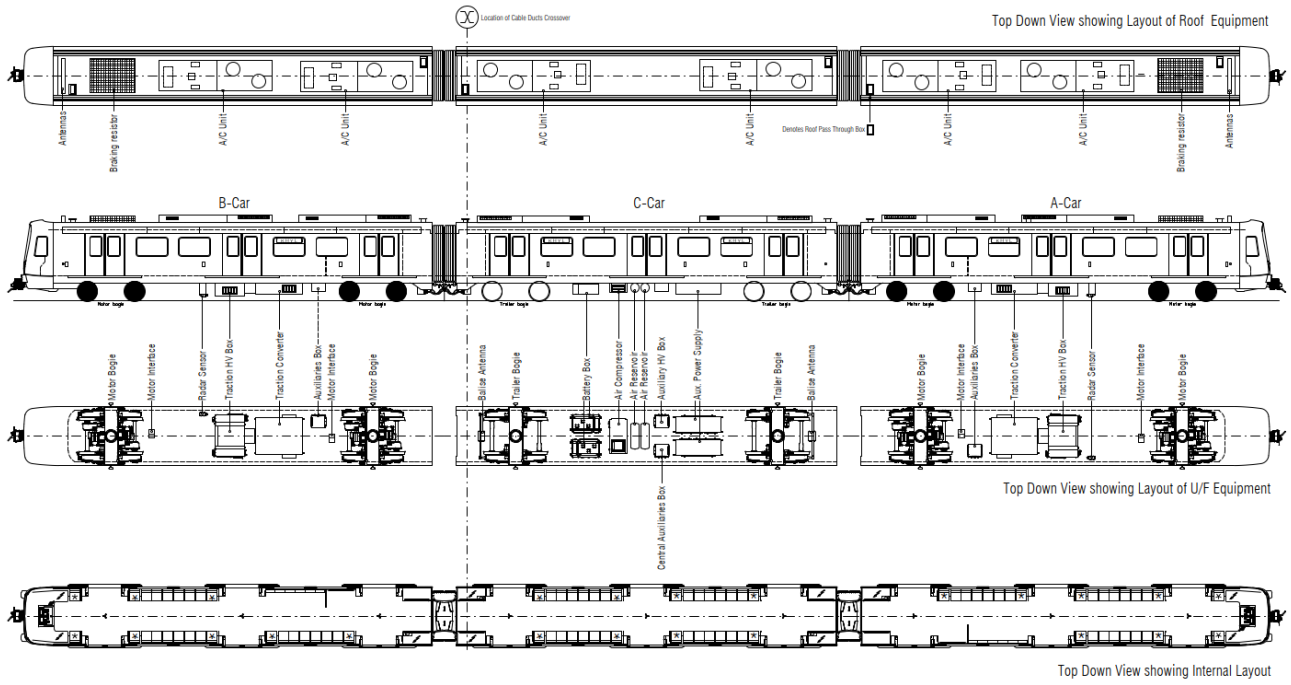

Figure 2 Train Layout Drawing

1.3 Validity of the Specification

This document applies and is valid for the entire project duration, beginning from the design phase, until the whole fleet (25 vehicles in total) reaches the requested availability, even for additional trains with identical configuration, built for the same or any other possible customer.

Requested availability stated in the RAM specification [V3].

There are plans and ambitions to expand the service in Kaohsiung, Taiwan with further metro-lines (routes).

1.4 System Responsibility

Upon submitting the proposal, the SU accepts the content in this document as binding.

It must be comprehensible within the quotation, how and if the SU will fulfil and comply with all requirements mentioned in this general technical specification, including any system-specific specification and document applicable.

If necessary, the SU must add comments to each requirement and indicate/state the compliance (can fulfil / cannot fulfil) they achieve with their design proposal.

The SU has the option/possibility to propose alternative solutions. The Purchaser (PU) is entitled to accept/reject the comments, or alternative solutions and is allowed to adjust the specification accordingly.

The SU has to discuss any critical comments with the PU at the earliest possible opportunity and has to contribute his own knowledge/experience to benefit this project.

If the SU does not submit a statement to this specification, it means the SU fully complies with this specification and all its requirements.

1.5 Acronyms and Abbreviations

SU = Supplier
PU = Purchaser
CU = Customer

For additional acronyms and abbreviations see the respective system-specific specification.

1.6 Applicable Specifications

In addition to the commercial specification [V1], the respective system-specific technical specifications apply. They define the required technical features and requirements of the specified product, so in general, functionality, interfaces, diagnostics, additional applicable standards/regulations and documents, required inspections, tests and technical documentation, etc.

The PU must be informed, if any contradictions between technical specifications, other applicable documents, standards or laws appear.

If parts of the contract contradict, the below hierarchy applies.

Integral parts of the contract:

1. Order, including time schedules
2. Commercial Specification
3. System-Specific Technical Specifications
4. General Technical Specification
5. Framework Contract
6. Quality and Safety Agreements
7. RAM-specification,
8. Documentation Agreement,
9. Training Specification

1.7 Applicable Documents and Appendices

This list include applicable documents, also general standards, Stadler Rheintal AG uses and apply for any potential SU.

[V1]	AL_5502152	L-4561_KHYL_Commercial_Specification
[V2]	AL_5501267	List of Applicable Standards
[V3]	AL_5460262	RAM Specification
[V4]	AL_5394777	Fire Protection Requirements to EN 45545-2 2020
[V5]	BU_1745837	Fire Hazard Analysis Method
[V6]	BU_1742367	Fire load calculation, Suppliers
[V7]	AL_4884481	Documentation Agreement
[V8]	BU_1591979	Training Specification
[V9]	AL_2237907	Delivery Specification Painted Parts
[V10]	AL_2211659	Specification for the Nature of Substrates for Work Samples
[V11]	AL_2429703	Work Samples of Glued Assemblies with STAR
[V12]	AL_5508161	Type Plate Specification
[V13]	AL_5503856	EMU Key Concept Design
[V14]	BU_4713408	RAM / LCC - Datasheet and Stadler PBS
[V15]	BU_2614607	TCMS Ethernet Network
[V16]	STAR_20220034	Cyber Security Supplier IT Network
[V17]	BU_3437624	Directive for the Handling of Silicone
[V18]	AL_4725062	Delivery Specification Corrosion Protection
[V19]	AL_5809366	Safety General Specification

1.8 Contract Language

The contractual language to the End-Customer is Chinese. All of SU's documents must be submitted at least in English or additionally in Chinese, unless otherwise specified.

1.9 Confidentiality

Between SU and PU, these technical specifications have to be held confidential. They are not allowed to be disclosed to third parties. Additionally the PU's internal guidelines need to be followed by the SU under the submission of a, non-disclosure agreement (NDA).

