



361A Old Finch Ave.
Toronto, ON M1B 5K7
www.torontozoo.com

Tel: 416-392-5900
Fax: 416-392-5934

Chair
Councillor Paul Ainslie
Chief Executive Officer
John Tracogna
Chief Operating Officer
Robin D. Hale

2018-01-15

**REQUEST FOR QUOTATION
GENERATOR INSTALLATION
AFRICAN RAINFOREST PAVILION
RFQ 04 (2018-01)**

The Toronto Zoo invites you to submit a quotation to provide labour, tools, materials and equipment to complete the installation and connection of a standby generator for the African Rainforest Pavilion at the Toronto Zoo. All work is to be completed in accordance with the drawings and specifications in the Request for Quotation (RFQ).

The work shall commence as soon as possible once the project is awarded and a Purchase Order has been issued. All work is to be completed by **Friday, 2018-05-25**.

The Quotation package includes Instructions, Terms & Conditions, Requirements, Drawings, and Forms. Quoted prices shall remain in effect for a period of ninety (90) days from the Quotation due date.

Site Meeting: A site meeting will be held on **Thursday, 2018-01-25, 0900 hours (9:00am)**, meeting at the Toronto Zoo, Administrative-Support Centre, 361A Old Finch Ave., Toronto, Ontario.

Due Date: Your quotation must be completed, and received by the Supervisor, Purchasing & Supply, Toronto Zoo, Administrative-Support Centre, 361A Old Finch Ave., Toronto, Ontario, M1B 5K7 by:

Thursday, 2018-02-08, 1200 hours (noon, local time)

The Board of Management of the Toronto Zoo reserves the right to reject any or all quotes or to accept any quote, should it deem such an action to be in its interests.

If you have any queries regarding this request for quote, please contact Peter Vasilopoulos, Supervisor of Purchasing & Supply, (416) 392-5916. If you have any technical queries regarding this request for quote, please contact Ben Knoop, Project Manager, (416) 392-6002.

Yours truly,

Paul K. Whittam
Interim Director of Administrative Services

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1.0 INSTRUCTIONS

- 1.1** Ensure that you have received all **fifteen (15)** pages, **five (5)** drawings, **one (1)** shop drawing package and **three (3)** specifications of the RFQ package.
- 1.2** A site meeting will be held on **Thursday, 2018-01-25, 0900 hours (9:00am)** meeting at the Toronto Zoo, Administrative-Support Centre, 361A Old Finch Ave., Scarborough, Ontario.
- 1.3** Complete ALL FORMS in section 4.0 and return by due date and time received on or before **Thursday, 2018-02-08, 1200 hours (noon, local time)** or your Quotation will not be considered. Include signed copies of any addenda with your proposal package.
- 1.4** Quotations must not be submitted by facsimile, email or any other electronic format.
- 1.5** Show itemized cost of HST if applicable.
- 1.6** Toronto Zoo reserves the right to award in whole or in part on the basis of the bids received, Lump Sum Price or Breakdown Price.
- 1.7** All Prices submitted shall be quoted in Canadian currency.
- 1.8** Use the attached submission label, when you submit your response in a sealed envelope or package and deliver to the Toronto Zoo.
- 1.9** Quotation prices shall remain in effect for a period of ninety (90) days from the Quotation due date.
- 1.10** Include product information, samples, and pictures, as necessary.
- 1.11** Provide references of at least three (3) clients for whom your company has performed similar work. References must include photos of three (3) different installations, client company name, contact name, address and e-mail address.
- 1.12** If applicable, suggested alternative products are acceptable, however all such products must be quoted separately and should not replace the Toronto Zoo requested product, work or service.
- 1.13** It is the responsibility of the Bidder to understand all aspects of the RFQ and to obtain clarification if necessary before submitting their quotation.
- 1.14** For any questions concerning the contract terms and conditions of this RFQ, please contact:

Peter Vasilopoulos, Supervisor,
Purchasing & Supply, Tel: 416-392-5916, Fax: 416-392-6711,
E-mail: pvasilopoulos@torontozoo.ca

Any questions regarding the work in this RFQ must be forwarded by the end of the day Thursday, 2018-02-01 to:

Ben Knoop,
Project Manager, Tel: 416-392-6002, Fax: 416-392-5934
E-mail: bknoop@torontozoo.ca

2.0 TERMS AND CONDITIONS

- 2.1 **Definitions:** Wherever used in the Request for Quotation the word “**Board**” means the Board of Management of the Toronto Zoo and the word “**Vendor**” or “**Contractor**” means the person or persons or Corporation to whom the purchase order is issued.
- 2.2 **Vendor Assurance:** Unless otherwise stated, the goods, material, articles, equipment, work or services, specified or called for in or under this Quotation, shall be delivered or completely performed, as the case may be, by the Vendor as soon as possible and in any event within the period set out herein as the guaranteed period of delivery or completion.
- 2.3 **Country of Origin:** Wherever possible, the goods, services, materials, articles or equipment, specified or called for in or under this Quotation, shall be of Canadian origin and manufacture.
- 2.4 **Delivery:** The prices stated in this Quotation cover the services, material, articles or equipment referred to herein, being delivered F.O.B. destination, freight, express, duty and all other charges prepaid, unless otherwise indicated herein. A detailed delivery ticket or piece tally, showing the exact quantity of goods, material, articles or equipment shall accompany each delivery. A receiver’s receipt shall not bind the Board to accept the goods, material, articles or equipment covered thereby, or the particulars of the delivery ticket or piece tally therefore. The Vendor shall not be entitled to any interest upon any bill due to delay in its approval by the CEO of the Toronto Zoo or his designate.
- 2.5 **Invoicing:** Unless otherwise indicated herein, the prices stated are payable in Canadian Funds at the head office of the Board. Any Harmonized Sales Tax (HST) applicable shall be shown as a separate item. The Vendor’s HST/Business registration number must be indicated on the invoice.

The Vendor shall clearly show any special charges such as packaging and freight, where applicable, as separate items on the invoice.

Payments to non-resident Vendors may be subject to withholding taxes under the Income Tax Act (Canada). Unless a non-resident Vendor provides the Board with a letter from Revenue Canada, Taxation waiving the withholding requirements, the Board will withhold the taxes it determines are required under the Income Tax Act (Canada).

- 2.6 **Notice of Delivery:** The Vendor shall notify the Purchasing Agent of the Board at the address given for the mailing of invoices, in writing as soon as possible of the details of the shipment of the goods, materials, articles or equipment.
- 2.7 **Right to Cancel:** The Board shall have the right to cancel at any time this Quotation or any contract or any part of any contract resulting from this Quotation in respect of the goods, material, articles, equipment, work or services set out in this Quotation or any such contract or part of such contract, not delivered or performed at the time of such cancellation, and the Board will not be responsible to make any payments in respect of any such goods, materials, articles, equipment, work or services and shall not incur any liability whatsoever in respect thereto.

In the event that the Vendor fails or neglects by any act or omission to comply with any of the conditions set out herein, this Quotation or any contract resulting from this Quotation may be unconditionally cancelled by the Board without notice to the Vendor.

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- 2.8 **Official Agreement:** No verbal arrangement or agreement, relating to the goods, material, articles, **equipment, work or services, specified or called for under this Quotation, will be considered binding**, and every notice advice or other communication pertaining thereto, must be in writing and signed by a duly authorized person.
- 2.9 **Worker's Rights:** The Vendor shall comply with the conditions of the Board relating to Worker's Rights, a copy of which is available on application to the Manager, Fair Wage and Labour Trades Office, City of Toronto, 18th Floor, West Tower, City Hall, Toronto, Ontario, M5H 2N2 or by phone at 416-392-7300.
- 2.10 **Insurance:** The Contractor shall, at his/her own expense obtain and, until the work is fully complete maintain, broad-scope insurance coverages, hereof, satisfactory to the Chief Executive Officer as to form and substance, with the indicated policy form of the Canadian Construction Documents Committee (CCDC), its equivalent or better subject to such modifications therein to cover unusual aspects of the work, working conditions or other circumstances as may be specified elsewhere in the Contract.

The Contractor shall effect, maintain and keep in force, at its sole cost and expense and satisfactory to the Chief Executive Officer as to form and substance the insurance described below:

- 2.10.1 All risks property insurance on property of every description and kind owned by the contractor or for which the Contractor is responsible while on the premises of the Board in an amount not less than full replacement value. The policy shall be endorsed to provide a waiver of subrogation against the Board for any loss or damage to insured property, however caused.
- 2.10.2 Commercial general liability insurance, including owners' and contractors' protective, products, completed operations, personal injury, employer's liability, contractual liability, occurrence basis property damage, liability arising from the sale of serving of alcoholic beverages and provisions for cross liability and severability of interests with a limit of not less than Two Million Dollars (\$2,000,000.00) per occurrence. The policy shall be endorsed to name the Board as an additional insured with respect to the operations of the Contractor under this agreement.
- 2.10.3 Standard automobile liability insurance for all owned vehicles with limits of not less than Two Million Dollars (\$2,000,000.00) per occurrence.
- 2.10.3.1 All policies of insurance required to be taken out by the Contractor shall be placed with insurers licensed to conduct business in the Province of Ontario and shall be subject to the approval of the Chief Executive Officer, acting reasonably.
- 2.10.3.2 The Contractor shall deliver to the Board evidence of the insurance required prior to the commencement of the agreement, in form and detail satisfactory to the Chief Executive Officer acting reasonably.
- 2.10.3.3 The provisions of this section 2.10 shall no way limit the requirements and obligations imposed on the Contractor elsewhere in the Contract, nor relieve the Contractor from compliance therewith and fulfillment thereof.

-
- 2.10.3.4 The parties agree that insurance policies may be subject to deductible amounts, which deductible amounts shall be borne by the Contractor.
- 2.10.3.5 The provisions of this article shall in no way limit the requirements and obligations imposed on the Contractor elsewhere in the Contract, nor relieve the Contractor from compliance therewith and fulfillment thereof.
- 2.11 **Indemnity:** The Vendor shall at all times well and truly save, defend, keep harmless and fully indemnify the Board, the City of Toronto, Toronto Region and Conservation Authority and their servants, employees, officers or agents, hereinafter called the “Indemnities”, from and against all actions, suits, claims, demands, losses, costs, charges, damages, and expenses, brought or made against or incurred by the Indemnities, its or their servants, officers, employees, agents or invitees in any way relating, directly or indirectly, to goods, material, articles or equipment supplied or to be supplied, or to the supplying of goods or services, pursuant to this Quotation, or any other claim, action, suit, demand, loss, cost, charge, damage or expense relating to copyright, trademark or patent with regard directly or indirectly with any such goods, services, material, articles or equipment or the supply or performance thereof.
- 2.12 **Liability for Acts of Vendor Employees, Contractors or Agents:** The Vendor acknowledges responsibility and accepts liability for the acts of any of its employees, contractors and agents while on Toronto Zoo property. The Toronto Zoo reserves the right to request background checks for any individual providing the services requested on behalf of the Vendor.
- 2.13 **Guaranty of Quotation:** All goods, material, articles, equipment, work or services, specified or called for in or under this Quotation, shall be supplied or performed at the price or process and on the basis set forth or referred to in and in accordance with the Offer and this Quotation. The basis on which this Quotation is given shall include any specifications, plans, price schedules, samples, addenda or other details pertaining thereto, or provided in connection therewith.
- 2.14 **Right of Notice:** Any notice that the Board may be required or desire to give to the Vendor shall for all purposes to be deemed to have been sufficiently and properly given and afforded by registered mail addressed to the Vendor at the address shown for the Vendor on this form and shall therefore be presumed to have been received by the Vendor on the third day following such registration.
- 2.15 **Formal Contract:** The Vendor may be required and shall, if requested by the solicitor for the Board so to do, to execute and enter into a formal contract that is satisfactory to the solicitor for the Board, in order to document the contract resulting from this Quotation and to embody indemnity and related provisions that in the opinion of such solicitor are required to protect the Board.
- 2.16 **Charity Status:** The Toronto Zoo is a registered charitable organization (registration #BN 119216398RR0001) and accordingly may be eligible for preferred pricing which should be reflected in the Quotation as submitted.
- 2.17 **Performance Evaluation:** The Contractor’s performance will be evaluated by the Chief Executive Officer and/or Chief Executive Officer’s Representative during the Contract and at the end of the Contract. In the event that the Contractor’s performance is considered unsatisfactory by the Chief Executive Officer and/or Chief Executive Officer’s Representative, the Contractor and/or its affiliates may become ineligible from bidding on future contracts issued by the Board.

- 2.8 **Insurance:** The Contractor shall, at his/her own expense obtain and, until the work is fully complete maintain, broad-scope insurance coverages, hereof, satisfactory to the Chief Executive Officer as to form and substance, with the indicated policy form of the Canadian Construction Documents Committee (CCDC), its equivalent or better subject to such modifications therein to cover unusual aspects of the work, working conditions or other circumstances as may be specified elsewhere in the Contract.
- 2.8.1 The Contractor shall effect, maintain and keep in force, at its sole cost and expense and satisfactory to the Chief Executive Officer as to form and substance the insurance described below:
- 2.8.2 All risks property insurance on property of every description and kind owned by the contractor or for which the Contractor is responsible while on the premises of the Board in an amount not less than full replacement value. The policy shall be endorsed to provide a waiver of subrogation against the Board for any loss or damage to insured property, however caused.
- 2.8.3 Commercial general liability insurance, including owners' and contractors' protective, products, completed operations, personal injury, employer's liability, contractual liability, occurrence basis property damage, liability arising from the sale of serving of alcoholic beverages and provisions for cross liability and severability of interests with a limit of not less than Two Million Dollars (\$2,000,000.00) per occurrence. The policy shall be endorsed to name the Board as an additional insured with respect to the operations of the Contractor under this agreement.
- 2.8.4 Standard automobile liability insurance for all owned vehicles with limits of not less than Two Million Dollars (\$2,000,000.00) per occurrence.
- 2.8.4.1 All policies of insurance required to be taken out by the Contractor shall be placed with insurers licensed to conduct business in the Province of Ontario and shall be subject to the approval of the Chief Executive Officer, acting reasonably.
- 2.8.4.2 The Contractor shall deliver to the Board evidence of the insurance required prior to the commencement of the agreement, in form and detail satisfactory to the Chief Executive Officer acting reasonably.
- 2.8.4.3 The provisions of this section 2.11 shall no way limit the requirements and obligations imposed on the Contractor elsewhere in the Contract, nor relieve the Contractor from compliance therewith and fulfillment thereof.
- 2.8.4.4 The parties agree that insurance policies may be subject to deductible amounts, which deductible amounts shall be borne by the Contractor.
- 2.8.4.5 The provisions of this article shall in no way limit the requirements and obligations imposed on the Contractor elsewhere in the Contract, nor relieve the Contractor from compliance therewith and fulfillment thereof.

3.0 PROJECT REQUIREMENTS

The work shall commence once the project has been awarded and a Purchase Order issued. The scope of work includes supply of all labour, tools, materials and equipment necessary to complete the installation of an emergency generator at the African Rainforest Pavilion at the Toronto Zoo. The generator is being supplied by the Toronto Zoo and will be commissioned by GAL Power once installed. All work is to be

completed in accordance with the drawings and specifications in the Request for Quotation (RFQ). The contractor is responsible for all pricing and all other arrangements with all subcontractors as required.

3.1 SCOPE OF WORK

1. Supply all labour, tools, materials and equipment to complete the work as outlined in the quotation documents, drawings and specifications.
2. All work to be completed in accordance with applicable codes (e.g. Building Code, Electrical Code, Fire Code, etc.)
3. The contractor shall supply the Zoo with copies of relevant certificates and licences for all workers prior to commencement of work.
4. All measurements to be site verified.
5. The successful bidder is responsible for all work indicated in the drawings and specifications except supply of the generator. The generator will be supplied by the Toronto Zoo through GAL Power. GAL Power will supply, deliver, and unload the generator to the Toronto Zoo. The Generator will be stored at a location close the construction site and is to be installed by the successful contractor. After installation, the generator will be commissioned by GAL Power.
6. Protect all areas not affected by the work. Any damage to these areas will be the responsibility of the contractor to rectify.
7. Clean the work area and remove all debris from site on a daily basis.
8. Excess material will be stored on the Toronto Zoo site for future use. Toronto Zoo staff will designate a suitable area for stockpiling of additional material.
9. The contractor is required to provide closeout documents including but not limited to as built drawings, warranty, and inspection certificates.

The Contractor is responsible for all pricing and all other arrangements with their subcontractors as required. Work is to be completed by **Friday, 2018-05-25**.

3.2 CONTRACTOR RESPONSIBILITIES

1. Regular meetings/communication with the Toronto Zoo Project Team to review project status and to discuss issues that may arise during the project.
2. Provide samples, mock ups, etc. as required to the Project Team.
3. Provide product information, MSDS sheets and colour samples to the Project Team prior to start of the work where applicable.
4. Provide the Zoo with a two (2) year warranty upon completion of the project.
5. Protect adjacent areas not included in the project. Any damage caused will be the responsibility of the contractor to rectify at no additional cost to the Zoo.

6. Clean-up the work area daily and make good any damage caused as a result of the work.
7. Secure the work site and provide construction signs and barriers to prevent injury to Zoo personnel and the public who will require access to the space during the work.
8. All electric current required for the work shall be provided or furnished by the Contractor. All temporary connections for electricity shall be subject to the approval of the Owner. All temporary lines will be furnished, installed, connected, and maintained by the Contractor in a professional manner satisfactory to the Owner and shall be removed by the Contractor in like manner upon completion of the work.
9. Upon award of contract, Contractor is to finish all work, including clean up and demobilization by the completion date specified.
10. Submit all shop drawings for review and approval prior to start of fabrication. Review of shop drawings shall not mean that the Toronto Zoo approves detail design inherent in shop drawings, responsibility for which shall remain with the Contractor submitting same, and such review shall not relieve the Contractor of his responsibility for errors or omissions in shop drawings or of his responsibility for meeting all requirements of the subcontract documents.
11. Submit close out documents as requested. Include warranties and “As built” drawings.

3.3 SAFETY SPECIFICATIONS

1. It is the responsibility of the Contractor to protect the site as required during construction.
2. Ensure that awareness of public safety is considered and protect visitors in the vicinity during the construction period.
3. All necessary personal protective equipment must be worn at all times and MSDS sheets must be available on site as required.
4. The contractor is to abide by applicable Toronto Zoo Health & Safety Policies, the Ontario Health and Safety Acts, the Ontario Building Code and all other applicable codes including the Fire Codes.
 - i. SAFE-002 Health & Safety Hazard Reporting
 - ii. SAFE-017 Contractors Safety
 - iii. SAFE-018 Vehicles on Site
 - iv. SAFE-007 Working in Confined Space
 - v. SAFE-025 Hot Work
 - vi. SAFE-013 Equipment Lockout/Tagout

Toronto Zoo’s Commitment to the City of Toronto’s Corporate Smog Alert Response Plan

5. It is the responsibility of the Contractor to ensure that the work site is properly protected at all times. All work sites must be marked and hoarded adequately with construction signs posted to secure and isolate the work site from the public or other personnel that have access to the area.

3.4 OTHER INFORMATION

The successful bidder must demonstrate the ability to complete the work to standards acceptable to the Zoo and prove past performance in the completion of similar types of work for other clients by providing relevant examples of work and references. The successful bidder must also demonstrate and guarantee that they can produce the work in the allotted time.

4.0 SUBMISSION FORMS:

I/We, hereby, submit the Quotation and will comply with all terms, conditions, specifications and drawings (when provided) as set out within the Board’s Quotation.

I/We, hereby, have received, allowed for and included as part of our submission all issued Addendum numbered _____.

This form must be completed, properly signed and received on or before the date and time specified or your Quotation will not be considered. Quotation prices shall remain in effect for a period of ninety (90) days from the Quotation due date.

The Board of Management of the Toronto Zoo reserves the right to reject any or all Quotations or to accept any Quotation, should it deem such action to be in its interests.

By signing and submitting this FORM, you are agreeing to the release of your quotation information, as deemed necessary by the Board, in order to conduct business associated with this quotation or project.

COMPANY INFORMATION	
Company Name:	
Name of authorized Signing Officer	Title:
Signature of authorized Signing Officer:	Date:
Contact Name:	Title:
Address:	
Telephone #:	Fax #:
Email:	Web Site:
HST #:	

4.1 QUOTATION PRICING - LUMP SUM PRICE

DESCRIPTION	Price complete, excluding HST
To provide all labour, tools, materials and equipment necessary to complete the installation of an emergency generator and all associated work at the Toronto Zoo as specified in the quotation documents, drawings & specifications of the RFQ package.	\$
HST	
Total	

COMMITMENT TO DELIVER	YES / NO
Please confirm that you are able to complete the work by Friday, 2018-05-25	

WARRANTY	Specify
Please confirm two (2) year warranty upon completion of the project.	

DISCOUNT	Discount	Days
Discount allowed for prompt payment and period within which invoice must be paid to qualify.	%	

Name of Firm:	
Signature of Signing Officer(s)	

SUBMISSION LABEL

This address label should be printed and affixed to the front of your sealed tender, quotation and proposal envelope/package submission. Toronto Zoo will not be held responsible for envelopes and packages that are not properly labelled or submitted to an address other than the one listed on this label.

Vendor Name _____

**RFQ 04 (2018-01) – GENERATOR INSTALLATION – AFRICAN RAINFOREST PAVILION
Due Date: Friday, 2018-02-08, 1200 hours (noon, local time)**

TO BE RETURNED TO

**TORONTO ZOO
C/O SUPERVISOR, PURCHASING & SUPPLY
ADMINISTRATIVE SUPPORT CENTRE
361A OLD FINCH AVE.
TORONTO, ONTARIO
M1B 5K7**

NOTICE OF NO BID

INSTRUCTIONS:

It is important to the Toronto Zoo to receive a reply from all invited bidders. If you are unable, or do not wish to submit a bid, please complete the following portions of this form. State your reason for not bidding by checking the applicable box(es) or by explaining briefly in the space provided. It is not necessary to return any other Request for Proposal/Quotation/Tender documents or forms. Please just return this completed form by fax or by mail prior to the official closing date. **Purchasing and Supply Fax Number: (416) 392-6711.**

A Proposal/Quotation/Tender is not submitted for the following reason(s):		
<input type="checkbox"/>	Project/quantity too large.	<input type="checkbox"/> Project/quantity too small.
<input type="checkbox"/>	We do not offer services or commodities to these requirements	<input type="checkbox"/> Cannot meet delivery or completion requirement
<input type="checkbox"/>	We do not offer this service or commodity.	<input type="checkbox"/> Agreements with other company do not permit us to sell directly.
<input type="checkbox"/>	Cannot handle due to present commitments.	<input type="checkbox"/> Licensing restrictions
<input type="checkbox"/>	Unable to bid competitively.	<input type="checkbox"/> We do not wish to bid on this service or commodity in the future.
<input type="checkbox"/>	Insufficient information to prepare quote/proposal/tender	<input type="checkbox"/> Specifications are not sufficiently defined
<input type="checkbox"/>	We are unable to meet bonding or insurance requirements.	

<u>Other reasons or additional comments (please explain):</u>

Company Name:	
Address	
Contact Person:	
Signature of Company Representative:	
Date:	
Phone Number:	
Email address	
Fax Number:	

APPENDIX A – LIST OF SUB-CONTRACTOR

<p>The Bidder proposes to sublet the following portions of the Work to the persons firms or corporations indicated. The Bidder (Contractor) is responsible for all pricing with all subcontractors.</p> <p>The Bidder submits that in proposing the under mentioned subcontractors, the Bidder has consulted each and have ascertained to our completed satisfaction that those names are fully acquainted with the extent and nature of the work and that they will execute their work with the requirements of the contract documents.</p>		
Work or services to be provided	Name and address of sub-contractor or person	Telephone

Name of Bidder:	
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POWER SYSTEMS TORONTO LTD

Toronto Zoo
400 kW Standby Outdoor Diesel Generator

Shop Drawings for Approval

GAL Ref No:	T00673
Prepared By:	Misbah Mazhar (905-795-8877)

WWW.GALPOWER.COM

GAL Power Systems Ottawa Ltd.
84 Bentley Avenue
Nepean, Ontario K2E 6T9
(613) 226-4876
FAX: (613) 226-7236
Toll free (800) 619-4219

Produits Énergétiques GAL Inc.
5800 Donahue
St-Laurent, Québec H4S 1C1
(514) 745-1242
FAX: (514) 745-1175
Toll free (800) 708-1242

GAL Power Systems Toronto Ltd.
217 Statesman Drive
Mississauga, Ontario L5S 1X4
(905) 795-8877
FAX: (905) 795-8878
Toll free (888) 230-5489

GAL Corporate Holdings Ltd.
84 Bentley avenue
Nepean, Ontario K2E 6T9
(613) 226-4876
FAX (613) 226-7236
Toll free (800) 619-4219



POWER SYSTEMS TORONTO LTD

Toronto Zoo

400 kW Standby Outdoor Diesel Generator

Table of Contents

1. Bill of Material
2. ISO & Warranty Certificates
3. Generating Set Data
4. Dimensional Drawing
5. Engine Data
6. Alternator Data
7. Control Panel Data
8. Circuit Breaker
9. Battery Charger
10. Starting Battery
11. Block Heater
12. Air Filter
13. Radiator
14. Fuel Water Separator
15. Electrical Package

GAL Reference No:	T00673
Prepared By:	Misbah Mazhar (905-795-8877)

WWW.GALPOWER.COM

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POWER SYSTEMS TORONTO LTD

Toronto Zoo
400 kW Standby Outdoor Diesel Generators

Bill of Material



GAL Reference No:	T00673
Prepared By:	Misbah Mazhar (905-795-8877)

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Nepean, Ontario K2E 6T9
(613) 226-4876
FAX (613) 226-7236
Toll free (800) 619-4219



Toronto Zoo 400kW DG Outdoor
(Quoted as per specs: 263213.13 ONLY)

GAL REF: T00673

Bill of Material

<u>STANDARD FEATURES</u>	
<u>Generating Set</u>	Standby, 400kW , +0% OL, 120/208V, 3Ph, 60Hz, 0.8pf, Outdoor Diesel Generator.
<u>Complete with</u>	<ul style="list-style-type: none"> - Excitation: Brushless with PMG required in 2.12.3 of specs. - Alternator oversized to meet 2.12.4 in specs. - Electronic governor. - Unit Mounted Digital Controller c/w all shutdowns / alarms per CSA282-15 - Engine block heater mounted on Genset & wired. - Standard batteries c/w mounted and wired charger, rack and cables. - Unit Mounted Radiator. - Mainline circuit breaker, mounted and wired. - Factory test witnessed by 1 Engineer (ONLY) as required in 3.4.1 of specs. - Moveable Light as required in 1.4.22 of specs.
<u>Enclosure</u>	Skin Tight - Weather Protected - Sound Attenuated - Equipped with AC/DC Lighting, Duplex Receptacles, Distribution Panel and Motorized Louvers . Noise level 75d BA @ 7m.
<u>Fuel Tank</u>	72 Hours , ULC listed, Double Walled Sub-Base Tank, in accordance with latest TSSA Regulations.
<u>Access Platform</u>	As required in 1.4.21 of specs.
<u>MISCELLANEOUS</u>	
<u>Warranty</u>	As required in the 3.2.1 of specs.
<u>Factory Test</u>	4 hours factory test at manufacturer's facility, as required in 3.4.6 of specs.
<u>Delivery</u>	At site after drawing approval, the following lead times would apply: 1 week to prepare shop drawings for approval +1 week allowed for review of shop drawings +12 weeks for the basic generating set +1 week for testing +1 week for freight 15-16 weeks total (= August 31 st with a PO placed by May 8 th)
<u>MOEE/TSSA</u>	MOEE/TSSA Charges - NOT INCLUDED.
<u>Site Test/Com.</u>	Startup, Commissioning (c/w temp load bank for testing). Site fuel - NOT included.
<u>Validity</u>	This proposal is valid for acceptance for 90 days .
<u>Payment</u>	To be reviewed.
<u>Freight</u>	Allowed to site on flat bed. Unloading included . Installation, permits & works not described above, are by others.
<u>Start Up</u>	Startup will be carried out by a "factory trained technician".
<u>Exclusions</u>	<ul style="list-style-type: none"> - Installation is BY OTHERS. - Any Transfer Switch is By Others.

This Proposal is limited to the scope described above.



POWER SYSTEMS TORONTO LTD

Toronto Zoo
400 kW Standby Outdoor Diesel Generator

ISO & Warranty Certificates



GAL Reference No:	T00673
Prepared By:	Misbah Mazhar (905-795-8877)

WWW.GALPOWER.COM

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Lloyd's Register
LRQA

CERTIFICATE OF APPROVAL

This is to certify that the Quality Management System of:

SDMO Industries
12 Bis rue de la Villeneuve
29228 BREST, France

has been approved by Lloyd's Register Quality Assurance
to the following Quality Management System Standards:

ISO 9001:2008

The Quality Management System is applicable to:

Sales, design, manufacture and installation of generating sets.
Provider of services such as training, technical assistance,
maintenance and supply of spare parts.

This certificate is valid only in association with the certificate schedule bearing the same number
on which the locations applicable to this approval are listed.

Approval
Certificate No: FQA 0352175

Original Approval: 10 November 1999

Current Certificate: 11 April 2015

Certificate Expiry: 10 April 2018

Issued by: Lloyd's Register Quality Assurance France SAS
For and on behalf of LRQA Limited



001

LRQA France, 1, boulevard Vivier Merle, 69443 Lyon cedex 03 France
For and on behalf of LRQA Ltd, Hiramford, Middlemarch Office Village, Siskin Drive, Coventry, CV3 4FJ, United Kingdom

This approval is carried out in accordance with the LRQA assessment and certification procedures and monitored by LRQA.
The use of the UKAS Accreditation Mark indicates Accreditation in respect of those activities covered by the Accreditation Certificate Number 001

Macro Revision 13



CERTIFICATE SCHEDULE

SDMO Industries 12 Bis rue de la Villeneuve 29228 BREST, France

Head Office

SDMO Industries
12 bis rue de la Villeneuve
29228 BREST

Activities

Sales, design, manufacture and installation of generating sets. Provider of services such as training, technical assistance, maintenance and supply of spare parts.

Locations

SDMO- Etablissement de Réaumur
rue Réaumur
29200 BREST

Activities

Manufacture of generating sets.

SDMO - Etablissement de Kergaradec
rue Jules Jansen
29490 GUIPAVAS

Sales, design, manufacture and installation of generating sets. Provider of services such as training, technical assistance, maintenance and supply of spare parts.

SDMO - Agence de Gennevilliers
"Le Signac"
1 avenue du Général de Gaulle
92230 GENNEVILLIERS

Sales and installation of generating sets.

SDMO - Agence de Metz
18 rue des Potiers d'Etain
57078 METZ

Sales and installation of generating sets.

SDMO - Agence de Valence
"Le Sud"
497 avenue Victor Hugo
26000 VALENCE

Sales and installation of generating sets.

Page 1 of 2



001

Approval Certificate No: FQA 0352175

LRQA France, 1, boulevard Vivier Merle, 69443 Lyon cedex 03 France
For and on behalf of LRQA Ltd, Hiramford, Middlemarch Office Village, Siskin Drive, Coventry, CV3 4FJ, United Kingdom
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The use of the UKAS Accreditation Mark indicates Accreditation in respect of those activities covered by the Accreditation Certificate Number 001

Macro Revision 15



Lloyd's Register
LRQA

CERTIFICATE SCHEDULE

SDMO Industries 12 Bis rue de la Villeneuve 29228 BREST, France

Locations

SDMO - Agence de Toulouse
"Les Espaces de Balma"
12 avenue Charles de Gaulle
31138 BALMA

Sales and installation of generating sets.

SDMO - Agence de Cholet
18 rue de la Gâtin
ZAC du Cormier
49303 CHOLET

Sales and installation of generating sets.

SDMO - Bureau d'Aix en Provence
Résidence la Galice
Allée Dr Bianchi
13090 AIX EN PROVENCE

Sales and installation of generating sets.

Approval
Certificate No: FQA 0352175

Original Approval: 10 November 1999

Current Certificate: 11 April 2015

Certificate Expiry: 10 April 2018

Page 2 of 2



001

Approval Certificate No: FQA 0352175

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Macro Revision 15



RULES GOVERNING THE APPLICATION OF THE "1 PLUS 1" YEAR EXTENDED WARRANTY

These rules governing the application of the "1 plus 1" year extended warranty complement SDMO Industries' general terms and conditions of sale.

1. Standard warranty

Motors, alternators and control cabinets supplied by SDMO Industries for generating sets benefit from a contractual warranty such as defined in SDMO Industries' general terms and conditions of sale.

2. Purpose

2.1 Description of the extended warranty

At the end of a standard warranty period, generating sets such as that defined in section 1 can benefit from an extended warranty leading to a duration of "1 + 1" years or a total of "1000" hours following commissioning or 30 months since the Exwork delivery date whichever of these 3 terms is reached first, according to the description and the agreement of the sales departments of SDMO Industries.

The extended warranty, which is not a substitute for the legal warranty against hidden defects, is intended to offer the CUSTOMER access to technical services such as those described in section 2.3 below.

2.2 Expenses covered by the extended warranty

During this period, SDMO Industries undertakes to cover the cost of labour and parts, excluding the cost of callout and of transporting parts, for the replacement of parts recognised by SDMO as being defective or having a fault in their design, materials or construction.

All costs of transporting a main component (engine, alternator, chassis, etc.) for the generator, or of transporting the generator itself, for carrying out repairs relating to the extended warranty will be met by the CUSTOMER.

2.3 Exclusions

The following are not covered by this extended warranty:

- Exhausts and exhaust ducts
- Fuel circuits and systems located upstream of the fuel filters
- Cooling systems and pipes
- Starter systems (batteries, compressors, air reservoirs, starters)
- Filters
- Hoses and tubes
- Seals
- Belts
- Relays
- Switches
- Lamps
- Diodes
- Commutators
- Level sensors, pressure sensors, temperature sensors, etc.
- Measurement indicators
- All consumables and wearing parts

Also excluded is all damage, fault or breakdown:

- not attributable to a defect in generating set design, materials, construction or assembly
 - resulting from external causes, such as impact, accident, vandalism, theft, etc.
 - resulting from abnormal use, a running or operating fault caused by the user, a modification of the generating set that is unplanned or unauthorised by SDMO Industries, inadequate storage, failure to respect the recommendations and preventive maintenance frequency recommended by SDMO Industries and/or the component manufacturers, a maintenance failure or use of an ingredient not approved by SDMO Industries and/or the component manufacturers.
 - resulting from fitting or use of non-original components or parts
- As well as:
- all installation and/or commissioning costs relating to the generating set

2.4 Limitations

Although SDMO Industries is a main contractor or leader in civil engineering, electricity and any other aspects of the external installation of the "generating set" unit, the extended warranty is limited to the sub-assemblies described in the above section.

3. Implementation

3.1 Limitations concerning the overall warranty

Repair or replacement of a part during the extended warranty period does not prolong the warranty of the overall equipment, such as defined in section 1 in the list of goods covered, beyond the duration agreed at the time of sale of the generating set.

3.2 Ownership of replaced parts

Parts replaced under the extended warranty become the property of SDMO Industries, to whom they should be returned at the end of the repair process.

3.3 Determination of the means of repair

Determination of the means of repair or replacement is the exclusive responsibility of SDMO Industries, as are any modifications to be carried out on the installation in the case of defects acknowledged.

3.4 Warranty on replaced parts

During the period of validity of the extended warranty, all replaced parts benefit from their own warranty, for parts and labour, equal to the limit defined in section 1.

3.5 Excluded charges

In the event that a technical service carried out by SDMO Industries is not covered by these conditions, or that one of the conditions of validity has not been respected by the CUSTOMER, all charges, including expert's report, are borne exclusively by the CUSTOMER: SDMO Industries reserves the right to claim from the CUSTOMER any expenses unduly incurred.

4. Conditions of validity

4.1 Incident and/or malfunction declaration

All generating set incidents and/or malfunctions must be declared by the CUSTOMER to SDMO Industries in writing on the first working day following discovery of the incident and/or malfunction.

4.2 Preventative Maintenance

The extended warranty is subject to the perfect execution of the recommended maintenance procedures by duly qualified personnel (for example: injectors, coolant pumps, injection pumps, etc.), under the terms recommended by SDMO and/or parts manufacturers; the cost of generating set maintenance is borne exclusively by the CUSTOMER.

Preventive maintenance programmes are provided by SDMO Industries, upon indication of the duration of extended warranties, hourly usage rates as well as operating modes (standby, EJP, 24/24, etc.); the Customer can subscribe to a maintenance contract with SDMO Industries.

4.3 Replacement of parts and use of ingredients

The extended warranty is subject to the use of consumables and wearing parts and ingredients that meet the recommendations of SDMO Industries and/or component manufacturers, as well as to the ongoing maintenance of the levels of liquids and lubricants.

4.4 Adherence to the conditions of validity

At the request of SDMO Industries, the CUSTOMER must be able to provide any written documents, and in particular the maintenance booklet, demonstrating that the maintenance of the generating set and the use of parts and ingredients meet the specifications and/or recommendations of SDMO Industries and/or component manufacturers.

4.5 Suspension or termination for breach of contract

Failure by the CUSTOMER to respect the conditions of validity and responsibility as stated above, as well as any refusal by the CUSTOMER to have repairs or preventive maintenance considered by SDMO Industries to be essential carried out can, as of right, lead to the suspension or limitation of the extended warranty as defined at the time of sale of the generating set.

To this end, SDMO Industries can suspend or terminate this warranty by sending the customer written notification by registered post with acknowledgement of receipt.



POWER SYSTEMS TORONTO LTD

Toronto Zoo
400 kW Standby Outdoor Diesel Generator

Generating Set Data



GAL Reference No:	T00673
Prepared By:	Misbah Mazhar (905-795-8877)

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DESCRIPTIVE

- Electronic governor
- Mechanically welded chassis with antivibration suspension
- Main line circuit breaker
- Radiator for core temperature of 48/50°C max with mechanical fan
- Protective grille for fan and rotating parts (CE option)
- 9 dB(A) silencer supplied separately
- Charger DC starting battery with electrolyte
- 24 V charge alternator and starter
- Delivered with oil and coolant -30°C
- Manual for use and installation

POWER DEFINITION

PRP : Prime Power is available for an unlimited number of annual operating hours in variable load applications, in accordance with ISO 8528-1. ESP : The standby power rating is applicable for supplying emergency power in variable load applications in accordance with ISO 8528-1. Overload is not allowed.

TERMS OF USE

According to the standard, the nominal power assigned by the genset is given for 25°C Air Inlet Temperature, of a barometric pressure of 100 kPa (100 m A.S.L.), and 30 % relative humidity. For particular conditions in your installation, refer to the derating table.

ASSOCIATED UNCERTAINTY

For the generating sets used indoor, where the acoustic pressure levels depends on the installation conditions, it is not possible to specify the ambient noise level in the exploitation and maintenance instructions . You will also find in our exploitation and maintenance instructions a warning concerning the air noise dangers and the need to implement appropriated preventive measures.

V400U

Engine ref.	TAD1344GE
Alternator ref.	KH01630T
Performance class	G3

GENERAL CHARACTERISTICS

Frequency (Hz)	60 Hz
Voltage (V)	480/277
Standard Control Panel	APM403
Optional control panel	APM802
Optional Control Panel	M80
Optional control panel	TELYS

POWER

Voltage	ESP		PRP		Standby Amps
	kWe	kVA	kWe	kVA	
480/277	400	500	364	455	601
440/254	400	500	364	455	656
220/127	400	500	364	455	1312
208/120	400	500	364	455	1388
600/347	400	500	364	455	481

DIMENSIONS COMPACT VERSION

Length (mm)	3160
Width (mm)	1340
Height (mm)	1805
Dry weight (kg)	3078
Tank capacity (L)	470

DIMENSIONS SOUNDPROOFED VERSION

Type soundproofing	M228
Length (mm)	4475
Width (mm)	1410
Height (mm)	2430
Dry weight (kg)	4048
Tank capacity (L)	470
Acoustic pressure level @1m in dB(A)	86
Guaranteed acoustic power level (Lwa)	105
Acoustic pressure level @7m in dB(A)	75

Please Refer to Dimensional Drawings for Actual Values



V400U

ENGINE CHARACTERISTICS

GENERAL ENGINE DATA

Engine brand	VOLVO
Engine ref.	TAD1344GE
Air inlet system	Turbo
Cylinders configuration	L
Number of cylinders	6
Displacement (L)	12,78
Charge Air coolant	Air/Air DC
Bore (mm) x Stroke (mm)	131 x 158
Compression ratio	18.1 : 1
Speed (RPM)	1800
Pistons speed (m/s)	9,48
Maximum stand-by power at rated RPM (kW)	449
Frequency regulation, steady state (%)	+/- 0.25%
BMEP (bar)	25,60
Governor type	Electronic

COOLING SYSTEM

Radiator & Engine capacity (L)	44
Fan power (kW)	18
Fan air flow w/o restriction (m3/s)	9,50
Available restriction on air flow (mm H2O)	25
Type of coolant	Glycol-Ethylene

EMISSIONS

Emission PM (g/kWh)	
Emission CO (g/kW.h)	
Emission HC+NOx (g/kWh)	0
Emission HC (g/kW.h)	0,14

EXHAUST

Exhaust gas temperature @ ESP 60Hz (°C)	490
Exhaust gas flow @ ESP 60Hz (L/s)	1376
Max. exhaust back pressure (mm H2O)	1000

FUEL

Fuel consumption 110% load (L/hr)	106,70
Fuel consumption 100% load (L/hr)	97
Fuel consumption 75% (L/h)	72,40
Fuel consumption 50% (L/h)	49,40
Maximum fuel pump flow (L/h)	130

OIL

Oil capacity (L)	36
Min. oil pressure (bar)	
Max. oil pressure (bar)	
Oil consumption 100% ESP (L/h)	2,30
Oil sump capacity (L)	30

HEAT BALANCE

Heat rejection to exhaust (kW)	324
Radiated heat to ambient (kW)	23
Heat rejection to coolant HT (kW)	180

AIR INTAKE

Max. intake restriction (mm H2O)	510
Intake air flow (L/s)	550

GENERAL DATA		OTHER DATA	
Alternator ref.	KH01630T	Continuous Nominal Rating 40°C (kVA)	456
Number of Phase	Three phase	Standby Rating 27°C (kVA)	530
Power factor (Cos Phi)	0,80	Efficiencies 100% of load (%)	93,30
Altitude (m)	0 à 1000	Air flow (m3/s)	1,10
Overspeed (rpm)	2250	Short circuit ratio (Kcc)	0,3610
Number of pole	4	Direct axis synchro reactance unsaturated (Xd) (%)	349
Capacity for maintaining short circuit at 3 In for 10 s	No	Quadra axis synchro reactance unsaturated (Xq) (%)	178
Insulation class	H	Open circuit time constant (T'do) (ms)	1738
T° class (H/125°), continuous 40°C	H / 125°K	Direct axis transient reactance saturated (X'd) (%)	20,10
T° class (H/163°C), standby 27°C	H / 163°K	Short circuit transient time constant (T'd) (ms)	100
Total Harmonic Distortion in no-load DHT (%)	<2	Direct axis subtranscient reactance saturated (X"q) (%)	14
AVR Regulation	Yes	Subtranscient time constant (T"d) (ms)	10
Total Harmonic Distortion, on linear load DHT (%)	<2	Quadra axis subtranscient reactance saturated (X"q) (%)	19,10
Wave form : NEMA=TIF	<50	Subtranscient time constant (T"q) (ms)	10
Wave form : CEI=FHT	<2	Zero sequence reactance unsaturated (Xo) (%)	0,80
Number of bearing	1	Negative sequence reactance saturated (X2) (%)	16,61
Coupling	Direct	Armature time constant (Ta) (ms)	15
Voltage regulation at established rating (+/- %)	0,50	No load excitation current (io) (A)	0,99
Recovery time (Delta U = 20% transient) (ms)	500	Full load excitation current (ic) (A)	3,93
Indication of protection	IP 23	Full load excitation voltage (uc) (V)	67,50
Technology	Brushless	Engine start (Delta U = 20% perm. or 30% trans.) (kVA)	718,09
		Transient dip (4/4 load) - PF : 0,8 AR (%)	18
		No load losses (W)	8553,31
		Heat rejection (W)	25782
		Unbalanced load acceptance ratio (%)	70

M80, transfer of information



The M80 is a dual-function control unit. It can be used as a basic terminal block for connecting a control box and as an instrument panel with a direct read facility, with displays giving a global view of your generating set's basic parameters.

