PORTLAND STREETCAR

Memo

To: Kathryn Levine

From: Gary Cooper

CC: Erick Moe

Date: January 22, 2018

Re: Replacement of Skoda 1-MPK-1 APS, and ACCU 3400 LVPS units

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Dear Mrs. Levine,

The purpose of this memo is to summarize and include all the documented that have been forth coming for this major component replacement on streetcars 1-7 model 10TO and T2 Streetcars manufactured by Skoda electric in 2001-2002.

As you know. Some time ago I wrote a summary report comparing and analyzing the specific issues that related to:

1.) The fact that we have not been able to get any new parts or repaired parts for the current 1-MPK-1 APS, and ACCU 3400 LVPS power supply units for a few years now.

2.) the cost analysis to replace these unit with common ABB equipment that exist on our current fleet of Inekon Trio cars. By using ABB M35 Bordline this reduces the number of spares we need to have, and reduces additional training required of employees for new equipment.

3.) The fact that Tacoma, who has the same Skoda 10T2 Streetcars, replaced their same Skoda inverters with the ABB Bordline M35 unit. In that process, Tacoma already worked out all the design, engineering and installation procedures, which have been provided to Portland Streetcar.

4.) The prices to go with ABB will be much less because of the existing retrofit design has already been done installed and proven on the same type of streetcar, and we have been given all the design documentation.

5.) Skoda is not really interested to support the "full" effort to retrofit our existing fleet of 10TO-T2 streetcar inverters and low voltage power supplies. They only want to supply the equipment to us. Communication is also very difficult with Skoda being a check company who has since been purchased by a new owner.

6.) ABB does have a US company to support these efforts and can comply with all City procurement requirements. They are currently an updated and registered supplier in the COP purchasing system.

7.) As an update to past reports. It is also a very good possibility that with purchases of two new streetcars, it is a very good chance those will come with ABB propulsion, Auxiliary electric (APS) and low voltage power supply (LVPS) units; that will have commonality to these existing and proposed M35 Bordline units for retrofit.

In closing I have included the following supporting documents for your further review:

- Report analysis dated May 20, 2016 which summarized the necessity for replacement, comparison of the options and cost, and why going with the existing ABB Tacoma design for commonality would be the best solution.

- Skoda email quote that listed just equipment cost and small engineering support, and nothing else. They were not interested in doing the modification.

- Updated ABB quote listing out all equipment, material, engineering and installation cost. We do not have staff to perform the level of hours and expertise necessary to retrofit all 7 streetcars as originally thought.

- Cost spread sheets comparison tables (2) itemized for Skoda and ABB cost analysis.

I know the magnitude of this effort is expensive, but we have no choice when we can no longer get replacement NEW parts, or the OLD parts repaired. The original analysis was back in 2016 and we have been fortunate to limp along longer than expected. However, we are at the end of those parts and future failures will start removing cars from service. Time is of essence to get something on order regardless of the path.

Thank you and please let me know what question or concerns you might have, if any.

Respectfully,

11/22/2018

Gary Cooper
Manager rail maintenance

SKODA AUX INVERTER 1MPK-1 UPGRADE REPLACEMENT

Background:

In 2001 and 2002 Skoda Transportation of Pilzen Czech Republic delivered seven (7) 10TO-T2 Streetcars that included two (2) 1MPK-1 auxiliary drive inverters (APS) per Streetcar produced by Skoda Electric, also in Pilzen. These inverters are used to run the auxiliary AC loads, which include things such as the heating ventilation and air conditions units (HVAC), propulsion cooling blower motors, cab blower hearing units, as well as other small AC loads. These inverters due this by inverting incoming 750 VDC, into a constant 400 VAC 50 hertz (HZ) output to these necessary and vital loads. These 7 Streetcars have been in service for 14 to 15 years.

With the above mentioned auxiliary drive inverters, there are also two (2) stand-alone ACCU 3400 low voltage battery chargers (LVPS) made by HB electronics in Prague Czech Republic. These battery charges provide regulated 24-28 vdc voltage for charging of the batteries, as well as in normal service provide the DC control power to all vital DC relays that function in the overall car control and operation. The importance with these chargers is that most rail vehicles do not use a stand-alone LVPS unit(s), but incorporate both auxiliary power supply (APS), and low voltage power supply (LVPS), into one combined unit or container.