1.10 Duty Cycles and Service Life of the Vehicle

Average hours of operation per day	18 [hours/day]
Days of operation per year	365 [day/year]
Average mileage per year and vehicle	120.000 [km/year]
Design life of vehicles / system	30 [year]

1.11 Time Schedule

Information about the time schedule and milestones to the end customer are listed below (Project Scope).

Item Nr.	Milestones End Customer	Date
1	**Notice To Proceed** (Official **START** for Metro-Project Yellow-Line in Taiwan, Kaoshiung)	**Apr 23**
2	**Conceptual Design Submitted**	**Dez 23**
3	Conceptual Design Customer Approval	Apr 24
4	**Detailed Design Submitted**	**Okt 24**
5	Detailed Design Customer Approval	Mär 25
6	**Final Design Submitted**	**Sep 25**
7	Final Design Customer Approval	Mär 26
8	**Start Carbody Construction Train 1**	**Jan 26**
9	End Carbody Construction Train 1 (Prototype)	Jul 26
10	**Final Assembly Train 1 Completed**	**Feb 27**
12	Start Dynamic Commissioning & Type Testing Train 1	Nov 27
11	**Factory Acceptance Test (FAT) Train 1 in Switzerland**	**Jan 28**
13	Arrival Train 1 and 2 in Taiwan	Jan 29
14	**Customer Acceptance Train 1 and 2 in Taiwan (Visual Inspection)**	**Jan 29**
17	Consignment Stock Delivered (Spare Parts Testing Phase)	Jan 29
15	**Start Dynamic Testing Train 1 and 2 in Taiwan (Endurance Run, Noise Tests, etc.)**	**Jul 29**
18	Employer Spare Parts Delivered	Sep 29
19	**Start Interface Test**	**Jan 30**
20	**Start System Integration Test**	**Apr 30**
16	All Trains Delivered	Jul 30
22	Training & Documentation Completed	Sep 30
21	**Start Revenue Service Simulation / Trial Run (7 days)**	**Jan 31**
23	**Substantial Completion All (25) Trains (incl. Training & Spare Parts)**	**Feb 31**
24	Start Employer Test Run incl. Adjustements	Mär 31
25	RAM Demonstration	Aug 31
26	**Final Acceptance**	**Aug 32**
27	Warranty End	Aug 34

2 Standards and Regulations

2.1 Applicable Laws and Standards

The SU must follow all the standards/regulations and versions stated in chapter 2.2. They can be obtained from the official sources, are mandatory and must be applied. The designated standards/regulations must be verified with a certification or independent expertise.

The use of newer versions of standards/regulations have to be approved by the PU. If a version for a standard/regulation is missing, the latest edition applies by the time the contract was signed with the PU.

If one or more applicable standard/regulation or version wants to be changed for any component or system by the SU, it has to be discussed with the PU. The SU must demonstrate/show, that the changes do not affect the vehicle's safety and the requirements are equivalent to the previous applicable standard/regulation.

If there are conflicting requirements in any standard/regulation, the PU has to be informed immediately. Also if the SU identifies any ambiguity or deviation between standards/regulations, the SU shall immediately consult the PU. The PU will decide the interpretation, priority and/or classification.

If any additional vehicles will be ordered, the list of applicable standards/regulations could be updated by the PU.

The following order of priority for standards/regulations have to be applied:

1. National Standards
2. Laws
3. Harmonised European Standards (EN, etc.)
4. International Standards (ISO, IEC, etc.)
5. Railway Industry Standards (UIC, etc.)
6. Other Standards/Regulations

2.2 General List of Standards and Regulations

See the document **AL_5501267** [V2] , that list all applicable standards/regulations for this project. All standards that are stated in this document, have to be according the version that are listed in the above mentioned document [V2].

Additional applicable standards/regulations are defined in the respective system-specific specification.

3 Technical Requirements and Properties

3.1 General Requirements

3.1.1 Sound related Requirements and Vibration

The noise-limit, the noise insulation-, and absorption-value of materials, components/systems must be agreed by the PU during the conceptual design-phase. So, the noise values of components/systems have to be listed by the SU in the quotation.

Some sound requirements for specific components/systems, can be found in the respective system-specific specification and/or applicable standards.

All equipment, attached to the bogie (for example propulsion components, etc.) have to follow the standard EN 13749.

In all operating modes, the PU must be immediately informed, if structure-borne sound/vibration transmissions from components/systems to the car body/vehicle cannot be fully eliminated and the SU must recommend appropriate measures to prevent/minimise them. Excitation of other vehicle components by structure-borne sound/vibration is also not permitted.

If necessary, suitable vibration-damping measures must be proposed and if approved by the PU, implemented by the SU. Design and dimensioning of vibration dampers mounted between equipment and the vehicle, must be co-ordinated with the PU.

So fittings and components, operation of vehicle-mounted systems, bogie movement and pressure pulses in windows/doors, when passing trains, shall not a exceed a certain noise limit, also its transmission to the passenger area must be considered. The noise limit is specified in the respective system-specific specification.

In all operating modes or conditions, the interior noise level must be free from rattles, whistles or whines, vibrations or other sound disturbances.

At maximum speed (80 km/h), the noise limit value in the passenger area must not exceed 70 dB (A).

3.1.2 Climatic and Environmental Conditions

As the trains (EMU`s) will operate in Kaohsiung, environmental conditions for Taiwan have to be considered, therefore they will be designed to handle tropical and subtropical climate (high temperatures and humidity appear).

Consider and obtain detailed information from the latest 15 year long-term meteorological statistics from the Central Weather Bureau or other relevant entities.

Preparation for weather conditions:
The SU has to show how he will fulfil the weather conditions.

Parameters applicable for Kaohsiung, Taiwan:

- Maximum temperature to be considered = +45º C
- Minimum temperature to be considered = 0º C
- Humidity = 100%
- Maximum altitude = 100 m

Train-operation with higher air-temperature, up to +55ºC is possible. This will probably, and can lead to a reduction of traction performance. Also the production in Switzerland must be considered.

All components/systems have to be designed to operate in a large temperature range without damage or failure. This implements, that the equipment withstands high, as well as low temperatures. If necessary, the SU takes measures to ensure the function of the components/systems.

For electronic devices, the applicable standard is EN 50155, Class T3 (-25/+45°C (outdoors) -25/+55°C (indoors)). The components/systems must withstand an operating temperature of 70°C and a storage temperature of maximum 80°C.

All Electronic equipment on the trains shall comply with EN 50155 and all safety related electronic components/systems shall comply with EN 50129.

