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TECHNICAL SPECIFICATION

FOUR-AXLE, DOUBLE-ENDED, LOW-FLOOR STREETCAR TYPE 10 T3 FOR THE CITY OF PORTLAND, OREGON

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1.0 GENERAL TOPICS AND DEFINITIONS

1.1 INTRODUCTION

This technical specification describes the type 10 T3 Streetcar vehicle that the partnership of OREGON IRON WORKS, Inc. and SKODA TRANSPORTATION s.r.o. intends to offer the City of Portland, Oregon in reply to the RFP # 105620.

This document should be used in addition to Part II, Section B, Sub-part B of the RFP. It outlines the content of each major system of the vehicle and is additionally intended to provide a clear image of the technical proposal for our team.

The new Streetcar is based on the existing Portland Streetcar, but using domestic components. The main design and manufacturing objective for this new vehicle is to preserve the positive features of the existing vehicle and to address any desired improvements, issues, while attaining full Buy-America compliance per the RFP requirements.

1.2 DOCUMENT ORGANIZATION

The organization of this document corresponds with the sections of the RFP. Each part of this technical specification addresses the RFP's requirements and describes in detail our solutions for the proposed vehicle.

1.3 DEFINITIONS

AW0	Weight of the vehicle without passengers
AW1	Weight + seated passengers + 4 standing passengers per sq. meter.
AW2	Weight + seated passengers + 6 standing passengers per sq. meter.
AW3	Weight + seated passengers + 6.6 standing passengers per sq. meter. Passenger weight: 70 kg.

1.4 ACRONYM AND ABBREVIATIONS

ANSI	American National Standard Institute
CMOS	Complementary Metal Oxide Semiconductor
DIN	Deutsche Industrie Norm (German Industrial Standard)
ECU	Electronic Control Unit
EMC	Electro magnetic Compatibility
EMI	Electro magnetic Interference
EN	European Norm
HVAC	Heating, Ventilating and Air Conditioning
IEC	International Electro-Technical Committee
IEEE	Institute of Electrical and Electronic Engineers
IGBT	Insulated Gate Bipolar Transistor
ISO	International Organization for Standards
LED	Light Emitting Diode
LRV	Light Rail Vehicle
MB	Maximum Brake

MSB	Maximum Service Brake
MTBF	Mean Time Between Failures
NFPA	National Fire Protection Association
RFP	Request for Proposals
SAE	Society of Automotive Engineers
SI	International System of Units
TOR	Top of Rail
TWC	Train to Wayside Communication

1.5 UNITS OF MEASURE

All units of measure on this technical specification are in accordance with the International System of Units (SI). All values are presented either in base units, or derived units; defined algebraically in terms of these fundamental units. The base units are consistent with the MKS (meter/kilogram/second) portion of the metric system.

A	Ampere
dB	Decibel
dBA	Decibel on the 'A' weighted scale
g	Acceleration due to Gravity (9.80665 m/s^2)
g	Gram
h	Hour
Hz	Hertz
J	Joule
kg	Kilogram
km	Kilometer
km/h	Kilometers per hour
kN	Kilonewton
kWh	Kilowatthour
l	Liter
m	Meter
m"	Cubic Meter (volume)
MHz	Mega Hertz
MPa	Mega Pascal
min	Minute
mm	Millimeter
mV	Millivolt
µV	Microvolt
N	Newton
Pa	Pascal
s	Second
V	Volt
Vac	Volt alternating current
Vdc	Volt direct current
°C	Degree Celsius

2. DESIGN AND PERFORMANCE

2.1 GENERAL DESIGN DESCRIPTION

The Streetcar type 10 T3 is a four-axle double-ended three-section low floor vehicle with a standard track gauge of 1,435 mm. The vehicle is equipped with two motorized (two-axle) trucks providing 100% adhesion. The trucks secure the required dynamic running and braking performances of the vehicle in all modes and during all weather conditions.

The vehicle consists of two end car sections with floors designed 780 mm above the top of the rail (TOR) and one suspended middle section with the low floor designed 350 mm above TOR. Both end car sections are mounted on motorized trucks. The low floor middle section is equipped on each side with two double-panel doors and one platform gap-bridging device positioned near the center of the vehicle. Inside the mid section is vacant floor space for two wheelchairs. The end sections are equipped with one single-panel door on each side of the vehicle.

Each end of the vehicle has a fully equipped driver's cab, which allows easy and safe operation of the vehicle. The operating control and performance is equal in both directions of operation. The vehicle is designed for single unit operating service. In case of breakdown, both end cabs are equipped with a manually controlled, folding coupler for towing.

The vehicle is fully compatible with the Portland Streetcar area environment including its right-of-way, station platforms, maintenance facility, existing vehicles and operating conditions. The wheel profile is according to figure 2-2 of the Tri-Met LRV Technical Specification and is designed to operate on the rail types 115 RE, RI-59 and RI-52 of standard track gauge.

The propulsion system of the vehicle consists of two IGBT based traction inverters mounted on the roof and four asynchronous traction motors mounted on the trucks. The vehicle is equipped with two functionally independent but coordinated regenerative propulsion systems. A nominal 750 V DC power supply is supplied from the overhead contact line. The vehicle has a balancing speed of 48 km/h on a level tangent track over the full range of wheel wear, at nominal line voltage and mean passenger load AW2. The maximum operating speed of the vehicle with fully worn wheels is 70 km/h.

Each operator's cab and the passenger compartment is provided with automatically controlled roof-mounted heating, ventilating and air conditioning units. In the passenger compartment, the HVAC units distribute air into two lateral upper channels. The units above the drivers cab distribute air into the ceiling covers with adjustable orifices. In addition, there are electric floor heaters mounted in the passenger compartment under the lower sidewall. The heating and ventilation system in the driver's cab is ducted to provide defrosting and demisting of both the windshield and side windows.

During the manufacturing phase, OREGON IRON WORKS, Inc. and SKODA TRANSPORTATION s.r.o. will use appropriate technologies and testing to guarantee all features and characteristic parameters stated in this technical specification.

The design and manufacturing of the type 10 T3 vehicle applies the latest knowledge verified in operating service. The vehicle is designed and manufactured in accordance with appropriate standards of ANSI, ASTM, DIN, EN, IEC, IEEE, ISO, UIC or other applicable standards. U.S. standards will supersede, where appropriate.

2.2 OPERATING ENVIRONMENT

The vehicle is designed for operation on city streets in mixed traffic with top speed of 48 km/h and according to the operating conditions and parameters stated below.

2.2.1 RIGHT-OF-WAY INTERFACE DESIGN CONSTRAINTS

Track gauge measured 14 mm under the TOR ..... 1,435 mm
Applicable rail types ..... 115 RE, RI-59, RI-52
Maximum gradient ..... 100 ‰
Minimum horizontal curve radius ..... 18 m
Minimum horizontal curve radius in depot (empty vehicle at low speed) ..... 16 m
Minimum vertical radius, crest section ..... 250 m
Minimum vertical radius, sag section ..... 250 m
Minimum crest and sag sections connected with a tangent section of 7.5 m in between ..... 250 m
Minimum crest and sag sections connected with no tangent section in between ..... 350 m
Minimum crest or sag superimposed with 20 m horizontal curve ..... 450 m
Front of accessible door opening from the front of front bumper:
For right-hand stops ..... 11,665 m
For left-hand stops ..... 7,165 m

2.2.2 ANTICIPATED CLIMATIC CONDITIONS

Environment temperature ..... -20° C to + 42° C
Average relative humidity outside the vehicle ..... 0 to 70 %
Maximum relative humidity outside the vehicle ..... 100 %
Maximum wind speed ..... 120 km/h
Maximum amount of precipitation (rainfall) ..... 15 $mm.min^{-1}$
Maximum level of water above TOR for distance of 120 m (at speed up to 16 km/h) ..... 50 mm

The vehicle is capable of operation after several days of standing in an open area unattended, as well as operation in adverse climatic conditions. Its equipment is protected against wind, water flow, and water turbulence caused by the movement of the vehicle. The vehicle is capable of operation in demanding weather conditions, such as snow, intense rain, and freezing.

2.2.3 WAYSIDE POWER SUPPLY

The vehicle is designed to operate from power supplied from an overhead contact line system, set as a single contact wire and fixed termination. All equipment on the vehicle is protected from damage or continued shutdown caused by random power interruptions due to isolation gaps, pantograph bounce or other reasons. Braking system performance is met regardless of conditions on the power line. The equipment is designed for plus polarity supply in the overhead catenary lines.

Nominal power supply voltage ..... 750 V dc
Maximum sustained power supply voltage ..... 925 V dc
Minimum sustained power supply voltage ..... 525 V dc

2.3 VEHICLE DIMENSIONS AND WEIGHTS

2.3.1 CARBODY DIMENSIONS

Vehicle length ..... 20,130 mm
Width of vehicle (excluding mirrors) ..... 2,460 mm
Low floor height from TOR at middle section (AW0) ..... 350 mm
Floor height from TOR at end sections (AW0) ..... 780 mm
Min. interior ceiling height from finished floor to finished ceiling - middle section .....2,200 mm
Min. interior ceiling height from finished floor to finished ceiling - end sections..... 2,100 mm
Clear opening width of double-panel doors fully opened ..... 1,300 mm
Clear opening width of single-panel door fully opened ..... 700 mm
Total clear opening width of all open doors at one side of vehicle ..... 3,300 mm
Clear side door height of double-panel door fully opened from finished floor..... 1,960 mm
Clear side door height of single-panel door fully opened from finished floor..... 2,060 mm
Maximum roof-mounted equipment height, exclusive of pantograph, above TOR
with new wheels and vehicle at AW0..... *3,430-3,450 mm
*= maximum height to be finalized upon selection of the HVAC supplier and unit
Maximum total static suspension deflection from AW0 to AW3 height ..... 50 mm

All height dimensions mentioned in this document, if not specified otherwise, are measured from the top of rail with AW0 load and new, unworn wheels.

2.3.2 PANTOGRAPH DIMENSIONS

Height above TOR of pantograph in the lockdown position at AW0, new wheels..... 4,060 mm
Pantograph operating height, during any condition of AW0 to AW4, new/worn wheel:
Maximum ..... 7,090 mm
Minimum ..... 3,920 mm
Collector head width over horns .....1,710 mm
Collector head carbon shoe length..... 1,001 mm
Longitudinal distance between carbon shoe centers ..... 357 mm
Maximum longitudinal distance from pivot center to panto shoe, locked down ..... 2,681 mm

2.3.3 WHEELS DIMENSIONS

Wheel diameter - new ..... 610 mm
Wheel diameter - worn ..... 530 mm
Wheel profile according to figure 2-2 of Tri-Met LRV Technical Specification.
Back-to-back dimension of wheels ..... 1,367 mm
Width of wheel tire ..... 114 mm

2.3.4 TRUCK DIMENSIONS

Wheelbase of truck ..... 1,880 mm
Centerline-to-centerline truck spacing ..... 11,800 mm
Nominal power of traction motors ..... 4 x 90 kW

2.3.5 CLEARANCE

Vertical undercar clearance from TOR with maximum suspension deflection and carbody roll, minimum vertical curve radius and fully worn wheels ..... 65 mm

2.3.6 WEIGHTS AND PASSENGER LOADING

The following table shows the number of sitting and standing passengers at the four individual load statuses:

Weight of empty car ..... 28 000 kg ± 3%
Weight of truck ..... 4,340 kg
Weight per axle at AW3 ..... 9,765 kg

LOAD	DESCRIPTION	SEATED + STANDEES	TOTAL	WEIGHTS
AW1	SEATED	30 + 0	30	30 170 kg
AW2	SEATED + 4 P / m^2	30 + 85	115	36 120 kg
AW3	SEATED + 6 P / m^2	30 + 127	157	39 060 kg
AW4	SEATED + 6.6 P / m^2	30 + 140	170	39 970 kg

Calculations in table above are based on 70 kg per passenger and one operator.

The area available for standing passengers is 21.25 m^2.

All equipment on the vehicle is arranged so that its weight is distributed to maximize adhesion and prevent any tendency to derail. The maximal difference in weight acting on trucks does not exceed 900 kg at any load condition and the lateral imbalance on wheels will not exceed 290 kg for all loading conditions.

2.4 SUPPLY VOLTAGES

There are several circuit networks on the vehicle.

Power supply voltage ..... 750 V dc
Auxiliary network voltage ..... 3x 460 V, 60 Hz
Vehicle battery voltage ..... 24 V dc

The low voltage system consists of the battery, low voltage power supply, battery chargers and related apparatuses. The battery nominal voltage is 24 V. The voltage may fluctuate between 16.8 V and 28 V. When the battery chargers are working, the voltage may reach 30.0 V dc. voltage spikes up to 33.6 V for one second will not the damage any equipment.

The AC power supply output is 3x 460 V, 60 Hz. It is a three-phase network, galvanically insulated from the overhead catenary power. All the equipment on the vehicle is protected from damage and improper operation due to high voltages transients or long-term overvoltages.

2.5 PERFORMANCE

The vehicle will operate satisfactorily on standard-gauge lines. The propulsion equipment is designed to operate at a nominal voltage of 750 Vdc. The nominal power of traction motors is reached at 31 km/h. The vehicle is capable of operating at speeds of 8 km/h or less for 20 minutes without overheating the vehicle equipment.

The minimum full acceleration average rate (at the maximum run position) is 1.39 m/s^2 for AW2 load or 1.30 m/s^2 at AW3.

The acceleration rate is available in the speed range between 0 and 40 km/h.

The acceleration from 0 to 40 km/h at AW2 load takes 8.96 s of flat and direct section of line (intended from a change in control signal).

The maximum speed is limited by software to 48 km/h. The maximum safe operating speed with fully worn wheels is 70 km/h, corresponding to the traction motors maximum 4800 rpm.

The main service brake is electro-dynamic, being a blend of regenerative and rheostatic. The maximum service brake rate at speeds between 5 km/h and 48 km/h at AW3 load is 1.34 m/s^2. Dynamic brake fade is at approximately 4.5 km/h. The mechanical brakes are used to provide the final stopping force. Should the electro-dynamic brake fail, the mechanical disc brakes will engage, achieving at least 0.95 m/s^2 for one stop.

