mcmillan

Reply to the Attention of	Laura Brazil
Direct Line	416.865.7814
Email Address	Laura.Brazil@mcmillan.ca
Our File No.	211923
Date	November 5, 2014

Ontario Energy Board
P.O. Box 2319
2300 Yonge Street
Suite 2700
Toronto, Ontario M4P 1E4

Attention: Board Secretary

Re: Greenfield South Power Corporation
Application for CPCN
EB-2014-0299

Please find enclosed the Supplementary Evidence of the Applicant, Greenfield South Power Corporation, dated November 5, 2014. The Supplementary Evidence is submitted further to Procedural Order No. 1 dated October 28, 2014, which included within the List of Issues certain topics that were not addressed in the Applicant's Pre-Filed Evidence.

Yours truly,

Laura Brazil

/kk
Attach.

Copy to: Mike Richmond (McMillan LLP)

ONTARIO ENERGY BOARD

IN THE MATTER of the *Ontario Energy Board Act, 1998*, S.O. 1998, c. 15 (Schd. B);

AND IN THE MATTER OF an application by Greenfield South Power Corporation for a certificate of public convenience and necessity, pursuant to section 8 of the *Municipal Franchises Act*, R.S.O. 1990, c. M. 55.

SUPPLEMENTARY EVIDENCE

OF THE APPLICANT

GREENFIELD SOUTH POWER CORPORATION

TABLE OF CONTENTS

APPENDICES

SUPPLEMENTARY EVIDENCE

ISSUE NO. 3: OUTSTANDING LANDOWNER MATTERS

Attached as Appendix 35 is the parcel register for the GEPP lands.

ISSUE NO. 4: GREENFIELD'S COMPETENCE AS BUILDER AND OPERATOR

Greenfield will comply with all TSSA and other safety requirements that apply to the GEPP Natural Gas Utilization System.

Operation of GEPP Natural Gas Utilization System

Greenfield will ensure the GEPP Natural Gas Utilization System is at all times operated by qualified and competent staff, under the leadership of a Chief Operating Engineer.

Todd Brillinger has been engaged as Chief Operating Engineer. He holds the following certifications and qualifications:

- Certificate of Qualification, Operating Engineer - First Class, TSSA
- Certificate of Completion, Boilers and Pressure Vessels Safety, Welding Qualifications (ASME Section IX), TSSA
- Certificate of Completion, Boilers and Pressure Vessels Safety, Repair and Alterations (National Board Inspection Code), TSSA
- Certificate of Completion, Boilers and Pressure Vessels Safety, Fabrication, Inspection, Examination and Testing of Power Piping (ASME B31.1), TSSA
- Certificate of Completion, Boilers and Pressure Vessels Safety, Establishing & Maintaining an Effective Quality System, TSSA
- Certificate of Completion, Fundamentals of Gas Turbine Construction and Operations, GE Power Systems
- Certificate of Completion, Training in Safety and Proficiency - Introduction to Supervision, Electrical & Utilities Safety Association of Ontario
- Certificate of Completion, Safety Training – Confined Space Entry, Electrical & Utilities Safety Association of Ontario
- Certificate of Completion, Safety Training – Arc Flash Risk Assessment, Electrical & Utilities Safety Association of Ontario
- Certificate of Completion, Safety Training – Lift Truck Operation including propane cylinder handling, Advanced Industrial Training
- Certificate of Completion, WHIMS Train the Trainer, Liftow Training Centre

Copies of each of the certificates listed above are attached at Appendix 16.

The TSSA designation of "Operating Engineer - First Class" means that the Chief Operating Engineer has fulfilled the requirements of the TSSA as set out in the TSSA's applicable examination and certification guide. A copy of Revision 5 of such guide, dated January 2014, is attached as Appendix 17.

A shift operator will be on site at all times and will hold at least a TSSA Certificate of Qualification - Second Class. Operators holding this designation have fulfilled the requirements of the TSSA as set out in the TSSA's applicable examination and certification guide. A copy of Revision 5 of such guide, dated January 2014, is attached as Appendix 18.

At least one assistant to the shift operators will also be on site at all times and will hold at least a TSSA Certificate of Qualification - Third Class. Operators holding this designation have fulfilled the requirements of the TSSA as set out in the TSSA's applicable examination and certification guide. A copy of Revision 6 of such guide, dated January 2014, is attached as Appendix 19.

As of the date of this Supplementary Evidence, Greenfield is continuing to recruit additional operations and maintenance staff. Operations staff that have already been engaged have employment contracts with Greenfield's affiliate, Eastern Power. Operations staff will enter into employment contracts directly with Greenfield prior to commercial operation of the GEPP.

In addition to recruiting its own qualified operations staff, Greenfield already has access to an operations and maintenance support organization consisting of licensed Professional Engineers, through its affiliate Eastern Power. Such Professional Engineers will develop and help manage the ongoing operations of the entire GEPP, including the GEPP Natural Gas Utilization System. Attached as Appendix 20 is a list of such Professional Engineers including their PEO licence numbers.

Construction of GEPP Natural Gas Utilization System

All welding for the GEPP Natural Gas Utilization System will be completed by qualified welders.

Attached as Appendix 21 are copies of the TSSA Welder/Welding Operator Certificates for some of the welders that may perform construction or maintenance of the GEPP Natural Gas Utilization System.

Before allowing welders to work, Greenfield ensures that all welders perform test welds as required under the applicable legislation. Sample test results are attached as Appendix 22.

In addition to the legislated test, Greenfield requires that all potential welders pass a Greenfield-mandated welding test. A sample of the Greenfield-mandated test results is attached as Appendix 23.

Greenfield's Quality Control Manual for Fabrication, Assembly and Erection of Power Piping Systems is attached as Appendix 24. The TSSA has issued a Certificate of Authorization confirming the adequacy of Greenfield's quality control program in accordance with the legislation and with the Boilers and Pressure Vessels Regulation. A copy of the TSSA Certificate of Authorization dated February 19, 2014 is attached as Appendix 25.

As stated above, the Chief Operating Engineer is designated by the TSSA as an Operating Engineer – First Class. The requirements for such designation include qualifications in respect of power plant construction practices, as described in section 4(c) of Appendix 17. They also include qualifications in respect of commissioning and de-commissioning of gas turbines and piping systems, as described in section 4(d) of Appendix 17.

The Professional Engineers listed in Appendix 20 are among those who designed the GEPP Natural Gas Utilization System. A copy of the design specifications and the TSSA approval in respect thereof is included as Appendix 15 to the Amended Pre-Filed Evidence of the Applicant dated September 25, 2014.

Attached at Appendix 26 are updated photographs showing the progress of construction for the GEPP.

ISSUE NOS. 1 AND 5: COST/ECONOMIC FACTORS RELATED TO SERVING THE GEPP BY GREENFIELD OR UNION GAS AND IMPACT OF GRANTING CERTIFICATE TO GREENFIELD ON UNION AND UNION'S RATEPAYERS

Information relating to GEPP's natural gas service and costs are set out in the following Appendices:

- Appendix 27: Natural Gas Cost Comparison
- Appendix 28: Vector Costs
- Appendix 29: Union Gas T2 Costs
- Appendix 30: Cost of Interruptible Natural Gas Service – Potential Loss of Profits
- Appendix 31: Eastern Power – Enbridge CDA – Natural Gas Interruptions
- Appendix 32: Schedule J to Amended and Restated Clean Energy Supply Contract between OPA and Greenfield
- Appendix 33: KPMG Substantially Enacted Income Tax Rates
- Appendix 34: Letter from Vector to Eastern Power dated October 26, 2012

Natural Gas Transportation Negotiations with Greenfield

Greenfield and Union Gas conducted negotiations for natural gas delivery services between the Summer of 2012 and the Fall of 2013. During that time, Union Gas presented the following two options to Greenfield:

- Union Gas Firm Service (T1 Service, which subsequently became T2 Service); and
- Union Gas Interruptible Service.

However, Union advised that T1 (now T2) Firm Service would require system reinforcements, but did not disclose the cost to Greenfield. Union would only finalize the costs after execution of a Letter of Indemnity to cover Union's costs, a liability which was not commercially reasonable for Greenfield to undertake.

When Greenfield requested that Union Gas consider other rate options, Union Gas responded that no other rate options could be made available.

Greenfield advised Union Gas that it was considering three potential natural gas transportation suppliers: Vector, TransCanada Pipelines, and Union Gas. All three suppliers have natural gas lines traversing the GEPP lands. Greenfield advised Union Gas that its transportation options were the least flexible and were not the most competitive. However, Union Gas never offered or discussed a Billing Contract Demand service with Greenfield related to a Vector connection, or an interruptible service based on Vector as indicated at page 11 of Union Gas' Leave to Construct application dated April 25, 2014 [EB-2014-0147].

Throughout the negotiations, Union Gas was made aware of Greenfield's need to be competitive with its closest electrical generation competitor in order to compete effectively in the electricity markets, both in Ontario and for potential exports to the United States.

Vector Pipeline Firm Service

Greenfield wishes to transport natural gas to its power plant location using Vector's Hourly Firm Transportation Service (FT-H) and Operational Variance Service (OVS). The FT-H service is a firm service and is not curtailed during periods of high natural gas demand. These services are described in more detail at Section 4 of Greenfield's Amended Pre-Filed Evidence and at Appendix 12 attached thereto.

Union Gas Interruptible Service

This service is not directly comparable to the Vector service because it is interruptible while the Vector service is firm. Union Gas has the ability to interrupt (curtail) natural gas service to interruptible customers during periods of high demand whereas Vector is not able curtail their firm service customers during periods of high demand.

Union Gas provided various cost numbers for interruptible service in different discussions with Greenfield because the rate schedule allows some variance for interruptible rates. The latest

information from Union Gas was in Union Gas' Leave to Construct application dated April 25, 2014 [EB-2014-0147]. Schedule 11 of the application showed annual revenue to Union Gas of $1,071,000 per year, which would be the annual cost to Greenfield.

In the event of an interruption of gas service during periods of high demand (when HOEP is high), Greenfield may be deemed to generate electricity under its contract with the Ontario Power Authority, and imputed revenues would be deemed to have been earned by Greenfield. Should Greenfield not be available to generate due to an interruption of gas service, it would directly lead to a reduction in the monthly payment by the OPA to Greenfield, a loss which would be attributable to the interruption of gas service. A copy of Schedule J to Greenfield's contract with the Ontario Power Authority, which describes such deemed dispatch and imputed net revenue, is attached as Appendix 32.

Union Gas Firm Service (T2 - Transportation Only)

In order to provide a fair comparison between the services offered by Union Gas and Vector, equivalent services must be compared. The relevant firm service offered by Union Gas is the T2 service. The T2 service has components related to gas transportation and gas storage. The Vector FT-H & OVS service is for transportation only and hence only the transportation related components of the Union gas T2 service should be considered.

Union Gas indicated that system reinforcements would be required to provide firm service. The cost of system upgrades is unknown. Union Gas was unwilling to do the analysis to provide the amount of the upgrade costs for firm service without Greenfield first signing a Letter of Indemnity. No cost of system upgrades has been provided to date.

Average Curtailments

The following is a summary of the average number of curtailments sustained by Eastern Power plants, which is based on Appendix 30:

Curtailment Period Summary	Days Of Curtailment
Winter 2013-2014	20.5
Winter 2012-2013	0.0
Winter 2011-2012	0.0
Winter 2010-2011	4.0
Average (4 Years)	**6.125**

Based on this experience, Greenfield has estimated that the GEPP would incur an average annual cost of interruptions of $540,000. This amount was determined by estimating the number of days of potential interruption based on Eastern Power's experience (and then conservatively estimating a one-third reduction in average curtailments), and multiplying it by the potential loss of revenue to Greenfield during these interruptions, which is estimated to be in the amount of $135,000 per day as indicated in Appendix 30. Greenfield's estimate assumes that there will be 4 days of interruption per year on average throughout the 20 year period (even though experience

has been over 6 days per year on average). The potential of interruptions generates considerable risk to Greenfield's operations and its cash flow stability, in addition to lost profits.

Summary

The chart below summarizes the qualitative differences between Vector and Union Gas service:

	Vector	**Union Gas Interruptible**	**Union Gas Firm (T2)**
No Risk of Interruptions	Yes	No	Yes
Ability to Use Other Gas Storage Systems	Yes	No	No
No Unknown System Upgrade Costs	Yes	Yes	No
Letter of Credit Requirement - Year 1 ($ millions)	0.5	6	7.9
Ability to Terminate after 7 Years	Yes	No	No
Ability to Compete on a Level Playing Field with Closest Competing Generator (Greenfield Energy Centre, which is connected to Vector)	Yes	No	No

As shown above, the qualitative factors associated with a Vector connection are more favourable than Union Gas' service offerings. With the Vector connection:

- Greenfield maintains flexibility in terms of storage options and the resulting flexibility to purchase and store gas;
- Greenfield maintains full flexibility after 7 years to restructure its gas transportation and supply as market changes may dictate;
- Greenfield maintains a level playing field with a similar larger local electrical generator;
- Greenfield ensures that it has a non-interruptible gas supply service to reduce operational risk;
- Greenfield's use of capital for Letters of Credits is less restricted, which will allow Greenfield to continue to grow its business; and
- Greenfield obtains natural gas services at a fraction of the cost of Union Gas' proposed services.

Technical Standards and Safety Authority

Ontario Certificate of Qualification

This is to certify that

TODD BRILLINGER

having complied with the
Technical Standards and Safety Act, Operating Engineers Regulation,
is issued this Certificate of Qualification as a

Operating Engineer First Class - Provincial

Certificate No. **OE00070086**

Issued Date **01-MAY-14**

Valid Until **29-MAY-15**

Issued by the Chief Officer

GE Power Systems

This is to Certify that

Todd Brillinger

has completed a training course covering

Fundamentals of Gas Turbine Construction and Operations

Presented by
*GE Energy **

6/27/2005 through 7/1/2005

Gas Turbine Instructor

* Services Outside of the USA Provided through General Electric International, Inc., A Wholly-Owned Subsidiary of the General Electric Co., USA

Electrical & Utilities Safety Association of Ontario

Recognition of Training in Safety and Proficiency

This is to certify that

Todd Brillinger

on January 30 to February 1, 2006
attended a three day course in

Introduction to Supervision

dated this seventh day of February, 2006

CET, MBA, CUSA
President and Chief Executive Officer

Chair

EUSA

Our Vision:

TO RELENTLESSLY PURSUE THE PATHS TO ZERO

Electrical & Utilities Safety Association of Ontario

Electrical & Utilities Safety Association of Ontario

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CET, MBA, CUSA
President and Chief Executive Officer

Chair

Recognition of Safety Training

Electrical & Utilities Safety Association of Ontario

Our Vision: To Relentlessly Pursue the Paths to Zero

This is to certify that

Todd Brillinger

on May 11, 2007 attended a one day course in

Confined Space Entry

0.70 CEU's approved by the OETC

CET, MBA, CUSA
President and Chief Executive Officer

Chair

May 31, 2007
Date

ZeroQuest®
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Our Vision: To Relentlessly Pursue the Paths to Zero

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Electrical & Utilities Safety Association of Ontario

This is to certify

Todd Brillinger

on May 11, 2007 attended a one day course in

Confined Space Entry

CET, MBA, CUSA
President and Chief Executive Officer
0.70 CEU's approved by the OETC

Chair

May 31, 2007

Recognition of Safety Training

Electrical & Utilities Safety Association of Ontario

Our Vision: To Relentlessly Pursue the Paths to Zero

This is to certify that

Todd T. Brillinger

On February 8, 2008 attended a half day course in

Arc Flash Risk Assessment

CET, MBA, CUSA
President and Chief Executive Officer

Chair

May 13, 2008
Date

ZeroQuest®
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Arc Flash Risk Assessment

CET, MBA, CUSA
President and Chief Executive Officer

Chair

May 13, 2008

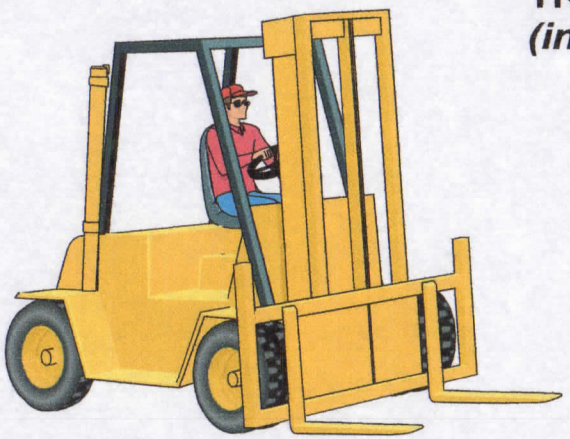
ATI
TRAINING

CERTIFICATE

AWARDED TO

Todd Brillinger - Eastern Power Limited

WHO HAS THIS DAY COMPLETED A SAFETY TRAINING PROGRAM FOR LIFT TRUCK OPERATORS
(including propane cylinder handling)



THIS 16th DAY OF March 20 10

Advanced Industrial Training

Grant Gilliland

Liftow Training Centre

Certificate of Completion

This certifies that

Todd Brillinger

has successfully completed the course requirements for

WHMIS Train the Trainer

Oct 25/05
Date of Issue

Instructor's Signature

Liftow CERTIFIED

Authorized Signature from Eastern Power Limited

Technical Standards and Safety Authority

Boilers and Pressure Vessels Safety

This certifies that ***Todd Brillinger*** attended the seminar on Welding Qualifications in accordance with ASME Section IX – October 2004.

Rick Mile
Operation Manager/Chief Inspector
Boilers & Pressure Vessels Safety

Technical Standards and Safety Authority

Boilers and Pressure Vessels Safety

This certifies that ***Todd Brillinger*** attended the seminar on Repair and Alterations based on the National Board Inspection Code Requirements – October 2004.

R.D. Mile
Chief Inspector,
Boilers & Pressure Vessels Safety

Technical Standards and Safety Authority

Boilers and Pressure Vessels Safety

This certifies that ***Todd Brillinger*** attended the seminar on the Fabrication, Inspection, Examination and Testing of Power Piping in accordance with ASME B31.1 – May 2005.

Rick Mile
Operation Manager/Chief Inspector
Boilers & Pressure Vessels Safety

Technical Standards and Safety Authority

Boilers and Pressure Vessels Safety

This certifies that ***Todd Brillinger*** attended the seminar on:

Establishing & Maintaining an Effective Quality System to meet TSSA Requirements

&

Repair and Alterations based on the National Board Inspection Code Requirements.

Nov 24th and 25th /2009

Andy Benko
Technical Services Specialist
Boilers & Pressure Vessels Safety Program

TECHNICAL STANDARDS & SAFETY AUTHORITY

TRAINING, EXAMINATION AND CERTIFICATION

CERTIFICATIONS PERSUANT TO THE OPERATING ENGINEERS REGULATION

(O. REG. 219/01)

1ST CLASS POWER (OPERATING) ENGINEER

EXAMINATION & CERTIFICATION GUIDE

REVISION 5

January 2014

This version replaces all previous

NEW IN THIS VERSION

- The 1st Class updated version replaces the Syllabus dated September 2003, Ontario.
- The 'General Information section' has been amended to accommodate Ontario's jurisdictional examination process requirements.
- The revised or new 1st Class syllabus included in this document is the same as the one listed on the SOPEEC website, dated September 01, 2006.
- The 'General Information Section' about SOPEEC, Examinations, Certification, Applications, Text Materials, etc., is located at the end of the document to permit easy syllabus access.
-

Important: Candidates for any class of certification as an Operating Engineer or Operator who have passed the required examinations, or any parts thereof, MUST obtain their certificate of qualification within five (5) years of such passing or re-writing of the examination will be required.

Syllabus: The following SOPEEC syllabus has been adopted by TSSA and provides the subject matter upon which the candidates will be examined.

REFERENCE SYLLABUS FOR REVISED FIRST CLASS CERTIFICATE OF COMPETENCY EXAMINATION.

INTRODUCTION:

This syllabus has been approved by the Standardization of Power Engineers Examinations Committee (SOPEEC) and the Association of Chief Inspectors (ACI).

This syllabus is intended to assist candidates studying for the First Class Engineers Certificate of Competency Examination.

The requirements to qualify for a First Class Examination are outlined in applicable jurisdictional Act and Regulations.

A candidate may write the papers for Part "A" or Part "B" at any scheduled examination after obtaining a Second Class Engineer's Certificate, provided, the candidate meets the jurisdictional minimum educational requirements.

RECOMMENDED STUDY PROGRAM:

It is recommended that, before undertaking this examination, the candidate completes the First Class Power Engineering Course offered through a recognized technical institute.

In addition to the foregoing course, it is recommended that the candidate becomes familiar with the publications listed in the "Reference Material for Power Engineering Students and Examination Candidates" which is obtainable from the various technical institutes or from the SOPEEC Website. (www.sopeec.org)

APPLICATION TO UNDERTAKE EXAMINATION:

A candidate must submit an application and the prescribed fee at least fifteen (15) business days before the date of examination.

EXAMINATION INSTRUCTIONS:

The examination consists of eight papers, each of 3½ hours duration. Each paper consists of seven questions of which five should be attempted.

A candidate will be provided with the following reference materials:

1. 2007 ASME Extract.
2. CSA B51 and B52 Extracts.
3. The jurisdictional Act and the applicable Regulations.

A candidate is allowed to bring the following items into the examination room:

1. Non-programmable calculator and drawing instruments.

NOTE: Handbook of Formula's, Steam and Refrigeration Tables will be provided; no other reference material will be allowed.

The candidate must show picture I.D. at the examination.

Part "A"
3 ½ Hours
First Paper

1. APPLIED THERMODYNAMICS AND PLANT CYCLES PRINCIPLES, TERMINOLOGIES, AND ADVANCED PRACTICAL CALCULATIONS INVOLVING:

a) Rankine and Brayton cycles applied to power plant systems.

b) Steady flow work, energy calculations for steam; calorimeters, steam turbine/condenser systems; steam nozzles.

c) Constant pressure, constant temperature, adiabatic processes for steam.

d) Energy relationships in non-flow processes.

e) Energy relationships, energy balance in steady flow processes; potential, thermal, internal, mechanical; energy conversions; nozzle flow process; throttling; work in heat engines (air compressors, turbines.)

f) Pressure, volume, temperature relationships, and work done during isothermal, adiabatic, and polytropic expansion and compression processes for gases.

g) Temperature, enthalpy, entropy characteristics, diagrams for steam; Temperature/Entropy chart use.

h) Enthalpy, entropy, quality calculations for steam.

i) Expansion and contraction of metals; affects on boiler components and piping systems.

j) Heat transfer by conduction; compound insulations; boiler component heat transfers; restricted heat transfer.

k) Refrigeration thermodynamics: capacity; performance; efficiency.

l) Specific heats of gases and vapours.

Part "A"
3 ½ Hours
Second Paper

2. PRINCIPLES OF APPLIED & FLUID MECHANICS PRINCIPLES, TERMINOLOGIES, AND ADVANCED PRACTICAL CALCULATIONS INVOLVING:

a) Work, power, and efficiencies of lifting machines.

b) Potential and kinetic energy; energy conservation.

c) Impulse and momentum; conservation of momentum; angular momentum.

d) Centripetal force and acceleration; balancing rotating masses; stresses in flywheel; radius of gyration, simple harmonic motion.

e) Torque, angular momentum, moments of inertia; centroids.

f) Torsion; shaft stresses; shaft power.

g) Stress and strain; modulus of elasticity; Hooke's Law; restricted expansion; elastic strain energy.

h) Shear forces and bending moments in beams; modulus of section; beam deflection.

i) Static fluid pressures and forces; liquid columns; hydraulics; manometers.

j) Buoyancy.

k) Fluids in motion; equation of continuity; liquid energy; Bernoulli's Theorem; venturi and orifice flows; turbulent and laminar flow; Reynold's Number.

l) Nozzle designs and flows.

Part "A"
3 ½ Hours
Third Paper

3. APPLIED ENGINEERING TECHNOLOGIES:

a) Metallurgy and metallography: in-depth knowledge of metals used in boilers, pressure vessels, piping, pumps, turbines, and ancillary equipment; metal structure; typical operational effects on metals in pressure equipment.

   i.) Thermal and dynamic stresses.

b) Corrosion: Corrosion theory and mechanisms, in depth corrosion chemistry for boilers, pipelines, cooling towers and pressure vessels; types of corrosion (including flow accelerated; heat affected zone corrosion, etc.); monitoring techniques and equipment; interpretation of corrosion results; prevention strategies (e.g. cathodic protection.)

c) Combustion: Fuel types, compositions, characteristics; low and high heat values; flame characteristics; boiler, fired-heater, and duct burner designs; burner design / operation vs. efficiency and emissions; effects of excess air; combustion troubleshooting; optimizing combustion; combustion and burner safety; combustion calculations for excess air, flue gas composition and analysis; combustion efficiency calculations; heat value calculations; staged combustion.

d) Advanced water treatment chemistry: in-depth knowledge of pre-treatment and internal boiler chemistry (for all common treatment methods); selection of pre-treatment and internal treatment strategies/programs for various size boilers (including equilibrium phosphate, coordinated phosphate, all volatile treatment, oxygenated, cycle chemistry, etc.); potable water, dealing with water treatment contractors and consultants; cooling water treatment.

Part "A"
3 ½ Hours
Fourth Paper

4. POWER PLANT OPERATIONS:

a) Energy Management practices; energy recovery systems (power factor correction; synchronous compensation; uninterruptible power supplies; distributed generation; emergency power; peak load reduction;) controllable losses; computerized performance management systems (data dumping, spreadsheets, and performance databases.)

b) Factors, components, calculations, and strategies/procedures for testing, maintaining and maximizing power plant efficiencies:

- boiler efficiency.
- gas turbine and combined cycle efficiency, including turbine inlet cooling.
- power generation efficiencies.
- overall plant/cycle efficiencies.

c) Power Plant construction practices: major factors, approaches, components in the design and construction process for a power (or process) plant; include new plant vs. expansion; equipment/system modifications; role of the chief engineer before and during construction; receiving/acceptance procedures for new vessels; tying into existing plant.

d) Commissioning and de-commissioning practices: outlines and specific procedures for commissioning new equipment, including boilers and auxiliaries, steam and gas turbines, piping systems, large pumps; start-up sequences; performance contracts for new plants/equipment; re-commissioning after major outages; de-commissioning.

e) Retrofitting: purposes, practices in redesign of existing boilers, turbines, and ancillary equipment; approval, design processes.

Part "B"
3 ½ Hours
First Paper

5. LEGISLATION AND CODES FOR INDUSTRIAL EQUIPMENT:

Familiarity with all applicable Codes and Standards applicable to the Chief Power/Operating Engineer, particularly the application and authority of each Code to vessel operation and repair, including the following:

a) Local and National Jurisdictional Codes, Acts and Regulations regarding boilers and pressure vessels: design, registration, operation, fees; engineer regulations; specific procedures of the chief engineer in applying the Acts and Regulations.

b) ASME, Section I – Power Boilers

   i.) includes thickness and pressure calculations, using Code paragraphs, for cylindrical components, heads, headers, tubing, power piping, compensations for openings, stayed surfaces, ligaments, staybolts, furnaces; safety valves sizes and capacities.

c) ASME, Section VIII – Pressure Vessels

   i.) includes design calculations for shells, heads, covers, opening reinforcements, and stayed surfaces.

d) ASME, Section IX – Welding.

e) CSA Standard B.51 – Construction and Inspection of Boilers and Pressure Vessels.

f) CSA Standard B.52 – Mechanical Refrigeration Code.

g) Power and Process Piping: ANSI B31.1 and B31.3.

API 510, 570 – Pressure Vessel Inspection Codes.

Part "B"
3 ½ Hours
Second Paper

6. SAFETY, LOSS AND ENVIRONMENTAL PROGRAM MANAGEMENT:

a) Components and administration of a loss control program; loss control standards.

b) Implementation and management of a complete plant safety program: safety attitude and motivation techniques; incident investigation & reporting; emergency response programs; work with occupational health and safety committee; safe work permits, safe work procedures and planning.

c) Safety Legislation in the workplace: identify Labour Canada, Workers' Compensation Board, and provincial legislation; legalities; responsibilities to enforce.

d) Risk Assessment and Risk Management Techniques including; Safety Audits (components, procedures, analysis, follow-up; working with safety inspectors) and HAZOP (hazardous operability)

e) Insurance programs; factors affecting insurance rates; insurance inspection procedures; working with insurance inspectors.

f) Environmental Legislation: identify/explain all applicable legislation (provincial and federal); legalities, responsibilities.

g) Environmental Permits: components of, including understanding of all terminology and units.

h) Environmental Audits: components, procedures, analysis, follow-up; working with environmental inspectors.

i) Environmental reporting procedures: routine reports and exceedences; spill clean up and containment.

j) Environmental Management Systems, including ISO 14000 series; purpose, components and influence.

k) Disposal and Reclamation: procedures and practices, including waste manifests.

Part "B"
3 ½ Hours
Third Paper

7. INSPECTION, MAINTENANCE AND REPAIR PRACTICES:

a) Project management skills: identify and apply project management techniques to plant maintenance; managing maintenance contractors; long term service agreements.

b) Predictive and preventive maintenance programs: components and management of; strategic/operational maintenance planning; run-to-failure, etc.; maintenance optimization.

c) Root Cause Analysis: purpose, procedure.

d) National Board requirements for owner inspection and quality control programs: components of a quality control program for vessel repairs; scope, authorities, interaction with jurisdictional inspectors, records and reporting procedures.

e) Boiler repairs: procedures for typical repairs to boiler parts, including cracks, ruptured tubes, etc. (step-by-step management of such repairs); safety valve maintenance.

f) Pressure vessel inspection and repair procedures (other than boiler) including cracks, corrosion etc.

g) Pressure vessel repair: repair procedures for pressure vessels, including cracks, corrosion, etc.

h) Pressure and power piping repairs: procedures for typical repairs to power plant piping.

i) Non-destructive examination: describe, in depth, the selection, equipment, applications, procedures, and interpretation of the results for the non-destructive examination methods (dye penetrant, magnetic particle, eddy current, radiographic, ultrasonic, electro-magnetic acoustic transducer); manage contracts and interpret results with non-destructive examination contractors; ASME Code, Section V; identify / explain inspection techniques as per Code.

j) Typical monitoring, inspection, and overhaul procedure for a large steam turbine, gas turbine, large multi-stage pump, and large alternator.

k) Rotating equipment monitoring including turbovisory monitoring (overall expansion, differential expansion, differential temperature, critical speed, oil whip, oil whirl, eccentricity) and vibration analysis (vibration theory, measurement, interpretation of results).

l) Oil analysis: purpose, theory and interpretation of oil analyses including lube oil and transmission oil.

Part "B"
3 ½ Hours
Fourth Paper

8. BUSINESS & WORKFORCE MANAGEMENT:

a) Budgets: techniques in preparation, control, and reporting; components of plant and department (utilities/power plant) budgets; zero-based budgeting (advantages & disadvantages.)

b) Balance sheet and bottom-line accounting: knowledge / significance of terminology (e.g. dual entry, credits, debits, revenue, expenses, liabilities, assets, balance sheet, income statements, cash flow); financial statements; accruals.

c) Inventory management techniques, such as: automated and computerized inventory systems; max / min; just in time.

d) Cost benefit and financial analysis calculations; net present value and internal rate of return models; return on investment.

e) Contracts: types of and control of; legalities of contracts; torts, legal and ethical liability, due diligence; force majeure.

f) Ethics and social responsibilities.

g) Problem solving and decision making techniques/models.

h) Leadership: styles, responsibilities; establishing and communicating plant/department goals; motivational models; communication practices; conflict resolution.

i) Labour Relations: internal and external; legislation; working with union and non-union workforces; recognizing & enforcing special workforce legislation; contract / term employees; contingent workforce; human resource and capacity planning; conflict resolution techniques.

j) Benchmarking: purposes, practices and techniques.

k) Public relations: communication practices; typical areas of public concern.

l) Recruitment, hiring, and interviewing techniques (including behavioral descriptive interviewing.)

m) Workforce development techniques: employee orientation; needs assessment; gap analysis; competency profiles; training methods and standards; performance management.

n) Change management techniques; psychology of change; promoting and managing workplace change; the manager's role as a change agent.

o) Plant management structures and organization; inter-departmental relationships and responsibilities, workforce styles (promoting teamwork; elements of teamwork and self-directed work teams; supervised work teams.)

GENERAL INFORMATION

NAME CHANGE

The designation of persons operating power plants in Ontario was Stationary Engineer until the summer of 2001 at which time it changed to Operating Engineer by the proclamation of the *Technical Standards & Safety Act* and its related *Operating Engineers Regulation* on June 27th, 2001.

In reference to power plant engineering, the previous Ontario designation 'Stationary', the current designation 'Operating' and the standard Canadian designation 'Power' all have the same meaning.

SOPEEC (stands for, "*Standardization of Power Engineering Examinations Committe*e").

In the effort to provide mobility for power plant operators across all of Canada, Ontario adopted the SOPEEC examination system in the latter part of the1990's. Currently all jurisdictions utilize the standardized SOPEEC examinations system, **(except Quebec at this time)**. This makes it now possible to complete writing the required examinations in another province or territory in Canada in the event a candidate moves.

To receive the **"standardized"** designation on your Certificate of Qualification, one must have written **" ALL"** of the required examinations in the **"SOPEEC format "***.* ***(No previously written provincial examinations can be recognized)***. The "standardized" designation allows you to be issued the same level of certification in all Canadian jurisdictions that are SOPEEC members. No further examination writing would be required.

ELIGIBILITY TO WRITE

A candidate must be in possession of a current 2nd Class Stationary, Operating, or Power Engineer certificate.

Candidate can start writing exams anytime after obtaining their 2nd Class certificate.