Current issues challenges with the 1-MPK-1 APS –ACCU 3400 LVPS

Although these units have been good units and reliable, they are also 15 years old. The age of the units is not necessarily the problem, it's that technology has advanced so much over the years that many of the parts in the container are obsolete, and can no longer be repaired by Skoda. This issue was known for approximately 3 years now. Unfortunatly standard contract language requires contractors to support their equipment for minimum of 10 years, which Skoda has done with their inverters. Skoda has also provided information that they are willing to completely rebuild UPGRADE these 1 MPK-1 APS units for us, but that is basically building a new unit out of it, and would end up at the capital cost of what a new APS unit can be purchased for. Additionally, it would be the current design with upgraded inverter as we have now, but does not address the stand alone LVPS, which to make the capital investment should be incorporated into the new product we purchase for operational improvements and consistency. Bottom line is Skoda cannot fix the 1 MPK-1 APS units we have, so we have no choice but to upgrade and replace these inverters before we have no parts and have to park Streetcars out of service.

As with the above challenge so too does this exist with ACCU 3400 LVPS units. As of the date of this report we have 1 Streetcar out of service because there are many challenges with parts repair from the original manufacturer. We have found another technical company to attempt to make repairs to a couple of units, but we won't know if that is successful until we receive those back and test them. These are proprietary units and the technical company does not have all the circuit drawings to confirm 100% that the units and their repairs will work. Additionally, we were finally able to get response form HB electronics, which it seems the company in 15 years has dwindled down to a 1 man shop of original owner. He has agreed this time to repair 8 spare units we have, but pretty much will be retiring so it leaves us no hope for future repairs from this company.

Limp along parts purchase to buy time

In 2013 Portland Streetcar was able to purchase some used spare parts for both 1 MPK-1 APS, as well as the ACCU 3400 LVPS units. When our original Streetcars 1-7 were purchased, the City of Tacoma also purchased three (3) 10T2 Streetcars from Skoda off of Portland Streetcar option car purchases. Since they were off of our options, Tacoma Streetcars major components; propulsion, braking, APS and LVPS units and operation design are exactly the same. As with Portland challenge to get inverter parts repaired, so too was the case with Tacoma. Being a smaller operation and much less cost to replace their fleet, Tacoma made the logical decision to replace all 3 cars with new Auxiliary APS units provided by ABB of Canada. The new unit name is the Bordline M35 unit, which Portland has these APS/LVPS units on our Inekon provide Trio Streetcars (3) 008-009-010. The Bordline M35 unit incorporates both APS and LVPS in one container, so Tacoma was able to replace both the 1 MPK-1 APS units, and the two ACCU 3400 LVPS units with two new Bordline M35 units.

Once the change was made by Tacoma there was really nothing they could do with the removed APS and LVPS units. Because Portland is in regular communication with Tacoma, and the need to have more time to plan our upgrade, we purchased all of Tacoma's 1 MPK-1 scrap inverters, and ACCU 3400 battery charges at scrap price < $300.00. However, not all were in perfect condition or were the internal parts so the hopes of a much longer spare parts supply, did not work out. For the price it did extend us much longer than would have been the case had we not got the parts. However, time and age have seen an increase in failures and we are using those spare parts more frequently.

Main component IGBT attempted repairs

The main component of both Auxiliary and propulsion inverters is the IGBT's (isolated gate bipolar transistors). The modules typically 1 per phase are used to switch at very high frequencies to invert the DC voltage into an AC output at constant or variable frequency (HZ). This would be the harmonics "high pitch noise" you hear when a Streetcar accelerates, or decelerates as it goes by. They generate a lot of heat in use, and have very big heat sinks incorporated in them. Unfortunatly, these have advanced so much the current modules are ¼ the size of original ones. This and time are why they are no longer repairable. However, we did find one company that believed they could repair these for us. But two attempts with this company proved fruitless, and the units failed immediately upon installation. We were not able to find any other company interested to try and make repairs to these IGBT modules. Again, there is just no parts existing to make the necessary rebuild repairs to the modules.

I MPK-1 Replacement stock parts left – Current status

The status of stock parts in the primary parts the IGBT modules, is getting very low. We have one complete working spare 1 MPK-1 inverter, with 6 intendent spare IGBT'S modules on the shelf. Based on the current usage rate, and as long as we don't see higher failure rates than trended. We can potentially last another year +/- before we are out of parts, and cars not able to run in service.

SKODA AUX INVERTER 1MPK-1 UPGRADE REPLACEMENT

Replacement cost analysis

It is estimated that the cost per 1 inverter will range between 45k and 60K, with two inverters required per Streetcar. I'm aware that with the ABB Bordline M35 replacement that those inverters we purchased by Tacoma for $39,000.00 for each inverter, with additional engineering and testing charges. Since a few years have passed I could safely anticipate that those same units today would cost approximately = > $45,000.00. I also had the initial quote from Skoda several years ago to refurbish the existing Skoda inverters at $55,000. Today I would assume that those would have increased by 5k to 10k, so this is where I get my estimates of 45k to 65K base per unit/container price. Additionally there would be a need for consulting services and design review for installation.