The emergency braking system uses a combination of mechanical disc brakes and track magnetic brakes. Emergency braking is mechanically activated from the driver's cab by pressing mushroom shaped pushbuttons, or in the event of the vehicle sliding, the magnetic track braking system will automatically engage at both cabs simultaneously. Emergency braking is not limited by jerking and is irretrievable until the vehicle comes to a complete stop. When braking between the 48 and 25 km/h, the average emergency brake rate is 2.23 m/s^2.

Wheel spin and slide correction is active at all situations except during emergency braking. Sanding is applied automatically during the correcting the major spins/slides, regardless of the traction coefficient.

During mode change (power to brake, power to coast, etc.), the dead time will not exceed 0.4 second. Jerk limits after any mode change dead time will be between 1.1 and 2.0 m/s^3 for maximum run/brake request, and between 0.45 and 2.0 m/s^3 for lower run/brake applications.

The "no motion" signal is detected at speeds below 5 km/h. The safe signal is generated by both propulsion and brake control after evaluating all speed sensors signals. The parking brake holds the vehicle loaded up to AW4 on 10 % grade.

The vehicle equipment is configured for continuous operation at AW2 loading on a duty cycle full acceleration. – 40 km/h continuous run on length 275 m – fully brake deceleration – 10 s stay in station. The cycle holds 34.8 s.

The vehicle is capable of towing an inoperative vehicle to the nearest station loaded to AW3 with mechanical brakes released.

2.6 NOISE, VIBRATION AND RIDE QUALITY

2.6.1 GENERAL

The audible noise measurement of the Type 10-T0 vehicle # 9172 (currently running in Portland) was performed by a SKODA TRANSPORATION s.r.o. certified test laboratory and consisted of following tests:

- measurement of noise emitted by fluorescent lamps of interior
- measurement of interior noise in both a motionless and moving
- measurement of exterior noise in both a motionless and moving

Stationary measurements were performed in the Municipal Mass Transit Authority Streetcar depot at Plzen, Czech Republic. Additionally, in 2001, interior noise testing of both a running and a stopped vehicle were performed on the Portland Streetcar line. Although some of the tests results exceeded the demands of the RFP, Škoda/OIW is planning improvements resulting in decreased noise levels both inside and outside the vehicle.

2.6.2 INTERIOR NOISE

Acoustic pressure $\mathbf{L_A}$ emitted by lighting fixtures does not exceed the limit published in RFP. Also values of interior noise measured during stationary test are satisfactory. In a running vehicle, the values for interior noise measured in operator's cabs is always below limits. In passenger compartments, the values at maximum vehicle speed exceed the limit by 2 dB. At speeds of 10 km/h and 25 km/h, the measured values are within the acceptable range.

2.6.3 EXTERIOR NOISE

Values for exterior noise measured during stationary testing did not exceed the RFP limit. Exterior noise measured at a distance of 7.5 m from the central axis exceeds permitted limit by 3dB at a speed of 25 km/h and 6 dB at 48 km/h. At a distance of 15 m, the limit is exceeded by 4 dB at maximum speed.

2.6.4 PLANNED IMPROVEMENTS

In order to address and fulfill the RFP requests on noise levels generated during the running mode of the vehicle, we are planning improvements to materials which have higher sound and vibration absorption properties; namely greater material thickness at all window glazing, improved insulation in the sidewalls and roof, and improved subflooring and floor covering materials.

The OIW/Skoda team is planning to exceed the current performance of the existent Portland Streetcars and to meet the RFP requirements for interior noise (70 dBA – vehicle stationary, empty and 75 dba – vehicle empty, on tangent track accelerating to 48 km/h or in max dynamic braking or friction braking).

The new vehicle incorporates many features designed to reduce the interior noise to the acceptable limits. Replacing the current side windows with a 6.5 mm laminated glass will significantly reduce the noise level. The proposed flooring, made of a composite "honey-comb" core encased between sheets of aluminum or fiberglass will also significantly reduce the interior noise versus the current plywood flooring. In addition, the OIW/Skoda Team is planning to employ a company specializing in the development and implementation of noise and insulation "packages", should these improvements prove insufficient. The OIW/Skoda Team will provide test results showing compliance with the RFP requirements.

2.7 ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY

Vehicle equipment is designed to not electrically interfere with the safe and proper operation of the vehicle itself or with any of the wayside equipment.

Considerations include:

- the use of shielded wires for power energy transmissions (traction, auxiliaries)
- the use of shielded wires for sensor connection
- the use of twisted shielded wires for communication cables
- separation of power cables from low-voltage and communication cables
- On the first prototype vehicle, the EMC will be tested according to EN 50121-3-1 norms

The measurement will include:

- radiated emissions
- conductive emissions according to limits defined in RFP
- inductive emission limits according to limits defined in RFP

2.8 VEHICLE SAFETY ANALYSIS

Addressing safety aspects, pedestrian bystanders and Streetcar personnel have been taken into account. Documents will be prepared as regards:

- Hazard identification
- Safety hazard analysis (SHA) defining the hazards, their probabilities, and impacts
- Failure mode affectivity critical analysis (FMECA) for components of vehicle control, i.e. propulsion, brakes and other safety related items
- Certificates verifying the material composition and properties influencing safety

3. CAR BODY

3.1 CAR BODY GENERAL

The vehicle carbody is made from bent and welded steel profiles or steel sheets as an improvement to the existing Portland Streetcar vehicle. Any highly exposed parts such as stairs, sidewall sheeting and roof sheeting will be made of stainless steel. The carbody is designed for a service life of 30 years, based on the material's resistance to corrosion and the influences of all operating conditions.

The front and rear underframes are provided with anticlimbers whose height and arrangement is fully compatible with the existing Portland Streetcar vehicles. These anticlimbers serve to absorb the impact of the vehicle into a solid obstacle or another vehicle. The driver's cabins, from the front of the vehicle back to the first passenger door, are designed for maximum operator safety.

The car is constructed of energy absorbing materials and components which may be easily repaired or replaced. The underframe and side walls have been designed to maximize passenger safety in the event of a side-impact collision. Emergency evacuation is possible in the event of damaged doors and side walls by removing the fixed parts of windows from within the vehicle's interior. Parts or components more exposed to potential damage, (such as bumpers), are easily removable and replaceable. The body structures of the individual sections are blasted and coated with a suitable weldable primer. The vehicle side wall sheet metal pieces are bonded to the car body with a high strength structural adhesive.

The roof structure is designed to support the load of maintenance personnel in addition to a full load of all the equipment installed on the roof. Water drainage from the roof is provided using anticorrosive ducts to the ground.

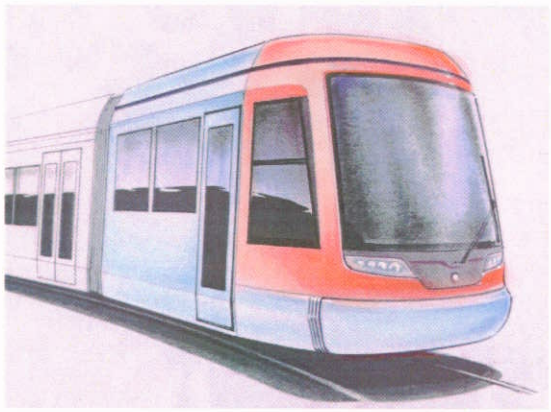
The vehicle doors are operated by a spindle mechanism with mechanical locks. These locks, together with the vehicle's electrical control system, prevent spontaneous, undesired opening of the doors, in the event of a collision. To unlock the doors of a damaged vehicle, mechanical handles are located near all doors. Once unlocked, doors may be opened by simply pushing on the door panels.

The vehicle body consists of three articulated sections connected by upper and lower joint connections. The end cabs are mounted on motorized trucks, the middle cab is suspended from the end cabs. The joint connection between sections provides for rotation around a vertical axis with the upper connection also providing lateral shifting. The vehicle sections are connected in a manner that absorbs all rail irregularities while passing over a section of curved track, regardless of wheel wear conditions; from maximum wheel size to maximum permissible wear.

The joint connections are fitted with bellows assemblies, composed of external bellows and an internal lining. This combination provides safe passage between the individual vehicle sections, secures the joints, and provides sound and thermal insulation characteristics comparable to other areas of the vehicle.

***** Optional offer: If desired by the customer, OIW/Skoda could provide an updated external appearance with more modern features and up-to-date styling.***

The following are "face-lift" renderings for the new prototype vehicle.



The following parameters have been established regarding the "face-lift" proposals:

- the windshield and driver's side windows will not change
- the welded steel frame and the interface with the fiberglass shell will not change
- Interior linings of the driver's cab will not change

The design modification would affect only the following parts:

- Upper roof cover
- Bumper cover
- Fiberglass end shell
- Head lights

The new appearance could have the following new features:

- circular head lamps
- bumper and bumper joint
- front fascia
- roof fairing

The advantages for the new appearance are as follows:

- a more modern, aerodynamic appearance
- a cleaner appearance at the joint between front and side bumper
- the upper roof cover would continuously connect to the front face

We propose this optional design, as the current vehicle design reflects a mid-nineties styling appearance. By 2008, when the new Streetcar arrives, it could already look outdated, being a 15 year old design. The proposed "face-lift" will provide a modern appearance with minimum changes to the current design and with no effect on the major vehicle systems.

3.2 STRUCTURAL DESIGN

The structure of the proposed body meets the RFP requirements and improves on the Type 10 T0 at the anticlimbers. The end sill compression passes structural compression load testing to 392 kN with no permanent deformation. This previously tested to 290 kN.

All car body structures have been FEA (finite element analysis) tested and validated by SKODA Transportation at an independent certified laboratory in Plzen, Czech Republic.

3.3 STRESS ANALYSIS

The 10 T3 vehicles use the same body shell/structure as the Streetcar vehicle. During the original design of the Portland vehicle all significant and required structural analysis work was performed. The FEA test results have been confirmed by structural testing (compression test). Reports are available and will be provided upon request. The result of the structural analysis and testing shows the body shell/structure meets the structural requirements typical for a vehicle of this type, and as required in the customer specification. All FEA and testing performed on the vehicle structure showed that the stress values are withitructure as the original Portland n the admissible limits of the body shell material.

3.4 JACK PADS AND HOIST INSERTS

The vehicle is equipped with appropriate lifting/jacking points on each section providing both lifting and re-railing of the vehicle. The first section has (on both sides) non-slip jacking pads at the centerline of the motorized trucks and two round hoist inserts near the doors. A third lifting/jacking pad is at the centerline of the underframe beneath the vehicle. Lifting or re-railing may be provided by means of either autocrane or hydraulic lifting devices.

3.5 FOLDING COUPLERS

To accomodate for towing, the vehicle is equipped (on both ends) with manually controlled mechanically foldable couplers, hidden behind a front shroud. The coupler is fully compatible with existing cars and is equipped with the "Prague head" 525 mm above TOR. The maximum operational load in tension or stress is 76 kN. The coupler is able to absorb energy of 4.7 kJ. During manual manipulation, the required force does not exceed 15 kg and the coupling of two vehicles does not take more than 4 minutes for skilled personel.

4. OPERATORS CAB

4.1 OPERATOR'S CONTROLS

Command and control buttons are available to provide relevant functions. The main controller, switches, buttons and displays are of a modern type recommended for public transport vehicles. The buttons are equipped with glued-on logos with long service life. Wording on the panel (including buttons) will not be subject to wear.

Controlling and signaling elements are ergonomically arranged on the driver's desk. The cabin and desk have been designed to ensure that the displays and controls are visible within a wide range of conditions. The light intensity of the backlit buttons and display are dimmer controllable. An auxiliary panel houses bypass and heating controllers, emergency drive switches and consumed and regenerated power counters.

There is a manual lever at the left-hand side of the driver, used to control driving and braking performance. In the event a driver becomes incapacitated, a driver's safety device, activated by the release of the revolved head of the lever, engages the protective circuits of the vehicle to apply maximum service brake. This ergonomically shaped lever and a comfortable elbow rest ensures comfortable control of the vehicle. An electronic horn may be activated by a foot pedal.

4.2 OPERATOR'S INDICATORS

The vehicle is equipped with an electronic diagnostic system for the benefit of maintenance personnel and drivers. The system collects data in the driver's and passenger cabins, monitoring for any subsystem failures. In the case of malfunction, it displays a brief description to the driver on the left side of the dashboard in front of driver and can easily be read under all lighting conditions. The system records any failure with a corresponding time and date.

A separate button is provided for an alarm bell at the right side of the desk. Also in the right side of the desk is a red mushroom-shaped brake button, designed for use in the event of emergency or following a failure of the control circuits. Driver cabins are fitted with an internal lighting system of two overhead fluorescent lamps. At night only the individual instruments and signal lamps need be left on. The light intensity of the backlit buttons and display are dimmer controllable.

4.3 MISCELLANEOUS CAB EQUIPMENT

Identical driver's stations are located at each end of the vehicle. These driver's stations are separated from the passenger space, and locked in order to prevent the driver from being disturbed by passengers. An audio system provides for two-way communication with the passengers, configured to provide the following communication options:

- from the operator to passengers, inside and outside the vehicle;
- alternating communication between a passenger inside the vehicle and the operator;
- from the passenger information system to passengers inside and/or outside the vehicle
- via pre-recorded announcement sequences and destination sign displays.

All heating or air-conditioning is thermostatically controlled by the driver. Each driver's station also has a heater situated beneath the cab, available for heating the cab without having to heat the passenger compartments. This heater has two independent circuits (750 Vdc) as well as a cell fan fed by 3x 460 V, 60 Hz. On the auxiliary panel is a control for either fan alone or fan with heating.

The driver's cabin is fitted with right-hand and left-hand window assemblies, providing for side views from the cabin. A portion of the assembly may be manually opened by sliding it horizontally. An adjustable interior mirror and two heated and remotely adjustable exterior mounted rear-view mirrors allow the driver an unobstructed view of all doors and the full vicinity of the vehicle.

The centerline of the spring loaded driver seat is located 150mm to the left of the vehicle's longitudinal centerline. The seat is able to swivel 30 degrees, and at the forward facing direction, automatically locks to prevent uncontrolled turning. The lock can be easily released by the operator while seated to permit swivelling.

