May 29, 20120

Alberta Electric System Operator **by E-mail**
2500, 330 – 5th Avenue SW
Calgary, Alberta
T2P 0L4

Attention: Tana Lailan, Project Manager – Transmission Project Delivery

Re: P-1898 Pattern Lanfine North Wind AGF
ATCO Service Proposal Estimate SP Rev-1 (for AESO FS V3 dated Feb 27, 2020)

Please find enclosed the revised Service Proposal (SP Rev-1) estimate for the P1898 Pattern Lanfine North Wind AGF project.

This Service Proposal is complying with the revised AESO Functional Specification (AESO FS version V3 dated Feb 27, 2020) and includes ATCO's replies to AESO review comments (item 1 to 11) received on January 24, 2019 for the previously submitted Service Proposal Rev-0.

The current revised Service Proposal (Rev-1) cost estimate is $12.48 million (+20%/-10%) which is less than the previous Service Proposal (SP Rev-0, January 9, 2019) estimate of $12.85 million which is due to:

- Decrease in costs due mainly to line design change
- Increase due to AC mitigation
- Revised PPS preparation costs

The current ISD for the project is September 30, 2022.

Sincerely,

Sridhar Rao

Sridhar Rao P.Eng, PMP
Project Manager | Transmission Projects
Transmission Division
7 Floor ATCO Centre, 10035 – 105 St. | Edmonton, AB T5J 2V6
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Pattern Lanfine North Wind AGF

AESO Project Number **P1898**

Service Proposal Rev-1
(AESO FS version V3 Final dated Feb 27, 2020)
Executive Summary

May 29, 2020

Issued to AESO

APEGA Permit to Practice P-000850

DOCUMENT CHANGE CONTROL

This chart contains a history of the revisions made to this document.

Rev.	Date of Issue	Brief Description of Change
0	January 11, 2019	Original version
1	May 29, 2020	Revised in accordance with AESO FS v3 Final dated Feb 27, 2020

Table of Contents

1 Project Summary

The Market Participant has applied to the AESO for transmission system access to connect its proposed 145MW Pattern Lanfine North Wind Aggregated generating facility in the Hanna area.

ATCO Electric as the Transmission Facility Owner (TFO) will build required modifications to the existing Lanfine 959S substation, build a new 144kV, single circuit transmission line 7L238 (approximately 13km) to connect to customer's substation (Buffalo Bird 601S).

This Service Proposal meets the requirements outlined in the AESO's Direction Letter, Functional Specification (AESO FS version V3 Final dated Feb 27, 2020), Authoritative Documents and other technical requirements.

Table 1-1: Information about the Project

Project Name	Pattern Lanfine North Wind AGF
TFO	ATCO Electric
Owner of the DTS / STS	Pattern Development Lanfine Wind ULC
Project Location	The project site is located approximately 7km northeast of the township of Oyen, Alberta
	AESO Planning Area & No: Hanna – 42
Substation(s)	Source: Lanfine 959S Proposed development: 144kV 7L238 and addition of one 144kV circuit breaker feeder bay at Lanfine 959S
Previous 2019 Service Proposal (Rev-0) Estimate	$12,848,500 (without AC mitigation)
This Service Proposal (Rev-1) Estimate	$12,482,546 (includes AC mitigation)
ISD	September 30, 2022

2 Scope of Work

This proposed project is to provide system access to the customer's substation (Buffalo Bird 601S) through the interconnection to the existing ATCO Lanfine 959S substation and build a new 144kV transmission line 7L238.

2.1 Transmission Line Scope

Line, surge & charging impedance, insulation levels will be provided on completion of detailed design. Laydown areas will be accommodated close to substation vicinity and will be determined closer to execution stage. Pipeline AC mitigation study has been carried out and costs included in the revised proposal. Right-of-Way and access way surveys will be accommodated closer to execution.

2.1.1 New 144kV 7L238 Transmission Line:

- Design and build approximately 13km of a new single circuit 144kV transmission line designated as 7L238 running between the existing Lanfine 959S and customer's Buffalo Bird 601S substation.
- The proposed conductor is 1–795 kcmil ACSR Drake/phase. The shield wire is 1- 3/8", 7 strands, grade 220 galvanized steel including a 24fiber OPGW. The minimum/maximum summer/winter capacity of 7L238 with this configuration is 257MVA/324MVA.
- Basic structure type for 7L238 is tangent wood Davit Arm (93), 45-90-degree angles (7) and wood 3-pole dead end (6) with mostly direct embedded foundations.
- Terminate the new 144kV 7L238 to the new 144kV circuit breaker (704) bay at Lanfine 959S.

  Note: Termination of 7L238 at Customer's Buffalo Bird 601S end is by the Customer.

2.2 Substations Scope

2.2.1 Proposed Lanfine 959S modifications:

- Install one (1) new 144kV circuit breaker (704) with its associated 144kV manually operated disconnect switch (704A).
- Install one (1) new 144kV motor operated disconnect switch (7L238DI) for the new line 7L238.
- Install three 144kV CT (704CT) and three 144kV PT (7L238PT).
- Modify the existing rigid bus span between 704B and 703B for re-termination of the rigid bus at new 704A disconnect.
- Terminate the new line 7L238 at Lanfine 959S end.

  Note: Expansion of Lanfine 959S is not required.

Salvage:

- Include for removal of existing steel structures with insulators (one structure located at 703B end and 3 individual structures located at 704B end of the existing bus span)

Protection and Control

- Design and build new 7L238 line protection relay in existing panel 7P3 including 21A/7L238 Siemens 7SA522 (A Protection) and 21B/7L238 SEL- 421-4 (B Protection).
- Design and build 144kV breaker fail protection in existing panel 7F1, with one 50BF/704 SEL-421-4 relay.
- Design and build RAS protection scheme in existing panel 7P3, with proposed two SEL-2100 relays for the RAS scheme.

Telecom

- Design and build one new single mode fiber optic cable between the 7L238 A-Frame and the existing Control Building.
- Install one (1) substation ground riser at the base of the 7L238 A-Frame leg to which the cable tray will be extended, for bonding OPGW and fiber transition cabinet.
- Provide communication link between Lanfine 959S and Customer's substation Buffalo Bird 601S (OPGW)
- Modify one telecom panel as required.

SCADA

- The SCADA automation work at Lanfine 959S substation consists of modifying the existing design and programs to reflect the proposed project modifications. One of the SEL-2032 will be replaced with a SEL-3530 (RTAC) to accommodate new SEL protection relays associated with addition of 7L238 to the existing substation.

- New alarms, analog values, controls and communication links to the existing SCADA platform (RTU and HMI). This SCADA data will provide consolidated local and remote (SOC) metering, annunciation and control for the new 144kV line 7L238.
- The new Schweitzer relays will communicate through the new SEL RTAC. The new Siemens relay (7L238 protection) will be added to the existing RS485 daisy chain for SCADA software point reports using DNP protocol.
- A communication link will be added to the new 'IPP Gateway System' for gathering data from the Client's substation (Buffalo Bird 601S) and provide the required supervision for the generating facility. Communications link requirements and design will be defined based on AESO requirements using a standard communication protocol between Buffalo Bird 601S and Tinchebray 972S substations.
- At this stage of the project there are no known duplicate scope of work with other projects in the area.

2.2.2 Nevis 766S modifications:

Protection and Control

- Design and build a new RAS protection panel (9S4); add two new SEL- 451 relays for new Pattern RAS protection scheme.

Telecom

- On site connection provisioning work on existing infrastructure is required.

SCADA

- The SCADA automation work at Nevis 766S substation consists of modifying the existing design and programs for the new RAS scheme.
- Add one (1) SEL-2100 Logic Processor and one (1) SEL-451 RAS protection relay.
- The SEL 451 will be connected via DNP3/IP to the existing Automation Switch over fiberoptic cable.

2.2.3 Monitor 774S modifications:

Protection and Control

- Design and build in existing protection panel (1G), add two new SEL- 451 relays for RAS protection and two SEL 2600 RTD modules for ambient temperature sensing.

Telecom

- On site connection provisioning work on existing infrastructure is required.

SCADA

- The SCADA automation work at Monitor 774S substation consists of modifying the existing design and programs to reflect the addition of the two (2) SEL-451 RAS Relays .
- The two existing SEL-2032s will be used to connect the new protection relays.

2.2.4 Tinchebray 972S modifications:

Protection and Control

- No Scope.

Telecom

- On site connection provisioning work on existing infrastructure is required.

SCADA

- The SCADA automation work at Tinchebray 972S substation consists of replacing the existing D20ME IPP RTU with Eaton SG-4250 Station Controller with provision for redundancy.
- All existing communication circuits will be cut over to the new Station Controller and new serial DNP3 circuit to Buffalo Bird 601s substation will be required to provide the customer's SCADA data to the AESO and ATCO SOC via ATCO Telecom network and to provide SCADA control to the open high side circuit breaker at the Customer's wind facility to the ATCO SOC.

3 Cost Estimates

The estimated cost to complete the project as described is CAD $12.48 million (+20% / -10%).

The estimated project costs are directly related to the proposed project as described in the AESO Functional Specification version V3 Final, dated February 27, 2020 and accurate to +20%/-10% range.

The cost estimate involved inputs and reviews from functional groups and includes anticipated Engineering, Construction, Commissioning, Health & Safety, Environment, Procurement, Land Administration, Right of Way planning (ROW), Project Management, Contingency, Escalation and E&S.

ATCO Electric forecasts the projects capital costs using engineering data defined in the Design Basis Memorandum, the AESO's Functional Specification, Single Line diagrams, apparatus/equipment data sheets, basic layouts, material takeoffs, quotes prices for equipment and budget pricing for subcontracts. The estimate also referenced past project experiences, historical unit and hourly costs from similar projects.

This cost estimate is valid for one year from the date of its submission to the AESO and provided there are no further changes to Scope, Schedule and Risk.

See detailed SP cost estimates (AESO files) attached.

4 Project Schedule

Task name	Date
AESO Functional Specification and SP Directions received	October 18, 2017
Service Proposal Rev-0 submitted to the AESO	January 9 2019
Revised AESO FS V3 Final dated Feb 27, 2020	March 6, 2020
Service Proposal Rev-1 submitted	May 30, 2020
FA submitted to the AUC	Aug 10, 2020
P&L received from AUC	Jan 1, 2021
Customer Backing required for full project cost	Dec 15, 2020
7L238 Line	
Detailed Engineering	Jan 4, 2021 – June 24, 2021
Line Material procurement	April 29, 2021 – Aug 9, 2021
7L238 Geotech Survey	Sept 1, 2021 – Oct 1, 2021
7L238 Construction	Oct 1, 2021 – Mar 8, 2022
7L238 Commissioning	July 8, 2022 – Sept 30, 2022
Lanfine 959S Modification	
Detailed Engineering	Jan 4, 2021 – June 24, 2021
Material procurement	April 29, 2021 – Oct 20, 2021
Lanfine 959S construction	Mar 18 2022 – Sept 30, 2022
Commissioning	July 8, 2022 - Sept 30, 2022
Telecom	
Detailed Engineering	Jan 4, 2021 – June 24, 2021
Material procurement	April 29, 2021 – Oct 20, 2021
Telecom construction	April 1, 2022 – Sept 30, 2022
Telecom Commissioning	July 8, 2022 – Sept 30, 2022
ISD	Sept 30, 2022

5 Assumptions

The Service Proposal estimate is based on the assumptions listed below.

5.1 General Assumptions:

- Customer will proceed with the project and continue to provide financial backing to meet the project ISD. Customer funding is required for Geotech survey that must be completed in winter 2021.
- Key milestone dates will be met as per project schedule. All required permits, approvals and funding is available on time to meet the ISD schedule.
- ATCO Electric will have full access to all main roads and access roads to complete their work.
- The estimate is based on 2020 Canadian Dollars. Forward inflation has been applied on labour, equipment and material costs based on expected price increases using ATCO Electric's in-house forecast data and price indexes. Inflation rates are calculated for 2019-2022.
- A contingency allowance is included in the Service Proposal estimate as shown on the summary sheet to cover the cost of items identified in the risk register.
- Taxes are not included in the Service Proposal estimate.

5.2 Engineering Assumptions:

Engineering scope of work is based on the following documents:

- AESO Functional Specification version V3 Final dated Feb 27, 2020.
- ATCO Electric Design Basis Memorandum (DBM) for the project.

5.3 Right of Way (ROW) Assumptions:

- This Service Proposal estimate may change depending on which 7L238 route will get approved (east route 10km vs west route 13km). We have assumed the west route in our estimate.
- This Service Proposal estimate is based on conducting early engagement work and two rounds of already completed public consultation.
- This Service Proposal estimate assumes that no fence expansion is required at Lanfine 959S substation.

5.4 Land Administration Assumptions:

- All third-party consents will have to be checked and renewed prior to Construction.

5.5 Indigenous Relations Assumptions:

- No Indigenous Relations engagement is required for this project.

5.6 Environment Assumptions:

- ATCO will include mitigation strategies for working during restricted activity periods (RAP) and working in sensitive environmental areas.

5.7 Construction Assumptions:

- ATCO Electric is the Prime Contractor for the project.
- All line foundations are assumed to be direct embed. Line construction is planned for winter. Additional substantial matting costs may be required for summer or wet construction.
- Required outages are available on time to maintain project schedule.
- All clearing and accesses activities will occur under dry ground conditions.
- Substation and line construction estimates are based on third party estimated contractor rates.
- The Customer will coordinate their work schedule to match ATCO Electric's schedule to avoid any delays.
- Demarcation between Customer and ATCO Electric is the 7L238 dead end outside of Buffalo Bird 601S substation. Customer will string the final span into their substation. The OPGW demarcation will be slack storage arm on the dead-end structure and Customer will be responsible for splicing the OPGW at this end.
- Level 3 cleaning for access mats is not included in the cost estimate.
- No hotline work is included in the cost estimate.

5.8 Commissioning:

- Planned outages will be secured as required and on schedule.

5.9 Environmental & Seasonal Constraints:

Wildlife/Environmental Concern	Restricted Activity Periods (RAP)	Impact/Mitigation
Key Critical Wildlife Zone	N/A	One environmentally significant area 3km north of the project area. No impact to the project.
Caribou Area	N/A	None within ATCO project area.
Class C Stream crossings	N/A	None within ATCO project area.
Fisheries Timings Constraints	N/A	No In-stream work
Migratory Birds - Wetlands	April 20 – Aug	Clearing should be completed prior to, or following

	25	migratory bird window. ATCO will follow their Environment Management System (EMS) and Environment Protection Plan (EPP).
Migratory Birds - Croplands	April 15 – Aug 30	
Sensitive Raptors	March 15 – Aug 31	Year-round setbacks on nesting sites (50m to 1000m) based on level of disturbance.
Sharp Tail Grouse	March 15 – June 15	If present within Project area, 500m setback applies during restriction dates. Follow EMS and EPP.
Amphibian breeding ponds	See note	If Amphibian breeding ponds present within project area – 100m setback from waterbody applies. Follow EMS and EPP.
Wetlands		Avoid /Mitigate (Follow EMS and EPP)
Rare Plants		If rare plants are in the vicinity of the project setback (30-300m depending on disturbance level).
Spring Breakup (wet-thawed conditions), and Top soil rutting concerns		Avoid/mitigate (follow EMS and EPP)
Cropland and vehicle/Equipment cleaning		Follow EMS and EPP. Not a confirmed clubroot country however do not want to spread noxious weeds.