PRACTICAL TIME REQUIREMENTS

All practical operating time served for the 1st Class shall be in a power plant that have a code rating as a B-12, B-25, and not more than 6 months (of the total time requirements) in a B-24 rated plant. *Refer to table 8 of the Operating Engineers Regulation for plant size and ratings.*

To be eligible for the 1st Class Operating Engineers Certificate of Qualification, you are to have utilized your 2nd Class certificate as an Operating/Power Engineer in a power plant for at least **30 months**

"or"

for those candidates that have successfully completed a full-time TSSA "approved-for-practical-time-reduction" Power Engineering course of study at a training facility, the required time is **21 months.** *The student must have successfully completed the program before any time reduction is granted*. Those trainers eligible to offer reduced time training will be identified accordingly in the 'Training Providers' listing on our web page.

TRAINING PROVIDERS

As a convenience for students, TSSA has compiled a list of known persons, organizations, and/or institutions currently offering training assistance. This list can be found on our "Operating Engineer" web home page under sub topic "Other" and is entitled "*Training Providers*".

… **<u>NB</u>: The fact that one has their name on the TSSA list <u>DOES NOT imply they have been approved, accredited or endorsed by TSSA in any way.</u>**

… **The process for 'approval' has just started in December of 2001, and those that are successful in obtaining TSSA <u>approval to offer "practical-time-reduction-training"</u> will be identified accordingly on the list. This list will be updated as approvals are given.**

Obviously, the number of training providers offering 2nd & 1ST Class courses is limited as the volume of students is not there, studies are more complicated, candidates are working at this level and are on shift work, and the geographic locations of the candidates.

EXAMINATIONS

There are 8 examinations, each 3.5 hours in duration. All the exams are essay style, requiring the candidate to answer any 5 of the 7 asked questions. Only the first five questions attempted will be marked. Read the introduction carefully as some papers have mandatory questions, which must be attempted. Minimum passing mark is 65%. Current Regulation states that a candidate is to wait a minimum of 60 days to re-write the examination.

When answering examination questions, the candidate is expected to give sufficient information to warrant the marks assigned. For questions involving calculation, the candidate is expected to state the formula, insert given data, work through the steps and state your answer with the correct units.

The examination candidate is expected to write legible, neat, and in pen. Sketches or drawings are to be in pencil and properly labelled. Rulers and (drawing) templates to be used as neatness is considered in the marking scheme. Candidate is to bring pen, pencil, eraser, ruler/template (for drawing) and a calculator. No other text or materials are allowed to be brought in by the candidate.

Examinations may be written at either the MTCU Exam Centres located in major cities in Ontario, **or** at TSSA in Toronto. To locate the nearest examination centre, refer to *Examination Centres Listing* on our web page.
To write at TSSA or MTCU examination centres, please register by filling an Application form. Applications are available on our website under Operating Engineers/Certification Information. Please fax to 416 –231-4078. Applications should reach TSSA fifteen (15) business days in advance prior to the examination date.

Exam centres provide all the necessary formulae booklets, Acts, Regulations, Codes, steam/refrigeration tables, etc

TEXT MATERIAL

The following list is provided for “convenience” and does not necessarily list all the text materials identified under each topic of study.

- **1st Class Power Engineering**
  Available from (PETS) at 1 866-256-8193

- **Reed’s Marine Engineering** series. Nautical Mind Bookstore, Toronto, Canada, 1 800 463-9951 for Canada and USA.
  (See individual exam papers for specific text needed).

- **“Metals & How to Weld Them”** by Jefferson & Woods… reference SOPEEC text list

- The **Technical Standards and Safety Act,** the **Operating Engineers Regulation** and the **Boilers and Pressure Vessels Regulation**; along with all pertinent **Director’s Orders**, are posted on TSSA Website and can be printed off for use in your studies.

- **CSA B51: "Boiler, Pressure Vessel and Pressure Piping Code"**
  Available at CSA International at (416) 747-4000

- **CSA B52: "Mechanical Refrigeration Code"**
  Available at CSA International at (416) 747-4000

- **2007 ASME Boiler and Pressure Vessel Code: - Academic Extract** contains materials from Sections I, II, IV and VIII of the 2007 ASME Boiler and Pressure Vessel Code and is available from PanGlobal Publishing at toll-free: 1-866-256-8193

- **"ASME Code Simplified"**... reference SOPEEC text list

- ASME Section VI: *Recommended Guidelines for the Care and Operation of Heating Boilers… see below*

- ASME Section VII*: Recommended Guidelines for Care and Operation of Power Boilers … see below*

- ASME Section IX: "*Welding and Brazing Qualifications…. see below*

ASME Code Books are available from:

ASME International
Three Park Avenue
New York, NY 10016-5990
1 800-843-2763 (U.S/Canada)

Note: These codes are very expensive; suggest you check your place of employment, your local library and/or the college/university bookstores for your resource.

Additional engineering text and reference materials are available from a broad range of authors and publishers and no specific text or reference material beyond the Act, Regulations and Codes should be considered as official.

Visit the SOPEEC website at www.sopeec.org for the "Suggested Reading List for Power Engineering Students" for further information and other possible resource texts.

In addition to the suggested reading list offered through the above SOPEEC link, the following text is also suggested as a resource for study.

Stationary Engineering, Fourth Edition
2008, by American Technical Publishers, Inc.
Author(s) Fredrick M. Steingress, Harold J. Frost and Daryl R. Walker

OBTAINING YOUR CERTIFICATE

Upon successful completion of the examinations and the completion of the required practical operating 'qualifying experience', as per the Operating Engineers Regulation 219/01, the candidate may apply to TSSA for their "Certificate of Qualification" by forwarding:

- The completed 'Application for an Ontario Certificate of Qualification as an Operating Engineer or Operator'.

- The completed Form 1, entitled 'Testimonial of Qualifying Experience'.

- **Cheque** (please view the **OE Fee schedule** from the Operating Engineers web page, under Forms & Fees, for initial certificate payment amount) made payable to "Technical Standards and Safety Authority" or to "TSSA" *and forward to*:

The Technical Standard and Safety Authority
Operating Engineers Program
3300 Bloor Street West
14th Floor, Centre Tower
Toronto, Ontario
M8X 2X4

Note: The above-required forms are available from the TSSA website, in the Operating Engineers Section, under "Forms and Fees".

Updated: January 7, 2014

TECHNICAL STANDARDS & SAFETY AUTHORITY

TRAINING, EXAMINATION AND CERTIFICATION

CERTIFICATIONS PERSUANT TO THE OPERATING ENGINEERS REGULATION
(O. REG. 219/01)

2ND CLASS POWER (OPERATING) ENGINEER

EXAMINATION & CERTIFICATION GUIDE
REVISION 5

January 2014

- This version replaces all previous

NEW IN THIS VERSION

- This version replaces the Syllabus dated September 2003 and April 2005, Ontario.
- The Revised or New 2nd Class Syllabus included in this document is the same as the one listed on the SOPEEC website, dated April 2013.

SOPEEC

Standardization of Power Engineering Examinations Committee

NOTE: PLEASE SEE THE GENERAL INFORMATION SECTION AT THE END OF THIS SYLLABUS

REVISED SECOND CLASS REFERENCE SYLLABUS

For

POWER ENGINEERS
CERTIFICATE of COMPETENCY
EXAMINATIONS

(Effective date April 01, 2005, Ontario)

- The syllabus has been approved by the Standardization of Power Engineers' Examinations Committee (SOPEEC), and the Association of Chief Inspectors (ACI).
-

Important: Candidates for any class of certification as an Operating Engineer or Operator who have passed the required examinations, or any parts thereof, MUST obtain their certificate of qualification within five (5) years of such passing or re-writing of the examination will be required.

REFERENCE SYLLABUS FOR REVISED SECOND CLASS EXAMINATION CANDIDATES

Part 'A'

First Paper (2A1)

1. A.S.M.E. Code, Sections 1 & 8, Calculations:

Design values to be computed for the following boiler and pressure vessel parts:

a. Cylindrical components; dished heads; unstayed flat heads, formed heads, shells and covers.

b. Openings and compensation: openings in shells, headers and heads; compensation required; strength of compensation, pressure vessel openings and reinforcements.

c. Stayed surfaces: dimensions and locations of staybolts, ligaments and braced surfaces.

d. Safety valves and safety relief valves: size and capacity.

e. Firetube Boilers:

   i. Combustion chambers and furnaces: plain circular furnaces; circular flues; Adamson ring reinforced and corrugated furnaces.

   ii. Stayed surfaces: maximum spacing of stays; areas of heads to be stayed; stresses in diagonal stays.

2. Industrial Administration:

a. Legislation: a thorough knowledge of the jurisdictional Act and the Regulations under the Act.

b. Installations: factors and codes governing plant designs and layouts; contract specifications; working knowledge of the engineering and administration involved in plant erection; practical modifications of existing plant.

c. Management:

   i. Functions and objectives of management.

   ii. Personnel management: selection of staff; personnel training; motivating personnel; disciplining employees.

   iii. Planning; decision making; report writing.

   iv. Plant maintenance; inspection; budgeting.

   v. Safety programs.

Part 'A'

First Paper (2A1)
(continued)

3. Applied Mechanics:

a. Velocity and acceleration: speed; linear velocity and acceleration; angular velocity and acceleration; relative and absolute velocity.

b. Mass, motion and inertia: force of gravity; weight; mass inertia; accelerating force; momentum.

c. Work, power and energy: work, graphical representation; indicated and brake horsepower; potential and kinetic energy; conservation of energy; flywheel.

d. Torque and angular motion: moment of inertia; radius of gyration; work done by torque.

e. Motion in a circular path: centripetal acceleration; centripetal and centrifugal force; balancing of rotating masses; governors.

f. Friction: coefficient of friction; frictional force; motion on horizontal and inclined planes; the screw thread; transmission of power by belt drives.

g. Moments: moments of forces; couple; centroids and second moments of area.

h. Stress and strain: modulus of elasticity; restricted expansion.

i. Shearing forces and bending moments: sign conventions; conditions of equilibrium; simply supported beams and cantilevers; concentrated and distributed loading; mathematical and graphical solutions for shearing force and bending moment diagrams.

j. Torsion: fundamental torsion equation; relationship between torque, stress and horsepower; maximum and mean torque; coupling bolts.

k. Pressure of liquids: density; specific gravity; pressure at any depth; centre of pressure; displacement.

l. Flow of liquids: pressure head; Bernoulli's law; Venturi meter; flow through orifices.

Part 'A'

Second Paper (2A2)

4. Thermodynamics:

a. Heat and measurement of heat: temperature scales; absolute temperature; units of heat and their relationship; specific heat; water equivalent; sensible and latent heat; heat mixtures.

b. Expansion of solids and heat transfer: linear, surface and volumetric expansion; conduction, convection and radiation.

c. Work and heat: mechanical equivalent of heat; laws of thermo-dynamics; Boyle's and Charles' Laws; general gas law; characteristic constant of a gas; specific heats of gases; thermal efficiency.

d. Expansion and compression of gases: Dalton's Law of partial pressures, adiabatic, isothermal and polytropic; ratios of expansion and compression; work done during expansion and compression.

e. Thermodynamics of steam: steam tables; saturated and superheated steam; dryness fraction; specific volume; specific heat of superheated steam; heat mixtures; throttling and separating calorimeters; internal energy of steam, enthalpy.

f. Entropy: entropy of water, evaporation and superheated steam; temperature-entropy diagrams and charts; computations of entropy values.

g. Practical Cycles:

   i. Practical cycles: Rankine; Otto; Diesel; Brayton, thermal efficiencies; pressure-volume and temperature-entropy diagrams.

   ii. Energy flow calculations; efficiency limits of heat engines, boiler and plant efficiencies, heat balance testing.

5. Metallurgy:

a. Non-ferrous metals: properties, composition and uses; copper; brasses; bronzes; aluminum; white metal.

b. The structure of metals: atoms; elements; crystalline structure of metals; grains and grain boundaries, metallographic examination.

c. Alloying elements in iron; iron-carbon equilibrium diagram; alloy steels; stainless steels and high-chromium alloys; cladding steels.

d. Heat treatment of metals: normalizing; annealing; spheroidizing; hardening; tempering; quenching.

e. Welding symbols

f. Metallurgical applications/specifications to power plant piping and tubing

g. Electrochemistry principles applied to corrosion, corrosion forms, control method, testing, monitoring, prevention and failure analysis (effective July 1, 2011).

Part 'A'

Second Paper (2A2)
(continued)

6. Testing of Materials:

a. Procedures and interpretations affecting tensile, hardness and impact tests; forms of specimens tested.

b. Mechanical, physical and thermal properties of ferrous metals: creep resistance, corrosion resistance and fatigue tests.

c. Weldment defects: dimensional defects; structural discontinuities; defective properties.

d. Nondestructive testing: visual inspection; magnetic particle inspection; liquid penetrant testing; proof tests; leak tests, ultrasonic, radiography, acoustic emission.

Part 'A'

Third Paper (2A3)

7. Boilers:

a. Steam generator design considerations.

b. Methods of heat transfer; circulation; steam generator ratings.

c. Specialized boiler designs and applications

d. Types and applications of firetube and watertube boilers/steam generators.

e. Boiler fittings, including safety devices, drum internals, soot blowers.

f. Boiler details: waterwalls; superheaters; desuperheaters; attemperators; economizers; air heaters; blow-down systems; flash tanks; steam separators.

g. Methods of installation and support: foundations; settings; methods of tubing; top drum erection; shop and field assembly.

h. Insulation: duct and baffle arrangements; boiler casings.

i. Operation: start up and shut down; boiling out; drying out refractory; lay-up procedure; safety precautions.

j. Maintenance; mechanical and chemical cleaning; inspection; upkeep and repairs; hydrostatic test; safety precautions.

k. ***Boiler Inspections:*** detailed procedure for complete inspection of a large boiler, including water side, fire side, and auxiliary equipment; thermal radiation techniques; inspection records and reporting procedures; liaison procedure with boiler inspector; involvement of other personnel in inspection (engineering staff, operators); inspection equipment; inspection safety.

8. Pumps:

a. Practical Applications of pumping theory for power plants;

b. Installation; maintenance; operation/control.

c. Constructional details including: impeller types; seal selection; shaft alignment; thrust balancers; tachometers.

d. Boiler feed pump re-circulation control.

9. Water Treatment:

a. Water and its impurities.

b. Methods of feedwater treatment: subsidence; coagulation; filtration; oil removal; lime-soda softening; hot process phosphate softening; sodium and hydrogen zeolite softening; silica removal; demineralization; deaeration; evaporation; electro-dialysis and electro-deionization (ED / EDI); reverse osmosis (RO); microfiltration

Part 'A'

Third Paper (2A3)
(continued)

c. Internal treatment of boiler water: control of scale, foam, embrittlement, return line corrosion; chelating agents; sludge conditioning; pH control; deaeration; carryover; blowdown; chemical feed systems; silica turbine blade deposits.

d. Analytical methods and equipment:

   i. Instruments: embrittlement detectors; steam purity; total solid meters; methods of steam sampling; measurement of pH.

   ii. Water analysis and interpretation of analytical results.

e. Cooling water treatment; slime and algae control, corrosion control.

f. Industrial waste treatment: effects caused by waste discharge; mechanical, chemical and biological methods of waste treatment.

g. Potable Water treatment and testing

Part 'B'

First Paper (2B1)

10. Heat Engines and Prime Movers:

a. Steam Turbines:

i. Applications of operating principles: impulse and reaction turbines, classifications.

ii. Construction: casings; rotors; dummy pistons; blading; diaphragms; glands; seals; flexible couplings; bearings; thrusts.

iii. Details: turning gears; drains; rotor adjustment; dynamic and static balancing; critical speed; lubricating oil systems; jacking oil pump; piping; reducing gears; expansion and anchoring.

iv. Control: governors; governor systems; control valves; grid type extraction valves; casing relief valves; overspeed trips; turbine supervisory equipment.

v. Operation: starting up and shutting down; normal operation; flow diagrams; efficiencies.

vi. Maintenance: repairs; shaft alignment; bearing; thrust, blade and packing clearances; blade fouling and erosion; cleaning after erection.

vii. Theory: nozzles; velocity diagrams; angle of entry and velocity calculations; work done on blades and blade characteristics.

viii. Condensing equipment

a. Condensers: types and constructional details; backwashing and cleaning; leak testing.

b. Condenser ancillary equipment: air ejectors; cooling water systems; intakes and intake screens; cooling towers and ponds; atmospheric exhaust valves; circulating pumps; condensate pumps.

b. Internal Combustion Engines:

i. Applications: two and four stroke, oil burning, gas and dual-fuel.

ii. Fuels: classification; properties; impurities; methods of purifying and clarifying; injection systems; ignition systems; scavenging and supercharging arrangements.

iii. Operation and maintenance: causes and prevention of incomplete combustion; starting up and shutting down: prevention of crankcase explosions; crankcase safety fittings; piston and cylinder troubles; repair and replacement of worn or broken parts.

iv. Cooling: piston and jacket cooling water systems; cooling water treatment and removal of deposits; lubricating oil systems.

Part 'B'

First Paper (2B1)
(continued)

c. Gas Turbines:

i. Applications of operating principles; types of gas turbines.

ii. Open and closed cycle systems; regeneration; intercooling and reheating.

iii. Gas turbine applications: dual shaft machines; free-piston gas generators, combined cycle.

iv. Construction: rotors; blading; compressors; combustors: combustion chambers.

v. Operation and control: starting up and shutting down; normal running procedures; control systems; safety devices.

11. Lubrication:

a. Plant lubrication programme: lubrication survey; types of lubricating systems, air compressor, gas turbine, internal combustion engine, steam turbine; lubricating oil / governing/seal oil systems;

b. Engine Lubricating oil maintenance: causes of deterioration; additives; oil purification equipment.

c. Applications of ball and roller bearings and their lubrication; bearing seals.

12. Piping:

a. Piping material identification and selection, appropriate Code procedures, inspection, leak tests.

b. Strength of piping; high temperature effects.

c. Support; expansion allowances; cold springing; drainage; insulation.

d. Theory and effects of water hammer.

e. Layouts of piping in Power and Pressure Plants.

13. Mechanical Drawing:

a. Pictorial drawing; geometrical constructions.

b. Orthographic, auxiliary, axonometric and oblique projections.

c. Sectioning and dimensioning.

d. Flow diagrams; piping drawings; charts.

e. Industrial Drawings, types and interpretation.

Part 'B'

Second Paper (2B2)

14. Power Plant Systems:

a. Feed water systems; layout and operation. regenerative feed heating cycle; closed feed systems; feed heaters; deaerators.

b. Steam Piping systems.

c. Fuel systems; layout and operation.

d. Steam Condensate system; layout and operation.

e. Cooling water systems; layout and operation.

f. Waste handling systems; layout and operation.

g. Integration of powerplant water systems.

15. Control Instrumentation:

a. Electrical and Electronic Pressure measuring devices and component placement/installation.

b. Electrical and Electronic Temperature measuring instruments and component placement / installation.

c. Flow measurements with differential pressure flow meters:
   i. Primary elements: orifice plate; flow nozzle; venturi tube; pitot tube; flow-nozzle pipes.

   ii. Indicating mechanisms: manometer; ring balance; force balance; electric.

   iii. Component placement/installation.

d. Liquid level measurement and control and component installation: ball-float; displacement-type; hydrostatic head; electric and pneumatic level transmission; electric and magnetic type level-limit devices; remote water-level indicators.

e. Final control elements: types and flow characteristics of control valves; construction details of control valves; power operators ---solenoid, pneumatic-diaphragm, power cylinder, and electric motor.

f. One, two and three element boiler feedwater control systems.

g. Superheated/reheated steam temperature control; steam pressure reducing and desuperheating control systems.

h. Modes of automatic control; two position (; proportional; proportional-plus-reset and proportional-plus-reset-plus-rate.

i. Control Systems: Distributed Control Systems, Programmable Logic Controller.

Part 'B'

Second Paper (2B2)
(continued)

16. Fuels and Combustion:

a. Combustion chemistry; chemical analysis of fuels.

b. Fuels: classification; heat values; properties; fuel handling.

c. Combustion: bomb calorimeter; analysis of flue gases; quantity of air required for combustion; draft calculations.

d. Furnace types and designs; refractories; arches; separately fired reheat furnace.

e. Firing equipment: pulverizers; oil and gas burners; storage and heating of oil; ash and slag disposal; ash fusion temperature, fuel burning systems.

f. Draft: systems and equipment.

g. Combustion Control:

i. Classification of systems; methods of operation; pneumatic, electric and hydraulic mediums; control systems and installations for gas, oil and coal firing.

ii. Flue-gas analysis; CO_2, O_2 and combustibles recorders.

iii. Combustion safeguards: purge and fan-failure interlock systems; flame-failure control systems; photoelectric tubes; rectifier rods.

iv. Packaged boiler-control systems: programming sequence; limiting devices and alarms.

17. Environmental Protection

a. Monitoring equipment and troubleshooting procedures: continuous emission monitoring systems; wastewater monitoring; data interpretation; troubleshooting.

c. Specific environmental controls and equipment: integrated environmental controls; technical knowledge and efficient operating practices and monitoring for the following:

i. flue gas desulphurization
ii. selective catalytic reduction
iii. NO_x reduction
iv. flue gas chemical conditioning
v. baghouses and precipitators

d. Significance of measured parameters:

i. Air quality particulates, stack opacity, SO_2 and NO_x concentration and mass flow, mercury, O_2, CO_2, hydrocarbons.

ii Wastewater - iron, phosphorous, biological oxygen demand, chemical oxygen demand, hydrocarbons, temperature, flow, pH, nitrogen.

Part 'B'

Third Paper (2B3)

18. Electrotechnology:

a. A.C. Theory:

i. The sine wave: generation of an alternating electromotive force; root mean square values; vector representation of sinusoidal quantities, peak, peak to peak.

ii. Resistance, inductance and capacitance in single-phase A.C. circuits; inductive reactance; capacitive reactance, impedance, resonance.

iii. Power in A.C. circuits; true and apparent power; practical importance of power factor; power factor correction.

iv. Three-phase circuits: delta and star connected alternators and loads, current and voltage relationships; three-phase power.

b. D.C. Machines:

i. Generators: principle of operation; construction; commutation; armature reaction; interpoles; compensating windings; lap and wave wound armatures; generator types and characteristics; parallel operation; voltage regulation; theory of self-excitation; efficiency and power losses; selection of generators and applications; parallel operation; ratings.

ii. Motors: principle of motor action; torque development; Fleming's left-hand rule; back electromotive force: voltage, current and speed computation; motor types and characteristics; starting arrangements; dynamic and regenerative braking; speed control; efficiency and power losses.

c. A. C. Machines:

i. Alternators: types; construction of stators, rotors and exciters; stator windings; relationship between speed, frequency and number of pole pairs; cooling systems; shaft sealing systems; voltage regulators; synchronizing; parallel operation; power factor control, voltage drops in armatures; rating, efficiency and power losses.

ii. Single-phase motors: universal, shaded pole and split-phase types; repulsion-start and reluctance-start types; capacitance starting method.

iii. Polyphase induction motors; principle of operation; rotating magnetic field; slip and rotor speed; stator and rotor construction; starting methods.

iv. Synchronous motors: general facts concerning synchronous motors; stator and rotor construction, starting methods.

v. Transformers: principle of transformer action; ratings; efficiency and losses; short and open circuit tests; types of construction; methods of cooling; connections; paralleling; instrument transformers.

vi. Protection of electrical systems: alternator stator and rotor protection devices; motor protection devices; transformer safety fittings.

vii. Circuit-protective equipment; interrupting capacity; fuses; switches; circuit-breakers; relays.

Part 'B'

Third Paper (2B3)
(continued)

19. Principles of Air and Gas Compression:

a. Applications of air and gas compression: effects of altitude, temperature, and humidity.

b. Reciprocating, axial, centrifugal and rotary compressors: operation, applications; construction; regulation and control; drive selection criteria and preventive maintenance.

c. Ancillary equipment: valves; coolers; receivers; oil and water separators; filters; unloaders; safety/relief valves; instruments; piping layouts, dryers.

20. Industrial/Commercial Refrigeration:

a. Applications of refrigeration: compression and absorption systems; thermoelectric refrigeration; hermetic cycles; cascade systems; heat pump systems.

b. Refrigerating plants: types; layouts; installation details.

c. Plant equipment: compressors; condensers; evaporators; liquid receivers; oil separators; absorbers; generators; heat exchangers; rectifiers; driers; scale traps; piping and fittings; cold room construction.

d. Operation of refrigerating plants: starting up and shutting down; charging; hand and automatic purging; automatic expansion valves; compressor lubrication; brine solutions; leak testing; trouble shooting.

e. Safety and control: Code requirements; safety fittings; compressor and system instrumentation and controls; cooling water system controls.

f. Computations of capacities and performances of refrigerating plants; ideal and practical refrigerant cycles; theoretical piston displacement; heat pump effect; theoretical power; pressure-enthalpy charts

GENERAL INFORMATION

The designation of persons operating power plants in Ontario was Stationary Engineer until the summer of 2001 at which time it changed to Operating Engineer by the proclamation of the Technical Standards & Safety Act and its related Operating Engineers Regulation on June 27th, 2001.

In reference to power plant engineering, the previous Ontario designation 'Stationary', the current designation 'Operating' and the standard Canadian designation 'Power' all have the same meaning and cover the same jurisdiction of work, in ALL Provinces and Territories, in Canada.

SOPEEC, stands for Standardization of Power Engineering Examinations Committee.

In the effort to provide mobility for power plant operators across all of Canada, Ontario adopted the SOPEEC examination system in the latter part of 1990's. Currently all jurisdictions except Quebec utilize the standardized SOPEEC examinations system, this makes it now possible to complete writing the required examinations in another province or territory in Canada, in the event a candidate moves.

To receive the 'standardized' designation on your Certificate of Qualification, one must have written ALL of the required examinations in the SOPEEC format. No previously written provincial examinations will be recognized. This 'Standardized' designation allows you to be issued the same level of certification in all other Canadian jurisdictions (except Quebec at this time). No further examination writing is required.

Recommended Study Program

It is recommended that before undertaking examinations, the candidate complete a Second Class Power Engineering Course offered through a recognized Technical Institute or Training Provider.

In addition to the foregoing course or courses, it is recommended that the candidate becomes familiar with the publications listed in the Reference Material for Power Engineering Students and Examination Candidates, listed later in this document.

Eligibility to Write

A candidate must have their valid 3rd Class Operating, or Power Engineering Certificate.
Candidates in Ontario, can then, and only then, commence to write their 2nd class Power Engineering examinations.

Practical Time Requirements

Practical operating time requirement is to take place in a plant that requires a 2nd Class Operating Engineer or higher. Refer to Table 8 of the Operating Engineers Regulation 219/01, for appropriate plant codes, sizes and/or ratings.

To be eligible for the 2nd Class Operating Engineers Certificate of Qualification, you are to have utilized your 3rd Class certificate as an operator of power plant equipment for at least
18 months,

'or'

those candidates that have successfully completed a full-time 'TSSA approved-for-practical-time-reduction' Power Engineering course of study at a training facility, the required time is
13 months. The student must have successfully completed the program before any time reduction is granted.

Training Providers

As a convenience for students, TSSA has compiled a list of organizations, and/or institutions currently offering 'TSSA Approved for Time Reduction', training assistance, only. The list can be found in the 'Operating Engineer section', of our TSSA Corporate website located at; http://www.tssa.org.

Note: The process for 'TSSA approval' began in December of 2001.
Trainers that are successful in obtaining TSSA approval, to offer "practical-time-reduction-training", will be identified accordingly by being listed on TSSA's Training Providers list, as approvals are granted.

Examinations

There are 6 examinations, each 3.5 hours in duration. All the exams are essay style, requiring the candidate to answer any 5, of the 7 asked questions. Only the first five questions attempted will be marked. Read the introduction carefully as some papers have mandatory questions, which must be attempted. The minimum passing mark is 65%. Current Regulation states that a candidate must wait a minimum of 60 days prior to rewriting an examination.

When answering examination questions, the candidate is expected to give sufficient information to warrant the marks assigned. For questions involving calculations, the candidate is expected to state the formula, insert given data, work through the steps and state your answer with the correct units in an appropriate closing statement.

The examination candidate is expected to write legible, neat, and in pen. Sketches or drawings are to be in pencil and properly labeled. Rulers and (drawing) templates are to be used as neatness is considered in the marking scheme.
Candidates are to bring a pen, pencil, eraser, ruler/template (for drawing) and a non-programmable calculator. No other text or materials are allowed to be brought into the examination room, by the candidate.

Examinations may be written at the MTCU Examination Centres located in major cities in Ontario, or at TSSA in Toronto. To locate the nearest examination centre refer to 'Examination Centres Listing', on our website at; http://www.tssa.org, in the 'Operating Engineers' section.
The examination candidate must submit an application and the prescribed fee at least fifteen (15) business days before the date of examination. Please refer to examination procedures for "Examination Registration Form, 2005".
Mail the application directly to "Examination Services", Technical Standards & Safety Authority, or Fax. Direct to TSSA at: (416) 231-4078.

Examination Centres will provide all the required reference materials, i.e. formulae booklets, Acts, Regulations, Codes, Steam/Refrigeration Tables, as an Operating Engineering Examination Reference Materials Manual.

Note: The items referenced above are the responsibility of the candidate to bring to the examination and must be shown to the Examiner or Invigilator for approval, upon request. Any individual not complying with the Invigilator's requests, will not be eligible to write or will not have their paper marked, and forfeit the examination fee for the examination sitting.
Mathematical Tables and Steam Tables will be provided and no other reference materials will be allowed.
The candidate must show picture I.D. at the examination.

Suggested Reference (Text) Materials

PanGlobal Publishing, formerly PEJV/SAIT, is the SOPEEC sanctioned provider of Power Engineering reference materials.

The following list provides telephone numbers that will assist the student in locating and/or obtaining the needed reference materials for study.

- **"2nd Class Power Engineering"** available from PanGlobal Publishing calling them directly at **Toll Free**; 1-866-256-8193

- **Reed's Marine Engineering** series. Nautical Mind Bookstore, Toronto, Canada, 1 800 463-9951.
  (See individual exam papers for specific text needed).

- **"Metals & How to Weld Them"** by Jefferson & Woods …. Reference SOPEEC text list.

- **The Technical Standards and Safety Act, the Operating Engineers Regulation and the Boilers and Pressure Vessels Regulation; these are posted on the TSSA Website and can be printed for use in your studies, free of charge.**

- **CSA B51:** "Boilers, Pressure Vessel and Piping Code" CSA International at; (416) 747-4000

- **CSA B52:** "Mechanical Refrigeration Code" ….. CSA International at; (416) 747-4000

- **2007 ASME Boiler and Pressure Vessel Code - Academic Extract** contains materials from Sections I, II, IV and VIII of the 2007 ASME Boiler and Pressure Vessel Code and is available from PanGlobal Publishing at toll-free: 1-866-256-8193

- **ASME Section I:** Rules for the Construction of Power Boilers Extract…. see below

- **"ASME Code Simplified"..** Reference SOPEEC text list

- **ASME Section VI** - Recommended Guidelines for the Care and Operation of Heating Boilers…. see below
- **ASME Section VII:** Recommended Guidelines for Care and Operation of Power Boilers … see below

- **ASME Section IX:** "Welding and Brazing Qualifications…. see below

For ASME Code Books (other than the Section 1 Extract) can be obtained from The American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990.

Note: these codes are very expensive. We suggest you check your place of employment, the local Library and/or the College/University bookstores for your resource.

Additional engineering text and reference materials are available from a broad range of authors and publishers and no specific text or reference material beyond the Act, Regulations and Codes should be considered as official.

Visit the SOPEEC website at www.sopeec.org for the "Recommended Reading List for Power Engineering Students" and for further information, other possible resource texts and sample 'only' questions.

In addition to the suggested reading list offered through the above SOPEEC link, the following text is also suggested as a resource for study.

Stationary Engineering, Fourth Edition
2008, by American Technical Publishers, Inc.
Author(s) Fredrick M. Steingress, Harold J. Frost and Daryl R. Walker

Obtaining Your Certificate

Upon successful completion of the examinations and the completion of the required practical operating 'qualifying experience', as per the Operating Engineers Regulation 219/01, the candidate may apply to TSSA for their "Certificate of Qualification" by forwarding:

- The completed 'Application for an Ontario Certificate of Qualification as an Operating Engineer or Operator'.

- The completed Form 1, entitled 'Testimonial of Qualifying Experience'.

- **Cheque** (please view the **OE Fee schedule** from the Operating Engineers web page, under Forms & Fees, for initial certificate payment amount) made payable to "Technical Standards and Safety Authority" or to "TSSA" *and forward to*:

The Technical Standard and Safety Authority
Operating Engineers Program
3300 Bloor Street West
14th Floor, Centre Tower
Toronto, Ontario M8X 2X4

Note: The above-required forms are available from the TSSA website, in the Operating Engineers Section, under "Forms and Fees".

Updated: January 7, 2014

TECHNICAL STANDARDS & SAFETY AUTHORITY

TRAINING, EXAMINATION AND CERTIFICATION

3RD CLASS POWER (OPERATING) ENGINEER

EXAMINATION & CERTIFICATION GUIDE

REVISION 6

CERTIFICATIONS PERSUANT TO THE OPERATING ENGINEERS REGULATION
(O. REG. 219/01)

JANUARY 2014

- This version replaces all previous

NEW IN THIS VERSION

- The 3rd Class updated version replaces the (New) Syllabus dated September 2003 and March 2007, Ontario.
- The 'General Information section' has been amended to accommodate Ontario's jurisdictional examination process requirements.
- The actual 3rd Class SOPEEC syllabus content is identical to the SOPEEC version and the previous September 2003, Ontario version, presently in use.
- The **'General Information Section'** about SOPEEC, Examinations, Certification, Applications, Text Materials, etc., is located at the end of the document to permit easy syllabus access.
-

Important: Candidates for any class of certification as an Operating Engineer or Operator who have passed the required examinations, or any parts thereof, MUST obtain their certificate of qualification within five (5) years of such passing or re-writing of the examination will be required.