According to EN ISO 12944-2/12944-6 ,the atmospheric corrosivity level for Taiwan is C5 (Medium).

At 100% relative humidity, condensation can occur. This must not lead to a malfunction or failure of components/systems.

Local rapid changes in the air temperature (3 K/s) can cause the condensation of water. Such conditions arise especially when entering and leaving a tunnel, and must also not lead to a malfunction or failure of the equipment. Please consider this fact already during the conceptual design-phase.

The design of electrical and mechanical equipment (components/systems) should take into account the maximum wind speed of typhoons. Maximum wind speed of a typhoon in Taiwan is 60 m/s.

The equipment must also be designed and installed to withstand seismic forces, equivalent to a horizontal acceleration of 0.24g and a max. vertical acceleration of 0.17g. The SU must submit a calculation analysis to confirm that the design withstands the seismic forces possible in Taiwan.

The following topics require special attention:

- Rust/corrosion
- Air pollution/harmful substances (carbon raised in tunnels, brake dust, industrial fumes, etc.)
- Natural influences (pollen, leaves, insects, birds, etc.)
- Salt water (Consider corrosion due to seawater (EN 12473))
- Rain
- Wind (Max. windspeed of 210km/h)
- Cleaning agents

3.1.3 Watertightness

As the trains watertightness must prevent water infiltrating into the exterior equipment, the car body structure itself (through welding seams or interfaces) and inside the interior area, each vehicle (including doors, windows, gangways, etc.) has to perform certain tests to confirm and meet the required watertightness. The SU will find further watertightness requirements in the respective system-specific specification and must follow EN 50215

Required watertightness test: The train will be sprayed on with water through nozzles (11L/min/m2) for at least 15 minutes continuously during the inspection and in order to verify the vehicles watertightness capability. The supplier has to follow the standard IEC61133, with a protection level of IPx5. The nozzles have to match with the standard stated in IEC 60529 IPx5. The water spray pattern will be designed with as many nozzle as necessary, to simultaneously cover the entire exterior surface.

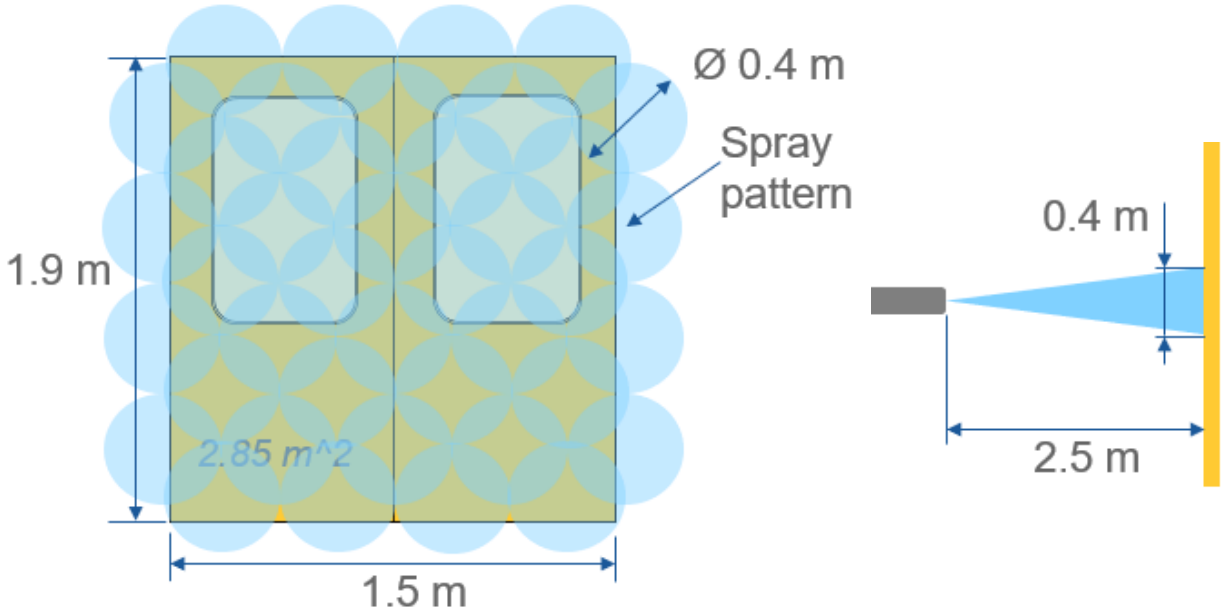

Figure 3: Watertightness-Test; Example of Spraying Pattern Arrangement.

3.1.4 Loading / Design Loads / Force

The SU has to send a structural analysis report that must be submitted to the PU at least 2 weeks before the FAI for review and approval.

The load-bearing structure of car body equipment (components/system) and their attachments must comply with the structural requirements defined in EN 12663-1, vehicle category P-III. Additional load cases in accordance with UIC 566 apply to interior equipment, such as fixed seats and tip-up seats.

The following information, stated in standard EN 12663-1, are important to be considered:

- The static acceleration loads, including the superposition, according to section 6.5.2 must be considered.
- The fatigue loads, according to section 6.6.4, 6.6.5, 6.6.6 and 6.7.3 must be considered. The evaluation has to consider a complete superposition of all load directions.
- In addition, a natural frequency analysis has to be carried out. All relevant natural frequencies must be > 20 Hz.
- For structures at risk of buckling, an additional stability assessment (e.g. bifurcation analysis) has to be carried out.
- Material properties shall be based on applicable European standards, wherever possible.

Higher loads can be defined in the respective system-specific specification. Where necessary, any other load case that may or can arise, have to be discussed and defined in close cooperation with the PU and are analysed, following the principles of EN 12663-1.

For structures exposed to aerodynamic loads, the supplier has to fulfil the standard EN 14067-5. The SU has to communicate the PU the intended loads for the calculation, which are part of the approval.

Weld seams shall be dimensioned according to EN 15085-3. Their safety categories shall be determined in cooperation with the PU.

Structurally relevant bolt connections, shall be assessed according to VDI 2230 Part 1 (November 2015) and DIN 25201-1. For static loads as described above, no slipping in any load case of the bolted component/system is admissible, otherwise measures need to be taken. Wherever necessary, the risk class of bolt connections shall be determined in cooperation with the PU.

The reaction forces at the interfaces to the car body shall be determined for all load cases and submitted to the PU for review and approval.

All onboard equipment and suspended components of the vehicle shall comply with IEC 61373 to ensure, no fracture and permanent deformation will occur, as well as, to ensure the reliability of these components. For components, that are directly attached to the vehicle body, the requirements according to category 1 – class A applies.