Offers the following functions:

Engine parameters: tachometer, working hours counter, coolant temperature indicator, oil pressure indicator, emergency stop button, customer connection terminal block, CE.

TELYS, ergonomic and user-friendly



The highly versatile TELYS control unit is complex yet accessible, thanks to the particular attention paid to optimising its ergonomics and ease of use. With its large display screen, buttons and scroll wheel, it places the accent on simplicity and communication.

The TELYS offers the following functions:

Electrical measurements: voltmeter, frequency meter, ammeter.

Engine parameters: working hours counter, oil pressure, coolant temperature, fuel level, engine speed, battery voltage.

Alarms and faults: oil pressure, coolant temperature, failure to start, overspeed, alternator min./max., battery voltage min./max., emergency stop, fuel level.

Ergonomics: wheel for navigating around the various menus.

Communication: remote control and operation software, USB connections, PC connection.

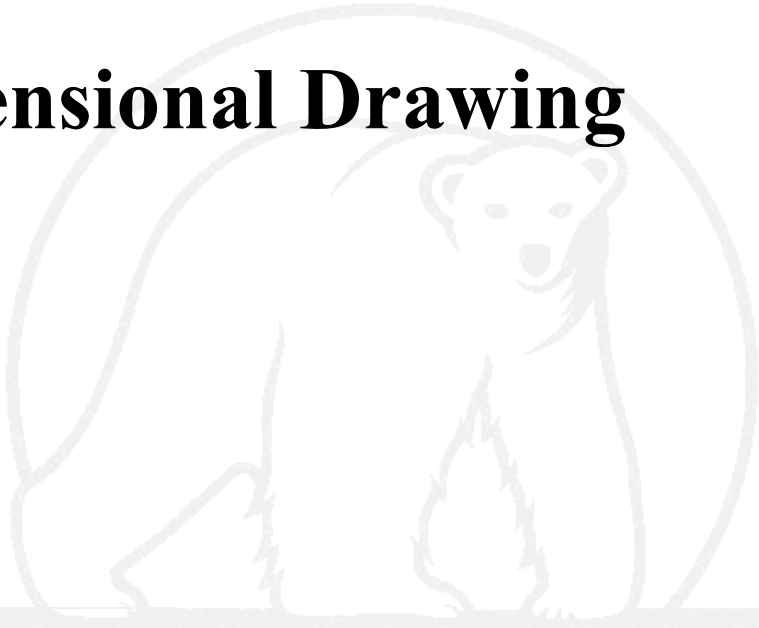
For more information on the product and its options, please refer to the sales documentation.



POWER SYSTEMS TORONTO LTD

Toronto Zoo
400 kW Standby Outdoor Diesel Generator

Dimensional Drawing



GAL Reference No:	T00673
Prepared By:	Misbah Mazhar (905-795-8877)

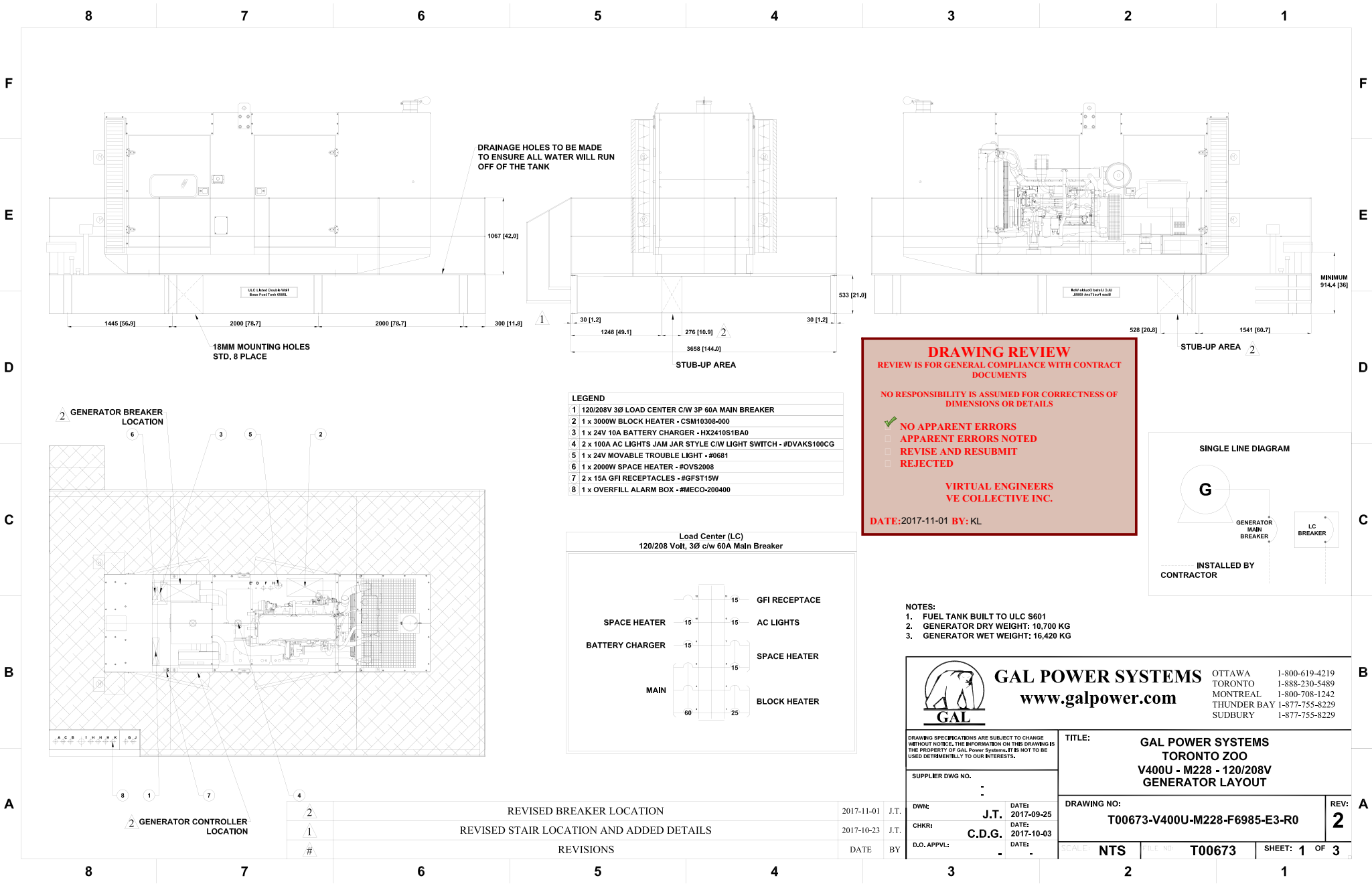
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DRAINAGE HOLES TO BE MADE TO ENSURE ALL WATER WILL RUN OFF OF THE TANK

18MM MOUNTING HOLES STD. 8 PLACE

LEGEND

1	120/208V 3Ø LOAD CENTER C/W 3P 60A MAIN BREAKER
2	1 x 3000W BLOCK HEATER - CSM10308-000
3	1 x 24V 10A BATTERY CHARGER - HX2410S1BA0
4	2 x 100A AC LIGHTS JAM JAR STYLE C/W LIGHT SWITCH - #DVAKS100CG
5	1 x 24V MOVABLE TROUBLE LIGHT - #0681
6	1 x 2000W SPACE HEATER - #OV52008
7	2 x 15A GFI RECEPTACLES - #GFST15W
8	1 x OVERFILL ALARM BOX - #MECO-200400

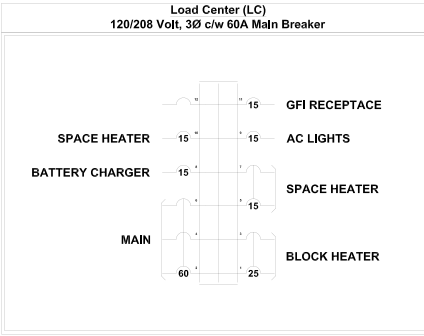
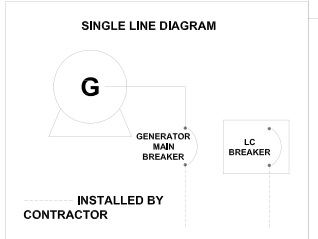
DRAWING REVIEW
 REVIEW IS FOR GENERAL COMPLIANCE WITH CONTRACT DOCUMENTS

NO RESPONSIBILITY IS ASSUMED FOR CORRECTNESS OF DIMENSIONS OR DETAILS

NO APPARENT ERRORS
 APPARENT ERRORS NOTED
 REVISE AND RESUBMIT
 REJECTED

VIRTUAL ENGINEERS
VE COLLECTIVE INC.

DATE: 2017-11-01 BY: KL



- NOTES:**
- FUEL TANK BUILT TO ULC S601
 - GENERATOR DRY WEIGHT: 10,700 KG
 - GENERATOR WET WEIGHT: 16,420 KG

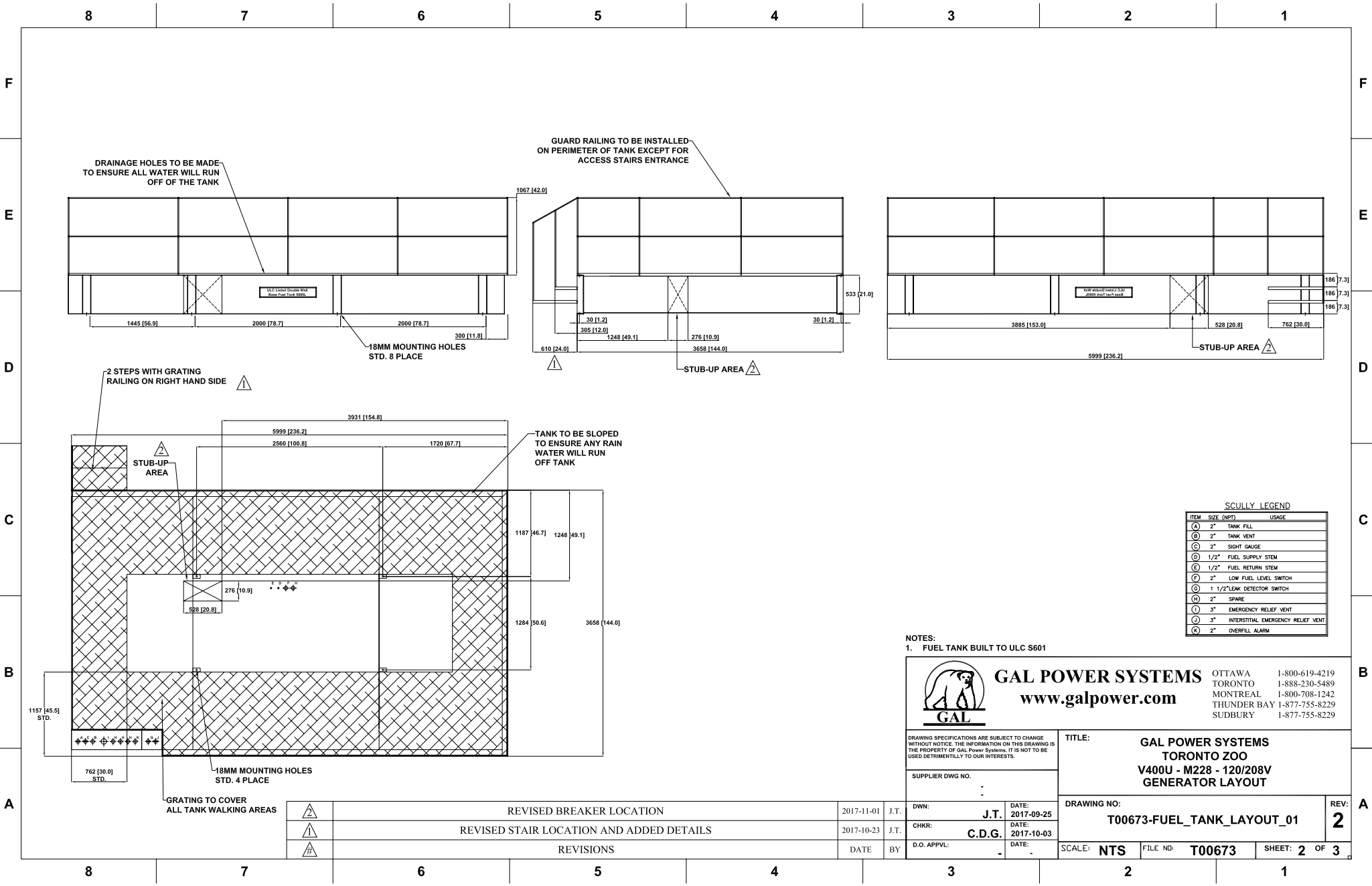
GAL POWER SYSTEMS

www.galpower.com

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 MONTREAL 1-800-708-1242
 THUNDER BAY 1-877-755-8229
 SUDBURY 1-877-755-8229

DRAWING SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE. THE INFORMATION ON THIS DRAWING IS THE PROPERTY OF GAL Power Systems, IT IS NOT TO BE USED DETRIMENTALLY TO OUR INTERESTS.		TITLE: GAL POWER SYSTEMS TORONTO ZOO V400U - M228 - 120/208V GENERATOR LAYOUT	
SUPPLIER DWG NO. :		DRAWING NO: T00673-V400U-M228-F6985-E3-R0	
DWN: J.T.	DATE: 2017-09-25	REV: 2	
CHKR: C.D.G.	DATE: 2017-10-03		
D.O. APPVL:	DATE:	SCALE: NTS	FILE NO: T00673
		SHEET: 1 OF 3	

#	REVISIONS	DATE	BY
2	REVISED BREAKER LOCATION	2017-11-01	J.T.
1	REVISED STAIR LOCATION AND ADDED DETAILS	2017-10-23	J.T.
#			



SCULLY LEGEND

ITEM	SIZE (NPS)	USAGE
(A)	2"	TANK FILL
(B)	2"	TANK VENT
(C)	2"	SIGHT GAUGE
(D)	1/2"	FUEL SUPPLY STEM
(E)	1/2"	FUEL RETURN STEM
(F)	2"	LOW FUEL LEVEL SWITCH
(G)	1 1/2"	LEAK DETECTOR SWITCH
(H)	2"	SPARE
(I)	3"	EMERGENCY RELIEF VENT
(J)	3"	INTERSTITIAL EMERGENCY RELIEF VENT
(K)	2"	OVERFILL ALARM

NOTES:
 1. FUEL TANK BUILT TO ULC S601

GAL POWER SYSTEMS

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SUPPLIER DWG NO. _____

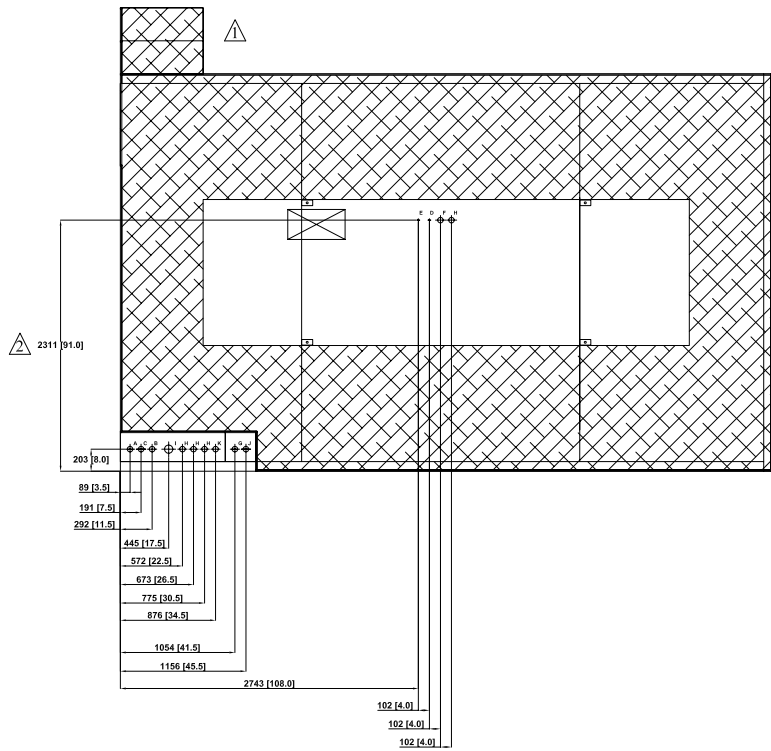
TITLE:
**GAL POWER SYSTEMS
 TORONTO ZOO
 V400U - M228 - 120/208V
 GENERATOR LAYOUT**

DWN:	J.T.	DATE:	2017-09-25	DRAWING NO:	T00673-FUEL_TANK_LAYOUT_01	REV:	2
CHKR:	C.D.G.	DATE:	2017-10-03	DATE:			
D.O. APPVL:		DATE:		SCALE:	NTS	FILE NO:	T00673
				SHEET:	2	OF	3

REV	DESCRIPTION	DATE	BY
2	REVISED BREAKER LOCATION	2017-11-01	J.T.
1	REVISED STAIR LOCATION AND ADDED DETAILS	2017-10-23	J.T.
#	REVISIONS		

8 7 6 5 4 3 2 1

F E D C B A



SCULLY LEGEND

ITEM	SIZE (NPS)	USAGE
(A)	2"	TANK FILL
(B)	2"	TANK VENT
(C)	2"	SIGHT GAUGE
(D)	1/2"	FUEL SUPPLY STEM
(E)	1/2"	FUEL RETURN STEM
(F)	2"	LOW FUEL LEVEL SWITCH
(G)	1 1/2"	LEAK DETECTOR SWITCH
(H)	2"	SPARE
(I)	3"	EMERGENCY RELIEF VENT
(J)	3"	INTERSTITIAL EMERGENCY RELIEF VENT
(K)	2"	OVERFILL ALARM

NOTES:
1. FUEL TANK BUILT TO ULC S601

GAL POWER SYSTEMS
www.galpower.com

OTTAWA 1-800-619-4219
TORONTO 1-888-230-5489
MONTREAL 1-800-708-1242
THUNDER BAY 1-877-755-8229
SUDBURY 1-877-755-8229

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SUPPLIER DWG NO. :

TITLE: **GAL POWER SYSTEMS TORONTO ZOO V400U - M228 - 120/208V GENERATOR LAYOUT**

△	REVISED BREAKER LOCATION	2017-11-01	J.T.	DWN: J.T.	DATE: 2017-09-25	DRAWING NO: T00673-FUEL_TANK_LAYOUT_02	REV: 2
1	REVISED STAIR LOCATION AND ADDED DETAILS	2017-10-23	J.T.	CHKR: C.D.G.	DATE: 2017-10-03	SCALE: NTS FILE NO: T00673 SHEET: 3 OF 3	
#	REVISIONS	DATE	BY	D.O. APPVL: -	DATE: -		

8 7 6 5 4 3 2 1



M228

Soundproofing canopy

STANDARD FEATURES

- They protect stationary and mobile generator against the bad weather, against the theft and enables the reduction of the noise level.
- Enclosures are of 12 gauge steel. Steel sheet are electro zinc coated before painting (inside and outside) with a polyester powder rust inhibiting coat .
- High corrosion resistance: stainless covered with zinc and made in dichromate, bolts and rivets, anodized aluminium alloy hinges flexible seals between body sections.
- Soundfoam between 20 and 50 mm (1 to 2 in) acoustical sound treatment
- Lifting eye(s) on top of the enclosure fixed to the skid
- Large doors allow easy access to the generator set for service and monitoring purposes
- Window in "securit" glass mounted on enclosure door for control viewing .
- A critical silencer is mounted inside the enclosure
- Emergency stop button is accessible from outside enclosure.



Model	Sound level			Dimensions (mm)	Weight (kgs)	Tank (l)
	dB(A)@1m	dB(A)@7m	LWA			
V400U	86	75	N/A	4475 x 1410 x 2430	4080	470

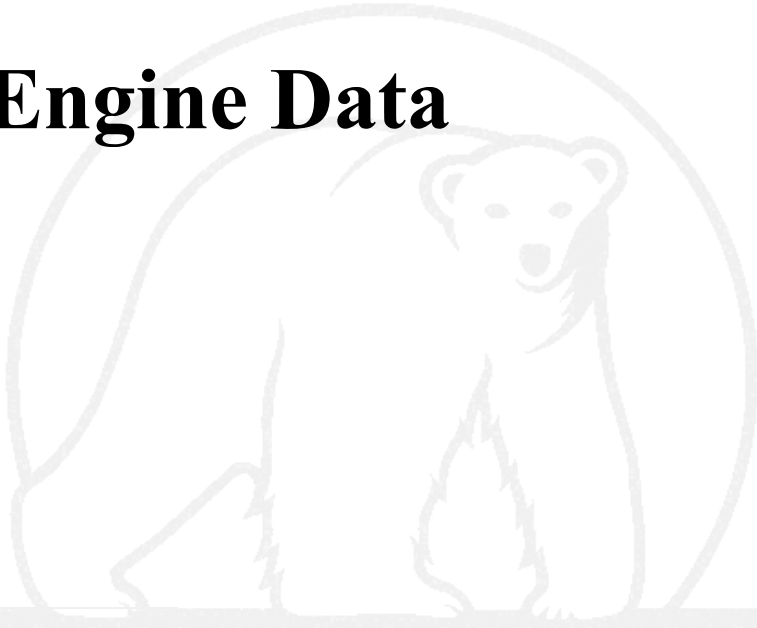
Please refer to Dimensional Drawings for Actual Values



POWER SYSTEMS TORONTO LTD

Toronto Zoo
400 kW Standby Outdoor Diesel Generator

Engine Data



GAL Reference No:	T00673
Prepared By:	Misbah Mazhar (905-795-8877)

WWW.GALPOWER.COM

GAL Power Systems Ottawa Ltd.
84 Bentley Avenue
Nepean, Ontario K2E 6T9
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General

In-line four stroke diesel engine with direct injection. Rotation direction, anti-clockwise viewed towards flywheel.

Turbocharged

Number of cylinders			6
Displacement, total		litre	12,78
		in ³	779,7
Firing order			1-5-3-6-2-4
Bore		mm	131
		in	5,16
Stroke		mm	158
		in	6,22
Compression ratio			18,1:1
Wet weight	Engine only	kg	1325
		lb	2921
	Engine incl. cooling system, air filtration system, and frame	kg	1790
		lb	3946

Performance

			rpm	1500	1800
Prime Power	without fan	kW		364	410
		hp		495	558
	with fan	kW		354	392
		hp		481	533
Standby Power	without fan	kW		399	449
		hp		543	611
	with fan	kW		389	431
		hp		529	586
Torque at:	Prime Power	Nm		2317	2175
		lbft		1709	1604
	Standby Power	Nm		2540	2382
		lbft		1873	1757
Mean piston speed		m/s		7,9	9,5
		ft/sec		26,0	31,2
Effective mean pressure at:	Prime Power	MPa		2,3	2,1
		psi		331	310
Effective mean pressure at:	Standby Power	MPa		2,5	2,3
		psi		362	340
Max combustion pressure at:	Prime Power	MPa		16,1	17,2
		psi		2335	2495
Max combustion pressure at:	Standby Power	MPa		17,2	18,1
		psi		2495	2625
Total mass moment of inertia, J (mR ²)		kgm ²		3,43	
		lbft ²		81,4	
Friction Power		kW		30	44
		hp		40,8	59,84
Derating see Technical Diagrams					

Engine noise emission

Test Standards: ISO 3744-1981 (E) sound power

Tolerance ± 0.75 dB(A)

		rpm	1500	1800
Measured sound power Lw	No load	dB(A)	113	116,4
	Prime Power	dB(A)	116,2	118,5
	Standby Power	dB(A)	116,5	118,5
Calculated sound pressure Lp at 1 m	No load	dB(A)	97,1	100,4
	Prime Power	dB(A)	99,8	102,2
	Standby Power	dB(A)	100	102,3

Unsilenced exhaust noise

Data calculated as sound pressure Lp.

Assumed microphone distance 1 m

	rpm	1500	1800
Prime Power	dB(A)	114	118
Standby Power	dB(A)	115	119

Test conditions for load acceptance data

Warm engine.	Generator	Model	Type of AVR
	Stamford	HCI544C	SX440

Load acceptance performance can vary due to actual alternator inertia, voltage regulator, type of load and local ambient conditions.

Single step load performance at 1500 rpm

Load (%)	Speed diff (%)		Recovery time (s)		Remaining load (%)	Speed diff (%)		Recovery time (s)	
	Prime	Standby	Prime	Standby		Prime	Standby	Prime	Standby
0-20	1,1	1,3	1,5	1,5	20-100	20,7	23,9	3,3	4,0
0-40	2,8	3,4	1,7	1,7	40-100	6,8	6,8	1,6	1,6
0-60	7,0	9,9	2,8	2,5	60-100	2,6	2,9	1,5	1,6
0-80	18,9	23,2	3,1	3,6	80-100	1,2	1,1	1,5	1,8
0-61	7,0		2,8		61-100	2,4		1,6	
0-65	10,0		2,4		65-100	2,1		1,6	
0-55		6,9		2,8	55-100		3,4		1,8
0-60		10,0		2,5	60-100		2,9		1,7
100-0	5,0	5,5	2,1	2,1					

Single step load performance at 1800 rpm

Load (%)	Speed diff %		Recovery time (s)		Remaining load (%)	Speed diff (%)		Recovery time (s)	
	Prime	Standby	Prime	Standby		Prime	Standby	Prime	Standby
0-20	1,0	1,1	1,7	1,8	20-100	6,5	8,4	1,9	3,4
0-40	2,2	2,4	2,2	2,0	40-100	3,0	3,7	2,0	1,7
0-60	4,1	4,2	2,2	1,6	60-100	1,9	2,2	2,5	2,3
0-80	8,7	9,3	3,2	2,6	80-100	0,9	0,9	1,9	2,0
0-78	6,5		2,1		78-100	0,9		2,2	
0-88	10,0		2,9		88-100	0,7		1,3	
0-71		6,4		1,4	71-100		1,5		2,1
0-80		10,0		3,0	80-100		1,0		1,8
100-0	3,7	4,0	2,1	2,1					

VOLVO PENTA

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03**Cold start performance**

	°C	rpm	1500	1800
Time from start to stay within 0.5% of no load speed at ambient temperature:	20	s	4,8	4,6
	5	s	5,7	5,2
	-15*	s	6,6	6,0

* With manifold heater 4 kW engaged, lubrication oil 15W/40 and block heater.

Block heater type	Make	Power kW	Engaged hours	Cooling water temp engine block
	Volvo	2	12	10°C 50°F

Lubrication system

		rpm	1500	1800
Lubricating oil consumption	Prime Power	litre/h	0,04	0,05
		US gal/h	0,011	0,013
	Standby Power	litre/h	0,04	0,05
		US gal/h	0,011	0,013
Oil system capacity including filters		litre	36	
		US gal	9,5	
Oil sump capacity:	max	litre	30	
		US gal	7,9	
	min	litre	19	
		US gal	5,0	
Oil change intervals/specifications:	VSD3	h	600	
	VSD2	h	400	
		h	200	
Engine angularity limits:	front up	°	20	
	front down	°	20	
	side tilt	°	20	
Oil pressure at rated speed		kPa	370 - 520	
		psi	54 - 75	
Lubrication oil temperature in oil sump:	max	°C	130	
		°F	266	
Oil filter micron size		µ	40	

* See also general section in the sales guide

Fuel system

		rpm	1500	1800
Prime Power Specific fuel consumption at:	25%	g/kWh	219	229
		lb/hph	0,355	0,371
		g/kWh	200	205
		lb/hph	0,324	0,332
	75%	g/kWh	197	200
		lb/hph	0,319	0,324
		g/kWh	194	201
		lb/hph	0,314	0,326
Standby Power Specific fuel consumption at:	25%	g/kWh	215	225
		lb/hph	0,349	0,365
		g/kWh	199	204
		lb/hph	0,323	0,331
	75%	g/kWh	198	201
		lb/hph	0,321	0,326
		g/kWh	195	202
		lb/hph	0,316	0,327

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03**Fuel system****rpm 1500 1800**

Fuel to conform to	ASTM-D975-No1 and 2D JIS KK 2204, EN 590		
System supply flow at:	litre/h US gal/h	120,0 31,7	130,0 34,3
Fuel supply line max restriction (Measured at fuel inlet connection)	kPa psi	30,0 4,4	30,0 4,4
Fuel supply line max pressure, engine stopped	kPa psi	20,0 2,9	20,0 2,9
System return flow	litre/h US gal/h	18,0 4,8	18,0 4,8
Fuel return line max restriction (Measured at fuel return connection)	kPa psi	20,0 2,9	20,0 2,9
Maximum allowable inlet fuel temp (Measured at fuel inlet connection)	°C °F	50 122	50 122
Prefilter / Water separator micron size	μ	10	
Fuel filter micron size	μ	5	
Governor type/make, standard	Volvo / EMS 2.2		
Injection pump type/make	Delphi E3		

Intake and exhaust system**rpm 1500 1800**

Air consumption at: (+25°C and 100kPa)	Prime Power	m ³ /min cfm	27 954	33 1165
	Standby Power	m ³ /min cfm	28 989	33 1165
Max allowable air intake restriction including piping		kPa psi	5 0,7	5 0,7
Air filter restriction clean Volvo Penta filter		kPa psi		
Heat rejection to exhaust at:	Prime Power	kW BTU/min	243 13819	280 15923
	Standby Power	kW BTU/min	266 15127	324 18426
Exhaust gas temperature after turbine at:	Prime Power	°C °F	440 824	440 824
	Standby Power	°C °F	465 869	490 914
Max allowable back pressure in exhaust line	Prime Power	kPa psi	9 1,3	9 1,3
	Standby Power	kPa psi	10 1,5	10 1,5
Exhaust gas flow at: (temp and pressure after turbine at the corresponding power setting)	Prime Power	m ³ /min cfm	63,5 2243	77,0 2719
	Standby Power	m ³ /min cfm	67,5 2384	82,0 2896

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03**Cooling system**

		rpm	1500	1800
Heat rejection radiation from engine at:	Prime Power	kW	13	22
		BTU/min	739	1251
	Standby Power	kW	15	23
		BTU/min	853	1308
Heat rejection to coolant at:	Prime Power	kW	143	165
		BTU/min	8132	9383
	Standby Power	kW	155	180
		BTU/min	8815	10236
Coolant	Volvo Penta coolant "ready mix" or Volvo Penta coolant mixed with clean fresh water 40 / 60			
Radiator cooling system type	Closed circuit			
Standard radiator core area		m ²	0,8	
		foot ²	8,61	
Fan diameter		mm	890	
		in	35,04	
Fan power consumption - LOW fan ratio		kW	6	11
		hp	8	15
Fan power consumption - STD fan ratio		kW	10	18
		hp	14	24
Fan drive ratio - LOW			0,84 : 1	
Fan drive ratio - STD			0,99 : 1	
Coolant capacity,	engine	litre	20	
		US gal	5,28	
	std radiator and hoses	litre	24	
		US gal	6,34	
Coolant pump	drive/ratio		Belt / 1,43 : 1	
Coolant flow with standard system		l/s	5	5,5
		US gal/s	1,32	1,45
Minimum coolant flow		l/s	5,0	5,5
		US gal/s	1,32	1,45
Maximum outer circuit restriction, including piping		kPa	39	47
		psi	5,7	6,8
Thermostat	start to open	°C	82	
		°F	180	
	fully open	°C	92	
		°F	198	
Maximum static pressure head (expansion tank height + pressure cap setting)		kPa	100	
		psi	14,5	
Minimum static pressure head (expansion tank height + pressure cap setting)		kPa	70	
		psi	10,2	
Standard pressure cap setting		kPa	70	
		psi	10,2	
Maximum top tank temperature		°C	107	
		°F	225	
Draw down capacity. The difference between min coolant level in the expansion tank and the lowest level where the engine's coolant system still are functioning		litre	1,8	
		US gal	0,48	

Charge air cooler system

		rpm	1500	1800
Heat rejection to charge air cooler	Prime Power	kW	64	94
		BTU/min	3640	5346
	Standby Power	kW	77	92
		BTU/min	4379	5232
Charge air mass flow	Prime Power	kg/s	0,48	0,62
	Standby Power	kg/s	0,51	0,63
Charge air inlet temp. (Charge air temp after turbo compressor)	Prime Power	°C	184	199
		°F	363	390
	Standby Power	°C	197	199
		°F	387	390
Charge air outlet temp. (Charge air temp after intercooler)	Prime Power	°C	44	44
		°F	111	111
	Standby Power	°C	45	45
		°F	113	113
Maximum pressure drop over charge air cooler incl. piping		kPa	8	
		psi	1,16	
Charge air pressure (After charge air cooler)		kPa	221	
		psi	32,05	
Standard charge air cooler core area		m ²	0,89	
		foot ²	9,58	

Cooling performance

Cooling air flow and external restriction at different radiator air temperatures based on 107°C TTT and 40% coolant. Valid at 1 atm. (radiator and cooling fan, see optional equipment)

Engine speed rpm	Air on temp °C	PRIME POWER		STANDBY POWER	
		Air flow m ³ /s	External restriction Pa	Air flow m ³ /s	External restriction Pa
1500	50	4,3	788	5,0	528
	55	5,1	482	5,8	246
	59	5,6	211	6,5	0
	63	6,5	0		
1800	40	4,2	1600	4,7	1308
	50	5,5	1019	6,0	812
	60	7,2	311	8,1	0
	63	8,1	0		
1500 (LOW 0,84)	35	3,1	680	3,5	582
	45	3,8	502	4,4	300
	50	4,3	338	4,9	115
	53	4,6	230	5,3	0
	58	5,3	0		
1800 (LOW 0,84)	35	3,9	940	4,2	850
	40	4,3	810	4,7	675
	45	4,8	630	5,2	480
	50	5,4	430	5,9	270
	54	6,0	240	6,6	0
	57	6,6	0		

Note! External restrictions are calculated for values >0 Pa

Engine management system

Functionality	Alternatives	Default setting
Governor mode	Isochronus / Droop	Isochronus
Governor droop	0-8 %	0,0
Governor response	Adjustable PID-constants (VODIA)	Standard
Dual speed	YES	1500 or 1800
Idle speed	600-1200	900
Fine speed adjustment	± 120	0
Stop function	Energized to Run / Stop	Energized to Stop
Preheating function	On / Off	On
Lamp test	On / Off	On

Engine sensor and switch settings

Parameter	Unit	Alarm level		Engine protection		
		Setting range	Default setting	Level	Action. Default/Alternative	
Oil temp	°C	120 - 130	125	Setting +5	Shut down.	
Oil pressure	Low idle	kPa	-	150,0	2,0	Shut down.
	1500 rpm	kPa	250 -220	250,0	-30,0	Shut down.
	1800 rpm	kPa	300 - 270	300,0	-30,0	Shut down.
Oil level		-	Min level	-	-	
Piston cooling pressure >1000 rpm	kPa	-	150	150,0	Shut down.	
Coolant temp	°C	95 - 101	98	Setting +2	Shut down.	
Coolant level		See cooling system	On	Low level		
Fuel feed pressure	Low idle	kPa	-	100	-	-
	>1400 rpm		-	200	-	-
Water in fuel		-	High level	-	-	
Crank case pressure	kPa	-	Increased pressure	Increased pressure	Shut down.	
Air filter pressure droop	kPa	-	5	-	-	
	0,0	Alarm level		Engine protection		
Altitude, above sea	m	-	-	-	Automatic derating, see section derating	
Charge air temp	°C	-	80	85	Shut down.	
Charge air pressure	kPa	-	350	360	Shut down.	
Engine speed	rpm	100 - 120% of rated speed	120% of rated speed	Alarm level	Shut down.	

