CITY OF
Saint Paul
ALASKA

City of Saint Paul Electric Utility Upgrades
Construction Work Plan
For
RUS Loan Application

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ELECTRIC POWER SYSTEMS
ePs inc.
electric Power Systems inc.
Consulting Engineers

Revisions

Revision	Date	Revision Notes
0		Initial Release
1	1/4/2023	Revision
2	1/12/2023	Revision

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Executive Summary

This report is a Construction Work Plan (CWP) for a vertically-integrated generation and distribution facility on Saint Paul island. This CWP addresses the work to replace existing, inoperable equipment with three new gensets that have been pre-purchased and are currently being packaged off site. The proposed generation facilities, three new John Deere generators, will replace inoperable and/or oversized gensets, and better match and serve the current loads with more reliable operation. With the gensets themselves already purchased, this CWP covers the installation of the gensets as well as the refitting or replacement of general plant support equipment, such as piping and radiators, as well as replacement of switchgear, patchworked together over the plant's life, and end-of-life distribution equipment.

CWP 1200 Includes:

- Demolition and installation of the above noted gensets under CWP Code 1201.
- Improvement of the cooling system for the new gensets, as well as connection to the heat recovery system as part of the cooling system installation for the subject gensets, under CWP Code 1201.
- This CWP includes work to address the fuel system deficiencies
- This CWP includes switchgear installation for the subject gensets under CWP Code 1203
- This CWP includes district heat system maintenance work under CWP 1204

CWP 600 Includes:

- The replacement of the G&W Switch under CWP Code 601
- Select transformer replacement under CWP Code 602 for items marked for immediate replacement per Appendix "A".
- Airport Feeder Upgrade under CWP Code 603

CWP 1200: Generation Systems

Building

This CWP includes the building maintenance items noted below under CWP 1201 & CWP 1202.

The existing powerhouse building is a durable tilt-up concrete construction and is generally in good condition. Maintenance to the building envelope should be scheduled as needed to extend the lifespan, however the building is one of the best generation assets owned by the City. There is plenty of space for upgrades and improvements, and the durable design should allow it to last for many years. There is no need for major reconfiguration to accept future generation upgrades.

The following items are currently in need of maintenance, replacement, or upgrades:

- Inspect roofing for leaks and repair as-needed. If repairs are not possible, the City should plan on a complete roof replacement or re-sealing before building structural members become damaged from water intrusion.
- Reconfigure HVAC ductwork to prevent further water intrusion and corrosion.
- Install entryway corridor to allow access to the operator’s office and locker room without having to pass through the generator room. There is currently no way to enter the building without having to put on hearing protection outside the structure.
- Replace the fire protection system and install an autodialer.
- Replace exterior entry doors, and add an awning.
- Upgrade T5s to modern LEDs.

Generation

This CWP includes the demolition and installation of gensets under CWP Code 1201.

The powerhouse contains six generators that are currently installed. Only two units are effectively operable in bays 5 and 6. Units 3 and 4 could potentially be placed into operation if the voltage

regulators are repaired, however they are too small to supply power independently and serve little functional purpose with the current load profiles. It was also noted during a recent site assessment that the unit batteries had been removed. An inspection of Unit 2 revealed that a number control and ancillary systems that were only partially complete and will require rework or installation to make the unit operational.

City of Saint Paul Installed Generation Assets					
Bay No. (EU ID)	Manufacturer, Model and Serial Number	Nameplate Rating	Installation Date	Hours	Operational Status
1 (1)	Caterpillar 3512 S.N. 67Z01239	855 kW 4160V	1998	80,394	Failed transformer (4160V)
2 (2a)	John Deere 613SHF485 S.N. RG6135L005911	460kW 480V	2008	0	Incomplete installation
3 (3)	Caterpillar 3406 S.N. 90U16623	200 kW 480V	1998	6027	Failed Voltage Regulator
4 (4)	Caterpillar 3412 S.N. 81Z01232	300 kW 480V	1998	46471	Failed Voltage Regulator
5 (5)	Caterpillar 3512 S.N. 67Z00739	650 kW 480V	1998	65522	Limited, due for overhaul
6 (6)	Caterpillar 3512 S.N. 67Z00740	855 kW 480V	1998	149,266	Operational

Load Profiles and Generation Capacity

The following table is an extract from the Load Forecast Study. Refer to the Load Forecast Study Summary for more information.

2022 CSP Peak Load Forecast Summary

Load Description	Low Load Case Based on 2021-2022 CSP Peak	High Load Case Based on 2021-2022 CSP Peak
2021-2022 Peak Load	385 kW	598 kW

These loads are currently supported by operating single generators. The installed CAT 3500 series generators are over capacity for the application and downsizing of installed equipment is recommended for future replacements.