With inverter replacement we would also require the Low voltage power supply (LVPS) incorporated into the new APS unit as 1 container, and go away from the HB electronics stand-alone LVPS units. This does not impact cost for replacement because as mentioned above, this is normally how the system are combined into one unit. In fact, it would probably cost more to require the unique design that was configured on our Skoda Streetcars. Regardless we have to make a change upgrade and it makes no sense to not have two containers per car that have the LVPS/APS unit combined. Additionally the battery charges have also become obsolete and we would need to upgrade those too. It only makes sense to combine these as is the case on our other 10 Streetcars.

				Total
Number of Units = 7 cars x 2	= 14	x	$55,000.	$770,000.00
Spare complete units	= 1	x	$55,000.	$55,000.00
Additional spare parts	=		$20,000.	$20,000.00
Engineering services – to include software, testing circuit design				$25,000.00
Contractor Unit installation – to install 2 units 4K each car				$28,000.00
Consulting services – design review, specification compliance.				$75,000.00
				Total = $973,000.00

Engineering services – This would include software development work to configure the NEW inverters to work with exiting system at 400 vac 50 HZ system. Also to include design work with connectors and wiring to configure to existing Portland Skoda Streetcar design including end product commissioning testing. Additionally, the services would include schematic design drawings, and configuration change documents.

Contractor installations – This would include the contractor or their contractors to install the 2 inverters on each car and modify circuits to work properly with existing fleet.

Consulting services - depending on contractor that delivers product, this work can become very extensive in the safety and electrical design review, and certification testing on the car. Proper safety

analysis of equipment and electrical components being installed is necessary especially if the product (inverters) have not been used in this application.

Where to save money lower cost

There is great potential savings and consistency if we were to purchases the Bordline M35 units from ABB.

1.) We already have these units on our newer Inekon Streetcars in the combined APS/LVPS configuration so we would have consistency in parts. We already have a spare container so we could reduce the above cost of a spare unit by $55,000.00, and only purchase added spare parts.

2.) Software development and configuration implementation has already been done on the Tacoma Streetcars for 400 vac 50 HZ, and we have the modification and electrical design package to implement as a direct replacement for Skoda cars. Since the software is developed and tested, this should reduce the vendor engineering cost by several thousand dollars. Additionally having this proven design on the same Streetcars in Tacoma, I'm confident that Portland Streetcar could handle this installation through staff labor without a contractor installation. That could save another $28,000.00. **In retrospect, we do not have the staff or skill level to perform this level of modification and testing certification in house. G Cooper 1/23/18.**

3.) Using a proven design there would not be the level of involvement for consulting services design review, because the design has already been reviewed and implemented. Although I don't think a total elimination of consulting services could happen. I do believe that this could be reduced to = < $25,000.00, which would save another $50,000.00.

4.) The ABB M35 Bordline cost would be close to or less than $45,000.00. That is 10k lower than the average, and 20k lower than what Skoda proposed. A purchase of the ABB units would lead to significant cost savings of potentially $140,000.00.

Total potential savings to go with ABB = **$273,000.00**

Conclusion

It is clear by the above data that we must move quickly to acquire the capital to replace the existing Skoda fleet 1 MPK-1 auxiliary power supply units, before we have no more parts and stock outs. With stock outs we will be parking Streetcars and loosing service. Unfortunate as it is, it's been 15 years since these cars and inverters were commissioned and delivered. If you think about technology advancements in things like computers systems or cell phones and how many of those we have all went through in that time. It makes perfect sense because this equipment is pretty much a computer in the sense of their electrical / electronic technology. Regardless we can't get parts repaired anymore, and soon will have no parts to repair the inverters so there is no choice we have, but to upgrade the units.

selection of supplier somewhere around the end of 2016, which means first deliveries in the later part of 2017.

Prepared by: Gary Cooper
Manager of Maintenance

Date: May 20, 2016

Cooper, Gary

From: Šrámek Milan <milan.sramek@skoda.cz>
Sent: Friday, November 25, 2016 9:24 AM
To: Cooper, Gary
Subject: [Approved Sender] RE: Inverters

Dear Gary,
Sorry for I took so long. We have tried to find similar aux inverter in our offer, but last of this type has been built was fort Cagliari trams 2006-2007 and 10 T3 in 2009. Actually we have other concept of auxiliaries but nothing exactly same. So we would go into new converter design with same topology of cabling, mechanical outline etc to fulfill your logical wish not to change external interface and not make any type tests on car. Suppliers of special components which are no more available did not gave us their budgets, so what is in below is rough non-binding estimate (I have no idea on shipment cost).