The ergonomically shaped seat and back cushion are upholstered with low smoke foam and covered with transportation grade fabric backed vinyl or leather. It has, at minimum, a 100 mm thickness of seat cushion, is equipped with adjustable lumbar support, a right side flip-up armrest, a fore-aft adjustment of 150 mm and height adjustment of 100 mm. ** The easily accessible control elements, located on the right-hand side of the base, enable the driver to adjust to the optimum driving position. The seat is securely bolted to the floor.

***** Optional offer – for improved performance: If desired by the customer, a pneumatic or electric motor could be installed. The swivel option may necessitate a location other than beneath the seat.***

A 4.5 kg capacity UL listed fire extinguisher with a minimum rating of 4-A:30-B:C, marine type, is mounted in each operator's cab, using a marine type bracket.

The windshield of each driver cabin is fitted with a washer and a single wiper blade providing a constant or intermittent wipe of at least 80% of the glass height and 60% of the width. These elements are controlled at the driver desk. The filler for topping off the fluid level of the washer is located at the right-hand corner area of the desk. To reduce light and thermal radiation into the cabin, green tinted glass is used. Also, the cabs are equipped with driver controlled, adjustable sunscreens, to aid the driver in all external light conditions including simultaneous front and side sunlight. **

***** Optional offer – for improved performance: If desired by the customer, the two tracks along which the side window screens slide up and down could be redesigned parallel, for easier operation than currently experienced.***

The current Portland street car vehicles have heating elements embedded in the PVB interlayer of the windshield and driver's side windows. This feature was not requested in the RFP and so has not been included in this proposal. The Type 10 T3 vehicle's heating and cooling system will feature ducting to provide a defogging/demisting/defrosting feature. Eliminating the heating element handles all maintenance concerns of glass overheating. Additionally, non-heated glass provides a significant cost benefit.

4.4 OTHER CAB EQUIPMENT

Access to the driver station is through the passenger cabin via a crosscab sliding door; able to open and close without intrusion into the passenger cabin floor space. The door is made of sheet steel and profiles. The door structure and suspension is designed to prevent noise and vibration, and is painted for corrosion resistance. It is lockable from both inside and outside using a cylindrical insert lock. A single key is used, per vehicle, to open either driver cabin door; (being at each end of the vehicle). In the door is a pane of glass, tinted green with light permeability at least 75 %, and matte finished to decrease reflectivity. Once in the passenger compartment, the driver exits the vehicle through the single-wing passenger door.

Built into the right side of the desk is a bin with a lid, providing a convenient storage of the driver's personal items. As an additional convenience, each cab will have a dual-plug 110 Volt AC power outlet.

5. PASSENGER DOORS

5.1 GENERAL

The 10 T3 vehicle is equipped on each side with two double-leaf doors located at the middle (C) section and one single-leaf door located on the front-end sections (A and B). The double-leaf two-wing doors on each side are located opposite each other. All the doors are intended for boarding of passengers.

The doors are of a sliding-plug type, controlled by signals from the operator's cabs. The doors are electrically controlled; each door has its own electrical control. Each doorway includes two door panels which slide in opposite directions, parallel to the sidewall of the Streetcar.

One double-leaf door per side is equipped with a bridgeplate to provide boarding to disabled persons. The bridgeplate is electrically operated and integrated with the door system.

The door system components are fully interchangeable between locations of the Streetcar. The same holds valid for the bridgeplate and its control.

5.2 DOOR PANELS

Door panels are made of a 28 mm aluminum sectional frame. The tracks for the guide rollers of the locking columns are integrated into the top and bottom sections. Each door panel is equipped with single-pane laminated safety glass.

At each door panel a locking column is installed in the portal. These locking columns are equipped with guide rollers, which run in tracks at the top and bottom of the door panels, by means of coupling tubes between the driving unit and the locking columns.

The door panels have a lip trim which seals against the frame on the portal. The door panels themselves are sealed against each other in the center by means of finger protecting rubber trailing edges.

5.3 DOOR OPERATOR

The door operator is located just above each door. The left and right leafs operate simultaneously. The twin panel sliding plug door is centrally driven by a 24V motor that generates a planetary gear, guiding the elements with a synchronous belt drive. The right and left door panels are arranged in a laterally reversed position to one another and move in opposite directions. A parallel steering system generates the outward rotation of the door panel. This movement is controlled by roller carriages firmly connected to the rotating arms and running along a curved portion of the guide. When the roller carriages reach a straight segment of the guide tracks, the rotation process ends and the door panels move parallel to the side wall of the Streetcar. The twin panel doors provide an entry clearance of 1300 mm, the single panel provide 700 mm.

5.4 BRIDGEPLATES

The retractable bridgeplate, situated beneath the side door threshold, is provided to bridge the gap between the doorway threshold and the wayside low platform at one doorway on each side of the vehicle. If the bridgeplate losses power, it will remain in the last commanded position. Bridgeplate motion is possible only when the vehicle is at a complete stop and only if doors are closed.

For bridgeplate operation, there are two independent command signals:

- bridgeplates (+ doors) release
- bridgeplate retract

After the bridgeplate is released by the driver, it can be retracted by passengers' buttons or passengers' tape switches. The bridgeplate motion is accompanied by visual and audible signals in the related door/bridgeplate area.

5.5 DOOR OPERATOR AND BRIDGEPLATE CONTROL PANEL

The control panels are behind the door mechanism cover above the door and can be opened using the square maintenance key.

5.6 DOOR FUNCTIONAL REQUIREMENT

If the doors lose power, they will remain in the last commanded position. The door closing/opening peak force is set to 115 kN. Maximum force on one leaf at closing is set to 65 kN. The door drive has locks retaining the door in a closed position, which is applied automatically after the door reaches the closed position. In each door there is also an emergency release handle to manually open the doors. The door system includes position-sensing switches to detect the door leaf position.

There are two independent door command signals; "door open" and "door release", which function only when the vehicle is at a complete stop. The passengers use local pushbuttons, located on the door leafs both inside and outside to send the open and release signals. Closing of the door is engaged by a "door close" signal, operating the door and bridgeplate.

5.7 DOOR OBSTRUCTION DETECTION

A sensitive edge with a pressure wave switch is installed in each door panel seal. After the switch detects an obstacle in the doorway, the door leafs immediately open and remain open for a preset period (adjustable between 1 and 10 seconds). This operation will recycle until the obstruction is removed.

5.8 CONTROL SWITCHES AND PUSHBUTTONS

All door controls are of a heavy-duty rail vehicle type, suitable for frequent use on Streetcars. The single-leaf doors, situated near the operator's cabs, function even if the battery main switch is switched-off. The door buttons are located beneath the covers alongside the doors and require the square maintenance key to unlock.

Also hidden under-cover is a mechanical lever for releasing the first door, should battery power not be available.

The cab door-control pushbuttons are functional only when the operator switch is in a forward, neutral or reverse position (any position other than "OFF") and the no-motion signal is set to "ON".

On the cab dashboard, are two groups of buttons; one designated for servicing the right side of the vehicle, the other servicing the left side. Also, on the right-hand side, there is an extra pushbutton, used to open the single-leaf door.

LED illuminated passenger pushbuttons are located on the double leaf doors. The single-leaf doors are equipped with non-illuminated buttons. The pressing of a passenger push button on a door-leaf gives the same "stop request" signal as a pressing of the tape switches, placed inside the passenger interior.

LED's also illuminate the passenger's bridgeplate request buttons. In the driver's cab, a bridgeplate deploy request indicator will function to notify the operator of any request.

If the bridgeplate button is pressed at a doorway after that door has opened, the door will immediately close, the bridgeplate will deploy, and the doors will reopen.

5.9 MANUAL DOOR RELEASE MECHANISM

The doors are equipped with a red colored emergency release lever. Activation of this mechanism will engage the irretrievable maximum service brake, and then allow the doors to be unlocked and manually pushed open. A label is present explaining that operating of lever will both release the door and stop the vehicle.

5.10 INTERLOCK REQUIREMENTS

The doors and bridgeplates are electronically interlocked and will operate only when the vehicle is at a complete stop. If the doors are not safely closed and locked, a light on the dashboard notifies the driver, the propulsion power is removed and the maximum service brake applied.

5.11 BYPASS DEVICES

A sealed door bypass is installed on the bypass board of each cab. The vehicle cannot move if any bypass switch is engaged, except when negated to ensure passenger safety.

Each door and bridgeplate has its own bridgeplate cut-out, situated behind a locked cover. This disconnects the bridgeplate motor and controller, ensuring that the bridge remains retracted and deactivates the local passenger control buttons. A "cut-out" signal on the dashboard alerts the driver.

5.12 ANNUNCIATORS

"Door open" status indicators are provided on the dashboard in each cab for each vehicle side situated among the door operation buttons.

Before the doors close are warning signals, both audible and visual, inside and outside of the vehicle. On the dashboard, there is also an audible bridgeplate request indicator, momentarily activated each time the passenger bridgeplate pushbutton is pressed.

Near the bridgeplate are audible warning beepers which begin signaling before any bridgeplate motion and continue until retraction has completed. The passenger buttons have green LED's to signal the "enabled" function.

6. HEATING, VENTILATING AND AIR CONDITIONING

6.1 GENERAL

The 10 T3 vehicle is equipped with six HVAC roof units providing and maintaining comfort in the driver's cabs and passenger compartments. Each 24V unit has its own thermostatic control and its own sensors. The galvanically-insulated three-phase units are 3 x 460 V, 60 Hz fed by IGBT converters. In the event of any auxiliary converter failing, only one half of each HVAC unit will go out of service.

All ducts are equipped with air filters to reduce dust entry. These filters are easily accessible for maintenance purposes. Air is distributed by ceiling mounted diffusers and two rows of ducts. The cooling circuits distribute air to all sections of the vehicle equally.

A dehumidifying system is provided in the driver's cabs, with the condensed water being drained behind the cab. All parts of the air conditioning system are high-quality; specially designed for mass transit rail vehicles.

6.2 VENTILATION

The fresh air intakes are at the floor level. Ventilation of both the passenger interior and the driver's cabs is accomplished using blower fans in the HVAC units. Driver cab ventilation is also possible using the cab heaters, which offer a separate mode of ventilation.

6.3 HEATING REQUIREMENTS

The vehicle passenger compartment heating is made by both the HVAC unit heaters and by passenger compartment sidewall heaters (behind protective covers). The heating is thermostatically controlled by the driver. Temperature is maintained between 18° C and 22° C at an outside temperature as low as –8° C.

6.4 AIR CONDITIONING FUNCTION

Air conditioning is accomplished using four unified HVAC units above the passenger compartments and 2 additional units above the driver cabs, one at each end. The units are compact and self contained so can be removed and reinstalled without disturbing any coolant piping. With an AW1 load, the temperature can be maintained between 22° C and 26° C with a relative humidity 60% or less at ambient temperatures up to 32° C.

6.5 CONTROLS

The HVAC units automatically engage upon activation of the operator's console, once the 750 Vdc is supplied from a pantograph.

6.6 HARDWARE REQUIREMENTS

The HVAC units and enclosures are made of high-quality materials (stainless-steel sheets, copper tubes etc.). The refrigerant compressors are fed by 3x 460 V, 60 Hz. Each HVAC unit has its own box of circuit breakers, contactors and electronic control. The R-407C refrigerant liquid is secured in a closed circuit.

7. ILLUMINATION

7.1 GENERAL DESCRIPTION

The vehicle illumination includes:

- passenger compartment interior lighting
- emergency interior lighting
- driver's cab lighting
- vehicle exterior lighting

Illumination components are specially developed for the transportation industry; made to withstand vibration and shock loads, climate change, voltage variation, etc.

The system elements include bulbs, fluorescent tubes, and LED lights, with all elements being powered by 24 V. While the batteries are charging, voltage may rise to about 28 V. Since bulb durability is influenced by continuous high voltage, the charging container has a special output to the bulbs, maintaining 24 V dc.

7.2 INTERIOR LIGHTING

Internal lighting is provided by two rows of fluorescent lights centered on the ceiling 1400 mm apart. These lights also provide emergency lighting. At each doorway threshold and platform, lights illuminate as the doors open and close. A switch on the driver's dashboard controls all the internal lighting functions. The light intensity is in accordance with the RFP.

The fluorescent fixtures are formed from aluminium profiles, onto which are fastened static converters, fluorescent tube brackets, end pieces, and a transparent cover.

Each driver cab has overhead fluorescent lighting controlled on the driver's desk. Three lights illuminate the dashboard; a fourth illuminates the bypass boards underneath the main dashboard. Light intensity is adjustable by means of dimmers. The driver cab lights are energized automatically once the 24 V network is activated.

7.3 EXTERIOR ILLUMINATION

All components of the vehicle exterior lighting system are of a waterproof, industrial style. The lamps have been designed for use in vehicles on surface roads. The lamps are monitored from the driver cab. The exterior lights are either bulbs or LED, as used throughout the automotive industry.

Each vehicle end has two adjustable headlights, activated according to the vehicle direction. A high beam indicator is installed in the dashboard.

Tail lights and stop lights (two of each) are on both ends of vehicle. Flashing amber lamps are located on both ends and in the central part of both sides of the vehicle to indicate changes in direction to other vehicles and pedestrians. These turn signals are engaged from a stalk at the driver desk.

7.4 EMERGENCY LIGHTING

In the case of a battery charging failure, certain lights will remain active; the door, floor lighting, the door and doorway floor lighting, all of the stairway lights, the cab dashboard lights, headlights, tail lights, stop and turn lights as well as exterior marker and indicator lamps.

8. AUXILIARY ELECTRICAL EQUIPMENT

8.1 GENERAL

The electrical equipment is fully operable at 750 Vdc rated catenary voltage. All equipment will work safely in the range of continuous voltages from 525 to 925 Vdc. Power parameters and mainly acceleration at running is guaranteed by nominal or higher voltage.

Nominal catenary voltage ..... 750 Vdc
Minimum catenary voltage ..... 525 Vdc
Maximum catenary voltage ..... 925 Vdc
Maximum catenary voltage at regeneration ..... 900 Vdc
Maximum dc link voltage at hazard brake (converters disconnected from catenary) ..... 975 Vdc

8.2 PRIMARY POWER SYSTEM

a) The pantograph is mounted on the "A" cab section of the three-sectional Streetcar. The head draws current from the overhead lines through two carbon strips. The pantograph meets IEC 494.