Engine protection can be disabled. For consequences please see VP International Limited Warranty Policy

Electrical system

Voltage and type		24V / insulated from earth	
Alternator:	make/output	A	Bosch 80 A
	tacho output	Hz/alt. Rev	6
	drive ratio		5,3:1
Starter motor	make	Melco	
	type	105P70	
	kW	7,0	
Number of teeth on:	flywheel	153	
	starter motor	12	
Max wiring resistance main circuit		mΩ	2
Cranking current at +20°C		A	180
Crank engine speed at 20°C		rpm	155

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Starter motor battery capacity:	max	Ah/A	2x225
	min at +5°C	Ah/A	-
Inlet manifold heater (at 20 V)		kW	4,0
Power relay for the manifold heater		A	1

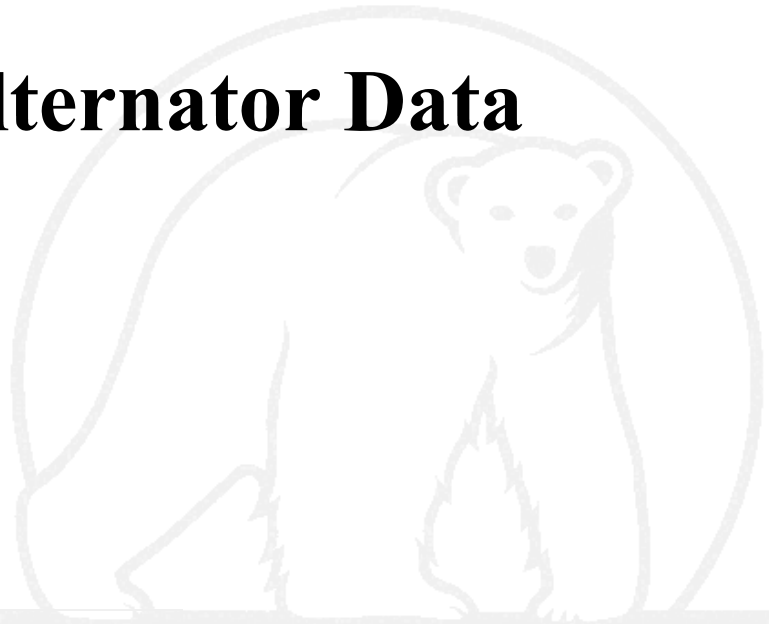
Power take off		rpm	1500	1800
Front end in line with crank shaft max:		Nm	-	
		lbft		
Front end belt pulley load. Direction of load viewed from flywheel side:	max left	kW	-	-
		hp		
	max down	kW	-	-
		hp		
	max right	kW	-	-
		hp		
Timing gear at compressor PTO max:		Nm	160	
		lbft	118	
Speed ratio direction of rotation viewed from flywheel side		0,91:1/clockwise		



POWER SYSTEMS TORONTO LTD

Toronto Zoo
400 kW Standby Outdoor Diesel Generator

Alternator Data



GAL Reference No:	T00673
Prepared By:	Misbah Mazhar (905-795-8877)

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DATASHEET ALTERNATOR

Alternator ref. KH01741T
 Alternator type KH01741TO4D



-GENERAL CHARACTERISTICS-

Voltage Type (V) **208/120** Altitude (m) 0-1000
 Number of Phase Three phase AVR Regulation Yes
 Number of pole 4 Indication of protection IP23

Capacity for maintaining short circuit at 3 In for 10 s Yes
 Winding type Dedicated

Efficiency & Power

Frequency (Hz) 60 Hz Nominal voltage (V) 208

	Class H				Class F	Class B
	125°C/ 40°C continuous	130°C/ 25°C standby	150°C/ 40°C standby	163°C/ 27°C standby	105°C/ 40°C continuous	80°C/ 40°C continuous
Nominal Rating(Kva)	483	483	525	545	458	386
Nominal Rating(KW)	386.40	386.40	420	436	366.40	308.80
Efficiency 100%	93.40	93.40	93.20	93.20	93.50	93.70

-ELECTRICAL CHARACTERISTICS-

Voltage regulation at established rating (+/- %) 0.50
 Insulation class H
 T° class (H/125°), continuous 40°C H / 125°K
 T° class (H/163°C), standby 27°C H / 163°K
 Wave form : NEMA=TIF <50
 Unbalanced load acceptance ratio (%) 70
 Number of wires 12
 Total Harmonic Distortion in no-load DHT (%) <2
 Wave form : CEI=FHT <2
 Total Harmonic Distortion, on linear load DHT (%) <2
 Technology Brushless
 L-L Harmonic Maximum - Single (%) 1,8
 Deviation Factor (%) 3

Reactances

Direct axis synchro reactance unsaturated (Xd) (%) 354
 Direct axis transient reactance saturated (X'd) (%) 20
 Direct axis subtransient reactance saturated (X''d) (%) 14
 Quadra axis synchro reactance unsaturated (Xq) (%) 180
 Quadra axis subtransient reactance saturated (X''q) (%) 18.90
 Zero sequence reactance unsaturated (Xo) (%) 0.80
 Negative sequence reactance saturated (X2) (%) 16.48

Short circuit ratio

Short circuit ratio (Kcc) 0.35
 Subtransient time constant (T''d) (ms) 10
 Short circuit transient time constant (T'd) (ms) 100
 Open circuit time constant (T'do) (ms) 1771

DATASHEET ALTERNATOR

Alternator ref. KH01741T
Alternator type KH01741TO4D



Subtransient time constant (T''q) (ms)	10
Leakage stator reactance (Xa)(%)	1
Stator Resistance (Ra)(%)	0.0160
Armature time constant (Ta) (ms)	15
No load excitation current (io) (A)	0.96
Full load excitation current (ic) (A)	3.90
Full load excitation voltage (uc) (V)	66.90
Heat rejection (W)	26904.53
No load losses (W)	8648.33
Stator resistance (for 20°C ambient) (Ω)	0.001440
Rotor resistance (for 20°C ambient) (Ω)	0.792430
Exciter resistance - stator/inductor (for 20° ambient) (Ω)	17.4040
Exciter resistance - rotor/armature (for 20° ambient) (Ω)	0.1280
Recovery time (Delta U = 20% transient) (ms)	500
Engine start (Delta U = 20% perm. or 30% trans.) (kVA)	764.40
Transient dip (4/4 load) - PF : 0,8 AR (%)	15

Additional electrical characteristics-

Winding X1, X2 auxiliary resistance (for 20° ambient) (Ω)	0.3570
Auxiliary winding X1, X2 excitation voltage at no load (V)	151.40
Winding Z1, Z2 auxiliary resistance (for 20° ambient) (Ω)	0.5020
Auxiliary winding Z1, Z2 excitation voltage at no load (V)	17.10

-MECHANICAL CHARACTERISTICS-

Number of bearing	1
Overspeed (rpm)	2250
Coupling	Direct

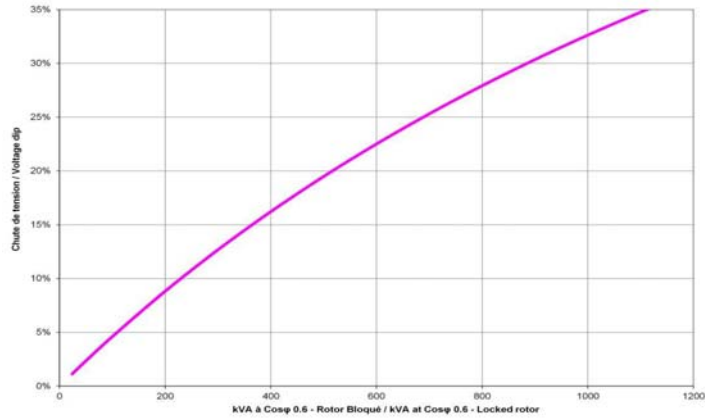
DATASHEET ALTERNATOR

Alternator ref. KH01741T
Alternator type KH01741TO4D

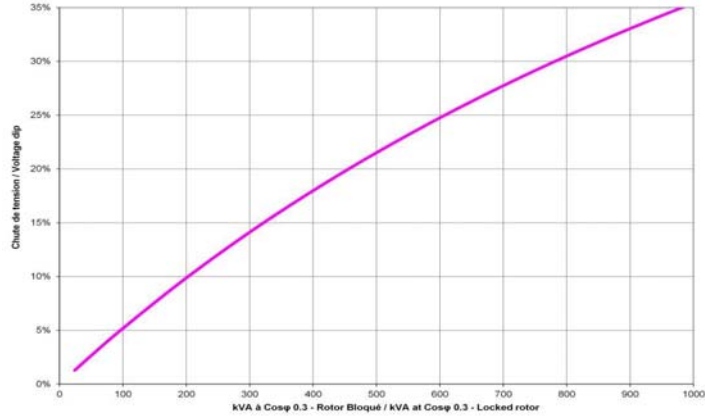


-TECHNICAL CURVES-

Motor starting curve locked rotor (0,6PF)



Motor starting curve locked rotor (0,3PF)

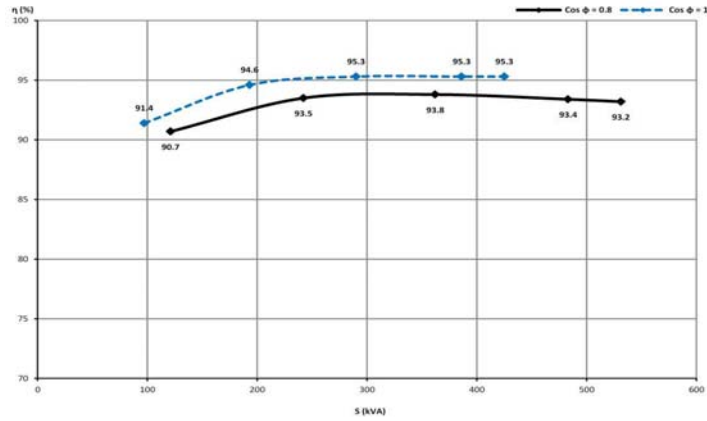


DATASHEET ALTERNATOR

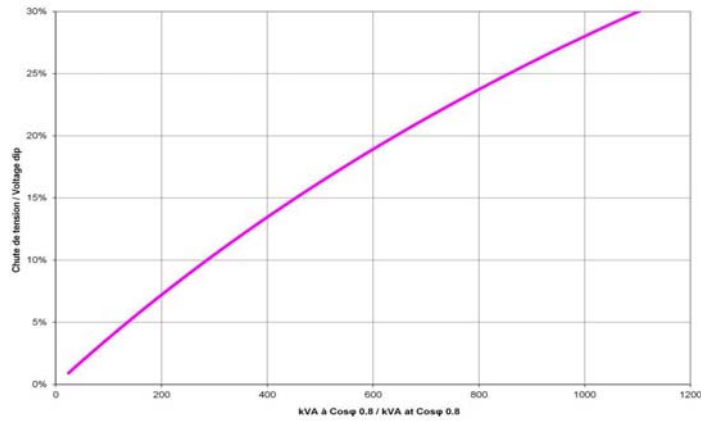
Alternator ref. KH01741T
Alternator type KH01741TO4D



Efficiencies curve (by excitation system)



Loading curve (by excitation system)

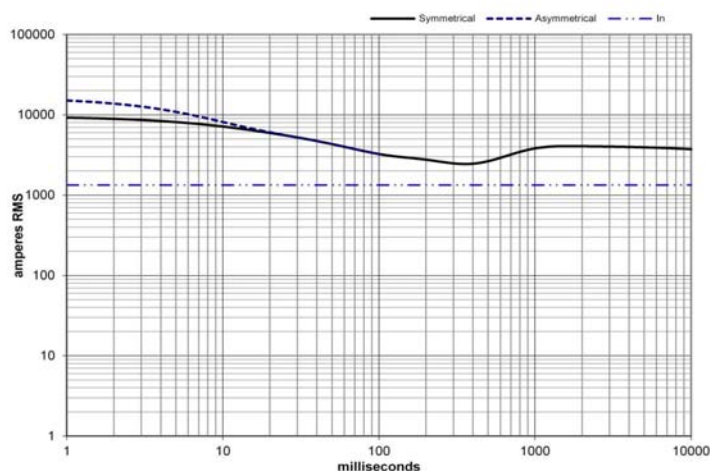


DATASHEET ALTERNATOR

Alternator ref. KH01741T
 Alternator type KH01741TO4D



Short circuit curve at no load and rated speed



Influence due to connection

Curves shown are for star (Y) connection

For other connections, use the following multiplication factors :

- Series delta : current value x 1.732
- Parallel star : current value x 2

Influence due to short-circuit

Curves are based on a three-phase short-circuit. For the other types of short-circuit, use the following multiplication factors :

(*) Capacity for maintaining short circuit at 3 In for 10 s = YES

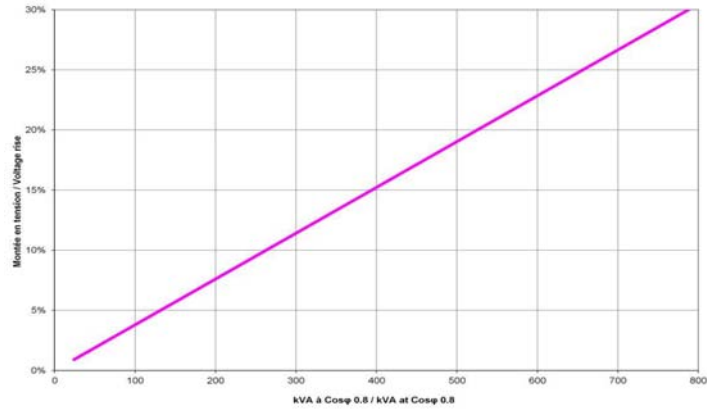
	3-phase	2-phase L/L	1-phase L/N
Instantané/ Instantaneous (max)	1	0.87	1.3
Countinuous/ Permanent	1	1.5	2.2
Durée maximale/ Maximum duration (*)	10 sec.	5 sec.	2 sec.

DATASHEET ALTERNATOR

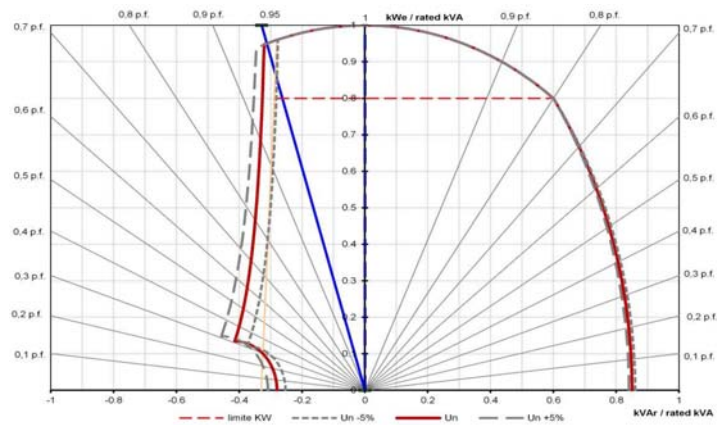
Alternator ref. KH01741T
Alternator type KH01741TO4D



Rejection curve (by excitation system)



Capability curve (PQ diagram)



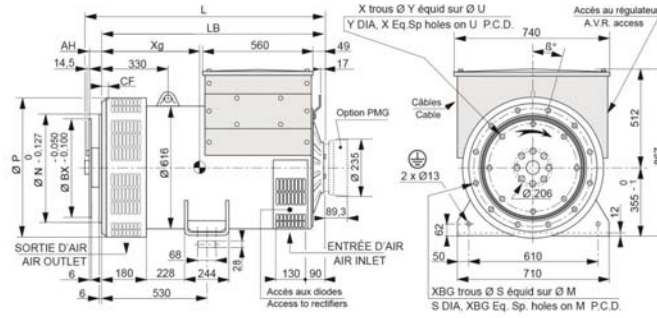
DATASHEET ALTERNATOR

Alternator ref. KH01741T
 Alternator type KH01741TO4D



DIMENSIONS-

Overall dimension drawing (Single bearing)



Dimensions (mm)						Accouplement / Coupling			
Type	L sans/without PMG	LB	Xg	Masse/Weight (kg)	Disque/Flex plate	11 1/2	14	18	
ALT-KH01630	1041	996	437	976	Bride/Flange S.A.E 1	X	X		
ALT-KH01741	1101	1056	471	1113	Bride/Flange S.A.E 1/2		X		
ALT-KH02070	1101	1056	471	1113	Bride/Flange S.A.E 0		X	X	
ALT-KH02450	1201	1156	511	1240					
ALT-KH02610	1201	1156	520	1289					
ALT-KH02880	1221	1176	545	1372					

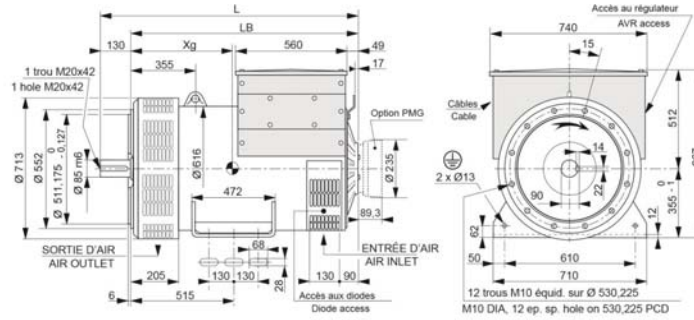
Bride / Flange (mm)							Disque / Flex plate (mm)						
S.A.E	P	N	M	XBG	S	β°	CF	S.A.E	BX	U	X	Y	AH
1	713	511.175	530.225	12	12	15°	15	11 1/2	352.42	333.38	8	11	39.6
1/2	713	584.2	619.125	12	14	15°	22	14	466.72	438.15	8	14	25.4
0	713	647.7	679.45	16	14	11° 15'	42	18	571.5	542.92	6	17	15.7

DATASHEET ALTERNATOR

Alternator ref. KH01741T
 Alternator type KH01741TO4D



Overall dimension drawing (Two bearings)



Dimensions (mm)				
Type	L sans / without PMG	LB	Xg	Masse / Weight (kg)
ALT-KH01630	1151	1021	457	996
ALT-KH01741	1211	1081	491	1126
ALT-KH02070	1211	1081	491	1126
ALT-KH02450	1311	1181	531	1253
ALT-KH02610	1311	1181	531	1302
ALT-KH02880	1331	1201	565	1392

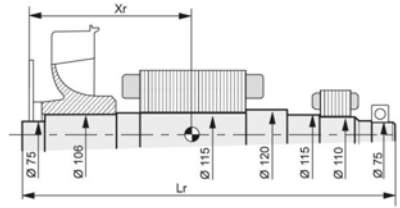
DATASHEET ALTERNATOR

Alternator ref. KH01741T
 Alternator type KH01741TO4D



-TORSIONAL ANALYSIS DATA-

Rotation part drawing for torsional vibration calculation (Single bearing)



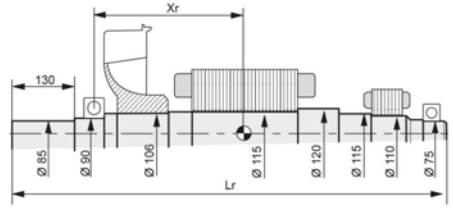
Centre de gravité : Xr (mm), Longueur du rotor Lr (mm), Masse : M (kg), Moment d'inertie : J (kgm²) : (4J = MD²)												
Centre of gravity: Xr (mm), Rotor length: Lr (mm), Weight: M (kg), Moment of inertia: J (kgm²): (4J = MD²)												
Type	Disque/Flex plate S.A.E. 11 1/2				Disque/Flex plate S.A.E. 14				Disque/Flex plate S.A.E. 18			
	Xr	Lr	M	J	Xr	Lr	M	J	Xr	Lr	M	J
ALT-KH01630	432.5	1029	387	5.99	418.3	1029	387	6.12	408.5	1029	387	6.38
ALT-KH01741	470	1089	442	6.90	456	1089	442	7.03	446	1089	442	7.29
ALT-KH02070	470	1089	442	6.90	456	1089	442	7.03	446	1089	442	7.29
ALT-KH02450	510	1189	495	7.61	496	1189	495	7.74	486	1189	495	8
ALT-KH02810	521	1189	514	8.01	507	1189	514	8.14	497	1189	514	8.40
ALT-KH02880	542	1209	547	8.52	528	1209	547	8.65	518	1209	547	8.91

DATASHEET ALTERNATOR

Alternator ref. KH01741T
 Alternator type KH01741TO4D



Rotation part drawing for torsional vibration calculation (Two bearings)



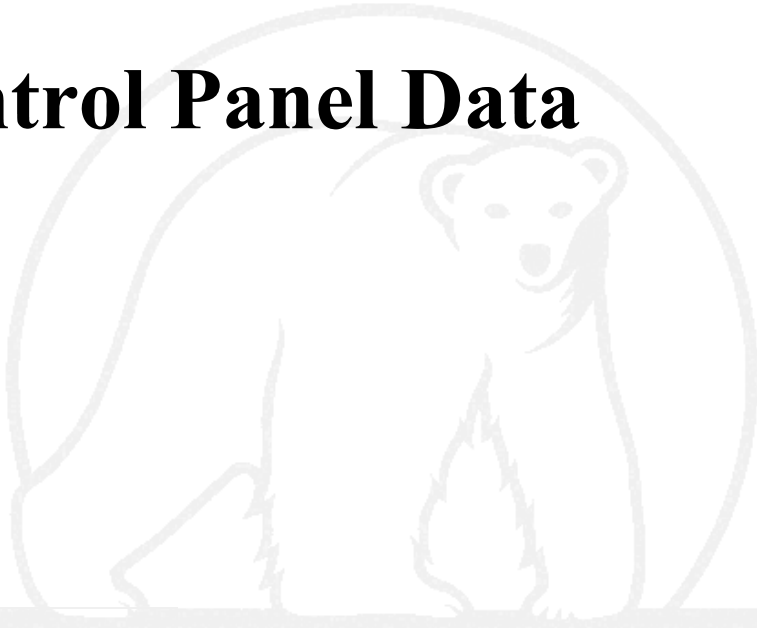
Centre de gravité : Xr (mm), Longueur du rotor Lr (mm), Masse : M (kg), Moment d'inertie : J (kgm²) ; (4J = MD³)												
Centre of gravity: Xr (mm), Rotor length: Lr (mm), Weight: M (kg), Moment of inertia: J (kgm²); (4J = MD³)												
Type	Disque/Flex plate S.A.E. 11 1/2				Disque/Flex plate S.A.E. 14				Disque/Flex plate S.A.E. 18			
	Xr	Lr	M	J	Xr	Lr	M	J	Xr	Lr	M	J
ALT-KH01630	432.5	1029	387	5.99	418.3	1029	387	6.12	408.5	1029	387	6.38
ALT-KH01741	470	1089	442	6.90	456	1089	442	7.03	446	1089	442	7.29
ALT-KH02070	470	1089	442	6.90	456	1089	442	7.03	446	1089	442	7.29
ALT-KH02450	510	1189	495	7.61	496	1189	495	7.74	486	1189	495	8
ALT-KH02810	521	1189	514	8.01	507	1189	514	8.14	497	1189	514	8.40
ALT-KH02880	542	1209	547	8.52	528	1209	547	8.65	518	1209	547	8.91



POWER SYSTEMS TORONTO LTD

Toronto Zoo
400 kW Standby Outdoor Diesel Generator

Control Panel Data



GAL Reference No:	T00673
Prepared By:	Misbah Mazhar (905-795-8877)

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MICS TELYS
ENGLISH

TEL/GB-2007/1



Global Power
Solution™

ISO 9001



SDMO industries
Implantation en France

NEW TELYS

Wholly developed by SDMO, the TELYS is fitted as standard, or as an option, to all our generating sets, to ensure efficient operation and surveillance of your installation. Streamlined and modernised, the new generation TELYS offers new functions in addition to those taken from the previous version. In its basic configuration, it is able to cover 80% of standard applications.

Its new design, directly inspired by the NEXYS, has a reduced number of buttons to offer you simplicity when operating your generating set. More than ever, SDMO has placed the emphasis on the user-friendliness of its product, the particular strength being communication (USB connections, PC connections, control software and remote operation).

2

SIMPLICITY

The straightforward TELYS interface ensures it is easy to use: a START button, STOP button, MENU button, ESCAPE button and 3 LEDs (operation, alarm and fault). The ridged control wheel makes this interface particularly easy to operate, as it allows you to scroll through the menus and make selections at a single touch. Pictograms ensure that all information given can be immediately understood.

USER-FRIENDLINESS

The TELYS has a large, backlit screen, the contrast for which does not need to be adjusted, making your installation a pleasure to use, whether inside or out, both day and night. The drop down menus and descriptions ensure that no further explanation is needed. The integrated maintenance tool⁽¹⁾ warns you of future servicing requirements and the fault finding aid guides you through any alarms or faults signalled by the TELYS.

MODULARITY

With the same format and design as the NEXYS, the TELYS can be easily fitted in place of the latter. To improve the control of your parameters and increase the potential of your installation, three cards can be connected to the TELYS (Inputs/Outputs, Speed/Voltage trimming⁽¹⁾, Synchronizing⁽²⁾). Certain aftermarket options can also be added to update the product and/or to personalise your generating sets.

COMMUNICATION

The generating set can be controlled and operating parameters viewed remotely, without having to install specific software, via a computer network, a landline telephone network or a mobile telephone network. The USB ports ensure that it is easy to recover any events connected to the operation of the generating sets, to change parameters or to update the software. Also, the TELYS is multilingual as standard and can also take some special languages as an option⁽¹⁾ (Arabic, Chinese, Russian)

(1) available from 2007 semester 1
 (2) available from 2007 semester 2

GENERATION

PRESENTATION

The TELYS is fitted as standard, or as an option, to all SDMO generating sets in the POWER PRODUCTS and RENTAL POWER ranges.

Types of control unit	TELYS
POWER PRODUCTS	
PACIFIC range (T7.5 to T44)	○
MONTANA range (J33 to J300)	○
MONTANA range (J400 to J440)	■
ATLANTIC range (V200 to V220)	○
ATLANTIC range (> V220)	■
EXEL range	○
PACIFIC range (T1250 to T2100)	○
RENTAL POWER	
From 16 to 275 kVA	○
From 330 to 700 kVA	■

○ Option
 ■ Basic

MICS TELYS

COMPLIANCE WITH STANDARDS

The TELYS has been developed following a process which exacts the highest quality. It complies with all major European, American and International standards and directives:

- Electromagnetic Compatibility (EMC) general standards: EN 61000-6-2 and EN 61000-6-4 (emission and protection)
- LOW VOLTAGE standards
- Salt spray test performance: In accordance with standard EN68011-2-11
- Protection index of a TELYS mounted to a console: IP31 with the soft USB port protective cover fitted (according to EN 60529)
- UL and CSA standards

In addition, the TELYS does not fall under the remit of directives 2002/95/CE and 2002/96/CE, which relate to Electrical and Electronic Equipment (DEEE).

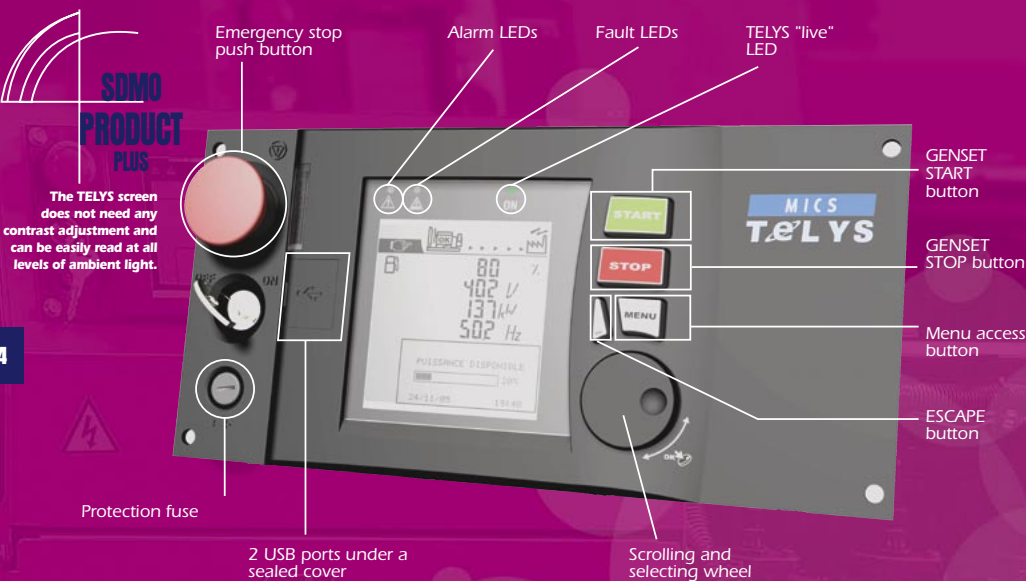
3



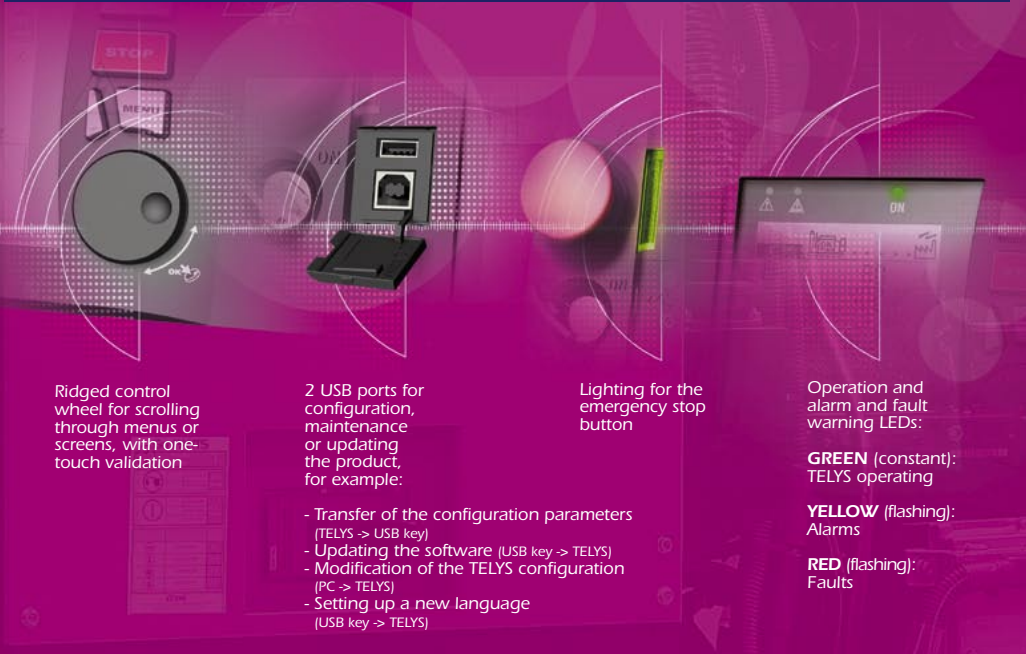
ATLANTIC generating set fitted with the TELYS

RENTAL POWER generating set fitted with the TELYS

PRESENTATION OF THE MMI (Man-Machine Interface)



ZOOM INTO ...

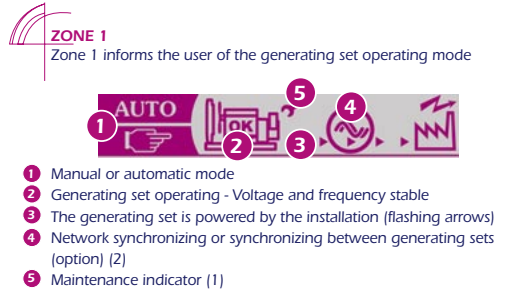


DISPLAY SCREEN

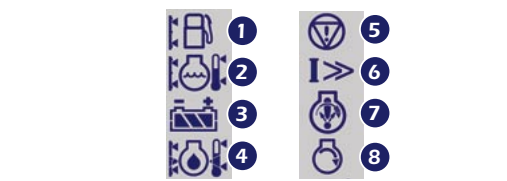
TELYS SCREEN

PRESENTATION

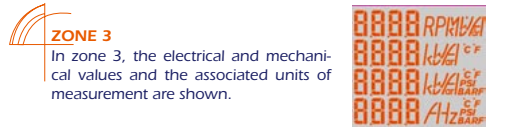
The large personalised TELYS screen, makes different information easy to read (pictograms, measurements and messages). Its backlit design gives it a contrast which is adapted to all types of ambient light. The section with graphics is split into four zones.



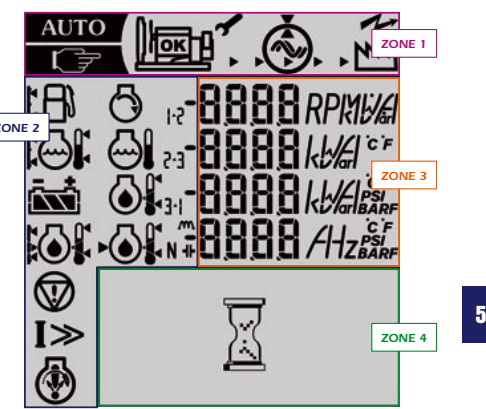
- 1 Manual or automatic mode
- 2 Generating set operating - Voltage and frequency stable
- 3 The generating set is powered by the installation (flashing arrows)
- 4 Network synchronizing or synchronizing between generating sets (option) (2)
- 5 Maintenance indicator (1)



- 1 Fuel Level
- 2 Coolant temperature and level
- 3 Battery voltage and charge
- 4 Oil pressure, temperature and level
- 5 Emergency stop
- 6 Overload
- 7 Failure to start, underspeed and overspeed
- 8 Engine speed



(1) available from 2007 semester 1
(2) available from 2007 semester 2



EXAMPLE OF SCREEN, GENSET STOPPED

AUTO	Genset in automatic mode, stopped
B 80 %	Fuel level indicator
11 °C	Coolant temperature indicator (units according to settings menu)
252 V	Battery voltage indicator
12 °C	Oil temperature indicator (units according to settings menu)
OPERATION AUTO START UP POSSIBLE WRENCH-TELY	Warning message

EXAMPLES OF SCREEN, GENSET RUNNING

AUTO	Genset in automatic mode, starting in progress
600 RPM	Engine Speed indicator
48 °C	HT coolant temperature indicator (units according to settings menu)
17 bar	Oil pressure indicator (units according to settings menu)
43 °C	Oil temperature indicator (units according to settings menu)
STARTING IN PROGRESS	Information message

AUTO	Genset in automatic mode, powered by the installation
B 80 %	Fuel level indicator
402 V	Voltage supplied indicator
226 kW	Indicator of active power active drawn from the installation
502 Hz	Current frequency indicator
AVAILABLE POWER	Bar graph of available power

MANUAL	Genset in manual mode
B 12 404 V	Indicator of phase to phase voltage between phases
23 403 V	Current frequency indicator
31 502 Hz	Current frequency indicator
ALARM LAST MESSAGE 25/08/05 13:30	Warning message

MAIN BOARD

MICS TELYS

The standard version of the TELYS consists of a main board and an MMI. This board is available in two versions, to ensure that all types of engines (electronic, traditional or mixed engines) can be managed



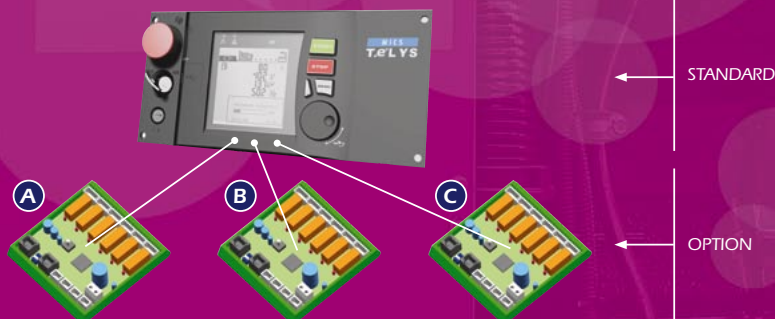
For external communication, the customer connection area is marked in white and offers 3 connection possibilities, for controlling and displaying parameters and remote operation.

- 1 RS 485 PORT - For specialised communication
- 2 ETHERNET PORT⁽¹⁾ - For connection to a modem or for working on the intranet
- 3 USB HOST PORT - For connecting a USB key

OPTIONAL CARDS

MICS TELYS

As an option, the TELYS can be connected to up to 3 types of card:



- A **1 Input/output card** - The input/output module enables additional logical inputs and outputs to be provided, as a supplement to those already available on the main board. . Inputs can be used for additional alarms or faults and outputs can be used for data transfers or to control options.
The input/output module is composed of 4 inputs and 6 outputs. A green LED is used to check the status of each output.
- B **1 card for speed and voltage trimming⁽¹⁾** - This card enables the engine speed and voltage supplied by the generating set to be adjusted.
- C **1 coupling card⁽²⁾ (1 for each generating set)** - The coupling card enables two types of configuration:
 - coupling between generating sets (without grid)
 - temporary coupling of a generating set to a grid

(1) available from 2007 semester 1
(2) available from 2007 semester 2

STANDARD SPECIFICATIONS

MICS TELYS

ELECTRICAL MEASUREMENTS	ENGINE MEASUREMENTS	SAFETY FEATURES
Single voltages	Fuel level (%)	Min/Max Alternator voltage
Composite voltages	Oil pressure (Bar/Psi)	Min/Max Alternator frequency
Frequency	Coolant temperature (°C/°F)	Min/Max Battery voltage
Active/reactive/apparent power	Oil temperature (°C/°F)	Overload and/or short circuit
Power factor	Battery voltage:	Active/reactive power return
Total and partial counter	Charging alternator current	Oil pressure
Total and partial active/reactive energy meter	Engine speed	Coolant temperature
Currents		Overspeed
		Underspeed

MAIN OPTIONS

MICS TELYS

INFORMATION REPORT	
CM402	Prewiring for auto start-up
CM403	Automatic Pack (Charger (12v) + Engine preheating 220/240 v (Relay + resistance)
CM404	Automatic Pack (Charger (24v) + Engine preheating 220/240 v (Relay + resistance)
CM405	Report pack (Genset running, General fault, Low diesel level fault or alarm)
CM406B	Adjustable mains detection in the control unit
CM407	Analog values displayed on screen (PH/TE)
CM408	Remote starter unit
CM409	Battery ammeter
CM410⁽¹⁾	Voltage trimming
CM411⁽¹⁾	Speed trimming (If elec regulator is possible and selected)
CM412	Sound alarm fitted in the control unit
CM415	Safety feature for low coolant level
CM416	Low fuel level safety feature for chassis tank (Alarm as standard)
CM418	Differential protection 30 or 300 mA (Non adjustable <= 50 A)
CM419	Differential protection 30 or 300 mA (Non adjustable <= 125 A)
CM420	Adjustable differential protection (time & threshold)
CM603	No preheating
CM604	Charger fault (24 V)
CM605⁽²⁾	EJP pack (Detection, warning management, forcing key)
CM607	Central processing unit with neutral (ITAN)
CM608	Central processing unit without neutral (ITSN)
CM610	NFPA1 10 module level 1
CM611	NFPA Visible transfer unit
CM613⁽²⁾	GES pack fitted on the genset
CM615⁽²⁾	Genset information transfer and inhibition unit
CM616	Low fuel level safety feature for separate tank
CM617	Low fuel level alarm for separate tank
CE100	Fixed distance report pack (Genset running, General fault, Low fuel level fault or alarm)
CE220	Configurable distance report pack (6 report maximum)
CE221	Genset ON
CE222	Genset in automatic mode
CE223	Genset in non-automatic mode
CE224	Genset in manual mode
CE225	Genset in test mode
CE226	Genset stopped
CE22A	General fault
CE22B	Non-starting fault
CE22C	Oil pressure fault
CE22D	Water temperature fault
CE22E	Low water level fault
CE22F	Overspeed fault
CE22G	Alternator voltage fault
CE22I	Overload fault
CE22J	Emergency stop triggered fault
CE22K	Bulk tank fault (Separate tank)
CE22L	Differential triggered fault
CE22M	Fuel level low for exterior tank fault
CE22S	General alarm
CE22T	Low fuel level alarm
CE22U	Loss of coolant preheating alarm
CE22V	Min battery voltage alarm
CE22W	Battery charger fault alarm
EXTERNAL COMMUNICATION	
CEA12⁽¹⁾	Remote control via local ETHERNET network or RS485 Mod Bus
CEA52	Remote control via PSTN fixed telephone network
CEA62	Remote control via GSM mobile telephone network



- 5 Basic languages: French, English, German, Spanish, Portuguese (Arabic, Chinese and Russian optional⁽¹⁾)
- Integrated software accessible via an internet browser, enabling certain parameters to be modified, TELYS data to be displayed, and the genset to be remotely controlled⁽¹⁾
- Integrated maintenance tool displaying future servicing requirements⁽¹⁾
- Integrated fault finding tool aiding the user in the event of any alarms and/or faults
- Ability to send e-mail, SMS or fax in the event of any alarms or faults (optional)⁽¹⁾
- Optional tropicalisation of the cards (to provide protection in extremely humid conditions)
- Operation at -20°C to +60°C
- Humidity: 95% at 45°C, 70% at 50°C, 50% at 60°C
- Different levels of access to the configuration parameters

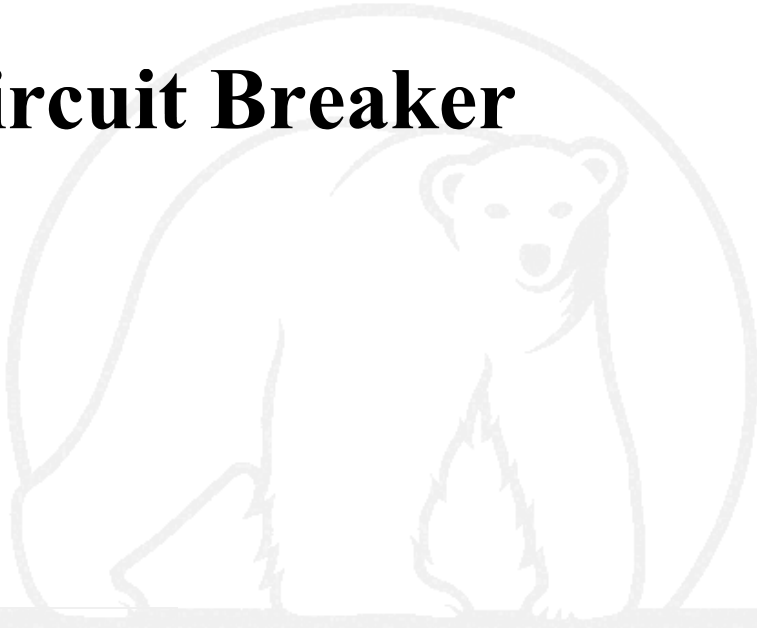
(1) available from 2007 semester 1
(2) France only



POWER SYSTEMS TORONTO LTD

Toronto Zoo
400 kW Standby Outdoor Diesel Generator

Circuit Breaker



GAL Reference No:	T00673
Prepared By:	Misbah Mazhar (905-795-8877)

WWW.GALPOWER.COM

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GENERAL CHARACTERISTICS

Presentation



COMPACT NS circuit breakers ensure the protection of sensitive equipment against overcurrent.
Rated capacities are available from 100A to 3,200A.

Reference used

RATING	TYPE	Part No.	Associated tripping device
3x1600A	NS	31613399201NE	Micrologic 2.0

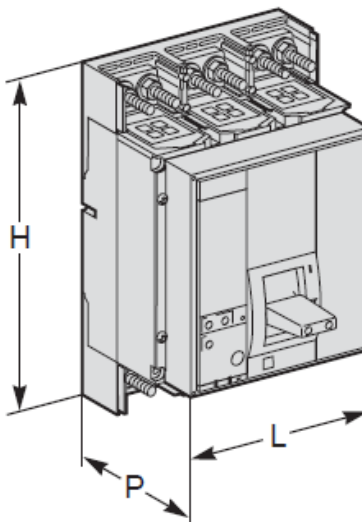
Part Ref. : 31613399201NE

Operational specifications

- Breaking capacity

Operating voltage	Frequency	Ultimate breaking capacity in kA RMS
220 / 240 VCA	50/60Hz	50
380 / 415 VCA		50
440 VCA		50
500VCA		40
525VCA		40
660 / 690V		30

Dimensions



Dimensions in mm		
L	H	P
210	327	147

Part Ref. : 31613399201NE

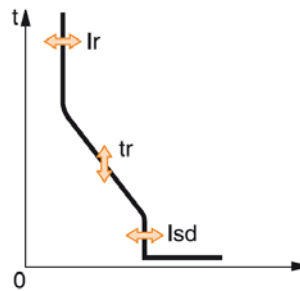
TRIPPING DEVICE SPECIFICATIONS



I_r : Adjustment of the long duration tripping threshold.

t_r : Long duration time delay adjustment.

I_{sd} : Instantaneous tripping threshold adjustment.