- one 25 kVA converter would be for 15 pcs on level of approx CZK 1.5 mil = approx 64 000 USD (see notice in below)
- 24 V chargers for one tram (not decided whether 2 independent boxes or 1 new box the two chargers) would be for CZK 0.86 mil = approx 37 000 USD

So if there would be an assistance e.g. 1 man 3 weeks of 7500 USD, it is 15x 64000 + 8x 37000 + 7500 = approx. 1.264 mil. USD
Another important issue is currency exchange rate. Actually is 27 CZK/EUR or 25.5 CZK/USD, but our currency is actually 5-10 % devaluated. In economy is expectation the Czech national bank will next year cease the interventions against Czech Koruna and exchange rate will be moved to e.g. 25 CZK/EUR or 23.5 CZK/USD.
So here is rough estimate, what is your opinion on it ?
Sorry for delay again and best regards,
Milan

Milan Sramek
Head of Electrical project dept.

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Czech Republic

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milan.sramek@skoda.cz
www.skoda.cz

From: Cooper, Gary [mailto:Gary.Cooper@portlandoregon.gov]
Sent: Wednesday, November 23, 2016 8:59 PM
To: Šrámek Milan
Subject: Inverters

Milan,

Any news or progress with inverter replacement quote? This is very pressing for me and will take time for me to get going on.

ABB US Inc.

Budgetary Offer
No. OPP-17-608157

Portland Bureau of Transportation
Gary Cooper - Manager, Streetcar Maintenance

1516 NW Northrup street
Portland, OR 97209
Phone: (503) 823-2199
Email: gary.cooper@portlandoregon.gov

ABB Inc.
5900 Eastport Blvd, Bldg V
Richmond, VA 23231-4453

ABB Contact
Elvis Dzindo
Mobile: (804) 774-6242

E-Mail: elvis.e.dzindo@us.abb.com
Website: http://www.abb.com/railway

Your reference	Your letter dated	Our reference	Date
		OPP-17-608157	2018-01-03

Subject: Quotation for Portland Streetcar with "Soundtransit Retrofit" BORDLINE® M35 auxiliary converter

Dear Mr. Cooper

ABB Inc. is pleased to submit for your consideration this budgetary offer for the retrofit / replacement of your existing Auxiliary Inverter / APS with our BORDLINE® M35 Auxilirary Power Converter for your fleet of 7 Skoda 10T Streetcars plus 1 spare APS and a list of recommended spares

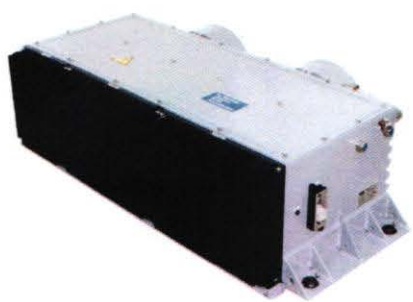
Should you require any further information, please do not hesitate to contact us.

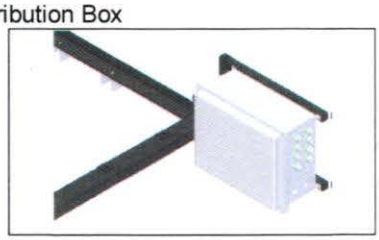
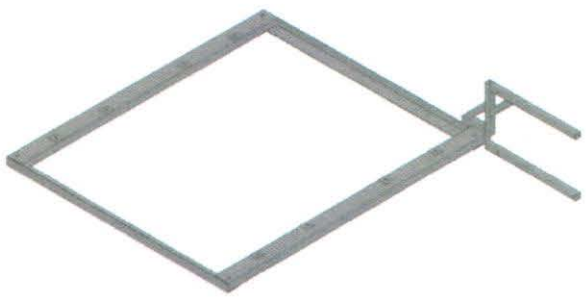
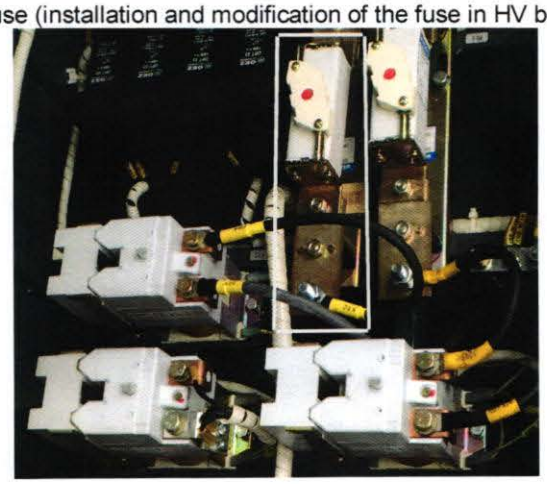
Yours faithfully

ABB US Inc.