6 Risk Management

Risk	Risk/Opportunity Description	Response Strategy	Response Description
Project Schedule	Customer decision to delay or cancel the project.	Mitigate	To coordinate with customer to prepare a revised project plan.
Project schedule	Construction schedule delays due to weather conditions or other factors.	Mitigate	Develop and implement work plans to allow flexibility in working in wet and unfrozen conditions.
Project Changes	Late changes impacting engineering, procurement and construction.	Mitigate	Perform site visits to confirm site conditions and constraints; Regular meetings with internal and external stakeholders to ensure early awareness of any proposed changes.
Regulatory	The amount of time required for the AUC to review a Facility Application is unknown.	Mitigate	Engineering and tendering activities shall be expedited (if possible)
Construction	Shortage of contractors or bidders for line/substation construction.	Accept	Determine contractor availability through an expression of interest early in the tendering process. Align contracts with other ATCO projects to utilize the same contractors where practical.
External Resourcing	Outage / System constraints which prevent system outages to be scheduled when needed for construction.	Accept	Outages will be planned ahead of the construction start. Engage in early discussions.
Operational	Any delay of long lead items which impact construction.	Mitigate	Long lead items will be ordered as part of early procurement order (before P&L).
Project Approval	Project may not be approved by AESO/AUC/Customer	Project schedule and cost will be impacted	To be addressed via change proposal

The contingency is allocated as follows:

CONTINGENCY / RISK REGISTER SUMMARY

RISK	DESCRIPTION	IMPACT	PROB	COST IMPACT	CONTINGENCY	ACTION	RESPONSE
1	Site and/or conditions that require additional matting	Medium	60%	$ 320,000	$ 192,000	Mitigate	1. Develop and implement safe access plan 2. Use mats to minimize site and access damage
2	Higher than expected labour market pricing	Medium	30%	$ 480,000	$ 144,000	Mitigate	1. Competitively bid labour contracts 2. Execute contracts in a timely manner
3	Changes impacting materials and construction	Medium	40%	$ 430,000	$ 172,000	Mitigate	1. Perform site visit to obtain actual site conditions (compare with as-builts) 2. Establish construction execution plans
5	Construction schedule delays due to weather conditions or other factors	Medium	30%	$ 260,000	$ 78,000	Mitigate	1. Develop and implement work plans to allow flexibility working in wet and unfrozen conditions 2. Confirm work plans during construction start-up meetings 3. Monitor progress and adjust schedule as required during construction
6	Changes impacting engineering and procurement	Medium	40%	$ 116,000	$ 46,400	Mitigate	1. Perform site visit to obtain actual site conditions (compare with as-builts) 2. Regular meetings with internal and external stakeholders to ensure early awareness of any proposed changes
7	Delayed, missing or damaged material	Medium	40%	$ 220,000	$ 88,000	Mitigate	1. Confirm Bill of Materials (BOM) during design reviews 2. Track material status from requisition to delivery
8	Additional work space and temporary access	Medium	40%	$ 160,000	$ 64,000	Mitigate	1. Perform site visit to obtain actual site conditions (compare with as-builts) 2. Establish construction execution plans
		TOTAL CONTINGENCY			**$ 784,400**		

7 Operation and Outages

Note: Specific outage dates will be available once the construction plan is finalized prior to execution.

7.1 144kV 7L238 and Lanfine 959S Modification

Outage requirements include the following:

Item	Length	CROW Permits	Reason
Outage on 703,707 & 700BS2 at 959S Lanfine Isolation Pts: 703A, 707B	65 days	GOI 2-51854	An outage is required to install the breaker bay for new breaker 704 with new line addition 7L238 at Lanfine
Outage on 901T at 766S Nevis Isolation Pts: 901TD	3 days	GOI 2-51855	An Outage is required to install the new RAS panel 9S4 and relay settings at Nevis
Outage to 701 at 774S Monitor Isolation Pts: 701A and 7L224D1	5 days	GOI 2-51856	An Outage to new RAS relays in existing panel at Monitor.
Outage to 702 at 767S Oyen Isolation Pts: 702A and 7L760D1	5 days	GOI 2-51857	An Outage is required to install the new RAS panel 7S1 and relay settings at Oyen.

8 Appendices

The following are included:

- Location and line route map
- Lanfine 959S proposed layout
- Substation SLD and SLPMD
- Tele-communication diagram
- Project schedule (timeline)
- Service Proposal Estimate AESO files

9 Approvals

ATCO Electric hereby submits this Service Proposal Rev-1 to the AESO for the work as described in AESO's directions.

Prepared by:

Sridhar Rao — May 15, 2020

Sridhar Rao Date

Project Manager

ATCO Electric Ltd.

Checked by:

Peter Martyniuk — 05/19/2020

Peter Martyniuk — Date

Manager Projects

ATCO Electric Ltd.

Approved by:

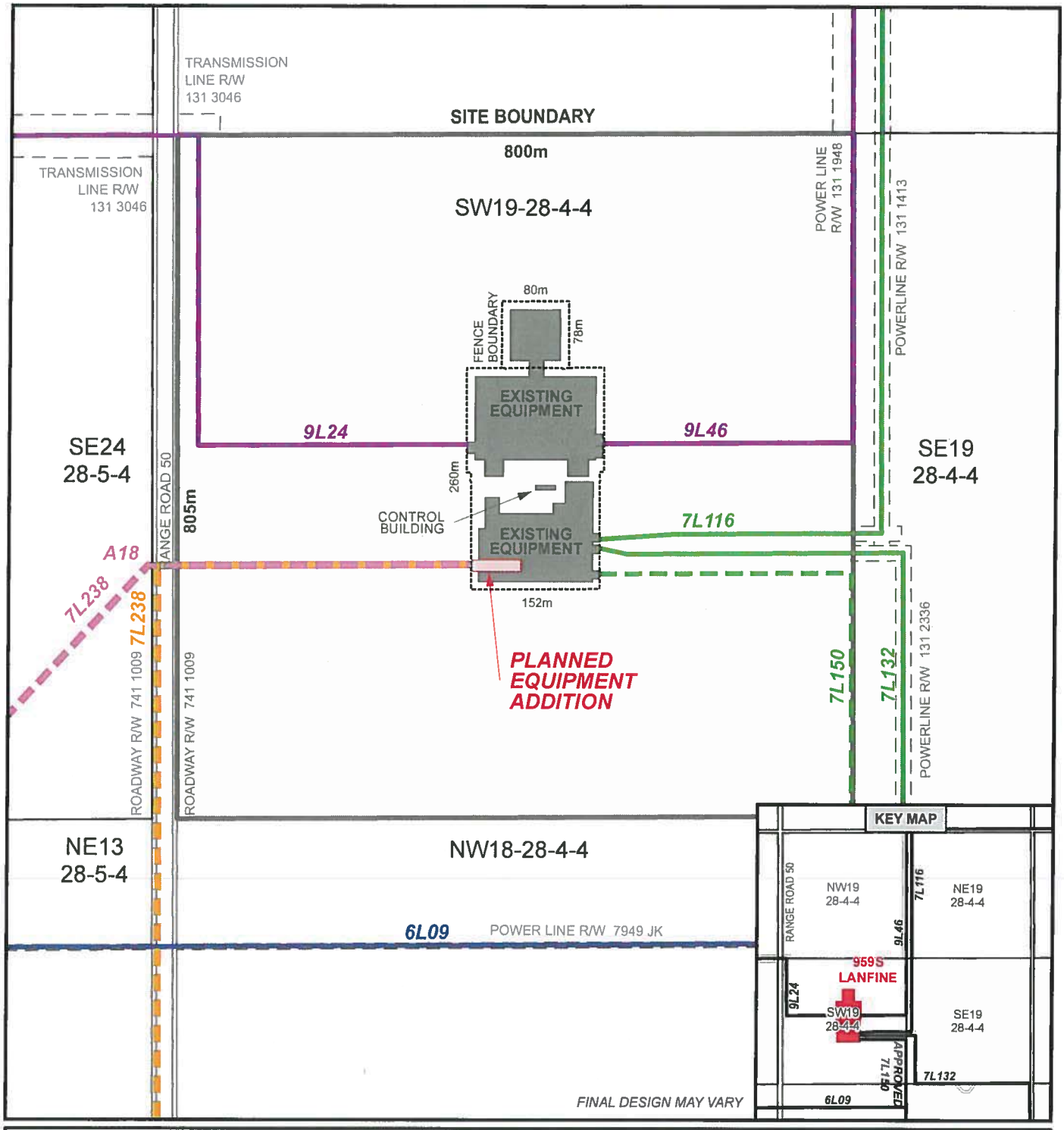
05/22/2020

Kumail Moledina — Date

Vice President, Projects & Construction

ATCO Electric Ltd.

Geographic Coordinate Value at Substation Fence Centroid = N51.4054, W110.5612



144 kv Transmission Line Route Concept West Option
144 kv Transmission Line Route Concept East Option
Planned Equipment Addition
Existing Equipment
Exisiting Site Boundary
Existing Fence
Existing 240 kV Transmission Line
Existing 144 kV Transmission Line
Existing 72 kV Transmission Line
Approved 144 kV Transmission Line

N W E S

0 110 220 Metres
0 250 500 Feet

NOTES:
- Only facilities in the vicinity of the project are shown.

ATCO

Buffalo Bird to Lanfine Transmission Project

959S LANFINE SUBSTATION PLANNED SITE LAYOUT

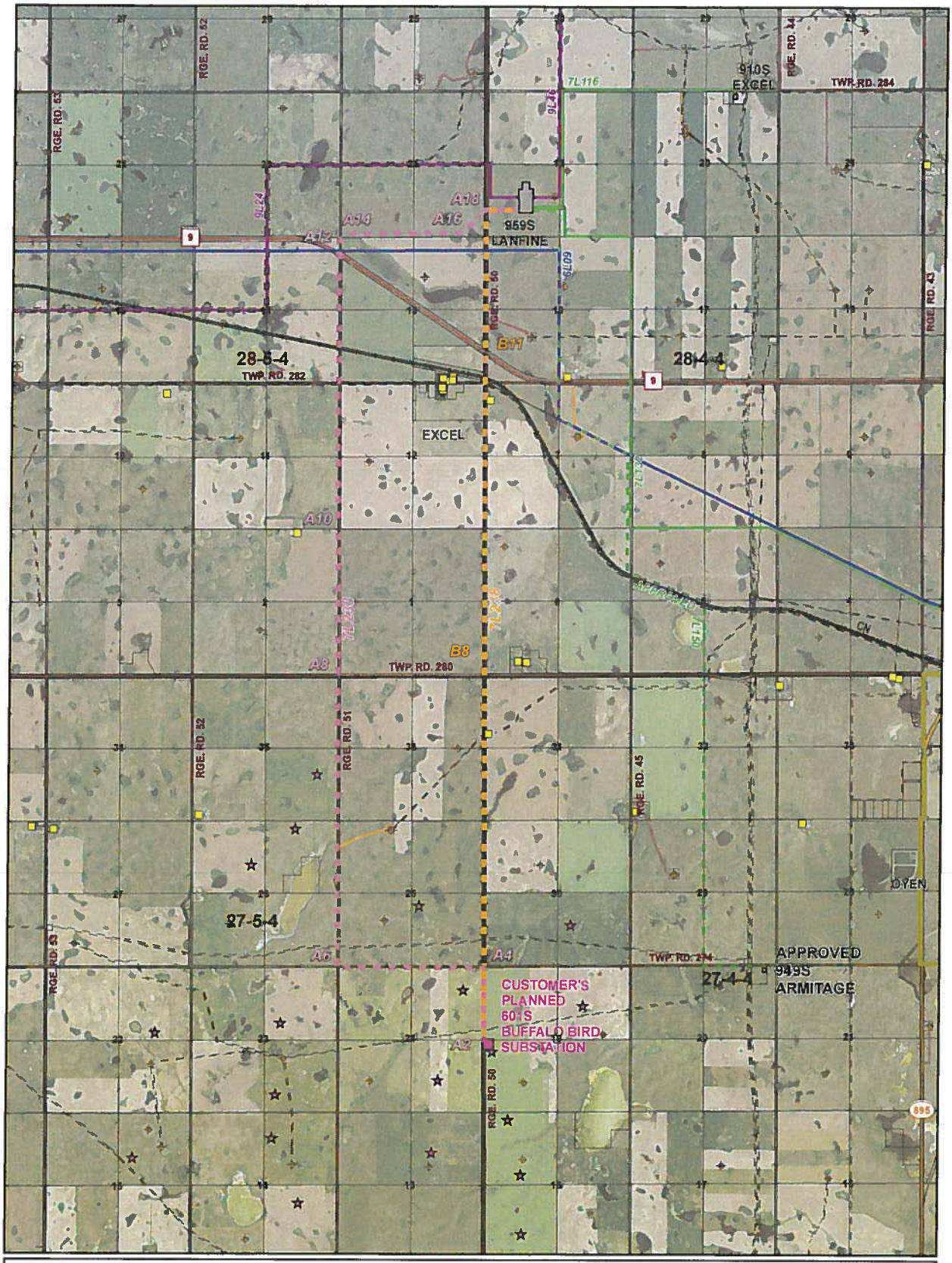
February 2018

RS-7L238 - N1 - 02

CREDIT NOTES
Alberta Data Partnerships, IHS Markit

Always practice extreme caution when near power lines!

Cartography By: CO | Approved By: LJ | 1:6,500 at Letter | Projection: NAD 1983 UTM Zone 12N | File Name: 7L238_Lanfine_Site_Layout



- Customer's Planned Substation
- Existing/Approved Substation
- 144 kV Transmission Line Route Concept West Option
- 144 kV Transmission Line Route Concept East Option
- Existing 240 kV Transmission Line
- Existing 144 kV Transmission Line
- Existing 72 kV Transmission Line
- Approved 144 kV Transmission Line
- Planned Wind Turbine
- Surface Well Sites
- Residence
- Primary Highway
- Secondary Highway
- Road
- Railway
- Existing Easement R/W
- Current Disposition
- Wellsite Existing/Abandoned
- Town

CREDIT NOTES
Alberta Data Partnerships, IHS Markit, ATCO Electric Jan 2018, Various

N W E S

Kilometres 0 0.25 0.5 Miles

NOTES
- Only facilities in the vicinity of the project are shown

ATCO

Buffalo Bird to Lanfine Transmission Project

ROUTE CONCEPTS MOSAIC

February 2018

RS-7L238 - N1 - 01

Cartography By: CO | Approved By: LJ | 1:40 000 at Tabloid | Projection: NAD 1983 UTM Zone 12N | File Name: 7L238_BuffaloBird_Lanfine_Route_Mosaic