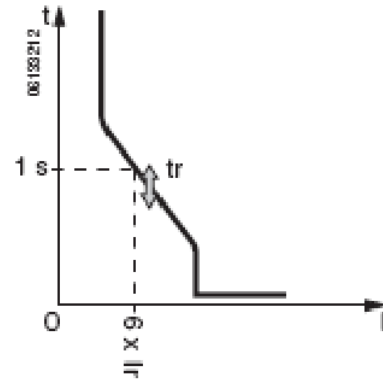
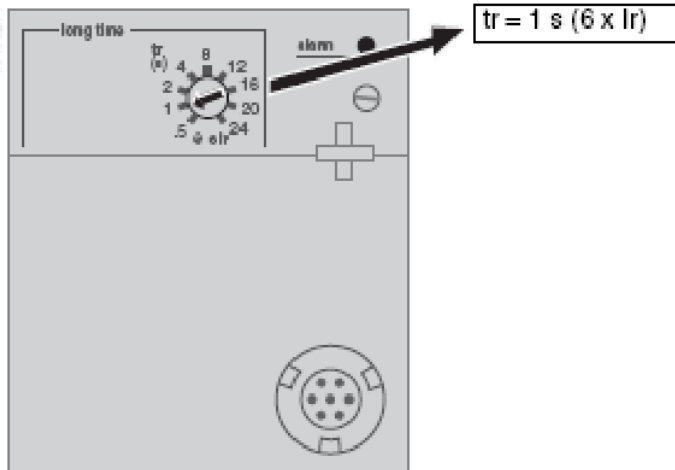


Protections		Micrologic 2.0									
Long delay											
Threshold (A)	$I_r = I_n \times \dots$	0.4	0.5	0.6	0.7	0.8	0.9	0.95	0.98	1	
	I_r	640	800	960	1120	1280	1440	1520	1568	1600	
Tripping between 1.05 and 1.20 I_r		Other ranges or inhibition by changing rating plug									
Time delay (s)	t_r at 1.5 x I_r	12.5	25	50	100	200	300	400	500	600	
	t_r at 6 x I_r	0.5	1	2	4	8	12	16	20	24	
	t_r at 7.2 x I_r	0.34	0.48	0.97	2.7	5.5	8.3	11	13.8	16.6	
Accuracy		0 to -20%									
Thermal memory		20 min before and after release									
Instantaneous protection											
Threshold	$I_{sd} = I_r \times \dots$	1.5	2	2.5	3	4	5	6	8	10	
Accuracy : $\pm 10\%$	$I_r = 0.4 I_n$	960	1280	1600	1920	2560	3200	3840	5120	6400	
	$I_r = 0.5 I_n$	1200	1600	2000	2400	3200	4000	4800	6400	8000	
	$I_r = 0.6 I_n$	1440	1920	2400	2880	3840	4800	5760	7680	9600	
	$I_r = 0.7 I_n$	1680	2240	2800	3360	4480	5600	6720	8960	11200	
	$I_r = 0.8 I_n$	1920	2560	3200	3840	5120	6400	7680	10240	12800	
	$I_r = 0.9 I_n$	2160	2880	3600	4320	5760	7200	8640	11520	14400	
	$I_r = 0.95 I_n$	2280	3040	3800	4560	6080	7600	9120	12160	15200	
	$I_r = 0.98 I_n$	2352	3136	3920	4704	6272	7840	9408	12544	15680	
	$I_r = 1 I_n$	2400	3200	4000	4800	6400	8000	9600	12800	16000	

Part Ref. : 31613399201NE

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4/6

The long duration time delay (t_r) defines the time period during which the circuit breaker will bring an overcurrent lower than the short duration tripping level or the instantaneous level before tripping.



ADDITIONAL ACCESSORIES

- Winding MX + OF



Controls the tripping of the device to which it is associated, and is equipped with an Open - Closed contact.

- Indicates the “open” or “closed” position of the device
- Performs an auto cut-off which keeps the control circuit under power.

- SD Contact



Indicates the position of the device “tripped upon fault”

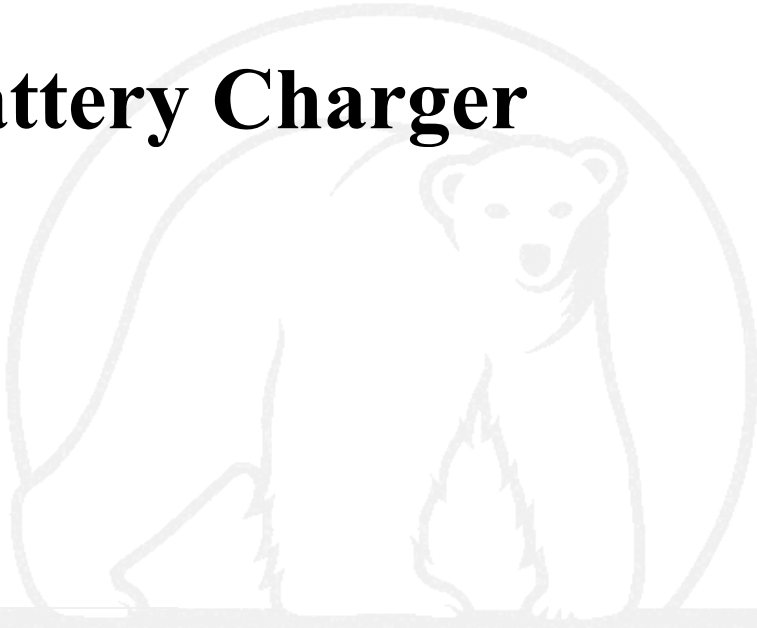
Part Ref. : 31613399201NE



POWER SYSTEMS TORONTO LTD

Toronto Zoo
400 kW Standby Outdoor Diesel Generator

Battery Charger



GAL Reference No:	T00673
Prepared By:	Misbah Mazhar (905-795-8877)

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AUTOMATIC BATTERY CHARGER WITH SCR TECHNOLOGY



BENEFITS

- ⊕ **Very safe and reliable**
- ⊕ **Secure for the battery**
- ⊕ **Fully automatic operation**
- ⊕ **Fast, precise & unique setup**
- ⊕ **Stability of the calibration**
- ⊕ **Short circuit & over current protection (no disconnect need at crank)**
- ⊕ **Full charge time optimization**
- ⊕ **Tough and durable design**
- ⊕ **Optional useful current/voltage display**
- ⊕ **Very reliable, 2 year warranty**
- ⊕ **Very competitive price**

GENERAL FEATURES

- Breaker & switch at power input
- Low voltage & reverse polarity indicators
- Very low variation of the output voltage vs input voltage
- Gradual decrease of current according to the load of the battery
- Contact set for low battery voltage alarm
- Compensation circuit for the voltage lost in the wires battery connection
- Set at factory according to the battery type used
- Model available with or without cabinet
- Standard models available the same day
- CSA certified

DESCRIPTION

Battery chargers from the HX series are designed to maintain the exact voltage needed by lead-acid or nickel-cadmium battery for optimal performance. These chargers use the SCR technology and have an automatic equalization mode.

The control circuit protects your battery against surcharge and limits the output current under short-circuit conditions.

Although very economic, these chargers have very important features including, quality of the DC output signal, full rate power and quick adjustment.

Chargers are available with or without a cabinet and remote installations of the power transformer is possible for cumbersome installations. An optional display, allowing reading voltage and current output of the charger, can also be used for the setup of the charger.

Dry contacts are available as an option for remote alarm indication.

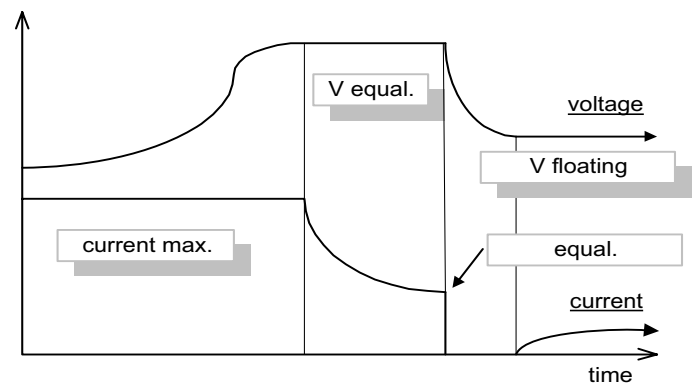
The reliability of the Enerotec Battery Charger is why we offer a two year warranty

OPERATION

Upon loss of charge, the charger increases the current to its maximum capacity. Voltage is then decreased to keep the maximum current value constant, for as long as it takes to reach the equalization voltage.

Once the equalization voltage is reached, the current decreases gradually to reach the current limit of the equalization mode, which is 50% of the maximum value of the charge.

At this level of charge, voltage drops to the value of floating voltage.



FEATURES

LED indicator:	- AC SUPPLY - EQUALIZE MODE - LOW BATTERY VOLTAGE - INVERSE POLARITY
Fault relay:	- LOW BATTERY VOLTAGE - CHARGER DEFAULT (option) - HIGH DC VOLTAGE (option) - AC LOSS. (option)
Pot. Setup:	- FLOATING VOLTAGE - EQUALIZATION VOLTAGE - LOW BATTERY VOLTAGE

Digital display for the voltage & current:

- Alternation delay of 2 seconds
- Precision of $\pm 1/10$ of the unity
- Jumper for supply with the battery

Correction circuit for precise voltage on the battery:

- $\pm .5\%$ precision between the display voltage and then from the terminal of the battery (with 15 feet of #10 AWG wire gauge)

Manual Equalize:

- Input terminal for the activation of the manual Equalize mode

MODELS

Standard basic 115 Vac model:

MODEL	OUTPUT VOLTAGE	OUTPUT CURRENT
HX1206S1	12 Vdc	6 A.
HX1210S1	12 Vdc	10 A.
HX2403S1	24 Vdc	3 A.
HX2410S1	24 Vdc	10 A.

OPTIONS

- Digital display module for the voltage and the current
- Dry contacts type C form for low voltage, high voltage, AC loss and battery disconnected faults
- 240 Vac nominal input voltage
- Wall mount and transportable with cable models
- Remote Installation of the transformer
- Connection cable & connectors
- Weekly exerciser

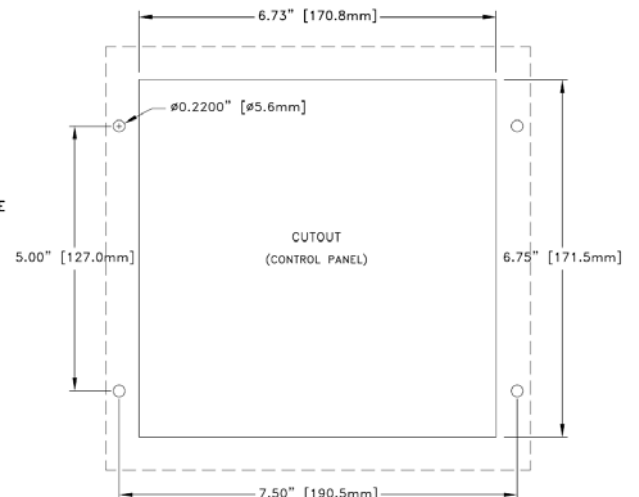
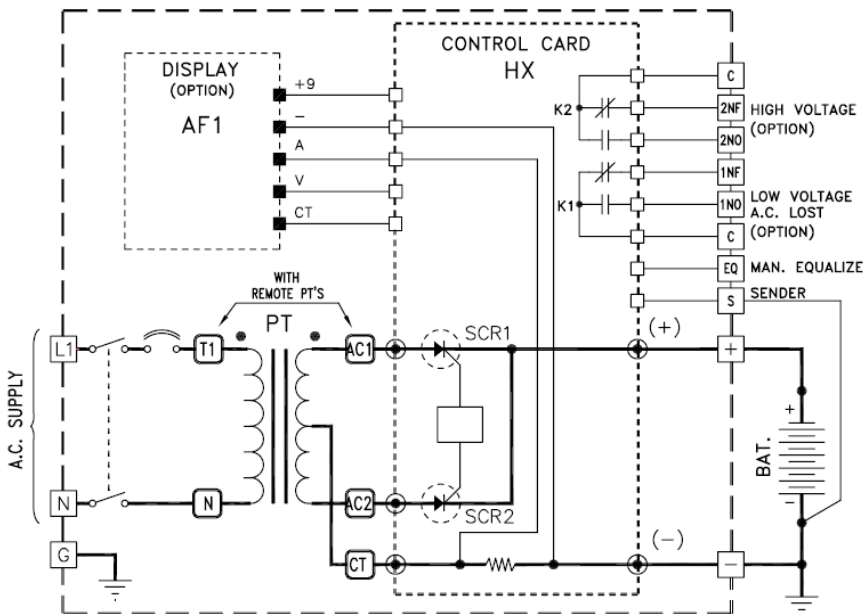
(Do not hesitate to contact us for other possibilities.)

SPECIFICATIONS

MODEL:	10 amp. (12 & 24 Vdc)	6 amp. (12 Vdc)	3 amp. (24 Vdc)
SUPPLY:	115 Vac, $\pm 6\%$ at full load (standard model)	115 Vac, $\pm 6\%$ at full load (standard model)	115 Vac, $\pm 6\%$ at full load (standard model)
OUTPUT:	Δ Vout of $\pm 0.1\%$ for Δ Vin of $\pm 6\%$ at full load.	Δ Vout of $\pm 0.1\%$ for Δ Vin of $\pm 6\%$ at full load.	Δ Vout of $\pm 0.1\%$ for Δ Vin of $\pm 6\%$ at full load.
WEIGHT: (with enclosure)	12 Vdc = 8.2 Kg (18.1 lbs) approx. 24 Vdc = 9.6 Kg (21.3 lbs.) approx.	3.6 Kg (8.5 lbs.) approx.	3.6 Kg (8.5 lbs.) approx.
DIMENSIONS:	Control: 8" H x 8" L x 4" P (max.) Cabinet: 8½" H x 12" L x 8" P	Control: 8" H x 8" L x 4" P (max.) Cabinet: 8" H x 8" L x 4½" P	Control: 8" H x 8" L x 4" P (max.) Cabinet: 8" H x 8" L x 4½" P
CONSTRUCTION:	Front plate: Alum. 0.1", painted black Enclosure: Steel, painted black.		
OPERATING TEMPERATURE:	-30°C / 40°C (charger). -35°C / 50°C (display).		

CONNECTIONS

CUTOUT

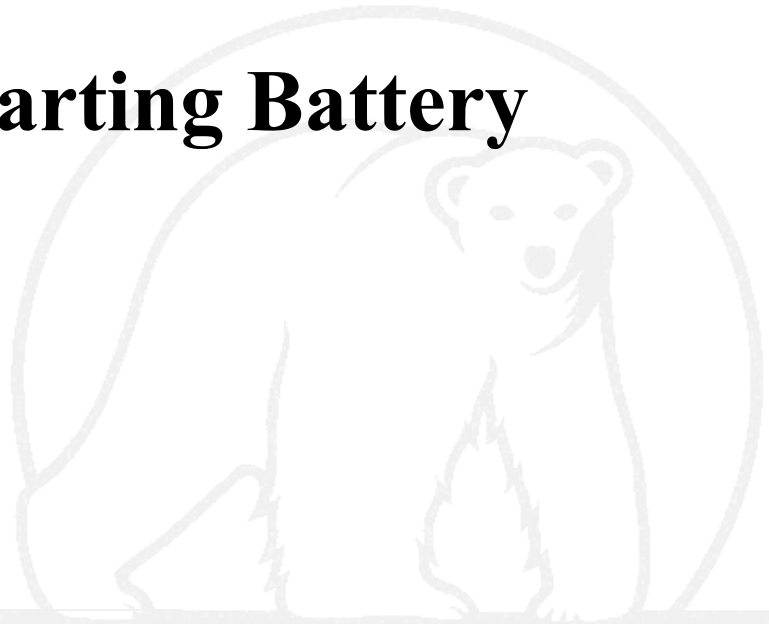




POWER SYSTEMS TORONTO LTD

Toronto Zoo
400 kW Standby Outdoor Diesel Generator

Starting Battery



GAL Reference No:	T00673
Prepared By:	Misbah Mazhar (905-795-8877)

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GENERAL SPECIFICATIONS

Application

The starting batteries provide the electricity for starting and feeding the unit. They are increased in number, according to the current-supply needs.

No maintenance is necessary and they are fitted with a grip for easy handling.

They are filled with electrolyte with a voltage of 12V.

They comply with the specifications of the motor manufacturer.

Composition

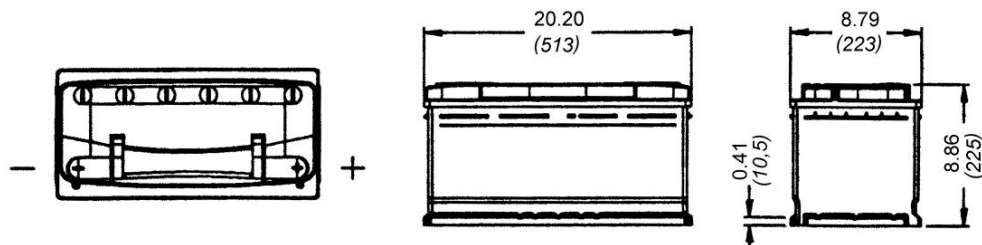
Not applicable

TECHNICAL SPECIFICATIONS

Specifications

Starting batteries of 12V-170Ah-1000A

Dimensions



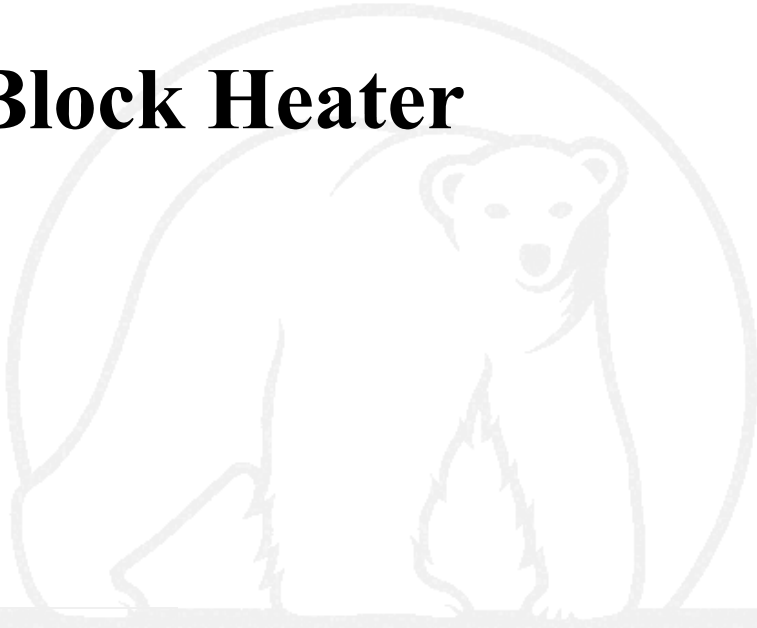
Part Number: 30702099901



POWER SYSTEMS TORONTO LTD

Toronto Zoo
400 kW Standby Outdoor Diesel Generator

Block Heater



GAL Reference No:	T00673
Prepared By:	Misbah Mazhar (905-795-8877)

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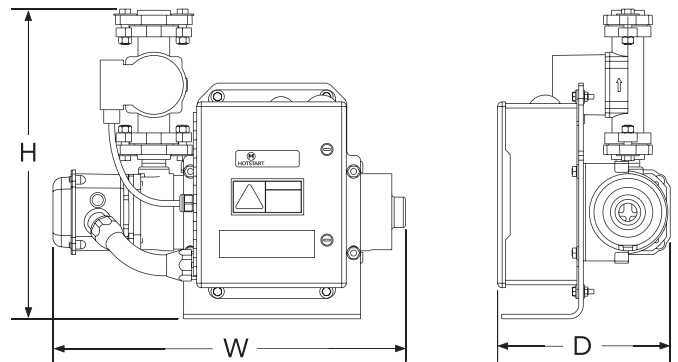
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CSM HOTflow™ Heating System

HOTSTART's CSM HOTflow™ heating system is a complete coolant preheater with thermostat, pump and all required controls. The CSM model heats engines ranging in size from 15L-100L displacement.

Forced circulation of the coolant delivers uniform heating throughout the entire engine, extends element life and offers a significant reduction in electrical consumption.



APPLICATION

HOTflow™ model CSM was developed to pre-heat diesel and gas engines for stationary land power, marine, large mining and construction equipment.

SPECIFICATIONS

- Heating Fluid: Engine coolant (50% glycol/50% water)
- Heat Power: 3, 6, 9 and 12 kW
- Voltage Range: 1 or 3 Phase 120-690V (50 or 60Hz)
- Fixed Thermostat: 100°-120°F (38°-49°C)
- Flow: 10GPM (2.2m³/hr) @ 10ft head (3 mWc)
- Pump Power: 70W (50Hz), 97W (60Hz)
- Max Pressure: 125 psi (860 kPa)
- Pressure Loss: 0.2 psi (1.5 kPa)
- Inlet Plumbing: 1.0" NPT
- Outlet Plumbing: 1.0" NPT
- Min/Max Ambient Temp: -4°F (-20°C)/104°F (40°C)
- Main Control Box Ingress Protection: NEMA 4 (IP66)
- Motor Ingress Protection: IP44 (50Hz), NEMA 2 (60Hz)

FEATURES

- UL-C/US listed - (60 Hz models) - E250789CE
- CE compliant (Style B models)
- Controls for automatic operation
- Compact design
- Easy to install

DIMENSIONS & WEIGHT

	Height (H)	Width (W)	Depth (D)	Weight
Style A	15.0" 383mm	19.4" 493mm	9.5" 242mm	37 lbs. 16.8 kg
Style B	17.0" 434mm	19.4" 493mm	9.5" 242mm	54 lbs. 24.5 kg

CSM HOTflow™ Heating System



Style A

Style B

PART NUMBERS

Engine Size		Power Supply			Heating System			
CID	Liter	Volts	Phase	Hz	Part Number	kW	Amps	Style
1000-2000	15-30	120	1	60	CSM10301-000	3	26.3	A
		208	1	60	CSM10308-000	3	15.1	A
		208	3	60	CSM30308-000	3	8.7	B
		230	1	50	CSM1030J-000	3	13.7	A
		240	1	60	CSM10302-000	3	13.1	A
		480	1	60	CSM10304-000	3	3.8	B
2000-3000	25-50	208	1	60	CSM10608-000	6	29.6	A
		208	3	60	CSM30608-000	6	17.1	B
		230	1	50	CSM1060J-000	6	26.7	A
		240	1	60	CSM10602-000	6	25.6	A
		400	3	50	CSM3060A-000	6	8.9	B
		440	3	60	CSM3060F-001	6	8.1	B
		480	1	60	CSM10604-000	6	12.8	B
		480	3	60	CSM30604-000	6	7.4	B
		575	3	60	CSM30605-000	6	6.2	B
3000-4500	50-75	208	1	60	CSM10908-000	9	44.0	A
		208	3	60	CSM30908-000	9	25.4	B
		230	1	50	CSM1090J-000	9	39.8	A
		240	1	60	CSM10902-000	9	38.1	A
		400	3	50	CSM3090A-000	9	13.2	B
		440	3	60	CSM3090F-001	9	12.2	B
		480	1	60	CSM10904-000	9	19.1	B
		480	3	60	CSM30904-000	9	11.0	B
		575	3	60	CSM30905-000	9	9.2	B
4500-6000	75-100	208	1	60	CSM11208-000	12	58.4	B
		208	3	60	CSM31208-000	12	33.7	B
		230	1	50	CSM1120J-000	12	52.8	B
		240	1	60	CSM11202-000	12	50.6	B
		400	3	50	CSM3120A-000	12	17.5	B
		440	3	60	CSM3120F-000	12	15.9	B
		480	1	60	CSM11204-000	12	25.3	B
		480	3	60	CSM31204-000	12	14.6	B
		575	3	60	CSM31205-000	12	12.2	B

Other voltages available. Consult the factory.



POWER SYSTEMS TORONTO LTD

Toronto Zoo
400 kW Standby Outdoor Diesel Generator

Air Filter



GAL Reference No:	T00673
Prepared By:	Misbah Mazhar (905-795-8877)

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GENERAL SPECIFICATIONS

Application

Air filters are medium grained, high quality single stage cartridge paper filters with the greatest possible paper area. The seal between the paper and the end-cover does not allow any particles to the engine to pass through.

Composition

Not applicable



TECHNICAL SPECIFICATIONS

Specifications

- Large filterable surface of the cartridges and a good spread of folds.

Airflow
ft ³ /min (m ³ /min)
1616 (45,8)

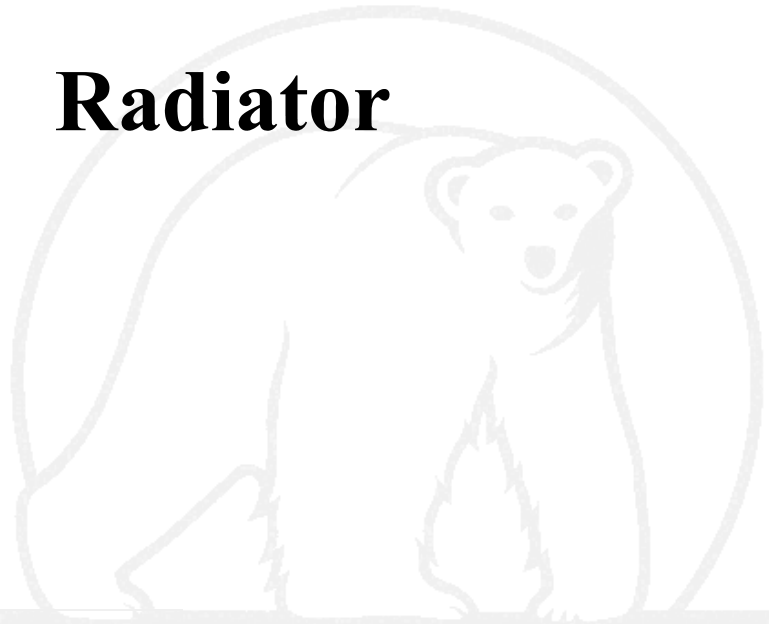
Part Number: VOLVO TAD1641GE 60Hz



POWER SYSTEMS TORONTO LTD

Toronto Zoo
400 kW Standby Outdoor Diesel Generators

Radiator



GAL Reference No:	T00673
Prepared By:	Misbah Mazhar (905-795-8877)

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GENERAL SPECIFICATIONS

Application

The cooling system ensures that the engine operates at the correct temperature. It is a closed circuit system and must always be filled with a mixture of coolant and water to protect against internal corrosion, cavitation and damage caused by freezing. The coolant should contain ethylene glycol of a good quality with a suitable chemical consistency for an adequate protection of the engine. Never use water by itself as coolant.

TECHNICAL SPECIFICATIONS

Specifications

▪ Cooling system type	Closed circuit
▪ Coolant capacity (engine + radiator with hoses)	9,69 gal (44 liter)
▪ Max. water temperature	225° F (107° C)
▪ Outlet water temperature	-° F (-° C)
▪ Fan power consumption	24,1 hp (18 kW)
▪ Coolant type	Glycol-Ethylene
▪ Air flow	- cfs (- m ³ /s)
▪ Thermostat	180-198 °F (82-92 °C)

Part Number: TAD1344GE 60 Hz



POWER SYSTEMS TORONTO LTD

Toronto Zoo
400 kW Standby Outdoor Diesel Generator

Fuel Water Separator



GAL Reference No:	T00673
Prepared By:	Misbah Mazhar (905-795-8877)

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GENERAL SPECIFICATIONS

Application

The diesel filter in the RACOR range is a fuel – water separator designed for modern engines.

This multiple centrifugal system is the solution to water and solid-contaminant problems in fuel.

Composition

The main components in the diesel filter are :

- A cover,
- A case with spring,
- A cartridge,
- A stopper plug,
- A bowl,
- A drain tap.

The assembly is sealed with a series of joints.



Part number : 30501154701

GENERAL SPECIFICATIONS

Fitting

The filter must be fitted on the intake side of the engine fuel pump so that it is easily accessible.

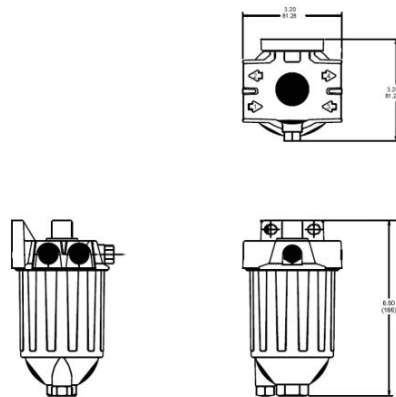
It can be fitted higher or lower than the tank. The best results are obtained when the intake opening of the filter is located by the upper part of the tank.

If the filter is fitted lower than the tank, a valve must be installed to prevent fuel leaks when the cover is removed.

When the filter has been fitted, it must be filled with fuel, so that the feed pump is not operated when dry.

The joints must also be checked for leaks and corrected if necessary.

Specifications



Output	Openings	Height	Depth	Width	Weight
gal/h (l/h)		Inch (mm)			Lb (Kg)
373 (1700)	M16x1.5	7,89 (244)	4,62 (117)	4,5 (114)	2,4 (1.09)

Part number : 30501154701

33512038901_1_1
2/2



POWER SYSTEMS TORONTO LTD

Toronto Zoo
400 kW Standby Outdoor Diesel Generator

Electrical Package

GAL Reference No:	T00673
Prepared By:	Misbah Mazhar (905-795-8877)

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Nepean, Ontario K2E 6T9
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Toll free (800) 619-4219

60A main breaker , All Breakers will be QO Series,
10,000 Air rated.

QO[®] Loadcentres and Circuit Breakers

Selection Guide

DE1
LOAD CENTRES

Contents	Description	Page
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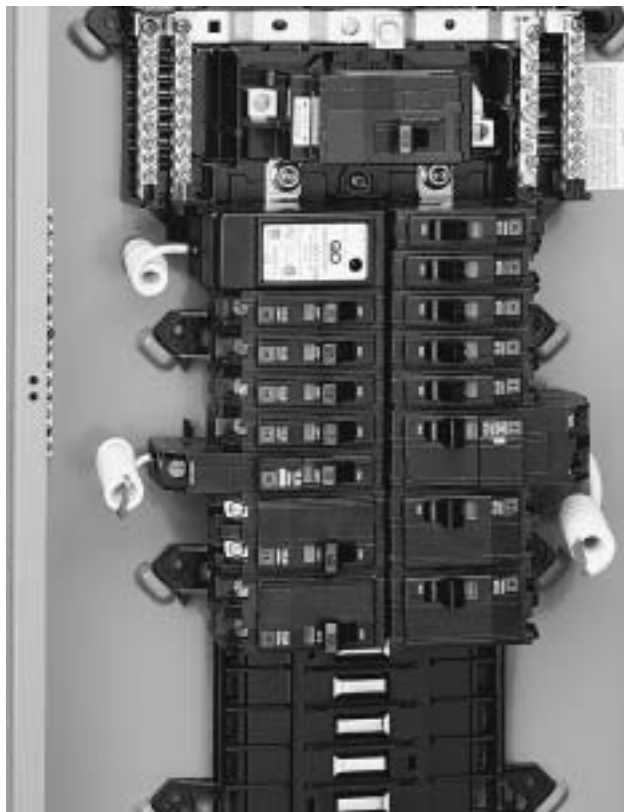
QO® Loadcentres and Circuit Breakers

General Information

QO® Loadcentres

- Pages:**
- DE1-6 to DE1-13
- Application:**
- Residential, commercial, and industrial
 - 30 through 225 Amperes
- Standards:**
- CSA Certified under File #LL-89066
- Enclosures:**
- Type 1 and 3R
- Features:**
- One piece, plated, shielded copper bus (S-Series)
 - Split branch neutral with 3-1/0 "built in" branch neutral lugs
 - Combination Slot/Robertson neutral, ground and trim screws
 - Additional ground bar provisions
 - Trims have automatic flush adjustment
- Accessories:**
- Secondary Surge Arresters
 - Sub-Feed Lugs
 - Filler Plates (for branch and main breakers)
 - Door Lock Kits
 - Neutral Lugs
- QwikPaks:**
- Contains our most popular mix of branch breakers, a main breaker and a complete Loadcentre (tub, trim, and interior)





Pages: • DE1-4 through DE1-5

Branches:

- QO-GFI - Ground Fault Indication
- QOT - Tandem Breakers
- QO-EPD - Equipment Ground Fault Protection
- QO-HID - High Intensity Discharge Lighting Systems
- QO-K - Key Operated Breakers
- QO-AFI - ARC Fault Circuit Interrupters
- QO-HM - High Magnetics

Features:

- QWIK-OPEN® Circuit Breakers
- VISI-TRIP® Indicator
- Tandem Circuit Breakers feature two 1-Pole breakers in the space of a 1-Pole QO breaker
- QO2175SB SURGEBREAKER® Secondary Surge Arrester
- Shunt Trips, Auxiliary Switches, and Alarm Switches are all available factory installed

For additional information,

- QO & QOB Miniature Circuit Breakers Catalogue 0730CT9801.
- QO-EPD Catalogue 0950CT9601
- Square D Series Ratings Guide Catalogue D0110AB9801EP R0
- Secondary Surge Arresters Catalogue 6671CT9701

QO® Loadcentres and Circuit Breakers

QO® Standard and Tandem Circuit Breakers

DE1 LOAD CENTRES

Plug-On Circuit Breakers - Amperes Interrupting Rating (AIR) in Amperes RMS Symmetrical

Ampere Rating Δ	One Pole - 120/240Vac	Two Pole - 120/240Vac Common Trip	Three Pole - 240Vac Common Trip
10,000 AIR			
10	QO110	QO210	QO310
15	QO115◆▲	QO215◆	QO315◆
15	QO115HM◆▲‡	—	—
20	QO120◆▲	QO220◆	QO320◆
20	QO120HM◆▲‡	—	—
25	QO125	QO225◆	QO325◆
30	QO130◆	QO230◆	QO330◆
35	QO135◆	QO235◆	QO335◆
40	QO140◆	QO240◆	QO340◆
45	QO145◆	QO245◆	QO345◆
50	QO150◆	QO250◆	QO350◆
60	QO160◆	QO260◆	QO360◆
70	QO170◆	QO270◆	QO370
80	—	QO280	QO380
90	—	QO290	QO390
100	—	QO2100	QO3100
110	—	QO2110	—
	—	QO2125 No DC rating	—
125	—	QO2150◆▼	—
	—	QO2175◆▼	—
	—	QO2200◆▼	—
22,000 AIR			
15	QO115VH▲	QO215VH	QO315VH
20	QO120VH▲	QO220VH	QO320VH
25	QO125VH	QO225VH	QO325VH
30	QO130VH	QO230VH	QO330VH
40	—	QO240VH	QO340VH
50	—	QO250VH	QO350VH
60	—	QO260VH	QO360VH
70	—	QO270VH	QO370VH
80	—	QO280VH	QO380VH
90	—	QO290VH	QO390VH
100	—	QO2100VH	QO3100VH
110	—	QO2110VH	—
	—	QO2125VH	—
125	—	QO2150VH□◆▼	—
	—	QO2175VH□◆▼	—
	—	QO2200VH□◆▼	—
42,000 AIR			
40	—	QOH240	—
45	—	QOH245	—
50	—	QOH250	—
60	—	QOH260	—
70	—	QOH270	—
80	—	QOH280	—
90	—	QOH290	—
100	—	QOH2100	—
110	—	QOH2110	—
125	—	QOH2125	—
65,000 AIR			
15	QH115▲	QH215	QH315
20	QH120▲	QH220	QH320
25	QH125	QH225	QH325
30	QH130	QH230	QH330

QO One Pole



1 Space Required

QO One Pole Tandem



1 Space Required

QO Two Pole



2 Spaces Required

QO Three Pole



3 Spaces Required

Tandem (Dual) Circuit Breakers 10,000 AIR

Ampere Rating Δ	One Pole - 120/240Vac	Two Single Pole Individual Trip - 120/240Vac
	1 Space Required	2 Spaces Required
15 & 15	QO1515◆	Order Two QO1515 or QO2020 Circuit Breakers and Handle Tie Catalogue # QOHT.
15 & 20	QO1520◆	
15 & 30	QO1530◆	
20 & 15	QO2015◆	
20 & 20	QO2020◆	
20 & 30	QO2030◆	
30 & 15	QO3015◆	
30 & 20	QO3020◆	
30 & 30	QO3030◆	

- Δ 10-30 ampere breakers are suitable for use with 60°C or 75°C conductors. 35-125 ampere breakers are suitable for use with 75°C conductors.
- ‡ High magnetic trip breakers are recommended for applications where high initial inrush current may occur.
- ▲ SWD (switching duty) rated. Suitable for switching 120Vac fluorescent lighting loads.
- ◆ HACR type for use with air conditioning, heating and refrigeration equipment having motor group combinations and marked for use with HACR type circuit breakers. HACR labelled one pole QO breakers not stocked. Order Only. Add suffix -5385.
- ▼ Requires four spaces (#1-300 kcmil Al/Cu). Not suitable for use in 3-phase panel. Use only in single phase panel rated 150A or greater.
- CSA Listed for use ahead of QO, QO-GFI, QO-EPD, QOT and QO-PL 10,000 AIR circuit breakers to permit their application at 22,000A fault level.

Application Information

- VISI-TRIP indication on all QO breakers.
- QO, VISI-TRIP and QWIK-GARD are registered trademarks of Square D.
- For more information consult Schneider Electric.
- Accessories page DE1-10.
- Add suffix 35 for 50°C calibration - 20% price adder.

Plug-On Circuit Breakers - Amperes Interrupting Rating (AIR) in Amperes RMS Symmetrical



One Pole
QO-AFI



One Pole
QO-GFI



Two Pole
QO-GFI



QO One Pole
with Shunt Trip



QOK Key
Operated

QO-GFI QWIK-GARD® circuit breakers provide overload and short circuit protection, combined with Class A ground fault protection. Class A denotes a ground fault circuit interrupter that will trip when a fault current to ground is 6 milliamperes or more, for people protection. Do not connect to more than 250 feet of load conductor for the total one-way run to prevent nuisance tripping.

Ampere Rating Δ	One Pole 120Vac		Two Pole-Common Trip 120/240Vac
	10,000 AIR	22,000 AIR	10,000 AIR
15	QO115GFI	QO115VHGFI	QO215GFI
20	QO120GFI	QO120VHGFI	QO220GFI
25	QO125GFI	QO125VHGFI	QO225GFI
30	QO130GFI	QO130VHGFI	QO230GFI
40	—	—	QO240GFI
50	—	—	QO250GFI
60	—	—	QO260GFI ♦

QO-EPD QO Circuit Breakers With 30 mA Equipment Ground Fault Protection

Ampere Rating Δ	One Pole 120Vac	Two Pole-Common Trip 120/240Vac
	10,000 AIR	10,000 AIR
15	QO115EPD	QO215EPD
20	QO120EPD	QO220EPD
25	QO125EPD	QO225EPD
30	QO130EPD	QO230EPD
40	—	QO240EPD
50	—	QO250EPD
60	—	QO260EPD

QO-K Key operated QO circuit breakers are available in single pole construction and can be mounted in any single pole space which will accept a standard QO. These circuit breakers can be turned ON or OFF or to RESET with a special key (Catalogue Number **QOK10**) included with the circuit breaker.

Ampere Rating Δ	One Pole 120Vac 10,000 AIR
10	QO110K
15	QO115K
20	QO120K
30	QO130K

QO-HM QO circuit breaker with high magnetics to withstand higher inrush currents than standard QO breaker.

Ampere Rating	One Pole 120Vac 10,000 AIR
15	QO115HM
20	QO120HM

Note:
QO GFI, EPD, AFI cannot be backfed.

Circuit Breaker Wire Sizes

Breaker Type	Ampere Rating Δ	Wire Size (AWG)	
		Aluminum	Copper
QO 1 Pole	10-30	#14-8	#14-8
	10-30	—	(2) #14-10
	35-70	#8-2	#8-2
QO 2 & 3 Pole	10-30	#14-8	#14-8
	35-70	#8-2	#8-2
	80-125	#12-2/0	#12-2/0
QOT	15-20	#12-8	#14-8
QO-GFI & QO-EPD	15-30	#12-8	#14-8
	40-60	#12-4	#14-6

QO-HID QO-HID Circuit Breakers - For Use on High Intensity Discharge Lighting Systems

HID circuit breakers are for use on circuits feeding fluorescent and High Intensity Discharge (HID) lighting systems such as mercury vapour, metal halide, or high pressure sodium. These circuit breakers are physically interchangeable with QO circuit breakers.

Ampere Rating Δ	One Pole 120/240Vac	Two Pole-Common Trip 120/240Vac	Three Pole-Common Trip 240Vac
	10,000 AIR	10,000 AIR	10,000 AIR
15	QO115HID▲	QO215HID	QO315HID
20	QO120HID▲	QO220HID	QO320HID
25	QO125HID	QO225HID	QO325HID
30	QO130HID	QO230HID	QO330HID
40	QO140HID	QO240HID	—
50	QO150HID	QO250HID	—

QO-AFI QO Arc Fault Circuit Interrupters (10,000 AIR)

Ampere Rating	Poles 120Vac	Catalogue Number
15	1	QO115AFI
20	1	QO120AFI

Circuit Breaker Factory Installed Accessories

Requires Additional Pole Space. Only one accessory per breaker. QO accessory terminals for (2) #14-12 Cu. Accessories are not available for Q2, QOM1, or QOB-VH (110-150 A) circuit breakers or QO molded case switches.

Factory Installed Accessories	Available On Breaker	Description	Add Suffix To Breaker Catalogue No.
Shunt Trip	QO	120Vac 208Vac 240Vac	1021
		12Vdc 24Vdc 12Vdc 24Vdc	1042
Auxiliary Switch	QO,-GFI,-EPD,	"A" Contact	1200
		"B" Contact	1201
Alarm Switch	QO,-GFI,-EPD,	120Vac	2100

Δ 10-30 ampere breakers are suitable for use with 60°C or 75°C conductors, 35-60 ampere breakers are suitable for use with 75°C conductors.
▲ SWD (switching duty) rated. Suitable for switching 120Vac fluorescent lighting loads.
♦ Suitable only for feeding 240Vac and 208Vac 2 wire loads. Does not contain load neutral connection.

Application Information

- VISI-TRIP indication on all QO breakers.
- QO, VISI-TRIP and QWIK-GARD are registered trademarks of Square D.
- For more information consult Schneider Electric.