Daniel Ludwikoski
Local Product Group Manger

Elvis Dzindo
Sales Traction USA

Item	Qty	Specification	Unit Price in USD	Extended Price in USD
01	15	**BORDLINE® - M35 Auxiliary Power Unit for the Retrofit Skoda 10T Streetcars** *Specification and norms are based on the original designed auxiliary converter according to [T5].* • Changes: ○ Integration of new Inverter Power Module (WR) with adaptations necessary on unit housing ○ Upgrade of ZK and BL Powermodules due to EOL1 of semiconductors • Units will be delivered with same interfaces and specifications as "Sound Transit" units used for Skoda T10 in Takoma project. No changes on control unit hardware or software, interfaces, battery characteristic (same battery will be used as in Takoma project). • The routine test of each unit will be performed according to Routine Test Specification [T4]. • A type test for the whole unit will not be performed for this delivery. • Adaptions of this unit will be documented in an adapted operating manual (based on original [T3]). 	**$62,000**	**$930,000**

02	7	**Installation Equipment** Items outlined below are based on the equipment and quantities needed per Streetcar • BORDLINE® M35 connect & sensor kit • AC Distribution Box  • BORDLINE® M35 adaptive mounting frame  • 2012T0148 Terminal Box Kit • Fuse (installation and modification of the fuse in HV box)  • Insulator (installation and modification of the Distribution box)	**$20,000**	**$140,000**

		 • Cabling,conduits, female connectors, terminations and lose material		
03	**1**	**Costs for Onsite Commissioning Support for 1st Streetcar** • 3 days on-site commissioning support (normal working time Mo-Fri, 8h/per day) by system specialist. Lead engineer of commissioning team Standard Preventive Maintenance (CAT 6). Transformer Engineering and type test ○ Date for installation/commissioning support shall be agreed three months ahead.		**$22,000**

04	1	**Non Recurrent Costs for Engineering & Onsite Installation** /(includes all of the following activities) • Removal of Existing APS units • Removal of Battery Chargers • Removal of Unused Cabling & Connectors • Removal of Existing Xbat Box components • Installation of New Adaptive Frame • Installation of New BORDLINE® M35 APU/APS Units • Installation of One AC Distribution Box; • Installation of the <Xbat Box> Fuse and Diode terminal blocks Original aux system / New aux system  **Total Cost to Retrofit the entire fleet of 7 Skoda Streetcars**		**$134,000**
		Total Price in USD		**$1,226,000**

Breakdown of Recommended Spares Pricing

Description	Additional Description	Part Number	Quantity	Unit Price in USD	Extended Price in USD
Power Module PM1	Bordline-M:BL-KK MK2 kpl.	3BHE019308R0006	2	**$10,619**	**$21,238**
Power Module PM2	Bordline-M35:ZK-KK MK2 kpl.	3BHE019378R0001	2	**$10,444**	**$20,888**
Power Module PM3	PBA B13	3BHE051113R0001	2	**$12,600**	**$25,200**
FAN ext	Rad-Venti:R2E250-AV65	3BHE029090R0002	1	**$1,318**	**$1,318**
FAN intern	Rad-Venti:R2E250-AV65	3BHB004261R0010	1	**$258**	**$258**
HBU-LT	PP D114 B1002	3BHE020570R1002	2	**$9,251**	**$18,502**
Varistor	POLIM-C 1.0 ND	1HC0011263R0100	2	**$335**	**$670**
Power Supply unit	KU D807 A01	3BHE018260R0001	2	**$978**	**$1,956**
Emergency start power supply unit	Power supply unit 750V/24V	3BHE036193R0001	2	**$2,213**	**$4,426**
Temperature sensor	NTC 10k	HUCD430236P0001	2	**$31**	**$62**

Total Price for Recommended Spares: $94,518

Reference Attachements

- [T1] Mechanical Drawing; Bordline-M35_Massbild.pdf; 3BHS344273 D05
- [T2] Electrical Interface Soundtransit; M35 DC 011_A02 Electrical Interface.pdf; 3BHS363553 E07 Rev. D
- [T3] Operating Manual; M35_DC_750_R_AD_011_A02_Handbuch eng.pdf; 3BHS363553 E04 Rev. B
- [T4] Routine Test Protocol; "Prüfprotkoll Sound Transit.pdf"; 3BHS363553 E22 Rev. B
- [T5] Technical Description; BORDLINE-M35 for SKODA 10 T 2012-04-24_.pdf; 3BHS363553 E01 Rev. A