CADD Filename: K:\cadd\substations\959s Lanfine\58844-E48226 (OCT. 2017)\300 Drawings\In Progress\959s 3D.3ds
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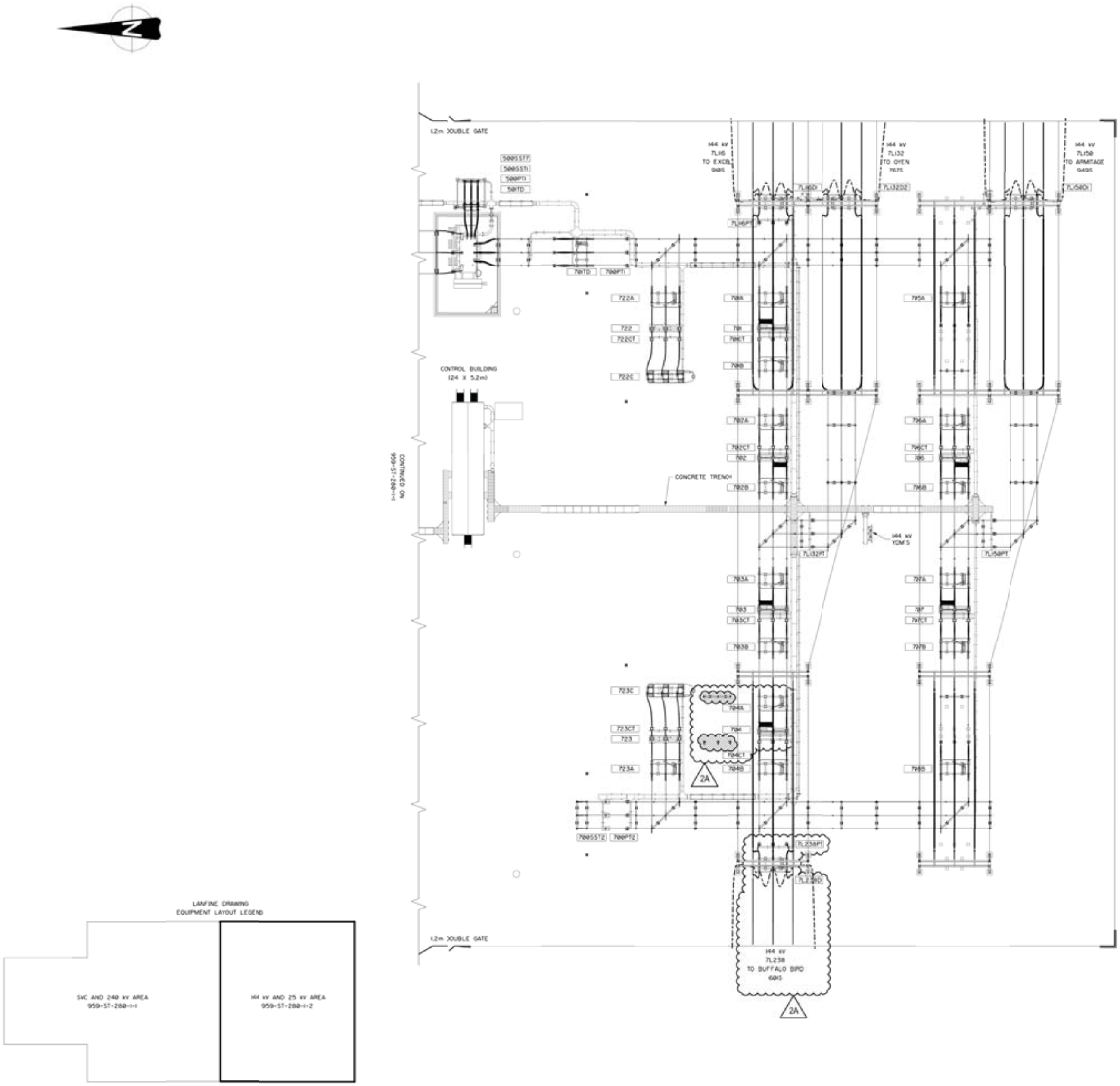


REFERENCE DRAWINGS	
DRAWING NUMBER	DRAWING TITLE
TS-CSL-959-2	CONCEPTUAL SINGLE LINE DIAGRAM
959-EL-500-0000-2	SLPMD
959-ST-280-1-1	EQUIP. LAYOUT - SVC & 240 kV AREA
959-ST-280-2-1	EQUIPMENT LIST

LEGEND:

- XXX — SLD EQUIPMENT DESIGNATION
- TO BE SUPPLIED AND INSTALLED BY LINE CONTRACTOR
- DEMOLITION

NO.	REVISION DESCRIPTION	DATE	DFTG.	DESIGN	CIVIL	TCOM	TCTRL	EL./PRT	COMM
2A	ADDED 144kV CIRCUIT BREAKER & ASSOCIATED DISCONNECT- ISSUE FOR DBM (E48226)	2017 10 24	VDA	VDA					
1	AS BUILT - HRTD - NEW SUBSTATION (PROJECT T16292)	2004 05 23	DG						BECHTEL
0	HRTD - NEW SUBSTATION - IFC (T16292)	11 01 27	GB	AB					

CONSULTANTS LOGO

PROFESSIONAL STAMPS

ISSUE FOR DBM ONLY
OCT. 24 2017

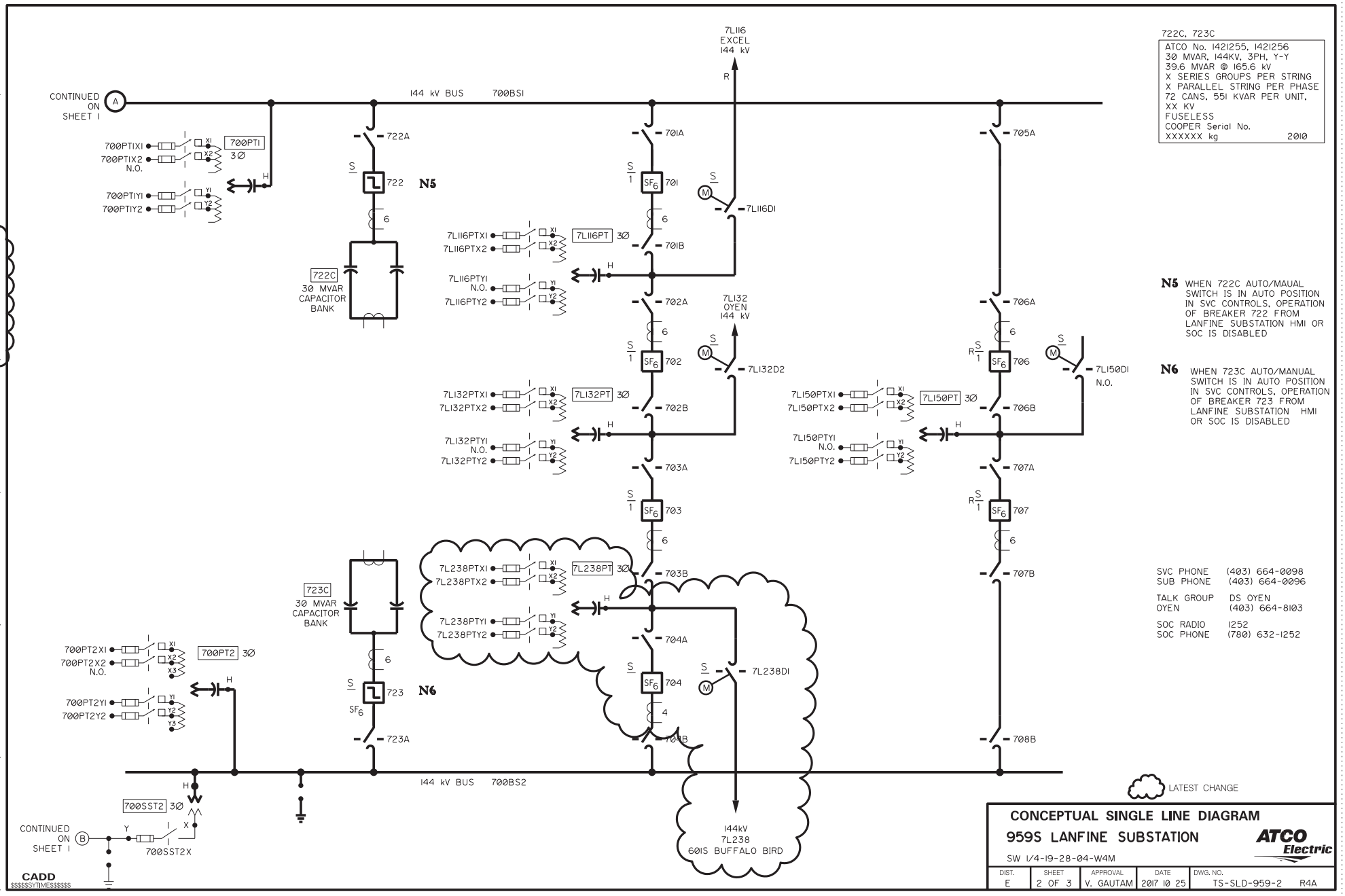
ATCO Electric

959S LANFINE SUBSTATION
EQUIPMENT LAYOUT
144 kV & 25 kV AREA

DRAWN	DATE	SCALE
A. BOILY	10 08 26	1:400

DESIGN BY	APPROVED BY
A. BOILY	L. HEBERT

DWG. NO. 959-ST-280-1-2 R1



722C, 723C

ATCO No. 1421255, 1421256
30 MVAR, 144KV, 3PH, Y-Y
39.6 MVAR @ 165.6 kV
X SERIES GROUPS PER STRING
X PARALLEL STRING PER PHASE
72 CANS, 551 KVAR PER UNIT.
XX KV
FUSELESS
COOPER Serial No.
XXXXXX kg 2010

N5 WHEN 722C AUTO/MAUAL SWITCH IS IN AUTO POSITION IN SVC CONTROLS, OPERATION OF BREAKER 722 FROM LANFINE SUBSTATION HMI OR SOC IS DISABLED

N6 WHEN 723C AUTO/MANUAL SWITCH IS IN AUTO POSITION IN SVC CONTROLS, OPERATION OF BREAKER 723 FROM LANFINE SUBSTATION HMI OR SOC IS DISABLED

SVC PHONE	(403) 664-0098
SUB PHONE	(403) 664-0096
TALK GROUP	DS OYEN
OYEN	(403) 664-8103
SOC RADIO	1252
SOC PHONE	(780) 632-1252

LATEST CHANGE

CONCEPTUAL SINGLE LINE DIAGRAM
959S LANFINE SUBSTATION

ATCO Electric

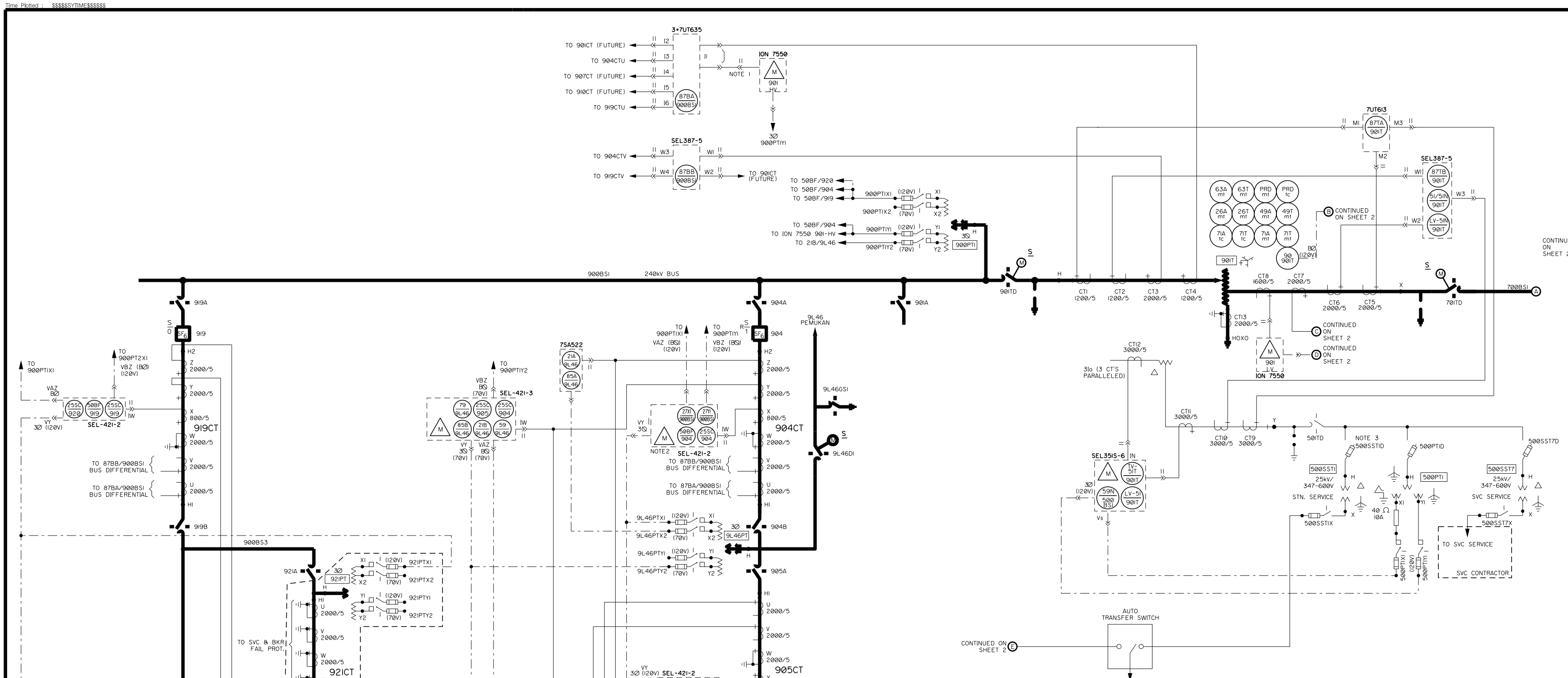
SW 1/4-19-28-04-W4M

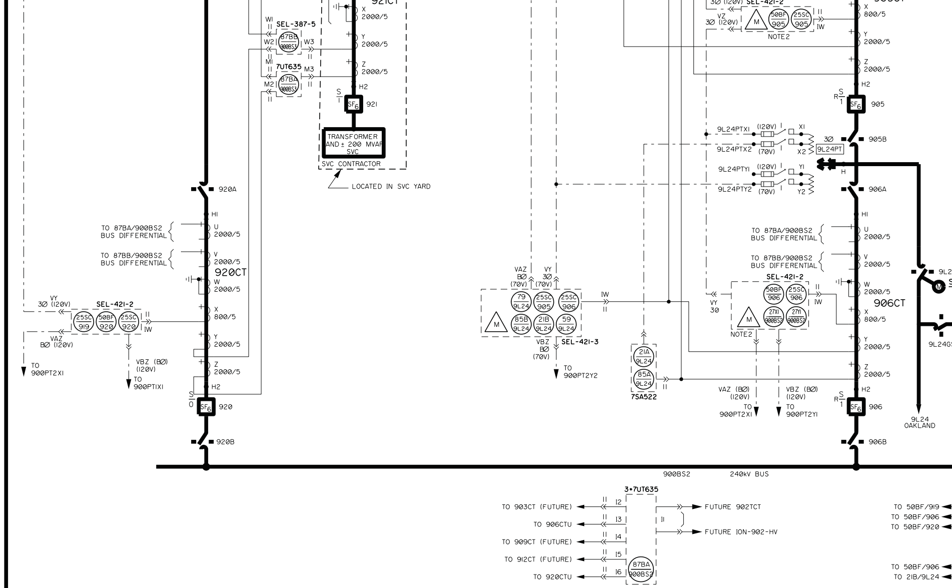
DIST.	SHEET	APPROVAL	DATE	DWG. NO.
E	2 OF 3	V. GAUTAM	2017 10 25	TS-SLD-959-2 R4A

CADD $$$$$$SYTIME$$$$$$

R0- INTERIM OPERATING SLD ISSUED 2014 05 30 A.XIA
R1- INTERIM OPERATING SLD UPDATED SUB PHONE. 2015 04 16 E. TSE
R2-OPERATING SLD ISSUED ADDED N.O. OPEN TO 7LI50DI 2015 07 30 V. GAUTAM
R3-OPERATING SLD ISSUED UPDATED SUB. PHONE NOS. 2017 02 10 V. GAUTAM
R4A-CONCEPTUAL SLD ISSUED APPR. 56844 PROJ. E48226 2017 10 25 V. GAUTAM

Plotted By: $$$USERNAME$$$





BREAKER 704, 704A, 704CT, 7L238PT, MOD 7I238DI AND SWITCH INFORMATION WILL BE ADDED DURING DESIGN STAGE.