QO® Loadcentres and Circuit Breakers

QO® Main Lugs Loadcentres - Type 1 Indoor

QO® Main Lugs Loadcentres (1Ø - 3W)

Mains Ampere Rating	Number of Circuits		Loadcentre Catalogue Number	Series	Trim Catalogue Number	Main Wire Size Al or Cu (AWG/MCM)	Box Size (see page 13)
	Standard QO	Tandem QO					
30	1	2	QO1L30S†	001	Included	12-10 Al or 14-10 Cu	1
	2	4	QO2L30SC●	G01	Included	12-10 Al or 14-10 Cu	2
70	2	4	QO2L70S+†	G01	Included	12-3 Al or 14-4 Cu	3
	4	8	QO4L100S▲■	G03	Included	8-1	4
100	6	12	QO6L100S/F■	G03	Included	8-1	4
	8	15	QO8L100S/F■	G03	Included	8-1	4
	12	24	CQO112L100GC	S01	Included	4-1	7
	16	32	CQO116L100GC	S01	Included	4-1	7
125	24	48	CQO124L125GC	S01	Included	4 - 2/0	8
	32	48	CQO132L125GC	S01	Included	4 - 2/0	9
	40	48	CQO140L125GC	S01	Included	4 - 250	11
200	32	64	CQO132L200GC	S01	Included	4 - 250	11
	40	80	CQO140L200GC	S01	Included	4 - 250	11
225	42	80	CQO142L225GC	S01	Included	4 - 300	12
	60	80	CQO160L225GC	S01	Included◆	4 - 300	14

QO® Main Lugs Loadcentres (3Ø - 4W)

Mains Ampere Rating	Number of Circuits		Loadcentre Catalogue Number	Series	Trim Catalogue Number	Main Wire Size Al or Cu (AWG/MCM)	Box Size (see page 13)
	Standard QO	Tandem QO					
100	3▼		QO403L100S†	G01	Included	12-1 Al or 14-1 Cu	5
	12▼	24	QO312ML1	S01	QOC16UC	4 - 2/0	7
125	20▼	40	QO320ML1	S01	QOC24UC	4 - 2/0	8
200	24▼	48	QO324ML2	S01	QOC30UC	4 - 250	10
	30▼	60	QO330ML2	S01	QOC30UC	4 - 250	10
225	42▼	60	QO342ML2	S01	QOC42UC	4 - 300	12

QO® Generator Panel (1Ø - 3W)

Mains Ampere Rating	Spaces	Max. Number Single Pole Circuits	Max. Number of Tandem Circuit Breakers	Loadcentre Catalogue Number	Main Wire Size Al or Cu (AWG/MCM)	Box Size (see page 13)
30	4	8	4	CQO48M30DSGP	#14-8	4
60	4	8	4	CQO48M60DSGP	#8-2	4

† Suitable for use as service equipment when used with a 2 pole breaker.

● Will not accept QO-GFI or QO-EPD breakers.

+ Maximum 20A QO-GFI breaker or AFI breaker.

▲ Maximum 70A branch breaker.

◆ Does not include a door.

■ 70 amp max Branch Breaker.

▼ Shunt trip feature not available on any 3Ø loadcentres. Feed-thru lugs cannot be added in filed-use QO3125SL to feed-thru to another loadcentre.

- Bus on 2-8 cct loadcentres is one piece, solid aluminum.
- Bus on 12-60 cct loadcentres is one piece, tin plated copper
- Neutral terminals, main and ground lugs on all devices are Aluminum.
- QODK60-2 door kit can be installed on 60A main lug loadcentre.

Application Information

- All loadcentres are suitable for both flush or surface mounting, unless suffixed:
 - F - flush mounting only.
 - S - surface mounting only.
- All Type 1 loadcentres are approved for vertical, horizontal, or inverted mounting.

- All 100A loadcentres are approved for 100A max. QO branch circuit breakers.
- All 125A loadcentres are approved for 125A max. QO branch circuit breakers.
- The maximum QO branch circuit breaker is 70 ampere (single pole), 200 ampere (two pole) and 100 ampere (three pole). Two pole QO breakers rated 150 - 200 ampere are restricted to Square D QO Single Phase load center, Series G1.

- Main lugs loadcentres cannot be field converted to service entrance approved, main breaker loadcentres.
- QO is a registered trademark of Square D.
- For more information, consult Schneider Electric.
- GC includes ground bar combination surface/flush cover.

QO® Loadcentres and Circuit Breakers

QO® Main Breaker Loadcentres - Type 1 Indoor QO® Loadcentre QwikPaks

LOAD CENTRES
DE1

Main Breaker Loadcentres (1PH - 3W)

Bus Ampere Rating	Main Breaker Amps	Number of Circuits		Loadcentre Catalogue Number	Series	Trim Catalogue Number	Main Wire Size Al/Cu (AWG/MCM)	Box Size (see page 13)
		Standard QO	Tandem QO					
Main Breaker Factory Installed								
100	60	12	24	CQO112M100C60	S01	Included	4 - 1	6
100	60	16	32	CQO116M100C60	S01	Included	4 - 1	7
100	100	16	32	CQO116M100C100	S01	Included	4 - 1	7
125	60	24	48	CQO124M125C60	S01	Included	4 - 2/0	8
125	100	24	48	CQO124M125C100	S01	Included	4 - 2/0	8
125	100	32	54	CQO132M125C100	S01	Included	4 - 2/0	9
125	125	32	54	CQO132M125C125	S01	Included	4 - 2/0	9
125	100	40	54	CQO140M125C100	S01	Included	4 - 2/0	11
125	125	40	54	CQO140M125C125	S01	Included	4 - 2/0	11

Main Breaker Factory Installed

200	200	32	64	CQO132M200C	S01	Included	4 - 250	11
		40	80	CQO140M200C	S01	Included	4 - 250	11
225	200	60	80	CQO160M200C	S01	Included	4 - 300	14

Main Breaker Loadcentres (3Ø - 4W)

Bus Ampere Rating	Main Breaker Amps	Number of Circuits		Loadcentre Catalogue Number	Series	Trim Catalogue Number	Main Wire Size Al or Cu (AWG/MCM)	Box Size (see page 13)
		Standard QO	Tandem QO					
Main Breaker Factory Installed (QO3100VH & QDL32200)								
100	100	24	30	QO324MB100	S01	QOC30UC	4 - 250	10
200	200	42	60	QO342MQB200	S01	QOC342UQC	4 - 250	13

QO® Loadcentre QwikPaks

QwikPak	Loadcentre	Main Breaker	Branch Breakers				
			QO115	QO215	QO220	QO230	QO240
QP24100	CQO124M125C100	QOM100VHL	10	3	0	1	1
QP32100	CQO132M125C100	QOM100VHL	10	3	0	1	1
QP40100	CQO140M125C100	QOM100VHL	10	3	0	1	1
QP32125	CQO132M125C125	QOM125VHL	10	3	0	1	1
QP40200	CQO140M200C	QOM2200VHL	10	3	0	1	1
QP40200Q	CQO140M200C	QOM2200VHL	14	2	3	2	1
QP60200	CQO160M200C	QOM2200VHL	10	3	0	1	1
QP60200Q	CQO160M200C	QOM2200VHL	14	2	3	2	1

Main Breakers

Main Breaker Frame Size	Amperage +	kAIC	Catalogue Number	Lug Wire Size AWG/KCMIL Al or Cu
QOM1	30	10	QOM30L	#12-2/0
	40		QOM40L	
	50		QOM50L	
	60		QOM60L	
	70		QOM70VHL	
QOM2▲	100	22	QOM100VHL	#4-2/0
	125		QOM125VHL	
	100		QOM2100VHL	
	125		QOM2125VHL	
	150		QOM2150VHL	
	200	22	QOM2200VHL	#4-250
	225		QOM2225VHL	

- ◆ Does not include a door. Order kit # QODK60-2.
- Rated 200A maximum with Aluminum conductors and 225A maximum with Copper conductors.
- ▲ Add suffix - 1021 for 240Vac shunt trip. Factory Installed Accessory.
- + Do not exceed the load centre mains rating.
- Bus on all devices is one-piece, solid copper, standard.
- Neutral terminals, main and ground lugs on all devices are Aluminum, standard.

Application Information

- All loadcentres are suitable for both flush or surface mounting.
- All Type 1 loadcentres are approved for vertical, horizontal, or inverted mounting.
- All 100A loadcentres are approved for 100A max. QO branch circuit breakers.
- All 125A loadcentres are approved for 125A max. QO branch circuit breakers.
- The maximum QO branch circuit breaker is 70 ampere (single pole), 200 ampere (two pole) and 100 ampere (three pole). Two pole QO breakers rated 150 - 200 ampere are restricted to Square D QO Single Phase load center, Series G1.
- Main Breaker loadcentres are approved for service entrance use. The main breaker compartment can be sealed and the main breaker can be locked.
- QO-L main breakers are 10 kAIC rated, QO-VHL main breakers are 22 kAIC rated.
- QO is a registered trademark of Square D.
- For more information, consult Schneider Electric.

QO® Loadcentres and Circuit Breakers

DE1 LOAD CENTRES

QO® Main Lugs/Main Breaker Loadcentres - Type 3R Weatherproof

Main Lugs Loadcentres (1Ø - 3W)

Bus Ampere Rating	Number of Circuits		Loadcentre Catalogue Number	Series	Trim Catalogue Number	Main Wire Size Al or Cu (AWG/MCM)	Box Size (see page 13)
	Standard QO	Tandem QO					
70	2	4	QO2L70RB†	G01	Included	12-3 Al or 14-4Cu	1RB
	6	12	QO6L100RB	G03	Included	8-1	2RB
100	8	15	QO8L100RB	G03	Included	8-1	2RB
	16	32	CQO116L100GRB	S01	Included	4-1	6RB
125	24	48	CQO124L125GRB	S01	Included	4-2/0	6RB
200	40	80	CQO140L200GRB	S01	Included	4-250	8RB

Main Lugs Loadcentres (3Ø - 4W)

Bus Ampere Rating	Number of Circuits		Loadcentre Catalogue Number	Series	Trim Catalogue Number	Main Wire Size Al or Cu (AWG/MCM)	Box Size (see page 13)
	Standard QO	Tandem QO					
100	3		QO403L100RB†	G01	Included	12-1 Al or 14-1 Cu	3RB
	12	24	QO312ML1RB	S01	Included	4-2/0	4RB
125	20	40	QO320ML1RB	S01	Included	4-2/0	5RB
200	30	60	QO330ML2RB	S01	Included	4-250	7RB
225	42	60	QO342ML2RB	S01	Included	4-300	9RB

Main Breaker Loadcentres (1Ø - 3W)

Bus Ampere Rating	Main Breaker Amps	Number of Circuits		Loadcentre Catalogue Number	Series	Trim Catalogue Number	Main Wire Size Al/Cu (AWG/MCM)	Box Size (see page 13)
		Standard QO	Tandem QO					
Main Breaker Factory Installed								
100	60	8	16	CQO18M100RB60	S01	Included	4 - 1	4RB
100	100	16	32	CQO116M100RB100	S01	Included	4 - 1	6RB
125	100	24	48	CQO124M125RB100	S01	Included	4 - 2/0	6RB
Main Breaker Factory Installed								
200	200	40	80	CQO140M200RB	S01	Included	4-250	8RB

Non-Metallic Enclosure (1Ø - 3W) Type 3R

Bus Ampere Rating	Number of Circuits		Loadcentre Catalogue Number	Trim Catalogue Number	Main Wire Size Al/Cu (AWG/MCM)	Box Size (see page 13)
	Standard QO	Tandem QO				
60	2	4	CQO24L60NRNM	Included	#14-4 / #14-4	1NM

QO Hot Tub / Pool / Spa Pack

20 to 60 amp non-metallic	2 pole QOGFCI factory installed into a type 3R enclosure	CQOE220GFIM
		CQOE230GFIM
		CQOE240GFIM
		CQOE250GFIM
		CQOE260GFIM▼



- † Suitable for use as service entrance equipment when used with a 2 pole breaker.
- ‡ Maximum 20 A QO-GFI breaker.
- ▼ 60 amp, 2 wire 240V only.

- Bus on 2-8 cct loadcentres is one-piece, solid aluminum. (Excluding CQO18M100RB.)
- Bus on 8-42 cct, S-Series loadcentres is one-piece, solid copper.
- Neutral terminals, main and ground lugs on all devices are Aluminum.

Application Information

- All 100A loadcentres are approved for 100A max. QO branch circuit breakers.
- All 125A loadcentres are approved for 125A max. QO branch circuit breakers.
- The maximum QO branch circuit breaker is 70 ampere (single pole), 200 ampere (two pole) and 100 ampere (three pole). Two pole QO breakers rated 150 - 200 ampere are restricted to Square D QO Single Phase load center, Series G1..
- Main Breaker loadcentres are approved for service entrance use. The main breaker compartment can be sealed and the main breaker can be locked.
- Main lugs loadcentres cannot be field converted to service entrance approved, mainbreaker loadcentres.
- Weatherproof Loadcentres are supplied with main entry hole cut in top endwall and closing cap (BCAP) installed. Hole accepts 3/4 in. to 2 in. hubs. Gasket not required.
- QO is a registered trademark of Square D.

QO® Loadcentres and Circuit Breakers

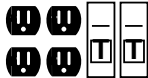
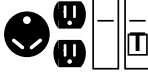


QO® Recreational Vehicle Park Loadcentres (ServicePak®) QO® Mobile Home and Trailer Loadcentres

DE1 LOAD CENTRES

Recreational Vehicle Park Loadcentres (ServicePak® Panels)

Ampere Rating		Spaces	Power Outlet Config.	Service	Canada Catalogue No.	Series	Main Wire Size (AWG/MCM)		Box Size (see page 13)
Mains	Sub-feed						Al	Cu	
Underground or Overhead Loop-Feed Terminals - Non-Pedestal Mounted ◆									
40	40	2	A	1Ø2W	QO2RV40A QO2RV40AG	E01	14 - 6	12 - 6	RVP1
50	50	2	B	1Ø2W	QO2RV50B QO2RV50BG QO2RV50BGFI	E01	14 - 6	12 - 6	RVP1
75	75	3	C	1Ø2W	QO3RV75C QO3RV75CG QO3RV75CGFI	E01	14 - 1	12 - 1	RVP2
Underground Loop-Feed Terminals - Pedestal Mounted ●									
50	200	2	B	1Ø2W	QO2RVP50B QO2RVP50BG QO2RVP50BGFI	E01	6 - 250		RVP1+Pedestal
75	200	3	C	1Ø2W	QO3RVP75C QO3RVP75CG QO3RVP75CGFI	E01	6 - 250		RVP2+Pedestal
100	200	4	D	1Ø3W	QO4RVP100D QO4RVP100DG QO4RVP100DGFI	E02	6 - 250		RVP2+Pedestal

Power Outlet Configurations

Configuration	Description
A	 <p>2 x 15 Amp, 120V, Duplex receptacles and ground 2 x QO115 breakers or 2 x QO115GFI</p>
B	 <p>1 x 15 Amp, 120V, Duplex receptacle and ground 1 x 30 Amp, 120V receptacle and ground 1 x QO115 breaker or 1 x QO115GFI 1 x QO130 breaker or 1 x QO130GFI</p>
C	 <p>1 x 15 Amp, 120V, Duplex receptacle and ground 2 x 30 AMP, 120V receptacles and ground 1 x QO115 breaker or 1 x QO115GFI 2 x QO130 breaker or 2 x QO130GFI</p>
D	 <p>1 x 15 Amp, 120V, Duplex receptacle and ground 1 x 30 AMP, 120V receptacle and ground 1 x 50 Amp, 120/240V, receptacle and ground 1 x QO115 breaker or 1 x QO115GFI 1 x QO130 breaker or 1 x QO130GFI 1 x QO250 breaker</p>

- Provide electrical power to individual recreational vehicle park sites.
- Each receptacle protected by appropriate GFI or Standard QO® circuit breaker.
- All receptacles and circuit breakers included.
- 10,000 RMS Symmetrical Ampere short circuit current rating.
- All enclosures are rainproof.
- No neutral bonding provisions.
- Loop-Feed provisions.
- Type 3R weatherproof.
- Optional configurations not available.



Mobile Home and Trailer Loadcentres

Mains Ampere Rating	Spaces	Service	Catalogue Number	Series	Main Wire Size (AWG/MCM)		Box Size (see page 13)
					Al	Cu	
Main Lugs Loadcentres							
30	2	1Ø2W	QO2L30TTS‡	G01	12 - 10	14 - 10	MH1
50	2	1Ø2W	QO2-4L50TTS+	G01	—	14 - 6	MH2
70	2	1Ø3W	QO2-4L70TS	G01	12 - 3	14 - 4	MH2
100	6	1Ø3W	QO6-12L100TF/S†	G01		4 - 1	MH3
100	6	1Ø3W	QO6-12L100DTF/S†	G01		4 - 1	MH3u

- ◆ Non-pedestal devices are supplied with main entry hole cut in top endwall and have closing cap (BCAP) installed. Hole accepts 3/4 in. to 2 1/2 in. hubs. Gasket not required.
- ◆ Non-pedestal devices have provisions to field install a Type "B" bolt on hub on the bottom endwall. For bottom feed from a conduit riser, order Type "B" hub and two mounting screws P/N: 80025-055-01; and two hex nuts, P/N: 23401-020-00.
- For pedestal devices, a stabilizer foot is available for use in unstable ground, P/N: HNP-SF.
- ‡ Will not accept QO-GFI circuit breakers.
- + Use #10 maximum size wire for QO-GFI circuit breakers.
- † 70A Max. branch circuit breaker and 70A Max. back fed main circuit breaker.

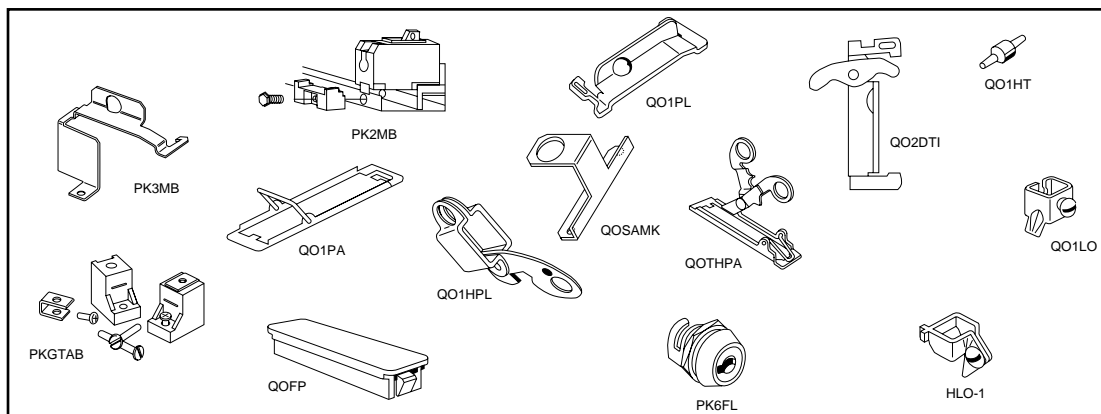
Application Information

- All Servicepak® Panels have their breakers and receptacles factory installed and prewired.
- Mobile Home and Trailer Loadcentres do not come with factory installed breakers. Order separately.
- Servicepak® Panels and Mobile Home and Trailer Loadcentres are not suitable for use as service equipment.
- All Servicepak® devices are set up for Loop-fed, therefore, there are 2 wires per phase, neutral and equipment ground.
- Servicepak® devices are suitable for surface mounting only.
- Power Outlet Configurations, other than those shown above, are not available.
- Servicepak® is a Registered Trademark of Square D.
- For more information, consult Schneider Electric.

QO® Loadcentres and Circuit Breakers

Accessories

	Description	Catalogue Number
Handle Attachments		
Handle Tie:	Converts any two adjacent 120/240Vac single pole QO breakers to independent trip two pole	QO1HT
	Converts any two adjacent 120/240Vac single pole side-by-side Tandem breakers to independent trip two pole	QO1HT
Handle Lock-Off:	Clamp for holding QO single pole handle in "ON" or "OFF" position.....	QO1LO
	Clamp for holding QO, either 1, 2 or 3-pole breaker handles in "ON" or "OFF" position.....	HLO-1
Handle Padlock Attachment:	For padlocking single pole QO breaker in "ON" or "OFF" position	
	Loose Attachment	QOHP
	Fixed Attachment	QO1PA
	For padlocking single pole side-by-side QO Tandem breaker in "ON" or "OFF" position.....	QO1HTPA
	For 2 and 3-pole QO breakers which require padlocking in either "ON" or "OFF" position	
	Loose Attachment.....	QO1HPL
	Fixed Attachment.....	QO1PL
	For padlocking QOM main circuit breakers in "OFF".....50-125A.....	QOM1PA
	150-225A.....	QOM2PA
	For padlocking 2-Pole QO-GFI in either "ON" or "OFF" position.....	GFI2PA
Mechanical Interlock Attachment:	For interlocking the handles of two 2-pole or one 2-pole and one 1-pole QO breakers mounted side-by-side so that only one breaker can be "ON" at a time.....	QO2DTI
Sub-feed lugs		
	125 ampere two pole plug-on – 2 spaces required (#12-2/0 Al/Cu)	QO2125SL
	125 ampere three pole plug-on – 3 spaces required (#12-2/0 Al/Cu)	QO3125SL
Filler Plates		
	Fills branch breaker openings in cover	QOFP
	Fills QOM1 main breaker opening in cover.....100-125A.....	QOM1FP
	Fills QOM2 main breaker opening in cover.....150-225A.....	QOM2FP
	Fills main breaker opening in 3Ø covers (S-Series)	KFP
Lock Kits		
	Converts door latch from spring catch to lock type.....	PK6FL
Neutral / Ground Lugs		
	Field installed for #12 to 2 Al or #14 to 4 Cu wire	LK70AN
	Field installed for #6 to 2/0 Al/Cu wire	LK100AN
	Field installed for #14 to 2/0 Al/Cu wire	LK125AN
	Field installed for #2 to 3/0 Al/Cu wire	LK150AN
Ground Bar Kits		
	Standard PK15GTA with a #1 to 4/0 Cu/Al Lug.....	PK15GTA-L
	Standard PK18GTA with a #1 to 4/0 Cu/Al Lug.....	PK18GTA-L
	Standard PK23GTA with a #1 to 4/0 Cu/Al Lug.....	PK23GTA-L
	Insulator Kit for PK9GTA thru PK27GTA.....	PKGTAB
Miscellaneous		
Retaining Kit:	QO main breaker barrier.....	40559-522-01
	Secures circuit breaker to interior when used as a back-fed main.	
	For use on QO6L100S/F, RB and QO8L100S/F, RB Loadcentres.	PK2MB
	Secures circuit breaker to interior when used as a back-fed main. For 3Ø Loadcentres (S-Series).....	PK3MB
Cover Sealing Strap:	Provides means of sealing trim mounting screws on QO load centre covers.....	QO1SE
Joint Compound	For use on plug-on connectors only. Recommended for use whenever QO plug-on breakers are removed and reinstalled for any reason. 57g container.....	PJC-7201
Touch-up Paint	Aerosol spray paint can – ASA 49	W469-X83



Application Information

- QO is a registered trademarks of Square D.
- For more information consult Schneider Electric.

SURGEBREAKER PLUS® Transient Voltage Surge Suppressor

Suitable for use in service entrance locations; Meets requirements of NEC Article 280, UL Listed 1449, 2nd Edition. Meets ANSI/IEEE C62.41-1988 and cUL certified.

- Whole home protection.
- AC line protection.
- Four line telephone (Analog POTS) or (Digital POTS) protection.
- Optional Digital Telephone Board (2 Digital, 2 POTS).
- Two line coaxial protection.
- Suitable for indoor applications only.
- Flush or surface mounting.
- LED status indicator.
- Modular design.

Single Phase Three Wire – 120/240 Vac

Description	Catalogue Number
Surgebreaker Plus	SDSB1175C



SDSB1175C

SURGEBREAKER™ Secondary Surge Arrester

Description	Catalogue Number	Surge Current		
		1,500A	5,000A	10,000A
QO Surgebreaker CSA and UL Listed Secondary Surge Arrester 150Vac line-to-ground maximum	QO2175SB	500V	625V	750V

- CSA Certified and UL Listed Secondary Surge Arresters.
- Meet ANSI/IEEE C62.11-1987.
- QO2175SB for QO load centers and combination devices, NQOD panelboards..
- Plug-on design requires two pole spaces.
- LED indicates operational status.
- Suitable for use in service entrance locations.



QO2175SB

Hard-Wired Secondary Surge Arresters

Description	Catalogue Number	Surge Current		
		1,500A	5,000A	10,000A
SECONDARY SURGE ARRESTER For 1Ø systems. 175Vac phase-to-ground maximum.	SDSA1175■	500V	625V	750V
SECONDARY SURGE ARRESTER for 3Ø systems. 650Vac phase-to-ground maximum.●	SDSA3650	1,525V	1,700V	1,925V

- CSA certified and UL Listed Secondary Surge Arresters.
- Meet ANSI/IEEE C62.11-1987.
- Suitable for indoor and outdoor applications.
- Suitable for use in service entrance locations.
- ◆ Measured with 1" lead length for 8/20us Combination Wave Surge Current for each Phase-to-Ground
- Catalogue Number QOSAMK required for installation in QO loadcentres (see page DE1-10 for diagram).
- Do not use on ungrounded systems. Systems shown may be solidly grounded or impedance grounded.



SDSA1175



SDSA3650

For Wiring Diagrams, see DE1-12

See Catalogue Section Order No. 6671CT9701 R8/99

Application Information

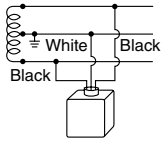
- For more information consult Schneider Electric.

QO® Loadcentres and Circuit Breakers

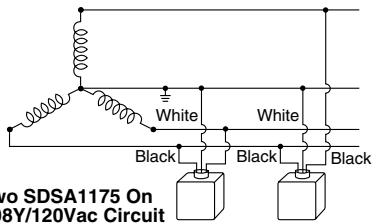
Surge Protective Devices, Wiring Diagrams

Secondary Surge Arresters

SDSA1175 Wiring Diagrams

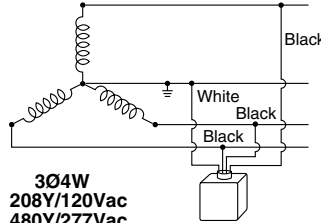


One SDSA1175 On 120/240Vac Circuit

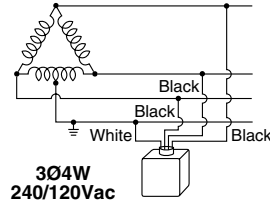


Two SDSA1175 On 208Y/120Vac Circuit

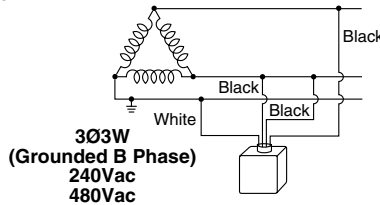
SDSA3650 Wiring Diagrams



**3Ø4W
208Y/120Vac
480Y/277Vac
600Y/347Vac**



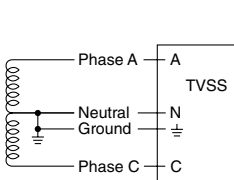
**3Ø4W
240/120Vac**



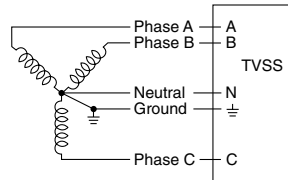
**3Ø3W
(Grounded B Phase)
240Vac
480Vac**

Note:
Systems shown may be solidly grounded or impedance grounded.

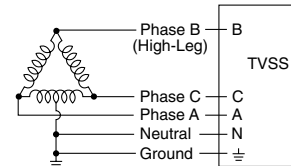
TVSS System Diagrams



120/240V Single Phase



208Y/120V, 480Y/277V Three Phase Wye



240/120V Three Phase High-Leg Delta

Note: The high-leg of the power system must connect to phase B of the TVSS.

Enclosure Dimensions

Type 1 QO Loadcentre Enclosures

Type 1 Box Size	Height (in./mm)	Width (in./mm)	Depth (in./mm)
1	5.50/140	3.00/76	3.50/89
2	6.75/171	3.75/95	3.00/76
3	9.25/235	4.75/121	3.25/83
4	12.75/324	9.00/229	3.75/95
5	13.25/377	6.00/152	3.50/89
6	15.00/381	14.25/362	3.75/95
7	18.00/457	14.25/362	3.75/95
8	21.00/533	14.25/362	3.75/95
9	26.25/667	14.25/362	3.75/95
10	30.00/762	14.25/362	3.75/95
11	34.00/864	14.25/362	3.75/95
12	38.00/965	14.25/362	3.75/95
13	40.00/1016	14.25/362	3.75/95
14	41.25/1048	14.25/362	3.75/95

Type 3R QO Loadcentre Enclosures

Type 3R Box Size	Height (in./mm)	Width (in./mm)	Depth (in./mm)
1NM	9.80/245	6.5/162.5	3.9/97.5
1RB	9.50/241	5.00/127	4.00/102
2RB	12.75/324	9.00/229	4.25/108
3RB	13.00/330	6.75/171	4.00/102
4RB	19.00/483	14.25/362	4.50/114
5RB	22.00/559	14.25/362	4.50/114
6RB	22.25/565	14.25/362	4.50/114
7RB	30.00/762	14.25/362	4.50/114
8RB	34.00/864	14.25/362	4.50/114
9RB	38.00/965	14.25/362	4.50/114

Recreational Vehicle Park Loadcentres

Box Size	Height (in./mm)	Width (in./mm)	Depth (in./mm)
RVP1	8.50/216	7.75/197	5.80/147
RVP2	16.40/417	7.75/197	5.80/147
Pedestal	50.90/129	7.60/193	3.50/89

Mobile Home and Trailer Loadcentres

Box Size	Height (in./mm)	Width (in./mm)	Depth (in./mm)
MH1	6.72/171	3.81/97	3.00/76
MH2	9.30/236	4.80/122	3.19/81
MH3	12.57/319	8.88/226	3.80/97

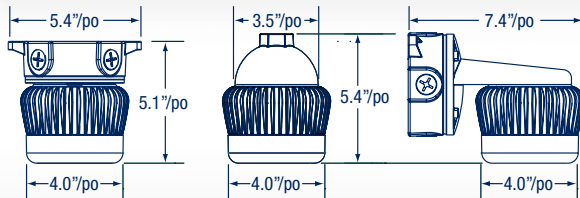
Application Information

- Dimensions for approximate only. Do not use for construction.

DVAKS SERIES LED/DEL

DVAKS SERIES LED/DEL

DIMENSIONAL DATA / DONNÉES DIMENSIONS



LEDs

Fully tested, high quality LEDs

HOUSING

Precision die cast aluminum housing with durable chip and fade resistant powder coat finish

LUMEN MAINTENANCE

Meets or exceeds 70% of initial lumens for a min. lifespan of 50,000 hours.

COLOUR STABILITY

High quality LEDs exceed industry standards

HEAT SINK

Highly efficient heat sinks to maintain the junction temperature significantly below the recommended maximum ratings which allows the fixture to exceed 70% of initial lumens at 50,000 hours, well beyond the useful life of traditional light sources.

COLOUR UNIFORMITY

Meets ANSI specification for the Chromaticity for Solid State Lighting products ANSIC78.377.2008

DEL

Ce luminaire utilise des DEL de haute qualité entièrement testées

BOÎTIER

Boîtier en aluminium moulé sous pression de précision avec revêtement en poudre durable résistant à l'écaillage et à la décoloration

MAINTIEN DES LUMENS

Ce luminaire génèrent au moins 70 % de leurs lumens initiaux pour au moins 50 000 heures de fonctionnement

STABILITÉ DE LA COULEUR

Ce luminaire utilisent des DEL qui excèdent les normes de l'industrie

DISSIPATEUR DE CHALEUR

Dissipation optimale de la chaleur maintenant la température de la jonction significativement en deçà des classifications maximales recommandées. Cela permet au luminaire de maintenir 70 % des lumens initiaux pendant au moins 50 000 heures, ce qui est bien au-delà de la vie utile des sources lumineuses traditionnelles.

UNIFORMITÉ DE LA COULEUR

Ce luminaire répondent aux spécifications de l'ANSI en ce qui concerne la chromaticité des produits d'éclairage à semi-conducteurs. ANSIC78.377.2008

**100% CANADIAN OWNED AND OPERATED
UNE ENTREPRISE EXCLUSIVEMENT CANADIENNE**

RAB DESIGN LIGHTING INC.

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RAB[®]

DESIGN

TRUSTED QUALITY SINCE 1968
UNE MARQUE DE CONFIANCE DEPUIS 1968

**AN LED RETROFIT SOLUTION TO
EXISTING VAKS/DVAKS SERIES FIXTURES**

**UNE SOLUTION D'ÉCLAIRAGE À DEL
POUR REMPLACER LES LUMINAIRES
DES SÉRIES VAKS ET DVAKS**



5
5 Year Guarantee
Garantie de 5 ans



Use with guard and globe (sold separately) to give fixture a more industrial look.

Pour donner au luminaire une allure industrielle, utilisez le globe et la grille de protection (vendus séparément).

www.rabdesign.ca

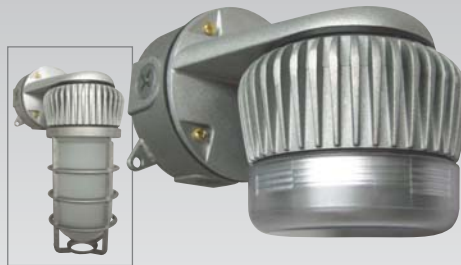
More Than Just **BOXES**
Beaucoup plus que des boîtes

LED/DEL**14W****Equivalent to 150W Incandescent or
26W CFL vapourproof fixtures****Équivalent à une lampe incandescente de 150 W ou à un
luminaire encastré CFL étanche à la vapeur de 26 W****CEILING MOUNT
MONTAGE AU PLAFOND**

DVAKS-LED-14W #89285

**WALL MOUNT
MONTAGE MURAL**

DVBKS-LED-14W #89286

**PENDANT
SUSPENSION**

DVCS-LED-14W #89287



Shown with optional globe and guard (sold separately)
Le globe et la grille de protection montrés sur l'image sont vendus séparément

FEATURES / CARACTÉRISTIQUES

Precision die cast aluminum with integrated heat sinking system designed for maximum heat dissipation

Clear polycarbonate lens is standard. Globe and guard options are available (see below)

Existing incandescent VAKS / DVAKS series globe and guard will fit new LED fixture

Fixture is disassembled for easy installation

Boîtier en aluminium moulé avec précision doté d'un dissipateur thermique conçu pour dissiper un maximum de chaleur

Lentille en polycarbonate transparent est standard. Options pour globes et grilles disponibles (Voir ci-dessous)

Le globe et la grille de protection des luminaires des séries VAKS et DVAKS peuvent être installés sur les nouveaux luminaires à DEL

Pour faciliter l'installation, les pièces du luminaire ne sont pas assemblées

TECH DATA / DONNÉES TECHNIQUES

LED Power Consumption Consommation énergétique – DEL	14W
Input Voltage / Tension d'alimentation	120V - 277V
Colour Temperature/Temp. de couleur	5,000K
Light Output / Intensité Lumineuse	1,131 lumens
Colour Rendering Index (CRI) Indice de rendu des couleurs (IRC)	> 65
Lamp Life (L70) Durée de l'ampoule (L70)	> 50,000H / approx. 17 years ¹ minimum de 17 années ¹
Working Temperature / Température de service	-40°C to 40 °C
Ingress Protection Grade / Classification IP	IP65



¹ Typical 8 hour daily usage / en fonction d'un usage type de 8 heures par jour

**AVAILABLE OPTIONS (sold separately) / AUTRES AUSSI DISPONIBLE (vendus séparément)**

GLASS / VERRE							Guard / Grill de Protection	POLYCARBONATE	
Frosted/Givré GL100F #08506	Clear/Claire GL100 #08507	Prismatic/Prismatique GL100CL-RIB #194164	Red/Rouge RGL100R #94206	Blue/Bleu RGL100B #94204	Green/Vert RGL100G #94205	Amber/Jaune RGL100A #94203	GD100CGS #07839	White/Blanc GL100PGO #08521	Clear/Claire GL100PG #08515



Cut down on cold drafts

The OAC heater provides a burst of heat in areas affected by cold drafts. Designed for residential, commercial and industrial use, the unit can be recessed or surface-mounted.

Powered by a closed factory-lubricated motor, the fan blows warm air downward to create air circulation.

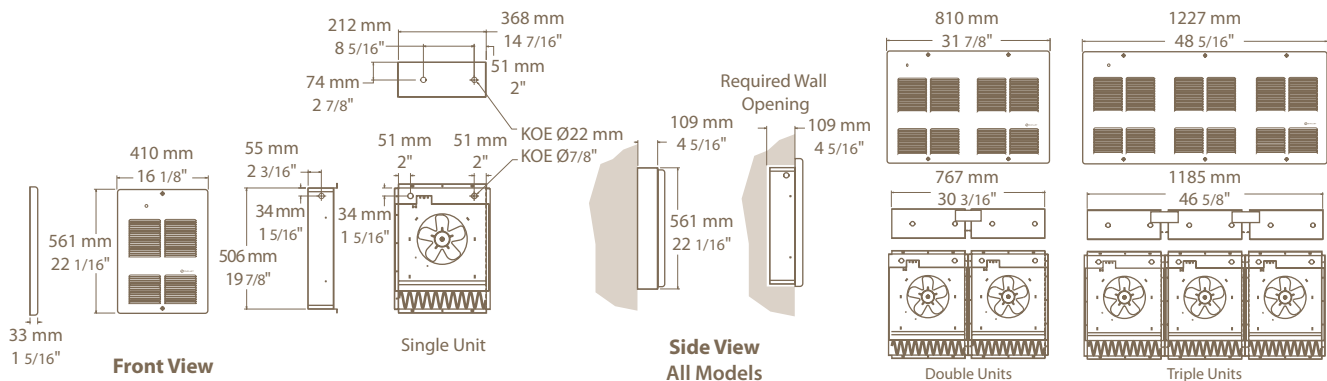
Surface Mounting Box



Recessed

Features

Color	<ul style="list-style-type: none"> - Standard: white, almond. - Optional: metallic silver, bronze, metallic charcoal, textured black, beige-grey, aluminum, semi-gloss black (upcharge of 10%). - Custom colors available upon request.
Finish	<ul style="list-style-type: none"> - Standard: epoxy/polyester powder paint.
Voltage	<ul style="list-style-type: none"> - 120V, 208V, 240V/208V, 277V, 347V, 480V, 600V, 1 or 3-phase.
Construction	<ul style="list-style-type: none"> - 18-gauge steel front cover. - Bottom air outlet. - High-limit temperature control with automatic reset.
Fan	<ul style="list-style-type: none"> - Closed, factory-lubricated motor. - 160 cfm fan (1.5 to 4.8kW; 55 dBA); 2 X 160 cfm fan (6 to 8kW; 58 dBA); 3 X 160 cfm fan (12kW; 61 dBA). - Fan delay purges heater of residual heat. <p><i>(Any remote thermostat or relay must be connected to the heater control terminal block.)</i></p>
Heating element Control	<ul style="list-style-type: none"> - Durable tubular heating element with fins. - Built-in thermostat with control knob or tamperproof adjustable with a screwdriver included. - 24V relay, with or without transformer available. <p><i>Note: Thermostat is not included in heater with factory installed relay.</i></p>
Installation	<ul style="list-style-type: none"> - Minimum clearance from the floor and adjacent walls: 10 in. (25.4 cm). - Adaptor for surface mounting available.
Warranty Applications	<ul style="list-style-type: none"> - 1-year warranty against defects. - Apartment building, commercial building, entrance way, stairwell, garage.