Terms & Conditions / Commercial Conditions

Bid Type	Budgetary
Offer validity	Until February 23th 2018
General Terms and Conditions	ABB Inc. Terms and Conditions of Sale apply to this proposal (available upon request).
Shipping	DDP Portland, OR, Incoterms 2010
Duties, Permits & Taxes	Not included in pricing
Insurance	Not included
Warranty	12 months from commissioning, with a maximum 24 months from delivery. The Supplier shall not be liable under warranty provision if the Customer installs components not purchased under this Agreement
Project Schedule	First units for 1st streetcar to be delivered 6 months from purchase order, remaining units will be delivered over 6 months after successful commissioning of the units on the first streetcar Onsite installation and commissioning schedule to be discussed and mutually agreed
Payment Terms	Equipment Costs: 100% payment on delivery of each unit Non-Recurreing Costs: 100% payment at order placement Payment conditions: net 30 days after invoice

REPLACEMENT COST AUXILLARY POWER SUPPLY (APS), AND LOW VOLTAGE POWER SUPPLY (LVPS) -SKODA email

APS **AUXILLARY POWER SUPPLY** - AC power supply to a streetcar. There are two pieces units per streetar.

LVPS **LOW VOLTAGE POWER SUPPLY**. Low voltage 24 VDC regulated and battery charging. Currently,Two units per car.

REASON To replace Skoda 1-MPK1 inverters and ACCU 3400 low voltage power supplies because we cannot get new or repaired parts for current units, and are out of parts to keep them working.

SKODA ELECTRIC - EQUIPMENT COST		
APS - Price for 1 unit	$64,000.00	No commonality to current APS on 10TO-T2 cars
Required 2 units per car	$128,000.00	
Standalone LVPS	$37,000.00	Skoda would combine 2 LVPS into one box / Unit.
Total cost equipment to retrofit 1 car	**$165,000.00**	
	x 7	
Total cost to retrofit 7 cars	$1,155,000.00	
ADD 1 Spare APS unit	$64,000.00	One Spare unit requied for failure and repairs of fleet
ADD 1 Spare LVPS unit	$37,000.00	One Spare unit requied for failure and repairs of fleet

1.) *Total cost - Equipment cost pluss one spare unit(s)* **$1,256,000.00**

SKODA Cost - Installation / Enginering/testing/spare parts		
Installation equipment / materials	0	No cost provided for supplied materials
On site comissioning support - 3 weeks	**$7,500.00**	
Non-recurring Engineering cost and on-site instllaition	0	Not interested to do instllation
SKODA - recommended spare parts	0	Did not provide recommended spare parts list

2.) *Total cost materials, instllation, testing, engineering and spare parts* **$7,500.00**

Totol cost Skoda 1 & 2 **$1,263,500.00**

REPLACEMENT COST AUXILLARY POWER SUPPLY (APS), AND LOW VOLTAGE POWER SUPPLY (LVPS) -ABB quote

APS **AUXILLARY POWER SUPPLY** - AC power supply to a streetcar. There are two pieces units per streetar.

LVPS **LOW VOLTAGE POWER SUPPLY** - Low voltage 24 VDC regulated and battery charging. Currently, there are two units per car.

REASON To replace Skoda 1-MPK1 inverters and ACCU 3400 low voltage power supplies because we cannot get new or repaired parts for current units, and are out of parts to keep them working.

ABB US Inc. - EQUIPMENT COST		
APS - Price for 1 unit	$62,000.00	Combines APS and LVPS to one unit, common units and parts to our current Inekon Trio cars 12T.
Required 2 units per car retrofit	$124,000.00	
Standalone LVPS	$0.00	APS and LVPS are combined into one unit
Total cost equipment to retrofit 1 car	**$124,000.00**	
	x 7	
Total cost to retrofit fleet 7 cars	$868,000.00	Total cost equipment alone
ADD 1 Spare APS unit	$62,000.00	One Spare unit requied for failure and repairs of fleet
ADD 1 Spare LVPS unit	NA	APS and LVPS are combined into one unit

1.) *Total cost - Equipment cost pluss one spare unit(s)* **$930,000.00**

ABB US Inc. - Installation / Enginering/testing/spare parts		
Installation equipment / materials	$140,000.00	$20.000 per car x 7 cars
On site comissioning support -	$22,000.00	full commissioning and testing of first streetcar
Non-recurring Engineering cost and on-site instllaition	$134,000.00	Cost for on-site personnel; lead engineer and installation personel to retorfit all 7 streetcars
ABB - recommended spare parts individual pieces	$94,518.00	Individual spare parts needed for internal unit repairs.