Syllabus: The following SOPEEC syllabus has been adopted by TSSA and provides the subject matter upon which the candidates will be examined.

Paper 3A-1

The candidate is to have a thorough knowledge of Section 1 of the Third Class Power Engineering course materials to successfully challenge the exam. There are ten lectures in this section covering Mechanics, Thermodynamics, Chemistry, Engineering Materials and Mechanical Drawing.

The examination consists of 150 multiple choice questions, each having 5 choices. Although many of the topics for this examination involve calculation, the numbers of questions requiring calculations, and those that do not, are balanced.

- Note: Since this course originated in another province, some Codes and Regulations may not be applicable in Ontario. Candidates are to reference the Technical Standards & Safety Act, related Regulations and Directors Orders, for this component.

- **Sample Questions** for the above materials can be accessed under 'Study Guide' on the SOPEEC website at www.sopeec.org

Topics of Study (Syllabus) for Paper 3A-1:

The following SOPEEC syllabus has been adopted by TSSA and provides the subject matter upon which the candidates will be examined.

1. APPLIED MATHEMATICS:

Use these mathematics disciplines to complete engineering calculations:

Elementary algebra (simple equations); trigonometry; mensuration (areas, volumes of plane and solid figures); natural and naperian logarithms (using calculators)

2. APPLIED MECHANICS:

Explain theories, define terminologies, and perform problem-solving calculations involving the following topics:

a. Application of forces; vector diagrams.
b. Forces on level and inclined surfaces.
c. Linear and angular velocity and acceleration.
d. Work, power and energy.
e. Moments of force and simple machines; mechanical advantage; velocity ratio; efficiency.
f. Stress and strain; safe working stress; yield point and ultimate strength; factor of safety.
g. Bending of beams; equilibrium, shearing forces and bending moments.
h. Density and specific gravity.

3. THERMODYNAMICS:

Explain theories, define terminologies and perform problem-solving calculations involving the following topics:

a. Temperature measurement units/scales.
b. Expansion of solids (linear, area and volume) and liquids.
c. Quantity of heat; specific heat.
d. Changes of state: sensible and latent heat, heat content in mixtures of water, ice and steam; saturated and superheated steam.
e. Steam tables; temperature-enthalpy charts; critical temperature and pressure; dryness fraction; equivalent evaporation, factor of evaporation.
f. Methods of heat transfer; conduction, convection, radiation.
g. Work and heat; mechanical equivalent of heat; laws of thermodynamics.
h. Expansion and compression of gases: Boyle's and Charle's laws of perfect gases, general gas law, characteristic gas constant; isothermal, adiabatic and polytropic processes; pressure-volume diagrams; work done in cylinders; indicated horsepower; thermal efficiency.

4. APPLIED SCIENCE:

a. Basic Chemistry:

I. Molecules, atoms, elements, compounds, mixtures.
II. Structure of the atom, atomic number, atomic weight, formula weights, the mole; molar mass calculations; periodic table of the elements.
III. Chemical formulae; balancing chemical equations.
IV. Properties of acids, bases, salts.
V. Simple organic chemistry; structure of hydrocarbons.
VI. Typical industrial applications of chemistry: water treatment, combustion; corrosion.

b. Metallurgy and Engineering Materials:

I. ANSI and ASME classifications of metals; methods of steel and iron production.
II. Properties, grades and applications of cast iron

III. Properties, grades and applications of steel; alloying metals and applications.
IV. Properties and applications of non-ferrous metals
V. Properties and applications of non-metallic materials; plastics, carbon fibres, ceramics, polymers.
VI. Corrosion principles; types of corrosion, corrosion monitoring and prevention methods and devices, corrosion inspection.

c. Industrial Drawings:
Identify components and interpret symbols for the following engineering drawings:
I. Process flow drawings.
II. Piping and instrument drawings.
III. Engineered construction drawings for pressure vessels and other equipment.
IV. Equipment layout.
V. Material balance.

Exam 3A-2

The candidate is to have a thorough knowledge of Section 2 of the Third Class Power Engineering course materials to successfully challenge the examination.

… There are 15 lectures in this section covering Codes, Safety, Environment, Fuels, Combustion, Piping Instrumentation, Electricity and the different types of power plants.

… The examination consists of 150 multiple-choice questions, with 5 choices given.

Sample Questions
For the above materials can be accessed under 'Study Guide' on the SOPEEC website at www.sopeec.org, see direct link on home page

Exam 3A-2 Syllabus: The following SOPEEC syllabus has been adopted by TSSA and provides the subject matter upon which the candidates will be examined:

5. INDUSTRIAL LEGISLATION:

a. General knowledge of the purpose, content and application of the boiler and pressure vessel codes and regulation, including the Power Engineers' Regulations in the student's jurisdiction.
b. State the purpose and describe the general content of each of the following codes:

I.
ASME Section I	-Power Boilers
ASME Section IV	-Heating Boilers
ASME Section V	-Nondestructive Examination
ASME Section VI	-Suggested Rules for Care of Heating Boilers
ASME Section VII	-Suggested Rules for Care of Power Boilers
ASME Section IX	-Welding & Brazing Qualifications

II.
CSA Standard B.51	-For Construction and Inspection of Boilers and Pressure Vessels
CSA Standard B.52	-Mechanical Refrigeration Code

III. National Board Inspection Code

6. CODE CALCULATIONS, A.S.M.E. Code Section I :

Use Code formulae and information to calculate the following (using SI units):

a. Designed thickness and allowable pressures of boiler tubes, drums, dished and hemispherical heads.
b. Sizes and capacities of boiler safety valves.

7. FUELS AND COMBUSTION:

a. Requirements for efficient combustion of boiler fuels; complete and incomplete combustion.
b. Classification, properties and combustion characteristics of coal, fuel oil and natural gas; other (non-fossil) fuels.
c. Fuel analysis; proximate, ultimate, fuel heat value; calorimetry.
d. Combustion chemistry; combustion equations for coal, oil, and gas; molar masses for combustion products.
e. Combustion calculations; oxygen, air and excess air required, given fuel analysis.
f. Flue gas analysis methods and devices; CO; CO_2 and O_2
g. Control of emission standards: NOx, SO_2, particulates.

8. PIPING:

a. Codes and standards for pressure piping: ASME, ANSI, CSA, ASTM; identification and sizes of piping; B31.1, B31.3; power piping vs. pressure piping.
b. Ferrous piping materials and methods of manufacture; specifications and service ratings; non-ferrous materials.
c. Non-metallic piping: materials and applications.
d. Strength of piping; effects of temperature on piping.
e. Piping connection methods: threaded, flanged, welded; design, materials, selection and installation of gaskets.
f. Designs and applications of expansion devices, supports and anchors.
g. Types of steam traps; trap sizing and selection; trap installation configurations, trap inspection installation configurations; trap inspection and maintenance; trap flow calculation.
h. Water hammer: effects; causes; design and operational preventions.
i. Insulation: purposes; benefits; characteristics; common materials and their uses; methods of application; cladding; care of insulated piping systems; calculations using configurations; valve trim; actuator types.

9. ELECTROTECHNOLOGY:

a. Direct Current Theory:
   I. Electron theory; theory of magnetism; magnetic field; force on conductor.
   II. Electromagnetic Induction: induced EMF; Faraday's and Lenz's Laws of Induction; Fleming's right-hand rule; self-induction in a coil; mutual induction.

b. Direct Current Machines:
   I. Generators: operating principles, construction, commutation, speed and voltage control; types (shunt, series and compound).
   II. Motors: principle of operation, torque development and measurement, armature reaction, interpoles, speed control, methods of starting, types (shunt, series and compound), protection devices.

c. Alternating Current Theory:
   I. Generation of an alternating EMF; sinusoidal waveforms; phase relationships.
   II. Resistance in AC circuits; inductive and capacitive reactance; impedance; power and power factor; single and multi-phase circuits.

d. Alternating Current Machines:
   I. Alternators: principle of operation, construction, voltage regulation, excitation methods, parallel operation, synchronizing procedures; automatic synchronizers, taking off the line, switchboard components (meters, breakers, machine protection relays).
   II. Motors: principle of operation of induction and synchronous motors; construction; speed and slip; starting methods for induction motors; speed control; variable speed starting, step-starting.
   III. Transformers: operating theory; types (design and construction), losses and efficiency; methods of cooling; safety and fire protection.

e. AC Systems, Switchgear, Safety:
   I. Components, layout, and operation of a typical industrial AC power system.
   II. Components of an AC generator panel.
   III. Circuit protective and switching equipment: fuses, safety switches; circuit breakers; circuit protection relays; automatic bus switchover (emergency supply to normal supply); grounding; lightning arresters.
   IV. UPS/Inverter Systems: purpose, components, operation; battery design and maintenance.
   V. Electrical safety for operators.

10. ELECTRICAL CALCUALTIONS:

Explain theories and perform calculations for:

a. Current, voltage, resistance in series and parallel circuits; using Ohm's Law and Kirchhoff's Laws; Wheatstone Bridge.

b. Temperature coefficient of resistance.
c. Work, energy, power: relationship between electrical, mechanical and heat units.
d. Sinusoidal Wave Forms: maximum, average and root mean square root values; frequency; phase.
e. AC Circuits: inductive reactance, capacitive reactance, impedance, KVA; power factor.
f. Relationship between poles, frequency, speed for AC machines.
g. Transformer calculations; step up and step down.

11. CONTROL INSTRUMENTATION:

a. Control loops and strategies:
   I. Applications of pneumatic, electric and electronic (digital) control systems; components and operation of typical control loops.
   II. On-off, proportional, reset, derivative control strategies.
   III. Feed forward, feedback, cascade, ratio, split-range, select control.
   IV. Alarm and shutdown functions in a control loop; operator interfaces with control loops

b. Instrument and Control Devices: design and principles of common temperature, pressure, flow, and level instruments.

c. Distributed and Logic Control Systems:
   I. Components, layout, functions of distributed control system.
   II. DCS operator interface components; trending; data logging; alarms and shut-downs.
   III. Programmable logic controllers: purpose, design, components; applications; ladder diagrams.
   IV. Supervisory control and data acquisition systems (SCADA) as used in process control: purpose and general functions.

12. INDUSTRIAL SAFETY AND FIRE PROTECTION:

a. Safety Management Programs
   I. Introduction to OH&S Acts in general
   II. Workplace OH&S Programs: setting up a program; purpose and interaction with WCB; company and employee responsibilities; typical components of an OH&S program: safety committees, hazard identification, incident investigation, personal safety equipment; work permit systems (equipment lock-out, confined space entry, hot and cold work, excavations); WHMIS (overview); emergency response plans.

b. Fire Protection Systems
   I. Classes of fire; extinguishing methods.
   II. Components and operation of industrial fire detection and alarm system.
   III. Sprinkler systems (dry and wet stand); pre-action and deluge; design and operation.
   IV. Fixed fire systems: firewater pump, loops, hydrants; vessel deluge system; foam systems.
   V. Industrial fire response

Exam 3B-1

The candidate is to have a thorough knowledge of Section 3 of the Third Class Power Engineering course materials to successfully challenge the exam. There are 15 lectures in this section, eleven with power boilers.

- This essay style examination requires one to explain, sketch, describe, state, or any combination of the above.
- 8 out of the 10 given questions are to be answered with each question worth 15 marks. Most questions will have several parts to them.
- Write in pen, sketch/draw in pencil.

Proper labeling of the components is expected, rulers/templates required for sketches and drawings. Detail and neatness on drawings count in the marking scheme

Sample Questions

For the above materials can be accessed under 'Study Guide' on the SOPEEC website at www.sopeec.org, see direct link on home page

Exam 3B-1 Syllabus: *The following SOPEEC syllabus has been adopted by TSSA and provides the subject matter upon which the candidates will be examined on:*

13. BOILERS:

a. Boiler Classification
   I. Definitions and designs of typical Watertube Boilers:
   Multi-drum bent tube; D, A, O configurations; packaged, once-through, forced circulation, critical vs. super-critical boilers.
   II. Special Boiler Designs; describe the design, components and operation of the following designs:
   Fluidized bed boilers, heat recovery steam generators (HRSG), black liquor boilers, waste heat boilers, refuse boilers, Bio-mass, high-pressure/high-temperature hot water boilers.

b. Boiler Construction
   I. Designs, fabrication, construction methods, and Code requirements for: shells, drums, tubes (include attachment methods), nozzles; headers; handholes/manholes.
   II. Field assembly of a large watertube boiler.
   III. Boiler metals – applications and purpose.

c. Boiler Heat Transfer Components
   I. Watertube boiler settings (brickwork and refractory) baffles; integral furnace designs and waterwalls; studded tubes; water-cooled walls; fin-tube, tangent-tube; flat-stud tube.
   II. Superheaters: primary, secondary, convection, radiant, integral, and separately-fired; operating characteristics.
   III. Reheater designs
   IV. Economizers: integral and separate; tube styles, advantages/disadvantages.
   V. Air Heaters: plate, tubular, rotary regenerative designs; heater corrosion control; advantages/disadvantages.
   VI. Sootblowers: stationary and retractable, locations, shot cleaning.

d. High Pressure Boiler Fittings
   Design, installation/location, operation, testing and Code requirements for each of the following boiler fittings:

   I. Water columns and gauge glasses; types of remote level indicators; illumination; safety shut-off.
   II. Safety valves; setting.
   III. Low-water fuel cut-offs; float and probe designs.
   IV. Steam outlet fittings and non-return designs.
   V. Pressure gauges; feedwater connections; vents; and blowdown valve designs; blowdown procedures; blowdown tank.
   VI. Drum Internals: baffles, scrubbers, separators, driers, piping circulation and separation of steam and water

e. Fuel, Draft, and Flue Gas Systems
   I. Coal firing equipment: mechanical, underfeed, crossfeed and overfeed stokers; pulverizers - impact, ball, ball-race and bowl mills; burner and furnace designs – turbulent vertical, tangential, cyclone; coal feed systems; ash handling systems – hydro and air, bottom ash.
   II. Oil burning equipment: oil burner designs – steam, oil and mechanical atomizing; components of large oil burner systems; start-up/shut-down of large oil burners; cleaning and maintenance.
   III. Gas burning equipment: burner designs – spud, multi-spud and ring; burner gas supply system; start-up sequence for gas burner; high-efficiency, low NOx burners.
   IV. Draft equipment: natural, forced, induced, balanced draft; draft fan designs, control methods; fan performance curves; draft measurement; windbox and air louvers; primary and secondary air.
   V. Flue gas clean-up methods and equipment: precipitators, filters, ash handling systems; SO_2 recovery systems.

f. Boiler Operation and Maintenance
   I. Manual start-up and shut-down procedure for large, industrial boilers.
   II. Initial start-up (commissioning) of a new boiler.
   III. Routine and emergency operations.
   IV. Causes and prevention of boiler furnace and pressure explosions.
   V. Chemical and mechanical boiler cleaning methods; boiling out.
   VI. Methods of cleaning and preparing a boiler for inspection.
   VII. Inspection: fire and water sides; safety.
   VIII. Hydrostatic test.

14. BOILER CONTROL SYSTEMS:

a. Boiler Water Level Control: components, purpose and operation of single-element, two-element, and three-element control systems; explain swell and shrinkage.

b. Combustion control:
   I. Design and operation of each of the following combustion control systems: direct pressure control of fuel and air, steam flow – air flow control, fuel flow – air flow control, air flow- fuel flow, multi-element control.
   II. Safety devices and interlocks.
   III. Flame failure detection: continuous, intermittent, interrupted pilots; photo-electric cells.
   IV. Automatic, programmed boiler start-up and shut-down sequence.

c. Steam temperature control: desuperheating control, attemperation, gas recirculation, gas bypass, tilting burners.

15. FEEDWATER TREATMENT:

a. Feedwater impurities and their effects on boiler operation.
b. External, feedwater treatment: explain the purpose, physical and/or chemical operating principles, system/equipment design and operation for each of the following: settling, coagulation and filtering, hot and cold lime-soda softening, hot phosphate softening, sodium and hydrogen zeolite softening, demineralization, dealkalization, mechanical deaeration, evaporation (multi-effect evaporators), reverse osmosis.

c. Internal Boiler Water Treatment:
   I. Causes, effects and controls for boiler internal water problems.
   II. PH control – magnetite layers, acidic and caustic corrosion.
   III. Sludge conditioning and dispersion; modern sludge dispersants.
   IV. Chemical deaeration – oxygen corrosion; sulphite programs; hydrazine.
   V. Carryover – priming, misting, foaming.
   VI. Dissolved solids – blowdown control; conductance; simple and heat recovery blowdown systems; automatic blowdown systems.
   VII. Return line corrosion – neutralizing and filming amines.
   VIII. Scale control – phosphate and chelate programs.

d. Chemical feed systems: shot and continuous feed systems; chemical feed pumps.
e. Feedwater and boiler water testing methods: automatic sampling systems and monitors; boiler and steam system parameters and test locations.

16. PUMPS:

a. Theory of pumping: define and explain pump head terms, perform pump head and pressure calculations, explain cavitation.
b. Reciprocating pumps: pump drivers; single and double-acting designs; plunger type; diaphragm type; pump protection.
c. Centrifugal pumps:
   I. Classification and principles of operation for volute, diffuser and turbine pumps; axial and mixed flow.
   II. Construction and components: single and multi-stage; impeller types; wear rings; shaft sealing arrangements – stuffing box, lantern ring, mechanical seals; balance disc; drum; opposed impellers.
   III. Operation: starting and stopping, priming
   IV. Typical pump installation; auto-recycle valve

d. Rotary pumps: design and operation of gear, lobe, screw.

17. WELDING PROCEDURES AND INSPECTION:

a. Welding Processes (overview): describe and state where each of these processes would be used – metal arc, shielded arc, submerged arc, gas (TIG), MIG.
b. Electrodes: classification, types and uses; where and why each would be used.
c. Fabrication and repairs: weld preparation; preheating, performing a boiler tube repair, postweld heat treatment (stress relieving).
d. Causes and effects of common weld defects.
e. Weld inspection procedures: non-destructive examination techniques; destructive examination techniques.
f. Welding Procedure and Welder's Performance Qualifications per ASME Code, Sect. 9.

18. PRESSURE VESSELS:

a. Explain design, construction, operation and repair regulation of pressure vessels, including stamping and nameplate details.
b. Head, nozzle, manway designs.
c. Loads and stresses on pressure vessels.
d. Typical components/fittings on a pressure vessel.
e. Safe operating and maintenance consideration, including hydro and pneumatic testing; inspection.

Exam 3B-2

The candidate is to have a thorough knowledge of Section 4 of the Third Class Power Engineering course materials to successfully challenge the exam. There are 9 lectures in this section covering Steam and Gas Turbines, Diesel Engines, Air Compression, Refrigeration, Bearings and Lubrication.

- As previously stated, the examinations consist of 150 multiple-choice questions each having 5 choices.

Sample Questions

For the above materials can be accessed under 'Study Guide' on the SOPEEC website at www.sopeec.org, see direct link on home page

Exam 3B-2 Syllabus: *The following SOPEEC syllabus has been adopted by TSSA and provides the subject matter upon which the candidates will be examined on:*

19. PRIME MOVERS:

a. Steam Turbines:
   I. Impulse and reaction principles; nozzles; blade shapes.
   II. Turbine arrangements, staging and compounding: principles and p-v diagrams for pressure, velocity, and pressure-velocity compounding.
   III. Turbine components: purpose, design, operation of the following: casings, disc and drum rotors, dummy pistons, journal and thrust bearings, barring gear, blade and shaft sealing glands, couplings, interceptor valves on reheat turbines.
   IV. Explain purpose and arrangements of condensing, bleeder, topping, extraction, cross and tandem compounded turbines.
   V. Turbine governor types; speed-sensitive, pressure-sensitive, nozzle, throttle, bypass, mechanical, mechanical hydraulic, electronic-hydraulic; droop and isochronous operation.
   VI. Starting up and shutting down condensing and extraction turbines.
   VII. Steam turbine condensers: types, air-cooled, water-cooled, Panier style; condenser auxiliaries; condenser operation; feedwater heater system.

b. Gas Turbines:
   I. Applications, advantages and disadvantages of gas turbines.

II. Basic cycle and improvements: open and closed cycles defined, regeneration, dual shaft arrangement, intercooling and reheating, typical gas turbine operating parameters and efficiency, combined steam and gas turbine cycles.
III. Main gas turbine components: radial and axial compressors, combustor arrangements and operation, turbine rotor designs.
IV. Gas turbine support systems: fuel supply systems; lubrication; barring gear; steam injection; intake and exhaust components.
V. Supervisory, protective, and control systems.
VI. Starting and stopping procedures and sequences; turbine washing.

c. Internal Combustion Engines:
   I. Gasoline engines: spark ignition defined, two-stroke cycle, four-stroke cycle, carburetion; carburetor design and operation, spark ignition components, fuel injection.
   II. Diesel engines: compression ignition defined, two-stroke cycle, four-stroke cycle, scavenging, fuel injection; fuel injectors; purpose and design of the major mechanical/structural components of a diesel engine; starting and maintenance procedures.
   III. Engine support systems: fuel systems, lubrication, governing, starting systems and methods, magneto system, cooling systems, supercharging and turbo-charging.
   IV. Thermodynamic heat engine cycles: explain the Otto, Diesel, and Brayton cycles.

20. COGENERATION:

Purpose, advantages, components or cogeneration systems; simple and combined cycle, using gas turbines and internal combustion engines; single and dual shaft arrangements; control strategies and components; environmental considerations; heat recovery boilers and water heaters; operating procedures; typical industrial cogeneration applications.

21. COMPRESSORS:

a. Theory of Compression:
   I. Adiabatic and isothermal compression; pressure volume relationships; compression ratio, capacity, multi-staging; effect of altitude and moisture.
   II. Applications for compression, including air and gas.

b. Positive Displacement Compressors:
   I. Reciprocating compressors: clearance volume; indicator diagrams; calculations for displacement and volumetric efficiency.
   II. Free piston compressor.
   III. Rotary compressors: sliding vane, lobe, and screw types (industrial screw type in detail, including control panel).

c. Dynamic Compressors:
   I. Design and operation of centrifugal and axial flow compressors; application as blowers.
   II. Compressor surge: causes and prevention; P-V curve; surge line, anti-surge system and control.

d. Starting and stopping procedures for positive displacement and dynamic compressors
e. Compressor Auxiliaries:
   I. Intercoolers/aftercoolers; moisture separators.
   II. Compressor control systems and devices: start and stop, variable and constant speed; safety devices.
   III. Lubrication: internal and external.
   IV. Compressor installation and piping layouts

f. Compressed Air System Components:
   I. Typical system layout; air receivers (wet and dry) fittings and operation; filters.
   II. Air dryers: system design, flows, operation; dewpoint monitoring.

22. REFRIGERATION:

a. Refrigerant classifications, properties, characteristics.
b. Compression Systems:
   I. Principle of compression refrigeration; typical system temperatures and pressures for simple refrigeration systems.
   II. Multi-stage systems: 2-stage with duplex compressors; 2-stage with booster compressor; low temperature multi-stage.
   III. Direct vs. indirect systems.
   IV. Typical refrigeration applications.

c. Absorption System: ammonia absorption system description and operating parameters.
d. Refrigeration System Auxiliaries:
   I. System controls: expansion valves, low-side float, high-side float, capillary tube.
   II. Compressor controls: temperature and pressure-actuated.
   III. Condenser cooling water control.
   IV. Safety devices and controls: pressure relief devices, high-pressure cut-out, low-pressure lube oil cut-out

e. CSA B52 Regulations: overview of the code for the safe operation, installation and repair of refrigeration equipment.
f. System Operation: Leak testing, charging, purging, troubleshooting (condenser, regulator, refrigerant strength, compressor discharge temperature); effects of moisture in system; effects of oil in the refrigerant; oil removal using oil separators, oil traps, oil still; operating and maintaining brine systems.

23. SPECIAL INDUSTRIAL EQUIPMENT:

Describe the general applications, designs, components, operation for the following:

a. Heat Exchangers: double pipe designs; shell-and-tube configurations, head designs, reboiler and feedwater heater fittings; plate frame; overhead aerial coolers; aerial steam condensers, including operation and control.
b. Cooling Towers: natural draft; atmospheric; hyperbolic; mechanical draft designs; operation and control.
c. Fired Heaters: multi-burner vertical designs; burner components and styles; fuel supply and control; interlocks and safety devices; indirect-fired heaters; horizontal designs; start-up and shutdown procedures.

24. WASTEWATER TREATMENT:

a. Purpose of WWT; typical wastewater pollutants and systems.
b. Theory and equipment for specific treatment process: removal of suspended solids (screening, floatation, sedimentation); removal of colloidal solids (chemical coagulation, flocculation, clarification); biological treatment (activated sludge, rotating biological contactors, trickling filters).
c. Operating parameters, controls and tests: nutrients, BOD, COD, pH, settleability.
d. Safety in wastewater treatment plants.

25. PLANT MAINTENANCE AND ADMINISTRATION:

Explain the purpose, typical design and administration of the following plant functions:

a. Communication and accountability structures.
b. Scheduled and preventative maintenance programs.
c. Record keeping; logbooks; logsheets.
d. Project control; critical path (applied to a complete boiler turnaround, as an example).
e. Operating standards and procedures.
f. Training and development practices; job skill profiles.
g. Environmental practices and supervision.

GENERAL INFORMATION

The designation of persons operating power plants in Ontario was Stationary Engineer until the summer of 2001 at which time it changed to Operating Engineer by the proclamation of the Technical Standards & Safety Act and its related Operating Engineers Regulation on June 27th, 2001.

In reference to power plant engineering, the previous Ontario designation 'Stationary', the current designation 'Operating' and the standard Canadian designation 'Power' all have the same meaning and cover the same jurisdiction of work, in ALL Provinces and Territories, in Canada.

SOPEEC, stands for Standardization of Power Engineering Examinations Committee.

In the effort to provide mobility for power plant operators across all of Canada, Ontario adopted the SOPEEC examination system in the latter part of 1990's. Currently all jurisdictions except Quebec utilize the standardized SOPEEC examinations system, this makes it now possible to complete writing the required examinations in another province or territory in Canada, in the event a candidate moves.
To receive the 'standardized' designation on your Certificate of Qualification, one must have written ALL of the required examinations in the SOPEEC format. No previously written provincial examinations will be recognized. This 'Standardized' designation allows you to be issued the same level of certification in all other Canadian jurisdictions (except Quebec at this time). No further examination writing is required.

Recommended Study Program

It is recommended that before undertaking examinations, the candidate complete a Third Class Power Engineering Course offered through a recognized Technical Institute or Training Provider.
In addition to the foregoing course or courses, it is recommended that the candidate becomes familiar with the publications listed in the Reference Material for Power Engineering Students and Examination Candidates, listed later in this document.

Eligibility to Write the 3rd Class Examinations

A candidate must be in possession of a 4th Class Stationary, Operating, or Power Engineer Certificate of Qualification that is in good standing, in Ontario. Those whose certificates have expired must first have their certificate re-instated.

Practical Time Requirements to obtain the 3rd Class Certificate

- To be eligible for the 3rd Class Operating Engineers Certificate of Qualification, you must have operated a registered attended plant as a 4th Class Operating Engineer for a minimum one year period, if you have not attended a fulltime TSSA approved training program. To determine the power plant size and rating in which you are to obtain your practical operating experience (as a 4th Class operator) towards your 3rd Class time, refer to Table 8 of the Operating Engineers Regulation;

'or'

- The above required practical plant operating time can be reduced by 11 months if you have graduated from a full-time TSSA approved 3rd Class Power Engineering training course. Refer to 'Training Providers' listing on our web page for those eligible to offer the "TSSA approved-for-practical-time-reduction" programs.

- The student is to have successfully completed the program before any time reduction is granted.

- The 1 month practical operating time served for the 3rd Class shall be in an attended plant that requires a 4TH Class Operating Engineer or higher. This registered training power plant must be located off-site in cooperation with private industry.

Training Providers

As a convenience for students, TSSA has compiled a list of organizations, and/or institutions currently offering 'TSSA Approved for Time Reduction', training. The list can be found in the 'Operating Engineer section', of our TSSA Corporate website located at; http://www.tssa.org.

Note: The process for 'TSSA approval' began in December of 2001.
Trainers successful in obtaining TSSA approval, to offer "practical-time-reduction-training", will be identified accordingly by being listed on TSSA's Training Providers list.

Examinations

- There are 4 examinations at the 3rd Class level, each 3.5 hours in duration and the pass mark is 65%. There is a 60 day mandatory waiting period to re-write examinations, as per the OE Regulations.
  - Exams 3A-1, 3A-2, and 3B-2, consist of 150 multiple-choice style questions.
  - Exam 3B-1 is in essay format requiring the candidate to answer any 8 of 10 given questions

- The examination candidate is expected to write legible, neat, and in pen. Sketches or drawings are to be in pencil and properly labeled. Rulers and drawing templates to be used as neatness is considered in the marking scheme.

Candidates are to bring a pen, pencil, eraser, ruler/template (for drawing) and a non-programmable calculator. **No other text or materials are allowed into the examination room, by the candidate.**

Please Note: The items referenced above are the responsibility of the candidate to bring to the examination and must be shown to the Examiner or Invigilator for approval, upon request. Any individual not complying with the Invigilator's requests, will not be eligible to write or will not have their paper marked, and forfeit the examination fee for the examination sitting.

The candidate must show picture I.D. at the examination.

Examination Centres will provide all the required reference materials, i.e. formulae booklets, Acts, Regulations, Codes, Steam/Refrigeration Tables, as an Operating Engineering Examination Reference Materials Manual.

Examinations may be written at the MTCU Examination Centres located in major cities in Ontario, or at TSSA in Toronto. To locate the nearest examination centre refer to 'Examination Centres Listing', on our website at; http://www.tssa.org, in the 'Operating Engineers' section.

The examination candidate must submit an application and the prescribed fee at least fifteen (15) business days before the date of examination. Please refer to examination procedures for "Examination Registration Form.

Mail the application directly to "Examination Services", Technical Standards & Safety Authority, or Fax. Direct to TSSA at: (416) 231-4078.

Suggested Reference (Text) Materials

Note: PanGlobal Publishing, formerly PEJV/SAIT, is the SOPEEC sanctioned provider of Power Engineering reference materials.

The following list provides telephone numbers that will assist the student in locating and/or obtaining the needed reference materials for study.

- **'3rd class Power Engineering'** available from PanGlobal Publishing by calling direct at; 1 866.256.8193.
- **Reed's Marine Engineering** series. Nautical Mind Bookstore, Toronto, Canada, 1 800 463-9951. *(See individual exam papers for specific text needed).*
- **"Metals & How to Weld Them"** by Jefferson & Woods …. Reference SOPEEC text list.
- **The Technical Standards and Safety Act, the Operating Engineers Regulation and the Boilers and Pressure Vessels Regulation; these are posted on the TSSA Website and can be printed for use in your studies, free of charge.**
- **2007 ASME Boiler and Pressure Vessel Code - Academic Extract** contains materials from Sections I, II, IV and VIII of the 2007 ASME Boiler and Pressure Vessel Code and is available from PanGlobal Publishing at toll-free: 1-866-256-8193
- **CSA B51:** "Boilers, Pressure Vessel and Piping Code" CSA International at; 416.747.4000
- **CSA B52:** "Mechanical Refrigeration Code" ….. CSA International at; 416.747.4000
- **2007 ASME Extract**
- **ASME Section I:** Rules for the Construction of Power Boilers Extract

- **'ASME Code Simplified'..** Reference SOPEEC text list

- **ASME Section VI** - Recommended Guidelines for the Care and Operation of Heating Boilers…. see below

- **ASME Section VII:** Recommended Guidelines for Care and Operation of Power Boilers

- **ASME Section IX:** "Welding and Brazing Qualifications…. see below

For ASME Code Books (other than the Section 1 Extract) can be obtained from The American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990.

Additional engineering text and reference materials are available from a broad range of authors and publishers and no specific text or reference material beyond the Act, Regulations and Codes should be considered as official.

Visit the SOPEEC website at www.sopeec.org for the "Recommended Reading List for Power Engineering Students" and for further information, other possible resource texts and sample 'only' questions.

In addition to the suggested reading list offered through the above SOPEEC link, the following texts are also suggested as a resource for study.

Stationary Engineering, Fourth Edition
2008, by American Technical Publishers, Inc.
Author(s) Fredrick M. Steingress, Harold J. Frost and Daryl R. Walker

Boiler Operator's Workbook, Fourth Edition
2008, by American Technical Publishers, Inc.
Author R. Dean Wilson

Commercial and Industrial Wiring
2009, by American Technical Publishers, Inc.
Author Randy Barnett

Obtaining Your Certificate

Upon successful completion of the examinations and the completion of the required practical operating 'qualifying experience', as per the Operating Engineers Regulation 219/01, the candidate may apply to TSSA for their "Certificate of Qualification" by forwarding:

- The completed 'Application for an Ontario Certificate of Qualification as an Operating Engineer or Operator'.

- The completed Form 1, entitled 'Testimonial of Qualifying Experience'.

- **Cheque** (please view the **OE Fee schedule** from the Operating Engineers web page, under Forms & Fees, for initial certificate

payment amount) made payable to “Technical Standards and Safety Authority” or to “TSSA” *and forward to*:

Technical Standards and Safety Authority
Operating Engineers Program
3300 Bloor Street West
14th Floor, Centre Tower
Toronto, Ontario
M8X 2X4

Note: The above-required forms are available from the TSSA website, in the Operating Engineers Section, under ‘Forms and Fees”.