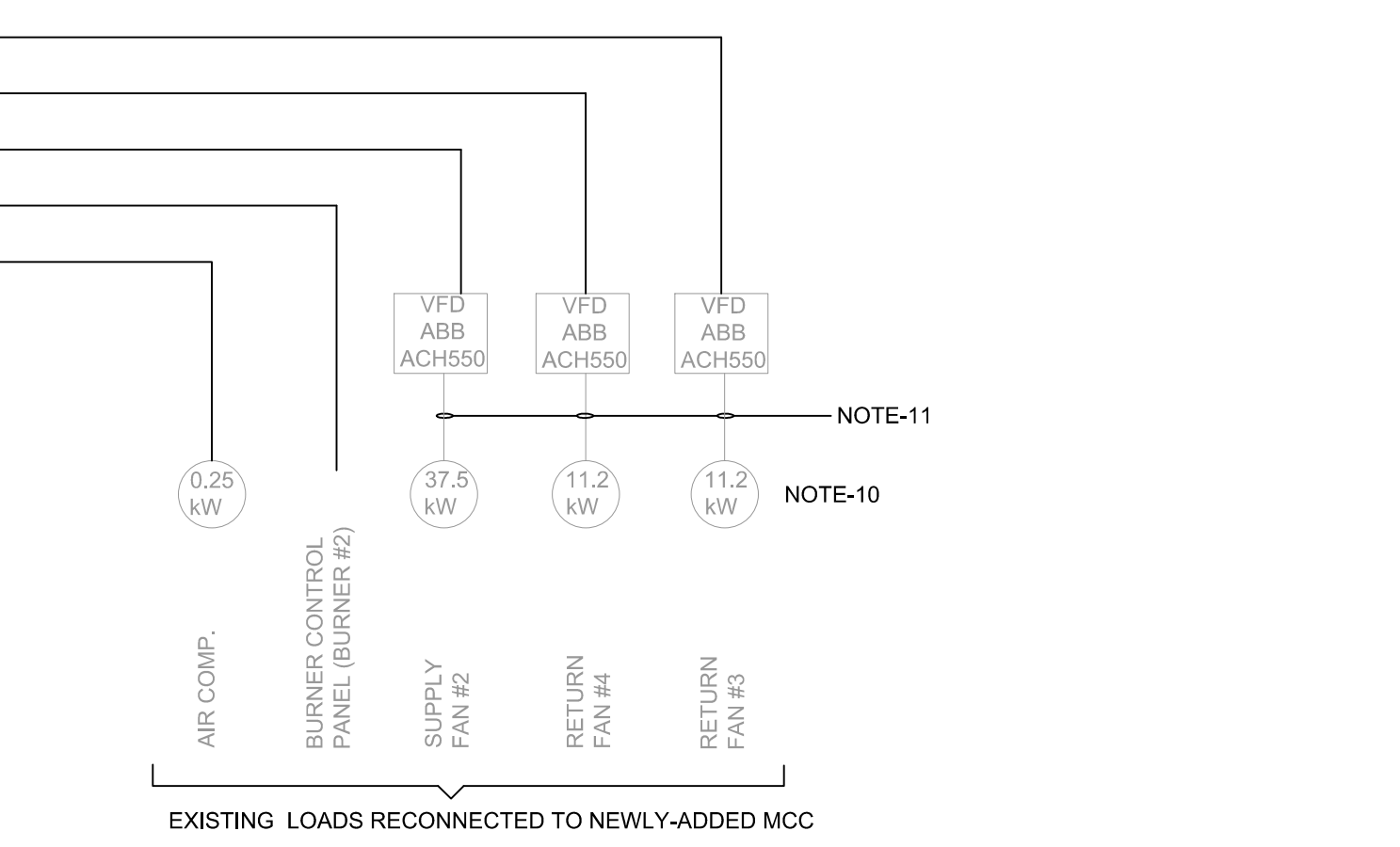
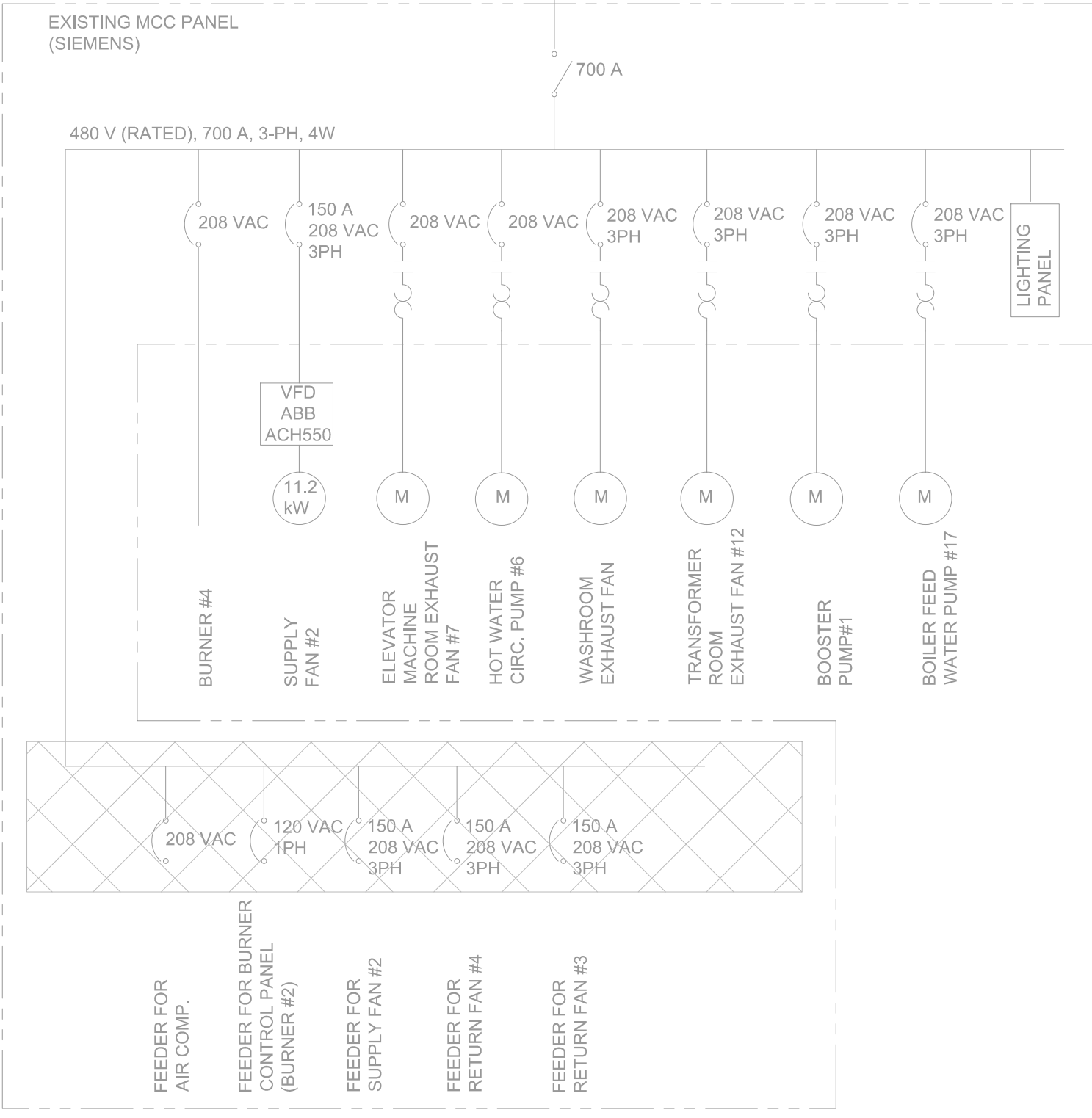
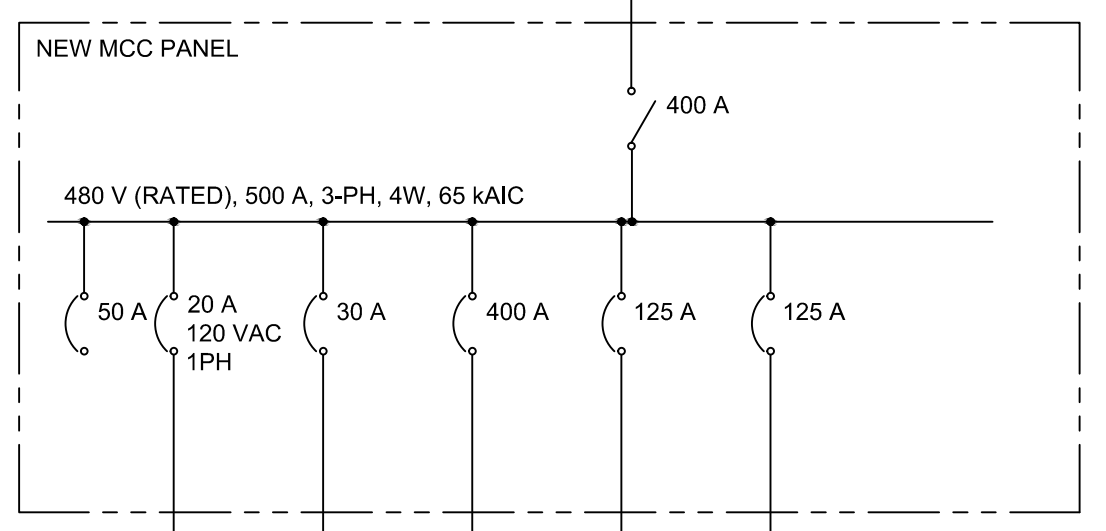
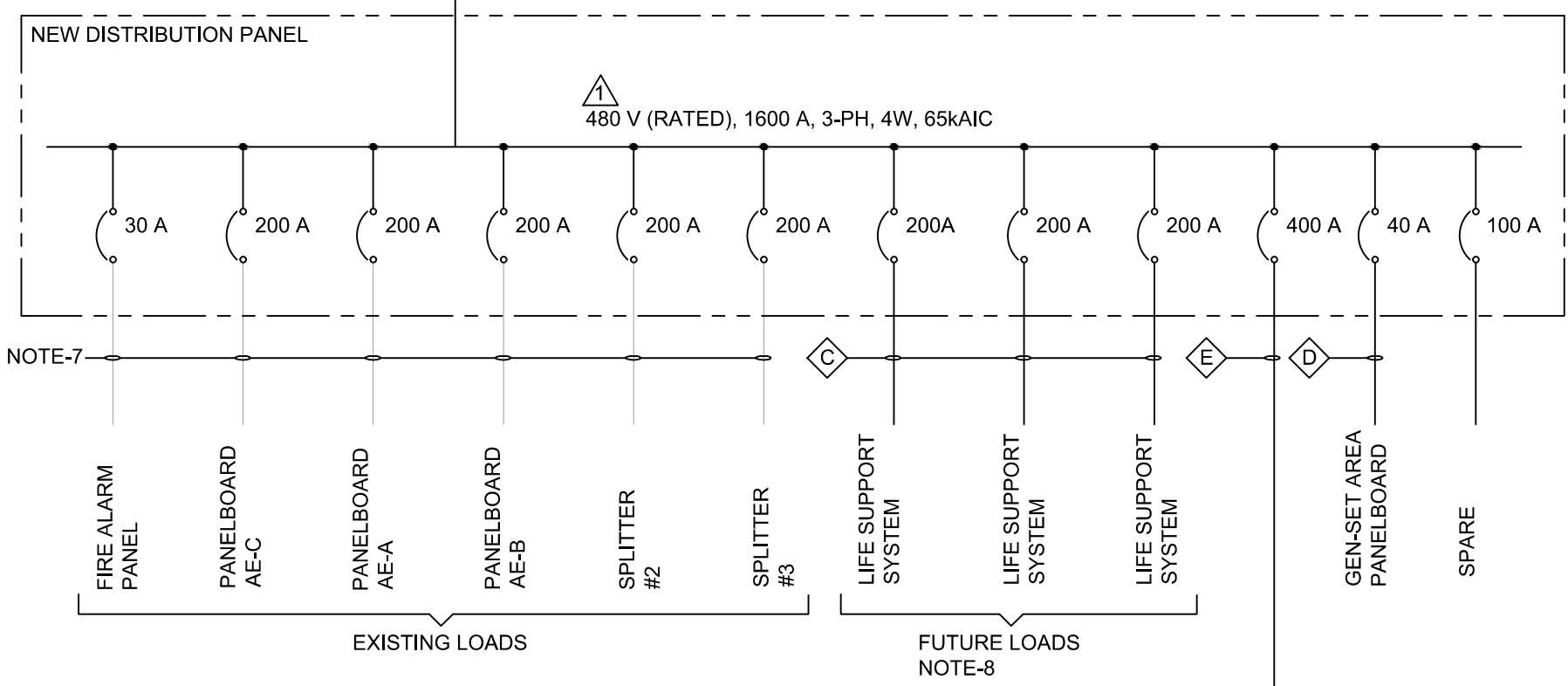
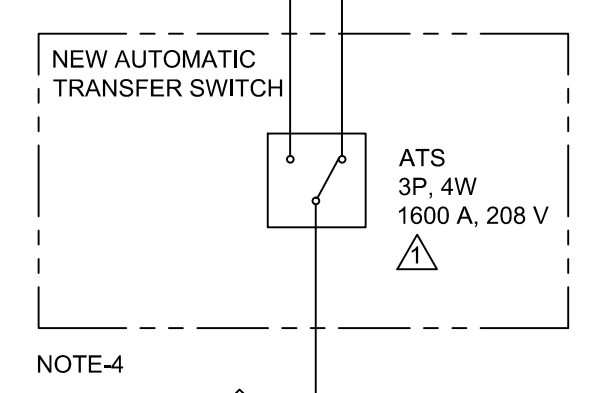
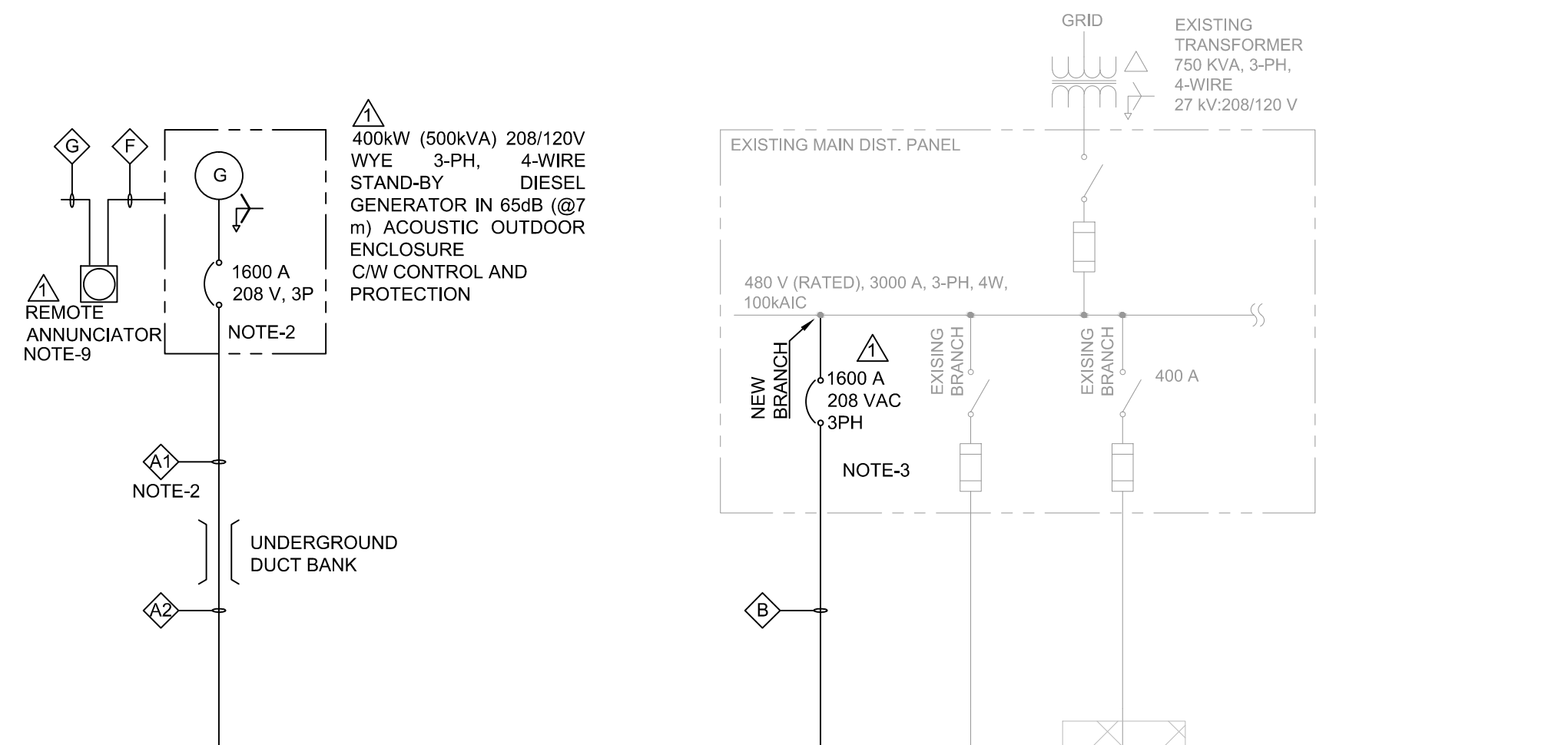
Models

Product #	Volts (ph)	Watts	Weight		Unit
			lb	kg	
OAC01502	120 (1)	1500	24.0	10.9	single
OAC02008	208 (1)	2000	24.0	10.9	single
OAC04008	208 (1)	4000	24.0	10.9	single
OAC04808	208 (1)	4800	24.0	10.9	single
OAC06038	208 (3)	6000	90.0	40.9	triple
OAC08008	208 (1)	8000	50.0	22.7	double
OAC09038	208 (3)	9000	90.0	40.9	triple
OAC12008	208 (1)	12000	90.0	40.9	triple
OAC12038	208 (3)	12000	90.0	40.9	triple
OAC01500	240/208 (1)	1500/1125	24.0	10.9	single
OAC02000	240/208 (1)	2000/1500	24.0	10.9	single
OAC03000	240/208 (1)	3000/2250	24.0	10.9	single
OAC04000	240/208 (1)	4000/3000	24.0	10.9	single
OAC04800	240/208 (1)	4800/3600	24.0	10.9	single
OAC06000	240/208 (1)	6000/4500	50.0	22.7	double
OAC08000	240/208 (1)	8000/6000	50.0	22.7	double
OAC12000	240/208 (1)	12000/9000	90.0	40.9	triple
OAC01507	347 (1)	1500	28.0	12.7	single
OAC02007	347 (1)	2000	28.0	12.7	single
OAC03007	347 (1)	3000	28.0	12.7	single
OAC04007	347 (1)	4000	28.0	12.7	single
OAC04807	347 (1)	4800	28.0	12.7	single
OAC06007	347 (1)	6000	50.0	22.7	double
OAC08007	347 (1)	8000	50.0	22.7	double
OAC12007	347 (1)	12000	90.0	40.9	triple
OAC01504	480 (1)	1500	28.0	12.7	single
OAC02004	480 (1)	2000	28.0	12.7	single
OAC03004	480 (1)	3000	28.0	12.7	single
OAC04004	480 (1)	4000	28.0	12.7	single
OAC04804	480 (1)	4800	28.0	12.7	single
OAC06004	480 (1)	6000	50.0	22.7	double
OAC08004	480 (1)	8000	50.0	22.7	double
OAC12004	480 (1)	12000	90.0	40.9	triple
OAC12034	480 (3)	12000	90.0	40.9	triple
OAC01506	600 (1)	1500	28.0	12.7	single
OAC02006	600 (1)	2000	28.0	12.7	single
OAC03006	600 (1)	3000	28.0	12.7	single
OAC04006	600 (1)	4000	28.0	12.7	single
OAC04806	600 (1)	4800	28.0	12.7	single
OAC06006	600 (1)	6000	50.0	22.7	double
OAC06036	600 (3)	6000	90.0	40.9	triple
OAC08006	600 (1)	8000	50.0	22.7	double
OAC09036	600 (3)	9000	90.0	40.9	triple
OAC12006	600 (1)	12000	90.0	40.9	triple
OAC12036	600 (3)	12000	90.0	40.9	triple

Options

Product #	Description	Factory Installed	Kit
OAC-BS1	Surface mounting box, single unit	-	✓
OAC-BS2	Surface mounting box, double unit	-	✓
OAC-BS3	Surface mounting box, triple unit	-	✓
OAC-DIS20	Disconnect switch, double-pole, 20A at 277V and less	✓	✓
OAC-DIS40	Disconnect switch, triple-pole, 40A at 600V max.	✓	✓
OAC-DIS80	Disconnect switch, triple-pole, 80A at 600V	✓	✓
OAC-IV	Fan switch	✓	-
OAC-O/O	On/Off switch	✓	-
OAC-R	24V relay, without transformer	✓	-
OAC-RT	24V relay, with transformer	✓	-

Add "BL" for white, "AM" for almond. Optional colors shown in the color chart section are available with a 10% upcharge. 277V available upon request.



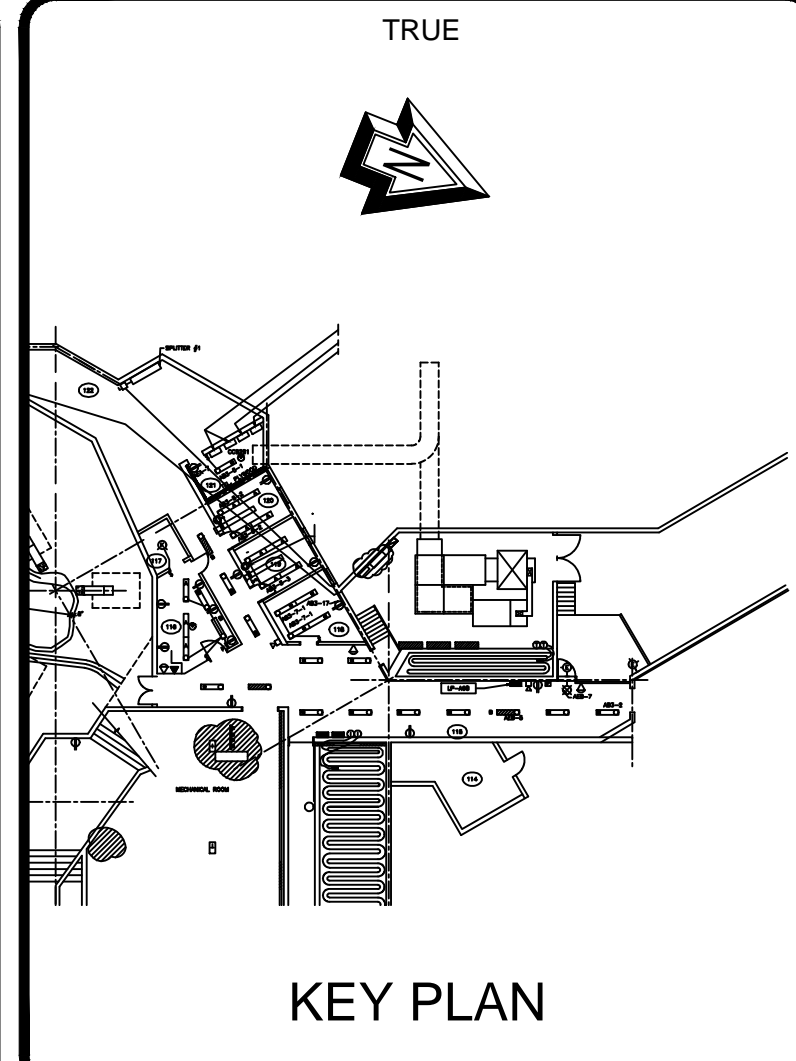
CONDUCTOR SCHEDULE

TAG	CONDUCTOR SIZE	CONDUCTOR NO.	NEUTRAL SIZE	VOLTAGE	CONDUCTOR INSULATION RATING (°C)	RACEWAY		CONDUCTOR JACKET
						METHOD	TYPE	
A1	500MCM	4C (PER PHASE +NEUTRAL)	500MCM	1.0 kV	90	4" CONDUIT	PVC	RWU90
A2	500MCM	4C (PER PHASE +NEUTRAL)	500MCM	1.0 kV	90	4" CONDUIT	PVC	RWU90
B	500MCM	4C (PER PHASE +NEUTRAL)	500MCM	1.0 kV	90	4" CONDUIT	EMT	RWU90
C	2/0 AWG	4C+BND	2/0	1.0 kV	90	2" CONDUIT	EMT	RWU90
D	#6 AWG	4C+BND	#6 AWG	1.0 kV	90	2 1/2" CONDUIT	PVC/UA	RWU90
E	350MCM	4C+BND	350MCM	1.0 kV	90	3" CONDUIT	EMT	RWU90
F	BUS CABLE (RS485)	TBD	N/A			3" CONDUIT	PVC/UA	TBD
G	POWER SUPPLY	TBD	TBD			1/2" CONDUIT	EMT	RWU90
H	#12 AWG	2C+BND	#12 AWG	1.0 kV	90	1/2" CONDUIT	EMT	RWU90
I	#10 AWG	4C+BND	#10 AWG	1.0 kV	90	1/2" CONDUIT	EMT	RWU90
J	#2/0 AWG	4C+BND	#2/0 AWG	1.0 kV	90	1" CONDUIT	EMT	RWU90
K	#6 AWG	4C+BND	#6 AWG	1.0 kV	90	3/4" CONDUIT	EMT	RWU90

LEGEND	
	CIRCUIT BREAKER
	FUSE
	GENERATOR
	TRANSFORMER
	AUTOMATIC TRANSFER SWITCH
	FULL-VOLTAGE NON-REVERSING MOTOR STARTER (FVNR)
	EXISTING EQUIPMENT TO BE REMOVED

INSTALLATION NOTES:

- EXISTING EQUIPMENT TO BE REMOVED PRIOR TO INSTALLATION OF NEW EQUIPMENT. BRANCH CIRCUIT CONDUCTORS TO BE RETAINED IF IN GOOD CONDITION.
- BOTH A1 AND A2 REFER TO ONE CONDUCTOR RUN; RACEWAY WILL TRANSITION FROM ONE TYPE TO ANOTHER ALONG CONDUCTOR ROUTE.
- NEW CIRCUIT BREAKER SHALL BE INSTALLED IN EXISTING SPARE 1600A COMPARTMENT FEEDER OF MAIN DISTRIBUTION PANEL (TO BE SUPPLIED ALONG WITH RETROFIT KIT).
- AUTOMATIC TRANSFER SWITCH AND DISTRIBUTION PANEL MIGHT BE IN A SINGLE ENCLOSURE.
- EXISTING MCC FEEDER TO BE INSPECTED FOR REUSE.
- SIZE AND SETTINGS FOR CIRCUIT BREAKER TO BE AS PER GENERATOR DAMAGE CURVE AND SHALL MEET COORDINATION STUDY RESULT.
- THE NEW DISTRIBUTION PANEL SHALL BE INSTALLED ON SAME LOCATION AS EXISTING PANEL. IF LENGTH ALLOWS, EXISTING CONDUCTORS SHALL BE RE-USED. INSTALLATION CONTRACTOR SHALL LAY NEW CABLE FOR FOLLOWING LOADS IF THERE IS INSUFFICIENT RUN OF CONDUCTOR TO BE CONNECTED TO NEW DISTRIBUTION PANEL:
- FIRE ALARM PANEL CABLE
- AE-C PANEL
- AE-E PANEL
- AE-B PANEL
- SPLITTER #2
- SPLITTER #3
- CONDUCTOR SIZE FOR THREE FEEDERS FOR LIFE SAFETY SYSTEM WILL BE FINALIZED UPON DETERMINING LOCATION AND SIZE OF LOADS.
- ANNUNCIATOR SHALL BE WALL MOUNTED AND INSTALLED IN ELECTRICAL ROOM CLOSE TO ATS.
- VFDS FOR FANS WILL REMAIN IN EXISTING LOCATION AND NEW MCC WILL ACCOMMODATE FEEDERS FOR THREE VFD-OPERATED FANS.
- EXISTING FEEDER CONDUCTORS SHALL BE RETAINED.
- NEW CABLES SHALL BE INSTALLED FOR EXISTING LOADS.



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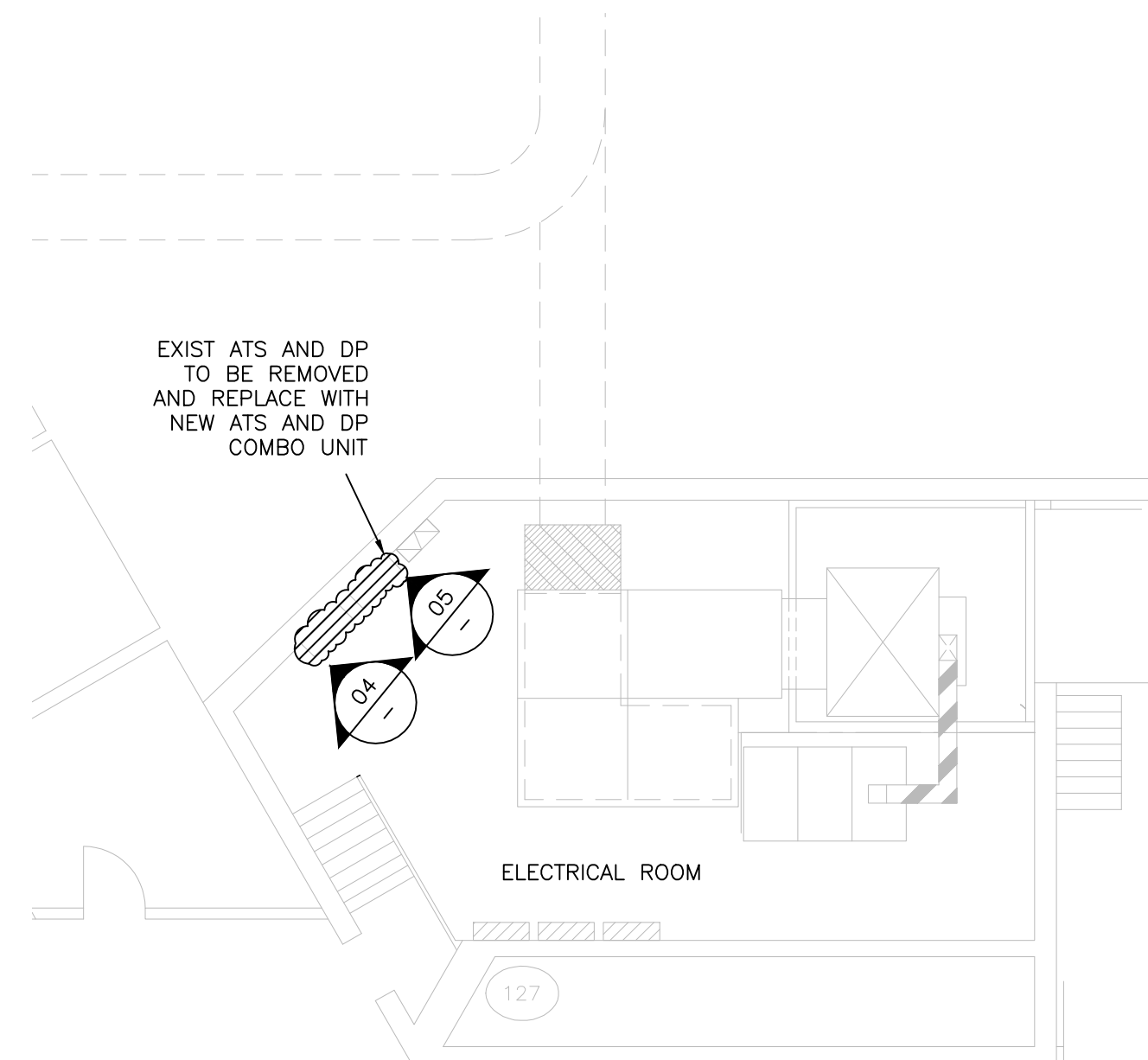
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PROJECT: **GENERATOR REPLACEMENT AFRICAN RAINFOREST PAVILION**

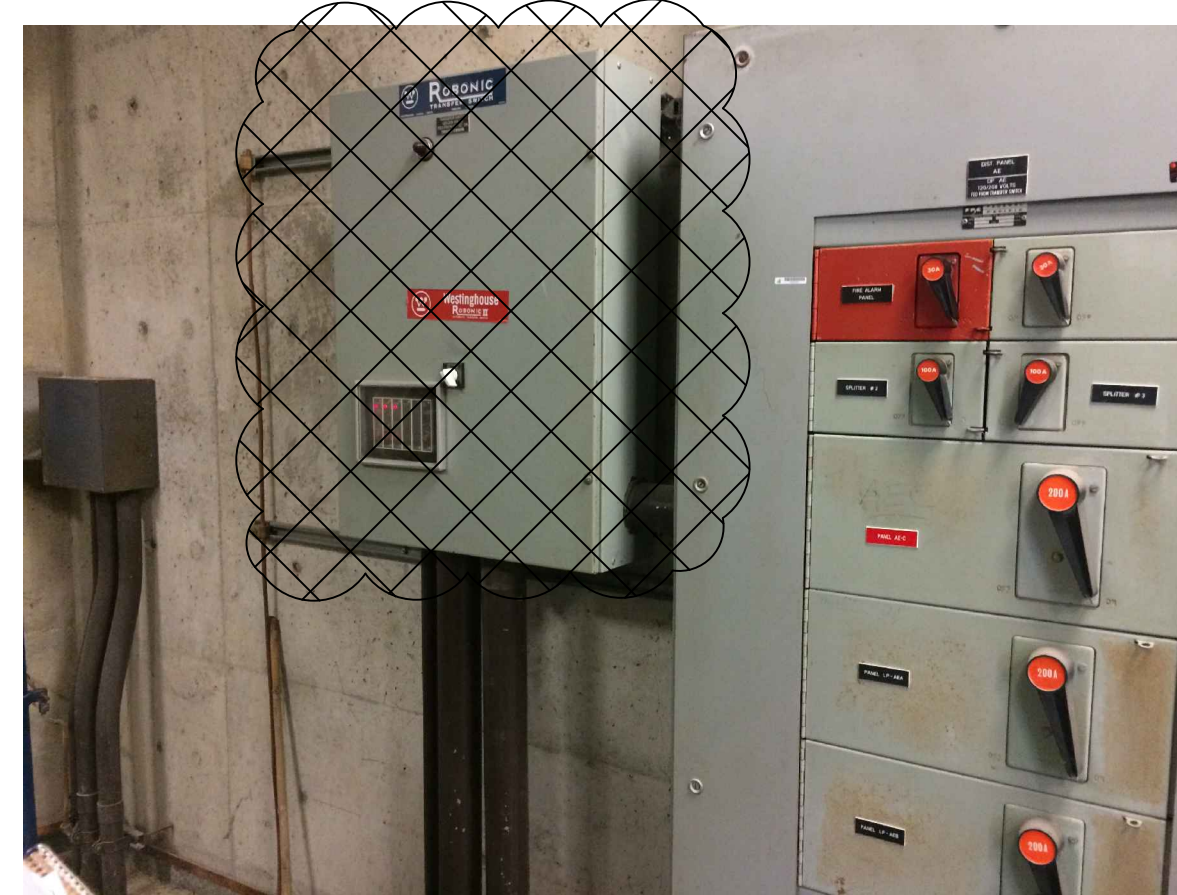
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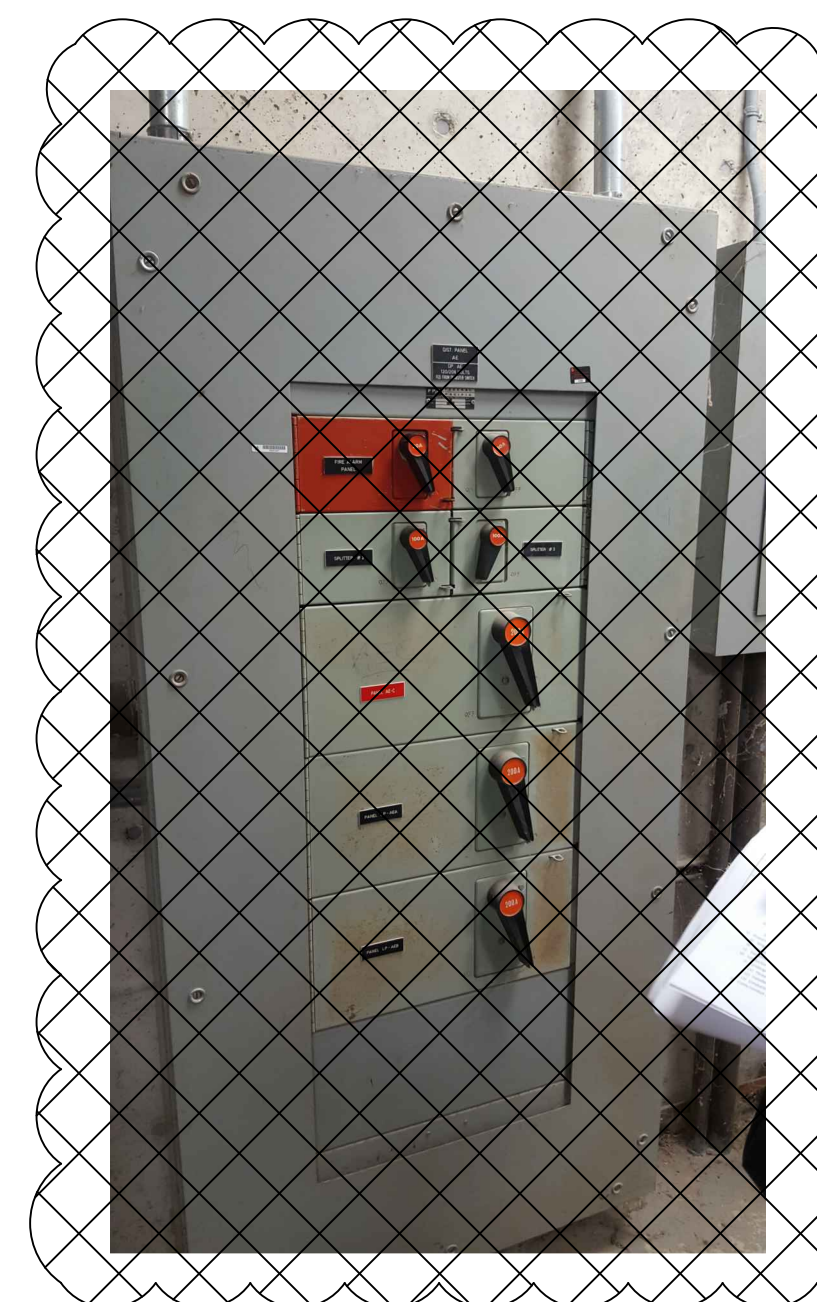
E-01



01 ELECTRICAL ROOM DEMOLITION
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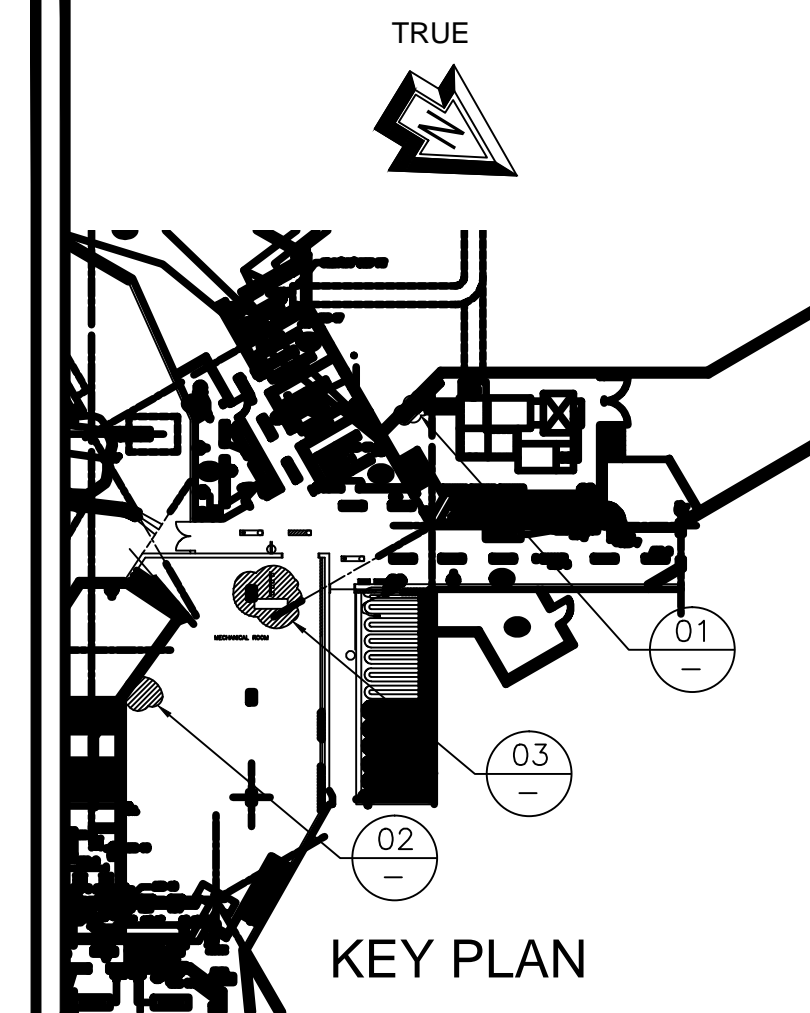
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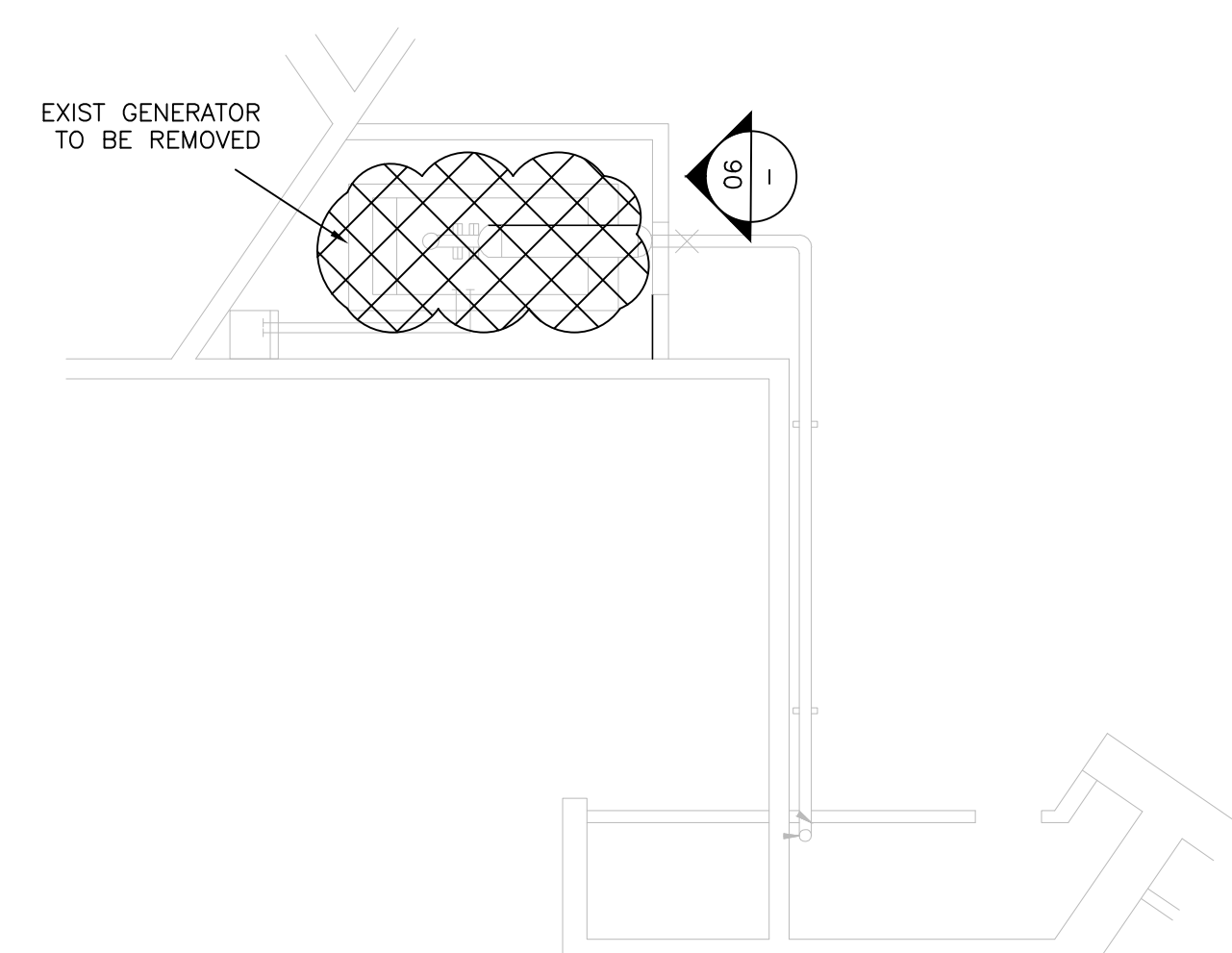
05 PHOTO
SCALE: N.T.S.