Planned Generator Replacements

The limited operational generation resources puts the City in a precarious position and immediate replacement is required. To this end, a group of three new John Deer generators have been previously purchased by the City and are currently at 49th State Power being configured as complete units on skids. These will ultimately replace units in bays 1, 3, and 4. The three new units, along with final installation and commissioning of unit 2, will restore the plant to a reliable operational status.

Changes to Air Permit

The City power plant currently operates under a Title V Operating air permit. The power plant was originally permitted to support local fish processor loads and was sized to meet those seasonal power demands. However, the existing old engine-generators are expensive for the City to maintain, are unreliable to operate, and because of the original Prevention of Significant Deterioration (PSD) air permitting process the existing old engine-generators will require source testing every 5 years as long as they are in the power plant.

With the City's proposed installation of Tier 2 marine engine-generators and removal of all existing old engine-generators (except for EU ID 2a) from the power plant, actual operating loads are low enough that the City can opt out of its current classification as a PSD facility as well as replace its current Title V Operating air permit with a more simple air permit type. The type of air permit that will be required depends on a number of factors. It could be a Pre Approved Emission Limit (PAEL) Permit or a Minor Permit. Regardless, the new air permit will contain fewer monitoring and reporting requirements, which will save the City significant costs for reporting and permit compliance.

Integration with other generation

TDX Renewable Power

Renewable energy is available from the TDX windfarm under a power purchase agreement. Unfortunately, a combination of technical issues have prevented the city from being able to effectively utilize this resource and it should not be presumed to be available in the future. Planned generation upgrades will anticipate eventual addition of renewable resources to allow for flexible integration when they become available. This CWP otherwise excludes improvements or repairs to integration of renewables.

Switchgear

This CWP includes switchgear installation for the subject gensets under CWP Code 1203.

The existing switchgear consists of four different sections:

- 480 volt switchgear for units 3 and 4 and neutral grounding resistor (older)
- 480 volt standalone two cubicle section for units 5 and 6 (newer)
- 480 volt standalone two cubicle section for unit 2 and the main feeder breaker (newer)
- 4160 volt section for unit 1

The 4160 volt switchgear is standalone for unit 1 and cables directly to the dedicated (failed) 4160 volt step up transformer and currently out of service.

The three 480 volt sections are connected using cable that is bolted to the bus of each section. The switchgear for units 3 and 4 is older gear using analog controls. The switchgear for units 2, 5 and 6 is more modern switchgear. The controls are based around the Woodward EasYgen controller (for each unit) and a plant control PLC for automated control.

The current configuration of the switchgear is patched together with the different sections of switchgear and a mix of modern digital and older analog controls. Adding the new John Deere units along with the existing units 2, 5 and 6 will require upgrading the switchgear. EPS is recommending a complete replacement of the switchgear with one integrated lineup that will include digital controls for all units, two feeder breakers and a station service breaker. By replacing the gear with one integrated line-up, all the control wiring and testing of the switchgear can be done prior to shipment to Saint Paul.

Station Service and Low Voltage Electrical Systems
The plant station service and low voltage systems appeared to be in good working condition with capacity to support the planned upgrades. This CWP excludes replacement of station service and low voltage electrical systems, except where incidental modification or expansion is needed to integrate new equipment.

Generator Cooling and Heat Recovery
This CWP includes improvement of the cooling system for the new gensets, as well as connection to the heat recovery system as part of the cooling system installation for the subject gensets, under CWP Code 1201. It does not include modification to the heat recovery system itself, which is covered in the next section.

The existing generator heat recovery and cooling system is based on an old design concept where generators are grouped into two common cooling systems. An exchanger connected to the two common cooling systems supplies heat to nearby city-owned buildings through an underground district heat piping system.

Common cooling systems are prone to system-wide coolant contamination if one generator has a mechanical problem. Failure of one generator can disable a group of generators simultaneously. The upgraded system will provide separate cooling systems for each generator to improve overall system reliability. Each generator will be able to connect to the district heating system individually. This adds to the number of components in the powerhouse, but improves the lifecycle management of equipment by reducing the cost and complexity associated with failures, repairs, and replacement of individual generators.

<u>District Heating System</u>

This CWP includes the district heat system maintenance work under CWP 1204.