Updated: January 7, 2014

Name	PEO Licence #
Gregory M. Vogt, P. Eng.	11384275
Hubert S. Vogt, P. Eng.	48273502
Aly Hindi, P. Eng.	19746015
Radha Sarkar, P. Eng.	40678013
Francis Itliong, P. Eng.	90482910
Raman Raghavan, P. Eng.	100114727
Susan Wang, P. Eng.	90427113
Sherry Wang, P. Eng.	100117433
Mike Southwood, P. Eng.	43732015
Jovan Momic, P. Eng.	100026290
Asif Aleem, P. Eng.	100109855
Qing Yan, P. Eng.	100117102
Raymond Luo, P. Eng.	100191269
Mike Detenbeck, P. Eng.	11321502

updated Oct 31, 2014
Rev 1

Technical Standards and Safety Authority
14th Floor - Centre Tower
3300 Bloor Street West
Toronto, Ontario M8X 2X4
Web site: www.tssa.org

Welder/Welding Operator Certificate

Technical Standards and Safety Act
Boilers and Pressure Vessels Regulation

No. 307530

Welder's Last Name	Initial	First Name	Signature	Stamp No.
Sauve		Glenn		GS3

Residence Address	Postal Code	Provincial Registration No.
152 North Mitton St. Unit A, Sarnia, Ontario	N 7 T 6 G 8	WP-T1294.5

Employer Name	Company PQR No.
Greenfield South Power Corporation	GW3-B
Street Address	**Company WPS No. used**
2275 Lake Shore Blvd. West, Suite 401	GW3-B (A)
Toronto, ON	**Postal Code** M 8 V 3 Y 3

Welding Process(es) Used SMAW — **Type(s)** ☑ manual ☐ machine ☐ semi-automatic ☐ automatic

Base Metal Spec. and Type/Grade or UNS No. SA106 Grade B — **Thickness(es)** 0.719 in — ☑ Test Coupon ☐ Production Weld

Variables for All Processes	Actual Values	Range Qualified
Backing (with/without)	F3 All/ F4+	F3 All, and F4+, F1+, F2+, F3+
Base metal P-Number to P-Number	1 to 1	1 through 15F, 34, 41-49
( ) Plate (x) Pipe (enter diameter if pipe or tube)	6"	O.D. 2 7/8" to Unlimited
Filler metal specification (SFA) and classification (QW-404) (info. only)	5.1	
Consumable insert for GTAW or PAW (QW-404)	N/A	
Welding position (1G, 5G, etc.) (QW-405)	6G	all positions, all fillets

Manual or Semi-automatic Variables (QW-350)	Actual Values	Range Qualified
Filler metal F-No. (QW-404)	F3 and F4	F3, F4, F1, F2
Filler metal product form for GTAW, PAW (QW-404)		
Weld deposit thickness for each welding process (QW-404)		
Process 1: SMAW 3 layers minimum ☐ Yes ☑ No	F3 0.125	F3 up to 0.25
Process 2: SMAW 3 layers minimum ☐ Yes ☑ No	F4 0.594	F4 up to 1.188
Vertical progression (uphill/downhill) (QW-405)	Uphill	Uphill, ~~Downhill~~ ONLY
GTAW, PAW or GMAW backing gas; or OFW fuel gas (QW-408)	N/A	N/A
GMAW transfer mode (spray/globular or pulse to short circuit) (QW-409)	N/A	N/A
GTAW welding current type & polarity (AC, DCEP, DCEN)(QW-409)	N/A	N/A

Machine Welding Variables (QW-361.2)	Actual Values	Range Qualified
Direct or remote visual control	N/A	N/A
Automatic arc voltage control (GTAW)	N/A	N/A
Automatic joint tracking	N/A	N/A
Multiple or single pass per side	N/A	N/A

Automatic Welding Variables (QW-361.1)	Actual Values	Range Qualified
Filler metal used ☐ Yes ☐ No (EBW or LBW)	N/A	N/A
Laser type for LBW (CO_2 to YAG etc.)	N/A	N/A
Continuous drive or inertia welding (FW)	N/A	N/A
Vacuum or out of vacuum (EBW)	N/A	N/A

Note: Values in "Range Qualified" are valid only when used with a Qualified Welding Procedure.

RESULTS

Visual Examination of Completed Weld (QW-302.4) Acceptable

☐ Transverse root and face bends [QW-462.3(a)]; ☐ Longitudinal root and face bends [QW-462.3(b)]; ☐ Side bends (QW-462.2);
☐ Pipe bend specimen, corrosion-resistant overlay [QW-462.5(c)]; ☐ Plate bend specimen, corrosion-resistant overlay [QW-462.5(d)];
☐ Pipe specimen, macro test for fusion [QW-462.5(b)]; ☐ Plate specimen, macro test for fusion [QW-462.5(e)]

Type	Result	Type	Result	Type	Result	Type	Result

Alternative volumetric examination results (QW-191) Acceptable ☑ RT or UT ☐ (check one)

Fillet weld — fracture test (QW-181.2) _____ Length and percent of defects _____

☐ Fillet welds in plate [QW-462.4(b)] ☐ Fillet welds in pipe [QW-462.4(c)]

Macro examination (QW-184) _____ Fillet size (in.) _____ x _____ Concavity/convexity (in.) _____

Other tests _____

Film or specimens evaluated by (print name) Mark Ryan Company TEAM Industrial

Mechanical tests conducted by (print name) _____ Laboratory test no. 11407-7500-1-1

Welding supervised by (print name) Francis Itliong

Test requested by (print name) Monika Vogt Tested at (print address): 477 Oil Springs Line, Courtright

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Boiler and Pressure Vessel Code.

Organization Greenfield South Power Corporation Signature Monika Vogt Date 10-07-2014 (dd-mm-yyyy)

FOR TSSA INSPECTOR USE ONLY

The Welder named above has passed the welding test required under Ontario's ***Technical Standards and Safety Act,*** Boilers and Pressure Vessels Regulation and is hereby authorized, subject to the limitations of this certificate.

Check (✓) applicable box below:

☑ To weld for the Employer named above only.
☐ For seeking employment only.

This Certificate expires: 07/21/2015 (dd-mm-yyyy)

Brian Alschewski ON* 0002100?2
Inspector Name and Number (Print)

Inspector Signature and Date 07/21/2014

PV 09397 (04/12)

Technical Standards and Safety Authority
14th Floor - Centre Tower
3300 Bloor Street West
Toronto, Ontario M8X 2X4
Web site: www.tssa.org

Welder/Welding Operator Certificate

Technical Standards and Safety Act
Boilers and Pressure Vessels Regulation

No. 307528

Welder's Last Name	Initial	First Name	Signature	Stamp No.
Rastoule		Cecil	Cecil A. Rastoule	CR1

Residence Address	Postal Code	Provincial Registration No.
488 Belmont Ave. P.O. Box 552, Corunna, ON	N0N1G0	WP-T1294.5

Employer Name	Company PQR No.
Greenfield South Power Corporation	GW3-B

Street Address	Company WPS No. used
2275 Lake Shore Blvd. West, Suite 401	GW3-B (A)

	Postal Code
Toronto, ON	M8V3Y3

Welding Process(es) Used SMAW — **Type(s)** ☑ manual ☐ machine ☐ semi-automatic ☐ automatic

Base Metal Spec. and Type/Grade or UNS No. SA106 Grade B — **Thickness(es)** 0.719 in — ☑ Test Coupon ☐ Production Weld

Variables for All Processes	Actual Values	Range Qualified
Backing (with/without)	F3 All/ F4+	F3 All, and F4+, F1+, F2+, F3+
Base metal P-Number to P-Number	1 to 1	1 through 15F, 34, 41-49
( ) Plate (x) Pipe (enter diameter if pipe or tube)	6"	O.D. 2 7/8" to Unlimited
Filler metal specification (SFA) and classification (QW-404) (info. only)	5.1	
Consumable insert for GTAW or PAW (QW-404)	N/A	
Welding position (1G, 5G, etc.) (QW-405)	6G	all positions, all fillets

Manual or Semi-automatic Variables (QW-350)	Actual Values	Range Qualified
Filler metal F-No. (QW-404)	F3 and F4	F3, F4, F1, F2
Filler metal product form for GTAW, PAW (QW-404)		
Weld deposit thickness for each welding process (QW-404)		
Process 1: SMAW 3 layers minimum ☐ Yes ☑ No	F3 0.125	F3 up to 0.25
Process 2: SMAW 3 layers minimum ☐ Yes ☑ No	F4 0.594	F4 up to 1.188
Vertical progression (uphill/downhill) (QW-405)	Uphill	Uphill, ~~Downtown~~ only
GTAW, PAW or GMAW backing gas; or OFW fuel gas (QW-408)	N/A	N/A
GMAW transfer mode (spray/globular or pulse to short circuit) (QW-409)	N/A	N/A
GTAW welding current type & polarity (AC, DCEP, DCEN)(QW-409)	N/A	N/A

Machine Welding Variables (QW-361.2)	Actual Values	Range Qualified
Direct or remote visual control	N/A	N/A
Automatic arc voltage control (GTAW)	N/A	N/A
Automatic joint tracking	N/A	N/A
Multiple or single pass per side	N/A	N/A

Automatic Welding Variables (QW-361.1)	Actual Values	Range Qualified
Filler metal used ☐ Yes ☐ No (EBW or LBW)	N/A	N/A
Laser type for LBW (CO_2 to YAG etc.)	N/A	N/A
Continuous drive or inertia welding (FW)	N/A	N/A
Vacuum or out of vacuum (EBW)	N/A	N/A

Note: Values in "Range Qualified" are valid only when used with a Qualified Welding Procedure.

RESULTS

Visual Examination of Completed Weld (QW-302.4) SATISFACTORY

☐ Transverse root and face bends [QW-462.3(a)]; ☐ Longitudinal root and face bends [QW-462.3(b)]; ☐ Side bends (QW-462.2);
☐ Pipe bend specimen, corrosion-resistant overlay [QW-462.5(c)]; ☐ Plate bend specimen, corrosion-resistant overlay [QW-462.5(d)];
☐ Pipe specimen, macro test for fusion [QW-462.5(b)]; ☐ Plate specimen, macro test for fusion [QW-462.5(e)]

Type	Result	Type	Result	Type	Result	Type	Result

Alternative volumetric examination results (QW-191) Acceptable ☑ RT or UT ☐ (check one)

Fillet weld — fracture test (QW-181.2) _____ Length and percent of defects _____

☐ Fillet welds in plate [QW-462.4(b)] ☐ Fillet welds in pipe [QW-462.4(c)]

Macro examination (QW-184) _____ Fillet size (in.) _____ x _____ Concavity/convexity (in.) _____

Other tests _____

Film or specimens evaluated by (print name) Dave Collier Company TEAM Industrial

Mechanical tests conducted by (print name) _____ Laboratory test no. 6" WT SCH160

Welding supervised by (print name) Francis Itliong

Test requested by (print name) Monika Vogt Tested at (print address): 477 Oil Springs Line, Courtright

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Boiler and Pressure Vessel Code.

Organization Greenfield South Power Corporation Signature Monika Vogt Date 13-06-2014 (dd-mm-yyyy)

FOR TSSA INSPECTOR USE ONLY

The Welder named above has passed the welding test required under Ontario's ***Technical Standards and Safety Act,*** Boilers and Pressure Vessels Regulation and is hereby authorized, subject to the limitations of this certificate.

Check (✓) applicable box below:

☑ To weld for the Employer named above only.
☐ For seeking employment only.

This Certificate expires: 07/21/2015 (dd-mm-yyyy)

RYAN AGNEW QW-100110072
Inspector Name and Number (Print)

Inspector Signature and Date 07/21/2014

PV 09397 (04/12)

Technical Standards and Safety Authority
14th Floor - Centre Tower
3300 Bloor Street West
Toronto, Ontario M8X 2X4
Web site: www.tssa.org

Welder/Welding Operator Certificate

Technical Standards and Safety Act
Boilers and Pressure Vessels Regulation

No. 312228

Welder's Last Name	Initial	First Name	Signature	Stamp No.
Rankin	J.	Reid	Reid Rankin	RR1

Residence Address	Postal Code	Provincial Registration No.
2916 Bigden Rd., Bigden Ontario	N0N1B0	WP-T1294.5

Employer Name	Company PQR No.
Greenfield South Power Corporation	GW3-B

Street Address	Company WPS No.used
2275 Lake Shore Blvd. West, Suite 401	GW3-B (A)

	Postal Code
Toronto, ON	M8V3Y3

Welding Process(es) Used SMAW — **Type(s)** ☑ manual ☐ machine ☐ semi-automatic ☐ automatic

Base Metal Spec. and Type/Grade or UNS No. SA106 Grade B — **Thickness(es)** 0.719 in — ☑ Test Coupon ☐ Production Weld

Variables for All Processes	Actual Values	Range Qualified
Backing (with/without)	F3 All/ F4+	F3 All, and F4+, F1+, F2+, F3+
Base metal P-Number to P-Number	1 to 1	1 through 15F, 34, 41-49
( ) Plate (x) Pipe (enter diameter if pipe or tube)	6"	O.D. 2 7/8" to Unlimited
Filler metal specification (SFA) and classification (QW-404) (info. only)	5.1	
Consumable insert for GTAW or PAW (QW-404)	N/A	
Welding position (1G, 5G, etc.) (QW-405)	6G	all positions, all fillets

Manual or Semi-automatic Variables (QW-350)	Actual Values	Range Qualified
Filler metal F-No. (QW-404)	F3 and F4	F3, F4, F1, F2
Filler metal product form for GTAW, PAW (QW-404)		
Weld deposit thickness for each welding process (QW-404)		
Process 1: SMAW 3 layers minimum ☐ Yes ☑ No	F3 0.125	F3 up to 0.25
Process 2: SMAW 3 layers minimum ☐ Yes ☑ No	F4 0.594	F4 up to 1.188
Vertical progression (uphill/downhill) (QW-405)	Uphill	Uphill, Downhill
GTAW, PAW or GMAW backing gas; or OFW fuel gas (QW-408)	N/A	N/A
GMAW transfer mode (spray/globular or pulse to short circuit) (QW-409)	N/A	N/A
GTAW welding current type & polarity (AC, DCEP, DCEN)(QW-409)	N/A	N/A

Machine Welding Variables (QW-361.2)	Actual Values	Range Qualified
Direct or remote visual control	N/A	N/A
Automatic arc voltage control (GTAW)	N/A	N/A
Automatic joint tracking	N/A	N/A
Multiple or single pass per side	N/A	N/A

Automatic Welding Variables (QW-361.1)	Actual Values	Range Qualified
Filler metal used ☐ Yes ☐ No (EBW or LBW)	N/A	N/A
Laser type for LBW (CO_2 to YAG etc.)	N/A	N/A
Continuous drive or inertia welding (FW)	N/A	N/A
Vacuum or out of vacuum (EBW)	N/A	N/A

Note: Values in "Range Qualified" are valid only when used with a Qualified Welding Procedure.

RESULTS

Visual Examination of Completed Weld (QW-302.4) Acceptable

☐ Transverse root and face bends [QW-462.3(a)]; ☐ Longitudinal root and face bends [QW-462.3(b)]; ☐ Side bends (QW-462.2);
☐ Pipe bend specimen, corrosion-resistant overlay [QW-462.5(c)]; ☐ Plate bend specimen, corrosion-resistant overlay [QW-462.5(d)];
☐ Pipe specimen, macro test for fusion [QW-462.5(b)]; ☐ Plate specimen, macro test for fusion [QW-462.5(e)]

Type	Result	Type	Result	Type	Result	Type	Result

Alternative volumetric examination results (QW-191) Acceptable ☑ RT or UT ☐ (check one)

Fillet weld — fracture test (QW-181.2) _____ Length and percent of defects _____

☐ Fillet welds in plate [QW-462.4(b)] ☐ Fillet welds in pipe [QW-462.4(c)]

Macro examination (QW-184) _____ Fillet size (in.) _____ x _____ Concavity/convexity (in.) _____

Other tests _____

Film or specimens evaluated by (print name) Dave Olderburg Company TEAM Industrial

Mechanical tests conducted by (print name) _____ Laboratory test no. _____

Welding supervised by (print name) Francis Itliong

Test requested by (print name) Monika Vogt Tested at (print address): 477 Oil Springs Line, Courtright

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Boiler and Pressure Vessel Code.

Organization Greenfield South Power Corporation Signature Monika Vogt Date 22-10-2014 (dd-mm-yyyy)

FOR TSSA INSPECTOR USE ONLY

The Welder named above has passed the welding test required under Ontario's ***Technical Standards and Safety Act,*** Boilers and Pressure Vessels Regulation and is hereby authorized, subject to the limitations of this certificate

Check (✓) applicable box below:

☑ To weld for the Employer named above only.
☐ For seeking employment only.

This Certificate expires: 22-10-2015 (dd-mm-yyyy)

STEPHEN ZHAO
Inspector Name and Number (Print)

Inspector Signature and Date

PV 09397(04/12)

Technical Standards and Safety Authority
14th Floor - Centre Tower
3300 Bloor Street West
Toronto, Ontario M8X 2X4
Web site: www.tssa.org

Welder/Welding Operator Certificate

Technical Standards and Safety Act
Boilers and Pressure Vessels Regulation

No. 312230

Welder's Last Name	Initial	First Name	Signature	Stamp No.
McDonald		Arthur	Art McDonald	AM2

Residence Address	Postal Code	Provincial Registration No.
2777 Greenfield Rd., Courtright, Ontario	N0H 1H0	WP-T1294.5

Employer Name	Company PQR No.
Greenfield South Power Corporation	GW3-B

Street Address	Company WPS No.used
2275 Lake Shore Blvd. West, Suite 401	GW3-B (A)

	Postal Code
Toronto, ON	M8V 3Y3

Welding Process(es) Used SMAW — **Type(s)** ☑ manual ☐ machine ☐ semi-automatic ☐ automatic

Base Metal Spec. and Type/Grade or UNS No. SA106 Grade B — **Thickness(es)** 0.719 in — ☑ Test Coupon ☐ Production Weld

Variables for All Processes	Actual Values	Range Qualified
Backing (with/without)	F3 All/ F4+	F3 All, and F4+, F1+, F2+, F3+
Base metal P-Number to P-Number	1 to 1	1 through 15F, 34, 41-49
( ) Plate (x) Pipe (enter diameter if pipe or tube)	6"	O.D. 2 7/8" to Unlimited
Filler metal specification (SFA) and classification (QW-404) (info. only)	5.1	
Consumable insert for GTAW or PAW (QW-404)	N/A	
Welding position (1G, 5G, etc.) (QW-405)	6G	all positions, all fillets

Manual or Semi-automatic Variables (QW-350)	Actual Values	Range Qualified
Filler metal F-No. (QW-404)	F3 and F4	F3, F4, F1, F2
Filler metal product form for GTAW, PAW (QW-404)		
Weld deposit thickness for each welding process (QW-404)		
Process 1: SMAW 3 layers minimum ☐ Yes ☑ No	F3 0.125	F3 up to 0.25
Process 2: SMAW 3 layers minimum ☐ Yes ☑ No	F4 0.594	F4 up to 1.188
Vertical progression (uphill/downhill) (QW-405)	Uphill	Uphill, Downhill
GTAW, PAW or GMAW backing gas; or OFW fuel gas (QW-408)	N/A	N/A
GMAW transfer mode (spray/globular or pulse to short circuit) (QW-409)	N/A	N/A
GTAW welding current type & polarity (AC, DCEP, DCEN)(QW-409)	N/A	N/A

Machine Welding Variables (QW-361.2)	Actual Values	Range Qualified
Direct or remote visual control	N/A	N/A
Automatic arc voltage control (GTAW)	N/A	N/A
Automatic joint tracking	N/A	N/A
Multiple or single pass per side	N/A	N/A

Automatic Welding Variables (QW-361.1)	Actual Values	Range Qualified
Filler metal used ☐ Yes ☐ No (EBW or LBW)	N/A	N/A
Laser type for LBW (CO_2 to YAG etc.)	N/A	N/A
Continuous drive or inertia welding (FW)	N/A	N/A
Vacuum or out of vacuum (EBW)	N/A	N/A

Note: Values in "Range Qualified" are valid only when used with a Qualified Welding Procedure.

RESULTS

Visual Examination of Completed Weld (QW-302.4) Acceptable

☐ Transverse root and face bends [QW-462.3(a)]; ☐ Longitudinal root and face bends [QW-462.3(b)]; ☐ Side bends (QW-462.2);
☐ Pipe bend specimen, corrosion-resistant overlay [QW-462.5(c)]; ☐ Plate bend specimen, corrosion-resistant overlay [QW-462.5(d)];
☐ Pipe specimen, macro test for fusion [QW-462.5(b)]; ☐ Plate specimen, macro test for fusion [QW-462.5(e)]

Type	Result	Type	Result	Type	Result	Type	Result

Alternative volumetric examination results (QW-191) Acceptable ☑ RT or UT ☐ (check one)

Fillet weld — fracture test (QW-181.2) _____ Length and percent of defects _____

☐ Fillet welds in plate [QW-462.4(b)] ☐ Fillet welds in pipe [QW-462.4(c)]

Macro examination (QW-184) _____ Fillet size (in.) _____ x _____ Concavity/convexity (in.) _____

Other tests _____

Film or specimens evaluated by (print name) Dave Oldenburg Company TEAM Industrial

Mechanical tests conducted by (print name) _____ Laboratory test no. _____

Welding supervised by (print name) Francis Itliong

Test requested by (print name) Monika Vogt Tested at (print address): 477 Oil Springs Line, Courtright

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Boiler and Pressure Vessel Code.

Organization Greenfield South Power Corporation Signature Monika Vogt Date 22-10-2014 (dd-mm-yyyy)

FOR TSSA INSPECTOR USE ONLY

The Welder named above has passed the welding test required under Ontario's ***Technical Standards and Safety Act,*** Boilers and Pressure Vessels Regulation and is hereby authorized, subject to the limitations of this certificate.

Check (✔) applicable box below:

☑ To weld for the Employer named above only.
☐ For seeking employment only.

This Certificate expires: 22-10-2015 (dd-mm-yyyy)

STEPHEN ZHAO #906
Inspector Name and Number (Print)

Inspector Signature and Date

PV 09397 (04/12)

Technical Standards and Safety Authority
14th Floor - Centre Tower
3300 Bloor Street West
Toronto, Ontario M8X 2X4
Web site: www.tssa.org

Welder/Welding Operator Certificate

Technical Standards and Safety Act
Boilers and Pressure Vessels Regulation

No. 400236

Welder's Last Name	Initial	First Name	Signature	Stamp No.
Macneil		Trevor		TM1

Residence Address	Postal Code	Provincial Registration No.
1303 Wiltshire Dr. Sarnia, ON	N7S 4N9	WP-T1294.5

Employer Name	Company PQR No.
Greenfield South Power Corporation	GW3-B
Street Address	**Company WPS No.used**
2275 Lake Shore Blvd. West, Suite 401	GW3-B (A)
Toronto, ON	**Postal Code** M8V 3Y3

Welding Process(es) Used SMAW — **Type(s)** ☑ manual ☐ machine ☐ semi-automatic ☐ automatic

Base Metal Spec. and Type/Grade or UNS No. SA106 Grade B — **Thickness(es)** 0.719 in — ☑ Test Coupon ☐ Production Weld

riables for All Processes	Actual Values	Range Qualified
Backing (with/without)	F3 All/ F4+	F3 All, and F4+, F1+, F2+, F3+
Base metal P-Number to P-Number	1 to 1	1 through 15F, 34, 41-49
( ) Plate (x) Pipe (enter diameter if pipe or tube)	6"	O.D. 2 7/8" to Unlimited
Filler metal specification (SFA) and classification (QW-404) (info. only)	5.1	
Consumable insert for GTAW or PAW (QW-404)	N/A	
Welding position (1G, 5G, etc.) (QW-405)	6G	all positions, all fillets

Manual or Semi-automatic Variables (QW-350)	Actual Values	Range Qualified
Filler metal F-No. (QW-404)	F3 and F4	F3, F4, F1, F2
Filler metal product form for GTAW, PAW (QW-404)		
Weld deposit thickness for each welding process (QW-404)		
Process 1: SMAW 3 layers minimum ☐ Yes ☑ No	F3 0.125	F3 up to 0.25
Process 2: SMAW 3 layers minimum ☐ Yes ☑ No	F4 0.594	F4 up to 1.188
Vertical progression (uphill/downhill) (QW-405)	Uphill	Uphill, Downhill
GTAW, PAW or GMAW backing gas; or OFW fuel gas (QW-408)	N/A	N/A
GMAW transfer mode (spray/globular or pulse to short circuit) (QW-409)	N/A	N/A
GTAW welding current type & polarity (AC, DCEP, DCEN)(QW-409)	N/A	N/A

Machine Welding Variables (QW-361.2)	Actual Values	Range Qualified
Direct or remote visual control	N/A	N/A
Automatic arc voltage control (GTAW)	N/A	N/A
Automatic joint tracking	N/A	N/A
Multiple or single pass per side	N/A	N/A

Automatic Welding Variables (QW-361.1)	Actual Values	Range Qualified
ıller metal used ☐ Yes ☐ No (EBW or LBW)	N/A	N/A
Laser type for LBW (CO_2 to YAG etc.)	N/A	N/A
Continuous drive or inertia welding (FW)	N/A	N/A
Vacuum or out of vacuum (EBW)	N/A	N/A

Note: Values in "Range Qualified" are valid only when used with a Qualified Welding Procedure.

RESULTS

Visual Examination of Completed Weld (QW-302.4) ACCEPTABLE

☐ Transverse root and face bends [QW-462.3(a)]; ☐ Longitudinal root and face bends [QW-462.3(b)]; ☐ Side bends (QW-462.2);
☐ Pipe bend specimen, corrosion-resistant overlay [QW-462.5(c)]; ☐ Plate bend specimen, corrosion-resistant overlay [QW-462.5(d)];
☐ Pipe specimen, macro test for fusion [QW-462.5(b)]; ☐ Plate specimen, macro test for fusion [QW-462.5(e)]

Type	Result	Type	Result	Type	Result	Type	Result

Alternative volumetric examination results (QW-191) Acceptable ☑ RT or UT ☐ (check one)

Fillet weld — fracture test (QW-181.2) _____ Length and percent of defects _____

☐ Fillet welds in plate [QW-462.4(b)] ☐ Fillet welds in pipe [QW-462.4(c)]

Macro examination (QW-184) _____ Fillet size (in.) _____ x _____ Concavity/convexity (in.) _____

Other tests _____

Film or specimens evaluated by (print name) Dave Collier Company TEAM Industrial

Mechanical tests conducted by (print name) _____ Laboratory test no. _____

Welding supervised by (print name) Francis Itliong

est requested by (print name) Monika Vogt Tested at (print address): 477 Oil Springs Line, Courtright

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Boiler and Pressure Vessel Code.

Organization Greenfield South Power Corporation Signature Monika Vogt Date 06-06-2014 (dd-mm-yyyy)

FOR TSSA INSPECTOR USE ONLY

The Welder named above has passed the welding test required under Ontario's ***Technical Standards and Safety Act,*** Boilers and Pressure Vessels Regulation and is hereby authorized, subject to the limitations of this certificate.

Check (✔) applicable box below:

☑ To weld for the Employer named above only.
☐ For seeking employment only.

This Certificate expires: 06-06-2015 (dd-mm-yyyy)

STEPHEN ZHAO #906
Inspector Name and Number (Print)

Inspector Signature and Date

Technical Standards and Safety Authority
14th Floor - Centre Tower
3300 Bloor Street West
Toronto, Ontario M8X 2X4
Web site: www.tssa.org

Welder/Welding Operator Certificate

Technical Standards and Safety Act
Boilers and Pressure Vessels Regulation

No. 312229

Welder's Last Name	Initial	First Name	Signature	Stamp No.
Lawrence		Joshua		JL1

Residence Address	Postal Code	Provincial Registration No.
353 Brentwood, Corunna Ontario	N0N1G0	WP-T1294.5

Employer Name	Company PQR No.
Greenfield South Power Corporation	GW3-B

Street Address	Company WPS No.used
2275 Lake Shore Blvd. West, Suite 401	GW3-B (A)

	Postal Code
Toronto, ON	M8V3Y3

Welding Process(es) Used SMAW — **Type(s)** ☑ manual ☐ machine ☐ semi-automatic ☐ automatic

Base Metal Spec. and Type/Grade or UNS No. SA106 Grade B — **Thickness(es)** 0.719 in — ☑ Test Coupon ☐ Production Weld

Variables for All Processes	Actual Values	Range Qualified
Backing (with/without)	F3 All/ F4+	F3 All, and F4+, F1+, F2+, F3+
Base metal P-Number to P-Number	1 to 1	1 through 15F, 34, 41-49
( ) Plate (x) Pipe (enter diameter if pipe or tube)	6"	O.D. 2 7/8" to Unlimited
Filler metal specification (SFA) and classification (QW-404) (info. only)	5.1	
Consumable insert for GTAW or PAW (QW-404)	N/A	
Welding position (1G, 5G, etc.) (QW-405)	6G	all positions, all fillets

Manual or Semi-automatic Variables (QW-350)	Actual Values	Range Qualified
Filler metal F-No. (QW-404)	F3 and F4	F3, F4, F1, F2
Filler metal product form for GTAW, PAW (QW-404)		
Weld deposit thickness for each welding process (QW-404)		
Process 1: SMAW 3 layers minimum ☐ Yes ☑ No	F3 0.125	F3 up to 0.25
Process 2: SMAW 3 layers minimum ☐ Yes ☑ No	F4 0.594	F4 up to 1.188
Vertical progression (uphill/downhill) (QW-405)	Uphill	Uphill, Downhill
GTAW, PAW or GMAW backing gas; or OFW fuel gas (QW-408)	N/A	N/A
GMAW transfer mode (spray/globular or pulse to short circuit) (QW-409)	N/A	N/A
GTAW welding current type & polarity (AC, DCEP, DCEN)(QW-409)	N/A	N/A

Machine Welding Variables (QW-361.2)	Actual Values	Range Qualified
Direct or remote visual control	N/A	N/A
Automatic arc voltage control (GTAW)	N/A	N/A
Automatic joint tracking	N/A	N/A
Multiple or single pass per side	N/A	N/A

Automatic Welding Variables (QW-361.1)	Actual Values	Range Qualified
Filler metal used ☐ Yes ☐ No (EBW or LBW)	N/A	N/A
Laser type for LBW (CO_2 to YAG etc.)	N/A	N/A
Continuous drive or inertia welding (FW)	N/A	N/A
Vacuum or out of vacuum (EBW)	N/A	N/A

Note: Values in "Range Qualified" are valid only when used with a Qualified Welding Procedure.

RESULTS

Visual Examination of Completed Weld (QW-302.4) Acceptable

☐ Transverse root and face bends [QW-462.3(a)]; ☐ Longitudinal root and face bends [QW-462.3(b)]; ☐ Side bends (QW-462.2);
☐ Pipe bend specimen, corrosion-resistant overlay [QW-462.5(c)]; ☐ Plate bend specimen, corrosion-resistant overlay [QW-462.5(d)];
☐ Pipe specimen, macro test for fusion [QW-462.5(b)]; ☐ Plate specimen, macro test for fusion [QW-462.5(e)]

Type	Result	Type	Result	Type	Result	Type	Result

Alternative volumetric examination results (QW-191) Acceptable ☑ RT or UT ☐ (check one)

Fillet weld — fracture test (QW-181.2) _____ Length and percent of defects _____

☐ Fillet welds in plate [QW-462.4(b)] ☐ Fillet welds in pipe [QW-462.4(c)]

Macro examination (QW-184) _____ Fillet size (in.) _____ x _____ Concavity/convexity (in.) _____

Other tests _____

Film or specimens evaluated by (print name) Dave Oldenburg Company TEAM Industrial

Mechanical tests conducted by (print name) _____ Laboratory test no. _____

Welding supervised by (print name) Francis Itliong

Test requested by (print name) Monika Vogt Tested at (print address): 477 Oil Springs Line, Courtright

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Boiler and Pressure Vessel Code.

Organization Greenfield South Power Corporation Signature Monika Vogt Date 22-10-2014 (dd-mm-yyyy)

FOR TSSA INSPECTOR USE ONLY

The Welder named above has passed the welding test required under Ontario's ***Technical Standards and Safety Act,*** Boilers and Pressure Vessels Regulation and is hereby authorized, subject to the limitations of this certificate.

Check (✓) applicable box below:

☑ To weld for the Employer named above only.
☐ For seeking employment only.