2.) *Total cost materials, instllation, testing, engineering and spare parts* **$390,518.00**

Totol cost ABB US Inc. 1 & 2 **$1,320,518.00**

ABB US Inc.

Firm Offer
No. OPP-17-608157

Portland Bureau of Transportation
Gary Cooper - Manager, Streetcar Maintenance

1516 NW Northrup street
Portland, OR 97209
Phone: (503) 823-2199
Email: gary.cooper@portlandoregon.gov

ABB Inc.
5900 Eastport Blvd, Bldg V
Richmond, VA 23231-4453

ABB Contact
Elvis Dzindo
Mobile: (804) 774-6242

E-Mail: elvis.e.dzindo@us.abb.com
Website: http://www.abb.com/railway

Your reference	Your letter dated	Our reference	Date
		OPP-17-608157	2018-03-08

Subject: Quotation for Portland Streetcar with "Soundtransit Retrofit" BORDLINE® M35 auxiliary converter

Dear Mr. Cooper

ABB Inc. is pleased to submit for your consideration this firm offer for the retrofit / replacement of your existing Auxiliary Inverter / APS with our BORDLINE® M35 Auxilirary Power Converter for your fleet of 7 Skoda 10T Streetcars plus 1 spare APS and a list of recommended spares

Should you require any further information, please do not hesitate to contact us.

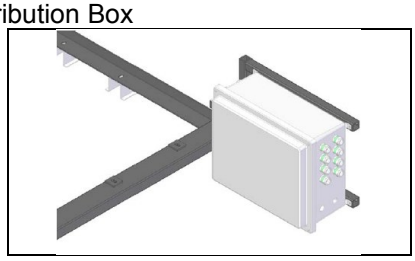
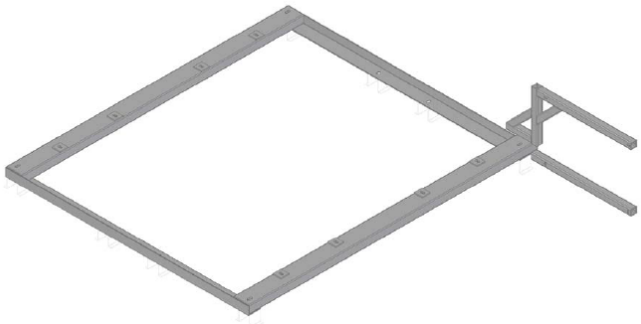
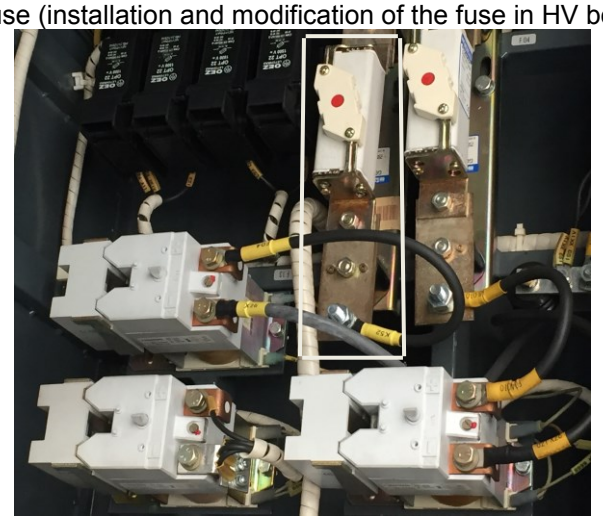
Yours faithfully

ABB US Inc.

Daniel Ludwikoski
Local Product Group Manger

Elvis Dzindo
Sales Traction USA

Item	Qty	Specification	Unit Price in USD	Extended Price in USD
01	15	**BORDLINE® - M35 Auxiliary Power Unit for the Retrofit Skoda 10T Streetcars** *Specification and norms are based on the original designed auxiliary converter according to [T5].* • Changes: ○ Integration of new Inverter Power Module (WR) with adaptations necessary on unit housing ○ Upgrade of ZK and BL Powermodules due to EOL1 of semiconductors • Units will be delivered with same interfaces and specifications as “Sound Transit” units used for Skoda T10 in Tacoma project. No changes on control unit hardware or software, interfaces, battery characteristic (same battery will be used as in Takoma project). • The routine test of each unit will be performed according to Routine Test Specification [T4]. • A type test for the whole unit will not be performed for this delivery. • Adaptions of this unit will be documented in an adapted operating manual (based on original [T3]). 	**$62,000**	**$930,000**