The fastening strength (including fatigue strength and impact strength) of all equipment installed on the train, shall consider the random impact-, and vibration-load that can occur, to ensure that the vehicle can operate reliable without generating fatigue damage, permanent deformation, disengagement, displacement to the car body or the component/system.

For more information, see applicable standards and respective system-specific specifications.

3.1.5 Fire Protection

The unit shall satisfy the fire safety requirements EN 45545 parts 1-7 in the respective current version for operation category 2 and design category A vehicles (2A).

3.1.5.1 Fire Protection Requirements of Materials

Material selection must be done according to EN 45545-2:2020 - Hazard Level HL 2.

Combustible materials shall be avoided. Fire behaviour, smoke development and smoke gas toxicity of the employed materials must be evidenced with fire protection test report. These requirements apply to any cables used along with any components to be supplied (with the exception of purely metallic, uncoated components).

Fire protection test reports must be provided by the SU for coated or painted metal components whose coating or paint structure differs from a coating or paint structure specified by the PU.

Only test reports from accredited test institutes (EN 17025:2017) are accepted. The test reports must be valid for the entire duration of the project. (Test reports are valid for a maximum of 5 years) For the purpose of documenting certification, the SU shall produce a materials verification list (UNIFE Fire Certificate Inventory List / List of Combustible Materials UNIFE Doc: TGFS.03) that includes component designations, details of quantities/volumes and weights etc. on the basis of which the valid fire protection certifications can be assigned clearly by the PU.

3.1.5.2 Electrical Components

Part 5 of EN 45545:2013+A1:2015 defines the fire protection requirements for electrical components. The SU must test the electronic components and devices according to EN 50155:2021. For the purpose of fire protection, these tests must take account of the electrical ignition propensity of a system

3.1.5.3 Fire barrier

The fire resistance of the barrier between underfloor area to the vehicle interior will be E30 and I30, verified in accordance of EN 45545-3:2013.

3.1.5.4 Fire detection system

To be able to detect a fire in a very early time when incident occur the passenger area and high power equipment cabinets will be equipped with a fire detection system. The alarm will be send directly to the OCC. If a fire is detected the CCTV will be linked with the affected compartment, HVAC will be switched off. In the equipment cabinets containing high-power components, the non-traction, non-braking and non-evacuation-relevant systems are shut down selectively.

3.1.5.5 Fire extinguisher

Each car will be equipped with extinguishers in accordance with EN45545-6:2015 in order to enable staff and passengers to extinguish a fire. The fire extinguishers are easy to reach and they will be possible to remove them without effort. Information signs (pictograms) draw attention to each fire extinguisher.

3.1.5.6 Fire Load Calculation

The PU must provide a fire load calculation for the entire vehicle. To this end, the SU shall compile a fire load calculation for the system he delivers. For this purpose, after the contract has been awarded, the PU provides an electronic Excel template entitled 'Fire Load Calculation, Suppliers' which must be used by the SU (BU_1742367) [V6].

3.1.5.7 Fire Risk Analysis

The PU must carry out a fire risk analysis for the entire vehicle according to EN 50553:2012/A2:2020 and EN IEC 60812:2006. To do this, the PU shall require a corresponding analysis of the SU's subsystem as part of preliminary work. The SU will execute a fire risk analysis for his system as per the "Methodology of Fire Risk Analysis" guide. The PU shall provide the SU with this guide after the contract has been awarded (BU_1745837) [V5]. The fire risk analysis constitutes an assessment of the fire risk of the supplied system. It is part of the set of documents required for approval of the entire vehicle.

3.1.6 Adhesive Bonding

The regulations of DIN 6701 series must always be considered for all adhesive bonding applications in railway vehicle bodies. To be permitted to perform an adhesive bonding technique, the SU must document the functional test for class A1 and A2. For class A3 and Z, individual tests are carried out if necessary.

The SU must document the adhesive-bonded joints, classify them in accordance with the requirements, and validate them by their classification with arithmetic proof or other measures (testing, for example).

Project-related requirements are specified by the PU, or are agreed between SU and PU for individual cases.

The necessary requirements (adhesive-bonding classes for example) are specifically agreed with the specialised bonding engineer (bonding supervisor) and the quality assurance department of the PU. They are not explained any further in this document.

Additionally 5 bonding samples might be required, which is defined in [V11].

3.1.7 Welding Assemblies

The SU must fulfil the requirements of the standard EN 15085 and relevant technical leaflets (such as DVS directives and leaflets).
The necessary requirements, such as weld performance classes, have to be specifically agreed by the specialised welding engineer and the quality assurance department of the PU.

3.1.8 Cleaning

The paint finish shall be capable of withstanding any detergents used for the cleaning process. A concept based on the paint structure will be established and submitted to the SU within the material order.

All non-powder coated, or painted metal components (floor coverings, windows, etc.) have to withstand the detergents used by the CU. Those will be communicated to the SU once known and as soon as possible in The PU will propose a coating during design phase, which is resistant to those cleaning agents and therefore necessary to follow.

3.1.9 Vandalism and Anti-climbing

Equipment (components/systems) have to be designed in such way, that damage due to vandalism is prevented as far as possible.

Appropriate measures must be proposed by the SU and/or co-ordinated directly with the PU. This applies in particular to:

- Finishing (graffiti-resistant)
- Materials (scratch-, deformation-, or fracture-resistant)

Internal and external material finishes and applied coatings must permit easy removal of graffiti by trained personnel, using proper graffiti cleaning chemicals. The original surfaces shall not degrade as a result of the removal process.

The Supplier has to demonstrate the removal of the following types of graffiti from a test panel:

- Permanent marker pen, leather dye, Aerosol paint. In all cases the graffiti shall be allowed to cure for 24 hours prior to any attempt for removal

Special requirements for all components in the passenger compartment are:

- Visible screws should be avoided if possible. If not, concept has to be agreed by the PU.
- Fissures and gaps must not constitute contact surfaces for leverage tools (pocket knives for example)
- The components must be impact-resistant
- Interior body side panels shall be easy to clean and resistant to fading and scratching
- Resist damage from scuffing or abrasion caused by contact with wheelchairs, passenger luggage or other possible items applicable
- Resist damage caused by cigarettes or other smoking materials

3.1.10 Ergonomics

Stadler vehicles are designed in accordance with the current state of the art and meet ergonomic standards such as EN 614, ISO 9241-210 and EN 13861.

As a guidance, the anthropometric data book of Chinese people, in Taiwan has to be considered. The PU will provide necessary data, if requested by the SU.

3.2 System-specific Requirements and Properties

3.2.1 Functionality

See respective system-specific specifications.

3.2.2 Mechanical Requirements

See applicable standards and respective system-specific specifications.