This Certificate expires: 22-10-2015 (dd-mm-yyyy)

STEPHEN SHAO #96
Inspector Name and Number (Print)

Inspector Signature and Date

PV 09397 (04/12)

Technical Standards and Safety Authority
14th Floor - Centre Tower
3300 Bloor Street West
Toronto, Ontario M8X 2X4
Web site: www.tssa.org

Welder/Welding Operator Certificate

Technical Standards and Safety Act
Boilers and Pressure Vessels Regulation

No. 312252

Welder's Last Name	Initial	First Name	Signature	Stamp No.
Jones	P	John		JJ2

Residence Address	Postal Code	Provincial Registration No.
Nahdee Lane, Walpole Island, Ontario	N8A4K9	WP-T1294.5

Employer Name	Company PQR No.
Greenfield South Power Corporation	GW3-B

Street Address	Company WPS No.used
2275 Lake Shore Blvd. West, Suite 401	GW3-B (A)

	Postal Code
Toronto, ON	M8V3Y3

Welding Process(es) Used SMAW — **Type(s)** ☑ manual ☐ machine ☐ semi-automatic ☐ automatic

Base Metal Spec. and Type/Grade or UNS No. SA106 Grade B — **Thickness(es)** 0.719 in — ☑ Test Coupon ☐ Production Weld

Variables for All Processes	Actual Values	Range Qualified
Backing (with/without)	F3 All/ F4+	F3 All, and F4+, F1+, F2+, F3+
Base metal P-Number to P-Number	1 to 1	1 through 15F, 34, 41-49
( ) Plate (x) Pipe (enter diameter if pipe or tube)	6"	O.D. 2 7/8" to Unlimited
Filler metal specification (SFA) and classification (QW-404) (info. only)	5.1	
Consumable insert for GTAW or PAW (QW-404)	N/A	
Welding position (1G, 5G, etc.) (QW-405)	6G	all positions, all fillets

Manual or Semi-automatic Variables (QW-350)	Actual Values	Range Qualified
Filler metal F-No. (QW-404)	F3 and F4	F3, F4, F1, F2
Filler metal product form for GTAW, PAW (QW-404)		
Weld deposit thickness for each welding process (QW-404)		
Process 1: SMAW 3 layers minimum ☐ Yes ☑ No	F3 0.125	F3 up to 0.25
Process 2: SMAW 3 layers minimum ☐ Yes ☑ No	F4 0.594	F4 up to 1.188
Vertical progression (uphill/downhill) (QW-405)	Uphill	Uphill, Downhill
GTAW, PAW or GMAW backing gas; or OFW fuel gas (QW-408)	N/A	N/A
GMAW transfer mode (spray/globular or pulse to short circuit) (QW-409)	N/A	N/A
GTAW welding current type & polarity (AC, DCEP, DCEN)(QW-409)	N/A	N/A

Machine Welding Variables (QW-361.2)	Actual Values	Range Qualified
Direct or remote visual control	N/A	N/A
Automatic arc voltage control (GTAW)	N/A	N/A
Automatic joint tracking	N/A	N/A
Multiple or single pass per side	N/A	N/A

Automatic Welding Variables (QW-361.1)	Actual Values	Range Qualified
Filler metal used ☐ Yes ☐ No (EBW or LBW)	N/A	N/A
Laser type for LBW (CO_2 to YAG etc.)	N/A	N/A
Continuous drive or inertia welding (FW)	N/A	N/A
Vacuum or out of vacuum (EBW)	N/A	N/A

Note: Values in "Range Qualified" are valid only when used with a Qualified Welding Procedure.

RESULTS

Visual Examination of Completed Weld (QW-302.4) Acceptable

☐ Transverse root and face bends [QW-462.3(a)]; ☐ Longitudinal root and face bends [QW-462.3(b)]; ☐ Side bends (QW-462.2);
☐ Pipe bend specimen, corrosion-resistant overlay [QW-462.5(c)]; ☐ Plate bend specimen, corrosion-resistant overlay [QW-462.5(d)];
☐ Pipe specimen, macro test for fusion [QW-462.5(b)]; ☐ Plate specimen, macro test for fusion [QW-462.5(e)]

Type	Result	Type	Result	Type	Result	Type	Result

Alternative volumetric examination results (QW-191) Acceptable ☑ RT or UT ☐ (check one)

Fillet weld — fracture test (QW-181.2) _____ Length and percent of defects _____

☐ Fillet welds in plate [QW-462.4(b)] ☐ Fillet welds in pipe [QW-462.4(c)]

Macro examination (QW-184) _____ Fillet size (in.) _____ x _____ Concavity/convexity (in.) _____

Other tests _____

Film or specimens evaluated by (print name) Dave Oldenburg Company TEAM Industrial

Mechanical tests conducted by (print name) _____ Laboratory test no. 52024581

Welding supervised by (print name) Francis Itliong

Test requested by (print name) Monika Vogt Tested at (print address): 477 Oil Springs Line, Courtright

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Boiler and Pressure Vessel Code.

Organization Greenfield South Power Corporation Signature Monika Vogt Date 18-09-2014 (dd-mm-yyyy)

FOR TSSA INSPECTOR USE ONLY

The Welder named above has passed the welding test required under Ontario's ***Technical Standards and Safety Act,*** Boilers and Pressure Vessels Regulation and is hereby authorized, subject to the limitations of this certificate.

Check (✓) applicable box below:

☐ To weld for the Employer named above only.
☐ For seeking employment only.

This Certificate expires: 18-09-2015 (dd-mm-yyyy)

STEPHEN ZHAO #906
Inspector Name and Number (Print)

Inspector Signature and Date

PV 09397 (04/12)

Technical Standards and Safety Authority
14th Floor - Centre Tower
3300 Bloor Street West
Toronto, Ontario M8X 2X4
Web site: www.tssa.org

Welder/Welding Operator Certificate

Technical Standards and Safety Act
Boilers and Pressure Vessels Regulation

No. 312251

Welder's Last Name	Initial	First Name	Signature	Stamp No.
James		Matthew		MJ1

Residence Address	Postal Code	Provincial Registration No.
1582 Second St., Courtright, Ontario	N0N1H0	WP-T1294.5

Employer Name	Company PQR No.
Greenfield South Power Corporation	GW3-B

Street Address	Company WPS No. used
2275 Lake Shore Blvd. West, Suite 401	GW3-B (A)

	Postal Code
Toronto, ON	M8V3Y3

Welding Process(es) Used SMAW — **Type(s)** ☑ manual ☐ machine ☐ semi-automatic ☐ automatic

Base Metal Spec. and Type/Grade or UNS No. SA106 Grade B — **Thickness(es)** 0.719 in — ☑ Test Coupon ☐ Production Weld

Variables for All Processes	Actual Values	Range Qualified
Backing (with/without)	F3 All/ F4+	F3 All, and F4+, F1+, F2+, F3+
Base metal P-Number to P-Number	1 to 1	1 through 15F, 34, 41-49
( ) Plate (x) Pipe (enter diameter if pipe or tube)	6"	O.D. 2 7/8" to Unlimited
Filler metal specification (SFA) and classification (QW-404) (info. only)	5.1	
Consumable insert for GTAW or PAW (QW-404)	N/A	
Welding position (1G, 5G, etc.) (QW-405)	6G	all positions, all fillets

Manual or Semi-automatic Variables (QW-350)	Actual Values	Range Qualified
Filler metal F-No. (QW-404)	F3 and F4	F3, F4, F1, F2
Filler metal product form for GTAW, PAW (QW-404)		
Weld deposit thickness for each welding process (QW-404)		
Process 1: SMAW 3 layers minimum ☐ Yes ☑ No	F3 0.125	F3 up to 0.25
Process 2: SMAW 3 layers minimum ☐ Yes ☑ No	F4 0.594	F4 up to 1.188
Vertical progression (uphill/downhill) (QW-405)	Uphill	Uphill, Downhill
GTAW, PAW or GMAW backing gas; or OFW fuel gas (QW-408)	N/A	N/A
GMAW transfer mode (spray/globular or pulse to short circuit) (QW-409)	N/A	N/A
GTAW welding current type & polarity (AC, DCEP, DCEN)(QW-409)	N/A	N/A

Machine Welding Variables (QW-361.2)	Actual Values	Range Qualified
Direct or remote visual control	N/A	N/A
Automatic arc voltage control (GTAW)	N/A	N/A
Automatic joint tracking	N/A	N/A
Multiple or single pass per side	N/A	N/A

Automatic Welding Variables (QW-361.1)	Actual Values	Range Qualified
Filler metal used ☐ Yes ☐ No (EBW or LBW)	N/A	N/A
Laser type for LBW (CO_2 to YAG etc.)	N/A	N/A
Continuous drive or inertia welding (FW)	N/A	N/A
Vacuum or out of vacuum (EBW)	N/A	N/A

Note: Values in "Range Qualified" are valid only when used with a Qualified Welding Procedure.

RESULTS

Visual Examination of Completed Weld (QW-302.4) Acceptable

☐ Transverse root and face bends [QW-462.3(a)]; ☐ Longitudinal root and face bends [QW-462.3(b)]; ☐ Side bends (QW-462.2);
☐ Pipe bend specimen, corrosion-resistant overlay [QW-462.5(c)]; ☐ Plate bend specimen, corrosion-resistant overlay [QW-462.5(d)];
☐ Pipe specimen, macro test for fusion [QW-462.5(b)]; ☐ Plate specimen, macro test for fusion [QW-462.5(e)]

Type	Result	Type	Result	Type	Result	Type	Result

Alternative volumetric examination results (QW-191) Acceptable ☑ RT or UT ☐ (check one)

Fillet weld — fracture test (QW-181.2) _____ Length and percent of defects _____

☐ Fillet welds in plate [QW-462.4(b)] ☐ Fillet welds in pipe [QW-462.4(c)]

Macro examination (QW-184) _____ Fillet size (in.) _____ x _____ Concavity/convexity (in.) _____

Other tests _____

Film or specimens evaluated by (print name) Dave Oldenburg Company TEAM Industrial

Mechanical tests conducted by (print name) _____ Laboratory test no. _____

Welding supervised by (print name) Francis Itliong

Test requested by (print name) Monika Vogt Tested at (print address): 477 Oil Springs Line, Courtright

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Boiler and Pressure Vessel Code.

Organization Greenfield South Power Corporation Signature Monika Vogt Date 18-09-2014 (dd-mm-yyyy)

FOR TSSA INSPECTOR USE ONLY

The Welder named above has passed the welding test required under Ontario's ***Technical Standards and Safety Act,*** Boilers and Pressure Vessels Regulation and is hereby authorized, subject to the limitations of this certificate.

Check (✓) applicable box below:

☑ To weld for the Employer named above only.
☐ For seeking employment only.

This Certificate expires: 18-09-2015 (dd-mm-yyyy)

STEPHEN ZHAO #896
Inspector Name and Number (Print)

Inspector Signature and Date

PV 09397 (04/12)

Technical Standards and Safety Authority
14th Floor - Centre Tower
3300 Bloor Street West
Toronto, Ontario M8X 2X4
Web site: www.tssa.org

Welder/Welding Operator Certificate

Technical Standards and Safety Act
Boilers and Pressure Vessels Regulation

No. 312223

Welder's Last Name	Initial	First Name	Signature	Stamp No.
Irwin		Dylan	Dylan Irwin	DI1

Residence Address	Postal Code	Provincial Registration No.
1595 Third St. Courtright, Ontario	N0N 1H0	WP-T1294.5

Employer Name	Company PQR No.
Greenfield South Power Corporation	GW3-B

Street Address	Company WPS No.used
2275 Lake Shore Blvd. West, Suite 401	GW3-B (A)

	Postal Code
Toronto, ON	M8V 3Y3

Welding Process(es) Used SMAW — **Type(s)** ☑ manual ☐ machine ☐ semi-automatic ☐ automatic

Base Metal Spec. and Type/Grade or UNS No. SA106 Grade B — **Thickness(es)** 0.719 in — ☑ Test Coupon ☐ Production Weld

Variables for All Processes	Actual Values	Range Qualified
Backing (with/without)	F3 All/ F4+	F3 All, and F4+, F1+, F2+, F3+
Base metal P-Number to P-Number	1 to 1	1 through 15F, 34, 41-49
( ) Plate (x) Pipe (enter diameter if pipe or tube)	6"	O.D. 2 7/8" to Unlimited
Filler metal specification (SFA) and classification (QW-404) (info. only)	5.1	
Consumable insert for GTAW or PAW (QW-404)	N/A	
Welding position (1G, 5G, etc.) (QW-405)	6G	all positions, all fillets

Manual or Semi-automatic Variables (QW-350)	Actual Values	Range Qualified
Filler metal F-No. (QW-404)	F3 and F4	F3, F4, F1, F2
Filler metal product form for GTAW, PAW (QW-404)		
Weld deposit thickness for each welding process (QW-404)		
Process 1: SMAW 3 layers minimum ☐ Yes ☑ No	F3 0.125	F3 up to 0.25
Process 2: SMAW 3 layers minimum ☐ Yes ☑ No	F4 0.594	F4 up to 1.188
Vertical progression (uphill/downhill) (QW-405)	Uphill	Uphill, Downhill
GTAW, PAW or GMAW backing gas; or OFW fuel gas (QW-408)	N/A	N/A
GMAW transfer mode (spray/globular or pulse to short circuit) (QW-409)	N/A	N/A
GTAW welding current type & polarity (AC, DCEP, DCEN)(QW-409)	N/A	N/A

Machine Welding Variables (QW-361.2)	Actual Values	Range Qualified
Direct or remote visual control	N/A	N/A
Automatic arc voltage control (GTAW)	N/A	N/A
Automatic joint tracking	N/A	N/A
Multiple or single pass per side	N/A	N/A

Automatic Welding Variables (QW-361.1)	Actual Values	Range Qualified
Filler metal used ☐ Yes ☐ No (EBW or LBW)	N/A	N/A
Laser type for LBW (CO_2 to YAG etc.)	N/A	N/A
Continuous drive or inertia welding (FW)	N/A	N/A
Vacuum or out of vacuum (EBW)	N/A	N/A

Note: Values in "Range Qualified" are valid only when used with a Qualified Welding Procedure.

RESULTS

Visual Examination of Completed Weld (QW-302.4) Acceptable

☐ Transverse root and face bends [QW-462.3(a)]; ☐ Longitudinal root and face bends [QW-462.3(b)]; ☐ Side bends (QW-462.2);
☐ Pipe bend specimen, corrosion-resistant overlay [QW-462.5(c)]; ☐ Plate bend specimen, corrosion-resistant overlay [QW-462.5(d)];
☐ Pipe specimen, macro test for fusion [QW-462.5(b)]; ☐ Plate specimen, macro test for fusion [QW-462.5(e)]

Type	Result	Type	Result	Type	Result	Type	Result

Alternative volumetric examination results (QW-191) Acceptable ☑ RT or UT ☐ (check one)

Fillet weld — fracture test (QW-181.2) _____ Length and percent of defects _____

☐ Fillet welds in plate [QW-462.4(b)] ☐ Fillet welds in pipe [QW-462.4(c)]

Macro examination (QW-184) _____ Fillet size (in.) _____ x _____ Concavity/convexity (in.) _____

Other tests _____

Film or specimens evaluated by (print name) Doug Mitchell Company TEAM Industrial

Mechanical tests conducted by (print name) _____ Laboratory test no. _____

Welding supervised by (print name) Francis Itliong

Test requested by (print name) Monika Vogt Tested at (print address): 477 Oil Springs Line, Courtright

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Boiler and Pressure Vessel Code.

Organization Greenfield South Power Corporation Signature Monika Vogt Date 14-08-2014 (dd-mm-yyyy)

FOR TSSA INSPECTOR USE ONLY

The Welder named above has passed the welding test required under Ontario's ***Technical Standards and Safety Act,*** Boilers and Pressure Vessels Regulation and is hereby authorized, subject to the limitations of this certificate.

Check (✓) applicable box below:

☑ To weld for the Employer named above only.
☐ For seeking employment only.

This Certificate expires: 14-08-2015 (dd-mm-yyyy)

STEPHEN ZHAO #906
Inspector Name and Number (Print)

Inspector Signature and Date

PV 09397 (04/12)

Technical Standards and Safety Authority
14th Floor - Centre Tower
3300 Bloor Street West
Toronto, Ontario M8X 2X4
Web site: www.tssa.org

Welder/Welding Operator Certificate

Technical Standards and Safety Act
Boilers and Pressure Vessels Regulation

No. 312256

Welder's Last Name	Initial	First Name	Signature	Stamp No.
Gleason		Kian		KG1

Residence Address	Postal Code	Provincial Registration No.
20 Vimy Crescent Apt 4, Sarnia, Ontario	N0W1H0	WP-T1294.5

Employer Name	Company PQR No.
Greenfield South Power Corporation	GW3-B

Street Address	Company WPS No.used
2275 Lake Shore Blvd. West, Suite 401	GW3-B (A)

	Postal Code
Toronto, ON	M8V3Y3

Welding Process(es) Used SMAW — **Type(s)** ☑ manual ☐ machine ☐ semi-automatic ☐ automatic

Base Metal Spec. and Type/Grade or UNS No. SA106 Grade B — **Thickness(es)** 0.719 in — ☑ Test Coupon ☐ Production Weld

Variables for All Processes	Actual Values	Range Qualified
Backing (with/without)	F3 All/ F4+	F3 All, and F4+, F1+, F2+, F3+
Base metal P-Number to P-Number	1 to 1	1 through 15F, 34, 41-49
( ) Plate (x) Pipe (enter diameter if pipe or tube)	6"	O.D. 2 7/8" to Unlimited
Filler metal specification (SFA) and classification (QW-404) (info. only)	5.1	
Consumable insert for GTAW or PAW (QW-404)	N/A	
Welding position (1G, 5G, etc.) (QW-405)	6G	all positions, all fillets

Manual or Semi-automatic Variables (QW-350)	Actual Values	Range Qualified
Filler metal F-No. (QW-404)	F3 and F4	F3, F4, F1, F2
Filler metal product form for GTAW, PAW (QW-404)		
Weld deposit thickness for each welding process (QW-404)		
Process 1: SMAW 3 layers minimum ☐ Yes ☑ No	F3 0.125	F3 up to 0.25
Process 2: SMAW 3 layers minimum ☐ Yes ☑ No	F4 0.594	F4 up to 1.188
Vertical progression (uphill/downhill) (QW-405)	Uphill	Uphill, Downhill
GTAW, PAW or GMAW backing gas; or OFW fuel gas (QW-408)	N/A	N/A
GMAW transfer mode (spray/globular or pulse to short circuit) (QW-409)	N/A	N/A
GTAW welding current type & polarity (AC, DCEP, DCEN)(QW-409)	N/A	N/A

Machine Welding Variables (QW-361.2)	Actual Values	Range Qualified
Direct or remote visual control	N/A	N/A
Automatic arc voltage control (GTAW)	N/A	N/A
Automatic joint tracking	N/A	N/A
Multiple or single pass per side	N/A	N/A

Automatic Welding Variables (QW-361.1)	Actual Values	Range Qualified
Filler metal used ☐ Yes ☐ No (EBW or LBW)	N/A	N/A
Laser type for LBW (CO_2 to YAG etc.)	N/A	N/A
Continuous drive or inertia welding (FW)	N/A	N/A
Vacuum or out of vacuum (EBW)	N/A	N/A

Note: Values in "Range Qualified" are valid only when used with a Qualified Welding Procedure.

RESULTS

Visual Examination of Completed Weld (QW-302.4) Acceptable

☐ Transverse root and face bends [QW-462.3(a)]; ☐ Longitudinal root and face bends [QW-462.3(b)]; ☐ Side bends (QW-462.2);
☐ Pipe bend specimen, corrosion-resistant overlay [QW-462.5(c)]; ☐ Plate bend specimen, corrosion-resistant overlay [QW-462.5(d)];
☐ Pipe specimen, macro test for fusion [QW-462.5(b)]; ☐ Plate specimen, macro test for fusion [QW-462.5(e)]

Type	Result	Type	Result	Type	Result	Type	Result

Alternative volumetric examination results (QW-191) Acceptable ☑ RT or UT ☐ (check one)

Fillet weld — fracture test (QW-181.2) _____ Length and percent of defects _____

☐ Fillet welds in plate [QW-462.4(b)] ☐ Fillet welds in pipe [QW-462.4(c)]

Macro examination (QW-184) _____ Fillet size (in.) _____ x _____ Concavity/convexity (in.) _____

Other tests _____

Film or specimens evaluated by (print name) Dave Oldenburg Company TEAM Industrial

Mechanical tests conducted by (print name) _____ Laboratory test no. _____

Welding supervised by (print name) Francis Itliong

Test requested by (print name) Monika Vogt Tested at (print address): 477 Oil Springs Line, Courtright

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Boiler and Pressure Vessel Code.

Organization Greenfield South Power Corporation Signature Monika Vogt Date 18-09-2014 (dd-mm-yyyy)

FOR TSSA INSPECTOR USE ONLY

The Welder named above has passed the welding test required under Ontario's ***Technical Standards and Safety Act,*** Boilers and Pressure Vessels Regulation and is hereby authorized, subject to the limitations of this certificate.

Check (✔) applicable box below:

☑ To weld for the Employer named above only.
☐ For seeking employment only.

This Certificate expires: 18-09-2015 (dd-mm-yyyy)

STEPHEN ZHAO #906
Inspector Name and Number (Print)

Inspector Signature and Date

PV 09397 (04/12)

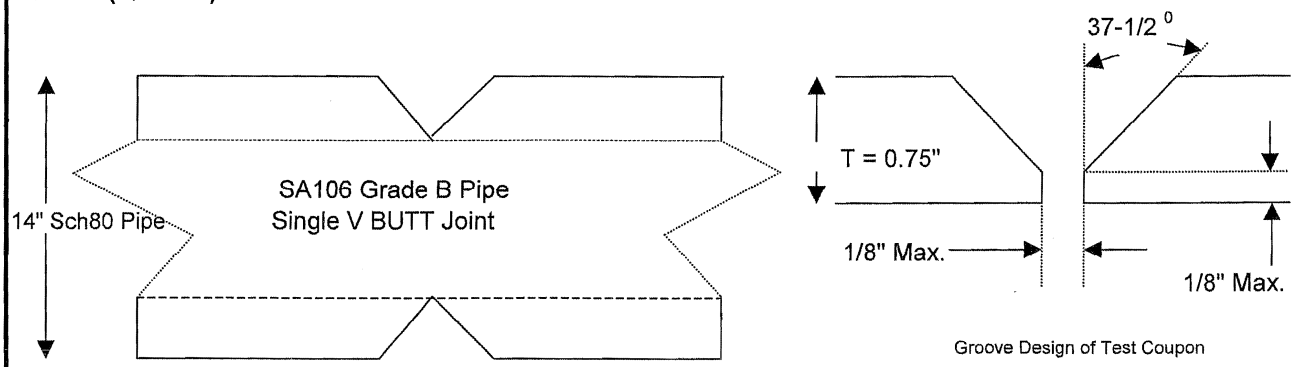
PROCEDURE QUALIFICATION RECORDS (PQR)

(See QW-200.2, Section IX, ASME Boiler and Pressure Vessel Code)

Record Actual Conditions Used to Weld Test Coupon

Company name	Greenfield South Power Corporation
Procedure Qualification Record No.	GW3-B
WPS No.	GW3-B (A)
Welding Process(es)	SMAW (Stick)
Types (Manual, Automatic, Semi-Auto.)	Manual

JOINTS (QW-402)



Groove Design of Test Coupon

(For combination qualifications, the deposited weld metal thickness shall be recorded for each filler metal or process used)

BASE METALS (QW-403)

Material Spec.	SA106		
Type or Grade	Grade B		
P-No.	1	to P-No.	1
Thickness of Test Coupon	0.75"		
Diameter of Test Coupon	14.00"		
Other			

FILLER METALS (QW-404)

SFA Specification	SFA 5.1	SFA 5.1
AWS Classification	E6010	E7018
Filler Metal F-No.	3	4
Weld Metal Analysis A-No.	1	1
Size of Filler Metal	1/8"	3/32"-5/32"
Other		
Weld Metal Thickness	0.125"	0.625"

POSITION (QW-405)

Position of Groove	1 G
Weld Progression (Up Hill, Down Hill)	N / A
Other	

PREHEAT (QW-406)

Preheat Temperature	10^0 C (53^0 F)
Interpass Temperature	93^0 C (200^0 F)
Other	

POSTWELD HEAT TREATMENT (QW-407)

Temperature	1150 +/- 25 Degrees F
Time	1 Hour
Other	

GAS (QW-408)

	Gas(es)	% Composition Mixti	Flow Rate
Shielding		N / A	
Trailing		N / A	
Backing		N / A	

ELECTRICAL CHARACTERISTICS (QW-409)

Current	DC		
Polarity	EP		
Amps.	75 - 220	Volts	24 - 30
Tungsten Electrode Size	N /A		
Other			

TECHNIQUE (QW-410)

Travel Speed	Manual	
String or Weave Bead	Root: String	Others: Weave
Oscillation	N / A	
Multipass or Single Pass (Per Side)	MultiPass	
Single or Multiple Electrodes	Single	
Other		

QW-483 (BACK)

PQR No. GW3-B

Tensile Test (QW-150)

Specimen No.	Width (in)	Thickness (in)	Area (sq. in)	Ultimate Total Load (lb)	Ultimate Unit Stress (psi)	Type of Failure & Location
T1	0.751	0.735	0.5520	39720	72000	Ductile mode in Weld Metal
T2	0.752	0.720	0.5414	38980	72000	Ductile mode in Weld Metal

Guided Bend Tests (QW-160)

Type and Figure No.			Result
1	Side	QW - 462.2	Meets the requirements of QW - 163 of Section IX.
2	Side	QW - 462.2	Meets the requirements of QW - 163 of Section IX.
3	Side	QW - 462.2	Meets the requirements of QW - 163 of Section IX.
4	Side	QW - 462.2	Meets the requirements of QW - 163 of Section IX.

Toughness Tests (QW-170)

Specimen No.	Notch Location	Specimen Size (in)	Test Temp. (F°)	Impact Values ft-lb	%Shear	Mills	Drop Weight Break (Y / N)

Comments:

Technical Standards and Safety Authority — Boilers and Pressure Vessels Safety Program
REGISTERED
W.P.S: WP-T 1294.5
Signed: [signature]
Date: DECEMBER 4, 2006

Fillet Weld Tests (QW-180)

Result - Satisfactory: Yes _____ No _____ Penetration into Parent Metal: Yes _____ No _____

Macro - Results:

Other Tests

Type Of Test:

Deposit Analysis

Other WPS # GM3-BCA)
NOTE: THE MAX. WELD PASS THK. IS 1/2". FC.

Welder's Name PIERCEY G. MERRILL Clock No. _____ Stamp No. 1

Tests Conducted By: Cambridge Materials Testing Limited Laboratory Test No. 430371 - 2006

We certify that the statements in this record are correct and that the tests welds were prepared, welded, and tested in accordance with the requirements of section IX of the ASME code.

Manufacturer Greenfield South Power Corporation

Date: October 27, 2006 By [signature]

(Detail of record of tests are illustrative only and may be modified to conform to the type and number of tests required by the code.)

WELDING PROCEDURE SPECIFICATIONS (WPS)

(See QW-200.1, Section IX, ASME Boiler and Pressure Vessel Code)

Company name Greenfield South Power Corporation

Welding Procedure Specification No. GW3-B (A) Date August 29, 2006 Supporting PQR No. GW3-B

Revision No. 0 Date August 29, 2006

Welding Process(es) SMAW Types (Manual, Automatic, Semi-Auto.) Manual

JOINTS (QW-402)

Joint Design Sigle V

Backing (Yes) No X

Backing Material (Type) N / A

(Refer to both backing and Retainers)

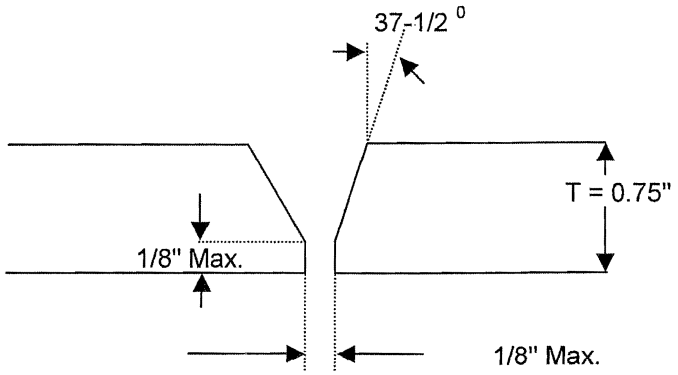
Metal N / A Non Fusing Metal N / A

Non Metalli N / A Other N / A

Sketches, Production Drawings, Weld Symbols or written Description should show the general arrangement of the parts to be welded. Where applicable, the root spacing and the details of weld groove may be Specified.

(At the option of the Mfgr., sketched may be attached to illustrate joint design, weld layers and bead sequence, e.g. for notch toughness procedures for multiple process procedures, etc.)

Details



BASE METALS (QW-403)

P-No. 1 Group No 1 to P-No. 1 Group No 1

OR

Specification Type and Grade SA106 Grade B

To Specification and Grade SA106 Grade B

OR

Chem. Analysis and Mech. Properties

To Chem. Analysis and Mech. Properties

Thickness Range

Base Metal: Groove: 0.1875" to 1.50"" Fillet: All thicknesses & Pipe / Tube Diameters

Other

FILLER METALS (QW-404)			
SFA Specification No.		SFA 5.1	SFA 5.1
AWS Classification No.		E6010	E7018
Filler Metal F-No.		3	4
Weld Metal Analysis A-No.		1	1
Size of Filler Metals		1/8"	3/32" - 5/32"
Weld Metal Thickness Range			
	Groove	0.250" Max.	1.25" (Max.)
	Fillet	All Sizes of Fillet welds	All Sizes of Fillet welds
Electrode-Flux (Class)	N / A		
Flux Trade Name	N / A		
Consumable Insert	N / A		
Other			

QW-482 (Back)

WPS # GW3-B (A) PQR# GW3-B

POSITION (QW-405)

Position(s) of Groove: All Positions (Electrodes <=3/16")
Welding Progression: Up Hill Down Hill
Positions of Fillet All Positions (Electrodes <=3/16")

POSTWELD HEAT TREATMENT(QW-407)

Temperaure Range 1150 +/- 25 Degrees F
Time Range 1 Hour / INCH.

GAS (QW-408)

	Percent composition		
	Gas(es)	(Mixture)	Flow Rate
Shielding	N / A	N / A	N / A
Trailing			
Backing			

PREHEAT (QW-406)

Preheat Temp. Min. 10^0 C (53^0 F)
Interpass Temp. Max 93^0 C (200^0 F)
Preheat Maintenance 93^0 C (200^0 F)
(Continuous or Special Heating, where applicable should be recorded)

ELECTRICAL CHARACTERISTICS (QW-409)

Current AC or DC DC Polarity EP (Electrode Positive)
Amps (Range) 40 - 220 Amps Volts (Range) 24 - 30 Volts

(Amps and Volts range should be recorded for each electrode size, position and thickness etc.. This information may be listed in a tabular form similar to that shown below).

Tungsten Electrode Type and Size N / A
(Pure Tungsten, 2% Thoriated, etc.)
Mode of Metal Transfer for GMAW N / A
(Spray Arc, Short Circuting Arc, etc.)

Electrode Wire Feed Speed Range N / A

TECHNIQUE (QW-410)

String or Weave Bead Root is Stringer and others with weaving
Orifice or Gas Cup Size N / A
Initial and Interpass Cleaning (Brushing, Grinding etc.) Chipping, Grinding and Wire Brushing
Method of Back Gouging N / A
Oscillation N / A
Contact Tube to Work Distance N / A
Multiple or Single Pass per Side Multiple Passes per single side
Multiple or Single Electrodes Single Electrode
Travel Speed (Range) Manual
Peening No peening
Other

Weld Layer(s)	Process	Filler Metal Class	Filler Metal Dia	Current Type Polarity	Current Amp Range	Volt Range	Travel Speed Range	Other
1	SMAW	E6010	1/8"	DCEP	75-125	26-30	Manual	None
2	SMAW	E7018	3/32"	DCEP	40-80	24-28	Manual	None
3	SMAW	E7018	1/8"	DCEP	115 - 165	24-28	Manual	None
4	SMAW	E7018	5/32"	DCEP	150 - 220	24-28	Manual	None
5	SMAW	E7018	5/32"	DCEP	150 - 220	24-28	Manual	None
6	SMAW	E7018	5/32"	DCEP	150 - 220	24-28	Manual	None

Greenfield South Welder Qualidications
October 29, 2014

Weld Procedure	Material
GW4-A	P91
GW3-B(A)	Carbon Steel
GW1-A	Stainless Steel

Trade	Name	Stamp Number	Qualifying To Procedures			Completed and Results		
			GW4-A	GW3-B(A)	GW1-A	GW4-A	GW3-B(A)	GW1-A
Pipefitters	Trevor Mecneil	TM1	P91	Carbon Steel	Stainless Steel	Pass	Pass	Pass
	Matthew James	MJ1	P91	Carbon Steel	Stainless Steel	Pass	Pass	Pass
	Cecil Rastoule	CR1	P91	Carbon Steel	Stainless Steel	Pass	Pass	Pass
	Reid J. Rankin	RR1	P91	Carbon Steel	Stainless Steel		Pass	*Progress
	Arthur McDonald	AM2	P91	Carbon Steel	Stainless Steel	-	Pass	-
	Joshua Lawrence	JL1	P91	Carbon Steel	Stainless Steel		Pass	*Progress
	Ron Muxlow	RM1	P91	Carbon Steel	Stainless Steel	Pass	Pass	
	Jeremy Fisher	JF1	P91	Carbon Steel	Stainless Steel	Pass	Pass	
	John P. Jones	JJ2	P91	Carbon Steel	Stainless Steel	Pass	Pass	
	Glenn Sauve	GS3	P91	Carbon Steel	Stainless Steel	Pass	Pass	Pass
	Dylan Irwin	DI1	-	Carbon Steel	-	-	Pass	-
	Kian Gleason	KG1	P91	Carbon Steel	Stainless Steel	Pass	Pass	?

Greenfield South Power Corporation
2275 Lake Shore Blvd. West, Suite 401
Toronto, ON M8V 3Y3

Quality Control Manual for Fabrication, Assembly and Erection of Power Piping Systems at Field Sites Controlled by the Above Location in accordance with CSA B51, ASME B31.1 Power Piping

Control Manual # 1
Issue # 1

Authorized by:
Hubert S. Vogt, P.Eng.
Vice President

Date: February 10, 2014

TABLE OF CONTENTS

Authorized by QC Manager:  Date: Feb 10/14

Accepted by (AI): Date: Feb 10/2014

STATEMENT OF AUTHORITY

This manual contains the requirements deemed necessary by this Company for the fabrication, assembly and erection of Power Piping Systems at field sites controlled at 2275 Lake Shore Blvd. West, Suite 401, Toronto in accordance with CSA-B51 and ASME B31.1 Power Piping.

Note: This manual does not cover the requirements for boiler proper piping under the jurisdiction of ASME Section I for Power Boilers, or for piping Codes other than those listed above.

The Quality Control Manager has the authority and responsibility to enforce the Quality Control system described, and the organizational freedom to identify Quality Control problems and to initiate, recommend and provide solutions, including the authority to stop work when necessary.