700SST2
ATCO # 1427656, 1427657, 1427664
ABB
TYPE SSVT-650-050
86750/347V ±2 STEPS X 2.5%
50KVA
SEE TABLE
1343Kg 2011

50ITD
ATCO # XXXX
AREVA
TYPE CGVB08
27KV, 1200A
SEE TABLE
2010

70ITD
ATCO # XXXX
AREVA
TYPE CGVB08
XXXKV, 2000A
SEE TABLE
2010

BKRS 722, 723
ATCO # XXXX
AREVA
TYPE GL314
170kV, 3150A
INTERRUPT 31.5KA
SEE TABLE
2010

7L116DI, 7L132D2, 7L150DI
ATCO # XXXX
AREVA
TYPE CGVB08
145KV, 1200A
SEE TABLE
2010

701A, 701B, 702A, 702B, 703A, 703B 704B, 722A, 723A, 705A, 708B, 706A, 706B, 707A, 707B
ATCO # XXXX
AREVA
TYPE CGVB08
145KV, 2000A
SEE TABLE
2011

90IT
ATCO # 1417131
ONAN/ONAF/ONAF
250/144/25kV
H-X=180/240/300 MVA
H-Y=40/53.3/66.7 MVA
H 250kV ±10 STEPS X 1.25%
%IZ H-X= XX %
H-Y= XX %
X-Y= XX %
2010

BKRS 904, 905, 906, 919, 920
ATCO # XXXX
ABB
TYPE HPL 300BI
300KV, 4000A, 50KA
TRIP TIME
SEE TABLE
2010

BKRS 701, 702, 703, 706, 707
ATCO # XXXX
AREVA
TYPE GL312
170KV, 3150A, 40KA
SEE TABLE
2010

901A, 903B, 904A, 904B, 905A, 905B, 906A, 906B, 919A, 919B, 920A, 920B, 921A
ATCO # XXXX
AREVA
TYPE CGVB08
245KV, 2000A
SEE TABLE
2011

90ITD
ATCO # XXXX
AREVA
TYPE CGVB08
245KV, 2000A
SEE TABLE
2011

9L24D2, 9L46DI
ATCO # XXXX
AREVA
TYPE CGVB08
245KV, 2000A
SEE TABLE
2010

722C, 723C
ATCO # 1421255, 1421256
30 MVAR, 144KV, 3PH, Y-Y
39.672 MVAR @ 165.6KV
12 SERIES GROUPS PER STRING
2 PARALLEL STRING PER PHASE
72 CANS, 551 KVAR, 15.935 KV
FUSELESS
SEE TABLE
2010

EQUIPMENT NUMBER / ATCO NUMBER	EQUIPMENT NUMBER / ATCO NUMBER
BREAKERS	SWITCH's
701 /1421056	701A /1421176
702 /1421057	701B /1421177
703 /1421058	702A /1421178
706 /1439646	702B /1421179
707 /1439790	703A /1421180
722 /1431541, 1431543, 1431544	703B /1421181
723 /1431545, 1431547, 1431548	704B /1421182
904 /1427682, 1427683, 1427684	705A /1421183
905 /1427685, 1427687, 1427688	706A /1421184
906 /1427689, 1427690, 1427694	706B /1439681
919 /1431505, 1431507, 1431508	707A /1439652
920 /1431509, 1431510, 1431511	707B /1439653
	708B /1439654
PT's	722A /1421174
500PTI /NO ATCO NUMBER	723A /1421175
700PTI /1427576, 1427577, 1427578	70ITD /1421202
700PT2 /1427579, 1427580, 1427581	7L116DI /1421203
7L116PT /1439658, 1439659, 1439660	7L132D2 /1421204
7L132PT /1427586, 1427587, 1427588	7L150DI /1421187
7L150PT /1427582, 1427584, 1427585	901A /1421104
900PTI /1427492, 1427493, 1427494	903B /1421106
900PT2 /1427495, 1427496, 1427498	904A /1421107
9L24PT /1427499, 1427500, 1427501	904B /1421108
9L46PT /1427502, 1427503, 1427505	905A /1421109
921PT /1454226, 1454227, 1454228	905B /1421110
	906A /1421112
CAP BANK	906B /1421113
722C /1421256	919A /1421114
723C /1421255	919B /1421115
	920A /1421116
CT's	920B /1421117
701CT /1439682, 1439884, 1439685	921A /1421129
702CT /1439693, 1439694, 1439695	90ITD /1421128
703CT /1439697, 1439699, 1439700	9L24D2 /1421139
706CT /1439663, 1439664, 1439669	9L46DI /1421140
707CT /1439666, 1439667, 1439668	50ITD 1421228
722CT /1439670, 1439672, 1439674	
723CT /1439655, 1439678, 1439681	SST
904CT /1421290, 1421309, 1421310	700SST2 /1427656/1427656?/1427666
905CT /1421312, 1421318, 1421319	
906CT /1421320, 1421321, 1421322	
919CT /1421324, 1421325, 1421326	
920CT /1427716, 1427717, 1427718	
722NCT /1436800	
723NCT /1436801	

PT	ATCO #	WDG	RATIO	CLASS
900PTI 900PT2 9L46PT 9L24PT	SEE TABLE	XI-X3	172500-115	0.3WXYZ0.6ZZ
		X2-X3	172500-69	0.3WXYZ0.6ZZ
		YI-Y3	172500-115	0.3WXYZ0.6ZZ
		Y2-Y3	172500-69	0.3WXYZ0.6ZZ
700PTI 700PT2 7L116PT 7L132PT 7L150PT 7L238PT		XI-X3	84000-120	0.3WXYZ0.6ZZ
		X2-X3	84000-70	0.3WXYZ0.6ZZ
		YI-Y3	84000-120	0.3WXYZ0.6ZZ
		Y2-Y3	84000-70	0.3WXYZ0.6ZZ
500PTI		XI-X3	14400-120	0.3WX0.6YZ
		X2-X3	14400-72	0.3WX0.6YZ
		YI-Y3	14400-120	0.3WX0.6YZ
		Y2-Y3	14400-72	0.3WX0.6YZ

4A

CT	ATCO #	CORE	RATIO	CLASS
904CT, 905CT, 906CT, 919CT, 920CT	SEE TABLE	W	2000/1500/1200/400-5	0.3B2.0
		U,V,X,Y,Z	2000/1500/1200/400-5	2.5L800
701CT, 702CT, 703CT, 706CT, 707CT, 722CT, 723CT		W	2000/1500/1200/400-5	0.3B2.0
		U,V,X,Y,Z	2000/1500/1200/400-5	2.5L800
90IT	XMER BUSHING CT	1,2,3,4	2000/1500/1200/400-5	2.5L800
		13	2000/1500/1200/400-5	2.5L400
		5,6,7	2000/1500/1200/400-5	2.5L400
		8	2000/1500/1200/400-5	0.3B2.0
		9,10,11	3000/2500/2200/1000-5	2.5L400
		12	3000/2500/2200/1000-5	2.5L400
722NCT, 723NCT		- -	5/5	C400
704CT		W,X,Y,Z	2000/1500/1200/400-5	2.5L800

4A

REFERENCE DRAWINGS	
DRAWING NUMBER	DRAWING TITLE

STANDARD BASE DRAWING APPROVAL

NO.	REVISION DESCRIPTION							
DATE	DFTG	DESIGN	CIVIL	TCOM	TCTRL	EL /PRT	STD	

LEGEND:

Symbol	Description
M (triangle)	METERING
T	TELEMETRY
DFR	DIGITAL FAULT RECORDER
402	IEEE DESIGNATIONS
DSM	DYNAMIC SWING MONITOR
« »	TEST SWITCH WIRED FOR BYPASS CURRENT
‖ «	TEST SWITCH WIRED FOR SHORTING CURRENT
«	TEST SWITCH FOR VOLTAGE CONNECTION

NOTES:

1. REVERSE POLARITY AT METER.
2. BREAKER MW & MVARS VALUES ARE SOMMATED IN RTUTO PROVIDE LINE METERING DATA.
3. BEFORE OPENING OR CLOSING DISCONNECT DISABLE 90IT TERTIARY 59N PROTECTION USING THE RELAY FRONT PUSH BUTTON.

NO.	REVISION DESCRIPTION	PROJECT	DATE	DFTG	DESIGN	CIVIL	TCOM	TCTRL	EL /PRT	COMM
4A	DBM - PATTERN LANFINE NORTH WIND AGF	PROJ. E48226	2017 11 16	AS	AS				ADS	
3	AS BUILT CORRECTION	PROJECT TI6292	2015 04 30	CB						DZ
2	AS BUILT - HRTD - NEW SUBSTATION	PROJECT TI6292	2013 12 20	DG						BECHTEL
1	HRTD - NEW SUBSTATION - DCN #11-388	PROJECT TI6292	11 10 27	CH	ES				RH	
0	HRTD - NEW SUBSTATION - IFC	PROJECT TI6292	11 03 08	SAG	RH				RH	

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PROFESSIONAL STAMPS

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ATCO Electric

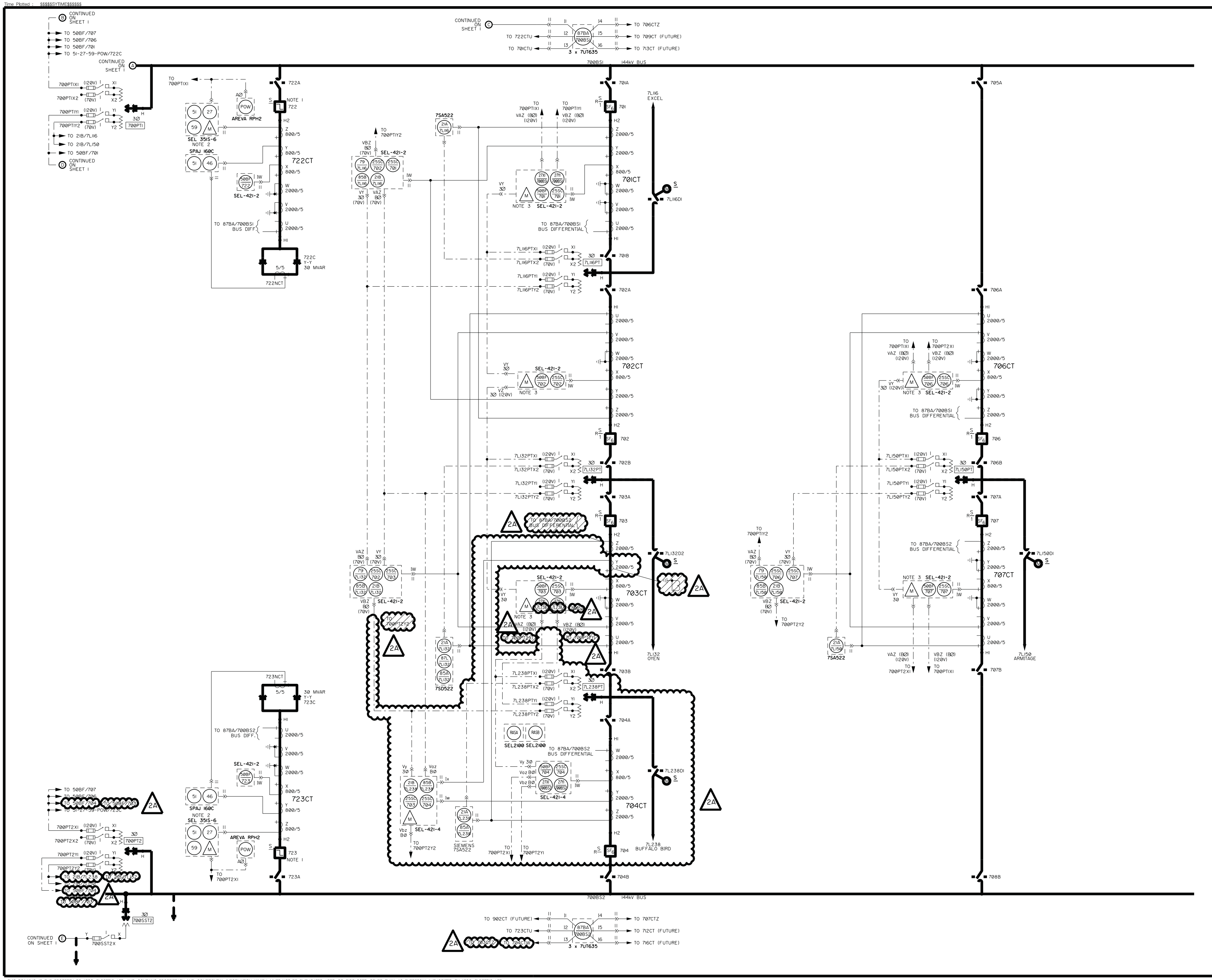
959S LANFINE SUBSTATION

SINGLE LINE PROTECTION AND METERING DIAGRAM

DRAWN	DATE	SCALE
AMOS	10 04 30	N/A
DESIGN BY RH	APPROVED BY RH	
DWG. NO. 959-EL-500-0000-1 R4A		

PLEASE DO NOT REMOVE REVISION 0

CADD Filename: $$$$$$DGN$SPECIFICATION$$$$$$
Plotted By: $$$USERNAME$$$
Time Plotted : $$$$$SYTIME$$$$$$



REFERENCE DRAWINGS	
DRAWING NUMBER	DRAWING TITLE

STANDARD BASE DRAWING APPROVAL

NO.	REVISION DESCRIPTION						
DATE	DFTG	DESIGN	CIVIL	TCOM	TCTRL	EL /PRT	STD

LEGEND:

M (triangle)	METERING
T	TELEMETRY
DFR	DIGITAL FAULT RECORDER
402	IEEE DESIGNATIONS
DSM	DYNAMIC SWING MONITOR
« »	TEST SWITCH WIRED FOR BYPASS CURRENT
II «	TEST SWITCH WIRED FOR SHORTING CURRENT
«	TEST SWITCH FOR VOLTAGE CONNECTION

NOTES:

1. BREAKER CLOSING CONTROLLED BY POINT-ON-WAVE CONTROLLER.
2. METERING TO BE REVERSED IN RTU FOR SCADA (ie. +VE MVAR INTO BUS).
3. BREAKER MW & MVARS VALUES ARE SOMMATED IN RTU TO PROVIDE LINE METERING DATA.