The main parameters are:

Rated voltage ..... 750 Vdc (525..975 V)
Nominal pressure on the contact wire ..... 80 kN (adjustable)
Carbon strip width ..... 60 mm

The pantograph is designed to assure safe and reliable service up to maximum speed. It operates by a spindle drive supplied by 24 V power. The pantograph has both electrical and mechanical locking related with the vehicle. In the case of emergency, it can be manually retracted by means of a lever situated in the cab. If emergency towing is used, the normal electric drive should be disconnected.

b) The vehicle circuits are protected from atmospheric transient voltages by a lightning arrester, installed on the roof near the pantograph

c) On the roof of the "A" cab section is a knife-switch box, located up line from the circuit breakers of the traction circuit equipment. The switch has four positions: NORMAL, AUXILIARY, OFF and SHOP. It is equipped with a plastic cover and a shop-plug.

d) The traction circuits are protected against over-current and short-circuit by a high-speed circuit breaker, set to approximately 1100 A. Forward of each circuit breaker (at the knife-switch box) is a 1260 A fuse. Each auxiliary circuit has its own fuse.

e) Each axle has its own ground-brush for conveying the current to the rails.

f) Line filters for traction converters (input L-C filters) are included in the traction converter covers. Line filters are also included in the auxiliary power converters for auxiliaries. Each converter (with a dc link capacitor) has a bleeder resistor permanently connected across the terminals.

8.3 AC POWER SUPPLY

The vehicle has two identical dc-ac auxiliary converters, supplied from the 750 Vdc catenary through protective fuses. These start automatically upon detection of catenary voltage. The auxiliary converters nominal output is 3 x 460 V, 60 Hz. Each auxiliary converter supplies one half of the vehicle's auxiliary network, i. e. HVAC units as well as converter and cab heater fans. The converter is of the same design as supplied on type 10 T vehicles in 2001-2002, so their construction is service proven. It includes air-cooled IGBTs as well as high-frequency (12 kHz) transformers for galvanic insulation.

8.4 LOW VOLTAGE POWER SYSTEM

The vehicle battery network is 24 Vdc with an operational range from 16.8 to 30 V continuously. It can accept short spikes up to 33.6 V for 1 second.

The vehicle has one main NiCd battery and one small auxiliary battery, rated below 16.8 V. The main battery is placed in a dedicated container under the vehicle floor. The battery box is designed to easily check and maintain electrolyte levels. Any decrease from a defined minimum battery voltage is signalled at the driver's desk. The battery is sufficiently robust to provide sufficient power for emergency lighting and other functions.

The battery is charged from two battery-chargers connected in parallel. Each charger has galvanic insulation and a fuse on its output. The chargers work immediately once catenary voltage is available. Both battery chargesrs are hold in a single container on the roof of the "B" cab section, alongside the low voltage auxiliary converters. There is also another converter (dc-dc chopper) for stabilizing the voltage to exactly 24 V, to protect the lighting features.

8.5 AUXILIARY ELECTRICAL DISTRIBUTION

The high voltage auxiliary circuits are protected by three-phase circuit breakers, situated in the high voltage auxiliary converter containers on the roof of the "C" cab section of the Streetcar.

The individual 750 Vdc contactors are fed through fuses. The fuses and the contactors are located in the contactor container, along with the connectors for portable testing units.

It is not necessary to open the electrical equipment containers on the roof in order to collect service data. The RS 232 service connectors for converter diagnostics are placed behind service panels in the passenger compartment.

9. PROPULSION SYSTEM AND CONTROL

9.1 GENERAL

The vehicle propulsion system is divided into two independent halves; their controls cooperate through a CAN bus line. There are two IGBT traction converters located on the roof of the C section, each feeding two three-phase asynchronous traction motors, connected electrically in parallel. For the electro-dynamic braking, the converters are able to brake both with regenerative (primary) or resistor braking (the amount of energy only that can not be recovered). The each traction converter has its own braking resistor block. The propulsion system is secured against the catenary line over-current by one high speed circuit breaker. In the case one of the converter fails, the vehicle can move with just one converter functioning. Each traction motor funs one axle with two wheels through the classic double-stage gears.

9.2 SYSTEM REQUIREMENTS

The traction converters are based on the air-cooled IGBT, microprocessor-controlled converters. The IGBT's themselves are made using the SKiiP Pack (Semikron integrated intelligent Power Pack) technology which saves the number of thermal transitions between the semiconductor and its air-cooler. The one SKiiP module also includes a current sensor, over-current protection, temperature sensor and driver in one compact module. This makes the propulsion converter very compact with minimum parts. The main advantage of using the SKiiP Pack modules is the increased strength for semiconductor chips; reduced thermal losses due to thermal transition is removed and higher compactness of converter block.

9.3 EQUIPMENT THERMAL CAPACITIES

The main components of the propulsion system are based either on the original Portland (10 T) design (traction motors, braking resistors) or are newly-developed based on experience with similar vehicles (traction converter and corresponding control units). In either case, the propulsion system components are over sized to ensure sufficient thermal capacity. Both the traction converters and the traction motors are equipped with sensors to constantly monitor their temperatures.

9.4 SWITCHING LINE TRANSITIONS

Each traction converter container includes a line filter limiting the switching line transitions from the overhead line. The vehicle equipment is designed to withstand all allowed vehicle and catenary transitions without damage or reduction of life expectancy.

9.5 ELECTROMAGNETIC INTERFERENCE

The vehicle propulsion system will be designed to fulfill the EMI limits according the EN 50121-3-1 norm, regarding shielding and grounding concepts (i.e. shielded cables, the steel traction converter protected with a line filter, and a filtering capacitor inside the converter). EMI compatibility will be demonstrated by measurement on the finished vehicle.

9.6 PERFORMANCE CHARACTERISTICS

The vehicle performance characteristics for both driving (running) and braking will be completely identical to the vehicle performances of the current Type 10 T vehicles delivered to the City of Portland in 2001-2002.

Dynamic braking capacity combines both regenerative and rheostatic braking. Braking is blended and overtaken by the mechanical brakes between speeds of 7 and 2 km/h.

Braking forces are independent of the catenary line voltage. Generally the propulsion system is ready to use the electric brakes whenever the vehicle is moving, with the traction inverters being controlled to energize the traction motors. If a lack of overhead voltage occurs, the propulsion system immediately disconnects from the catenary line and sets a very low electrical brake, which excites the traction motors. This readies the propulsion system for braking, should there be a subsequent short circuit on the catenary line.

The regenerative brake has priority over the resistor brake. If the catenary line voltage reaches its maximal value (925 V) during regenerative braking, the excess energy is dissipated in the braking resistor. If the desired braking performance can not be reached due to low voltage, the propulsion system is disconnected from the catenary line and all braking energy is dissipated in the braking resistors independently.

Reversing of vehicle direction is possible only from a complete stop. The change of direction is made by the traction converter control (two phases changed) based on a signal from the cab reverse switch.

In each cab are over-switches to disconnect the failed traction propulsion converter, as well as a disbreaking device. The disconnection of one truck is independent from the second truck. In case one truck is disconnected, the speed limit is applied.

Both propulsion drive control and brake control are equipped with a wheel spin-slide correction. Wheel rotation speed information is taken from speed sensors placed on the traction motors. This correction does not engage during emergency braking.

The vehicle control limits the maximum reachable speed to 48 km/h. If required, the software-enabled speed limit can be exceeded by engaging the over-speed bypass.

The control circuits verify that the requested braking effort is produced by the propulsion system. If a lack of braking effort occurs, the feedback is transferred to the friction brake control unit and the dynamic brake fault is indicated.

Propulsion system faults will be communicated to the driver by means of displays or warning lamps and will be recorded.

9.7 SYSTEM COMPONENTS

The traction motor (Type MLU 3436 K/4) is the same design as was used on the Type 10 T vehicles, and as such, is a service proven component. It is a three-phase, squirrel cage, four-pole, air-cooled machine with a thermal insulation of Class 200. They were designed and tested in accordance with the IEC 349 standards (EN 60349-2). The traction motor is fastened to the truck frame and is connected to the gearbox through a resilient coupling.

The connection of the traction motor phases to vehicle cabling will be done through a three-phase shielded connector. The main advantages of using the original traction motor type is its and high reliability and compatibility with those delivered originally.

The dynamic brake resistors are place on the roof of the mid cab section of the vehicle. Their design is state of the art and is similar to the existing 10 T resistors. The resistor consists of two self-ventilated blocks. Each block is insulated from its frame and the frame is insulated from vehicle resistor's box. This box is covered by a screen, preventing infiltration of dangerous parts from above.

The contactors – both link and charging – are placed on the traction converter container. One high speed circuit breaker protects the two parallel connected propulsion converters. Also, a four positions knife switch is installed. No other contact apparatus is installed on the traction system.

A line filter is placed on each traction converter. The filter consists of the input choke and DC – link capacitors. The control system will check the DC-link capacity to prevent the changes of the values that may cause excessive EMI.

The traction converter is situated in the roof-containers on the roof of the vehicle mid cab section. The converter has air-forced cooling by a three-phase motor fan. The converter filter choke and charging circuits and the power semiconductors are cooled in a common air duct.

The converter container has propulsion control segregated from the area of power converters. The control part and power part are connected by means of galvanic separated circuits. 32-bit microprocessors with I/O peripherals are used for the converters controls. The converters take data both from the CAN buses and from direct wire inputs. Each converter has its own control, including diagnostic monitoring functions. All the controls are equipped with diagnostic connectors and data memories to simplify the maintenance. The customer will be given diagnostic software to collect and analyze the data from converter control.

10. TRUCK ASSEMBLIES

10.1 GENERAL

The vehicle has two motorized two-axle trucks mounted under the end sections providing 100% adhesion. The trucks are suitable for safe operation at speeds up to 70 km/h and provide sufficient ride quality at speeds up to 48 km/h. Individual drive of each axle is powered by two laterally mounted asynchronous traction motors. Trucks are fully based on existing Portland Streetcar service proven design.

10.2 DESIGN CONSIDERATIONS

The trucks are designed for an operating service life of 30 years without the need of structural repairs. Both trucks on the vehicle are identical and interchangeable. The wheelbase is 1880 mm. The traction motor and gearbox are connected together with a gear teeth coupling which allows mutual relative movements. The traction motors are bolted to the middle crossbeam of the truck frame and are fully supported by the primary suspension.

Each axle of the traction truck is fitted with a passive electro-hydraulic brake unit, mounted on the flange of the gearbox, and acting as a passive energy accumulator. When the unit is without power, it automatically applies pressure on brake disc. When pressure is applied on one of the two brake circuits (main and emergency) from the diaphragm accumulator, the disc is gradually released. When pressure is released, the braking force and disc pressure is renewed.

The axle collectors and other wearable parts are serviceable at an assembly pit without disassembling the trucks. The cabling on the truck frame is not fastened to the pipe adapting pieces. A running test will have been performed on a test stand by the manufacturer before shipping.

To protect the vehicle body against pollutants and water, mudguards are fastened to the bogie frame at the wheel points. The trucks are epoxy primed and top coated in polyurethane paint.

10.3 SUSPENSION SYSTEM

The trucks are equipped with primary and secondary suspensions. The suspension is placed on the truck frame, at the lateral centerline of longitudinal beams. The primary suspension consists of elastomer elements complemented with vertical hydraulic dampers. The secondary suspension consists of two sets of coil steel springs combined with elastomer elements. The coil springs are placed on a bump stop base; the lower part of which is rubber and upper part is a fixed steel bump stop.

The springs are secured by a guide board, inserted on the upper rubber board. The location of the springs on the truck frame relates to the rim. When wheels become worn, the vehicle height can be adjusted by jacking the vehicle and adding complementary steel plates on the secondary suspension.

10.4 TRUCK FRAME AND BOLSTER

The truck frame structure made from bent and welded steel sheets. There are no sliding parts, in order to retain the journal bearings in their proper position. The transmission of traction and brake forces between the vehicle body and the truck frame is provided by traction supports with rubber blocks on both sides of truck frame.

10.5 JOURNAL BEARINGS

The design of the axle bearing units is service proven for a life of 2,800,000 km. The journal bearings are made as closed units with permanent lubricant fittings, with no additional lubrication required before 1,200,000 km or 10 years of operation.

10.6 WHEELS

The wheel design has been service proven on the existing Portland Streetcar vehicles. The wheels are equipped with rubber-sprung tires, serving as an electrical interface for grounding. They are also equipped with an earth coupling, which over bridges the rubber suspension. The wheels are designed for disassembly from the axle using pressurized oil.

10.7 AXLES

Axles are made of the machined hot rolled steel bars. The axle design has been service proven on the existing Portland Streetcar vehicles.

10.8 WHEEL-AXLE ASSEMBLY

The wheels, axle bearings and ground brush rings are press-fitted to the axle. The cast iron axle boxes safely transfer the forces between the truck frame and the axle.

10.9 TRACK BRAKE AND SUPPORT

Electromagnetic track brakes are suspended from the bearing boxes, in a positive lateral alignment with the running rail. The solenoid of the track brake creates a vertical attractive force between the brake shoe and the rail. This creates adequate longitudinal braking force to stop the vehicle.

10.10 SAFETY BARS

Safety bars are provided at the outboard ends of the trucks. These can easily be removed and replaced for servicing or identification. The safety bar supports also serve as supports for the sanding hose.

10.11 GROUNDING DEVICE

On each axle, there is a grounding device bridging the axle bearings, to allow for the safe passage of current to the rail. The axle bearing is sealed to prevent the penetration of pollutants from the grounding brush.

10.12 WHEEL FLANGE LUBRICATION SYSTEM

Each forward axle is equipped with a wheel flange lubrication system based on spring pressed carbon sticks. These can easily be removed and replaced for servicing or identification

10.13 TRUCK SERIAL NUMBER

Each truck serial number appears in 20 mm height characters on a plate conspicuously located on the right side of the truck.

10.14 GEARBOX AND COUPLING

A cast iron gearbox, fastened to the hydraulic brake unit, transfers torque from the traction motor to the axle. The registration speedometer sensor is bolted to the gearbox driving the first axle. The reaction moment of the gearbox is transferred by a flexible rod suspended from the truck frame. Oil vapor pressure is controlled by a vent plug. The gearbox is equipped with a drainage plug for removing minor metallic impurities and an oil level monitoring gauge. The overall gear ratio value is 6.8406.