A comprehensive inspection of the underground piping or heat exchangers at the client connections (other City-owned buildings) has not been completed recently. It is presumed that the system is functional and can be placed back into service after the powerhouse upgrades are complete. It is expected that there will be a reduction in overall heat delivery capacity with the new generators, and the City may need to look at building maintenance to reduce heat loss.

The district heat system is currently in need of the following work:

- Inspection of the entire system.
- Flushing and basic maintenance on the entire system.
- Public Works Building
  - New pumps
  - Repair/replace leaking pipe on outside of building
  - New thermostats
  - New vents and gauges
- Motor Pool Building
  - Investigate and repair system temperature issue
  - Add heating elements in Equipment Bay
- Polar Star Building
  - Investigate and repair system pressure issue
- Gas Station
  - Repair/replace leak in the pipe between Power Plant and Gas Station (heat service to client currently disabled)
- Fire Station
  - Investigate and repair potentially undersized heat exchange equipment

District heating systems (heat recovery) are subject to many common misconceptions about their use and effectiveness. The following observations are based on EPS' experience working with similar systems, and may be helpful as the City discusses future plans and upgrades.

- Heat recovery systems can save money. The savings is from offsetting heating oil consumption in buildings. This increases the overall plant efficiency and is comparable to adding a renewable energy system.

- Heat recovery systems are limited. Extending a heat recovery system beyond its available capacity can void all efficiency gains. A common problem occurs when excessive heating loads start driving how operators dispatch units in the powerhouse. If the powerhouse needs to run "the big unit" or an "extra unit" to keep up with heat demands, the added operating cost to the powerhouse invariably offsets any efficiency gained by having the system. The added cost is hidden in overhaul expenses, reduced equipment life span, and increased fuel consumption.

- Recovered heat is not "waste heat" or free. The cost of operating a district heating system is usually buried in the capital cost and maintenance of installed equipment such as heat exchangers, piping, and pumps. A common error is assuming that once the piping is installed it will last forever, leaving the utility operators unprepared for the expense of system

replacement. Underground piping, insulation, and heat exchangers may only last 15 years, and replacement can cost between several hundred thousand to over one million dollars..

- Modern diesel generators produce less easily-recoverable heat. Connected heating loads may need to be downsized as old generators are replaced with new variations. There are several technical reasons for those changes. In many cases, reduced heating capacity can be offset by simply sealing up leaky building envelopes.

Fuel System
This CWP includes total replacement of the power plant fuel system and fuel supply pipeline from the bulk fuel facility.

Power Plant Fuel System

The power plant fuel system has reached a state of near complete failure and has been jury rigged to support basic operations. Complete replacement of the system, including all tanks, controls, and an underground line from the City's bulk fuel facility is planned. The new system will include the following features:

- A new 500' double wall buried fuel line from the truck rack to the power plant
- Two new intermediate bulk fuel tanks outside the powerhouse (previously purchased by the City) on a pre-cast concrete foundation.
- An automated fuel transfer system supplying two new 660 gallon day tanks from the intermediate tanks.
- A high-capacity primary filtration system.
- Fuel headers running the length of the engine bays to allow connection of current and future generation equipment to either of the two day tanks.
- Fuel coolers on the generator return piping
- A fire suppression system and enclosure for the day tanks.

The new system has been specifically designed to be adaptable to future generation configurations with minimal modifications.

CWP 600 12470Y7200V Electrical Distribution Systems

G&W Switch at the Powerhouse
This CWP includes the replacement of the G&W Switch under CWP Code 601.

In the Spring of 2022, while performing system assessments, it was found that the SF6 gas which provides arc extinguishing properties in the 15kV distribution system switch was critically low. This led to an investigation of possible sources of leaks in July 2022. This investigation was inconclusive in finding any source of a leak. An elevated amount of SF6 gas was added and to date has generally been maintained with small variations likely due to ambient temperature changes. Since the introduction of the G&W Electric SF6 switch technology which the current switch utilizes, G&W Electric has developed a switch that eliminates SF6 gas completely and utilizes "Solid Dielectric" vacuum

bottle technology. The proposed switch incorporates SEL-751 relays which will easily be integrated into an overall control system providing both protection of the distribution system as well as control and
metering.

The "G&W Switch" is critical to the distribution system since it is the source of all feeders to the City of Saint Paul.

Transformers
This CWP includes select transformer replacement under CWP Code 602 for items marked for replacement per Appendix "A".

The existing system was reviewed by Chris Davis from Electric Power Systems on April 7th, 8th, and 9th of 2022. Many of the relatively newer pieces of pad mounted equipment showed considerable rust damage. Most older pieces of equipment could not be opened and/or closed or were nearing complete failure. The harsh weather and salty environment on Saint Paul Island promotes unusually high rates of corrosion.