NO.	REVISION DESCRIPTION						
DATE	DFTG	DESIGN	CIVIL	TCOM	TCTRL	EL /PRT	COMM
NO.	REVISION DESCRIPTION						
DATE	DFTG	DESIGN	CIVIL	TCOM	TCTRL	EL /PRT	COMM
NO.	REVISION DESCRIPTION						
DATE	DFTG	DESIGN	CIVIL	TCOM	TCTRL	EL /PRT	COMM
NO. 2A	REVISION DESCRIPTION DBM - PATTERN LANFINE NORTH WIND AGF						PROJ. E48226
DATE 2017 11 16	DFTG AS	DESIGN AS	CIVIL	TCOM	TCTRL	EL /PRT ADS	COMM
NO. 1	REVISION DESCRIPTION AS BUILT - HRTD - NEW SUBSTATION						PROJECT T16292
DATE 2013 12 20	DFTG DG	DESIGN	CIVIL	TCOM	TCTRL	EL /PRT	COMM BECHTEL
NO. 0	REVISION DESCRIPTION HRTD - NEW SUBSTATION - IFC						PROJECT T16292
DATE 11 02 03	DFTG SAG	DESIGN RH	CIVIL	TCOM	TCTRL	EL /PRT RH	COMM

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PROFESSIONAL STAMPS

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ATCO Electric

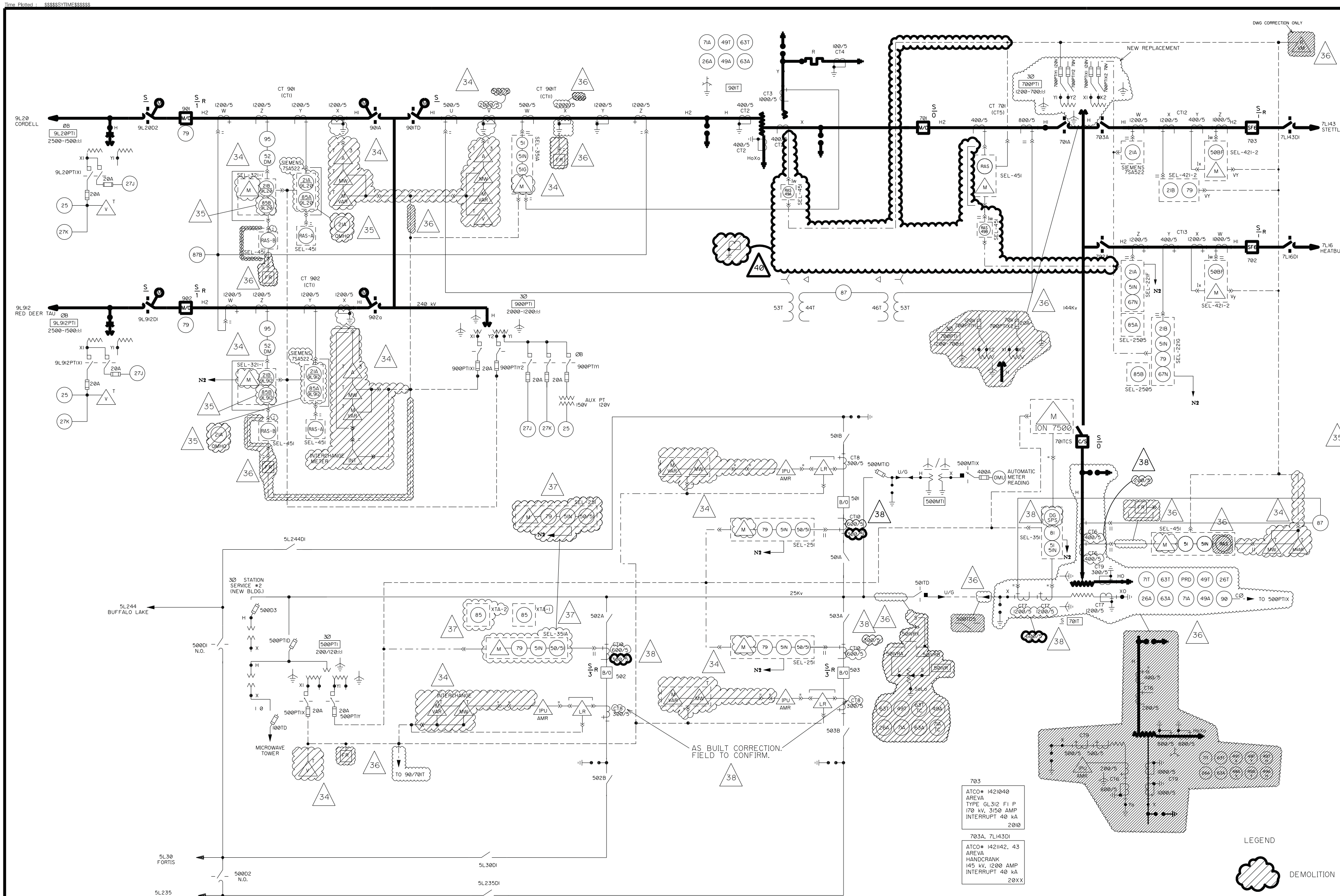
959S LANFINE SUBSTATION

SINGLE LINE PROTECTION AND METERING DIAGRAM

DRAWN GB	DATE 10 01 21	SCALE N/A
DESIGN BY SD		APPROVED BY RH
DWG. NO. 959-EL-500-0000-2 R2A		

PLEASE DO NOT REMOVE REVISION 0

CADD Filename: $$$$$$$DGN$SPECIFICATION$$$$$$$
Plotted By: $$$USERNAME$$$
Time Plotted : $$$$$SYTIME$$$$$$



RESISTOR ON TERTIARY OF 901T
4 IN SERIES EACH RATED
100 A, 3600 V

PT'S: 9L20PTI,9L912PTI
TRENCH ELECTRIC
2500/1500 I
TYPE - TEMP 287
CO # 32789-32790

901T - (CO.#17860,ONAN/ONAF/ONAF, F-P
H,X - 60/80/100, 240 kV /138.7kV
144kV /83.2kV
Y - 21,28,35 - 14.4kV
%IZ,PN=H-X=3.65, H-Y=17.2,
X-Y=12.95 @ 60
ZO=H .L .T @ 60

701T - CO.# C29883, ONAN/ONAF*/ONAF*
H,X - 20/26.6/33.3 MVA,144 kV Grd Y/83.2 kV
Y-10/13.3/16.6 MVA,14.4/29.94kV
%IZ,PN=H-X=5.96, H-Y=16.0,
Y-X=10.5 @ 20 MVA
ZO=H .L .T MOLONEY 1981

701T - CO.# 34079, ONAN/ONAF/ONAF
H-X 144/25 kV, 12/16/20 MVA
%IZ H-X= 7.4 %, (12MVA)
TAP CHART 42
OLTC 144kV +10/-10%, 21 STEPS
ABB S/N 32S0236 1992

501VR - CO.#33309, 25/33 MVA ONAN, ONAF
±10% IN 32 STEPS
FPL 1989

240kV BREAKERS (901,902):
SP & SH,2000A,4 CYCLES,264kV
TYPE HPF 514p/4F
(CO.#18748 - 49)

144 kV BREAKERS:
701 - ASEA, HLD145/1250A
(CO.# C10924)

25kV BREAKERS & CT'S:
- 5L30, BKR 502, CO.#32245 (#C10921)
- 5L235, BKR 503, CO. #31852
CGE TYPE FKP 25kV 1200A,INT. 500MVA 1981
- 5L244, BKR 501, CO. #31853
CGE TYPE FKP 25kV 1200A,INT. 500MVA 1981

AS BUILT CORRECTION.
FIELD TO CONFIRM THE CHANGE.

PT	ATCO#	WDG.	RATIO	CLASS	REVENUE APPROVAL #
700PTI		X1-X3	84000-120	0.3WXYZ / 0.6ZZ / 1PY	AE-1023
		X2-X3	84000-70	0.3WXYZ / 0.6ZZ / 1PY	
		Y1-Y3	84000-120	0.3WXYZ / 0.6ZZ / 1PY	
		Y2-Y3	84000-70	0.3WXYZ / 0.6ZZ / 1PY	

240kV CT'S (CT1 & 2):
- ASEA, IMBD245A4, 1200A, CRF=1.25,
CO.# 19250 - 59

144kV CT'S (CT5):
- ASEA, IMBD145A2
CO.#

500MTI
ONAN
300 kVA
%IZ = 1.79%
HV = 24940Y/14400V
LV = 480Y/277V
ABB, STYLE - V19E534DGH
2359 kg 1997

702
ATCO# 824661
ABB
TYPE LTB145D1/B
158 kV, 2000 AMP
INTERRUPT 31.5 kA
2006

	RATIO	RATING	WINDING	CO.#
CT1	1200/1000/800/600/500-5	2.5L400	Y,Z,W	
		0.3B2.0	X	
CT2	400/300/100-5	2.5L400		
CT3	2000/1500/500-5	2.5L400		
CT4	20	2.5H50		
CT5	1200/800/400/200-5-5	2.5L200		
CT6	400/300/200/100-5	2.5L400	H, Y	701T
CT7	1200/800/200-5	2.5L80 / 2.5L400	Y	701T
		0.6B1.0 / 0.3B2.0	X	
CT8	600/400/150/100-5	0.3B1.0		
CT9	300/200/100-5	2.5L400	X	701T
CT10	600/400/150/100-5	2.5L100		
CT11	2000/1600/800/500-5	0.3B2.0	V,Y	33786,
			U,W,X,Z	7,8
CT12	1200/800/200-5	2.5L400	W,X,Z	1421333-38
		0.3B2.0	Y	
CT13	1200/800/200-5	2.5L400	W,X,Z	
		0.3B2.0	Y	

800/600/400/200/100-5
400/200/100-5-5
1000/800/600/400/200/100-5
XMER
450/300/250/200/150/100/50-5 2.5L100
500/400/300/200/100-5

AS BUILT CORRECTION.
FIELD TO CONFIRM.

REFERENCE DRAWINGS

DRAWING NUMBER	DRAWING TITLE

STANDARD BASE DRAWING APPROVAL

NO.	REVISION DESCRIPTION						
DATE	DFTG	DESIGN	CIVIL	TCOM	TCTRL	EL /PRT	STD

LEGEND:

M (triangle)	METERING
T	TELEMETRY
DFR	DIGITAL FAULT RECORDER
XXX (circle)	IEEE DESIGNATIONS
DSM	DYNAMIC SWING MONITOR
« »	TEST SWITCH WIRED FOR BYPASS CURRENT
ll «	TEST SWITCH WIRED FOR SHORTING CURRENT
«	TEST SWITCH FOR VOLTAGE CONNECTION

N2 ← SCHWEITZER COMM. PROCESSOR SEL-2020

NOTE:
2. MODIFICATION OF CT9 CONNECTION TO 87 PROTECTION IN REVISION 23 NO LONGER REQUIRED.

NO.	REVISION DESCRIPTION							
34	DCN#16-825 - SALVAGE TRANSDUCER (PROJECT E46830)							
DATE 2016 04 30	DFTG AN	DESIGN AN	CIVIL	TCOM	TCTRL	EL /PRT SB	COMM	
40	DBM - PATTERN LANFINE NORTH WIND AGF (PROJECT E48226)							
DATE 2017 11 16	DFTG AS	DESIGN AS	CIVIL	TCOM	TCTRL	EL /PRT ADS	COMM	
DBM	HALKIRK 2 WIND POWER (E48111)							
DATE 2017 02 03	DFTG YX	DESIGN YX	CIVIL	TCOM	TCTRL	EL /PRT SL	COMM	
38	DCN#17-867 - 701T TRANSFORMER REPLACEMENT (PROJECT E47619)							
DATE 2017 01 13	DFTG NX	DESIGN NX	CIVIL	TCOM	TCTRL	EL /PRT SB	COMM	
37	JUST FREEHOLD DG CAPACITY INCREASE (PROJECT E58813)							
DATE 2016 12 02	DFTG PP	DESIGN PP	CIVIL	TCOM	TCTRL	EL /PRT SB	COMM	
36	701T TRANSFORMER REPLACEMENT (PROJECT E47619)							
DATE 2016 07 18	DFTG JR	DESIGN JR	CIVIL	TCOM	TCTRL	EL /PRT SB	COMM	
35	RFL RELAY REPLACEMENT (PROJECT E46887)							
DATE 2016 06 30	DFTG NX	DESIGN NX	CIVIL	TCOM	TCTRL	EL /PRT SB	COMM	

CONSULTANTS LOGO

PROFESSIONAL STAMPS

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ATCO Electric

766S NEVIS SUBSTATION

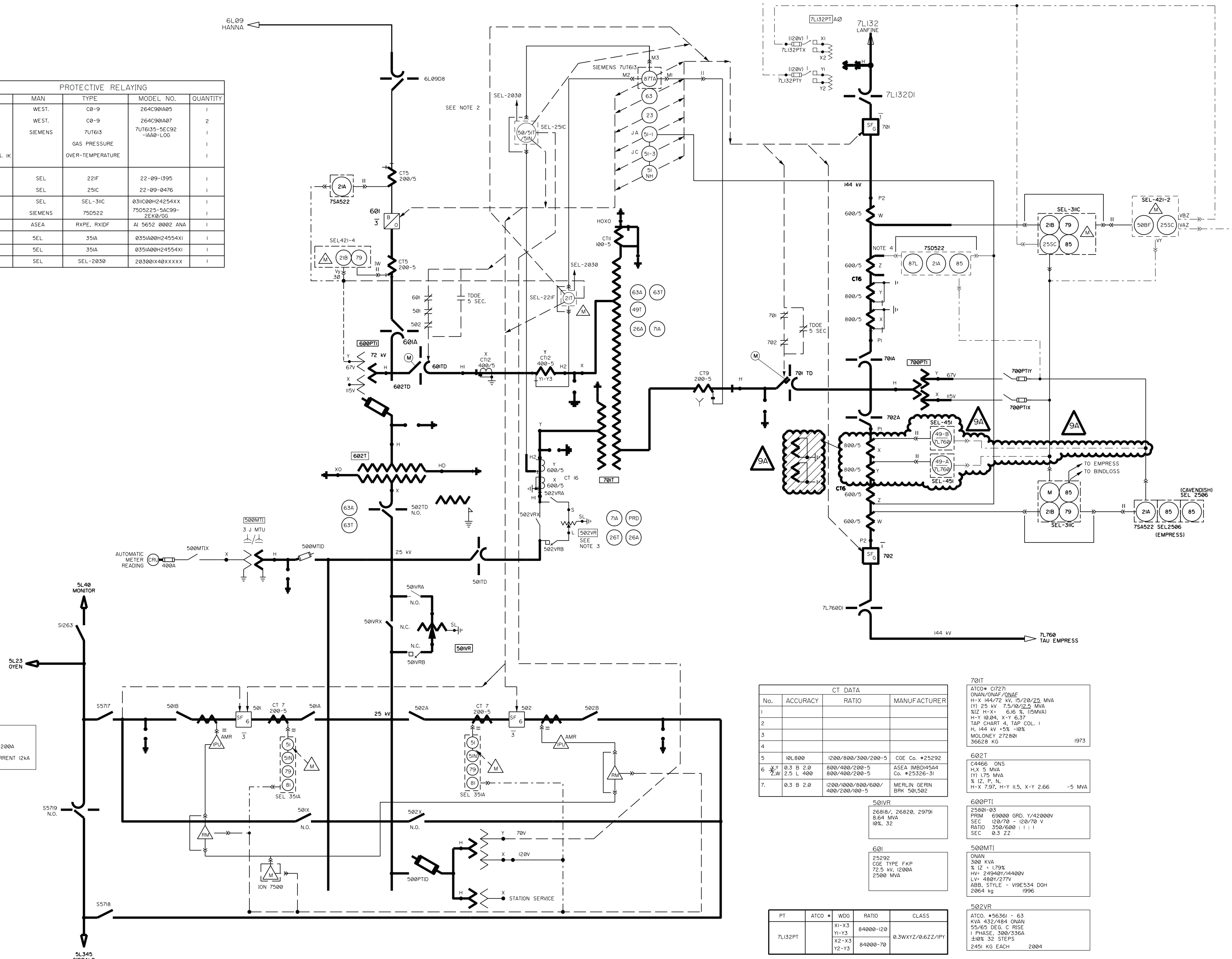
SINGLE LINE PROTECTION
AND METERING DIAGRAM

DRAWN PG	DATE 91 04 04	SCALE N/A
DESIGN BY	APPROVED BY	
DWG. NO. 766-EL-500-0-1 DBM		

CADD Filename: $$$$$$DGN$SPECIFICATION$$$$$$
Plotted By: $$$USERNAME$$$
Time Plotted : $$$$$SYTIME$$$$$$

PROTECTIVE RELAYING

DEVICE	PANEL	MAN	TYPE	MODEL NO.	QUANTITY
51NH	1K	WEST.	CO-9	264C901A05	1
51-1,51-3	1K	WEST.	CO-9	264C901A07	2
87TA	1K	SIEMENS	7UT613	7UT6135-5EC92 -1AA0-LOG	1
63	1K		GAS PRESSURE		1
23	144/72 kV TRANS. 1K		OVER-TEMPERATURE		1
21T	PANEL 2K	SEL	221F	22-09-1395	1
50/51T	PANEL 2K	SEL	251C	22-09-0476	1
21B/79	2C	SEL	SEL-311C	0311C00H24254XX	1
872-21A	2C	SIEMENS	7SD522	7SD5225-5AC99-2EK0/GG	1
67N	1B	ASEA	RXPE, RXIDF	A1 5652 0002 ANA	1
51/81/79	1E	SEL	351A	0351A00H24554X1	1
51/81/79	2E	SEL	351A	0351A00H24554X1	1
CP	1Z	SEL	SEL-2030	20300IX40XXXXX	1



501, 502
CO # 33752, 33753
MERLIN GERIN TYPE SF6-FB4
RATED VOLTAGE 25 kV
RATED CONTINUOUS CURRENT 1200A
RATED INTERRUPTING MVA 561
RATED MAX. INTERRUPTING CURRENT 12kA
INTERRUPTING TIME 5 CYCLES.