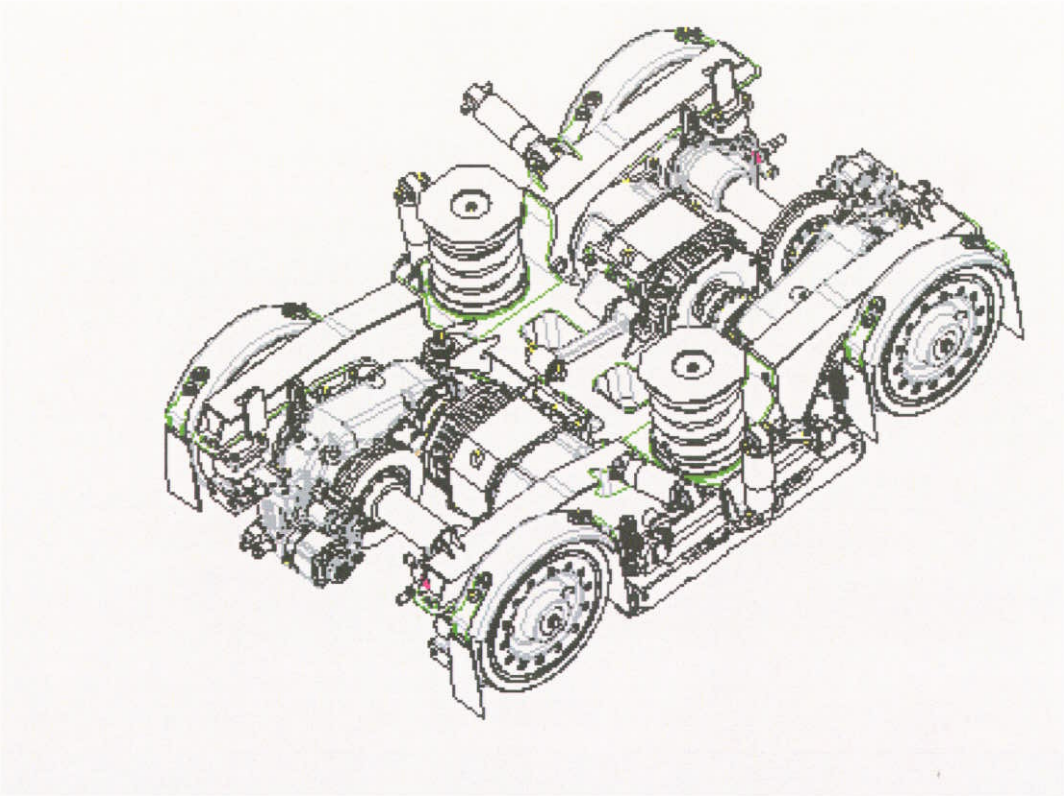
The gearbox contains two pairs of carbonized, hardened front gears, with skew teeth made without undercutting the tooth heel. After grinding the sides of the teeth, a defectoscopic check is performed. Thermal and chemical-thermal treatment is done in a controlled atmosphere to prevent the possibility of any decarbonised layers.

Oil replacement of the gearboxes (SAE 80W/90) should be done after 200, 000 km or 5 years of operation. This is performed directly in the bogie at the mounted gearbox. The bearing and gearing lubrication is performed by bathing the gears in an oil dip, then spraying oil into the gearbox.

The expected service life of the gearbox roller bearings is 2,000,000 km, which is 2 times the vehicle overhaul recommendation. The expected service life of axle bearings is 2,800,000 km, being 2.8 times the vehicle overhaul recommendation. The axle bearings have a constant fill of lubricant and do not require additional lubrication during operation. The interval of maintenance of these bearings is the lesser of 1,200,000 km or 10 years of operation. A routine gearbox overhaul should be performed after 1,000,000 km. This can be done without removing the axle.

***** Optional offer: If desired by the customer, OIW could provide an improved design for the bogie assembly. Following is a brief description of the improved bogie design, description of the proposal and the advantages/improvements of the system It is totally at the customer's discretion whether this proposal will be implemented or not.***

Following is a description of the proposed improvements for the traction bogie for 10T3 Streetcar. The bogie assembly can be seen on following figure.



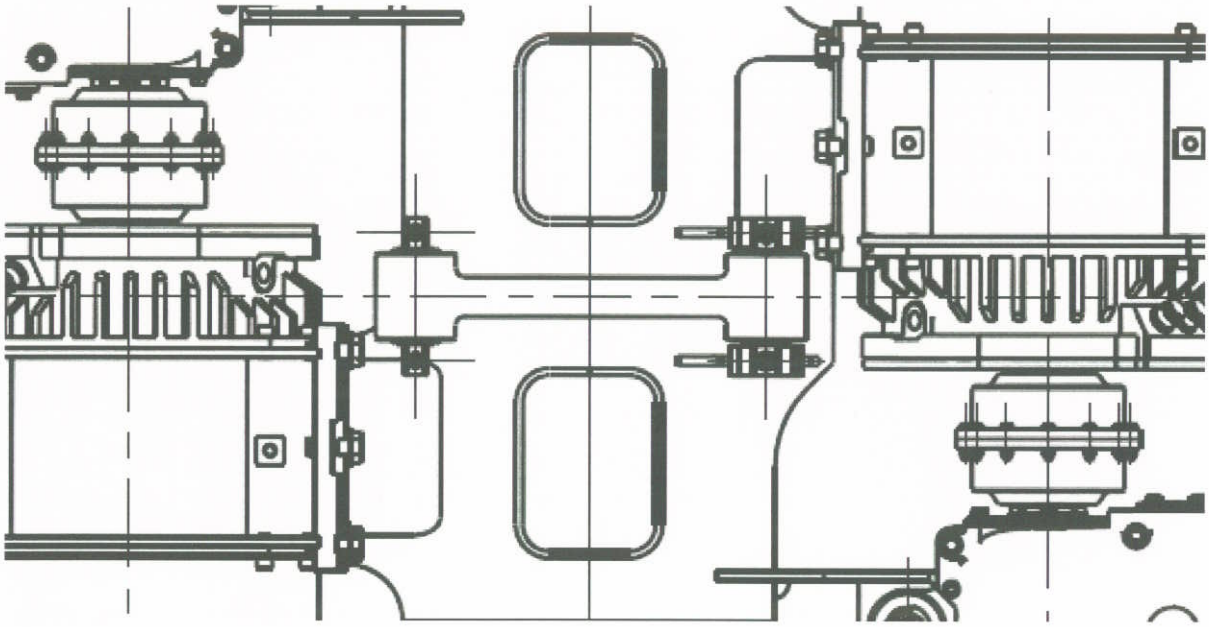
Proposed improvements:

Longitudinal force transmission between bogie frame and carbody.

Current design is based on two rubber blocks on each side of the bogie frame. These pressed rubber blocks transmit the longitudinal forces to the supports on the underframe.

In order to improve the wear of the rubber blocks due to vertical movements in secondary suspension and resulting friction forces and to improve the riding comfort we proposed a design where the force transmission is accomplished through one connecting rod with silentblocks on both ends positioned in the middle of the bogie frame. Similar solution can be seen on following figure.

Currently the Skoda vehicles for the City of Cagliari in Italy and for the City of Prague already use this design with very good results. These improvements have been sucessfully tested on the first two Streetcars for Prague and Cagliari.



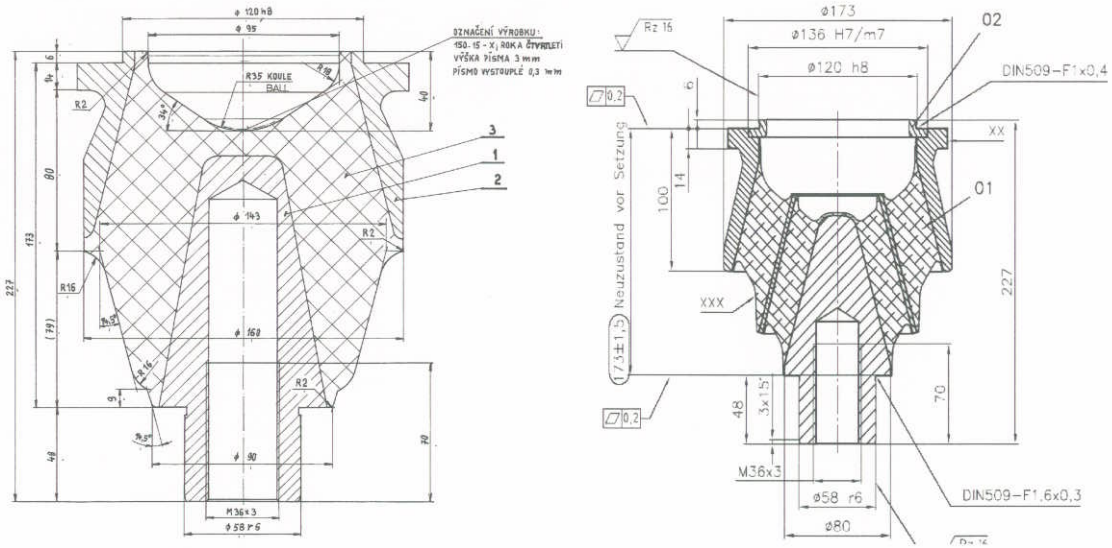
This solution does not transmit the sine-wave movements to the car body, minimizing the wear on the rubber parts and so requiring less frequent maintenance inspections.

Modified coupling between traction motor and gearbox. The current coupling type KWD ZK 110-1 has a rubber gasket between the inner and outer rings. During operating service, the rubber gaskets may fail resulting in leakage of oil and eventual failure of the un-lubricated coupling.

On the proposed solution we provide steel bellow sealing instead of rubber gasket. This results in a robust solution highly durable against any riding conditions that can occur and it will reduce the maintenance costs. Any failure of a coupling means always dismantling of the whole bogie from Streetcar and also dismantling of the whole wheelset from bogie frame which is always a long down time.

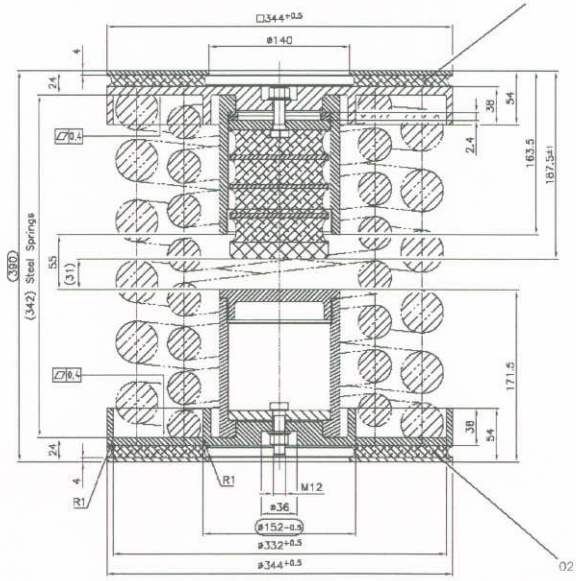
New primary suspension. The current Portland primary suspension is a rubber block shown on the following figure. This block has vertical stiffness 1388 N/mm. The tests on operating service showed that this value could be changed to improve the ride. We propose a double rubber layer block with lower vertical stiffness to value of 870 N/mm.

The double layer blocks solution is shown on the figure below.



The double layer blocks, currently used on Streetcars in Cagliari and Prague, allow for higher movements of the whole wheelset in the bogie frame which provides a smoother ride. Improvement of riding comfort has been successfully tested on the first two Prague Streetcars.

Modified secondary suspension. This solution is based on duplex helical steel springs on both sides of the bogie. These springs have linear characteristic, so the vertical natural frequency (part of riding comfort value) of the vehicle differs between empty and fully occupied car, which is not wanted. We propose a new inner multilayer silentblock. Solution can be seen on following figure.



This configuration allows the rubber silentblock to assist the steel helical springs. The natural frequency of the vehicle will be constant at higher loads which improves the riding comfort.

11. FRICTION BRAKE SYSTEM

11.1 GENERAL

The braking system of the vehicle, supplied from Knorr-Bremse Corporation, is made up of one friction brake system. This system may be used independently or with the dynamic brake system and magnetic track brake system in combination. The friction brake system is service proven and fully compatible with the existing Portland Streetcar vehicles.

The friction brake system provides electro-hydraulic controlled spring applied (passive) service for parking and emergency braking on both motorized trucks of the vehicle. The brake calipers incorporate the spring actuation mechanisms together with a hydraulic auxiliary release capability. The friction braking is provided on each axle of the vehicle.

11.2 SYSTEM DESCRIPTION

The brake system of the vehicle provides the following functions:

Service braking - the dynamic brake system acts within a range of 48 to 5 km/h, friction brake system acts below 5 km/h; brake force is continuous from 0 to 100%; AW0/AW3; deceleration 1.34 m/s^2.

Maximum service brake – the dynamic brake system acts within a range of 48 to 5 km/h, friction brake system acts below 5 km/h; brake force is maximal; AW0/AW3; deceleration 1.34 m/s^2.

Dynamic brake failure 50 % - the dynamic brake system acts within a range of 48 to 5 km/h, friction brake system acts in range 48 km/h to to full stop; brake force is continuous from 0 to 100%; AW0/AW3; deceleration 1.34 m/s^2.

Dynamic brake failure 100 % - friction brake system acts in a range from 48 km/h to full stop, brake force is continues from 0 to 100%; AW0/AW3; deceleration 0.94 m/s^2.

Emergency brake with dynamic brake – dynamic brake system acts in a range from 48 to 5 km/h, friction brake system acts in a range from 48 km/h to stop, at constant level at AW0; track brake acts until full stop; brake force is maximal; AW0/AW3; deceleration 2.23 to 2.90 m/s^2 in range from 48 to 25 km/h, in range from 25 km/h to full stop has not been defined.

Emergency brake without dynamic brake – friction brake system acts in range 48 km/h to full stop; track brake acts until full stop; brake force is maximal; AW0/AW3; deceleration 2.23 - 2.90 m/s^2 in range 48 – 25 km/h, in range 25 km/h to full stop has not been defined.

In case of dynamic braking failure, the disc brakes assume the full braking power of the vehicle at any speed. Then the vehicle can continue, but at a restricted speed.