3.2.2.1 General Notes for Mechanical Components

- Bevel sharp edges. Use a sharp-edge protection, wherever necessary or possible.
- Piping:
    - Avoid water pockets.
    - Attachment clamps must not produce any sound or vibration.
    - Fittings: have to be accessible, also when installed on vehicle.
- With the exception of electrical cabinets inside the vehicle, systems that require fresh air (for cooling, etc.), must take the air directly from outside the vehicle. Based on the ambient (environmental) parameters, the SU must take proper measures (plan filters, etc. for example)
- If equipment (components/systems) require lubricants or other consumables during regular operation, the selected types and grades that want to be used by the SU, have to be proposed and/or coordinated with and agreed by the PU.
- Protective measures (enclosures, protection plates, etc.) have to be installed wherever necessary (areas bearing risk of injuries; during operation or maintenance, for example), in accordance with applicable regulations, standards, or laws
- Frost protection of hydraulic systems must be ensured (Antifreeze-agent, for example).

The PU reserves the right to point out any minor/major disconformity that is not listed above and has to be changed by the SU, if requested.

3.2.2.2 Weight

Keeping the weight to a minimum is essential. The SU should submit recommendations for lowering the weight, but should at least achieve the weight, specified in the respective system-specific specification.

The weight and centre of gravity of components/systems must be listed within the offer. Weights of the individual components for a assembled system must be listed too.

The SU shall provide a weight calculation (centre of gravity included) for the components/systems, that always includes the margin of possible errors of the individual weights and the information of whether they are weighed, calculated or estimated.The weight will be controlled at the FAI. If the weight exceeds the specified value, it will be penalized, as described in the commercial specification [V1]. If the component/system does not have a FAI, the weighed mass must be latest sent to the PU four weeks prior delivery.

3.2.2.3 Tolerances

General tolerances according to ISO 2768, class m-K must be applied.

If other tolerances have to be considered or have to be applied, they are specified by the PU in the respective system-specific specifications In those cases, a interface drawing has to be provided and agreed upon.

3.2.2.4 Materials

If requested by the PU, the SU shall provide material declaration. This declaration shall provide a material break down by weight of the different components. At least 95% of the total mass of the component must be declared. The Contractor must document the use of all restricted materials in the material declaration list aligned with the information in this chapter.

The vehicle parts shall not be made of PVC, urethane foam, or rubber foam. The use of materials that are known to be detrimental to health is also not allowed, but the PU may grant approval of certain materials upon request.

The following Swiss and European regulations concerning the handling of hazardous materials must be complied with, regardless of the application:

- REACH Regulation: (EC) No 1907/2006 as amended
- RoHS Directive: 2011/65/EU

Materials and products subject to these regulations and restrictions (e.g. asbestos, PCB, CFCs, etc.) are forbidden in accordance with the specifications in the above-mentioned regulations. In addition, regional or project specific requirements may apply at the SU's request. Conformity with the regulations must be confirmed in a compliance statement. Conditions of restricted materials and substances shall be met. Furthermore, components that exceed regulated concentration limits of certain materials and substances must be declared in a substance declaration. In this case the SU has to seek approval for an exception of the use of the respective substance or material by the PU.

The directive on the handling of silicone [V17] has the aim of avoiding any possible contamination with substances that are incompatible with paint, in particular substances containing silicone in the painting area and adhesive area. This should reduce paint surface and adhesive adhesion faults and prevent from the associated time-consuming and cost-intensive rework. Sprays, silicone oils and silicone greases are specially critical. Before using sprays, greases and sealing compounds, always ensure that they are free of silicone. In case of doubt, this must be clarified with the PU. For more information, see applicable standards and respective system-specific specifications.

3.2.2.5 Surface / Corrosion

To take proper measures (surface treatment; coating/finishing), see details of the environmental conditions/properties, that have to be considered for the respective project in chapter 3.1.2.

Additionally, the SU must comply with the requirements of the applicable system-specific-specification, as well as the general coating guidelines [V9] [V10] [V18].

The coated metal surface of components/systems must be protected against corrosion to fit their intended use and resist the specified corrosivity category. According to EN ISO 12944-2/12944-6, the atmospheric corrosivity category for Taiwan has to be considered. However, another category with higher requirements may be specified in the specifications of certain components/systems. The most restrictive has to be applied.

In general, steel is recommended using Zinc-Nickel plating or hot dip galvanisation. For stainless steel, corrosion resistance CRC Class III (according to DIN EN 10088) is mandatory, especially for exterior equipment. Blank metal surfaces are not accepted. Corrosion protection requirements are summarized in [V18].

Due to the climatic and environmental conditions (see chapter 3.1.2), A4 screws have to be used for structural exterior connections, as well as for the entry area. For heavy duty and if deemed necessary, zinc flake coating screws can be used, but only, together with appropriate preservation.

The SU has the right to follow or deviate from the previous recommendations regarding material choice, as long as the selected material, coatings and conservation materials withstand the climatic and environmental conditions for the entire life cycle of the vehicle.
Following these recommendations does not exclude the supplier from their liability. All deviations shall be submitted by the SU to the PU for approval.

The SU must take care when pairing materials, so interfaces between different metal components (fasteners, riveting etc.) shall be protected to avoid electrical corrosion.

The coating applied (bogies, couplers, onboard equipment, closures, etc.), shall use coating (material and process), that is also endurable and have good resistance to friction, moisture, oil, specified water pressure (washing process), and the rail transport environment in general or at least similar applications.

As long as for powder-coating nothing different is explicitly specified by the PU, a minimum of double layer powder coating has to be applied.

The coating details of equipment (including surface treatment level, coating material, coating layers, film thickness, colour shades, etc.) and relevant documents, shall be submitted for the PU`s review and approval.
Before series production begins, 10 sample plates of the painted component must be delivered. The sample plates must be approved by the PU. Detailed information can be found in [V9].

For more information, see applicable standards and respective system-specific specifications.

3.2.2.6 Identification / Type Plate

All components/systems must be labelled. Signs and markings must be durable and easy to read. The labels should at least contain the following data:

- Manufacturer Name
- Date of manufacture
- Article Number Stadler

For any further information, please refer to the type plate specification [V12], which will be established in co-operation with the End-Customer and submitted to the SU.

3.2.2.7 Locking Concept

Cabinets and enclosed equipment (components/systems) of any kind must have a locking concept that has to be agreed by the PU.

If a component/system has a lock installed, special requirements apply. The SU must follow the locking concept supplied [V13] by the PU. If a key is required to be integrated in their component/system, the SU has to sign a confirmation that the needed key has been retained. In the event of loss or non-return, the SU will be held liable for any damage caused to the PU, according the commercial specification [V1].