02	**7**	**Installation Equipment** Items outlined below are based on the equipment and quantities needed per Streetcar • BORDLINE® M35 connect & sensor kit • AC Distribution Box  • BORDLINE® M35 adaptive mounting frame  • 2012T0148 Terminal Box Kit • Fuse (installation and modification of the fuse in HV box)  • Insulator (installation and modification of the Distribution box)	**$20,000**	**$140,000**

		 • Cabling,conduits, female connectors, terminations and lose material		
03	**1**	**Costs for Onsite Commissioning Support for 1st Streetcar** • 3 days on-site commissioning support (normal working time Mo-Fri, 8h/per day) by system specialist. Lead engineer of commissioning team Standard Preventive Maintenance (CAT 6). Transformer Engineering and type test ○ Date for installation/commissioning support shall be agreed three months ahead.		**$22,000**

04	1	**Non Recurrent Costs for Engineering & Onsite Installation** /(includes all of the following activities) • Removal of Existing APS units • Removal of Battery Chargers • Removal of Unused Cabling & Connectors • Removal of Existing Xbat Box components • Installation of New Adaptive Frame • Installation of New BORDLINE® M35 APU/APS Units • Installation of One AC Distribution Box; • Installation of the <Xbat Box> Fuse and Diode terminal blocks		**$134,000**

Original aux system	New aux system
	

Recommanded Spare parts

Description	Additional Description	Part Number	Quantity	Unit Price in USD	Extended Price in USD
Power Module PM1	Bordline-M:BL-KK MK2 kpl.	3BHE019308R0006	2	**$10,619**	**$21,238**
Power Module PM2	Bordline-M35:ZK-KK MK2 kpl.	3BHE019378R0001	2	**$10,444**	**$20,888**
Power Module PM3	PBA B13	3BHE051113R0001	2	**$12,600**	**$25,200**
FAN ext	Rad-Venti:R2E250-AV65	3BHE029090R0002	1	**$1,318**	**$1,318**
FAN intern	Rad-Venti:R2E250-AV65	3BHB004261R0010	1	**$258**	**$258**
HBU-LT	PP D114 B1002	3BHE020570R1002	2	**$9,251**	**$18,502**
Varistor	POLIM-C 1.0 ND	1HC0011263R0100	2	**$335**	**$670**
Power Supply unit	KU D807 A01	3BHE018260R0001	2	**$978**	**$1,956**
Emergency start power supply unit	Power supply unit 750V/24V	3BHE036193R0001	2	**$2,213**	**$4,426**
Temperature sensor	NTC 10k	HUCD430236P0001	2	**$31**	**$62**

Total price for Recommended spares : $94'518

		Total Price in USD		**$1,320,518**

Reference Attachements

- [T1] Mechanical Drawing; Bordline-M35_Massbild.pdf; 3BHS344273 D05
- [T2] Electrical Interface Soundtransit; M35 DC 011_A02 Electrical Interface.pdf; 3BHS363553 E07 Rev. D
- [T3] Operating Manual; M35_DC_750_R_AD_011_A02_Handbuch eng.pdf; 3BHS363553 E04 Rev. B
- [T4] Routine Test Protocol; “Prüfprotkoll Sound Transit.pdf”; 3BHS363553 E22 Rev. B
- [T5] Technical Description; BORDLINE-M35 for SKODA 10 T 2012-04-24_.pdf; 3BHS363553 E01 Rev. A

Terms & Conditions / Commercial Conditions

Bid Type	Firm
Offer validity	Until March 26th 2018
General Terms and Conditions	ABB Inc. Terms and Conditions of Sale apply to this proposal (available upon request).
Shipping	DDP Portland, OR, Incoterms 2010
Duties, Permits & Taxes	Not included in pricing
Insurance	Not included
Warranty	12 months from commissioning, with a maximum 24 months from delivery. The Supplier shall not be liable under warranty provision if the Customer installs components not purchased under this Agreement
Project Schedule	First units for 1st streetcar to be delivered 6 months from purchase order, remaining units will be delivered over 6 months after successful commissioning of the units on the first streetcar Onsite installation and commissioning schedule to be discussed and mutually agreed
Payment Terms	Equipment Costs: 100% payment on delivery of each unit Non-Recurreing Costs: 100% payment at order placement Payment conditions: net 30 days after invoice