11.3 POWER SOURCE

The friction brake control equipment is powered by the 24 V DC low voltage power supply.

11.4 DYNAMIC BRAKE INTERFACE

An independent friction brake ECU is provided in the brake system. The dynamic brake signal is utilized by the disc brake control logic system for each truck, reducing the disc brake effort in response to the presence of dynamic braking.

11.5 PARKING BRAKE

A passive, spring-applied, parking brake is provided for each axle of the vehicle. The parking brake is configured to release when the parking brake valve is de-energized.

11.6 DISC BRAKE CUTOUT

In the event of a failure or a loss of electric power in the car control system, the spring applied brakes will engage. If the vehicle needs to be moved or towed, these brakes can be released using a manual hydraulic release system consisting of two auxiliary release units. Each truck system incorporates its own auxiliary release unit mounted separately in both driver cabs.

11.7 DISC BRAKE – PROPULSION SYSTEM INTERLOCKS

The disc brake system is interlocked with the propulsion system such that propulsion is removed if any disc brake remains applied (on any truck of the vehicle) for more than 7 seconds after application of propulsion. Complete disc brake release is possible at all vehicle speeds down to 0 km/h. The ECU detects low supply pressure and low fluid levels and applies the disc brake. Simultaneously, the information is sent to the vehicle control logic, which removes propulsion.

11.8 THERMAL CAPACITY (DUTY CYCLE)

The friction brake system provides the thermal capacity to handle braking below 5 km/h during normal operation at AW3 loading in addition to a full stop with maximum service brake. Furthermore, the friction brake system has the capability for at least one 48km/h stop, in the event of complete dynamic brake failure. The thermal capacity of the friction brake system has been service proven by existing Portland Streetcar vehicles.

11.9 TRACK BRAKE

The vehicle is equipped with four non-adhesive electro-magnetic track brakes. Each bogie is equipped with two track brakes, one for each side, electrically connected in parallel and supplied through contactors from the 24 V vehicle battery.

Track brake application during emergency stopping is interlocked with the no-motion detection circuitry. Track brake system is effective at all speeds from maximum down to full stop over all conditions of curves and grades. The track brake force is not modulated by blending, load compensation or any other means.

Track brake control and logic is provided by relays and contactors separate from the disc brake propulsion control logic. Each truck's track brakes are controlled by a separate relay and contactor circuit, fed from a dedicated cicuit breaker.

11.10 SANDING SYSTEM

The vehicle is equipped with an automatic sanding system, which may also be controlled manually. The system automatically delivers sand between the wheel and rail, correcting for major sliding and emergency braking. If the emergency brake is applied, sanding is activated automatically to increase the braking effectiveness. The sanding system distributes the sand effectively and uniformly in front of each wheel. A low sand level in the storage boxes is signalled at the driver's desk. The automatic sanding application is interlocked with the motion detection circuitry. The manual sanding (initiated by a driver's footswitch), operates independent of the motion detection circuitry. Sander control and logic is provided by relays separate from the friction brake control logic. The sand is electrically heated to ensure it stays permanently dry. The sand storage boxes are filled from inside the vehicle.

12. COMMUNICATION SYSTEM

12.1 GENERAL

The vehicle communication system includes the public address (PA), passenger emergency intercom, cab-to cab intercom, passenger information and train-to-wayside communication (TWC) systems.

Communication and passenger information system supplier is Meister-Electronics, Inc. They have extensive experience with communication systems for the public transportation.

12.2 AUDIO COMMUNICATIONS FUNCTIONAL DESCRIPTION

Audio communication system makes announcements to passengers automatically or manually inside and outside the vehicle. It includes microphone, amplifier, and ambient noise sensing and vehicle acoustics control. Automatic announcement system works in coordination with the destination sign system and the door operating system. For passenger safety, the intercom system provides communication between the passengers and the operator and between the cabs.

12.3 PUBLIC ADDRESS SYSTEM

Announcements are possible inside the vehicle, on the left and right exterior, and to the other driver's cab. The operator can use either interior or exterior speakers or both for the announcement. The volume level in the vehicle is adjustable between +6 dB and +12 dB above the average input level. The sound is distributed evenly throughout the passenger sections and will not vary more than ± 3 dB.

12.3.1 INTERIOR SPEAKERS

Interior speakers (Type: EL135, 8 pieces) are flush mounted in the roof ceiling panels. Speaker enclosures are 3mm thick aluminum plate.

- Maximum power: 8W
- Maximum speaker volume: 92 dB

12.3.2 EXTERIOR SPEAKERS

Exterior speakers (Type: HS6-BR, 4 pieces) are mounted on the roof, two on the left side and two on the right side of the car. The mounting area is close to the doorways so the passengers can easily hear the announcements. They are water proof and protected from mechanical damage of car wash brushes.

- Maximum power: 6W
- Speaker volume: 99 dB

12.3.3 AMPLIFIERS

One amplifier unit is located in each vehicle, connected through the vehicle-data and low frequency audio lines to the Vehicle Acoustic Controller and Main Controller Unit modules. Each unit contains three 5-watt amplifiers. This single unit is used to drive both the interior and the exterior speakers. This arrangement allows for the elimination of the 70.7 Volt.

12.3.4 CAB MICROPHONE

Both operator cabs have a heavy duty, high noise suppression, goose neck, type microphone. Type: ME-251/320.

12.4 INTERCOM SYSTEM

Intercom system enables calls between driver cabs and also from the passenger area to the driver cabs.

12.4.1 CAB-TO-CAB INTERCOM

Cab-to-cab intercom provides communication between other vehicles during towing.

12.4.2 PASSENGER INTERCOM

There are two passenger intercom stations in the passenger area near the double-leaf doorways. This position of the intercom station allows for easy access by disabled persons. Passenger intercom unit include communication request push button, status indication LEDs (*busy*-yellow, *wait*-red, *talk*-green), loudspeaker and microphone.

12.5 PASSENGER INFORMATION SYSTEM

12.5.1 AUTOMATIC DESTINATION SYSTEM

The vehicle information system includes destination signs behind the windshields at both ends of the vehicle. Control of the display corresponds with the route selected by the driver. The display simultaneously changes on the destination signs in both cabins. The displays use high-contrast yellow text on a black background. The signs use a high resolution, full matrix (26x180) LCD screen, which will function delay-free under all temperature and lighting conditions of the Portland area. There are no mechanical elements. The programming can be accomplished using universal interfaces based on Windows PC software for RS232/RS422.

12.5.2 AUTOMATIC STATION ANNOUNCEMENT AND DISPLAY SYSTEM

When the driver selects a destination, the destination boards adjust and the automatic announcement system resets according to the route. The travel direction is announced on the PA system before the vehicle starts; then stations are announced at a predetermined distance before arriving.

In transit, the information of those PA announcements is displayed on four LED displays, located throughout the car. These signs are capable of displaying up to 24 characters and can scroll long text strings. Also shown is a "**STOP**" display, confirming for the passengers that a stop has been requested. A corresponding display on the driver's desk is easily readable from the driver's position.

12.6 TRAIN-TO-WAYSIDE COMMUNICATION SYSTEM (TWC)

The vehicle is equipped with a train-to-wayside (TWC) communication system. This system is compatible with the existing TriMet LRT system.

12.6.1 SYSTEM DESCRIPTION

On each end of the Streetcar is installed a HP2 transponder, which transmit digital information to the wayside loop antennas in the track way.

12.6.2 FUNCTIONAL REQUIREMENT

A Vetag transponder transmits a 19-bit data message to the wayside antenna. This message includes:

- Train Number
- Route Number
- Car Number
- Stationary Preempt/Activation
- Switch Call (Left or Right)
- Active Cab (on for active cab)
- End of Train

12.6.3 CARBORNE EQUIPMENT

Each Streetcar is equipped with the following:

- Two transponder (HP2) assemblies (one per end)
- Two cab control panels (Vetag Code Control Box-one per cab)
- HP2 Transponder Extension Cable
- CCB Cable with connector
- CCB Power Cable

All carborne TWC equipment is identical in all cabs and it is energized from the low voltage power system through a dedicated circuit breaker.

12.6.3.1 CAB CONTROL PANEL AND INTERCONNECT WIRING

The Vetag Code Control Box includes four backlit buttons that light when the active cab is passing over a wayside loop and is being interrogated for the following inputs and signals:

- 24V battery positive from a dedicated circuit breaker
- Battery negative
- Cab active signal
- End-of-train signal

12.6.3.2 TRANSPONDER ASSEMBLY

Each transponder is installed on the longitudinal centerline of the vehicle 2350mm from the front of the car. The mounting bracket isolates the transponder from vibration when the Streetcar moving. The transponder cable is equipped with a waterproof AMP bayonet connector.

Transponder function:

- Receive a 100 KHz interrogation signal via the ferrite antenna to activate the transponder and cause it to transmit a data message via the same antenna.
- Activate the backlight in the console panel switches when an interrogation signal is received to indicate that the transponder is located over a wayside loop.
- Transmit the 19-bit data message that is indicated by the cab control panel to the wayside interrogator.

13. INTERIOR AND EXTERIOR APPOINTMENTS

13.1 GENERAL

Options for the interior colors will be provided to the city within (90) days of NTP. This includes all sidewall and ceiling trim panels, all window surrounds, the new flooring material and step covers, and the proposed fabric for seats.

13.2 INTERIOR FINISHING AND ACCESSORIES

13.2.1 INSULATION

Insulation of floor, sidewalls and roof – domestic origin ANCO TEXTRAFINE (or equivalent product); an insulation manufactured from long, textile-type glass fibers and bonded together with a thermosetting phenolic resin. This product is resistant to dilute acids, alkalis, greases, gasolines, and aliphatic oils. It will not mold, rot, nor sustain vermin. It does not corrode any metals, settle under car vibration, have an odor or capability of absorbing odors. It is unaffected by temperature factors up to 230 degrees Celsius. This insulating material fills the entire space between the panels of the internal facing and the external sheet metal.

13.2.2 FLOOR – SUBFLOORING MATERIAL

We are pursuing two sub-flooring products, (a base line solution and an improved design). The base line passenger compartment sub-floor could be formed from domestic 5/8" exterior grade plywood, manufactured of seven layers of domestically-grown wood, and glued with melamine formaldehyde glue. This flame resistant product is also treated to provide water resistance to inclement weather, flowing water, or humidity. The flammability ratings are pursuant to standard UIC 564.2 – Category B.

This plywood sub-flooring is glued down over small profiles of rubber which have previously been fixed to the structure of the vehicle body, providing the bond gap required to ensure a 2 to 4 mm thickness of glue. This seals against water penetration into the floor and restricts noise and vibration transfer into the vehicle.

As an improvement, an alternative sub-flooring material composed of a composite core material encased in aluminum or fiberglass skins could replace the plywood.

The performances of the flooring system will improve by using the composite material; this new material significantly reduces the noise level inside the vehicle and the overall weight of the body, while increasing its structural effect on the overall body structure. The flammability, water and environment resistant characteristics of the composite material equal or exceed the plywood/base line material. This design and manufacturing solution is risk free and is currently being used on many LRV and transit vehicles in general.

13.2.3 FLOOR – FLOOR COVERING

Koroseal anti-skid floor covering is then bonded to the vehicle sub-floor with domestically manufactured Betamate; a low energy substrate adhesive specifically designed for adhering anti-skid, vinyl floor covering materials. For the composite "sandwich" solution the floor covering could be molded-in over the "sandwich" top skin.

Where the flooring meets the sidewalls, the covering forms a cove, then continues up the wall to a height of at least 100 mm. The vehicle floor forms a complete tub, fitted with openings for water drainage. The joints of the individual subflooring boards are seam welded and made impenetrable to water for at least 10 years. All connections are easy to repair, should the need occur. The seat supports being cantilevered into the sidewalls together with this vinyl flooring, allows for easy cleaning of the entire vehicle floor.

At the articulation sections and door sills, the edges of the floor are trimmed with a stainless steel molding. At the leading edge of each stair step, a textured yellow safety nosing covers the top one inch of each riser and extends across the full width of the step platform for a three inch depth.

13.2.4 WINDOWS

All side windows and the glazing in all passenger compartment doors are made of single glaze, chemically tempered safety glass,* pursuant to standard ECE 43R. The glass is tinted light green with a minimum of 75 % light permeability. The glass thickness is 6.5 mm; being a lamination of two glass layers sandwiching a PVB interlayer. **

*Chemically tempering glass eliminates the distortion common with heat treatments, which could be especially noticeable when layers are laminated.

***** Optional offer – for improved performance: If desired by the customer, the interior face of all glazing can be coated with an optically clear, distortion free polyester film. This lowers the risk of injury from breaking glass while providing an anti-graffiti measure. The multi-layered 6-mil (.006") sacrificial laminate provides a significant resistant to etching and scratching of the underlying glass surface.***

The basic dimensions of side windows in the passenger compartment are:

- 1083 mm vertically x 1308 mm; at twelve locations throughout the three cab sections
- 1083 mm vertically x 833 mm; at two locations in the end cabs, crosscab from the single-wing doors

All windows are bonded to the vehicle body using cement SIKA 265 with corresponding activators. From the inside, the glazing is sealed by cement SIKA 221.

The side glass assemblies of each driver's cabin are divided into two parts. Part of each assembly is a fixed, single glaze, chemically tempered 6.5 mm safety glass, having the same appearance and specs as the passenger windows. The remainder of each assembly includes a two-piece sliding pane, which can be manually opened by the driver.

The current Portland street car vehicles have heating elements embedded in the PVB interlayer of the windshield and driver's side windows. This feature was not requested in the RFP and so has not been included in this proposal. The Type 10 T3 vehicle's heating and cooling system will feature ducting to provide a defogging/demisting/defrosting feature.
Eliminating the heating element handles all maintenance concerns of glass overheating. Additionally, non-heated glass provides you a significant cost benefit.

The windshields are made of clear single glaze, chemically tempered safety glass. The glass is tinted light green with a minimum of 75 % light permeability. The glass thickness is 6.5 mm; being a lamination of two glass layers sandwiching a PVB interlayer. The glass is installed so that the driver is not subjected to external glares or reflections from inside the car. The windshield passes the testing standard ECE 43R.