3.2.3 Pneumatic Requirements

See applicable standards [V2] and respective system-specific specifications.

3.2.4 Electrical Requirements

3.2.4.1 General Notes for Electrical Components

- Electrical equipment and its installation on the vehicle shall be designed and dimensioned so that it conforms to and satisfies the applicable parts of the components and shall be assured in accordance with EN 50153.
- The delivery shall be constructed and designed so that it does not cause electrical interference, voltages, currents or other phenomena that may damage or interfere with other vehicles or infrastructure.
- All expected mechanical, thermal, electrical, climatic and environmental loads that typically occur in rail applications must be taken into account in the design of the electrical components. The system design must meet the requirements of EN 50155.
- The delivery shall comply with “Guidelines for Restricting Time-varying Electric Field, Magnetic Field & Electromagnetic Field” (0 Hz – 300 GHz), for the parts relevant according to EN 50500 (Measurement procedures of magnetic field levels generated by electronic and electrical apparatus in the railway environment with respect to human exposure).
- The interface drawings must always show the tolerances of the interfaces towards each other as well as their dimensions.
- Electrical installations shall be of the two-pole type, i.e. all electrical equipment shall have a separate return conductor

3.2.4.2 Energy Supply

The low-voltage power supplies are 110 VDC in accordance with EN 50155 and on request 24 VDC. The power supply for apparatus with a higher power rating, is 380 VAC at 60 Hz in accordance with EN 50533, Class 1. Other voltages and the choice of power supply must be discussed and agreed with the PU. The used voltage for the subsystem will be discussed with supplier during the design phase in accordance to the power consumption of the component.

3.2.4.3 EMC

An EMC test report according to DIN EN 50121-3-2 must be submitted for all individual electrical components. After prior agreement, this can also be in the form of test certificates from an independent accredited body.

Electric circuits must not be connected to the vehicle ground. Deviations must be agreed with the vehicle manufacturer in advance.

Functions of the rail infrastructure, such as track vacancy detection systems or the operator's radio systems, must not be affected by the vehicle. Corresponding EMC limit values and requirements must therefore be considered (EN 50121-3, EN 50238).

Likewise, the vehicle must not influence or interfere with other electronic devices, e.g. radio-based systems for data transmission (radio networks, telephone networks, radio and television systems, WLAN networks, etc.).

3.2.4.4 Grounding

The SU must enable the connection to protective ground of all electrically conductive, touchable parts and surfaces, such as terminal boxes, covers, doors, etc. To determine the cross-section, the contact voltage in case of a failure, shall be calculated by the SU. Standards EN 50153, UIC 533 and EN 50122 must be applied in this case. Further on, for grounding connections the EN 50343 shall be applied. The contact surfaces shall be protected from corrosion.

The PU reserves the right of publishing project-specific and binding specifications of the mechanical grounding structure.

The grounding connection points between vehicle and delivery object are agreed with the PU in the course of the project.

Protective earth and signal earth (if both exist) must be routed and implemented separately.

3.2.4.5 Power Consumption

See applicable standards and respective system-specific specification.

3.2.4.6 Cabling and Electrical Connections

The type of cable, line, unit, connector, and terminal identification at the interfaces to the vehicle must be agreed with the PU. The identifications must be permanently affixed (including for loose cables) and easily readable. Cable and wire identifiers must be in protected transparent plastic envelopes.

Unless specified otherwise, metric cable glands and threads are used. Cable hoses made from synthetic material must be halogen-free and comply with the fire prevention regulations. The material of hose and pipe systems must be selected as required by the expected mechanical loads and the places of installation in the vehicle.

The applicable standards must be observed for cable routing in rail vehicles and line dimensioning. EN 50343, in particular, is decisive for railway applications.

The preferred connector for outdoor use is Harting Han HPR.

Cabling concepts that have an effect on the electronic vehicle system must be agreed between PU and SU.

Durability must be considered when labeling elements to prevent future peeling and smudging (please refer to chapter 3.2.2.6 of this specification).

Additional, the CU requirements in the table below are mandatory for every SU to follow

Item No.	Contractual ID	Requirement Text
1	2.15.(2).C.c.	All control and power cable connectors shall be placed in the enclosures or in the junction box with waterproof gaskets, or the connector itself shall be waterproof. The opening for cable shall be sealed with the waterproof cover.
2	2.18.(5).A.	The conductor in the wire (cable) shall all be pure copper. All the wires (cables) shall be coded and/or numbered by color for easy identification, and its writing shall be clear and not erasable.
3	2.18.(5).B.	The installation of wires (cables) shall be tied firmly with the appropriate fixing device. If the arrangement of wires (cables) has the concern of damage from friction, the protection device shall be added. The wires (cables) shall comply with the fire prevention provisions stated in Section 2.6 of this Specification with respect to the flammability, smoke-generating value (including the toxic smoke) etc.
4	2.18.(5).C.	The appropriate spare quantity shall be considered for the electrical circuit, control wire, and others of the equipment, and shall comply with the specification/standards of IEC 60077 and IEC 60571/EN 50155.
5	2.18.(5).D.	The wire (cable) joints outside the vehicle (including that between vehicles and between vehicle roof and chassis) shall be protected by water-proof devices, which shall comply with the water-proof standard of IP 56 at least as specified in IEC60529. When arranging and constructing cable and its joint outside the vehicle, the design of wear resistance of the cables and the waterproof and rust-proof design of the cable joints (including related contacts) should be considered. The configuration design of 750VDC high-voltage cables (such as insulation barriers, etc.) between vehicles should take the requirements of insulation and arc protection into consideration.

Comment PU: Please ignore the red marked text and refer to chapter 3.1.5 of this specification for fire prevention.

3.2.4.7 Communication interface

(Sub)systems and components that are controlled by electronics or software and equipped with internal diagnostic systems are connected to the train control and monitoring system (TCMS) via Ethernet according to specification [V15].

3.2.5 Software Requirements

The train network shall comply with IEC 61375 or IEEE 1473, or equivalent or better train network standards with verified supply record and high safety.

The software shall be developed according to EN 50657 and provide as a minimum the corresponding documents for the following development phases, unless the supplier has already a developed software according to the EN 50657.

Documents shall be per system, as appropriate.