CT DATA

No.	ACCURACY	RATIO	MANUFACTURER
1			
2			
3			
4			
5	10L800	1200/800/300/200-5	CGE Co. #25292
6 X,Y / Z,W	0.3 B 2.0 / 2.5 L 400	800/400/200-5 / 800/400/200-5	ASEA IMBD145A4 Co. #25326-31
7.	0.3 B 2.0	1200/1000/800/600/400/200/100-5	MERLIN GERIN BRK 501,502

PT	ATCO #	WDG	RATIO	CLASS
7L132PT		X1-X3 Y1-Y3	84000-120	0.3WXYZ/0.6ZZ/1PY
		X2-X3 Y2-Y3	84000-70	

501VR
26818/, 26820, 29791
8.64 MVA
10%, 32

601
25292
CGE TYPE FKP
72.5 kV, 1200A
2500 MVA

701T
ATCO# C17271
ONAN/ONAF/ONAF
H-X 144/72 kV, 15/20/25 MVA
(Y) 25 kV 7.5/10/12.5 MVA
%IZ H-X= 6.16 %, (15MVA)
H-Y 10.04, X-Y 6.37
TAP CHART 4, TAP COL. 1
H, 144 kV +5% -10%
MOLONEY 272801
36628 KG 1973

602T
C4466 ONS
H,X 5 MVA
(Y) 1.75 MVA
% IZ, P, N,
H-X 7.97, H-Y 11.5, X-Y 2.66 -5 MVA

600PT1
25801-03
PRIM 69000 GRD. Y/42000V
SEC 120/70 - 120/70 V
RATIO 350/600 : 1 : 1
SEC 0.3 ZZ

500MT1
ONAN
300 KVA
% IZ = 1.79%
HV= 24940Y/14400V
LV= 480Y/277V
ABB, STYLE - V19E534 DGH
2064 kg 1996

502VR
ATCO. #56361 - 63
KVA 432/484 ONAN
55/65 DEG. C RISE
1 PHASE, 300/336A
±10% 32 STEPS
2451 KG EACH 2004

REFERENCE DRAWINGS

DRAWING NUMBER	DRAWING TITLE

STANDARD BASE DRAWING APPROVAL

NO.	REVISION DESCRIPTION						
DATE	DFTG	DESIGN	CIVIL	TCOM	TCTRL	EL /PRT	STD

NOTES:

1. ONLY ONE STAGE OF WINDING TEMPERATURE @ 105 C. LEFT AS PER ORIGINAL DESIGN AS A TRIP STAGE.
2. CURRENTS ENTERING OVERCURRENT ARE REVERSED TO ENABLE THE MHO ELEMENT TO LOOK TOWARD 25 kV BUS.
3. 502VR NON-ELECTRICAL TRIPS NOT CONNECTED TO 701T LOCKOUT RELAY.
4. CT POLARITIES REVERSED TO RELAY.

LEGEND:

Symbol	Meaning
M (triangle)	METERING
T	TELEMETRY
DFR	DIGITAL FAULT RECORDER
XXX (circle)	IEEE DESIGNATIONS
DSM	DYNAMIC SWING MONITOR
« »	TEST SWITCH WIRED FOR BYPASS CURRENT
II «	TEST SWITCH WIRED FOR SHORTING CURRENT
«	TEST SWITCH FOR VOLTAGE CONNECTION

NO.	REVISION DESCRIPTION	PROJ.	DATE	DFTG	DESIGN	CIVIL	TCOM	TCTRL	EL /PRT	COMM
5	6L09 67N RELAY REPLACEMENT	PROJ. E46894	2015 03 31	GR	GR				AX	
9A	DBM - PATTERN LANFINE NORTH WIND AGF	PROJ. E48226	2017 11 12	AS	AS				ADS	
8	AS BUILT FIELD CORRECTION	PROJ. E08291	2017 10 05	JT	JT				FH	
7	AS BUILT-6L09 67N RELAY REPLACEMENT	PROJ. E46894	2016 03 18	CB						KM
6	AS BUILT CORRECTION	PROJ. E16251/E17059	2016 03 18	CB						
0	RENUMBERED FROM 7290-2 R34	PROJECT T16251	11 02 03	JPH	GG				SH	

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PROFESSIONAL STAMPS

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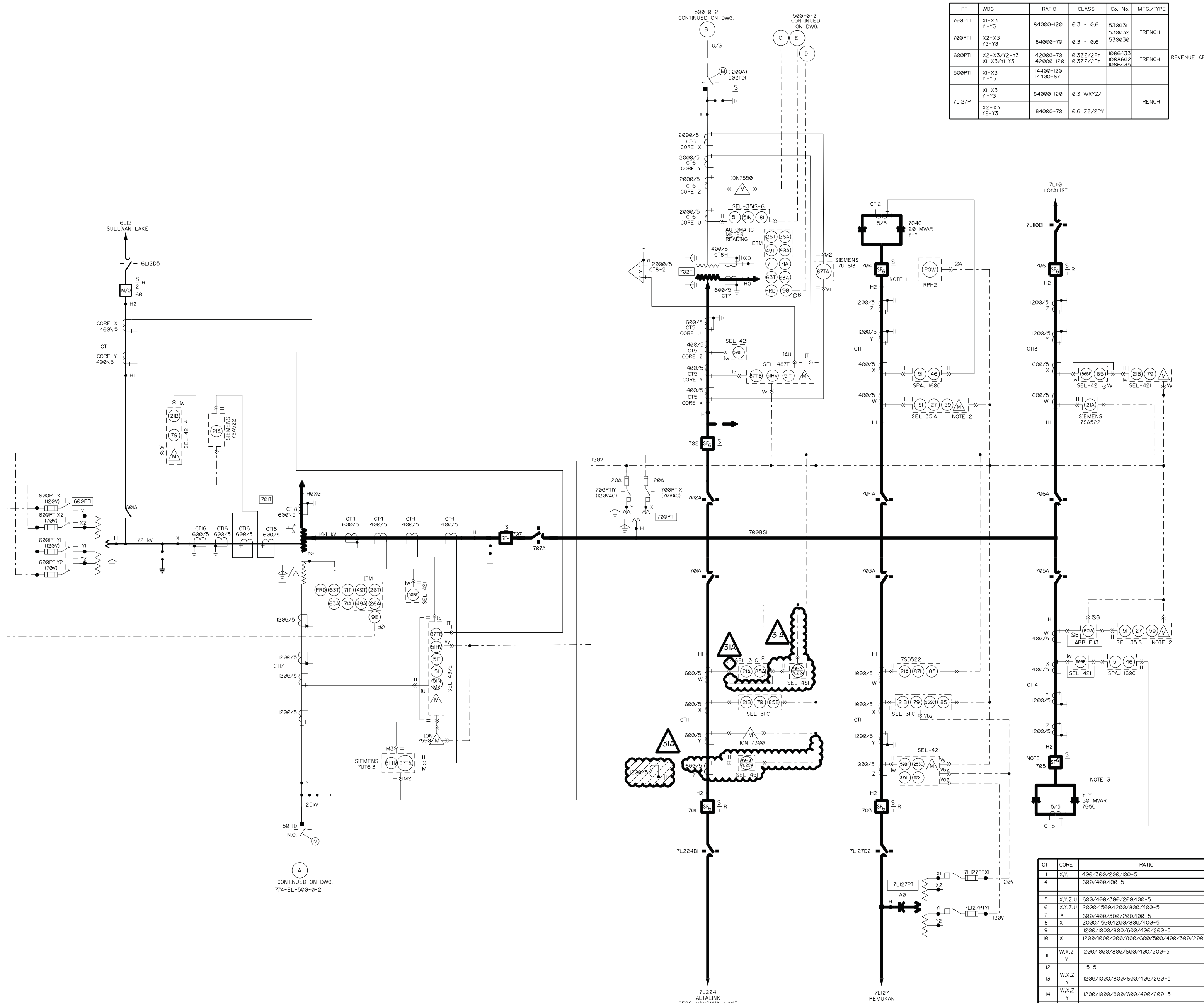
ATCO Electric

767S OYEN SUBSTATION

SINGLE LINE PROTECTION AND METERING DIAGRAM

DRAWN	DATE	SCALE NONE
DESIGN BY		APPROVED BY
DWG. NO. 767-EL-500-0000-1 R9A		

CADD Filename: $$$$$$DGN$SPECIFICATION$$$$$$
Plotted By: $$$USERNAME$$$
Time Plotted : $$$$SYTIME$$$$$$



PT	WDG	RATIO	CLASS	Co. No.	MFG./TYPE
700PT1	X1-X3 Y1-Y3	84000-120	0.3 - 0.6	530031 530032 530030	TRENCH
700PT1	X2-X3 Y2-Y3	84000-70	0.3 - 0.6		
600PT1	X2-X3/Y2-Y3 X1-X3/Y1-Y3	42000-70 42000-120	0.3ZZ/2PY 0.3ZZ/2PY	1086433 1088602 1086435	TRENCH
500PT1	X1-X3 Y1-Y3	14400-120 14400-67			
7L127PT	X1-X3 Y1-Y3	84000-120	0.3 WXYZ/		TRENCH
	X2-X3 Y2-Y3	84000-70	0.6 ZZ/2PY		

REVENUE APPROVAL#

701T
14771326 ONAN/ONAF/ONAF
H, X-15/20/25 MVA
Y-10/13.3/16.7 MVA
H, 144kV + 5%-15% 21 TAPS
TAP CHART 86
%IZ, H-X= %@ 15 MVA
H-Y= %@ 10 MVA
X-Y= %@ 10 MVA
HYUNDAI. S/N ELT408338
58740kg 2016

702T
ATCO No.14682411
ONAN/ONAF/ONAF
H-X 25/33/41.6 MVA
OLTC, H.144kV + 10%, 21 TAPS
TAP CHART 42, TAP COL 3
%IZ, P N=H-X 7.4%, 25 MVA
%IZ, ZØ =H
MANUFACTURER, SERIAL No. T.040N.001251.01
58875 kg 2014

707
AE# 14679373
ABB
TYPE LTB170D1/B
170kV, 3150A
INTERRUPT 40 kA
20XX

601
CO. # 14698
ASEA M/O
TYPE HLC
72.5kV, 1600A, 350kV BIL
20kA SYM
1971

501, 502
CO. No. 34416, 34417
ASEA VACUUM BREAKER
TYPE R
27.5 kV, 1250A, 150 kV BIL
12.5 kA, STYLE 5RB1114B01327
1997

503
CO. # 33824
METERING GERIN TYPE FB4
150 kV BIL, 1200 A, 25 kV
SYM, INTER 12kA
1991

501VR
31043, 31048, 31049 ONS
8.64 MVA
+ 10%, 32
GE, 1235517, 1235522, 1235523
1 703 kg EACH,
1980

701, 702, 703
AE#659595, 659596, 659597
ABB
TYPE LTB145D1/B
158kV, 2000A
31.5 kA SYM
2004

704
AE#659600, 659601, 659602
AREVA
TYPE GL314 1P/3P
170kV, 3150A
40 kA SYM
2004

704C
AE#659570
COOPER
20.016 MVAR, 144KV, 3PH, Y-Y
6 SERIES GROUPS PER STRING
2 PARALLEL STRINGS PER PHASE
36 CANS, 556 KVAR, 13.856 KV
FUSELESS 2004

706
AE#1092394
AREVA
TYPE GL312P
170kV, 3150A
INTERRUPT 40 kA
2008

705C
AE# 1301636
COOPER
29.99 MVAR @ 144KV, 3PH, Y-Y
36.288 MVAR @ 158.4KV
6 SERIES GROUPS PER STRING
4 PARALLEL STRINGS PER PHASE
72 CANS, 504 KVAR, 15.242 KV
FUSELESS 2009

705
AE# 1301635
ABB
TYPE HPL170B1US
ZERO CROSSING BREAKER
TIME SPAN POLE A/B/C +4.2/0/0 ms
170 kV, 2000 AMP
INTERRUPT 31.5 kA 2009

CT	CORE	RATIO	ACC CLASS	CO#	MFG./TYPE
1	X,Y,	400/300/200/100-5	2.5L400	22223-25	ASEA IBMD 72A2
4		600/400/100-5	2.5L800/0.3B1.8	14771326	TRANS. 701T BUSHING CT'S
5	X,Y,Z,U	600/400/300/200/100-5	2.5L400/0.3B1.8	14682411	TRANS. 702T BUSHING CT'S
6	X,Y,Z,U	2000/1500/1200/800/400-5	2.5L400/0.3B1.8		
7	X	600/400/300/200/100-5	2.5L400		
8	X	2000/1500/1200/800/400-5	2.5L400		
9		1200/1000/800/600/400/200-5	10L400,0.3B2.0	33824	MERLIN GERIN
10	X	1200/1000/900/800/600/500/400/300/200-5	2.5L400	34416 34417	ABB TYPE R
11	W,X,Z Y	1200/1000/800/600/400/200-5	2.5L400 0.3B2.0	624194 - 624205	ABB TYPE IMB145 REV. APPROVED
12		5-5	C400	--	--
13	W,X,Z Y	1200/1000/800/600/400/200-5	2.5L400 0.3B2.0	1092207- 1092209	TRENCH IOSK 145
14	W,X,Z Y	1200/1000/800/600/400/200-5	2.5L800 0.3B2.0	1301641- 1301643	TRENCH IOSK 145
15		5-5	C400	--	--
16		600/400/100-5	2.5L400/0.3B1.8	14771326	TRANS. 701T BUSHING CT'S
17		1200/800/200-5	2.5L400/0.3B1.8		
18		600/400/100-5	2.5L800		

REFERENCE DRAWINGS

DRAWING NUMBER	DRAWING TITLE

STANDARD BASE DRAWING APPROVAL

NO.	REVISION DESCRIPTION							
DATE	DFTG	DESIGN	CIVIL	TCOM	TCTRL	EL /PRT	STD	

LEGEND:

Symbol	Meaning
M	METERING
T	TELEMETRY
DFR	DIGITAL FAULT RECORDER
XXX	IEEE DESIGNATIONS
DSM	DYNAMIC SWING MONITOR
« »	TEST SWITCH WIRED FOR BYPASS CURRENT
II «	TEST SWITCH WIRED FOR SHORTING CURRENT
«	TEST SWITCH FOR VOLTAGE CONNECTION

NOTES:

1. BREAKER CLOSING CONTROLLED BY POINT-ON-WAVE CONTROLLER.
2. METERING TO BE REVERSED IN RTU FOR SCADA (ie. +VE MVAR INTO BUS).
3. MUST REVERSE CT POLARITY CONNECTION.