GENERAL DEMOLITION NOTES

1. THIS FACILITY IS TO REMAIN IN WHERE POSSIBLE OPERATION FOR THE DURATION OF THE WORK. DEMOLITION WORK SHALL NOT INTERFERE WITH OPERATIONS AND IS TO BE SCHEDULED WITH THE FACILITY OPERATOR.
2. ALL WORK TO COMPLY WITH THE OWNER'S SAFETY PLANS AND SAFETY PROGRAM.
3. ALL WORK TO COMPLY WITH CONTRACTOR'S SAFETY PLANS AND SAFETY PROGRAM.
4. SEPARATE ALL MATERIALS ON SITE AS PER APPLICABLE ONTARIO REGULATIONS.
5. PROTECT ALL STRUCTURAL MEMBERS TO REMAIN. SHORE AND BRACE AS REQUIRED.
6. THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH ARCHITECTURAL, STRUCTURAL, MECHANICAL, ELECTRICAL, DEMOLITION AND CONSTRUCTION DRAWINGS.
7. DIMENSIONS GIVEN ON THESE DRAWING ARE APPROXIMATIONS ONLY. CONTRACTOR TO VERIFY ALL DIMENSIONS ON SITE.
8. ALLOW FOR TEMPORARY ELECTRICAL, MECHANICAL AND INSTRUMENTATION CONNECTIONS TO BE INSTALLED PRIOR TO DEMOLITION WHERE NECESSARY.
9. PROVIDE DUST CONTROL SYSTEM DURING DEMOLITION AND TO ALL WORK THAT MAY POTENTIALLY PRODUCE DUST.
10. PROTECT ALL EXISTING EQUIPMENT FROM DUST DEBRIS AND DAMAGE DURING DEMOLITION.
11. PROVIDE FIRE WATCH FOR DURATION OF PERIODS WHEN FIRE ALARM SYSTEMS ARE NOT OPERATIONAL DUE TO CONTRACTED WORK.
12. PROTECT ALL EXISTING DETECTION EQUIPMENT THAT MAY BE AFFECTED BY DEMOLITION WORK.
13. PROVIDE TEMPORARY GUARDRAILS IN COMPLIANCE WITH ONTARIO OH&S ACT & REGULATION IN ALL LOCATIONS WHERE A WALL OR BARRIER IS REMOVED, THEREBY CRATING A FALL HAZARD.



KEY PLAN



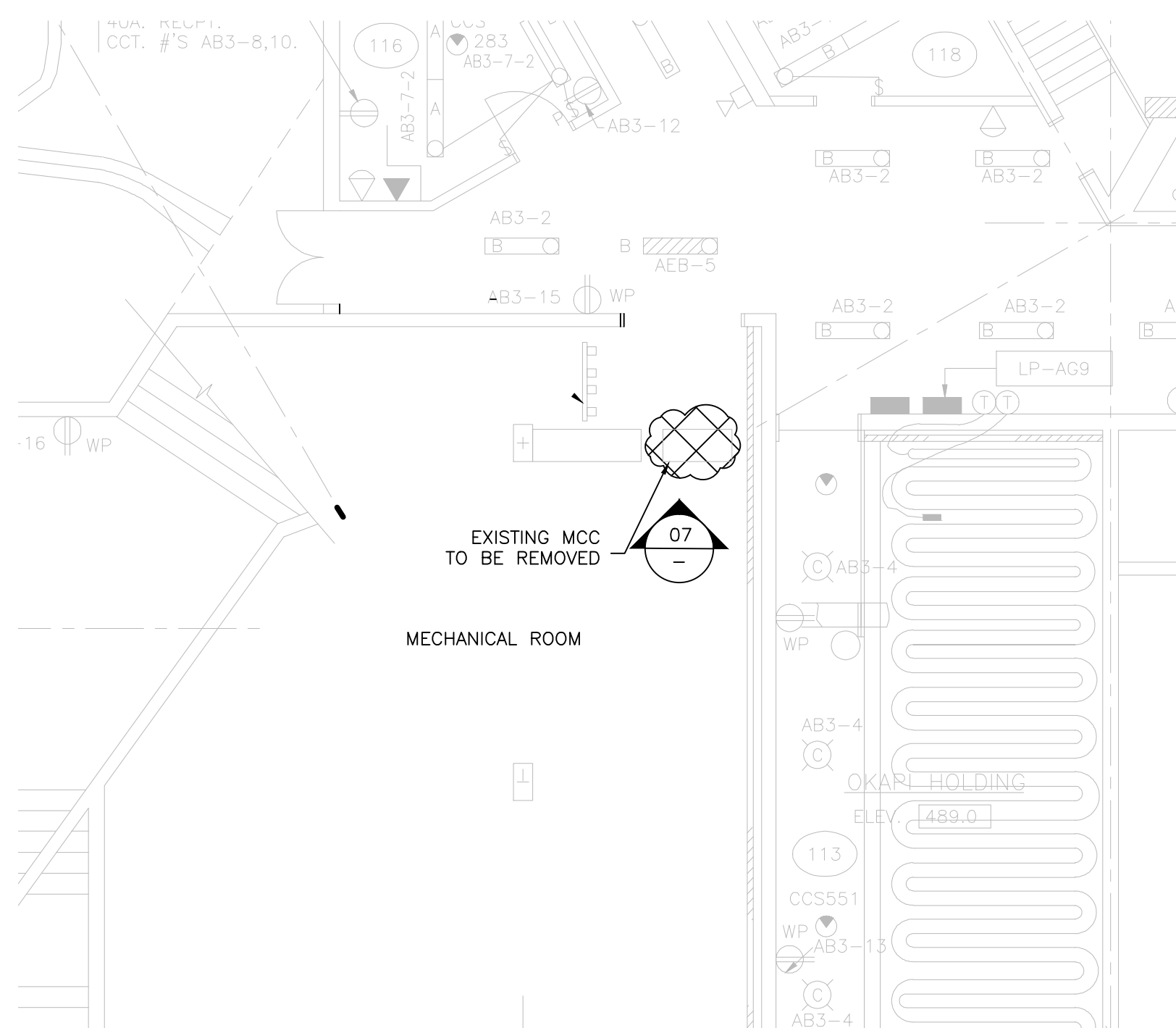
02 GENERATOR ROOM DEMOLITION
SCALE: N.T.S.



06 PHOTO
SCALE: N.T.S.



07 PHOTO
SCALE: N.T.S.



03 MECHANICAL ROOM DEMOLITION
SCALE: N.T.S.

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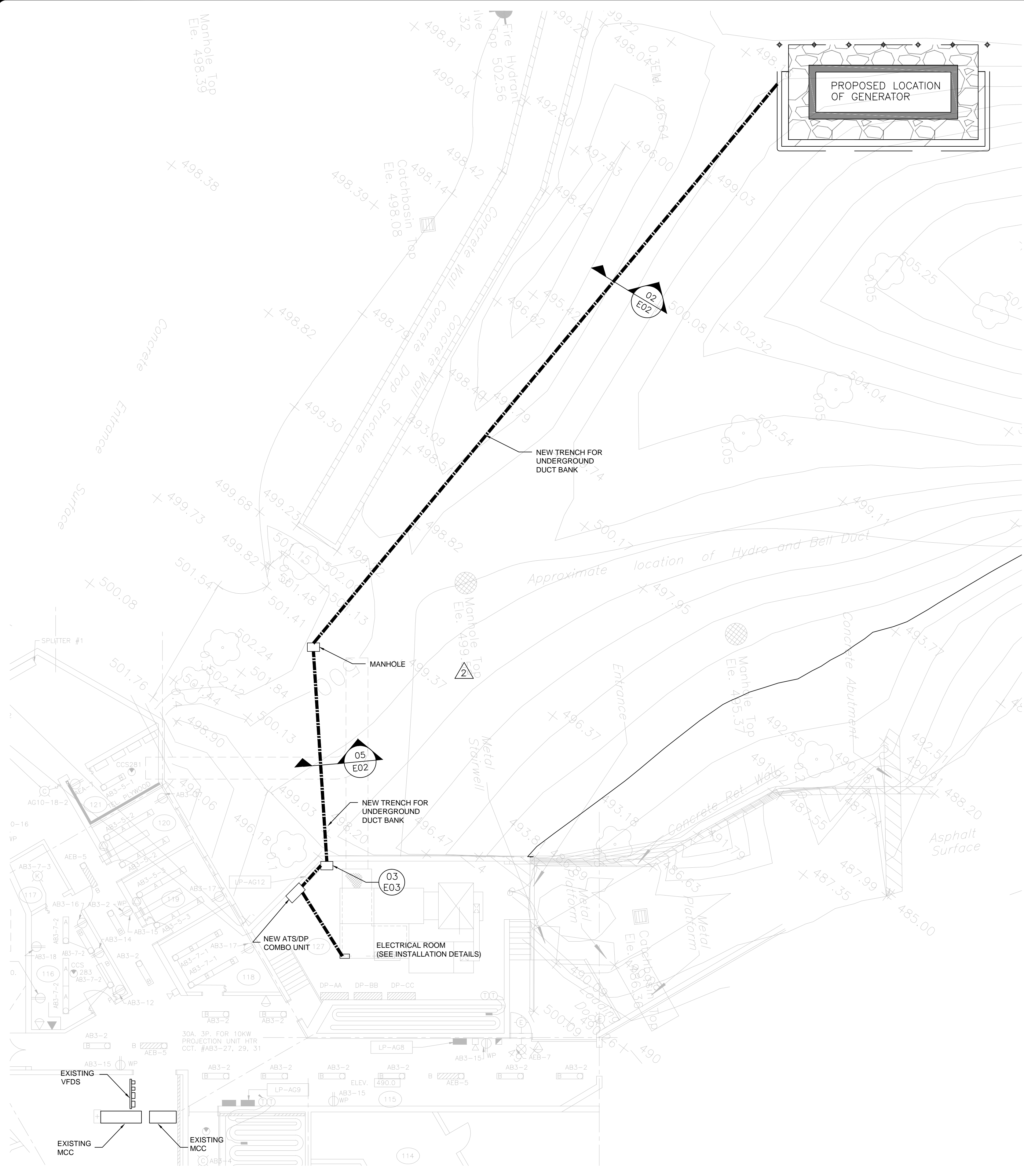
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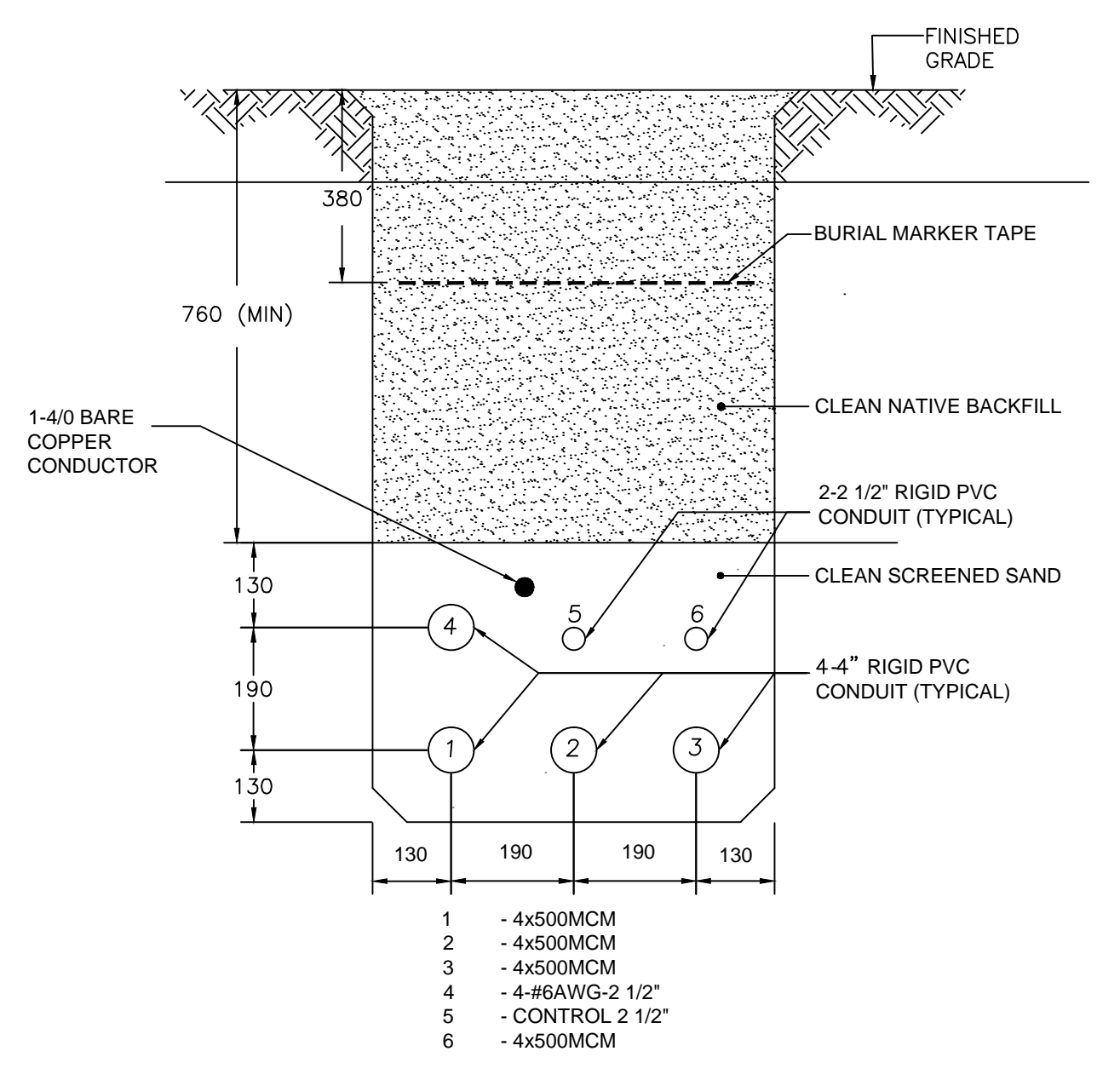
PROJECT:
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DRAWING:
DEMOLITION PLAN

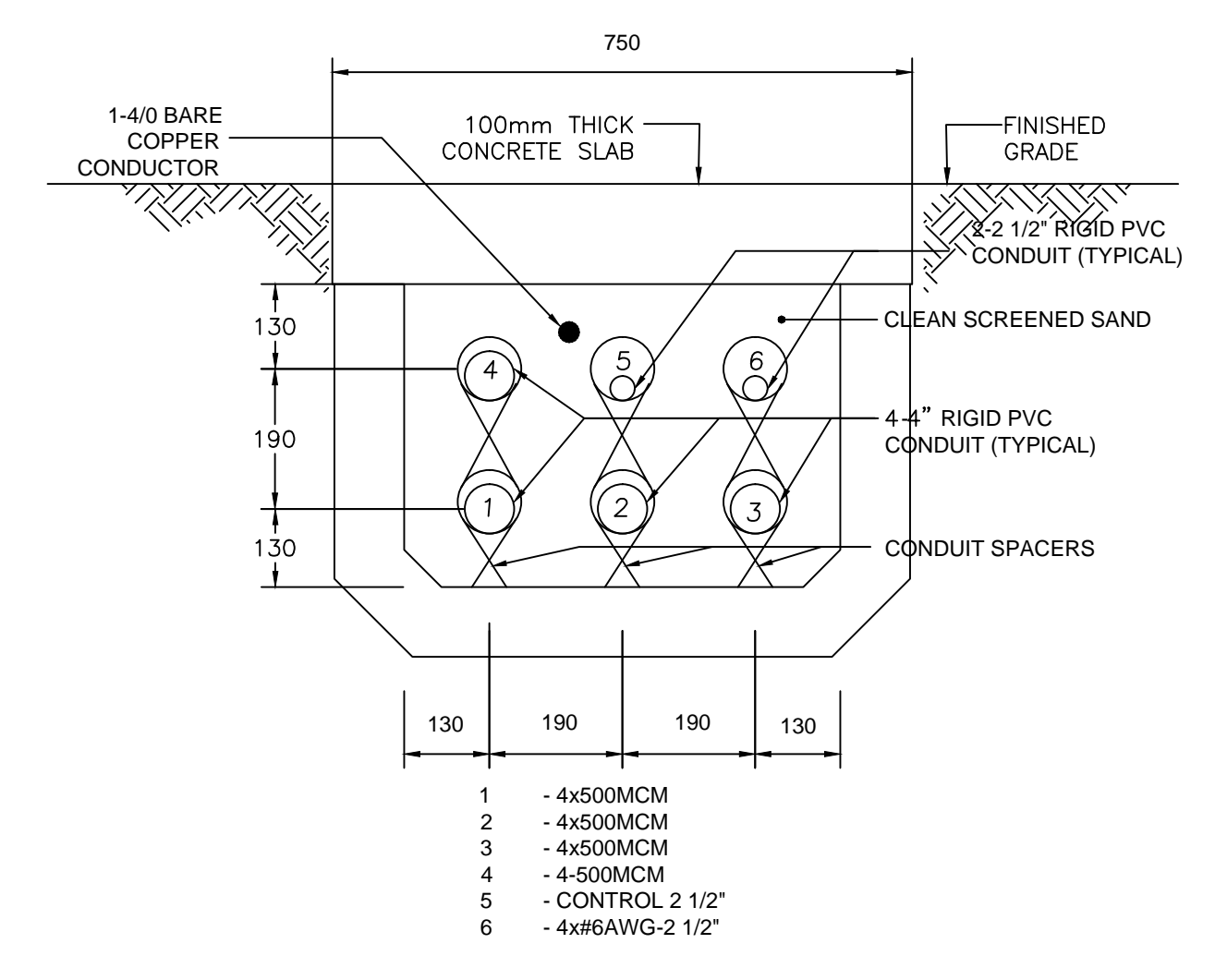
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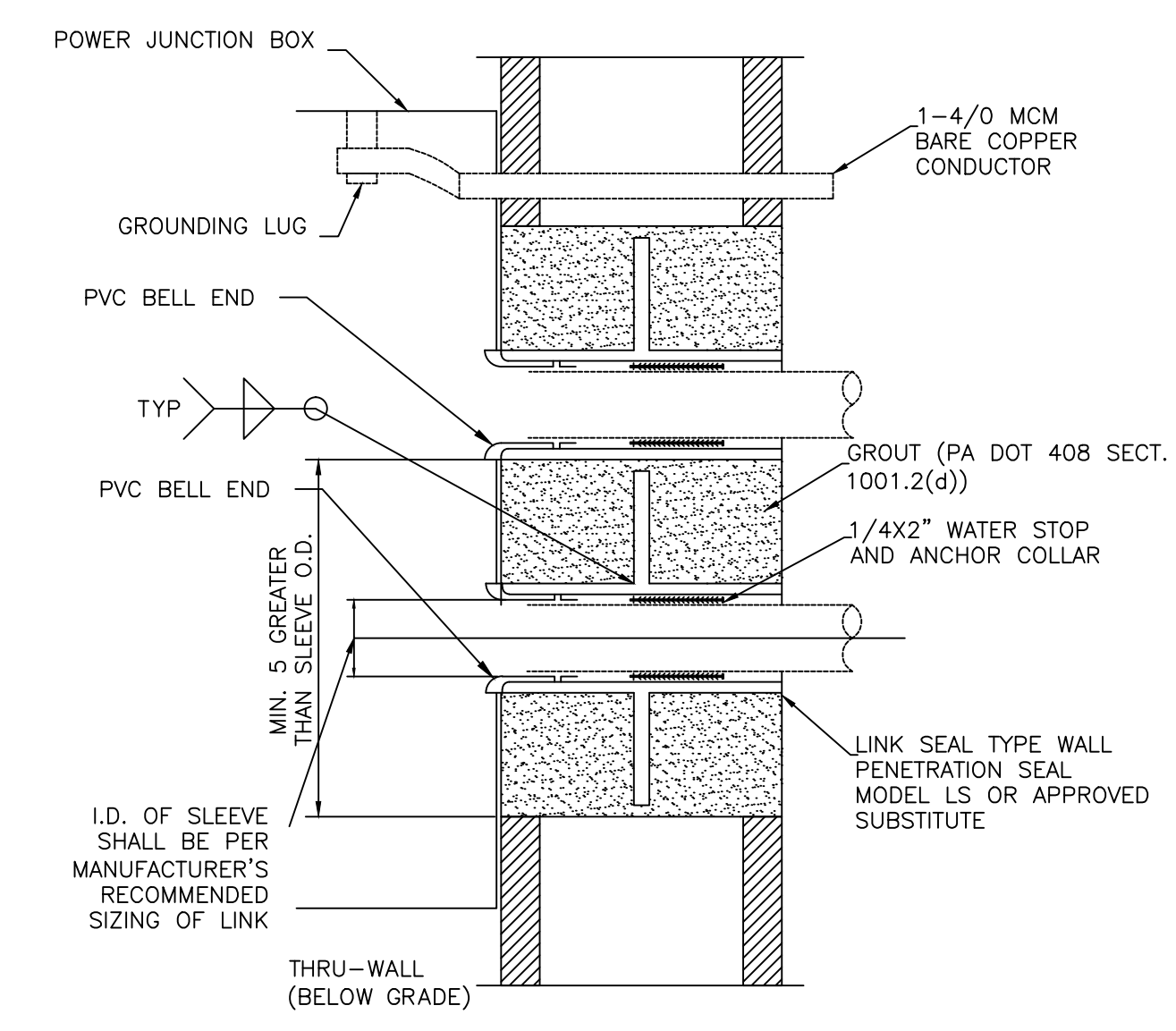
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02 UNDERGROUND CONDUIT
E03 SCALE: N.T.S

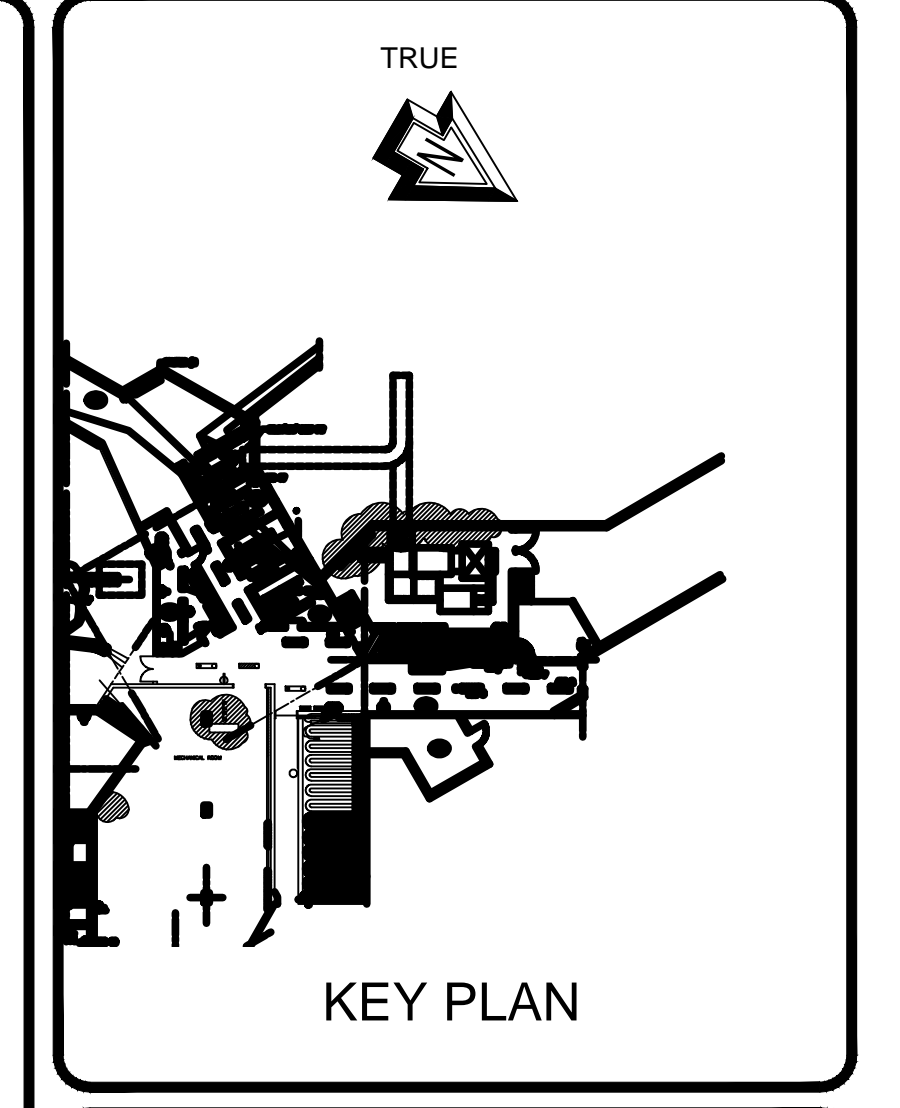


05 UNDERGROUND CONDUIT IN CONCRETE TRENCH
E03 SCALE: N.T.S



03 CONDUIT PENETRATION DETAIL
E03 SCALE: N.T.S

- NOTES**
- CONDUITS SHALL BE WALL-MOUNTED USING GALVANIZED STEEL 2-HOLE STRAPS:
 - 4x500MCM IN 4" EMT
 - 4x500MCM IN 4" EMT
 - 4x500MCM IN 4" EMT
 - 4x500MCM IN 4" EMT
 - 4x#6AWG IN 2 1/2" EMT
 - CONTROL IN 2 1/2" EMT
 - CONDUITS SHALL BE CEILING-SUSPENDED USING GALVANIZED STEEL HANGERS AND THREADED ROD:
 - 4x500MCM IN 4" EMT
 - 4x500MCM IN 4" EMT
 - 4x500MCM IN 4" EMT
 - 4x500MCM IN 4" EMT



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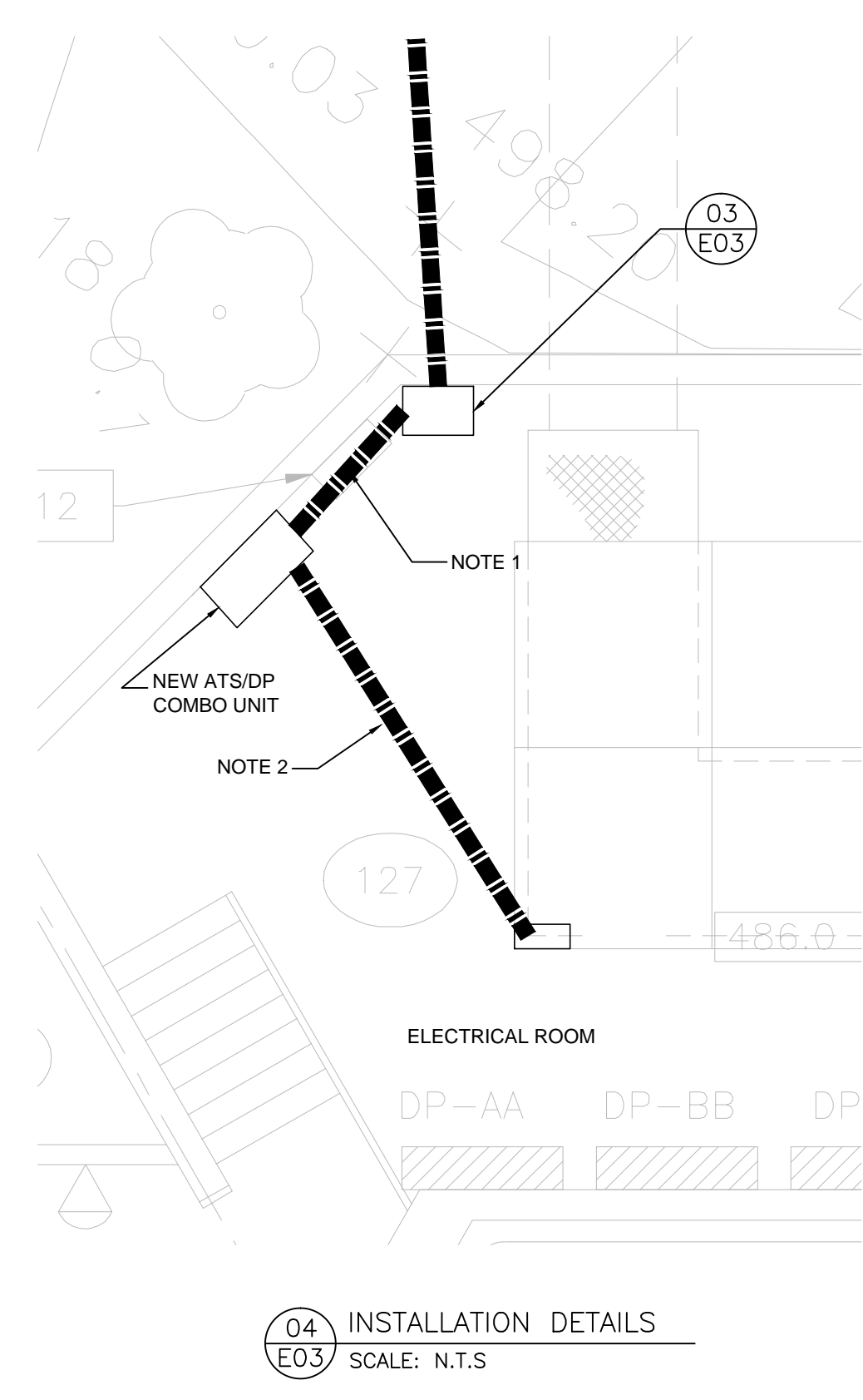
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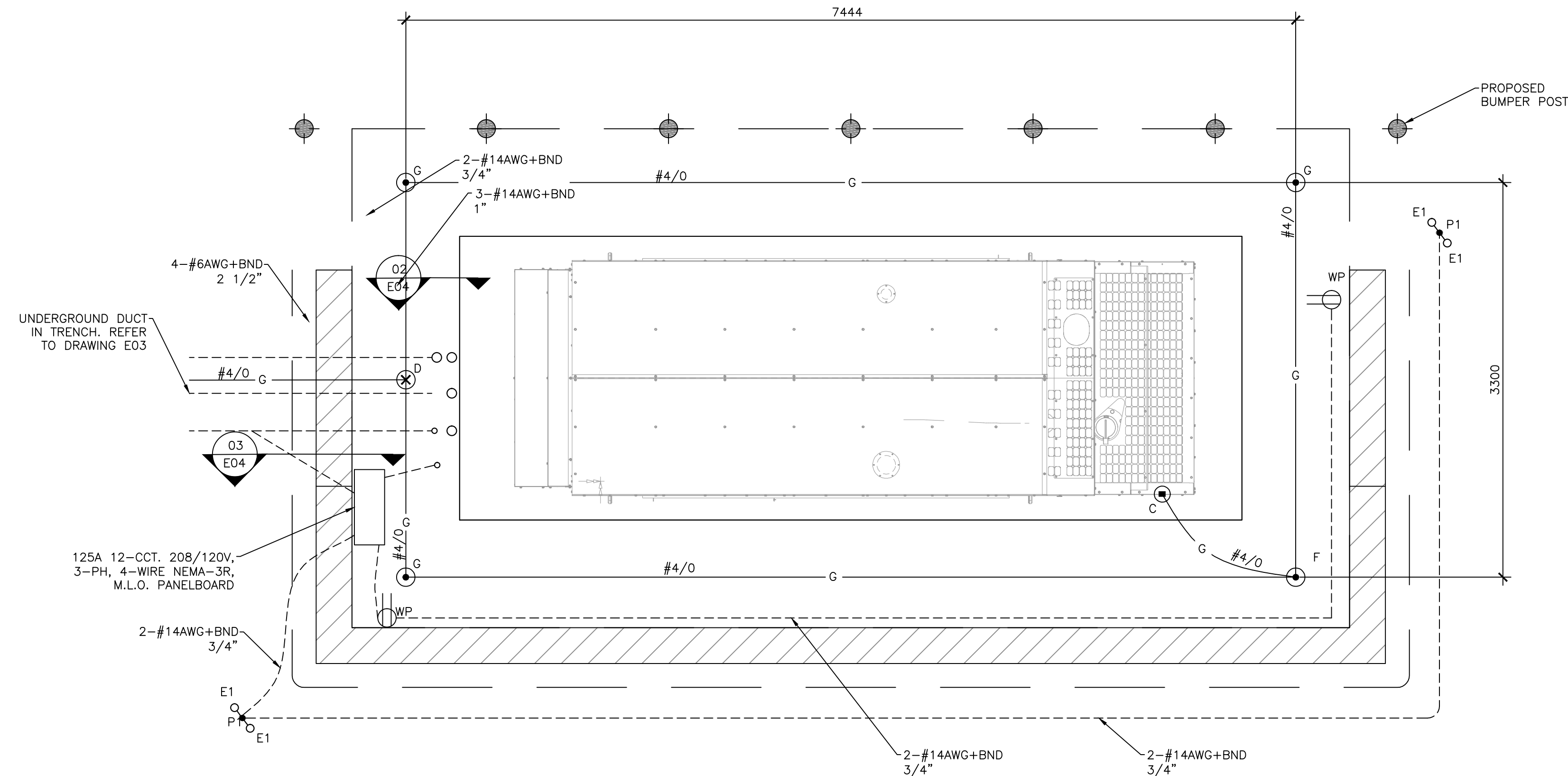
PROJECT:
**GENERATOR REPLACEMENT
AFRICAN RAINFOREST PAVILION**

DRAWING:
ELECTRICAL LAYOUT

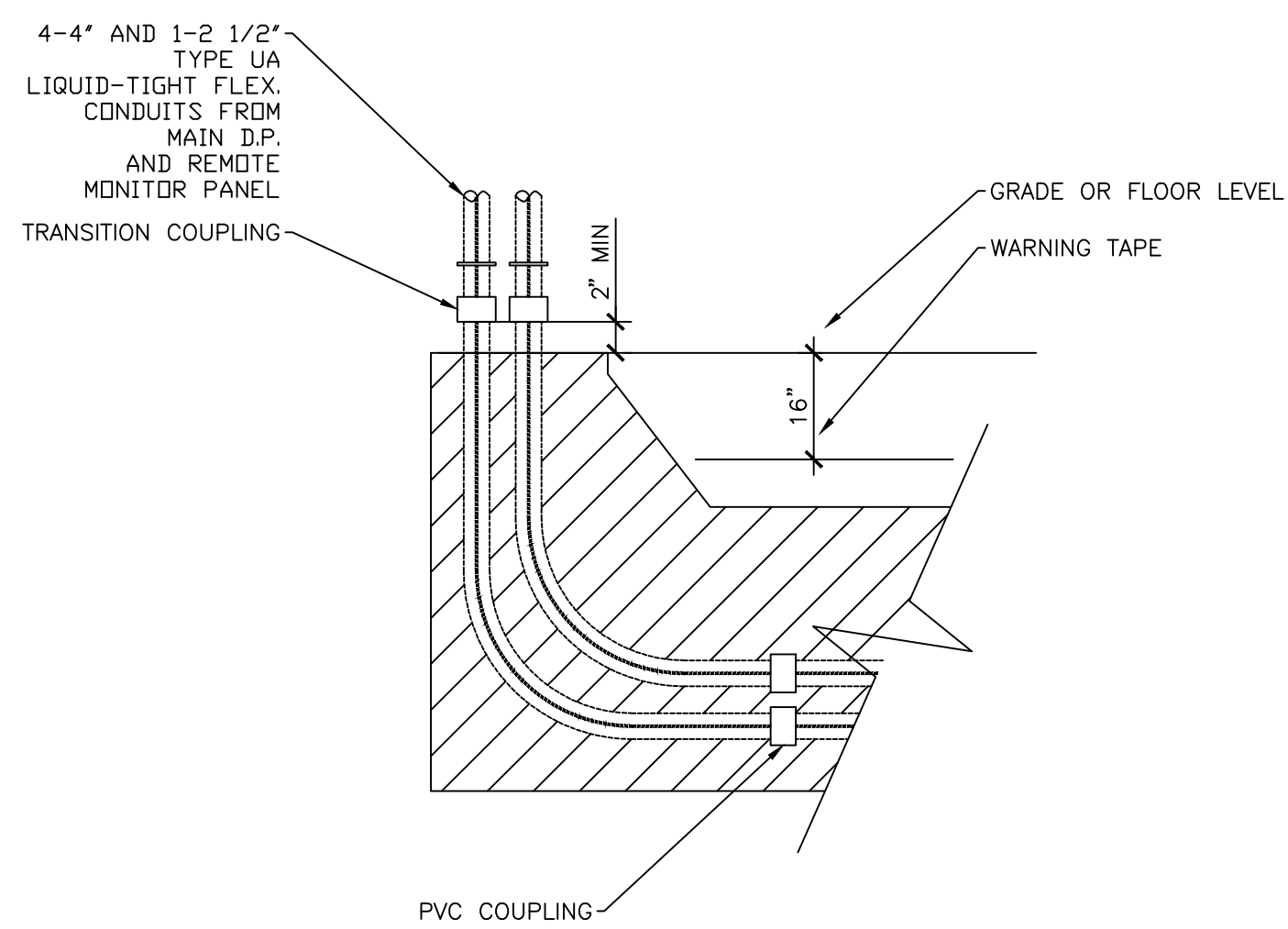
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DRAWN BY: KL **E03**
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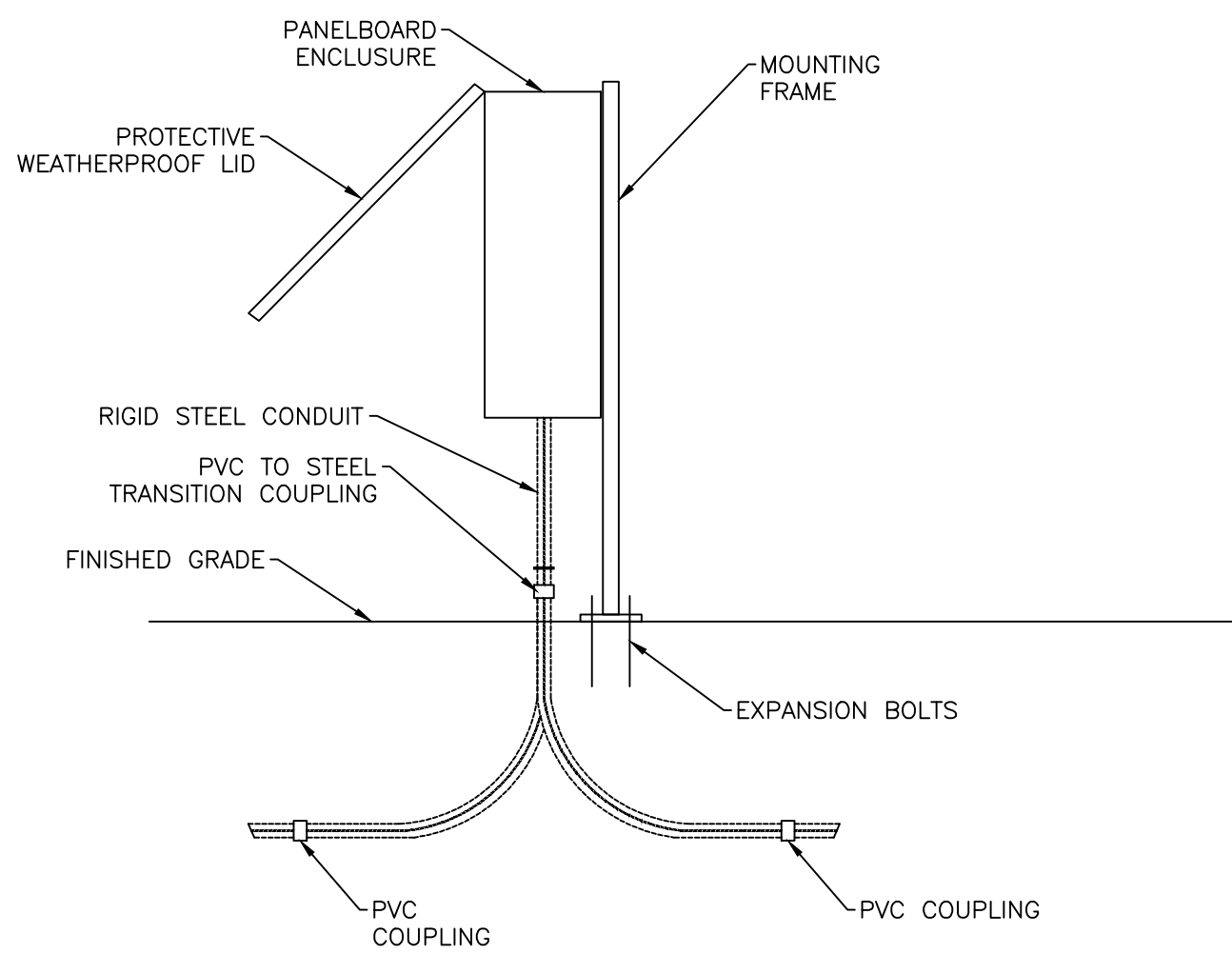
04 INSTALLATION DETAILS
E03 SCALE: N.T.S



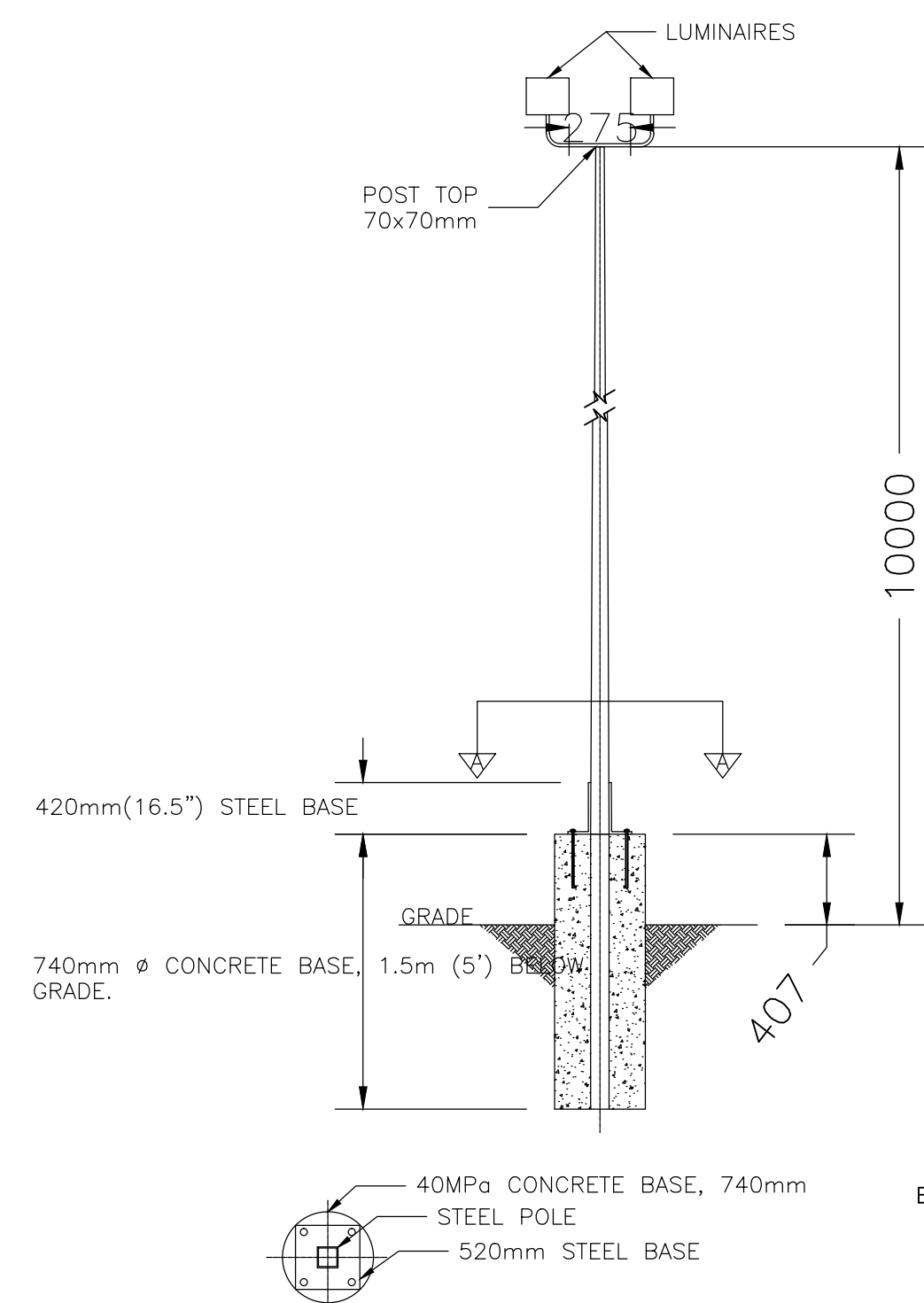
01 POWER, LIGHTING AND GROUNDING PLAN
E04 SCALE: N.T.S.