- System Functional Description (SFD)
- Software Quality Assurance Plan (SQAP)
- Software Configuration Management Plan (SCMP)
- Software Verification and Validation Report (SVVR)
- Software Requirements Specification (SRS)
- Interface Control Documents (ICD)
- Software Design Description (SDD)
- Software Requirements Traceability Matrix (SRTM)
- Software Test Procedure (STPr)
- Software Test Report (STR)
- Software Version Description (SVD)
- Software User Manual (SUM)

- Software Release Note (SRN)

Table of content shall include the following:
General
Approval of software release
Hardware dependencies
Software dependencies
Compatibility in multiple operation
Known problems and open issues
Changes
Software integration report
Warning threat situation
SW-Download on CPU
New software problems
Document changes

If a system includes more than one software component, the SU must always deliver one complete software package with one version. Further on, a software release note and a software test report for each new software version has to be delivered by the SU with at least the following information:

Every SU of a system to be integrated into the TRDP-based TCMS network has to have his implementation tested by the PU. The test procedure is specified in more detail in a separate document. The PU requires all TRDP communication patterns with UDP, but not with TCP.

Please refer to the following table regarding the deadlines of the different software versions.

SW Version	Deadline
Version for Software/Communication Tests	6 months prior to static commissioning of first vehicle
Full functional release candidate for tests on train	3 months prior to commissioning of first vehicle
First official version 1.0 including release notes (Documentation)	Prior to first type test

Additionally Software documentation has to be delivered.

3.2.6 Diagnosis and Failure Behavior

Unless otherwise specified, an accumulative fault message must be provided for all electrical systems and the signal formation down to the lowest replaceable unit (LRU) (e.g. ok, warning, out of order, end of live of the LRU will be reached) is to be agreed with the PU.

The special requirements of this document must be taken into account for (sub)systems and components that are equipped with internal diagnostic systems or a diagnosis storage system that is controlled by electronics or software.

Unless specified otherwise, the fault and status data is captured and stored in the subsystem control unit and sent to the TCMS via ethernet including the pre- and after environmental data (environmental data need to be agreed together with PU). Type and scope, transfer path, and, if necessary, signal generation and acknowledgement/reset functions of the transferred messages must be agreed for each project with the PU, or be defined in a separate diagnosis concept.

Depending on the type of project and delivered object, the following points must be agreed with the PU:

- If MMI or operating unit exists: Method of displaying diagnosis information
- Workshop diagnosis: Display of diagnosis and operation parameters via service software to support service staff (service laptops), service interfaces, software tools, and related documentation. The service software, including the necessary configuration files, shall be supplied in all cases.
- Components/systems with vehicle bus connection: Transfer of diagnostic information and selected operation and process data to a higher-order control system for visualisation, transfer of data to an operation centre, or to a display in a leading vehicle.
- Implementation of the diagnosis level for the function concerned or the smallest economically replaceable unit that corresponds to the components that can be replaced in the vehicle on site (such as modular drawer units, board modules, motors, temperature sensors, etc.). The diagnosis level is to be broken down to a level of exchange units and individual devices that is economically sound for maintenance purposes.
- Diagnosis quality and safety: Fault recognition and disclosure of safety-relevant faults, and detection of triggered safety functions.
- Diagnosis quality: Avoiding continual coming/going entries of faults (by implementing time windows and thresholds, for example)
- Diagnosis quality: Suppression of sequential fault or incorrect messages (for example power failure, system start-up, initialisation processes, time conditions)
- Diagnosis quality: Triggering any (semi-) automatic test runs to implement the disclosure of faults in certain functions.
- Target group-oriented preparation and categorisation of diagnostic messages
- Event codes, remedial texts and reference to maintenance / repair documentation
- Unless agreed otherwise, compliance with DIN EN 60706-5 'Maintainability of equipment - Part 5: Testability and diagnostic testing'.
- Software development documentation, software development process
- Supply of Diagnose software including licenses

4 Interfaces

See respective system-specific specification.

5 RAM/LCC, Special Tools, Spare Parts and Maintenance Requirements

This chapter only covers basic RAMS/LCC topics that must be achieved. The exact requirements for the respective project are specified in the corresponding RAM specification [V3].

5.1 Risk analysis

The supplier must conduct a comprehensive risk analysis to identify potential risks and their impact on the system.

5.2 Requirement management

The supplier must implement effective requirement management to ensure that all requirements are captured, documented, and managed.

5.3 Development process

The supplier must implement a clearly defined development process that meet the requirements of the standard EN 50126.

5.4 Verification and validation

The supplier must implement verification and validation procedures to ensure, that the system meet the requirements and operates safely and reliably.

5.5 System integration

The supplier must ensure, that the system is fully and securely integrated into the overall infrastructure.

5.6 Lifecycle management

The supplier must ensure, that the system is maintained and supported throughout its entire lifecycle.

5.7 Documentation

The supplier must provide comprehensive documentation that meet the requirements stated in chapter 7.

5.8 Reliability

As a supplier, it is necessary to ensure that the technical system delivered, can perform its functions without failure or interruption to ensure high reliability. To maintain the reliability of the system and to detect and correct problems early, regular maintenance and repair work is required.

5.9 Availability

The supplier must ensure, that the technical system has high availability and can continuously perform its intended functions. This requires regular maintenance intervals and fast repair times in case of malfunctions. The supplier should also take appropriate measures to minimize environmental influences such as extreme temperatures or humidity, thereby increasing the availability of the system.

These requirements ensure that a system is safe, reliable, and available, and that risks are minimized to avoid potential damages.

5.10 Life Cycle Cost (LCC)

The supplier must consider the LCC of the system and ensure, that the system is designed to be cost-effective throughout its entire life cycle. This includes the proper selection of materials, the maintainability, and the reliability of the system. The Stadler template BU_4713408 [V14] has to be used for the representation of the LCC.

5.11 Maintainability

The supplier must ensure, that the system is designed to be easily and safely maintained. This includes the design of components that are easily accessible, as well as the use of standardized components and procedures.

The opening and closing space required (e.g. for maintenance purposes) and the outer dimensions of components have to be specified in the interface drawing and in the 3D model. The 3D model must allow each of these states to be shown/hidden.

Additional see respective system specific technical specification.

5.12 Accessibility

The supplier must ensure that the system is designed to be easily accessible, this includes the placement of components in easily accessible locations.

5.13 Spare parts

The supplier must ensure, that spare parts are available for the system. This includes planning for spare part procurement throughout the system's life cycle and selecting components that are readily available.

5.14 Special tools

The supplier must ensure, that no special tools are required for system-maintenance, that are not easily available or unreasonably expensive. This includes the design of components that can be maintained with standard tools.

By fulfilling these requirements, the supplier can ensure that the system is cost-effective, maintainable, accessible and reliable throughout its entire life cycle. Specific requirements will be provided to the SU in a RAM specification.

5.15 Maintenance Justification

See RAM Specification [V3].

6 Safety

See [V19] and respective system-specific specification.