NO.	REVISION DESCRIPTION	PROJECT	DATE	DFTG	DESIGN	CIVIL	TCOM	TCTRL	EL /PRT	COMM
28	IFC - 7L127 CTR INCREASE	PROJECT E58086	2016 10 31	EC	EC				JW	
27	701T REPLACEMENT & CONTROL BLD 1 SALVAGE	PROJECT E45954	2016-03-07	YX	YX				SL	
26	AS BUILT - REV. 24 & 25	PROJ. E20402/E20332	2015 06 30	MC						KJ
31A	DBM - PATTERN LANFINE NORTH WIND AGF	PROJ. E48226	2017 11 16	AS	AS				ADS	
30	AS BUILT - 701T REPLACEMENT	PROJ. E45954	2017 10 02	CB						BN
29	AS BUILT - 7L127 CTR INCREASE	PROJECT E58086	2017 01 12	EC						BN

CONSULTANTS LOGO

PROFESSIONAL STAMPS

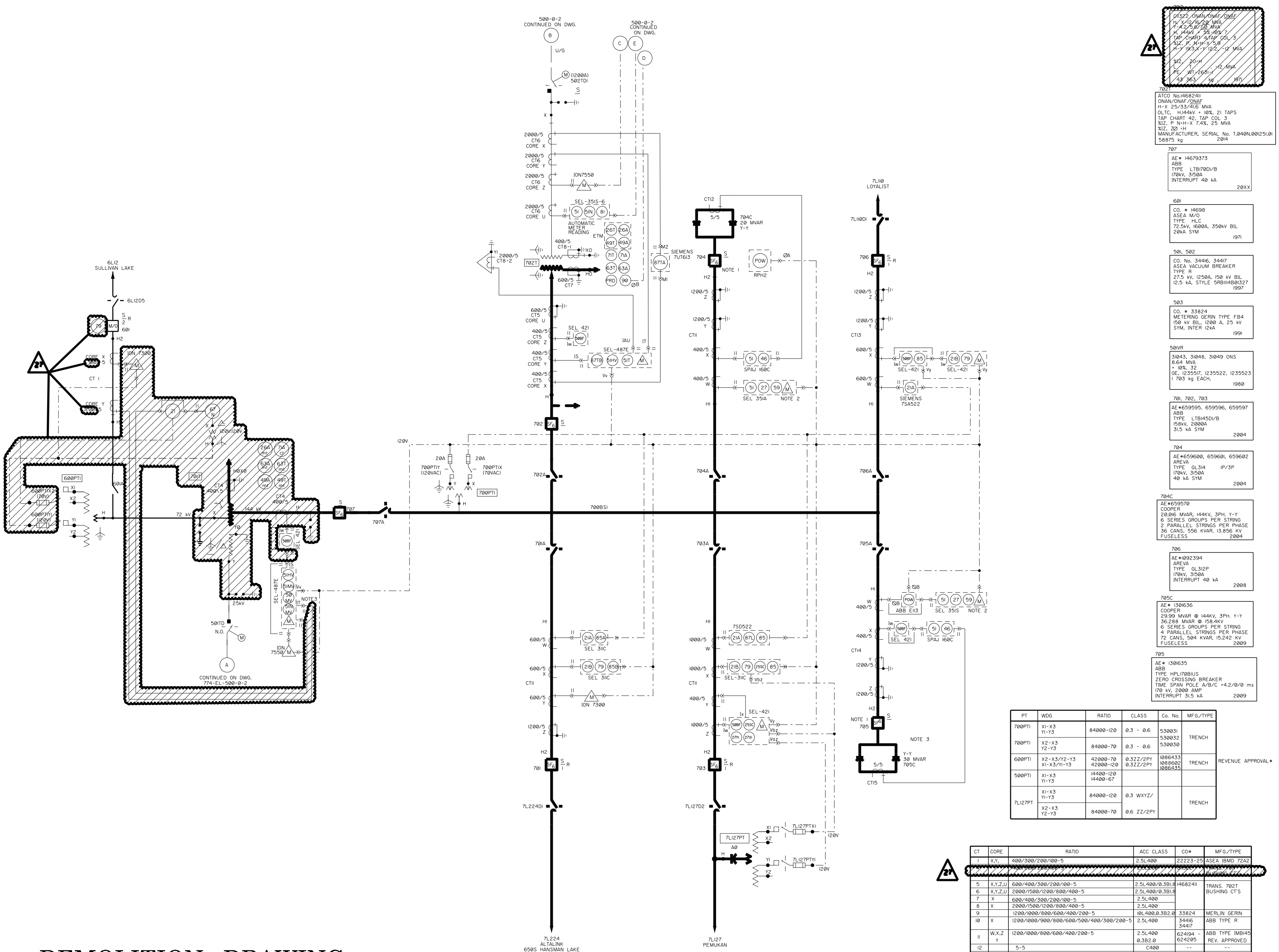
FOR DBM ONLY

ATCO Electric

774S MONITOR SUBSTATION

SINGLE LINE PROTECTION AND METERING DIAGRAM

DRAWN	DATE	SCALE
MCs	1997 07 03	NONE
DESIGN BY DW	APPROVED BY	
DWG. NO. 774-EL-500-0-1	R31A	SHEET 1 OF 2



PT	WDG	RATIO	CLASS	Co. No.	MFG./TYPE
700PT1	X1-X3 Y1-Y3	84000-120	0.3 - 0.6	530031 530032 530030	TRENCH
700PT1	X2-X3 Y2-Y3	84000-70	0.3 - 0.6		
600PT1	X2-X3/Y2-Y3 X1-X3/Y1-Y3	42000-70 42000-120	0.3ZZ/2PY 0.3ZZ/2PY	1086433 1088602 1086435	TRENCH
500PT1	X1-X3 Y1-Y3	14400-120 14400-67			
7L127PT	X1-X3 Y1-Y3	84000-120	0.3 WXYZ/		TRENCH
	X2-X3 Y2-Y3	84000-70	0.6 ZZ/2PY		

REVENUE APPROVAL#

CT	CORE	RATIO	ACC CLASS	CO#	MFG./TYPE
1	X,Y,	400/300/200/100-5	2.5L400	22223-25	ASEA IBMD 72A2
4		400/300/200/100-5	2.5L200	[illegible]	TRANS. [illegible] BUSHING CT'S
5	X,Y,Z,U	600/400/300/200/100-5	2.5L400/0.3B1.8	14682411	TRANS. 702T BUSHING CT'S
6	X,Y,Z,U	2000/1500/1200/800/400-5	2.5L400/0.3B1.8		
7	X	600/400/300/200/100-5	2.5L400		
8	X	2000/1500/1200/800/400-5	2.5L400		
9		1200/1000/800/600/400/200-5	10L400,0.3B2.0	33824	MERLIN GERIN
10	X	1200/1000/900/800/600/500/400/300/200-5	2.5L400	34416 34417	ABB TYPE R
11	W,X,Z Y	1200/1000/800/600/400/200-5	2.5L400 0.3B2.0	624194 - 624205	ABB TYPE IMB145 REV. APPROVED
12		5-5	C400	--	--
13	W,X,Z Y	1200/1000/800/600/400/200-5	2.5L400 0.3B2.0	1092207- 1092209	TRENCH 10SK 145
14	W,X,Z Y	1200/1000/800/600/400/200-5	2.5L800 0.3B2.0	1301641- 1301643	TRENCH 10SK 145
15		5-5	C400	--	--

DEMOLITION DRAWING

REFERENCE DRAWINGS

DRAWING NUMBER	DRAWING TITLE

STANDARD BASE DRAWING APPROVAL

NO.	REVISION DESCRIPTION
DATE	DFTG DESIGN CIVIL TCOM TCTRL EL/PRT STD

LEGEND:

- METERING
- TELEMETRY
- DIGITAL FAULT RECORDER
- IEEE DESIGNATIONS
- DYNAMIC SWING MONITOR
- TEST SWITCH WIRED FOR BYPASS CURRENT
- TEST SWITCH WIRED FOR SHORTING CURRENT
- TEST SWITCH FOR VOLTAGE CONNECTION

NOTES:

1. BREAKER CLOSING CONTROLLED BY POINT-ON-WAVE CONTROLLER.
2. METERING TO BE REVERSED IN RTU FOR SCADA (ie. +VE MVAR INTO BUS).

LEGEND

DEMOLITION

CONSTRUCTION

NO.	REVISION DESCRIPTION	PROJECT	DATE	DFTG	DESIGN	CIVIL	TCOM	TCTRL	EL/PRT	COMM
22	HRTD - LINE 7L127 ADDITION- IFC	PROJECT T16246	11 04 26	JPH	NP				SH	
27	701T REPLACEMENT & CONTROL BLD 2 SALVAGE	PROJECT E45954	2016-03-07	YX	YX				SL	
26	AS BUILT - REV. 24 & 25	PROJ. E20402/E20332	2015 06 30	MC						KJ
25	DCN 14-741	PROJ. #E20402/E20332	2014 06 27	JM					JW	
24	702T CAPACITY UPGRADE	PROJ.#E20402 & E20332	2014 04 17	EH	JW				JW	
23	AS BUILT - HRTD - LINE 7L127 ADDITION	PROJECT T16246	2013 11 22	DG						JS

CONSULTANTS LOGO

PROFESSIONAL STAMPS

APEGGA Permit to Practice # P0850

ATCO Electric

774S MONITOR SUBSTATION

SINGLE LINE PROTECTION AND METERING DIAGRAM

DRAWN	DATE	SCALE
MCs	1997 07 03	NONE

DESIGN BY: DW
APPROVED BY:

DWG. NO. 774-EL-500-0-1 R27 DEMO SHEET 1 OF 2

PLEASE DO NOT REMOVE REVISION 0

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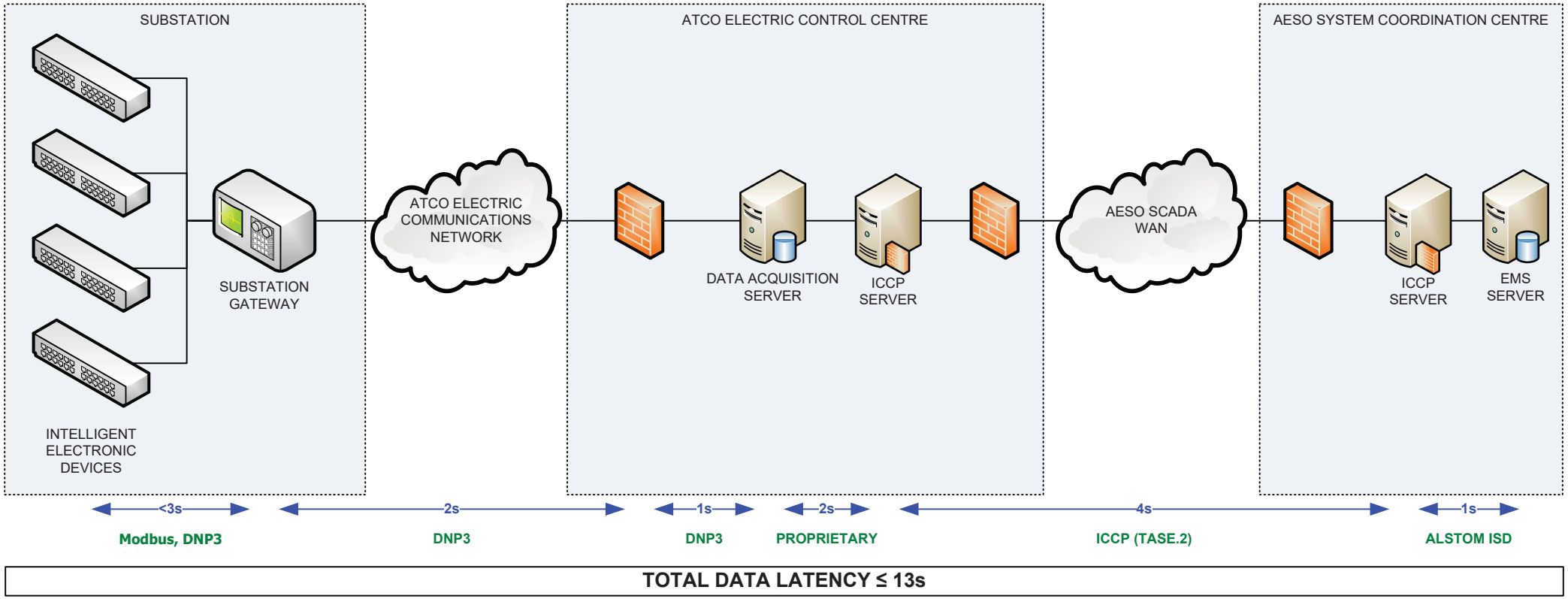
ATCO Electric to AESO Communications - IP