The present CSP specification for purchasing transformers uses mild-steel. The transformers are not holding up very well. 15 year old transformers are showing serious signs of rust, to the point that many are very difficult to open. 20 year old transformers in general, will not lock anymore. The "Jerry's Transformers" that used rhino bed liner paint are doing a little better, but the rust is still evident. Padmount transformers should last 30-40 years minimum.

Stainless steel transformers only cost 20-25% more per transformer and the life will double. EPS recommends that all new pad mounted equipment should be stainless steel. In addition, switch cabinets using Solid Dielectric switches should be considered to eliminate any exposed contacts.

The “Equipment Condition Assessment” table in Appendix “A” indicates the proposed replacement schedule for the next ten years. Immediate repairs necessary to make the equipment safe to the general public are also listed. The table is ordered by replacement priority.

Due to long procurement timelines that do not appear to be improving, the schedule is based around a 2.5 year lead time for each replacement. The proposed replacement schedule for high priority is 2023 procurement and 2025 install. Medium priority is 2028 procurement and 2030 install. The low priority replacement is a 2033 procurement for a 2035 install.

Distribution Feeders
This CWP includes the Airport Feeder Upgrade under CWP Code 603.

The original installation included exposed neutral conductors. Exposed neutral conductor (non-jacketed 15kV cable) is notorious for corrosion of the neutral to the point that neutral is no longer continuous in the system. Normally corrosion like this is evident at the terminations at transformers. No failure was observed while opening equipment. Since the conductor is directly buried, corrosion

could happen between devices with no way to observe the failure. The exposed neutral cable would then be relying on earth-return for the neutral path which is not allowed by NESC. The exposed neutral cable in the system is +35 years old and needs to be replaced. The proposed Airport Feeder Upgrade will replace most of the cable in question.

Due to long lead times, the materials will need to be procured in 2023 for a 2025 installation.

Load Forecast Study (Summary)

The following is a summary. Refer to the City of Saint Paul 2022 Load Forecast Report for more information.

Based on an average CSP load of 465kW in 2022, we are expecting a Low Load case of 275kW in 2032, a reduction of 69%. The reduction would be driven by energy efficiency and population decline.

If all of the proposed new customers are added to the system, we expect the High Load case to reach a peak demand of 825kW, an increase of 77%. The major drivers for the increase would be adding Trident Seafoods as an off-season customer and adding a large-scale community greenhouse.

2022 CSP Peak Load Forecast Summary

Load Description	Low Load Case Based on 2021-2022 CSP Peak	High Load Case Based on 2021-2022 CSP Peak
2021-2022 Peak Load	385 kW	598 kW
Population or Economic Reduction	- 110 kW	- 110 kW
Potential New customers	+0 MW	+ 550 kW
2028 Peak Load Summary	275 kW	1,148 kW