***** Optional offer - for improved performance: If the customer chooses to add a heating feature, we would recommend adding timer cutoffs to the on/off switches. The output at the side glass will be 250W at 24 V. The windshield output will require 500W at 24V.***

13.2.5 PASSENGER SEATING

There are thirty padded and upholstered seats in the passenger compartment fixed to powder coated, corrosion proof steel frames. Except where a seat is mounted over a sanding box compartment, the frames are cantilevered and anchored at the sidewall. ** All the seats inserts are identical, vandal-resistant and may easily be maintained or replaced.

The design of the seat includes a heavy duty grab rail extending across the seat back, (similar in location to the headrest of an automotive seat). This is a variance from the style of the current streetcar, which has the hand grip mounted on the aisle side at the upper corner of the seat back.
Where two seats are clustered on a single frame, there is an ergonomically satisfying "individualized" seat allocated to each passenger (as opposed to bench style seating). The distance between centerlines of clustered seats is at least 430 mm.

***** Optional offer – for improved performance: If desired by the customer, one seating position could be eliminated, providing floor space for the ticket dispenser equipment. This would be near a door in the low-floor middle cab section, so as to be accessible by persons with disabilities.***

13.2.6 STANCHIONS, HANDRAILS AND WINDSCREENS

The vehicle interiors are fitted with vertical and overhead horizontal rails to provide comfort and safety. These stainless steel accessories are sufficiently robust to help passengers maintain a secure balance while in motion and during entry or egress from the vehicle. The surfaces are resistant to wear and damage.

At all required sections, especially near door areas, will be hand grips in sufficient numbers and strength. These grips will hang loosely along the horizontal rails dropping to a height such that a 1.7 meters (5'7") tall person can easily reach and hold. The grips will have stainless or powder coated tamper resistant fasteners.

It will not be necessary for maintenance to remove the rails in order to replace any worn grips. They are fire resistant and have an expected service life of 10 years.

The seats adjacent to the doors are protected from drafts by partitions.

13.2.7 KEYS AND LOCKS

Three different types of keys are provided for access to various areas of the car:

- Master Controller Key – a standard cylindrical insert lock and key; provides access to the driver's cabins and operates the master controller key switch.

- Crew Key – an 8 mm square key; provides access to the cab breaker panels, exterior forward door manual release, the sanding boxes, overhead and underseat access panels containing items or equipment that may require operator access, and can be used to operate the door crew switch.

- Maintenance Key – a triangular key; provides access for maintenance personnel to open all other access panels and can be used for exterior side skirt removal.

13.2.8 WALLS AND CEILING

The interior trim of the passenger compartment consists of the following components:

Sideboards below window surrounds – domestic origin KYDEX 62015 sheeting. This 4.0 mm thick thermoplastic material is available in the same color and texture as the current streetcars. It is of one color throughout, easily cleaned and highly graffiti resistant. Flammability testing achieves the requirements of standard UL 94, classification HB.

The materials used for wall facing are easy to maintain and resistant to damage by vandalism. The Kydex side panels are fastened to the carbody structure, and in the lower part, screwed to sheet metal to withstand a 22 kg impact without cracking or damage.

Window surrounds are screwed into the structure along the upper frame, while the sides and lower frame are fastened using dry zipper. This manner of fastening together with the internal insulation material secures noise impermeability and strength requirements. The fastening system used decreases the difficulty of component replacement and shortens the maintenance time. The assembly and fastening points of panels are standard and compatible with the current vehicle.

Sidewall columns and window surrounds of the passenger compartment – fiberglass laminate of domestic material and production. Material composition – Gelcoat of a minimum cured thickness of 12 mils (0.012") and polyester resin of Norpol (or equivalent product) with 30% to 40% glass mat. Material thickness 4 mm with gel coated side having a smooth painted finish. Level of flammability pursuant to standard DIN 5510-2 class of flammability: S3, smoking capacity class: SR2, dripping class ST2, and test method pursuant to DIN 54 837.

The headlining at the passenger compartment ceiling also consists of 4 mm thick KYDEX sheeting matching the color of the sidewalls. In the articulation areas between the cabs (above the stairs), the panels are gray, approximating the color of the interior bellows. The headlining panels are bonded to the structure, and trim the entire cab length.

Where the ceiling transitions into the sidewall is a slanted region of locked plastic access panels. These can be opened using a square maintenance key and hinge upward to access any hidden electrical or mechanical equipment. All trim components are secured to eliminate possible vibration and noise concerns.

13.3 PIVOTING ARTICULATION SECTIONS

The joints of the cab sections have been designed in such a way as to ensure an easy disconnection; the joints and mechanisms may be accessed from above or below. The joints are able to withstand the stresses of lifting and re-railing in the event of derailment.

In order to reduce the volume of noise and dust penetrating the vehicle interior, a two part transition bellows assembly seals the passenger cabin. The external bellows are aesthetically complemented by covers that enclose the cabling and connecting mechanisms on the roof, complying with the fire safety certificate requirements of DIN 5510.

The internal transition bellows portion consists of ceiling and side panels. These structures are intended to prevent access to pinch points where squeezing injuries could occur. The transition has a continuous shape, free from sharp edges and projections. The components have been surface treated and so are easily maintainable. The full assembly and supporting elements of the bellows have a 30 year expected service life in operation.

13.4 INTERIOR EQUIPMENT

Beneath all surfaces of the vehicle, adequate insulation will be provided to reduce heat and noise transmission. A route map holder will be available on each door and at other suitable places where seated passengers can easily see them. A 6 kg fire extinguisher is provided within a sealed, transparent cabinet.

14. TESTING

14.1 GENERAL

The proposed vehicle has been safety proven over thousands of service hours on the streets of Portland. Specifically, five vehicles of this design have been operating since 2001, with two more cars brought into service in 2002. Three additional cars have been used in Tacoma, WA since 2002. With this extensive background of service, we will not be re-testing the unchanged systems or components of the proposed vehicle. Where systems are unchanged, OIW will provide type test data to demonstrate compliance with the latest RFP requirements.

Following is a partial list summarizing some of the types of tests Škoda had previously performed on the existing Portland vehicles:

Mechanical tests:

- Vehicle dimensions
- Weight test
- Vehicle hydraulic system test
- Body and external box tightness test
- Horizontal and vertical arch test
- Brake test
- Operating conditions, comfort, noise tests
- Pantograph test
- Resistance test during vehicle movement

Electrical tests:

- Dielectric tests
- Value accordance test on auxiliary units
- Acceleration and braking test
- Short-term disconnection and jump at power (trolley) test
- Power disconnecting test
- Vehicle short circuit test
- Internal voltage control test
- Lightning and other effects protection test
- Vehicle battery charging test
- Electric brake test
- Energy consumption test

Deviations from the original design are minimized. Where deviation has occurred, OIW's approach is to work only with service proven components that equal or exceed the standards of quality and reliability found on the current Portland vehicles.

OIW is planning to fully test the prototype vehicle in accordance with the RFP requirements and, additionally, to perform all necessary (and typical) testing applicable to a production manufactured street car vehicle (functional and performance testing).

OIW uses a team approach to understand system functions and requirements, considering the operational and environmental factors of Portland All available information, including drawings, specifications, schematics, and functional descriptions of the systems, are organized and researched for comparison against the existent design. OIW will track and manage actions taken throughout the design process. We believe this approach will guarantee any safety issues are identified and resolved early in the process.

The testing process will be conducted in parallel to the production of the streetcar when applicable, with functional and performance tests performed last. The testing activity will start with design reviews to identify the design differences, and if necessary, the appropriate testing will be performed to prove that the design is the same or better.

A key element of the testing and assurance program is the material and vendor certification of the components/systems supplied. Sub-supplier selection and certification is carefully conducted with attention to the component's reliability, design and past performance. OIW will provide suppliers with technical and functional spec's and the tests their component will need to pass and will follow their successful completion.

The required certifications and/or sub tests are part of the purchase order, and are maintained as part of the history/record book. These reports are submitted with contract letters in compliance with the test program. Dimensional compliance, workmanship, and overall quality are recorded as the build progresses. The suppliers are required to certify the correct installation, at OIW, of their components/systems and to provide on site support/participation (where applicable).

Safety and minimal risk are of first priority and the entire activity of our team is directed to serve this purpose. We have verified and will continue to test and evaluate every feature of the vehicle in order to present our maximum guarantee that our product is completely safe and complies with all applicable standards and regulations.

OIW/Škoda will prepare a program regarding implementation of testing and present it for PSI approval three months before commencement of testing. The OIW/Škoda team will perform and document the following categories of tests:

14.2 COMPONENT QUALIFICATION TESTS

Please refer to the attachment "Test Plan Chart 2", for a full description of the component qualification tests.

14.3 SYSTEM QUALIFICATION TESTS

Please refer to the attachment "Test Plan Chart 2", for a full description of the system qualification tests.

CAR LEVEL QUALIFICATION TESTS

Please refer to the attachment "Test Plan Chart 2", for a full description of the car level qualification tests.

SYSTEM CONFORMANCE TESTS

Please refer to the attachment "Test Plan Chart 2", for a full description of the system conformance tests.

VEHICLE STATIC TESTS

Please refer to the attachment "Test Plan Chart 2", for a full description of the vehicle static tests.

ACCEPTANCE TESTING

Please refer to the attachment "Test Plan Chart 2", for a full description of the acceptance testing.

14.4 TEMPORARY ACCEPTANCE

Provisional acceptance will be assumed upon completion of this full testing regime. Upon completion of this acceptance, transferring of ownership of the vehicle will pass to PSI, and the guarantee period will begin.

15. MATERIALS AND WORKMANSHIP

15.1 GENERAL

New materials are used throughout, in accordance with applicable requirements of internationally accepted standards; (ISO, UIC, IEC, DIN). OIW/Škoda will supply English language copies of the applicable standard as required for review by the City of Portland.

None of the materials used in the vehicle are subject to corrosion caused by the actual material during operation. Additionally, all connecting materials are equipped with a corresponding surface finish, so as to not contribute to the creation of corrosion.

Unless specifically permitted, the following materials are not used in the construction of the vehicle:

- asbestos
- PVC
- lead in brake shoes
- urethane foam
- aluminum threaded fasteners

The European electrical standards listed below were followed in the manufacture of the current Portland Streetcar. The prototype (Type 10 T3) vehicle will be manufactured to U.S. equivalents. The electrical system will equal or exceed the values demanded by these European standards.

DIN 43620	Fuses
DIN 54837	Flammability testing of parts and assemblies in rail vehicles
ECE 43R	Uniform provisions concerning the approval of safety glazing materials and their installation on vehicles
ECE 48	Uniform provisions concerning the approval of vehicles with regard to the installation of lighting and light-signalling devices
EN 50155	Electro magnetic compliance
EN 50163	Supply voltages
EN 50207	Power converters for electrical traction systems
EN 50305	High voltage cables
EN 50306	High voltage cables
EN 50343	High voltage cables
EN 50355	High voltage cables
EN 60077	High voltage fuses
EN 60077-3	DC circuit brakes
EN 60310	Traction transformers and inductances
EN 60322	High power resistors
EN 61881	Power electronic capacitors
EN ISO 3095	Railway applications - Acoustics - Measurement of noise emitted by railbound vehicles
EN ISO 3381	Railway applications - Acoustics - Measurement of noise inside railbound vehicles
EN 12 663	Railway applications – Structural requirements for rail vehicle bodies

IEC 623	Batteries
IEC 77	Electrical traction equipment regulations
ISO 2631	Guidelines concerning the effects of body vibrations on humans (Guide related to effect on humans from body vibrations)
UIC 515-4	Tests of structural strength of vehicle undercarriages (Car bogie chassis structural strength tests)
UIC 564-2	Fire protection regulations
UIC 615-4	Motive power units - Bogies and running gear - Bogie frame structure strength tests
UIC 505	Railway transport stock - Rolling stock construction gauge

15.2 JOINING AND FASTENING

All fasteners (screws, rivets, etc.) used throughout in the vehicle are of high quality and are as robust as is recommended for heavy operation in vehicles.

The screws used for assembly of panels and interior trim in the passenger compartment are of one standard type, and are made of stainless material. The screw heads will not protrude above the surface of any interior trim panels.

15.3 STAINLESS STEEL

Stainless steel sheets are used for the exterior body panels.

15.4 STEEL STANDARDS

The European material standards listed below were followed in the manufacture of the current Portland Streetcar. The prototype (Type 10 T3) vehicle will use domestic materials where possible and available. The mechanical properties of these U.S. equivalent materials will equal or exceed the values demanded by the European standards.

- carbody structure – closed profiles: S 355 J2G3 pursuant to EN 10025
- carbody structure – chassis – closed profiles: S 355 J2H pursuant to EN 10210
- carbody structure – chassis – sheet metals: 11 503.1 pursuant to CSN 41 1503 (equivalent P 355 NL1 pursuant to standard EN 10028/3-92, German numerical designation: 1.0566).
- bogie frame – sheet metals: 11 449.1 pursuant to CSN 41 1449 (TStE 315 pursuant to standard DIN 17102 and also P 315 NL pursuant to standard SEW 081-84, German numerical designation: 1.0508).
- External vehicle sheet metals: 1.4301 pursuant to EN 10259.

15.5 STEEL CASTINGS

The selection of steel castings used in any location throughout the car will be based upon composition, heat treatment, and design best suited for the intended service.

All steel castings will be suitably marked with pattern and serial numbers in a manner that will not impair their strength. The quality and steel grade of the material will be determined after selection of castings supplier and will be further discussed with PSI.

15.6 ALUMINUM

Only carbon steel is used for any structural component of the body; aluminum is not used.

15.7 WELDING AND BRAZING

The manufacturer will control the quality of all welding and brazing, including that of its subcontractors. Prior to performing work under this contract, all welders will be tested to confirm their ability to operate the welding equipment and to make the types of welds required by the AWS standards of D 1.1.

15.8 ELASTOMERS

All elastomeric parts are of neoprene unless otherwise specified or approved. Elastomers have been compounded and cured to perform in the Portland environment as defined at Section 2 of these specifications. Elastomers have a high resistance to ultraviolet and other solar radiation, to ozone, oxidation, heat, oil and grease, cleaning and washing fluids, and acid. All resilient parts will have a service life no less than ten (10) years.

15.9 GLAZING MATERIALS

See description given at section 13.2.4.

15.10 FLOOR COVERING

See description given at section 13.2.3.