In the event of conflict between the Quality Control Manager and other personnel, problems shall be brought to me for final resolution in accordance with the applicable Code and this Quality Control Manual's requirements.

This Quality Control Manual and future revisions or additions to this manual and its implementation have the full support of management.

Signed: 

Name: Hubert S. Vogt, P.Eng.

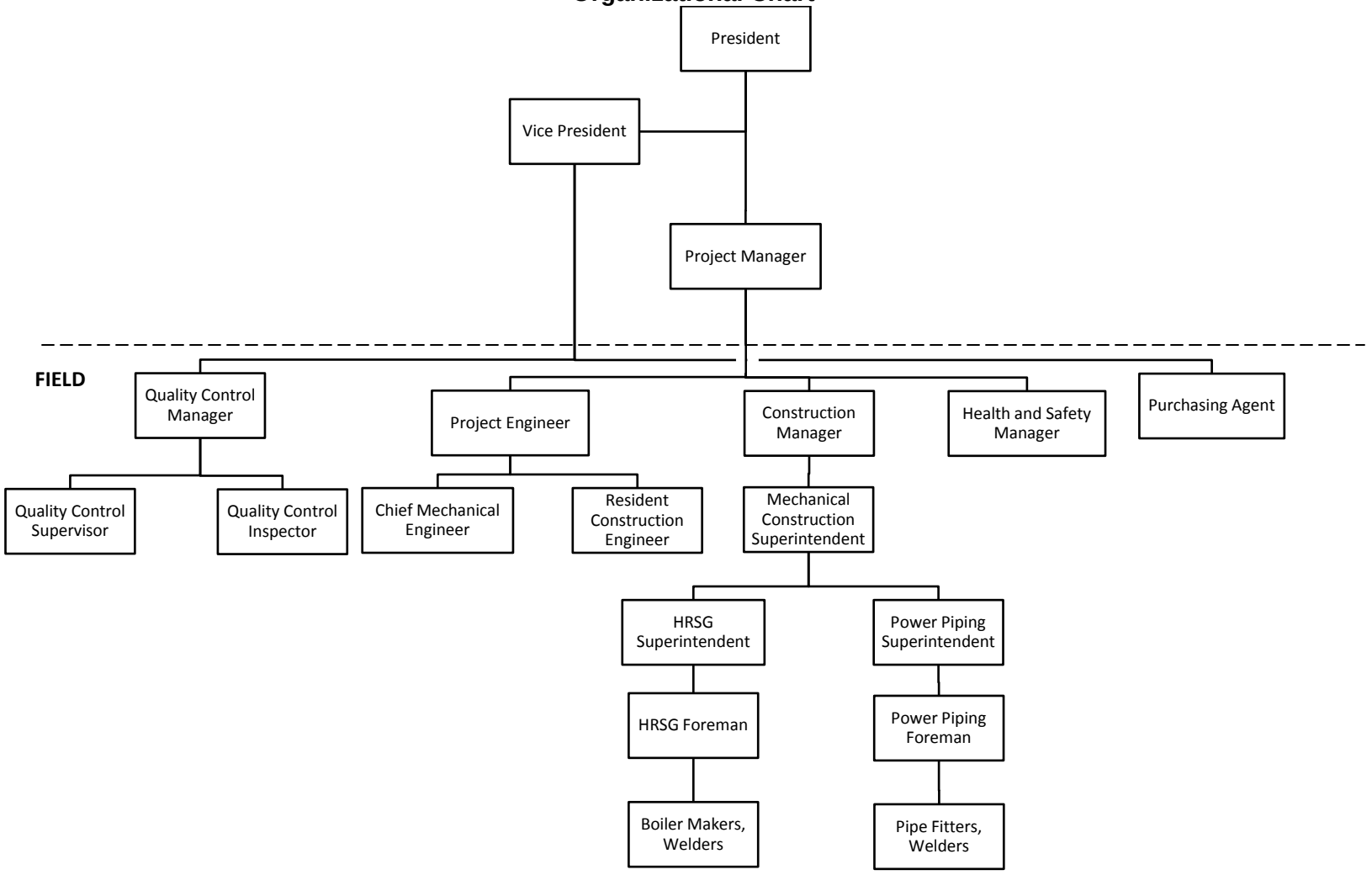
Title: Vice President

Date: February 10, 2014

Revision Control Record

Rev	Section	Paragraph	Description	Quality Control Manager	Authorized Inspector
0	all	all	New issue	[signature] FEB/10/14	[signature] Feb 10/2014

Organizational Chart



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Note: Also field staff, when required

MANUAL REVISION CONTROL

1.0 The Quality Control Manager is responsible for the control, preparation, approval, revision, distribution and implementation of this Quality Control Manual.

1.1 The Quality Control Manager reviews ASME Code Addenda and makes any required changes to the manual within six (6) months of the addenda issue date.

1.2 Revision of the manual will be carried out by changing any affected portion(s), advancing the revision number on each page of that section and adding the revision number enclosed in a triangle in the right hand column adjacent to each change, for all revisions after 0 (Original Issue).

1.3 All proposed revisions shall be submitted to the Authorized Inspector for acceptance prior to inclusion or implementation. This acceptance will be indicated by signing of the accepted revisions shown on a Revision Control Record (see page iii).

1.4 The Revision Control Record, Table of Contents page and all revised sections will be updated to indicate all revisions and presented to the Authorized Inspector for acceptance. After acceptance by the Authorized Inspector, a copy of these documents will be distributed to all controlled manual holders for inclusion in their copy. Insertion of revisions is the responsibility of each recipient. Acknowledgement of receipt is indicated on the Document Transmittal (Exhibit #7), which is returned to the Quality Control Manager.

1.5 A distribution log of controlled manual holders shall be maintained by the Quality control Manager. Only holders of controlled manuals will receive revisions as described in 1.2 above.

1.6 If uncontrolled copies of the manual are issued, they will be current at the time of issue, but will not be logged nor will they be updated as new revisions are issued.

DRAWINGS, DESIGN CALCULATIONS AND SPECIFICATIONS

2.0 It is the responsibility of the Quality Control Manager to ensure that piping system drawings are submitted to the TSSA for registration.

2.1 The drawing information shall contain as a minimum the following information:

- Code of construction
- Design temperature and pressure
- Safety valve setting and location
- Service fluid
- Test pressure and the type of test (hydrostatic, pneumatic, etc.)

2.2 Specifications:

- Pipe size and schedule
- Pipe material specifications (ASME/ASTM)
- Firing classification, identification, rating and fitting registration number
- Pipe joining methods (welding, brazing, etc.)
- Non-destructive examination
- Statement describing maximum support spacing, type and anchor location

2.3 For piping, sufficient calculations shall be provided to the TSSA design registration engineer to permit design registration to take place.

MATERIAL CONTROL

3.0 All material is ordered from a Purchase Order form (Exhibit #1) based upon the information provided in the bill of material. It may be prepared by the Quality Control Manager or any other personnel and shall be approved by the Vice President.

3.1 The Quality Control Manager will ensure that all material is ordered to the correct ASME or ASTM specification as shown in the registered design. No substitution of material shall be permitted without the approval of the Quality Control Manager and the concurrence of the Authorized Inspector.

3.2 All Purchase Orders (Exhibit #1) are prepared by the Quality Control Manager or any other personnel and shall include, as a minimum, the following:

a) Purchase Order Number.
b) Date and Work Order Number.
c) Material description, identification, specifications and Code section.
d) Requirements for copies of mill test reports from the producing mill, or certificates of compliance when specified by the Code.
e) Partial Data Reports for parts manufactured by sub-vendors.
f) Any supplementary Code and/or quality requirements.

3.3 Distribution of Purchase Orders is as follows:

a) One copy Head Office
b) One copy Quality Control Manager
c) One copy on-site
d)

RECEIVING INSPECTION

3.4 Upon receipt, the Field Foreman checks the material and the quantity received after unloading in the receiving area, and if satisfied signs the shipping packing slip, indicating the number of pieces received. After signing, the packing slip is attached to the Purchase Order (Exhibit # 1) Field Copy and is filed with the on-site copy. Quality control is advised.

3.5 The Quality Control Inspector is responsible for conducting a visual and dimensional inspection of incoming material to assure compliance with requirements, and will use the Receiving Inspection Report (Exhibit #2) to record the results of the inspection.

MATERIAL CONTROL

3.6 For piping, the Field Foreman will ensure that the identification marking is traceable to the ASME or ASTM specification:

a) After cutting, the material will be given a colour code or number code for traceability to the original specification.
b) If unlisted material is used, the material must be traceable to a specification and mill test reports are mandatory. Unlisted material may only be used when accepted by TSSA and allowed by the Code of construction.

3.7 The Quality Control Manager has the responsibility of accepting all documentation received with the material, and will compare the physical and chemical properties as stated on the copies of the original mill test reports for compliance with Section 11 of the ASME Code, plus any other special ASME Code requirements.

3.8 After verifying the original identification markings, the Quality Control Manager will initial the test reports, ensure that the work order number is marked on them and place a copy in the job file.

3.9 All other documentation will then be checked such as partial data reports, formed head certification, certificates of compliance, etc., and if they are in order, the Quality Control Manager will initial them, enter the work order number, and place the documentation in the job file.

3.10 When material is found to be acceptable, it is marked with the work order number and sprayed green. If for stock, it will be marked with the applicable purchase order number and sprayed green. If found non-conforming, it is tagged “Hold” (Exhibit #5) and handled in accordance with Section 5 of this manual.

3.11 Items too small to accommodate markings, will be suitably bundled and tagged with a green acceptance tag (Exhibit #5) which will have the work order or purchase order number on it as applicable.

WELDING MATERIAL

3.12 Welding Material will be procured by the Quality Control Manager or his designate upon receipt of purchase requisition from the Field Foreman.

3.13 All welding material will be ordered to Section 11, Part C, of the ASME Code (SFA Specifications) and the Quality Control Inspector will be responsible for checking and accepting incoming welding material as being in compliance with the purchase order and ASME requirements.

MATERIAL CONTROL

3.14 Any damaged or non-conforming welding material will be rejected and returned to the supplier, and the reason noted on the purchase order copy.

MATERIAL ORDERED FOR STOCK

3.15 Material will be ordered for stock by the Field Foreman who will issue a memo to the Purchasing Agent when supplies fall below a pre-determined level, as determined by the Field Foreman. The Purchasing Agent will issue a Purchase Order (Exhibit #1) for this material in the same way as outlined in Paragraph 3.2.

EXAMINATION AND INSPECTION PROGRAM

4.0 When Piping work is scheduled for production, the Quality Control Manager shall be responsible for ensuring that it is in accordance with ASME B31.1 of the ASME Code and the latest revision of the accepted drawings.

> Note: Annual eye examinations shall be performed on all personnel performing inspections when required by the Code of Construction. It is the responsibility of the Quality Control Manager to ensure these examinations are carried out and the records maintained.

4.1 The Quality Control Manager will prepare an Inspection and Test Checklist (Exhibit #3) which will list all the important stages of repair or alteration that require examination, and will provide columns for sign off and dating of inspections performed by Quality Control personnel when each function is complete. No work shall proceed past these inspection points until the Quality Control Manager or his delegate has signed them off.

4.2 The Inspection and Test Checklist (Exhibit #3) will also list the welding procedures to be used, non-destructive examination or heat treatment requirements, and any other special inspection functions required pertaining to the fabrication or testing of the boiler or pressure vessel. The checklist will also provide columns for hold points, sign off and dating of any inspection performed by the Authorized Inspector.

4.3 Prior to the start of fabrication, the Quality Control Manager will notify the Authorized Inspector, and make available the Inspection and Test Checklist, latest revised drawings, design calculations and all job related documents required by the Authorized Inspector, for initial review and designation of mandatory hold points on the Inspection and Test Checklist.

4.4 No work shall proceed past these hold points until signed off by the Authorized Inspector, and the Quality Control Manager will give the Authorized Inspector sufficient notice in advance of such upcoming hold points to permit the required inspections to be carried out.

4.5 The Quality Control Manager and personnel will be responsible for examination and testing of parts before, during and after fabrication, ensuring that all required inspection points are signed off and accepted before the next step of fabrication proceeds. Parts and/or workmanship that fail to meet any of the requirements will be identified with a "Hold Tag" (Exhibit #5) and held as being non-conforming as per Section 5.

4.6 The Field Foreman will ascertain from the Quality Control Manager that material in the storage area has been released for fabrication before moving it to the manufacturing area.

EXAMINATION AND INSPECTION PROGRAM

4.7 Heat identification and work order numbers on material will be transferred prior to cutting into two or more parts. The Quality Control Manager will verify this operation. The work order number must be specified on all items and parts to maintain traceability throughout fabrication. See paragraph 3.3(a) and (b) for piping.

4.8 Traceability of the material to the original identification markings shall be by one or more of the following methods: accurate transfer of the original identification markings to a location where the markings will be visible on the completed item; identification by a coded marking traceable to the original required marking; or recording the required markings using, methods such as material tabulations or as built sketches which assure identification of each piece of material during fabrication and subsequent identification in the completed item.

4.9 In addition to the inspection functions detailed in the Inspection and Test Checklist (Exhibit #3), the Quality Control Manager or designee shall ensure that:

a) Welding is completed as per the weld procedure specifications.
b) Non-destructive examination, including radiography is carried out if required and any subsequent repairs completed satisfactorily.
c) Welds are ground if required, nozzles radiuses and a full dimensional check made on weld reinforcements, fillet welds etc. to ensure design and Code conformity.
d) Heat treatment charts, radiographs and any non-destructive examination reports are reviewed and accepted prior to the hydrostatic test.
e) Adequate supports are provided, properly installed and fastened. (Table S1, page 4)
f) Flexible hoses have CRN's and are of the correct pressure/temperature rating and type for the service.

4.10 No weld repairs are allowed to be made to material without prior consultation with the Authorized Inspector for concurrence with the proposed repair procedure.

4.11 The Quality Control Manager will be responsible for performing the final inspection and monitoring the final Hydrostatic Test, which will also be witnessed by the Authorized Inspector.

4.12 The Quality Control Manager will examine the Inspection and Test Checklist to ensure that all required examinations and tests have been witnessed and signed off, and that the Job File documentation such as Material Certification, Partial Data Reports, Non-Destructive Examination Reports, Heat Treatment charts, etc., have been accepted and signed off where necessary.

EXAMINATION AND INSPECTION PROGRAM

4.13 The Hydrostatic Test procedure shall be in conformance with the requirements of the applicable ASME Code section and contractual requirements if any and include the following:

a) All welding and repairs must be completed before testing.
b) Suitable means will be provided to ensure the exclusion of all air within the piping.
c) The piping and water temperatures shall not be below 70 degrees Fahrenheit and all exterior surfaces must be dry. Testing will not be carried out if the piping item is "sweating" due to humid conditions.
d) A currently calibrated pressure test gauge, supplied by the Quality Control Manager, will be attached to the highest point on the vessel or piping system. It shall be graduated to not less than 1 1/2 times, and approximately twice but not more than 4 times the test pressure.
e) The test pressure shall be as per the accepted drawing and applicable Code requirements; held for approximately 15 minutes with sufficient time to allow for a complete visual examination of the piping, boiler or pressure vessel, and shall not be exceeded by more than 6% for power boilers.

4.14 For hydrostatic and pneumatic testing of piping, the requirements shall be implemented as described in ASME B31.1, Section 137.

4.15 For piping, should a pneumatic test be permitted, special precautions must be taken to ensure personnel safety and the provisions of the applicable Code section(s) adhered to.

4.16 For piping parts or systems, the Quality Control Manager shall complete the TSSA Piping Systems Installation Test Data Report and present it to the Authorized Inspector for his signature and date when accepted.

TABLE S1

ASME B31.1

TABLE 121.5
SUGGESTED PIPE SUPPORT SPACING

Nominal Pipe Size (NPS) inches	Suggested Maximum Support Span			
	Water Service		Steam. Gas, or Air Service	
	Feet	Metre	Feet	Metre
1	7	2.1	9	2.7
2	10	3.0	13	4.0
3	12	3.7	15	4.6
4	14	4.3	17	5.2
6	17	5.2	21	6.4
8	19	5.8	24	7.3
12	23	7.0	30	9.1
16	27	8.2	35	10.7
20	30	9.1	39	11.9
24	32	9.8	42	12.8

GENERAL NOTES:

a) Suggested maximum spacing between pipe supports for horizontal straight runs of standard and heavier pipe at maximum operating temperature of 750°F (400°C).

b) Does not apply where span calculations are made or where there are concentrated loads between supports, such as flanges, valves, specialties, etc.

c) The spacing is based on affixed beam support with a bending stress not exceeding 2300 psi (15.86 MPa) and insulated pipe filled with water or the equivalent weight of steel pipe for steam, gas or air service, and the pitch of the line is such that a sag of 0.1 inches (2.5 mm) between supports is permissible.

CORRECTION OF NON-CONFORMITIES

5.0 Non-conformities are conditions that fail to meet the applicable rules of CSA-B51 or the applicable ASME Code.

5.1 Non-conformities may be identified as follows:

a) Use-as-is
b) Repair or Rework using an approved procedure
c) Scrap

5.2 When non-conformities are discovered, the Field Foreman shall identify the non-conforming item by affixing a red "HOLD" tag (Exhibit #5) to the part, and where size permits, the affected item will be segregated from any conforming items in a "Hold area". Larger items shall be considered segregated if they are conspicuously identified with the HOLD tag. The reason for the non-conformity will be briefly noted on the HOLD tag by the Field Foreman who will initial it and then notify the Quality Control Manager.

5.3 The Quality Control Manager will be responsible for preparing a Non-Conformance Report (Exhibit #4), which will be numbered for easy reference. This report will describe the item(s) affected, non-conforming condition, work order number, drawing number and part number (if applicable). No work will be allowed to proceed on the item until a satisfactory solution to the non-conformity has been provided.

5.4 Non-conformities will be reviewed by the Field Foreman, and the Quality Control Manager. The proposed action must be approved by the Quality Control Manager. The Authorized Inspector will be asked for concurrence before the proposed action is implemented. The Authorized Inspector will be given the opportunity to designate additional "HOLD points" on a revised Inspection and Test Checklist should any welding repairs be proposed including repairs to material. Authorized Inspector concurrence must also be obtained for any welding procedures to be utilized.

5.5 Items identified as "Use-as-is" require an engineering resolution. The Quality Control Manager will review and approve such proposed action and the Authorized Inspector concurrence shall be obtained.

5.6 Items identified as scrap may be disposed of without further input from the Authorized Inspector.

CORRECTION OF NON-CONFORMITIES

5.7 When the non-conformance situation is resolved and final inspection of the proposed action is complete, the Quality Control Manager will complete the Non-Conformance Report, obtain signatures of those concerned and forward copies of the report to the affected personnel. All Non-Conformance Reports will be made available to the Authorized Inspector for review. Copies of all Non-Conformance Reports shall be maintained by the Quality Control Manager.

5.8 The Quality Control Manager will be responsible for removing "HOLD" tags, signing off and retaining Non-Conformance Reports in the Job File, and for maintaining an effective follow up program to ensure prompt action is taken to remedy the cause of non-conformities.

5.9 Materials, parts and/or documentation identified as scrap on the Non-Conformance Report shall be tagged with a red tag, labeled as “SCRAP” (Exhibit #5) by the Quality Control Manager and removed from the work area immediately.

WELDING CONTROL

Note: All welding to include the word brazing as well

6.0 All welding, including tack welding, shall be performed by welders or welding operators qualified to welding procedure specifications (WPS) that have been written and subsequently qualified to Section IX of the ASME Code, plus any additional requirements of the applicable Code section to which the work is being performed. It is the responsibility of the Quality Control Manager to review the welding requirements in the applicable Codes of construction to ensure that the construction Codes do not take exception to what is permitted by ASME Section IX.

6.1 All documentation and records of qualified welding procedures and personnel shall be maintained and kept on file by the Quality Control Manager.

WELDING PROCEDURES AND PERSONNEL QUALIFICATION

6.2 The Quality Control Manager is responsible for developing the welding parameters required by the ASME Code and will liaise with the Mechanical Design Engineer in preparation of the welding procedure specifications to be used for production.

6.3 Welding procedure specifications will take into account the process to be used, type of material, qualification limits, etc., required by the applicable specifications. They will be documented on a Welding Procedure Specification Sheet which will list the essential, non-essential and where necessary supplementary essential variables within the process to be used.

6.4 Any revisions and/or updating of welding procedures will be the responsibility of the Quality Control Manager and the Quality Control Manager will be responsible for the disposal of voided procedures.

6.5 The Quality Control Manager will conduct the qualification tests for each procedure to be utilized, which will also be witnessed by the Authorized Inspector. The weldments to be tested for qualification of procedures shall be welded either by direct employees or by individuals engaged by contract for their services as welder or welding operators under the full supervision and control of Greenfield South Power Corporation.

6.6 All variables, if recorded, shall be the actual variables (including ranges) used during the welding of the test coupon. Variables that are not monitored during welding shall not be recorded.

6.7 It is permissible to subcontract any or all of the work of preparation of test metal for welding and subsequent work on preparation of test specimens from the completed weldment, performance of non-destructive examination and mechanical tests provided that Greenfield South Power Corporation accepts the responsibility for any such work.

WELDING CONTROL

6.8 When the WPS has been qualified, in accordance with the ASME Code requirements, the results will be documented on a Procedure Qualification Record (PQR) by the Quality Control Manager who will date and certify this document on behalf of the Company.

6.9 Copies of the WPS and the PQR will be submitted to the relevant jurisdiction for registration by the Quality Control Manager. The Quality Control Manager will liaise with the subcontracted test laboratory and keep all of the test results on file.

6.10 The Quality Control Manager will conduct/supervise the Welder/Welding Operator Performance Qualification Tests in accordance with the qualified welding procedures. These tests will also be witnessed by the Authorized Inspector. The welders or welding operators used to produce test weldments shall be under the full supervision and control of Greenfield South Power Corporation during the production of these test weldments.

6.11 The Quality Control Manager will be responsible for documenting and certifying the Welder Performance Test form on behalf of the company.

6.12 A Welders Record Log (Exhibit #8) shall be maintained by the Quality Control Manager which will list the process or processes for which each welder is qualified. This will record, on a monthly basis, evidence that the welder maintains current qualification(s) on each process.

6.13 A welder or welding operator must be re-qualified when one of the following conditions occurs:

a) When he has not welded with a process during a period of 6 months or more, his qualifications for that process shall expire; unless, within the six month period prior to his expiration of qualification.
b) A welder has welded using a manual or semi-automatic welding process which maintain his qualification for manual and semi-automatic welding with that process
c) A welding operator has welded with a machine or automatic welding process which will maintain his qualification for machine and automatic welding with that process.
d) When there is a specific reason to question his ability to make welds that meet the specification, the qualifications which support the welding he is doing shall be revoked. All other qualifications not questioned remain in effect.

WELDING CONTROL

PRODUCTION WELDING

e) The Authorized Inspector shall have the right to require re-qualification of any welding procedure. The Quality Control Manager will make available all documentation and records pertaining to welding for the Authorized Inspector's review.

6.14 The Quality Control Manager shall have control over production welding and will be responsible for:

a) Ensuring that all welders are provided with and are qualified to the applicable WPS required for the job and that correct instructions are given in the use of the WPS.
b) Verifying that the copies of the WPS to be used in fabrication are specified on the shop drawings and are available to the welders in the weld area.

6.15 All qualified welders and welding operators will be issued with an identification number to be used for stamping adjacent to any welded joints made by them at intervals of not greater than three (3) feet. Where stamping is not feasible, the Quality Control Manager shall keep a Weld Map which will record the welded joints performed by the qualified welder.

6.16 A log of the identification number of welders or welding operators will be maintained by the Quality Control Manager. Should a welder or welding operator's employment be terminated, the welder’s or welding operator’s identification number will not be used for a minimum period of twelve months.

6.17 Tack welding will only be performed by qualified welders to qualified welding procedures. Tack welds shall be removed or properly prepared for inclusion in the final weld. They will be visually inspected for cracks by the welder or welding operator prior to welding. Cracked tack welds will be completely removed.

CLEANING OF SURFACES TO BE WELDED

6.18 The surfaces to be welded shall be clean and free of scale, rust, oil, grease, slag, detrimental oxides and other deleterious foreign material. The method and extent of cleaning should be determined based on the material to be welded and the contaminant to be removed. When weld metal is to be deposited over a previously welded surface, all slag shall be removed by a roughing tool, chisel, chipping hammer or other suitable means to prevent inclusion of impurities in the weld metal.

6.19 Cast surfaces to be welded shall be machined, chipped, or ground to remove foundry scale and to expose sound metal.

WELDING CONTROL

REPAIR OF WELD DEFECTS

6.20 Defects such as cracks, pinholes and incomplete fusion, detected visually or by hydrostatic or pneumatic test or by the examinations prescribed in the Code of construction shall be removed by mechanical means or by thermal gouging processes after which the joint shall be re-welded.

WELDING MATERIAL

6.21 The Quality Control Manager is responsible for systematically checking welding material in storage and in use for proper handling, application, protection and distribution. Welding material will be stored in designated clean, dry areas and stainless steel material will be separated from carbon steel material.

6.22 Bare rods and welding wire will be kept in individual containers according to size and type and these containers will be properly marked for identification. Flux material will be stored in individually identified bins in a clean dry storage area.

6.23 Low hydrogen electrodes will be purchased, received and stored in hermetically sealed containers. When the containers are opened the electrodes will be placed in a heated holding oven prior to issuing to the welders. This oven will be maintained at a temperature recommended by the electrode manufacturer.

6.24 The Quality Control Manager will control the issue and return of these low hydrogen electrodes and will keep a weld rod issue log showing times, dates, quantities issued and returned.

6.25 Low hydrogen electrodes will be issued only in sufficient quantity to complete a weld or for a four hour period, whichever is less, after which unconsumed electrodes will be examined by the Quality Control Manager for condition, cleanliness and identification prior to returning them to the holding oven.

6.26 Damaged electrodes will be scrapped and a bin will be provided in the weld area for rod end disposal.

6.27 Welding gases will be subjected to the same control as other welding materials and the Quality Control Manager will ensure that welding gas cylinders and supply piping are properly identified before use.

NON-DESTRUCTIVE EXAMINATION

7.0 All non-destructive examinations (NDE) and procedures will be made in accordance with ASME Section V and the requirements of the applicable Code section to which the work is being performed. The responsibility for determining NDE requirements rests with the Quality Control Manager. NDE service will be performed for the Company by an approved sub-contractor, employing a qualified Level III CGSB Examiner.

7.1 The Quality Control Manager will review the qualification records of the sub-contractor and ensure that the Level III Examiner and personnel supervised by him are properly qualified and certified in accordance with CGSB requirements.

7.2 The sub-contractor's Level III CGSB examiner shall be responsible for the preparation of any required written NDE procedures (including Ultrasonic Testing, Liquid Penetrant and Magnetic Particle examination procedures) and any shooting sketches, which will be reviewed and accepted by the Quality Control Manager for compliance with all the requirements of the applicable ASME Codes. The Quality Control Manager will also be responsible for acceptance of any revisions and the disposal of voided procedures.

7.3 A documented record of qualification levels, training, examinations and past experience shall be maintained by the Quality Control Manager for each NDE technician employed by the sub-contractor performing ASME Code NDE examinations for the Company.

7.4 The sub-contractor's written procedures and all personnel qualification records will be made available to the Authorized Inspector for review.

7.5 All NDE procedures shall be demonstrated as being capable of producing meaningful results to the satisfaction of the Authorized Inspector. The Authorized Inspector has the right to request re-qualification of any NDE procedures or personnel.

7.6 All radiographs shall be interpreted by a Level II or III Examiner before presentation to the Quality Control Manager, who will review and accept these and any other NDE results, on behalf of the Company.

NON-DESTRUCTIVE EXAMINATION

7.7 The Quality Control Manager shall be responsible for the review, interpretation, evaluation and acceptance of all completed radiographs to assure compliance with the requirements of the Code, on behalf of the company.

7.8 As an aid to review and evaluation, radiographic technique documentation shall be completed prior to the evaluation. A radiograph review form shall be completed during the evaluation showing the name of the Manufacturer's representative who performed the final acceptance of the radiographs and date performed. Acceptance shall be completed prior to presentation of the radiographs and accompanying documentation to the Authorized Inspector.

7.9 Liquid Penetrant and Magnetic Particle examinations are performed by sub-contractors personnel, who are qualified and certified in accordance with CGSB Standards.

7.10 To meet Canadian Jurisdictional requirements, NDE personnel shall be certified to the CGSB standard as conducted by the Canadian Government, Department of Energy Mines and Resources. The standards are as follows:

CAN/CGSB-4g.9712-95 "Qualification and Certification of Non-destructive Testing Personnel"

Only CGSB Level III personnel are permitted to develop procedures.

7.11 For visual examination of Power Piping, individuals shall be qualified in accordance with ANSI B31.1. For Radiography requirements, see Table R1.

7.12 Radiography requirements for ASME B31.1 Power Piping shall be performed as per Table 136.4, the acceptance criteria are listed in 136.5 for that Code.

HEAT TREATMENT

8.0 All Post Weld Heat Treatment (PWHT) will be carried out by outside contractors

8.1 The Quality Control Manager shall ensure that all PWHT procedures are in accordance with the requirements of the Code of construction and ASME B31.1.

8.2 The Quality Control Manager will be responsible for the following:

a) approval and acceptance of the PWHT procedures,
b) the identification and traceability of items being heat treated,
c) acceptance of the calibration records for the equipment used, and
d) acceptance for the time/temperature chart(s).

8.3 The Quality Control Manager shall file and retain all reports for the Authorized Inspector.

CALIBRATION

9.0 Examination, measuring and test equipment not required to be calibrated, such as linear scales, steel tapes, rules, squares, levels, etc. used for non-precision measurement or layout, will be examined at regular intervals by The Quality Control Manager who will be responsible for ensuring that they are kept in good condition. Any such equipment found worn or damaged will be replaced.

9.1 Examination, measuring and test equipment, including pressure gauges, requiring calibration shall be under the control of the Quality Control Manager who shall be responsible for the following:

a) Ensuring that all items are maintained in good condition and are checked for signs of damage before use.
b) Removal from service of any such equipment found to be defective, or suspected to be so.
c) Ensuring only equipment currently in calibration is used.
d) Performing, or arranging for calibration of measuring and test equipment, the results of which shall be traceable to National Standards.
e) Establishing and maintaining a calibration frequency schedule for the type of equipment and its corresponding amount of use.

9.2 All calibrated items shall be permanently identified with an identification or serial number and shall have a label or sticker affixed showing the identification or serial number, date calibrated and due calibration date.

9.3 The Quality Control Manager will maintain a Record of Calibration (Exhibit # 6) for each piece of measuring and test equipment showing:

a) Type of equipment
b) Identification and serial number
c) Location
d) Calibration frequency
e) Check method and tolerance
f) Date of calibration and next due date
g) Result of calibration and person or organization performing the calibration

CALIBRATION

9.4 Master pressure test gauges shall be calibrated every twelve months. This calibration shall be performed by an approved testing laboratory using a dead weight tester traceable to National Standards for certification.

9.5 Hydrostatic pressure test gauges shall be checked against the master pressure gauge once every three months or when an error is suspected, or before any hydrostatic test.

9.6 Parts checked since the previous calibration with equipment found to be in error or out of calibration shall be considered unacceptable until it can be determined that all requirements have been met.

9.7 Examination, measuring and testing equipment found to be defective are to be immediately withdrawn from service by the Quality Control Manager and tagged as such, until it has been repaired or replaced in accordance with this section.

9.8 When new items of measuring and test equipment are purchased, they shall be delivered to the Quality Control Manager for checking, proper labeling and records of calibration to be established.

9.9 All measuring and test equipment records will be kept on file and maintained in good order by the Quality Control Manager who will make these records available for review by the Authorized Inspector.

9.10 The calibration records for all equipment owned by the employees or subcontractors and used to verify Code compliance, shall be maintained by Quality Control Manager.

RECORDS RETENTION

10.0 All records and documentation accumulated during the course of an work order will be the responsibility of the Quality Control Manager and will be maintained for all manufactured parts as required by the applicable ASME Code and customer contract.

10.1 These records will be made available to the Authorized Inspector for review and analysis prior to certification of the TSSA Data Report.

10.2 Radiographic films, radiographic and ultrasonic examination reports, data reports and Job File documentation shall be retained in the engineering office for the period of time required by the applicable Code of construction but not less than 3 years.

AUTHORIZED INSPECTOR

11.0 The Authorized Inspector (AI) is a representative of the Authorized Inspection Agency and carries out inspections on all Code items built by the Company.

11.1 The Authorized Inspection Agency is:

The Technical Standards and Safety Authority
Boilers and Pressure Vessels Safety Division
14th Floor, Centre Tower
3300 Bloor Street West
Toronto, Ontario M8X 2X4

11.2 The Authorized Inspector shall have been qualified by written examination under the rules of any state in the USA or any Province of Canada, which has adopted the ASME Boiler and Pressure Vessel Code.

11.3 A current copy of this Quality Control Manual shall be provided to the Authorized Inspector for use at the plant or field site.

11.4 The Quality Control Manager shall be responsible for liaison with the Authorized Inspector and will furnish all drawings, calculations, specifications, checklists, repair procedures, records and any other documentation required by the Authorized Inspector.

11.5 The Authorized Inspector shall be kept informed of work progress and shall be given reasonable advance notice, by the Quality Control Manager of upcoming inspection hold points or tests.

11.6 The Authorized Inspector will be informed of all non-conformities and the Quality Control Manager will obtain the Authorized Inspector's concurrence prior to corrective action being implemented.

11.7 The Authorized Inspector has the right to request re-qualification of any welder, welding operator, NDE procedures or NDE personnel, and has the right to make any inspections to certify that all piping, repairs or alterations are in strict compliance with all of the applicable ASME Code requirements.