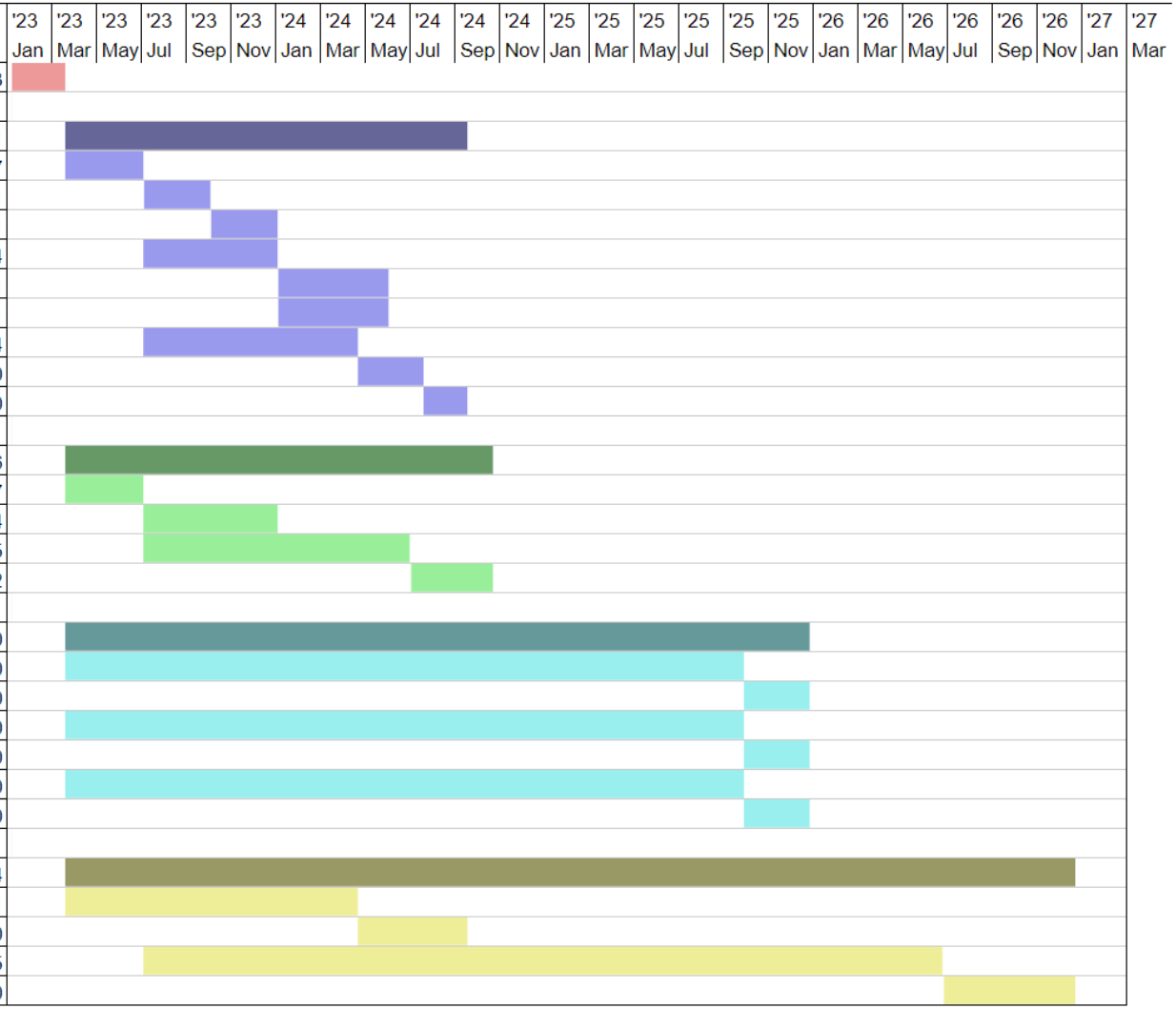
Construction Costs

For construction costs, reference document "RUS Construction Costs" document.

Schedule

The following is an approximate construction schedule for all CWP 1200 items, as well as CWP 601, CWP 602, and CWP 603:

Description	Start	End	Days
RUS FUNDING APPROVED	1/1/'23	3/15/'23	73
CWP 1200 - GENERATION	3/15/'23	9/16/'24	551
35% DESIGN	3/15/2023	6/30/'23	107
65% DESIGN	7/1/'23	9/30/'23	91
100% DESIGN	10/1/'23	12/31/'23	91
PROCUREMENT	6/30/'23	12/31/'23	184
MECH DEMO/INSTALL	1/1/'24	5/31/'24	151
ELEC DEMO/INSTALL	1/1/'24	5/31/'24	151
PROCURE SWITCHGEAR	6/30/'23	4/19/'24	294
ELEC DEMO/INSTALL	4/19/'24	7/18/'24	90
COMMISSIONING	7/18/'24	9/16/'24	60
CWP 601 - G&W Switch	3/15/'23	10/21/'24	586
35% DESIGN	3/15/'23	6/30/'23	107
100% DESIGN	6/30/'23	12/31/'23	184
PROCURE LONG LEAD EQUIP.	6/30/'23	6/29/'24	365
INSTALL/COMMISSIONING	7/1/'24	10/21/'24	112
CWP 602 Transformers	3/15/'23	12/29/'25	1,020
High priority procurement	3/15/'23	9/30/'25	930
High priority install	9/30/'25	12/29/'25	90
Medium priority procurement	3/15/'23	9/30/'25	930
Medium priority install	9/30/'25	12/29/'25	90
Low priority procurement	3/15/'23	9/30/'25	930
Low prioirty install	9/30/'25	12/29/'25	90
CWP 603 - Feeder replacement	3/15/'23	12/28/'26	1,384
35% DESIGN	3/15/'23	4/19/'24	401
100% DESIGN	4/19/'24	9/16/'24	150
PROCURE LONG LEAD EQUIP.	6/30/'23	6/29/'26	1,095
INSTALL/COMMISSIONING	7/1/'26	12/28/'26	180



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Reference Document A: City of Saint Paul, Electrical Distribution System, Equipment Condition Assessment
Reference Document B: City of Saint Paul, 2022 Load Forecast
Reference Document C: RUS Project Construction Costs