15.11 PIPING AND TUBING

All pressurized pipes and hoses are designed to withstand twice the pressure rating of the pressure release valves. The pipes are stainless and seamless. The connections are located at accessible points. They may be serviced without dismantling other equipment. The connections are made corrosion resistant.

15.12 PAINTS AND COATINGS

The main measure for corrosion prevention throughout the vehicle is the electrophoretic deposition (e-coating) of the raw structures. The battery case is covered by an appropriate painting system. The manufacturer provides 10-year warranty for painted areas. Options for the interior and exterior color scheme, finishing and general appearance of the vehicle will be submitted to PSI within ninety days of NTP (notice to proceed).

The following table describes the procedure followed in the painting of the existing Portland streetcars, as recommended by PPG. We will be adhering to a similar or superior procedure, applicable to painting the vehicle and applying a "show surface quality" standard to painting of the exterior body panels:

PPG Paint System			
Operation	**Working Action**	**Paint Material**	**Thickness**
1.	Degreasing	Chemclean	
2.	Phosphating	Chemfos	
3.	Cataphoresis (e-coating)	Enviroprime 2000	30µm
4.	Gluing of cover sheet metals		
5.	Primer for stainless steel and Al sheets	P 565-767-E2	15µm
6.	Local cementation	Galvaplast 77	
7.	Grinding of cemented areas		
8.	Filler	XPP40003-MH	50µm
9.	Grinding of filler		
10.	Top coat	2K PU Durethane MC 2K PU Deltron - metal lacquer	50µm 20µm
11.	Colorless lacquer for metal lacquer	2K PU Clear Coat 228 065	50µm

15.13 FLAMMABILITY AND SMOKE

All materials are carefully selected so as to minimize any fire risk. The materials conform to the European or U.S. equivalent standards of non-flammability: ISO 3795, UIC 564.2, UL 94, and EN 13501-1.

15.14 WOOD AND PANELS

The quality and material grade specifications will be further discussed with PSI, following supplier selection.

15.15 FIBERGLASS REINFORCED PANELS

The quality and material grade specifications will be further discussed with PSI, following supplier selection.

15.16 WIRE AND CABLE

a) All cables and wires will meet the U.S. standards for railway and public transport applications.

b) The terminals, relays, and cables are marked by yellow labels showing the wire numbers or codes which correspond to the electrical schematics.

c) Cables are equipped with suitable supports, covers, plastic protective elements, etc. to prevent any adverse effects from buckling and vibration caused by the vehicle's movements.

15.16.1 CONDUCTORS

All wire conductor is stranded; there is no solid wire. The conductors will be made of tinned, fine copper strands as per IEC 228, class 5 (DIN VDE 0295 class 5), or per ICEA standard.

15.16.2 WIRING INSULATION

Wire insulation is made from a halogen free, electron-beam cross-linked polyolefin co-polymer with an improved fire performance and an increased temperature range.

Characteristics:

- temperature range -40°C to +120°C
- high resistance to heat, cold, oil, abrasion, ozone and weathering
- increased corona resistance
- halogen free, low smoke, low toxicity
- flame retardant
- soldering iron resistant
- flexible, weight optimized and easy to strip
- fire classes: BS 6853 -Ia, DIN 5510-1 1-4, NF F 16-101 F0

The insulation is rated as low voltage on 600/1000V and as high voltage on 1800/3000V.

15.16.2.1 WIRE INSULATION FOR HIGH TEMPERATURE APPLICATIONS

Only high temperature insulated wire is used where high temperatures are likely, such as at the cab-heater. The wire insulation for this application is made from Teflon. (Operating temperature: -100 °C/ +205 °C sort-time +230 °C). This meets the requirements of DIN VDE 0881 and IEC 673. The conductor material is made of tinned, fine copper strands as per IEC 228, class 5 (DIN VDE 0295 class 5).

15.16.2.2 WIRE INSULATION WITHIN EQUIPMENT

The quality of wires and cables, conductors and insulation used inside the traction containers is equal to that installed between the traction containers or other open area of the Streetcar.

15.16.2.3 WIRE INSULATION IN CROWDED LOCATION

Wire insulation in crowded location is equal to that used at other location of the car, plus they are protect with a spiral wrap covering. This cover is flame retardant, abrasion protected polyethylene.

15.16.3 MULTI-CONDUCTOR CABLES

The conductors of the multi-conductor cables are color coded and made of silver plated copper strands with a braided shield (85% coverage). Insulation is flame retardant, extruded TFE Teflon. It conforms to MIL-W-16878/4 Type E requirement.

15.17 WIRING INSTALLATION

15.17.1 GENERAL

Wires and cables conform to the U.S. equivalents of Fire Class:

- BS 6853 -Ia, DIN 5510-1 1-4, NF F 16-101 F0
- All car wires have a circuit protection

15.17.2 WIRING

Wires are sized for the intended load, voltage drop, temperature and flexibility requirements. Regardless of load, the minimum wire size is as follows:

Wire pulled through conduit:
- (similar to 14 AWG) 2.5 mm²

Wire on electric units, cards and card track – 1.5 mm²
- (do not use smaller size wires, it is better)

Wire which is laid in, rather than pulled through wire ducts:
- (similar to 16 AWG) 1.5 mm²

15.17.3 WIRE HANDLING

All wiring is performed by an experienced, electrically trained workforce, using appropiate tools for stripping insulation, cutting, tinning, harness making, crimping, etc. All wiring tools and equipment is used following the recomendations of the tool and equipment manufacturer.

Cables are equipped with suitable supports, covering tubes, plastic protective elements etc. to prevent any adverse effects caused by buckling and vibration made by the vehicle's movement. Wires are protected from damaged throughout the production process.

15.17.4 CIRCUIT SEPERATION

The following circuit groups are isolated from each other:

- High voltage circuits
- AC circuits
- Communication wires
- Battery voltage level circuits
- Semiconductor voltage level circuits

15.17.5 ROUTING OF WIRING

All wiring (excluding any connected to moving parts, such as the bogie or pantograph) is installed in wire channels or fixed to the car body to protect it from motion and vibration.

All wires and cables that run on the roof or other open area. are equipped with waterproof conduits and bulkheads. Traction containers and junction box entry and egress points also use waterproof conduits. All metal conduits are grounded to the car body.

All wires are to fastened with a UV and ozone resistant wire tie or clamp every 450 mm. These clamps are made from nylon and stainless steel, covered with silicon rubber.

Excess length of wire on the terminal ends to allow for service and reattachment:

- three times on 6 mm² or smaller wire
- two times on 10 mm² or smaller wire

All cables at the terminal ends are coded with a permanent yellow labels corresponding with the electrical schematics. The label is yellow with black machined printing. They are oil, grease, and UV resistant.

15.18 WIRING CONNECTIONS

All terminals, boards and connectors meet the standards for railway and public transportation applications. Terminals are crimped mechanically to the wires. The terminal boards are compression clamp and bolted ring terminal type. Connectors are heavy duty, high quality, multi pins, of a locked and keyed position type. Connectors on the roof or other exposed area are waterproof. Sealing pins are used on any unused connector pins. Ground wire is made from tinned, braided copper ground band cable between any relative moving locations (such as between the car body and truck frame). On the fixed equipment, standard wire or cable is used for the ground connection. All ground connections are of a bolted type.

15.19 SEMI-CONDUCTOR STANDARDS

All discrete diodes used on the low voltage system are transient suppression devices, rated to 1000V PIV and are JEDEC registered and numbered.

15.20 PRINTED CIRCUIT BOARD STANDARDS

The circuit board materials meet with requirement of DIN/ICE 249 and conform to MIL-P-13949 type GB. Components are installed only on one side of the board.

All components are labelled on the circuit board as stated in the equipment drawings list. The board markings show the polarity of the capacitors and the diodes, showing the first pin of the integrated circuits. Both side of the circuit board are coated with a clear protective coating. The manner of the board installation protects it from shock, vibration and damage from being keyed in an incorrect location or direction. The circuit board connectors are heavy duty, highly reliable, and have been proven through long term application. Card edge connectors are not used.

15.21 MICROPROCESSOR BASED SYSTEMS

The microprocessor based control system use Intel (2527 or similar) family microcontroller. For internal and external memories rewritable flash memories are used and for the diagnostic's data storage SD card (Secure Digital Card) is used. The software language is in both English and Czech and aligns with the RFP requirements.

15.22 CONTACTORS AND RELAYS

All contactors and relays used on the Streetcar meet the U.S. equivalent of the European standard requirements for rail or transit vehicle. IEC 60077-1, IEC 60077-2, IEC 60088-2-1, IEC 60088-2-2, IEC 60088-2-3. All contactors and relays are equipped with suppresser elements. Time relays are of the electronic type. Contactors and relays are identified according to the circuit diagrams.

15.23 SWITCHES

Switches in the operator cab are rocker type developed for passenger transport vehicles. They are dust and spray-water protected according to DIN40050.

Electrical performance: From 20 mA to 8A at 24V. The current on the contact will not exceed 60% of the manufacturer's recommended value. Switches in the passenger area and exterior are waterproof type.

15.24 CIRCUIT BREAKERS

High voltage and high speed DC circuit breakers have been developed especially as protective cut-outs for use in feeding railway power lines. They are single pole units, bi-directional, with electro magnetic blow-out, direct instantaneous over current release, natural air cooling and electrical operating system.

Low voltage circuit breakers are thermal and thermal-magnetic single pole type for use in vehicles. The degree of protection is (IEC 60529) on the operating area (IP40), and on the terminal area IP00. They have manual reset and release capability.

15.25 FUSES

Streetcar is equipped with high voltage fuses to protect the electric equipments and wires. Fuse and holder nominal voltage rate is 750 VDC and the maximum insulation voltage is minimum 1000 VDC.

15.26 BUS BARS

All bus bars used are made from 100% IACS copper with zinc protection on the surface.

15.27 CAPACITORS AND RESISTORS – SKODA ELECTRIC

All capacitors are hermetically sealed in metal cases. They are derated 20% for voltage based on the nominal supply voltage and maximum case temperature. The resistors are derated 50% for power dissipation, except the braking resistors.

15.28 TRANSFORMERS AND INDUCTORS - SKODA ELECTRIC

Transformer and inductors are derated 10% for current fluctuations.

15.29 SWITCH, BREAKER AND FUSE PANELS

All switches and circuit breakers are dead front types installed in the appropriate equipment enclosure. They are clearly identified in accordance with the circuit diagrams. Power distribution to the circuit breakers and switches is from a bus bar or bus circuit.

Distribution of power by successive (daisy-chained) connection between devices is not used

16. SYSTEM SUPPORT

16.1 MANUALS AND CATALOGS

The support manuals will include:

- Operator's Instruction and Troubleshooting Manual
- Maintenance, Servicing and Heavy Repair Manuals
- Parts Catalogs
- Training Manuals
- Special Test Equipment manuals

The Operator's Instruction and Troubleshooting Manual will contain all information needed for the optimum operation of the vehicle.

The Maintenance, Servicing and Heavy Repair Manuals will contain all information needed for the preventive maintenance inspection, on-vehicle running maintenance, adjustments, diagnostics, troubleshooting, equipment specification and schematics for the vehicle.

The Parts Catalogs will list and describe every component with its related parts.

The Training Manuals will contain the necessary materials for the training.

The Special Test Equipment manuals will include setup and testing procedures for each test device plus all information required for periodic inspection and servicing requirements.

These documents will be based on the 2001 documents which accompanied the existing Portland vehicles, upgraded according to any new components and/or design.

All documentation will be in English, provided in loose-leaf form. The Operator's Instruction and Troubleshooting Manual will be pocked-sized, the Maintenance Manual, Parts Catalog and Training Manuals will be Standard Sized. In addition, an electronic format version will be provided. The drawings will be in .dwg or .pdf formats.

With regards to the maintenance facility; training and manuals will provide for the proper handling, storage, and disposal of hazardous materials. Manuals will be used to clearly identify any hazardous maintenance procedure and will include instructions on how to reduce or eliminate the hazards of the procedure.

Documents describing the maintenance, failure detection, repair, heavy maintenance, testing and understanding of the vehicle will be included.

This documentation will include:

- Body shell drawings
- Drawing of bogie and related units
- Vehicle component and assembly documentation
- Electrical equipment
- Vehicle cable diagrams

- Vehicle electric diagrams
- Hydraulic system
- HVAC system
- Vehicle test procedure
- Maintenance documents for individual blocks
- Spare parts lists
- Data sheets of separated elements
- Driver's manual

16.2 DIAGNOSTIC TEST EQUIPMENT

OIW-Skoda will provide (laptop PC compatible) software necessary to perform comprehensive, "in-service" testing of the vehicle. This testing will relate to the diagnostics, maintenance, and operational parameters of the following on-board systems:

- propulsion system (including spin/slip control)
- auxiliary converters, low voltage power supply and vehicle control
- friction brake system
- battery chargers
- HVAC system
- Door and bridgeplate systems
- Communication system
- On-board ticket vending machines
- On-board ticket validators
- Event recorder

OIW-Skoda is proposing to deliver any special tools, jigs, fixtures, hand and power tools, with corresponding manuals and drawings for the purposes of collecting diagnostic data and performing maintenance for any components which are different from the original (2001) components and sub-systems. All special tools will be delivered in quantities of two, with a list of manufacturer, part numbers and prices enabling PSI to purchase additional quantities.

16.3 USER EDUCATION

The user training consists of two major categories:

- Operator personnel training: includes basic vehicle operation, detection and resolution of service problems and impact on vehicle and passenger safety.
- Maintenance personnel training: includes preventive and corrective maintenance, overhauls of components and assemblies, and diagnostic software tools.

Each of these two formal sessions will be two weeks in length with considerable hands on training. There will be written and practical tests, covering at a minimum, the following:

- Basic safety
- Operational overview
- Operation for the Mechanic
- Use of the diagnostics system
- Fault identification

- General Maintenance
- Trouble shooting
- Parts manual review

The training will be conducted at the Portland Streetcar workshop, both in the classroom and the streetcar. The program could be attended by instructors, supervisors, mechanics, technicians and train operators. OIW suggests that potential trainers from PSI attend, (or at certain times, participate), during the production of the car as an exercise to help establish the fundamental understanding of the car's construction.

The Staff Training materials will be available sixty days before the commencement of training, including all the attachments, drawings and procedures.