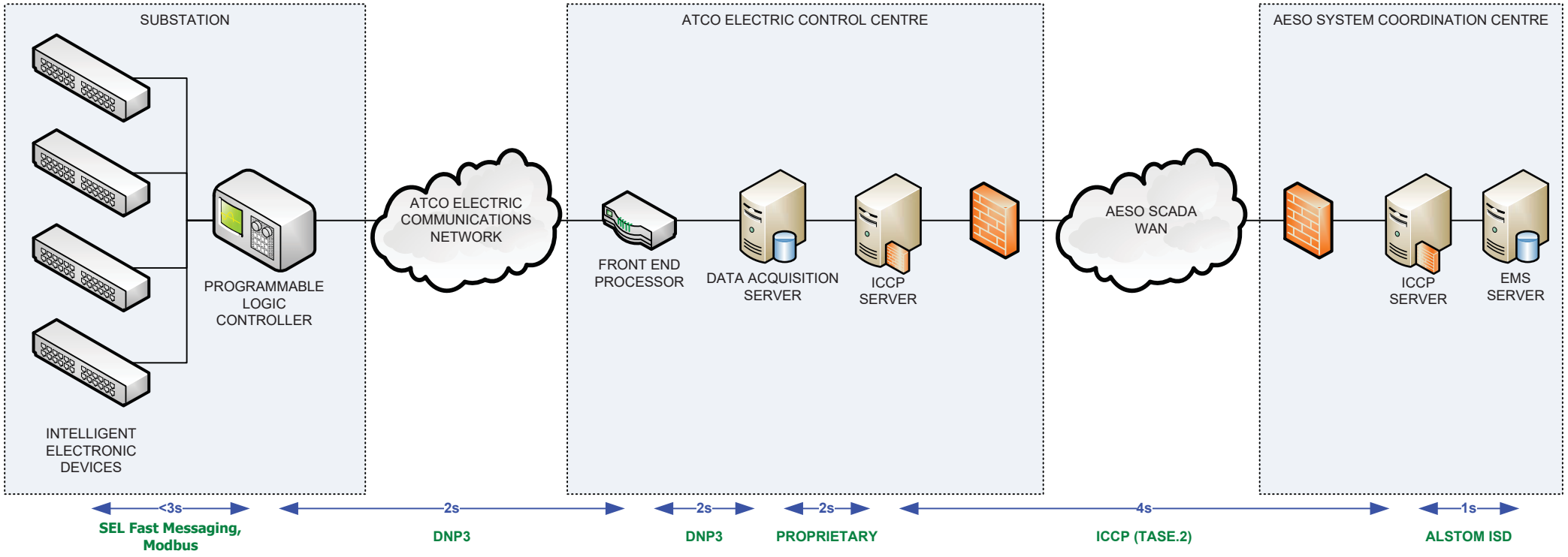
Substation: 766S Nevis



TOTAL DATA LATENCY ≤ 13s

ATCO Electric to AESO Communications - Serial

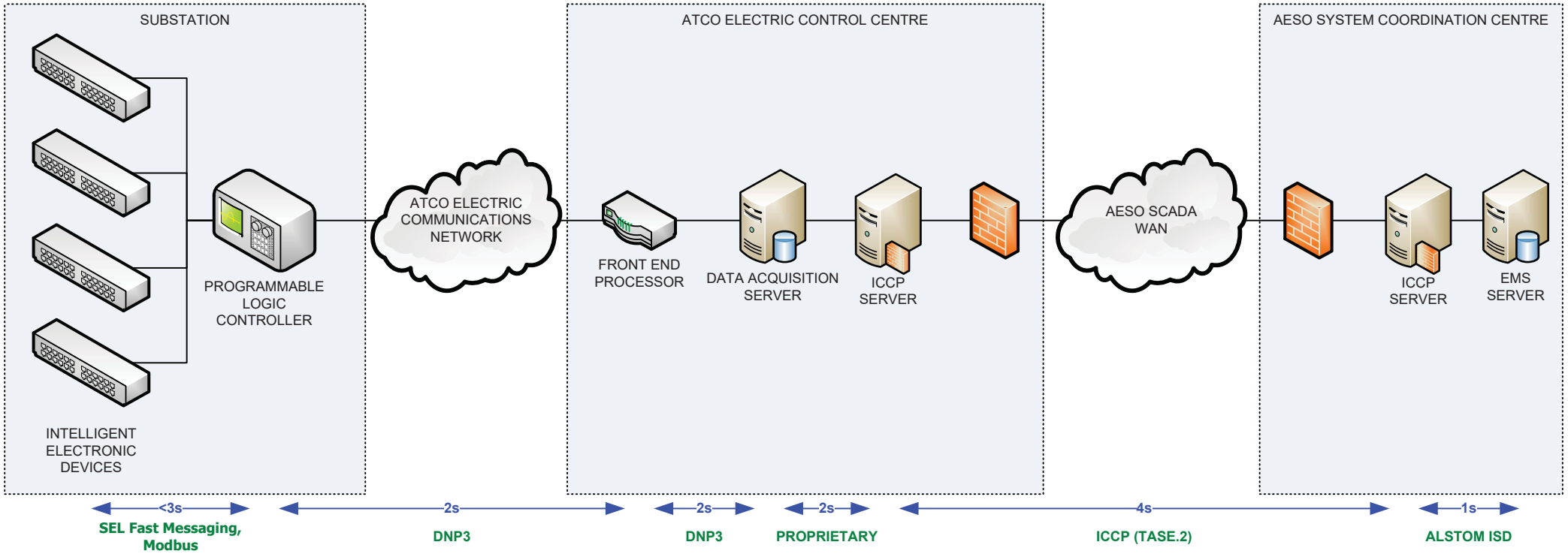
Substation: 767S Oyen



TOTAL DATA LATENCY ≤ 14s

ATCO Electric to AESO Communications - Serial

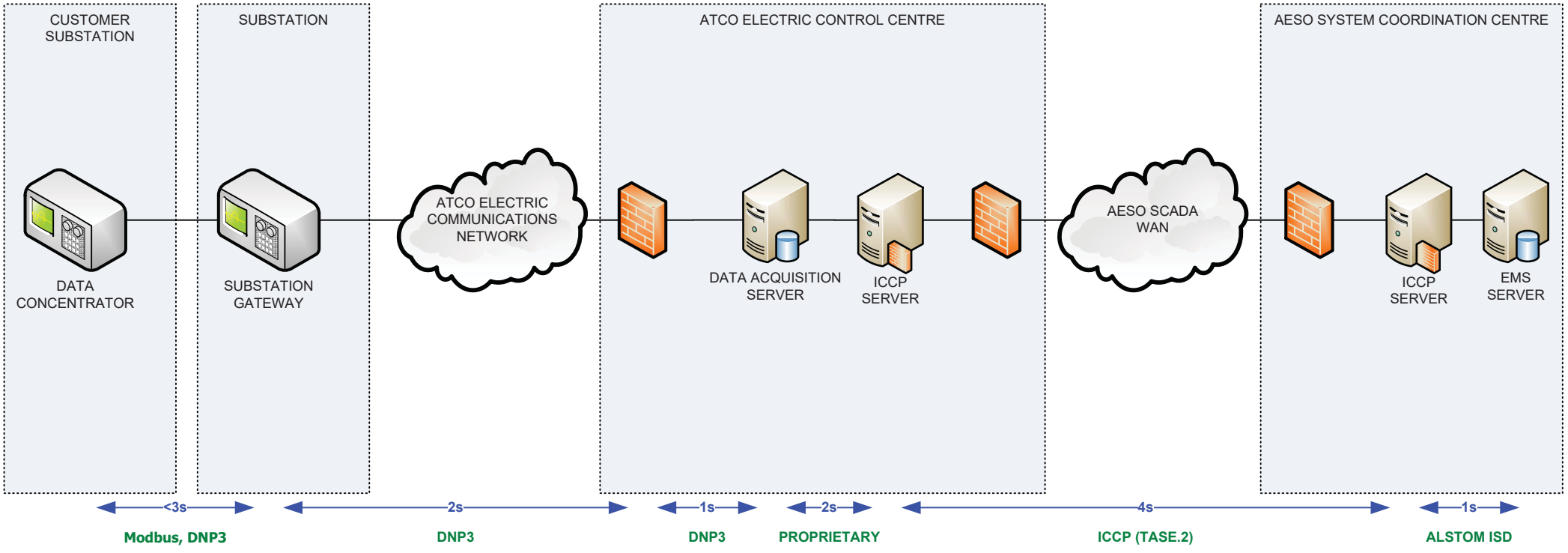
Substation: 774S Monitor



TOTAL DATA LATENCY ≤ 14s

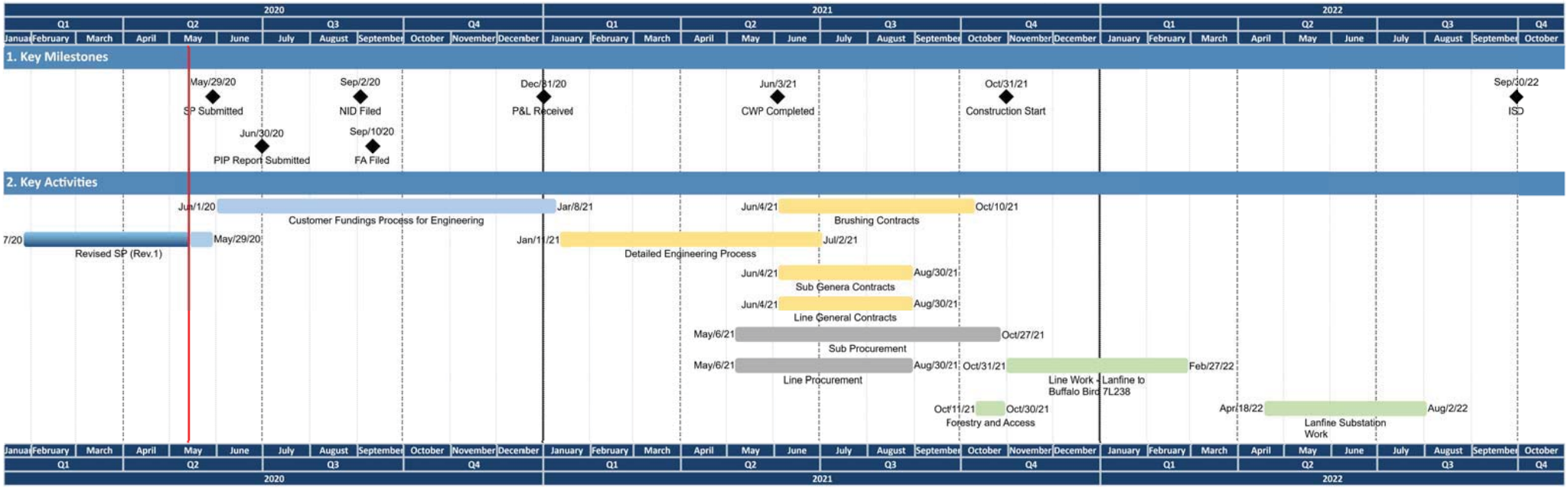
ATCO Electric to AESO Communications - IP

Substation: 601S Buffalo Bird via 972S Tinchebray



TOTAL DATA LATENCY ≤ 13s

ATCO	U000775 - P1898 Pattern Lanfine North WAGF	Project Manager: Sridhar Rao



Data Date: May/14/20	Page 1 of 1	Scheduler: Jang Cha

ACTUAL WORK | CRITICAL | MILESTONE | DATA DATE LINE | DEFINE (Stage 0 & 1) | EVALUATE (Stage 2) | DEVELOP (Stage 3) | DESIGN (Stage 4) | MATERIALS | EXECUTE (Stage 5)

AESO Project Name & No.	Pattern Lanfine North Wind AGF		P1898	
	Estimate Basis	Service Proposal		
High Range	10%	Low Range	-20%	
In Service Date	Sep. 01-22	01-May-20		
Date of Estimate:	SP Estimate Rev.1 2020-04-20	SP Estimate Rev.0 2019-01-02	Difference	ASSUMPTIONS
TRANSMISSION LINE				
Material	$ 1,392,762	$ 3,565,069	$ (2,172,307)	Wood SC Structures Type vs Steel DC Structures Type
Labour	$ 3,870,198	$ 3,290,522	$ 579,676	Added AC Mitigation cost in SP R1 ($750K)
TOTAL TRANSMISSION LINE	**$ 5,262,960**	**$ 6,855,591**	**$ (1,592,631)**	
SUBSTATION				
Material	$ 360,553	$ 395,729	$ (35,176)	
Labour	$ 784,293	$ 925,986	$ (141,693)	
TOTAL SUBSTATION	**$ 1,144,846**	**$ 1,321,715**	**$ (176,869)**	
TELECOMMUNICATION				
Material	$ 18,565	$ 18,981	$ (416)	
Labour	$ 52,198	$ 52,108	$ 90	
TOTAL TELECOMMUNCATIONS	**$ 70,763**	**$ 71,089**	**$ (326)**	
OWNERS				
Pre-SP Cost	$ 72,311	$ 56,630	$ 15,681	
Service Proposal	$ 210,890	$ 98,006	$ 112,884	
Facility Applications	$ 1,023,417	$ 441,184	$ 582,233	Added $500K for AUC Hearing
Regulatory & Compliance	$ 10,000	$ 10,000	$ -	
Land Rights - Easements	$ 298,377	$ 298,377	$ -	
Land - Damage Claims	$ 54,000	$ 54,000	$ -	
Land - Acquisitions	$ -	$ -	$ -	
Land - Other	$ -	$ -	$ -	
TOTAL OWNERS COST	**$ 1,668,995**	**$ 958,197**	**$ 710,798**	
DISTRIBUTED				
Procurement Management	$ 117,213	$ 145,971	$ (28,758)	
Project Management	$ 328,985	$ 330,068	$ (1,083)	
Construction Management	$ 636,265	$ 573,503	$ 62,762	
Contingency	$ 784,400	$ 844,400	$ (60,000)	
Escalation	$ 195,519	$ 61,995	$ 133,524	
TOTAL DISTRIBUTED	**$ 2,062,382**	**$ 1,955,937**	**$ 106,445**	
SALVAGE				
Transmission Line Labour	$ -	$ -	$ -	
Substation Labour	$ 10,080	$ 10,080	$ -	
Telecom Labour	$ -	$ -	$ -	
Land Remediation and Reclamation			$ -	
TOTAL SALVAGE	**$ 10,080**	**$ 10,080**	**$ -**	
OTHER COSTS				
AFUDC	$ 933,917	$ -	$ 933,917	Added cost in SP R1
E&S	$ 1,328,603	$ 1,675,891	$ (347,288)	
TOTAL OTHER	**$ 2,262,520**	**$ 1,675,891**	**$ 586,629**	
TOTAL PROJECT	**$ 12,482,546**	**$ 12,848,500**	**$ (365,955)**	

58844 SP Estimate R0 vs R1 with Actuals cost of 53750 and 55680 project

	58843 SP Estimate 2020 Rev.1	58844 SP Estimate 2019 Rev.0	2014-04-16 Actuals	2014-04-16 Actuals	2014-10-16 Actuals	
PROJECT	approx. 13km of a new single circuit structures 144kV transmission line designated as 7L238 running between the existing Lanfine 959S and customer's Buffalo Bird 601S substation	approx. 13km of a new double circuit structures 144kV transmission line **(only one side strung)** designated as 7L238 running between the existing Lanfine 959S and customer's Buffalo Bird 601S substation	**56539 E18927 marguerite-wolf 144kv S/C Line**	**56660 Beartrap 144kV Line and New Substation**	**55680 Hangingstone SAGD 1**	
SCOPE	Conductor is 1–795 kcmil ACSR Drake; shield wire is 1- 3/8" grade 220 galvanized steel and including a 24fiber OPGW. Tangent **wood** Davit Arm (93), 45-90 degree angles (7) and **wood** 3-pole dead end (6) Assumed direct embedded foundations.	Conductor is 1–795 kcmil ACSR Drake; shield wire is 1- 3/8" grade 220 galvanized steel and including a 24fiber OPGW. Tangent **steel** Davit Arm (93), 45-90 degree angles (7) and **steel** 3-pole dead end (6) Assumed direct embedded foundations.	Steel Monopole Qty, 96; Conductor is 1–795 kcmil ACSR Drake and including a 24fiber OPGW; 12 Bucket Piles, 6 Concrete Piles	Wood poles structures Qty. Conductor: 477 Hawk & Overhead Shield Wire considered 3/8" **3 x 144kv Switch Str** Foundation: 50% Direct Embedment and 50% Bucket Pile	Wood poles structures Qty. 34 Conductor: Patrige 266.8 kcmil Overhead Shield Wire considered 3/8" Foundation: 50% Direct Embedment and 50% Bucket Pile	**Explanation (Discrepancy)**
LINE DISCRIPTIONS	7L238 144kV S/C 13km	7L238 144kV D/C (only one side strung) 13km	7L587 144kV S/C 14km	7LA24 BEARTRAP 940S TO T-TAP WITH 7L24 17.9km	144kV 7L36 (6.8 km) + D/C 144kV 7L194/7L155 (1.8 km) 8.6km	
Lines						
Materials						
Foundations	$ 145,006	$ 40,432		$ 77,000	$ 198,259	Cost for GUY WIRE and Anchors & Material Distribution
Structures	$ 403,136	$ 2,689,066	$ 1,327,000	$ 1,143,000	$ 333,818	58844 Wood Pole 144kV **S/C structure** Qty. 106 vs 56539 Steel Monopole 144kV **S/C structure** Qty,96
Hardware	$ 445,774	$ 434,837	$ 255,000	$ 400,000	$ 511,830	
Conductor	$ 398,846	$ 400,734	$ 452,000	$ 117,000	$ 100,994	
OPGW	$ 85,800					
Misc			$ -		$ -	
Subtotal - Material	**$ 1,392,762**	**$ 3,565,069**	**$ 2,034,000**	**$ 1,737,000**	**$ 1,144,901**	
Labour						
Detailed Engineering	$ 208,000	$ 208,000	$ 354,000	$ 613,000	$ 139,824	
R/W Preparation & Brushing & Survey	$ 778,157	$ 779,307	$ 2,777,000	$ 2,038,000	$ 640,256	58844 only 2ha Line Brushing vs 56539 Line Brushing 42 ha
Construction	$ 2,865,591	$ 2,279,845	$ 4,776,000	$ 3,342,000	$ 1,572,548	58845 Assumed direct embedded foundations vs 56539 12 Bucket Piles, 6 Concrete Piles; 58844 Construction cost 2018 vs 56539 Construction cost 2014
Commissioning	$ 18,450	$ 23,370	$ 46,000	$ 72,000	$ 66,751	
Subtotal - Labor	**$ 3,870,198**	**$ 3,290,522**	**$ 7,953,000**	**$ 6,065,000**	**$ 2,419,379**	
Sub Total-Material and Labour	**$ 5,262,960**	**$ 6,855,591**	**$ 9,987,000**	**$ 7,802,000**	**$ 3,564,280**	
	$ 404,843	**$ 527,353**	**$ 713,357**	**$ 435,866**	**$ 414,451**	