11.8 The Quality Control Manager will provide assistance to the Authorized Inspector during the required inspection surveillance monitoring of the Quality Control system, and to the Authorized Inspector Supervisor during any required audits.

11.9 The Authorized Inspector and Authorized Inspector Supervisor shall have free access to such parts of all plants as concerned with the supply or manufacture of material for piping when so requested. The AI and AIS shall be permitted access at all times while work on the piping is being performed, to all parts of the manufacturing plant that concern the construction of piping and to the site of field erected piping during the period of assembly and testing of the piping.

PIPING FIELD ASSEMBLY

12.1 All other requirements of this manual shall apply in addition to this section which details the methods used by Greenfield South Power Corporation for field assembly of piping systems controlled from at 2275 Lake Shore Blvd. West, Suite 401, Toronto

12.2 The Quality Control Manager is responsible for all Quality Control activities on the field site.

12.3 The Quality Control Manager is responsible for assembly, welding and any other construction activities on the field site.

12.4 The inspection travel sheet will be prepared by Quality Control Manager and submitted to the field site AI for review and insertion of hold points prior to the field site work commencing.

12.5 Receiving inspection at the field site will be carried out in accordance with Section 3 of this manual and all documentation will be made available to the field site AI.

12.6 Welding parts that are shop fabricated and shipped to the field site require the applicable marking and completed partial data reports signed by the manufacturing shop AI. The marking and partial data reports will be used as the basis for acceptance of weld parts by the field site AI.

12.6 The Quality Control Manager is responsible for preparing and certifying the TSSA Piping System Installations Test Data Report.

12.7 The Quality Control Manager shall submit the Piping System Installation Test Data Report to the field site AI for review and signature.

12.8 The Quality Control Manager shall collect all required records and return them to Greenfield South Power Corporation, in accordance with Section 10 of this manual.

SAMPLE FORMS (EXHIBITS)

CONTENTS

PURCHASE ORDER FORM

Date :	November 13, 2004	**PO# :**	KV - xx-xxx

Vendor: Name: ABC Company
Address: 123 Anywhere Street
ThisTown, ThisProvince, xxx xxx
Tel: (416) xxx-xxxx Fax: (416) xxx-xxxx
Contact: ContactPerson

WORK ORDER #:	00519

Qty	Description of Items	Price		
		Unit	Sub-Total	ACCOUNT
1	1" 1500 LB SA 105 R.F. S.O. FLANGE, SCH 80 BORE	xx.xx	xx.xx	XXX
2	1" 900 LB SA 105 S.W. ANGLE GLOBE VALVE	xx.xx	xx.xx	XXX
2	1" 3000 LB SA 105 S.W. 45 DEG ELBOW	xx.xx	xx.xx	xxx
18	1" SCH. 80 SA 106 pipe	xx.xx	xx.xx	xxx
	as per ASME BPVC Section II, Part A and ASME			
	B31.1			
	Note: all materials must be clearly marked or labeled as per ASTM/ASME Code, Mill Test Reports CRN, and partial data report, must be included with shipment of material			
Needed for:		GST	xxx.xx	
Delivery:	included / as noted above	extra		
		TOTAL:	**xxx.xx**	

Originator (print name) | **Plant Approval** | **Head Office Approval (only if $500.00 or more)**

Shipping Address
Greenfield South Power Corporation
Keele Valley Power Plant
Maple, Ontario L6A 1S8
Tel #: (905) 832-9107/832-5989
Fax #: (905) 832-9431

Billing Address
Greenfield South Power Corporation
2275 Lake Shore Blvd. W., Suite 401
Toronto, Ontario M8V 3Y3
Tel #: (416) 234-1301
Fax #: (416) 234-8336

DIRECTIONS

1. Exit from Hwy 400 at Major Mackenzie Dr.
2. East on Major Mackenzie Dr. to McNaughton Road
3. Follow McNaughton Road into Keele Valley Landfill Site

Receiving Inspection Report

Project No.: WO 00519 Date: 10/12/04

Item No./Description	Date Received	Dimension Compliance		Documentation Compliance		Identification Compliance		Initial	Date
		Yes	No	Yes	No	Yes	No		
KV-42C-0256	10/12/04	yes		yes		yes			10/12/04
KV-42C-0258	15/12/04	yes		yes		yes			15/12/04

GREENFIELD SOUTH POWER CORPORATION - GREEN ELECTRON POWER PROJECT
INSPECTION AND TEST PLAN
BALANCE OF PLANT PIPE ASSEMBLY AND ERECTION

ITP No. _____ Rev. No.: _____ Date: _____
System Name: _____ Author: _____
Pipe/Line No.: _____ Pressure: _____ psig
ISO/DWG No.: _____ Temperature: _____ °F
P&ID DWG No.: _____
Ref. Code(s): _____

Task No.	Task Description	Quality Control Activity	Controlling Documents	Acceptance Criteria	Verifying Documents				Notes
					Greenfield		TSSA		
					QC	Initial	QC	Initial	
1	Review Drawings	Review	QC Manual	QC Manual					
2	Receiving Inspection Report	Review	QC Manual	QC Manual					
3	MTR Review	Review	ASME II	ASME II					
4	Verify Material and Grade	Review	ASME II	ASME II					
5	Verify Welder Qualifications	Review	ASME B31.1	ASME IX					
6	Verify Weld Procedures (WPS)	Review		ASME IX					
7	Verify Welding Consumables	Review		ASME II C					
8	Prep Weld per WPS	Review							
9	Joint fit-up per WPS	Inspect							
10	Visual and Dimensional Inspection	Inspect	Spool Dwg	ISO Dwg					
11	Pre-heating Requirements	Review	WPS	ASME B31.1					
12	PWHT Requirements	Review	WPS	ASME B31.1					
13	NDE as required	Review	ASME B31.1	ASME B31.1					
14	Hydro Static Test	Verify	ASME B31.1	ASME B31.1					
15	Compile Documentation	Verify	QC Manual	QC Manual					

Non-Conformance Report

Report No: _____
Work Order No.: _____
PO No.: _____

Description of Non-Conformity:

Signed: _____
Engineer
Signed: _____
QC Manager

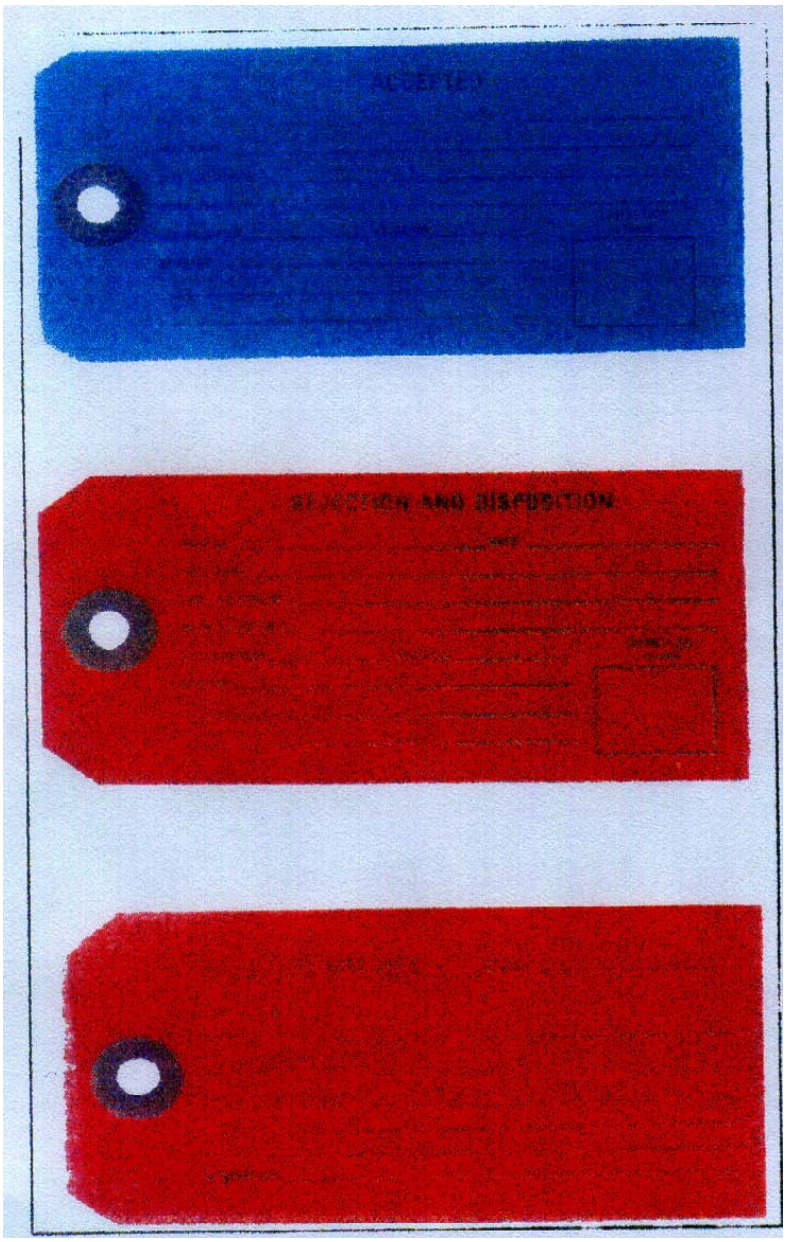
Recommended Solution:

Signed: _____
Engineer
Date:
Signed: _____
QC Manager
Date: _____
Signed: _____
AI

Disposition Complete

Signed: _____ Date: _____
QC Manager
Signed: _____ Date: _____
AI

Tags



Record of Calibration

Equipment	Serial No.	Identification No.	Calibration Frequency	Check Method	Date (d/m/y)	Due Date (d/m/y)	Result	Initial
Pressure Test Gauge	1234.0	PTG01	3 months	Section 9	15/11/04	15/02/05	pass	
Master Pressure Gauge	1235.0	MPG02	12 months	Section 9	01/01/04	01/01/05	pass	
Pressure Test Gauge	1235.5	PTG03	3 months	Section 9	17/10/04	17/01/05	pass	

Document Transmittal

Date: _____

Reference: _____

Attention: _____

Enclosed are documents and/or revisions for inclusion in your QC Manual, Controlled Copy Number . Please insert the enclosed sections in the appropriate places. Sign below and fax the signed Document Transmittal form, Attention: QC Manager, to Head Office, at (416) 234-8336.

NO. OF COPIES	TYPE OF COPY	DOCUMENT OR ITEM NUMBER	REV. NO.	DESCRIPTION
2		QCM	1	Sections revised: Sections 4, 5.1

I certify that I have received the above documents and/or revisions and have discarded the superseded documents and/or sections

_____ _____ _____

Date Signature Title

Welder's Name	Welder ID No.	Welding/Brazing Procedure Specification								System / Drawing No.	Log Entry (dd/mm/yy)	Comments
		GW1-A	GW2-A	GW3-A	GW3-B	GW4-A	GW5-A	GW6-A	GB1-A			

TSSA Repair Program

14.0 At the present time, Greenfield South Power Corporation will not be involved with the TSSA Repair Program. Should this program be required, the manual shall be revised to include the requirements and shall be presented to TSSA for concurrence and signature, in accordance with Section 1 of this manual.

14th Floor, Centre Tower
3300 Bloor Street West
Toronto, Ontario
Canada M8X 2X4
Tel.: 416.734.3300
Fax.:416.231.6183
Toll Free: 1.877.682.8772

www.tssa.org

TECHNICAL STANDARDS AND SAFETY AUTHORITY

CERTIFICATE OF AUTHORIZATION

This is to certify the named company as having had the adequacy of their quality program verified for the scope shown below in accordance with the *Ontario Technical Standards and Safety Act, 2000* and the Boilers and Pressure Vessels Regulation.

Company Name: GREENFIELD SOUTH POWER CORPORATION
2275 LAKE SHORE BLVD WEST, SUITE 401
TORONTO, ON M8V 3Y3
CANADA

Scope: Fabrication, assembly and erection of power piping at field sites controlled by the above location in accordance with CSA Standard B51, Boiler, Pressure Vessel and Pressure Piping Code and ASME B31.1 Power Piping.

Authorized: 19-FEB-2014

Expires: 06-MAR-2017

Certificate Number: QA 03597

Director
Boilers and Pressure Vessels Safety Program

Technical
Standards and
Safety Authority

Ontario Registration of a Fuels Safety Contractor

Technical Standards and Safety Act

This Registration is issued to carry on business as a

Heating Fuels Contractor

Registration Number:
000235597

Located at:

2275 LAKE SHORE BLVD W
SUITE 401
TORONTO ON M8V 3Y3
CANADA

Expires on 21-SEP-15

GREENFIELD SOUTH POWER CORPORATION
2275 LAKE SHORE BLVD W
SUITE 401
TORONTO ON M8V 3Y3
CANADA

Issued by the Director

FS 09165 (04/09)

This Registration Is Not Transferable.

OPERATION OF THIS BUSINESS WITHOUT A VALID REGISTRATION IS AN OFFENCE UNDER THE ACT.

This registration, or a copy of the registration, shall be displayed in a conspicuous place at the business premises set out on the registration.

Issued under the ***Technical Standards and Safety Act, 2000,***
and the applicable regulation and subject to the limitations thereof.
Gaseous Fuels Regulation (O.Reg. #212/01)
Liquid Fuels Regulation (O.Reg. #213/01)

For all enquiries or to update any of the information on this registration, please contact the Technical Standards and Safety Authority.

Telephone: 1.877.682.8772
E-mail: *customerservices@tssa.org*

GREENFIELD SOUTH POWER CORPORATION
2275 LAKE SHORE BLVD W
SUITE 401
TORONTO ON M8V 3Y3
CANADA


10/27/2014
MOL


10/27/2014


13-11-6656
Richards-Wilcox
50 tonne
10/27/2014


10/27/2014


10/27/2014

Green Electron - Estimated Cost of Different Natural Gas Service Options

4-Nov-14

Weighted Average Cost of Capital (WACC)	6.70	%

Weighted Average Cost of Capital (WACC) Inputs

Cost of Debt	6.00	%
Tax Rate	25.00	%
% Equity (for WACC)	40.00	%
% Debt (for WACC)	60.00	%
Required Equity Return	10.00	%
Weighted Average Cost of Capital (WACC)	**6.70**	%

Notes:

1) The Green Electron Power Project has a 20 year power purchase agreement with the Ontario Power Authority and 20 years was used as the comparison period to match the term of the power purchase agreement.
2) Assumed Letter of Credit required for 1 year of firm service costs plus capital cost declining over time.
3) Only transportation costs were included in the rate comparison (storage components were not included).
4) The WACC was used to determine the annual cost of Letters of Credit.

Estimated Cost of Gas Service (Capital & Operating Costs) - Vector Pipeline

Contract Year	Upfront Capital Cost ($)	Annual Cost of Service ($)	LC Amount ($)	LC Cost ($/year)	Total Cost ($/year)
0	1,625,000	0	0	0	1,625,000
1	0	540,000	530,000	35,510	575,510
2	0	540,000	530,000	35,510	575,510
3	0	540,000	530,000	35,510	575,510
4	0	540,000	530,000	35,510	575,510
5	0	540,000	530,000	35,510	575,510
6	0	540,000	530,000	35,510	575,510
7	0	540,000	530,000	35,510	575,510
8	0	540,000	530,000	35,510	575,510
9	0	540,000	530,000	35,510	575,510
10	0	540,000	530,000	35,510	575,510
11	0	540,000	530,000	35,510	575,510
12	0	540,000	530,000	35,510	575,510
13	0	540,000	530,000	35,510	575,510
14	0	540,000	530,000	35,510	575,510
15	0	540,000	530,000	35,510	575,510
16	0	540,000	530,000	35,510	575,510
17	0	540,000	530,000	35,510	575,510
18	0	540,000	530,000	35,510	575,510
19	0	540,000	530,000	35,510	575,510
20	0	540,000	530,000	35,510	575,510

Net Present Value (NPV) **$7,866,747**

Notes (Vector):

1) The 1,625,000 Capital Cost is made up of the $1,125,000 cost in the GEPP Vector Interconnect Agreement + $500,000 of additional costs to be incurred by GSPC to complete the interconnection.

Estimated Cost of Gas Service (Capital & Operating Costs) - Union Gas Interruptible

Contract Year	Upfront Capital Cost ($)	Annual Cost of Service ($)	LC Amount ($)	LC Cost ($/year)	Total Cost ($/year)
0	250,000	0	6,000,000	402,000	652,000
1	0	1,621,000	6,000,000	402,000	2,023,000
2	0	1,621,000	5,400,000	361,800	1,982,800
3	0	1,621,000	4,800,000	321,600	1,942,600
4	0	1,621,000	4,200,000	281,400	1,902,400
5	0	1,621,000	3,600,000	241,200	1,862,200
6	0	1,621,000	3,000,000	201,000	1,822,000
7	0	1,621,000	2,400,000	160,800	1,781,800
8	0	1,621,000	1,800,000	120,600	1,741,600
9	0	1,621,000	1,200,000	80,400	1,701,400
10	0	1,621,000	600,000	40,200	1,661,200
11	0	1,621,000	0	0	1,621,000
12	0	1,621,000	0	0	1,621,000
13	0	1,621,000	0	0	1,621,000
14	0	1,621,000	0	0	1,621,000
15	0	1,621,000	0	0	1,621,000
16	0	1,621,000	0	0	1,621,000
17	0	1,621,000	0	0	1,621,000
18	0	1,621,000	0	0	1,621,000
19	0	1,621,000	0	0	1,621,000
20	0	1,621,000	0	0	1,621,000

Net Present Value (NPV) **$19,959,491**

Notes (Union Gas Interruptible):

1) The capital cost of $250,000 is the cost to bring the gas from Union's proposed meter station to the Green Electron plant. Union's $6,000,000 capital cost is not a capital cost to Greenfield because it is not required to be paid upfront and will be paid by Greenfield and recovered by Union through the annual rates.

2) The annual cost of service is based on Union's $1,071,000 estimate (Union LTC EB-2014-0147 - Schedule 11) + $540,000 Greenfield estimated cost of interruptions + $10,000 Greenfield estimated annual O&M cost.

Estimated Cost of Gas Service (Capital & Operating Costs) - Union Gas Firm Service - T2 Rate (Transportation Only)

Contract Year	Upfront Capital Cost ($)	Annual Cost of Service ($)	LC Amount ($)	LC Cost ($/year)	Total Cost ($/year)
0	250,000	0	6,000,000	402,000	652,000
1	0	1,906,000	7,896,000	529,032	2,435,032
2	0	1,906,000	7,296,000	488,832	2,394,832
3	0	1,906,000	6,696,000	448,632	2,354,632
4	0	1,906,000	6,096,000	408,432	2,314,432
5	0	1,906,000	5,496,000	368,232	2,274,232
6	0	1,906,000	4,896,000	328,032	2,234,032
7	0	1,906,000	4,296,000	287,832	2,193,832
8	0	1,906,000	3,696,000	247,632	2,153,632
9	0	1,906,000	3,096,000	207,432	2,113,432
10	0	1,906,000	2,496,000	167,232	2,073,232
11	0	1,906,000	1,896,000	127,032	2,033,032
12	0	1,906,000	1,896,000	127,032	2,033,032
13	0	1,906,000	1,896,000	127,032	2,033,032
14	0	1,906,000	1,896,000	127,032	2,033,032
15	0	1,906,000	1,896,000	127,032	2,033,032
16	0	1,906,000	1,896,000	127,032	2,033,032
17	0	1,906,000	1,896,000	127,032	2,033,032
18	0	1,906,000	1,896,000	127,032	2,033,032
19	0	1,906,000	1,896,000	127,032	2,033,032
20	0	1,906,000	1,896,000	127,032	2,033,032

Net Present Value (NPV) **$24,428,222**

Notes (Union Gas T2 - Transportation Only):

1) The capital cost of $250,000 is the cost to bring the gas from Union's proposed meter station to the Green Electron plant. Union's minimum $6,000,000 capital cost is not a capital cost to Greenfield because it is not required to be paid upfront and will be recovered through the annual rates. This is a minimum cost because not all potential upgrade costs to provide firm service were disclosed by Union Gas to Greenfield.

2) The annual cost of service is based on Union's current rate schedule for T2 transportation services + $10,000 Greenfield estimated O&M cost.

Summary - Compare 20 Year NPV Cost of Different Services

	20 Year NPV ($)	Additional Cost (NPV) ($)
Vector Pipeline	7,866,747	0
Union Gas Interruptible	19,959,491	12,092,744
Union Gas Firm Service (T2 Rate)	24,428,222	16,561,475

Summary - Compare Year 1 Annual Cost of Different Services

	Year 1 Annual Cost ($)	Additional Cost ($)
Vector Pipeline	575,510	0
Union Gas Interruptible	2,023,000	1,447,490
Union Gas Firm Service (T2 Rate)	2,435,032	1,859,522

Green Electron Power Project - Natural Gas Transportation
4-Nov-14

Green Electron Power Project Operating Characteristics

Maximum Hourly Flow	**2,320**	GJ/hr
Daily Contract Demand	**55,680**	GJ/day
Load Factor	**30%**	
Annual Volume	**6,096,960**	GJ/year

Vector Cost Estimate

15-year Firm Transportation Service (FT-H)			Monthly Cost	Annual Cost
Monthly Reservation Charge	$0.5705	/GJ	**$31,765**	**$381,185**

Operational Variance Service (OVS)			Monthly Cost	Annual Cost
Hourly Variance Quantity (HVQ)	1,000	GJ/H		
Daily Variance Quantity (DVQ)	5,000	GJ/Day		
OVS Demand Charge	$0.0700	/GJ of DVQ	**$10,646**	**$127,750**
OVS Usage Charge	$0.0563	/GJ		

Vector Charges	
Firm Transportation (FT-H) Charge	$381,185
OVS Demand Charge	$127,750
OVS Usage Charges	$20,550
Subtotal - Vector Charges	**$529,485**
GSPC O&M Costs	$10,000
Total Costs (Vector + GSPC)	**$539,485**

Green Electron Power Project - Union Gas - Estimated T2 Rate Charges (Transportation Only)
4-Nov-14

Union T2 Service - Union Dawn to Plant
Q4 2014 T2 Rates (T2 is the T1 equivalent for large customers, new rate class to avoid cross subsidization)

Union South Zone Average Heat Value	38.07	MJ/m3	Effective April 1, 2013 to March 31, 2014
Approximate Plant Maximum Demand			
	2,320	GJ/h HHV	
	60,940	m3/h	
Expected Firm Contract Demand Hours	20	h	
Expected Firm Contract Demand	1,218,807	m3/day	
Expected Load Factor	30	%	
Estimated Annual Volume	160,151,300	m3	
Fuel Ratio	0.248	%	
Natural Gas Cost	5.00	$/GJ	
	0.19035	$/m3	

T2 Transportation Cost Estimate

		$/m3/Month	m3/Month	$/m3	$/Month
Customer Charge					6,013.02
Demand Charge					
First X of Firm Contract Demand	140,870	0.203436			28,658.03
All Contract Demand Over X	140,870	0.107608			115,994.69
Commodity Charge					
All Firm Deliveries			13,345,942	0.000078	1,040.98
Fuel Ratio (Compressor Fuel)			33,098	0.190350	6,300.19
Monthly Cost					**158,006.92**
Annual Charge - Union Gas					**1,896,083.03**
GSPC O&M Costs Per Year					10,000.00
Total Costs - Union Gas + GSPC O&M					**1,906,083.03**

THIS IS ONLY THE TRANSPORTATION PORTION OF THE T2 RATE.
THE T2 RATE ALSO INCLUDES A STORAGE COMPONENT WHICH IS NOT INCLUDED IN THE ABOVE ANALYSIS FOR A FAIR COMPARISON

Green Electron - Cost of Interruptible Natural Gas Service - Potential Loss of Profits

Power Plant Capacity (average during interruptions)	300.0	MW
Estimated Spark Spread During Gas Interruptions	25.00	$/MWh
Estimated Deemed Dispatch Load Factor During Interruptions	75	%
Estimated Interruptions Per Year	4	Events/Year

Notes:

1) Spark Spread During Interruptions. The spark spread is the difference between the electricity price and the cost of natural gas required to generate electricity.
The spark spread will be high durng interruptions because interruptions happen during high demand periods for gas which often happen to be high demand periods for electricity.
GEPP PPA caps spark spread loss at $75/MWh adjusted for inflation.
2) Plant Dispatch Factor During Interruptions. Electricity demand will also be high during gas interruptions which will result in a plant dispatch factor that will be higher to meet the increased demand.
3) Estimated Interruptions Per Year. GSPC has estimated that there will be 4 interruptions on average per year.

Potential Costs of Interruptions Versus Days of Interruption Per Year

Days of Interruption Per Year	Estimated Lost Deemed Generation (MWh)	Estimated Cost Per Unit of Lost Deemed Generation ($/MWh)	Estimated Loss Due To Interruptions ($)	
0.0	0	25.00	0.00	
1.0	5,400	25.00	135,000.00	
2.0	10,800	25.00	270,000.00	
3.0	16,200	25.00	405,000.00	
4.0	21,600	25.00	540,000.00	GSPC Estimated Scenario
5.0	27,000	25.00	675,000.00	
6.0	32,400	25.00	810,000.00	
7.0	37,800	25.00	945,000.00	
8.0	43,200	25.00	1,080,000.00	
9.0	48,600	25.00	1,215,000.00	
10.0	54,000	25.00	1,350,000.00	

Eastern Power - Enbridge CDA - Natural Gas Interruptions

3-Nov-14

Curtailment Period (Winter 2013-2014)	Days of Curtailment
Curtailment - 14Dec20139PM - 17Dec9AM	2.5
Curtailment - 2Jan201410AM - 4Jan10AM	2.0
Curtailment - 6Jan201410AM - 9Jan10AM	3.0
Curtailment - 20Jan201410AM - 24Jan10AM	4.0
Curtailment - 25Feb201410AM - 1Mar10AM	4.0
Curtailment - 3Mar201410AM - 5Mar10AM	2.0
Curtailment - 15Mar201410AM - 18Mar10AM	3.0
	20.5

Curtailment Period (Winter 2012-2013)	Days of Curtailment
	0.0
	0.0

Curtailment Period (Winter 2011-2012)	Days of Curtailment
	0.0
	0.0

Curtailment Period (Winter 2010-2011)	Days of Curtailment
Curtailment - 22Jan2011_10AM - 24Jan2011_10AM	2.0
Curtailment - 21Feb2011_10AM - 23Feb2011_10AM	2.0
	4.0

Curtailment Period Summary	Days Of Curtailment
Winter 2013-2014	20.5
Winter 2012-2013	0.0
Winter 2011-2012	0.0
Winter 2010-2011	4.0
Average (4 Years)	**6.125**

EXHIBIT J
CALCULATION OF CSP AND RSP

This Exhibit J sets out the calculation of the Contingent Support Payment and the Revenue Sharing Payment, as applicable, for a given Settlement Month "*m*" in Contract Year "*y*", which is a four stage calculation which involves:

Stage I	Determination of the Total Monthly Fixed Capacity Payment;
Stage II	Determination of the Variable Energy Cost;
Stage III	Determination of the Imputed Net Revenue; and
Stage IV	Determination of the Contingent Support Payment and the Revenue Sharing Payment.

Except as expressly set forth below, all references to Sections are to Sections of the Agreement.

1.0 STAGE I: DETERMINATION OF TOTAL MONTHLY FIXED CAPACITY PAYMENT

1.1 The **Total Monthly Fixed Capacity Payment** is calculated as follows:

$TMFCP_m$ = (CRF_m x $FMCRF_m$ x NRR_y x AACC)	
where:	
$TMFCP_m$	is the Total Monthly Fixed Capacity Payment for the Contract Facility (in $ for the month).
CRF_m	is the Capacity Reduction Factor for Settlement Month "*m*" as defined in Section 15.6, and expressed as a fraction. The Capacity Reduction Factor shall be 1.0 unless and to the extent the circumstances set out in Sections 15.6(d) and (e) apply. If the Capacity Reduction Factor changes during the Settlement Month, then CRF will be calculated as a weighted average based on the number of days of the Settlement Month during which the different values of CRF apply.
NRR_y	is the Net Revenue Requirement (in $/MW-month). For the first Contract Year, the Net Revenue Requirement shall be equal to the amount set out in Exhibit B. For the second and each succeeding Contract Year, a portion of the Net Revenue Requirement shall be adjusted on the first day of such Contract Year to the percentage increase or decrease (if any) between the CPI effective as of the first day of such Contract Year compared with the CPI effective as of the Term Commencement Date, and shall be calculated as follows: **NRR_y** = (NRR_B x NRRIF x CPI_Y/CPI_B) + (NRR_B x (1-NRRIF))

NRR_B	is the Net Revenue Requirement (in $/MW-month) as set out in Exhibit B.
NRRIF	is the Net Revenue Requirement Indexing Factor set out in Exhibit B, and expressed as a decimal figure between 0.00 and 0.20.
CPI_y	is the CPI applicable to the calendar month during which the first day of Contract Year "*y*" occurs.
CPI_B	is the CPI applicable to the calendar month during which the Term Commencement Date occurs.
AACC	is the Annual Average Contract Capacity (in MW), which shall be the simple average of the Summer Contract Capacity and the Winter Contract Capacity.
$FMCRF_m$	is the Force Majeure Capacity Reduction Factor for the Settlement Month which shall be equal to 1.0 if there are no Outages affecting a Imputed Production Hour resulting from an event of Force Majeure, otherwise it shall be calculated as follows: $\mathbf{FMCRF_m} = 1 - \frac{\sum_{FMOH=1}^{FMOH=FMOH_m} FMOC_{FMOH}}{ACC_m \times IPH_m}$
ACC_m	is the Adjusted Contract Capacity (in MW) for the Settlement Month "*m*", and is calculated as follows: $\mathbf{ACC_m} = CC_m \times CRF_m$
CC_m	is the Contract Capacity (in MW) in Settlement Month "*m*", which shall be the Summer Contract Capacity or the Winter Contract Capacity, as applicable.
IPH	is an Imputed Production Hour, which is an hour in Settlement Month "*m*" that is contained within an Imputed Production Interval which occurred, in whole or in part, in Settlement Month "*m*".
IPH_m	is the total number of Imputed Production Hours in Settlement Month "*m*".
$FMOC_{FMOH}$	is the Force Majeure Outage Capacity in any Force Majeure Outage Hour, which is calculated as follows: $\mathbf{FMOC_{FMOH}} = ACC_m - FMAC_{FMOH}$
$FMAC_{FMOH}$	is the Force Majeure Available Capacity (in MW), which is the capacity available for dispatch from the Contract Facility as reported by the Supplier to the IESO in respect of a Force Majeure Outage Hour.

FMOH	is a Force Majeure Outage Hour, which is an hour within any Imputed Production Interval in Settlement Month "*m*" for which the Supplier has notified the IESO and the Buyer, as applicable, of an Outage caused by an event of Force Majeure. For greater certainty, any FMOH is by definition also an IPH; however, Outages must continue to be reported to the IESO and the Buyer for all Outage Hours.
$FMOH_m$	is the total number of Force Majeure Outage Hours in Settlement Month "*m*".

2.0 STAGE II: DETERMINATION OF VARIABLE ENERGY COST

2.1 Calculation of Variable Energy Cost

The calculation of the Variable Energy Cost for each hour "*h*" during Settlement Month "*m*" is as follows:

$\mathbf{VEC_h} = (GP_h \times CHR) + O\&M_y$	
where:	
VEC_h	is the Variable Energy Cost for hour "*h*" (in $/MWh).
GP_h	is the Gas Price for hour "*h*" (in $/MMBTU) and shall be determined as follows: (i) for Directed Dispatch Hours that are subject to a Directed Dispatch Order (LT) and are not subject to a Cancelled Directed Dispatch Order, the Gas Price (in $/MMBTU) is the Gas Price (LT) applicable for the day as agreed upon by the Parties pursuant to paragraphs 3(o)(i) and (p)(i) of Exhibit G, otherwise the Gas Price is the Gas Price (DA) for the day, as applicable; and (ii) for all other hours, the Gas Price is the Gas Price (DA) for the day. The Gas Price (DA) shall be converted from US dollars to Dollars using the applicable conversion rate set out in Section 1.1.
CHR	is the Contract Heat Rate (in MMBTU/MWh), which shall be the Summer Contract Heat Rate or the Winter Contract Heat Rate, as applicable.
$O\&M_y$	is the O&M Cost set out in Exhibit B, as adjusted for indexation to the CPI as described in Section 2.2 of this Exhibit J (in $/MWh).

2.2 Indexation of O&M Cost

For the first Contract Year, the O&M Cost shall be equal to the amount set out in Exhibit B. For the second and each succeeding Contract Year, the O&M Cost shall be adjusted on the first day of such Contract Year to the percentage increase or decrease (if any) between the CPI applicable to the calendar month during which the first day of such Contract Year occurs and the CPI applicable to the calendar month during which the first day of the immediately prior Contract Year occurs and shall be calculated as follows:

$\mathbf{O\&M_y} = O\&M_{y-1} \times \frac{CPI_y}{CPI_{y-1}}$	
where:	
$O\&M_y$	is the O&M Cost (in $/MWh) for Contract Year "*y*". For the first Contract Year, the O&M Cost shall be equal to the amount set out in Exhibit B.
$O\&M_{y-1}$	is the O&M Cost (in $/MWh) for the Contract Year immediately preceding Contract year "*y*".
CPI_y	is the CPI applicable to the calendar month during which the first day of Contract Year "*y*" occurs.
CPI_{y-1}	is the CPI applicable to the calendar month during which the first day of the Contract Year immediately preceding Contract Year "*y*" occurs.