7 Tests and Acceptance

The purpose of the tests/inspections are, to verify the function of the equipment (components/systems), also to ensure that train operation can commence without complications and fulfil the specified requirements of the respective project.

7.1 Inspections and Test Schedule

Where the respective system-specific specification does not make a stipulation, the SU has to make a proposal for testing the equipment (component/system). The in-vehicle integration test will be scope of the vehicle type-testing. For the integration tests, the SU`s quotation must include support in Switzerland and if necessary or ordered, in Taiwan.

7.2 Test Certificates and Test Documentation

The required test certificates will be defined in the order, or in the system-specific specification. The test documentation of system-specific inspections will be handed over to the Customer if requested, even if this is not required in the system-specific specification.

So in general, compliance must be demonstrated with relevant test reports and/or certificates according to specified standards and/or requirements. If the tested item/system is used by the SU in previous projects, the same documentation can be provided but must be approved by the PU.

7.3 PreFAI

The PU reserves the right to carry out a pre-FAI inspection for all FAIs, attended by the customer.

If ordered, Pre-FAIs are carried out at the SU's expenses. The requirements of a pre-FAI are defined in consultation with the end customer (CU) and communicated by the PU to the SU. The scope of a pre-inspection is identical to the one of the customer FAI to ensure optimal preparation.

The closer the SU collaborates and shows transparency with the PU, the more likely, a pre-FAI is not requested.

The SU reserves the right to perform an audit when deemed necessary.

7.4 First Article Inspection

If an FAI is ordered, the specified equipment (components/systems) are subject for the First Article Inspection (FAI) before they are installed in the vehicle.

The FAI includes the following points in particular:

- Visual inspection
- Dimension inspection (for example, general outer dimensions and dimensions relevant for interfaces)
- Weighing and definition of the centre of gravity
- Functional check, also the compliance of all requirements specified.
- Documentation check (for example, calculations, test reports, general certification necessary, etc..)

A FAI plan is developed by the Stadler Project Quality Manager (PQM) until the end of the design phase, which contains all details needed for the SU. The SU shall prepare and submit the FAI documentation according the documentation agreement [V7], prior to the first delivery and submit it for approval to the PU. Non-compliance with delivery deadlines, lead to fines that will be charged according the commercial specification [V1]. The FAI is automatically not completed unless all documentation is delivered and accepted.

The FAI generally takes place at the SU's production facilities, but can be held directly at the PU site. This will be decided by the PU. The date is announced at least 4 weeks in advance and is communicated through the Stadler PQM to the SU. The CU has the right to attend the FAI

A not approved FAI has to be repeated. To this, the SU is bound to invite the PU ten days before repeating the FAI. An approximate FAI repetition date has be fixed between SU und PU on the day of the not approved FAI. All costs and charges included) of this repetition are for SU's account.

The results of the FAI will be included in an FAI report. The report will contain any faults detected, the agreed-upon actions to be taken and has to be signed by all parties present.

Any faults detected, must be rectified by the SU as soon as possible or defined and agreed by both parties (latest before the handover to series production). Updates on fault-correction must be reported to the PQM, without prior request. After the faults have been remedied successfully (relevant proof to be provided), the PQM decides, if the FAI needs to be repeated.

The realization and completion of the FAI does not absolve the SU in any way from fulfilling its contractual obligations, deliveries and the overall schedule.

7.5 Type Test

Type tests on selected systems are normally performed on the first component/system and/or vehicle. Also to validate the evidence needed and to demonstrate compliance with the relevant/applicable standards/requirements.

The required type tests will be specified in the system-specific specification. This will include confirmation of when, by whom and where the testing will be performed, and which tests the CU will witness.

Type test protocols relevant for the authorisation or for the CU`s acceptance have to be provided if necessary and/or specified.

For some type testing, the presence and support of the SU’s specialists is required. This also includes support for all proves needed to authorise/approve the vehicle.

7.6 Series Test

If a 3.1 test certificate is ordered, the SU has to deliver the corresponding documentation. Further documents needed and requirements to be fulfilled for series tests, will be listed in the order and/or the respective system specific specification.

7.7 Acceptance

The tests/inspections must be performed under certain conditions, specified by the PU and have to be passed by the SU in order to be accepted by the PU.

See respective system-specific specification for more information.

8 Documentation

The SU must provide comprehensive documentation that fulfil the requirements specified in here, the respective system-specific specification and comply with the “documentation agreement” [V7].

8.1 User Documentation

The user documentation has to fulfil the requirements of the “documentation agreement” [V7] and further specifications, which will be attached to the request for quotation.

8.2 Engineering Documentation

The technical vehicle documentation has also to be created in accordance with the documentation agreement [V7]. The exact documentation needed, additionally will be specified in the respective system-specific specification. The SU must fulfil the delivery times stated in the “documentation agreement” [V7], otherwise the commercial specification [V1] applies.

The Engineering documentation submitted for review in each design phase, shall at least include the following items:

- Drawings of components/systems and parts (complete set of drawings)
- Bill of material (including material information, weight, etc.)
- Data sheets
- 3D-Model (stp.file)
- Calculation reports
- Schematic, Cable List, List of Electrical Components

Dimensions shall be expressed in metric system.

8.2.1.1 Installation Instructions

See applicable standards and respective system-specific specifications.

8.3 Configuration Management

The PU has to be informed immediately, if components/systems are modified in any way and be must be presented to the PU in advance for approval.

The following conditions are major examples for changes that are significant for the respective/applicable equipment (component/system):

- Changes in dimensions
- Change of the weight and/or the centre of gravity
- Changes that affect assembly or installation
- Changes that effect mechanical, electrical, hydraulic or pneumatic interfaces
- Changes to the surface treatment
- Changes that may affect the function and/or has effects on the characteristics
- Changes that may affect the associated official approval
- Changes that may result in the degradation of performance characteristics
- Changes that affect reliability, availability, maintainability or safety
- Relocation of the production site, or changing sub-suppliers
- Changes that affect energy consumption
- Software changes

Such changes may require a partial or complete repetition of the first article inspection (FAI).

The configuration management documented, has to be in accordance with the PU requirements.

For further information about the change/configuration management process, please refer to the commercial specification [V1] and applicable standards [V2].

9 Training and Support

The courses are usually held at the maintenance location of the PU. The training takes place on an operational vehicle. The necessary infrastructure, as well as a training room in the proximity of the vehicle, is provided by the PU free of charge.

The courses are held according the training specification [V8] and training documents has to be supplied according the “documentation agreement” [V7].

Support for the initial installation and verification on the first vehicle, also additional CU training might be required. This will be specified within the order.

10 Scope of Delivery

See respective system-specific specification and prior the inquiry/order.