2.3 Calculation of Start-Up Costs

The calculation of the Start-Up Costs for each day "*d*" during Settlement Month "*m*" is calculated as follows:

$\mathbf{SUC_d}$ = Start-Up Costs (in MMBTU/start-up) x GP_d	
where:	
Start-Up Costs	are the Start-Up Costs (in MMBTU/start-up) as set out in Exhibit B.
GP_d	is the Gas Price applicable for day "*d*" (in $/MMBTU) and shall be determined as follows: (i) for days that are subject to a Directed Dispatch Order (LT) and are not subject to a Cancelled Directed Dispatch Order, the Gas Price (in $/MMBTU) is the Gas Price (LT) applicable for the day as agreed upon by the Parties pursuant to paragraphs 3(o)(i) and (p)(i) of Exhibit G, otherwise the Gas Price is the Gas Price (DA) for the day, as applicable; and (ii) for all other days, the Gas Price is the Gas Price (DA) for the day. The Gas Price (DA) shall be converted from US dollars to Dollars

	using the applicable conversion rate set out in Section 1.1.

3.0 STAGE III: DETERMINATION OF IMPUTED PRODUCTION INTERVALS, IMPUTED GROSS ENERGY MARKET REVENUE AND IMPUTED NET REVENUE

Subject to the provisions below, the Contract Facility shall be deemed to operate, and hence, be imputed to produce Electricity at the Adjusted Contract Capacity ("ACC"), for all hours within all Imputed Production Intervals contained in whole or in part in any month.

3.1 Imputed Production Intervals

An "**Imputed Production Interval**" ("IPI") is either a Deemed Dispatch Interval or a Directed Dispatch Interval. For purposes of this Exhibit J, a set of two or more contiguous Deemed Dispatch Intervals shall be treated as a single Imputed Production Interval and day "*d*" shall mean the twenty-four (24) hour period between the beginning of the hour ending 01:00 (EST) and the end of hour ending 24:00 (EST). In respect of any hours in an Imputed Production Interval, the following shall apply:

(i) Any hour that is either a Deemed Dispatch Hour or a Directed Dispatch Hour will be an Imputed Production Hour.

(ii) Any Imputed Production Hour that is not immediately preceded by an Imputed Production Hour (including Imputed Production Hours in the previous day) will be considered an Imputed Start-Up Hour, and ISU_d will equal the total of the Imputed Start-Up Hours in day "*d*", subject to ISU_d not being greater than the sum of $DeemSU_d$ plus $DirSU_d$. If zero (0), one (1), two (2), or three (3) Imputed Start-Up Hours occur in a day, then $ISU_d = 0, 1, 2,$ or 3, respectively, subject to ISU_d not being greater than the sum of $DeemSU_d$ and $DirSU_d$.

3.1.1. Deemed Dispatch Interval

In respect of any hour which is not the subject of a Directed Dispatch Order or is the subject of a Cancelled Directed Dispatch Order, the following shall apply:

(i) A "**Deemed Dispatch Interval**" is a contiguous set of *n* Deemed Dispatch Hours for which the Contract Facility is deemed to have operated, which is all hours between and including a Deemed Start-Up Hour and a Deemed Shut-Down Hour. For greater certainty, it is possible for two or more Deemed Dispatch Intervals to be contiguous. A Deemed Dispatch Interval may consist of only one hour. For greater certainty, it is possible for a Deemed Start-Up Hour and a Deemed Shut-Down Hour to be the same hour.

(ii) A "**Deemed Start-Up Hour**" is the first hour of a Deemed Dispatch Interval, and is the first hour, other than a Directed Dispatch Hour, following a Deemed Shut-Down Hour in which the Pre-Dispatch Price for that hour h, as published three hours prior to that hour, exceeds the applicable Variable Energy Cost, and the HOEP was greater than or equal to the applicable Variable Energy Cost for the Contract Facility for that hour *h* or for the previous hour *h-1*. Notwithstanding the foregoing, the requirement that the Deemed Start-Up Hour follow a Deemed Shut-Down Hour shall not apply to the first Deemed Start-Up Hour in the Term.

(iii) A "**Deemed Start-Up**" ("**DeemSU**") is deemed to have occurred at the time of the first Deemed Start-Up Hour in day "*d*". If one or more Deemed Start-Ups takes place in a day, then $DeemSU_d = 1$; otherwise $DeemSU_d = 0$.

(iv) A "**Deemed Shut-Down Hour**" is the last hour in a Deemed Dispatch Interval, and is the first hour within a Deemed Dispatch Interval in which,

(a) HOEP was less than or equal to the applicable Variable Energy Cost for the Contract Facility for that hour *h*, and for the previous hour *h-1*, or

(b) the Pre-Dispatch Prices, as published in that hour h, for hours *h+1*, *h+2* and *h+3* are all less than the applicable Variable Energy Cost for the Contract Facility, or

(c) the following hour is a Directed Start-Up Hour.

3.1.2. Directed Dispatch Interval

In respect of any hours which are the subject of a Directed Dispatch Order, in addition to the terms set forth in Exhibit G, the following shall apply:

(i) A "**Directed Dispatch Interval**" is a contiguous set of *n* Directed Dispatch Hours for which the Contract Facility is directed to operate, which is all hours between and including a Directed Start-Up Hour and a Directed Shut-Down Hour as set out in a Directed Dispatch Order. For greater certainty, it is possible for a Directed Dispatch Interval and a Deemed Dispatch Interval to be contiguous.

(ii) A "**Directed Start-Up**" ("**DirSU**") is deemed to have occurred at the time of the first Directed Start-Up Hour that starts in day "*d*", resulting from a Directed Dispatch Order. If the Directed Dispatch Order specifies a second Directed Production Interval in day "*d*", a second Directed Start-Up is deemed to have occurred at the time of the second Directed Start-Up Hour in day "*d*". If one Directed Start-Up takes

place in a day, then $DirSU_d = 1$ and if two Directed Start-Ups take place in a day, then $DirSU_d = 2$.

3.2 Calculation of Imputed Gross Energy Market Revenue

The Imputed Gross Energy Market Revenue is calculated as follows:

$$\mathbf{IGEMR_m} = \sum_{IPH=1}^{IPH=IPH_M} IP_{IPH} \times HOEP_{IPH} - \sum_{ROH=1}^{ROH=ROH_m} ROC_{ROH} \times OHOEP_m - \sum_{FMOH=1}^{FMOH=FMOH_m} FMOC_{FMOH} \times HOEP_{FMOH}$$

where:	
$IGEMR_m$	is the Imputed Gross Energy Market Revenue (in $) for Settlement Month "*m*".
IP_{IPH}	is the Imputed Production corresponding to a given Imputed Production Hour, which is calculated as the Adjusted Contract Capacity for the Settlement Month, "*m*", (ACC_m), calculated in accordance with Section 1.1 of this Exhibit J, multiplied by one hour.
IPH	is an Imputed Production Hour, which is an hour in Settlement Month "*m*" that is contained within an Imputed Production Interval which occurred, in whole or in part, in Settlement Month "*m*". For greater certainty, IPH shall include all ROH and FMOH.
IPH_m	is the total number of Imputed Production Hours in Settlement Month "*m*".
$HOEP_{IPH}$	is the Hourly Ontario Energy Price corresponding to a given Imputed Production Hour (expressed in $/MWh).
$OHOEP_m$	is the Outage HOEP adjustment for Settlement Month "*m*", determined as follows: (a) if the difference between the weighted average HOEP for all Reported Outage Hours in month *m* and the weighted average relevant Variable Energy Cost for all Reported Outage Hours in month *m* is equal to or less than Max $Increment_y$, then OHOEPm = zero; and (b) if the difference between the weighted average HOEP for all Reported Outage Hours in month *m* and the weighted average relevant Variable Energy Cost for all Reported Outage Hours in month *m* is greater than Max $Increment_y$, then $OHOEP_m$ equals that calculated difference minus Max $Increment_y$. For the purposes of determining Outage HOEP, where a weighted average is referred to, the weight for each hour shall be expressed by

	multiplying ROC for such hour multiplied by one hour.
ROC	is the Reported Outage Capacity in any hour, which is calculated as follows: **ROC** = $ACC_m - ROAC_{ROH}$ where ACC_m the Adjusted Contract Capacity (in MW) in Settlement Month "*m*", calculated in accordance with the formula provided in Section 1.1 of this Exhibit J.
ROC_{ROH}	is the ROC corresponding to a given Reported Outage Hour.
$ROAC_{ROH}$	is the Reported Outage Availability Capacity (in MW), which is the capacity available for dispatch from the Contract Facility as reported by the Supplier to the IESO in respect of a Reported Outage Hour.
ROH	is a Reported Outage Hour, which is an hour within any Imputed Production Interval in Settlement Month "*m*" for which the Supplier has notified the IESO and the Buyer, as appropriate, of an Outage that is not the result of an event of Force Majeure. For greater certainty, any ROH is by definition also an IPH; however, Outages must continue to be reported to the IESO and the Buyer for all Outage Hours.
ROH_m	is the total number of Reported Outage Hours in Settlement Month "*m*".
Max $Increment_y$	is equal to $75.00/MWh until December 31, 2007. From and after January 1, 2008, and for each succeeding calendar year, Max $Increment_y$ shall be adjusted on the first day of such calendar year to the percentage increase or decrease (if any) between the CPI effective as of the first day of such calendar year and the CPI effective as of the first day of the immediately prior calendar year.
$FMOC_{FMOH}$	is the Force Majeure Outage Capacity in any Force Majeure Outage Hour, which is calculated as described in Section 1.1 of this Exhibit J.
FMOH	is a Force Majeure Outage Hour as defined in Section 1.1 of this Exhibit J.
$FMOH_m$	is the total number of Force Majeure Outage Hours in Settlement Month "*m*".
$HOEP_{FMOH}$	is the HOEP corresponding to a given Force Majeure Outage Hour.

3.3 Calculation of Imputed Net Revenue

The Imputed Net Revenue is calculated as follows:

$\mathbf{INR_m} = IGEMR_m - IVEC_m + RFCRP_m + RFFC_m + NINRR_m - GCA_m$	
where:	
INR_m	is the Imputed Net Revenue (in $) in Settlement Month "*m*".
$IGEMR_m$	is the Imputed Gross Energy Market Revenue (in $) in Settlement Month "*m*".
$IVEC_m$	is the Imputed Variable Energy Cost (in $) in Settlement Month "*m*", which is equal to the aggregate Variable Energy Cost for the total Imputed Production during the Settlement Month "*m*", calculated as follows: $$\mathbf{IVEC_m} = \sum_{d=1}^{d=day_m} \left[\begin{array}{l} (SUC_d \times ISU_d) + \left(\sum_{IPH=1}^{IPH=IPH_d} VEC_h \times IP_{IPH} \right) - \\ (SUC_d \times ISU_d) \times \left(\frac{\sum_{FMOH=1}^{FMOH=FMOH_d} FMOC_{FMOH}}{ACC_m \times IPH_d} \right) - \\ \left(\sum_{FMOH=1}^{FMOH=FMOH_d} VEC_h \times FMOC_{FMOH} \right) - \\ (SUC_d \times ISU_d) \times \left(\frac{\sum_{ROH=1}^{ROH=ROH_d} ROC_{ROH}}{ACC_m \times IPH_d} \right) \end{array} \right]$$
day_m	is the number of days in the Settlement Month "*m*".
ISU_d	is the number of Imputed Start-Ups for day "*d*" calculated according to Section 3.1 of this Exhibit J.
SUC_d	are the Start-Up Costs (in $) for day "*d*" calculated according to Section 2.3 of this Exhibit J.
VEC_h	is the Variable Energy Cost for hour "*h*" (in $/MWh) calculated according to Section 2.1 of this Exhibit J.
IPH	is an Imputed Production Hour, which is an hour in day "*d*" that is contained within an Imputed Production Interval which occurred, in whole or in part, in day "*d*".
IPH_d	is the total number of Imputed Production Hours in day "*d*".

IP_{IPH}	is the Imputed Production corresponding to a given Imputed Production Hour (in MWh), which is calculated as the Adjusted Contract Capacity for the Settlement Month, "*m*" (ACC_m), calculated in accordance with Section 1.1 of this Exhibit J, multiplied by one hour.
FMOH	is a Force Majeure Outage Hour as defined in Section 1.1 of this Exhibit J.
$FMOH_d$	is the number of Force Majeure Outage Hours in day "*d*".
$FMOC_{FMOH}$	is the Force Majeure Outage Capacity in any Force Majeure Outage Hour, which is calculated as described in Section 1.1 of this Exhibit J.
ROH	is a Reported Outage Hour as defined in Section 3.2 of this Exhibit J.
ROH_d	is the total number of Reported Outage Hours in day "*d*".
ROC	is the Reported Outage Capacity in any hour, which is calculated according to Section 3.2 of this Exhibit J.
ROC_{ROH}	is the ROC corresponding to a given Reported Outage Hour.
$RFCRP_m$	is: (a) 100% of the net revenue (in $) arising from any Future Contract Related Products that are Capacity Products; and (b) 50% of the net revenue (in $) arising from all Future Contract Related Products other than Capacity Products; corresponding to Settlement Month "*m*", where net revenue is calculated as the revenue received from the applicable Future Contract Related Products less any reasonable costs incurred by the Supplier to receive such revenue. For greater certainty, such costs shall be determined on an actual cost basis without mark-up, as confirmed by the Buyer and Supplier, and which shall be subject to verification by the Buyer, from time to time.
$NINRR_m$	is the Negative Interval Net Revenue Recapture that is applicable to all those Imputed Production Intervals that are Deemed Dispatch Intervals only (provided that for purposes of calculating NINRR, (i) a set of two or more contiguous Deemed Dispatch Intervals shall be treated as a single Imputed Production Interval, and (ii) any Deemed Dispatch Interval having a Deemed Shut-Down Hour that meet the conditions set out in Section 3.1.1(iv)(c) of this Exhibit J shall be excluded from the calculation of NINRR) in Settlement Month "*m*" where $IVEC_{IPI}$ was greater than $IGEMR_{IPI}$, and is calculated as the cumulated sum of $IVEC_{IPI}$ less $IGEMR_{IPI}$, where:

	$\mathbf{IVEC_{IPI}} = \left[\sum_{IPH=1}^{IPH=IPIH} VEC_{IPH} \times IP_{IPH} \right] + SUC_{IPI}$ and $\mathbf{IGEMR_{IPI}} = \sum_{IPH=1}^{IPH=IPIH} IP_{IPH} \times HOEP_{IPH}$
VEC_{IPH}	is the applicable Variable Energy Cost for the Contract Facility for those Imputed Production Hours during an Imputed Production Interval where $IVEC_{IPI}$ was greater than $IGEMR_{IPI}$.
SUC_{IPI}	are the Start-Up Costs, if the Imputed Production Interval for which $IVEC_{IPI}$ was greater than $IGEMR_{IPI}$ has an Imputed Start-Up Hour that is the first Imputed Start-Up Hour of the day in which such Imputed Production Interval falls.
IPIH	is the total number of Imputed Production Hours in the Imputed Production Interval for which $IVEC_{IPI}$ was greater than $IGEMR_{IPI}$.
GCA_m	is the Gas Cancellation Amount (in $) in Settlement Month "*m*", calculated as follows: $\mathbf{GCA_m} = \sum_{d=1}^{d=day_c} GCP_d \times GCV_d$
GCP_d	is the Gas Cancellation Price (in $/MMBTU) for any day "*d*" that was the subject of a Directed Dispatch Order (LT) and (i) which order was cancelled by a full or partial Cancelled Directed Dispatch Order, or (ii) during which day any Directed Dispatch Hour is affected by an Outage caused by an event of Force Majeure, and is calculated as follows: (a) In the event of a sale of the Gas Cancellation Volume of Gas that is not a deemed sale pursuant to Section 3(r) of Exhibit G, then the Gas Cancellation Price is equal to the Gas Price $(LT)_d$ minus the price (net of Gas Sale Transaction Costs) at which the Gas Cancellation Volume (GCV_d), as calculated below, is sold by the Supplier using Commercially Reasonable Efforts. (b) In the event of a sale of the Gas Cancellation Volume of Gas that is a deemed sale pursuant to Section 3(t) of Exhibit G, then the Gas Cancellation Price is equal to Gas Price $(LT)_d$ minus the target price mutually agreed by the Parties pursuant to Section 3(t) of Exhibit G. For greater certainty, GCP_d may be a negative number.
GCV_d	is the Gas Cancellation Volume (in MMBTU) associated with the total Directed Dispatch Hours for any day "*d*" that were the subject of a Directed Dispatch Order (LT) and:

	(i) where such order was cancelled by a full or partial Cancelled Directed Dispatch Order, the Gas Cancellation Volume shall be an amount equivalent to (A) the applicable Contract Heat Rate multiplied by the applicable Adjusted Contract Capacity in the Settlement Month, "*m*", and multiplied by such total number of cancelled Directed Dispatch Hours, plus (B) the Start-Up Costs (in MMBTU per start-up) set out in Exhibit B multiplied by the applicable number of $DirSU_d$ cancelled as a result of the Cancelled Directed Dispatch Order; or (ii) where during such day any Directed Dispatch Hour is affected by an Outage caused by an event of Force Majeure, the Gas Cancellation Volume shall be an amount equivalent to (A) the applicable Contract Heat Rate multiplied by the weighted average $FMOC_{FMOH}$ over all FMOH in day "*d*" and multiplied by $FMOH_d$, plus (B) the Start-Up Costs (in MMBTU per start-up) set out in Exhibit B multiplied by the applicable number of $DirSU_d$ cancelled as a result of the Outage caused by the event of Force Majeure.
GSTC	is the Gas Sale Transaction Costs (in $/MMBTU) which represents those transaction costs incurred by the Supplier in a sale of the Gas Cancellation Volume that is not a deemed sale pursuant to Section 3(t) of Exhibit G. The Supplier shall, upon the Buyer's request, provide reasonable evidence of the GSTC for audit and verification by the Buyer from time to time.
day_c	is the total number of days in Settlement Month "*m*" which were the subject of a Directed Dispatch Order (LT) and (i) which order was cancelled for such days by a full or partial Cancelled Directed Dispatch Order, or (ii) were affected by an Outage caused by an event of Force Majeure.
$RFFC_m$	is any revenue to the Supplier in the Settlement Month "*m*" arising from the sale, disposition, or encumbrance of the Supplier's interest in the Further Credits as set out in Section 2.12(d)(v) of the Agreement.

4.0 STAGE IV: DETERMINATION OF CONTINGENT SUPPORT PAYMENT AND REVENUE SHARING PAYMENT

4.1 The Contingent Support Payment and Revenue Sharing Payment for a Settlement Month are calculated as follows:

If $TMFCP_m > INR_m$, then: $\mathbf{CSP_m} = TMFCP_m - INR_m$ and $\mathbf{RSP_m} = 0$.

If $TMFCP_m < INR_m$, then: $\mathbf{RSP_m} = INR_m - TMFCP_m$ and $\mathbf{CSP_m} = 0$.

If $TMFCP_m = INR_m$, then: $\mathbf{RSP_m} = 0$ and $\mathbf{CSP_m} = 0$.

where:	
$TMFCP_m$	is the Total Monthly Fixed Capacity Payment (in $) for Settlement Month "*m*".
INR_m	is the Imputed Net Revenue (in $) in Settlement Month "*m*".
CSP_m	is the Contingent Support Payment (in $), if any, for Settlement Month "*m*".
RSP_m	is the Revenue Sharing Payment (in $), if any, for Settlement Month "*m*".

KPMG

TAX

Substantively Enacted Income Tax Rates for General Corporations

KPMG LLP

Income Tax Rates for Income Earned by a General Corporation[1] – **General Corporate Income Rate[2]**

Substantively Enacted[3] as at December 31, 2010

	2009	2010	2011	2012	2013	2014 and Beyond
Federal						
Federal corporate rate	38.00%	38.00%	38.00%	38.00%	38.00%	38.00%
Less: federal abatement	(10.00)	(10.00)	(10.00)	(10.00)	(10.00)	(10.00)
	28.00	28.00	28.00	28.00	28.00	28.00
Less: rate reduction	(9.00)	(10.00)	(11.50)	(13.00)	(13.00)	(13.00)
Gross federal rate	**19.00**	**18.00**	**16.50**	**15.00**	**15.00**	**15.00**
Provincial						
British Columbia	11.00%	10.50%	10.00%	10.00%	10.00%	10.00%
Alberta	10.00	10.00	10.00	10.00	10.00	10.00
Saskatchewan	12.00	12.00	12.00	12.00	12.00	12.00
Manitoba	12.50	12.00	12.00	12.00	12.00	12.00
Ontario	14.00	13.00	11.75	11.25	10.50	10.00
Québec	11.90	11.90	11.90	11.90	11.90	11.90
New Brunswick	12.50	11.50	10.50	9.00	8.00	8.00
Nova Scotia	16.00	16.00	16.00	16.00	16.00	16.00
Prince Edward Island	16.00	16.00	16.00	16.00	16.00	16.00
Newfoundland	14.00	14.00	14.00	14.00	14.00	14.00

Income Tax Rates for Income Earned by a General Corporation[1] – **Manufacturing and Processing Rate[4]**

Substantively Enacted[3] as at December 31, 2010

	2009	2010	2011	2012	2013 and Beyond
Federal					
Federal corporate rate	38.00%	38.00%	38.00%	38.00%	38.00%
Less: federal abatement	(10.00)	(10.00)	(10.00)	(10.00)	(10.00)
	28.00	28.00	28.00	28.00	28.00
Less: M&P reduction	(9.00)	(10.00)	(11.50)	(13.00)	(13.00)
Less: rate reduction	0.00	0.00	0.00	0.00	0.00
Gross federal rate	**19.00**	**18.00**	**16.50**	**15.00**	**15.00**
Provincial					
British Columbia	11.00%	10.50%	10.00%	10.00%	10.00%
Alberta	10.00	10.00	10.00	10.00	10.00
Saskatchewan	10.00	10.00	10.00	10.00	10.00
Manitoba	12.50	12.00	12.00	12.00	12.00
Ontario	12.00	11.00	10.00	10.00	10.00
Québec	11.90	11.90	11.90	11.90	11.90
New Brunswick	12.50	11.50	10.50	9.00	8.00
Nova Scotia	16.00	16.00	16.00	16.00	16.00
Prince Edward Island	16.00	16.00	16.00	16.00	16.00
Newfoundland	5.00	5.00	5.00	5.00	5.00

Notes:

1 The federal and provincial tax rates shown in the tables apply to income earned by corporations other than Canadian-controlled private corporations (CCPCs). In general, this includes public companies, and their subsidiaries, that are resident in Canada, and Canadian resident private companies that are controlled by non-residents.

The tax rates included in this table have been updated to reflect federal and provincial income tax rate changes that were substantively enacted in the period January 1, 2010 - December 31, 2010.

All rates have been prorated based on the effective date and assuming the taxation year was a calendar year end.

2 These income tax rates also apply to investment income earned by general corporations.

3 For Canadian GAAP purposes, a corporation's recorded income tax liabilities and assets in their financial statements should be measured using tax rates that are considered to be "substantively enacted" at the balance sheet date. In general, where there is a majority government, federal and provincial tax changes are considered to be "substantively enacted" for Canadian GAAP purposes when a tax bill containing the detailed legislation is tabled for first reading in the House of Commons or the provincial legislature. In the case of a minority government, however, the "substantively enacted" test is more stringent and requires the enabling legislation to have passed third reading in the House of Commons or the provincial legislature.

For U.S. GAAP purposes, a corporation's recorded income tax liabilities and assets in their financial statements should be measured using tax rates that are considered to be enacted at the balance sheet date. In general, tax rate changes are considered enacted once the relevant bill has received Royal Assent.

When tax rate changes are considered enacted or "substantively enacted", the effect of the change in tax rate is reflected in the period in which the changes are enacted or "substantively enacted". The effect of the change is recorded to income as a component of future tax expense in the period that includes the date of enactment or substantive enactment. For example, if a bill becomes "substantively enacted" for Canadian GAAP purposes (enacted for U.S. GAAP purposes) on December 31, the tax rate changes should be reflected in the corporation's financial statements for the quarter that includes December 31.

4 Corporations that derive at least 10% of their gross revenue for the year from manufacturing or processing goods in Canada for sale or lease can claim the manufacturing and processing (M&P) deduction against their M&P income. General corporations that earn income from M&P activities are subject to the same rates as those that apply to CCPCs.

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October 26, 2012

[via email]
Ms. Susan Wang
Eastern Power Limited

Ms. Wang:

Recent conversations with Eastern Power have identified the specific gas transportation requirements for a proposed powerplant that it is developing. In response to these discussions, Vector offers the following package of transportation services for Eastern Power's consideration.

1. Firm Hourly Service, FT-H. In order to satisfy the firm transportation requirements of Eastern, Vector proposes the following service:

Primary Receipt	Union–Dawn or Sombra-Enbridge Gas Distribution
Primary Delivery	New Interconnection with Eastern Power
MDQ	37,120 GJ per day
Start Date	December 1, 2013
End Date	November 30, 2028

16 hour load profile of 2,320 GJ per hour

The FT-H service allows a shipper to tailor a nomination around a non-steady flow requirement. A shaped profile can be nominated based on the day-ahead market with different flows each hour. Changes can also be made to the nomination profile with at least a one hour notification to be effective the following hour. There are two main requirements for this service. The first is that the receipt and delivery volumes need to be equal and synchronous each hour. This demands that Eastern contract with a third-party storage provider that has a service that will match up to FT-H (both Union and Enbridge have such services). The second requirement is that nominations cannot be made for retroactive hours.

Demand Toll will be the Vector Pipeline Limited Partnership Maximum 15-Year Toll for 16-hour FT-H service in accordance with Vector's NEB Tariff. This toll is currently CDN $0.5705 x 24/16 hours = $0.8558 per GJ per month. This yields a monthly demand charge of $31,767.30 for the proposed volume.

There are no surcharges in Canada at this time. However, there is an Abandonment Cost Recovery surcharge that is being proposed for NEB regulated pipelines that is supposed to go into effect prior to 2015. It is expected that this surcharge will be fractions of a penny per GJ.

2. Operational Variance Service. As an enhancement to the FT-H Vector also proposes that Eastern Power contract for OVS. OVS allows a tolerance around the nominated hourly profile under FT-H, and allows for a way to handle any imbalance at the end of the gas day.

HVQ	1,000 GJ per hour for up to 5 hours
DVQ	5,000 GJ per day

The HVQ, or Hourly Variance Quantity, is the amount that the plant is able to deviate over or under the nominations of the FT-H. The DVQ, or Daily Variance Quantity, is the total daily imbalance allowed. Like FT-H, OVS requires a service from a storage provider that will match up to it.

The OVS service has both service and usage components. Vector is offering Eastern a discounted Monthly Service Charge on the DVQ of CDN $0.07 per GJ, which equates to $10,645.83 per month. Additionally any imbalance at the end of each gas day will be transferred to or from storage for a daily Usage Charge of $0.0563 per GJ. The Usage Charge is based on the currently effective Maximum Toll from Vector's NEB Gas Tariff.

3. Interconnection Facilities. Vector also proposes to construct and install a new interconnection and metering facility to Eastern Power off of its 42-inch Canadian Mainline. The details of the interconnection will be laid out in a separate Interconnection Agreement. Vector proposes that the capital outlay required for this facility be fully reimbursed by Eastern Power. Vector will contract for the engineering, construction and operation of this facility through Union Gas Limited, its service provider in Ontario.

This proposal is valid through December 31, 2012 and is subject to the terms and conditions of Vector Pipeline Limited Partnership's NEB Tariff and Vector's senior management approval. Furthermore, the volumes discussed in this proposal are subject to the capacity that is available on Vector's system at the time Vector receives a valid Request for Service from Eastern Power.

Vector hopes that this proposal provides Eastern enough options to meet its transportation requirements for the new gas-fired plant. Should you have any questions, please feel free to call me at 734-462-0236.

Sincerely,

Matt Malinowski

Matt Malinowski

Cc: John Donaldson-Vector

Ontario ServiceOntario

PARCEL REGISTER (ABBREVIATED) FOR PROPERTY IDENTIFIER

LAND REGISTRY OFFICE #25

43308-0105 (LT)

PREPARED FOR JanineB01
ON 2014/11/05 AT 09:34:46

* CERTIFIED IN ACCORDANCE WITH THE LAND TITLES ACT * SUBJECT TO RESERVATIONS IN CROWN GRANT *

PROPERTY DESCRIPTION: PT LT 26 CON 2 MOORE; PT LT 26 PL 24 MOORE; PT RDAL BTN LT 26 CON 1 AND LT 26 PL24 MOORE PT 1 TO 10, 25R1585, CLOSED BY MO28032; S/T L225170, L241804, L820086, L841498, L871611, L871615, L872940, L872941; ST. CLAIR

PROPERTY REMARKS:

ESTATE/QUALIFIER:
FEE SIMPLE
LT CONVERSION QUALIFIED

RECENTLY:
FIRST CONVERSION FROM BOOK

PIN CREATION DATE:
2007/04/23

OWNERS' NAMES
GREENFIELD SOUTH POWER CORPORATION

CAPACITY SHARE

REG. NUM.	DATE	INSTRUMENT TYPE	AMOUNT	PARTIES FROM	PARTIES TO	CERT/ CHKD
** PRINTOUT INCLUDES ALL DOCUMENT TYPES (DELETED INSTRUMENTS NOT INCLUDED) **						
**SUBJECT, ON FIRST REGISTRATION UNDER THE LAND TITLES ACT, TO:						
** SUBSECTION 44(1) OF THE LAND TITLES ACT, EXCEPT PARAGRAPH 11, PARAGRAPH 14, PROVINCIAL SUCCESSION DUTIES *						
** AND ESCHEATS OR FORFEITURE TO THE CROWN.						
** THE RIGHTS OF ANY PERSON WHO WOULD, BUT FOR THE LAND TITLES ACT, BE ENTITLED TO THE LAND OR ANY PART OF						
** IT THROUGH LENGTH OF ADVERSE POSSESSION, PRESCRIPTION, MISDESCRIPTION OR BOUNDARIES SETTLED BY						
** CONVENTION.						
** ANY LEASE TO WHICH THE SUBSECTION 70(2) OF THE REGISTRY ACT APPLIES.						
**DATE OF CONVERSION TO LAND TITLES: 2007/04/23 **						
PLMO24	1890/09/04	PLAN SUBDIVISION				C
L225170	1966/05/26	TRANSFER EASEMENT			UNION GAS COMPANY OF CANADA, LIMITED	C
	REMARKS: SKETCH ATTACHED.					
L241804	1967/07/21	TRANSFER EASEMENT			TRANS-CANADA PIPE LINES LIMITED	C
PP1007	1967/08/01	PLAN MISCELLANEOUS				C
L255453	1968/07/03	SUP DEED TRST&MORT	$10		NATIONAL TRUST COMPANY LIMITED	C
L313359	1972/06/19	SUP DEED TRST&MORT	$1		NATIONAL TRUST COMPANY LIMITED	C
	REMARKS: FOR CONSIDERATION SEE DOCUMENT					
L327030	1973/04/13	SUP DEED TRST&MORT	$1		NATIONAL TRUST COMPANY LIMITED	C
	REMARKS: FOR CONSIDERATION SEE DOCUMENT					

NOTE: ADJOINING PROPERTIES SHOULD BE INVESTIGATED TO ASCERTAIN DESCRIPTIVE INCONSISTENCIES, IF ANY, WITH DESCRIPTION REPRESENTED FOR THIS PROPERTY.
NOTE: ENSURE THAT YOUR PRINTOUT STATES THE TOTAL NUMBER OF PAGES AND THAT YOU HAVE PICKED THEM ALL UP.

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25R1585	1975/11/12	PLAN REFERENCE				C
L492155	1981/06/04	SUP DEED TRST&MORT	$1		NATIONAL TRUST CO. LTD.	C
	REMARKS: FOR CONSIDERATION SEE DOCUMENT					
L504091	1982/03/22	DEED TRUST MORT	$1		NATIONAL TRUST COMPANY, LIMITED	C
	REMARKS: FOR CONSIDERATION SEE DOCUMENT					
L507494	1982/06/11	SUP DEED TRST&MORT	$1		NATIONAL TRUST CO. LTD.	C
	REMARKS: FOR CONSIDERATION SEE DOCUMENT					
25R5094	1988/10/20	PLAN REFERENCE				C
L721648	1992/09/18	NOTICE OF CLAIM				C
	REMARKS: MULTI					
L808927	1998/01/13	NOTICE OF CLAIM				C
	REMARKS: MULTI					
25R7642	1998/08/14	PLAN REFERENCE				C
L820086	1998/09/15	TRANSFER EASEMENT			TRANSCANADA PIPELINES LIMITED	C
25R7932	1999/12/10	PLAN REFERENCE				C
L841498	1999/12/16	TRANSFER EASEMENT			VECTOR PIPELINE LIMITED PARTNERSHIP	C
25R8361	2001/11/13	PLAN REFERENCE				C
L871611	2001/11/15	TRANSFER EASEMENT			UNION GAS LIMITED	C
L871615	2001/11/15	TRANSFER EASEMENT			UNION GAS LIMITED	C
L872940	2001/12/11	TRANSFER EASEMENT			UNION GAS LIMITED	C
L872941	2001/12/11	TRANSFER EASEMENT			UNION GAS LIMITED	C
L956346	2006/07/06	NOTICE OF CLAIM				C
	REMARKS: MULTI					

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LA34560	2008/06/20	LR'S ORDER		LAND REGISTRAR - LRO NO. 25	LAND REGISTRAR - LRO NO. 25	C
	REMARKS: TO DELETE L248037, AMEND THUMBNAIL DESCRIPTION BY REMOVING S/T L248037					
LA115857	2012/12/21	TRANSFER	$1,043,015	J RINK FARMS LTD.	GREENFIELD SOUTH POWER CORPORATION	C
	REMARKS: PLANNING ACT STATEMENTS.					
LA128123	2013/10/09	CONSTRUCTION LIEN	$89,058	911904 ONTARIO LTD.		C
	REMARKS: C.O.B. VOZZA CONTRACTING					

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