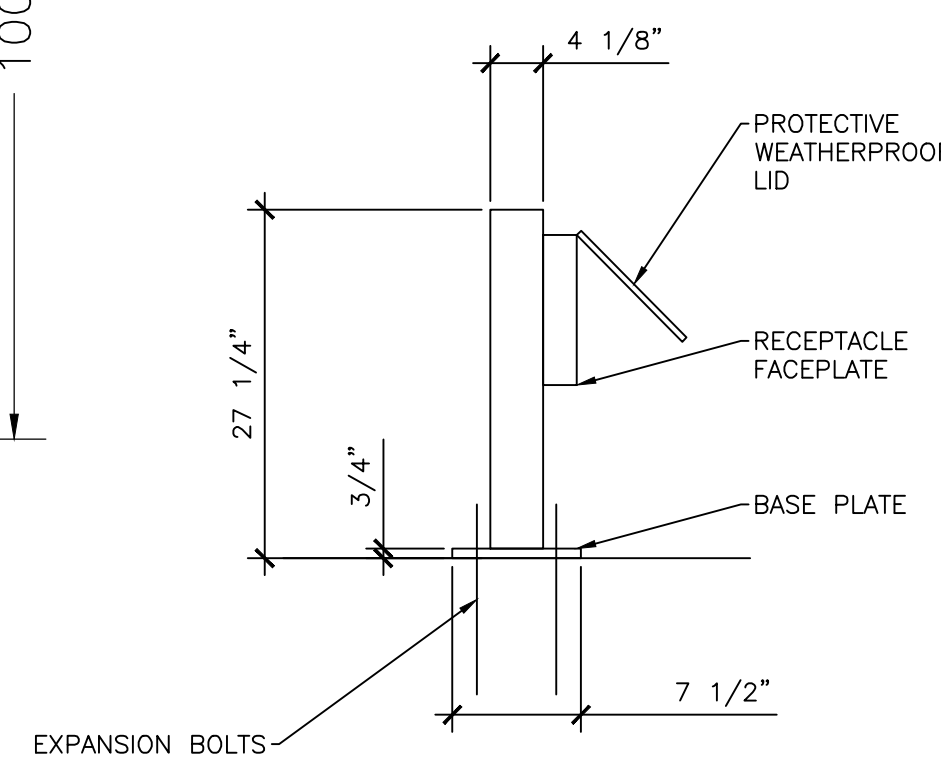
02 DUCT BANK STUB-UP DETAIL
E04 SCALE: N.T.S.



03 GENSET AREA PANELBOARD MOUNTING AND STUB-UP DETAIL
E04 SCALE: N.T.S.



04 OUTDOOR LIGHTING P1 (ELEVATION)
E04 SCALE: N.T.S.

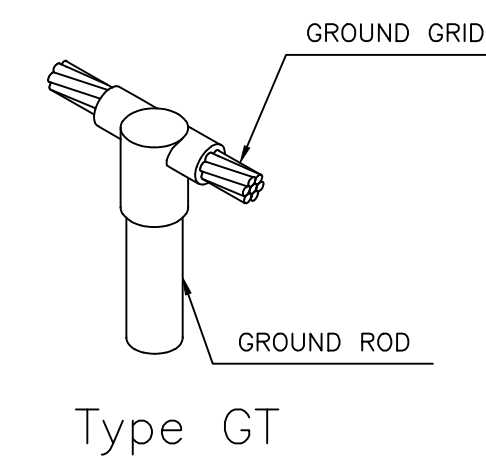


05 DUPLEX RECEPT. PEDESTAL DETAIL
E04 SCALE: N.T.S.

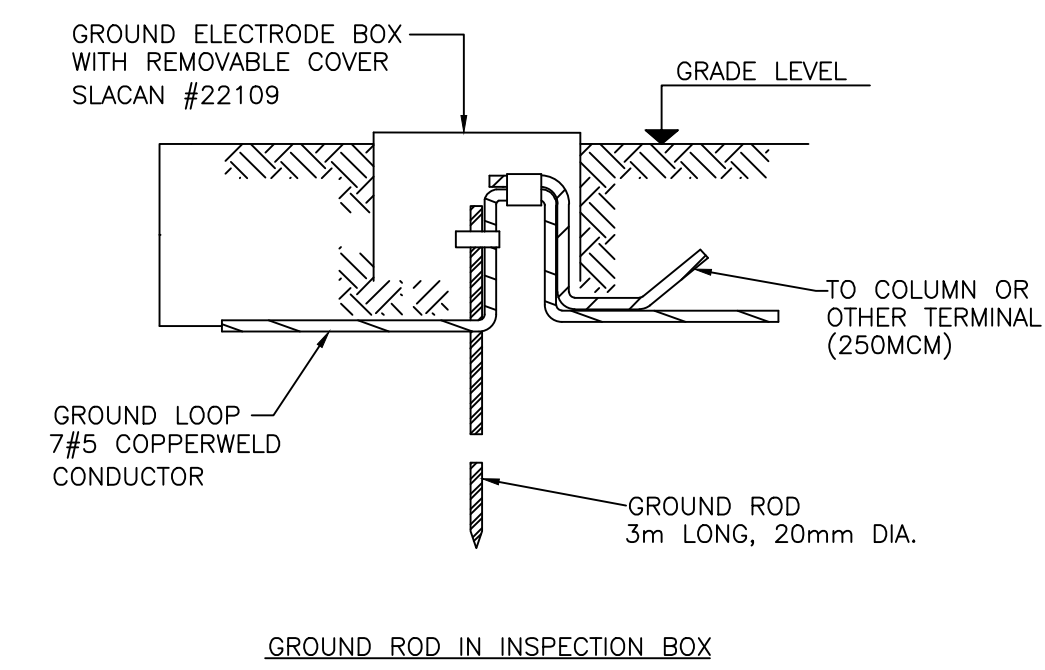
LEGEND

—	BURIED	COPPER GROUND CONDUCTOR, SIZE AS SPECIFIED ON LAYOUT DRAWING (250MCM)
- - -	EXPOSED	
⊙ C	GROUND LUGS - DETAIL C	
⊙ F	INSPECTION BOX - DETAIL F	
⊙ G	GROUND ROD CONNECTION - TYPE GT	
⊙ D	THERMOWELD CONNECTION - TYPE TA	
⊙ P1	PROPOSED POLE AND LIGHTING (SEE DETAIL 05)	
⊙ WP	WEATHERPROOF DUPLEX RECEPT. (SEE DETAIL 04)	

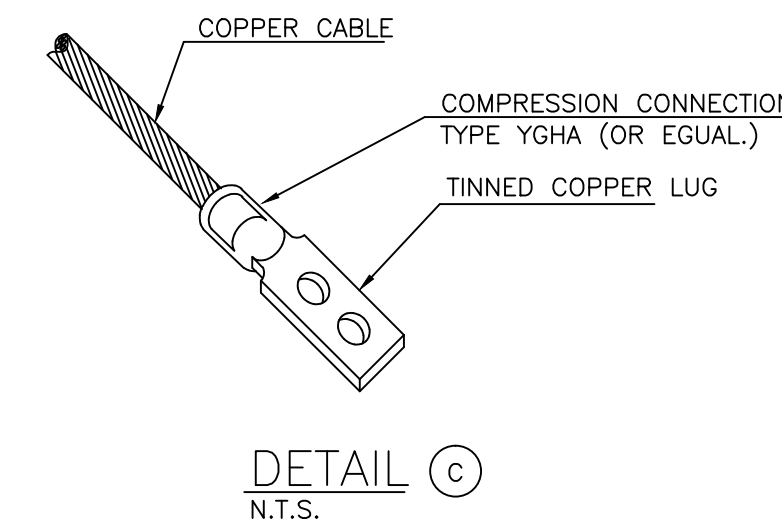
TOTAL GROUNDING RODS: 3
CONDUCTOR SIZE & LENGTH: 250MCM, 22 m (APPROX.)



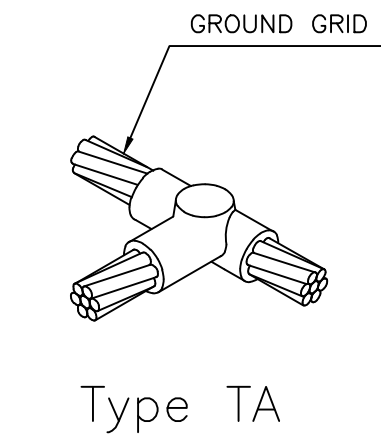
Type GT



DETAIL F
N.T.S.



DETAIL C
N.T.S.

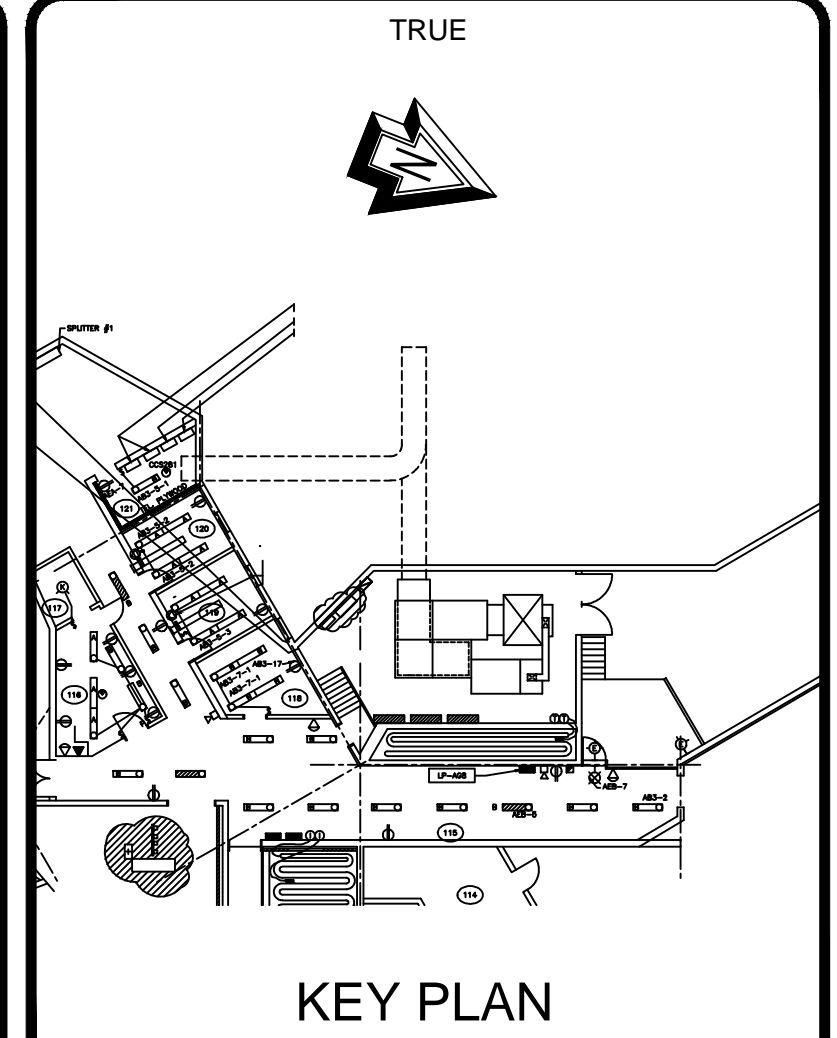


Type TA

06 GROUNDING DETAILS
E04 SCALE: N.T.S.

PANEL TAG NAME: TBD		208/120V, 3Ø, 4-WIRE + GND		FED FROM: ELECT. RM DP.				
		MAINS: 100A, Cu		MOUNTING: SURFACE MOUNTED				
		MAIN LUGS ONLY		LOCATION: GENSET PAD				
DEM. FCTR.	LOAD-kw	CIRCUIT DESCRIPTION	PROT.	CIRCUITS	PROT.	CIRCUIT DESCRIPTION	LOAD-kw	DEM. FCTR.
		GENSET SHORE PWR.	2P	1 A 2 1P		NOT USED		
			40A	3 B 4 1P		NOT USED		
		OUTDOOR RECEPT.	1P 15A	5 C 6 1P 15A		OUTDOOR LIGHTING		
		NOT USED	1P	7 A 8 1P		NOT USED		
		NOT USED	1P	9 B 10 1P		NOT USED		
		NOT USED	1P	11 C 12 1P		NOT USED		

07 GENSET AREA PANELBOARD SCHEDULE
E04 SCALE: N.T.S.



KEY PLAN

NO	DATE	ISSUED FOR	APPROVED BY
3	23 FEB 2017	ISSUED FOR PERMIT	RAW
2	01 FEB 2017	ISSUED FOR REVIEW	RAW
1	01 DEC 2016	ISSUED FOR 100% REVIEW	RAW
0	8 NOV 2016	ISSUED FOR 70% REVIEW	KL

REVISIONS

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3760 14TH AVENUE, SUITE 302 MARKHAM, ONTARIO L3R 3T7 TEL: (905) 707-0704 1-(866) 337-9333 FAX: (905) 475-1605

PROJECT: GENERATOR REPLACEMENT AFRICAN RAINFOREST PAVILION

DRAWING: POWER, LIGHTING, AND GROUNDING PLAN

DATE: 8 NOV 2016 PROJECT NO: 51502
SCALE: NTS DRAWING NO:
DRAWN BY: KL E-04
CHECKED BY: RAW

GENERAL NOTES

- ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED. IF REQUIRED THE CONTRACTOR SHALL FIELD VERIFY ALL DIMENSIONS BEFORE CONSTRUCTION AND REPORT DISCREPANCIES BEFORE PROCEEDING WITH THE WORK.
- DESIGN BASED ON INFORMATION PROVIDED. IF IT IS DISCOVERED THAT INFORMATION WAS INCORRECT THE ENGINEER MUST BE INFORMED.
- CONCRETE PAD TOP SURFACE ELEVATION MAY VARY BETWEEN 25mm MINIMUM TO 152mm MAXIMUM ABOVE GRADE.
- IT IS CONTRACTOR'S RESPONSIBILITY TO LOCATE ALL EXISTING SERVICES.
- PROVIDE PROTECTION TO PREVENT SILT AND DEBRIS FROM ENTERING STORM SEWER SYSTEM IN CONSTRUCTION AREA.
- THE CONTRACTOR SHALL RECTIFY ALL DISTURBED AREAS TO THE ORIGINAL CONDITIONS OR BETTER AND TO THE SATISFACTION OF THE TORONTO ZOO.

SITE CONDITIONS & PREPARATION

- SOIL IS FREE OF TOXIC AND HAZARDOUS MATERIALS.
- SITE AREA IS FREE OF CORROSIVE ENVIRONMENT.
- CONCRETE PAD SHALL NOT BE INSTALLED OVER UNDERGROUND PIPING, SEWER, DRAINS OR ELECTRICAL POWER LINES.
- THE SUBGRADE BENEATH THE SLAB SHALL BE COMPACTED TO 95% MAXIMUM DRY DENSITY PER ASTM D698 AND EXTEND AT LEAST 0.9m BEYOND PAD PERIPHERIES.
- FOUNDATION DESIGN IS BASED ON AN ALLOWABLE SOIL BEARING PRESSURE OF 2000PSF
- FOR SOIL CONDITIONS HAVING BEARING PRESSURES OF LESS THAN 2000PSF CONSULT WITH THE ENGINEER.
- SOIL TESTING (WHEN REQUIRED) SHALL BE CONDUCTED WITH A CIRCUMFERENCE OF 7.62m OF WHERE THE FOUNDATION IS TO BE POURED.
- STYROFOAM INSULATION REQUIRED.
- "IN GROUND" DEPTH OF ALL FOUNDATION SHALL BE 152mm MINIMUM BELOW GRADE.
- UNPAINTED EQUIPMENT AND STRUCTURAL STEEL WORK SHALL BE PAINTED WITH INORGANIC ZINC PRIMER FINISH

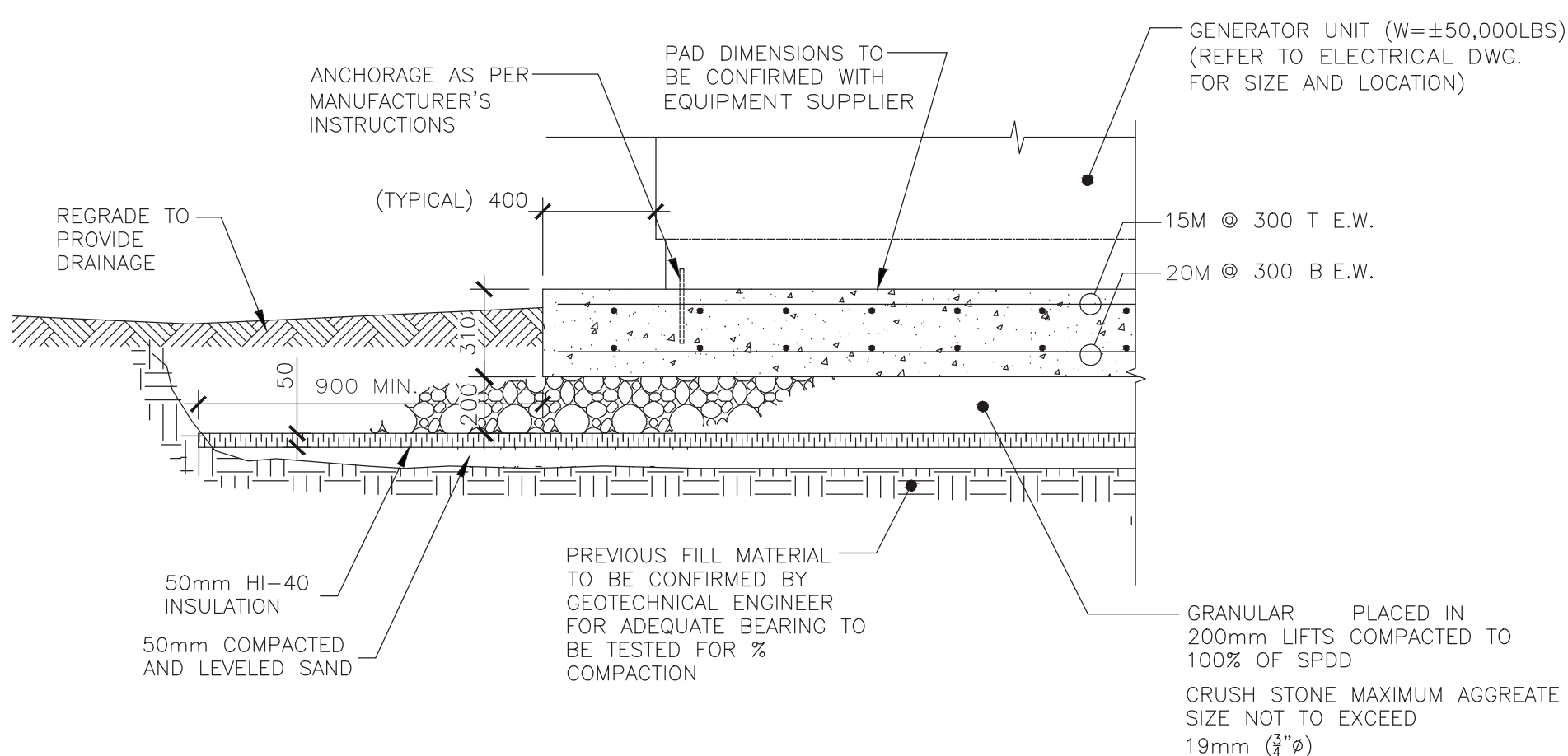
CONCRETE SPECIFICATIONS & REQUIREMENTS

- CONCRETE WORK SHALL BE IN ACCORDANCE WITH THE REQUIREMENTS OF CAN/CSA-A23.1, "CONCRETE MATERIALS AND METHODS OF CONCRETE CONSTRUCTION" AND CAN/CSA-A23.3, "DESIGN OF CONCRETE STRUCTURES FOR BUILDINGS"
- CONCRETE SHALL HAVE A MINIMUM CYLINDER TEST STRENGTH AT 28 DAYS OF 32 MPa. SHALL HAVE A MAXIMUM AGGREGATE SIZE OF 20mm AND SHALL CONTAIN WATER-REDUCING AND AIR-ENTRAINING AGENTS WITH 5-8% AIR.
- REINFORCING STEEL SHALL BE GRADE 400 IN ACCORDANCE WITH CSA G30.18. WELDED WIRE FABRIC SHALL BE IN ACCORDANCE WITH ASTM A185 OR ASTM A497.
- WELDED WIRE FABRIC SHALL BE IN ACCORDANCE WITH ASTM A185 OR ASTM A497. CEMENT EXCEPT WHERE THE USE OF SULPHATE RESISTANT CEMENT IS REQUIRED BY LOCAL AUTHORITIES. SLAG CEMENT SHALL NOT BE PERMITTED WITHOUT SPECIAL PERMISSION.
- CONCRETE WALL SHALL CONFORM TO THE REQUIREMENTS OF ACI 305R, "HOT WEATHER CONDITIONS" AND ACI 306R, "COLD WEATHER CONCRETING".
- EDGES OF FORMED JOINTS OF PERMANENTLY EXPOSED SURFACE SHALL BE BEVELED.
- ANCHOR BOLTS PLACEMENT WHERE APPLICABLE:
 - PRIOR TO POURING CONCRETE, ENSURE THAT MARKINGS ARE PLACED FOR ANCHOR BOLTS TO PREVENT OBSTRUCTION WITH THE STEEL RE-BARS.
 - GREASE EXPOSED ANCHOR BOLT THREADS.
 - THE TOP SURFACE OF THE SLAB SHALL RECEIVE A HEAVY BROOM FINISH.
 - POSITION THE GENERATOR SO THAT PROPER DRAINAGE AWAY FROM THE TANK IS ASSURED. WHERE POSSIBLE, THE TANK FOUNDATION SHALL BE LOCATED ON SOUND UNDISTURBED GROUND FREE OF ORGANIC MATERIAL OR CONTAMINANTS.

COLD WEATHER CONCRETE POURING

- WHEN THE AMBIENT TEMPERATURE FALLS BELOW 5°C OR WHEN THERE IS A PROBABILITY OF IT FALLING BELOW 5°C WITHIN 24 HOURS OF PLACING THE CONCRETE, THE CONTRACTOR SHALL MAKE PROVISIONS FOR HEATING THE WATER, AGGREGATES AND FRESHLY DEPOSITED CONCRETE.
- AGGREGATES SHALL BE HEATED TO A TEMPERATURE OF NOT MORE THAN 65°C. FOR CONCRETE CONTAINING SILICA FUME, THE AGGREGATE SHALL NOT BE HEATED TO MORE THAN 40°C. THE HEATING APPARATUS AND THE HOUSING FOR THE AGGREGATES SHALL BE SUFFICIENT TO HEAT THE AGGREGATES UNIFORMLY WITHOUT THE POSSIBILITY OF THE OCCURRENCE OF HOT SPOTS WHICH MAY BURN THE MATERIALS.
- THE WATER SHALL BE HEATED TO A TEMPERATURE OF NOT MORE THAN 65°C. FOR CONCRETE CONTAINING SILICA FUME, THE WATER SHALL NOT BE HEATED TO MORE THAN 40°C.
- THE TEMPERATURE OF THE MIXED CONCRETE SHALL NOT BE LESS THAN 15°C AND NOT MORE THAN 25°C AT THE TIME OF PLACING IN THE FORMS. TEMPERATURE REQUIREMENTS FOR CONCRETE CONTAINING SILICA FUME SHALL BE BETWEEN 10°C AND 18°C AT THE TIME OF PLACING IN THE FORMS.
- HOARDING ENCLOSURES SHALL BE CONSTRUCTED TO WITHSTAND WIND AND SNOW LOADS AND SHALL BE REASONABLY AIRTIGHT. THE HOUSING SHALL PROVIDE SUFFICIENT SPACE BETWEEN THE CONCRETE AND THE ENCLOSURE TO PERMIT FREE CIRCULATION OF WARMED AIR. THE HEATING APPARATUS AND HOUSING SHALL BE SUFFICIENT TO ENCLOSE AND PROTECT THE STRUCTURE IN SUCH A WAY THAT THE AIR SURROUNDING THE FRESH CONCRETE IS KEPT AT A TEMPERATURE OF NOT LESS THAN 15°C AND NOT MORE THAN 25°C FOR 4 DAYS, NOT COUNTING THE DAY ON WHICH THE CONCRETE WAS DEPOSITED. DURING THE NEXT 3 DAYS, THE CONCRETE SHALL BE ALLOWED TO GRADUALLY COOL TO A TEMPERATURE OF NOT LESS THAN 5°C WITH THE DROP IN TEMPERATURE NEVER EXCEEDING 5°C OVER AN 8 HOUR PERIOD.

GENERAL CONTRACTOR TO HIRE AN INSPECTION AND TESTING COMPANY FOR THE FOLLOWING:
 -CONCRETE STRENGTH TEST
 -GEOTECH. CONSULTANT TO TEST THE SOIL BEARING CAPACITY AND THE -SOIL COMPACTION TESTS
 -REBAR INSPECTION REPORTS
 -GENERAL CONTRACTOR TO SUBMIT ARMOUR STONE DESIGN AND SHOP DRAWINGS SEALED BY PROFESSIONAL ENGINEER OF ONTARIO

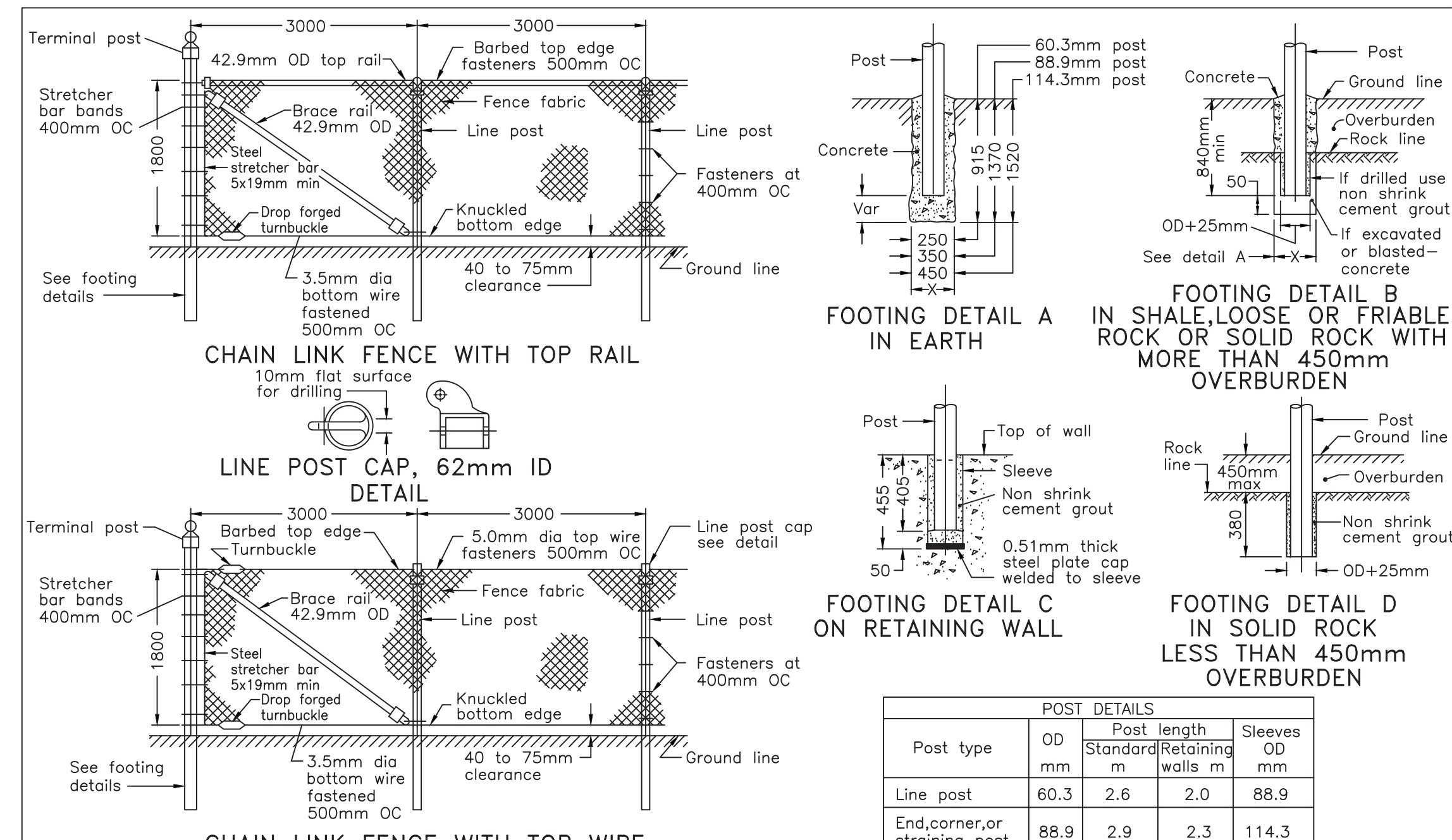


1 SECTION S01
SCALE: N.T.S

- LOCATION OF ALL EXISTING UTILITIES IN THE FIELD TO BE ESTABLISHED BY THE CONTRACTOR.
- THE CONTRACTOR(S) SHALL BE SOLELY RESPONSIBLE FOR LOCATES, EXPOSING, SUPPORTING AND PROTECTING OF ALL UNDERGROUND AND OVERHEAD UTILITIES AND STRUCTURES EXISTING AT THE TIME OF CONSTRUCTION IN THE AREA OF HIS WORK. WHETHER SHOWN ON THE PLANS OR NOT, AND FOR ALL REPAIRS AND CONSEQUENCES RESULTING FROM DAMAGE TO SAME.
- THE CONTRACTOR(S) SHALL BE SOLELY RESPONSIBLE TO GIVE 72 HOURS WRITTEN NOTICE TO UTILITIES PRIOR TO CROSSING SUCH UTILITIES, FOR THE PURPOSE OF INSPECTION BY THE CONCERNED UTILITY. THIS INSPECTION WILL BE FOR THE DURATION OF THE CONSTRUCTION, WITH THE CONTRACTOR RESPONSIBLE FOR ALL COSTS ARISING FROM SUCH INSPECTION.

PLAN VIEW S01
SCALE: 1:100

D1 TYPICAL BUMPER POST S01
SCALE: N.T.S

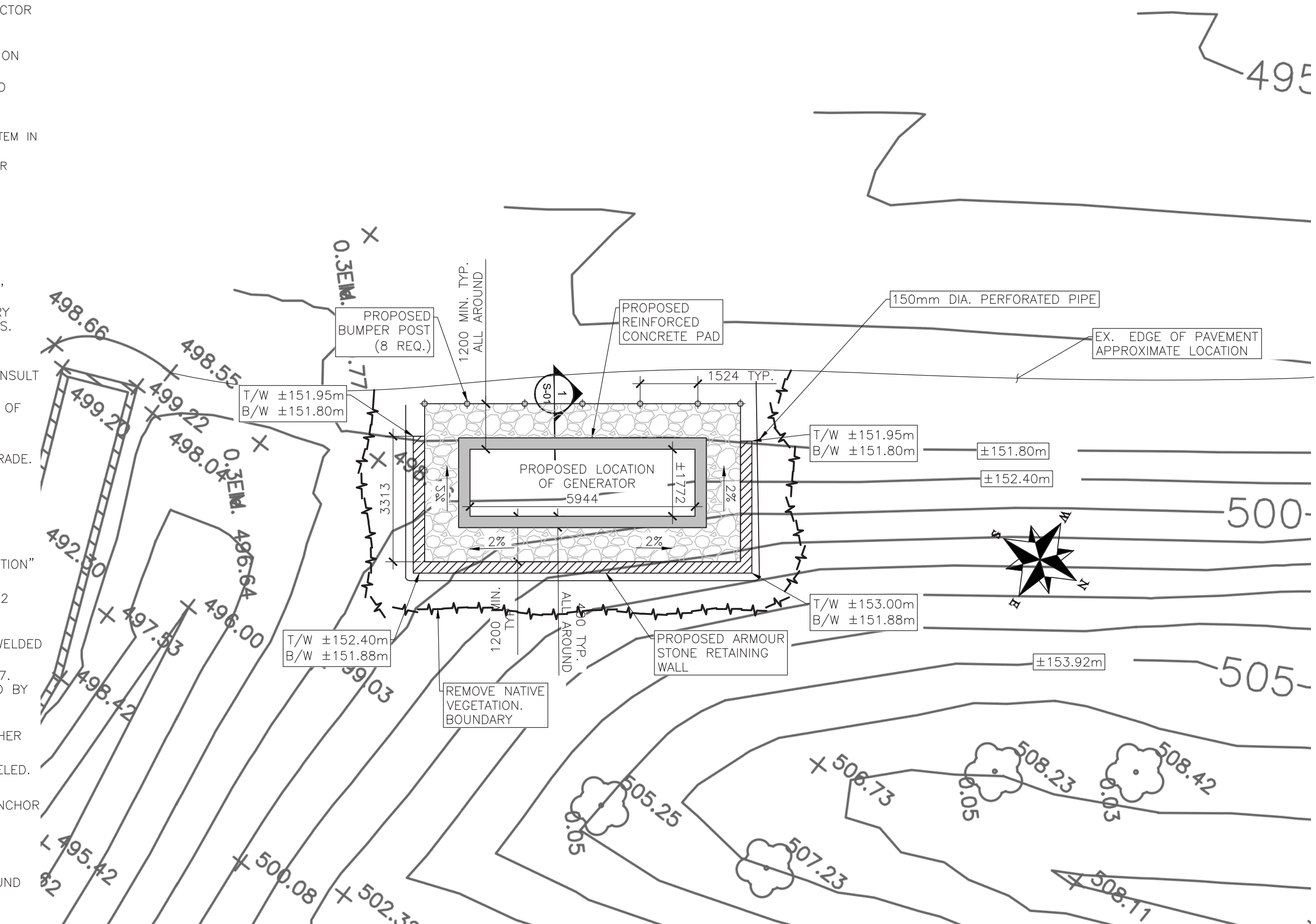


NOTE:
A All dimensions are in millimetres unless otherwise shown.

ONTARIO PROVINCIAL STANDARD DRAWING Nov 2001 Rev 0

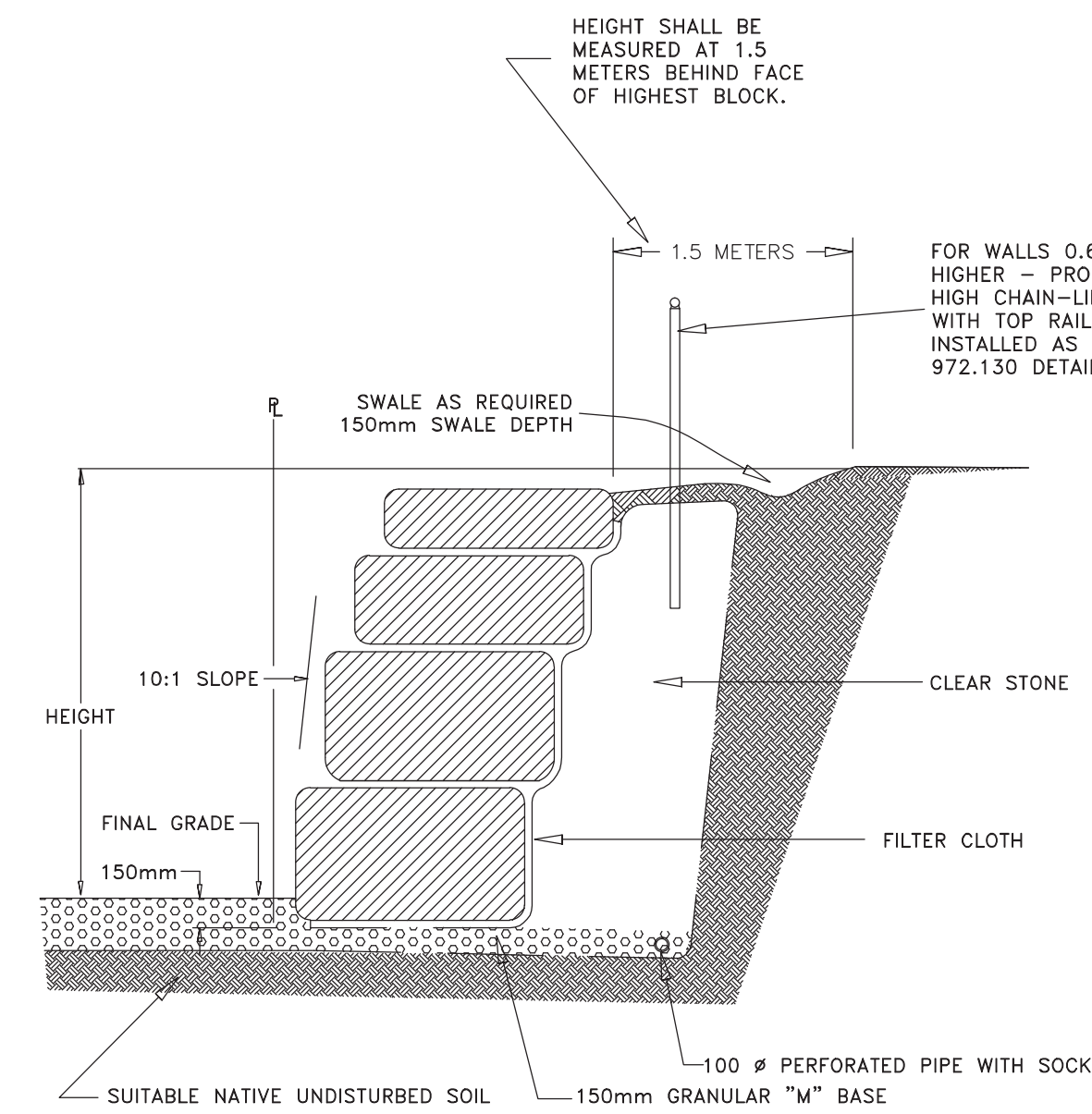
FENCE, CHAIN LINK
INSTALLATION - ROADWAY

OPSD - 972.130



- NOTES:**
- ALL WALLS TO BE APPROVED BY DEPARTMENTAL REPRESENTATIVE PRIOR TO CONSTRUCTION.
 - WALLS 1.0m IN HEIGHT OR HIGHER MUST BE DESIGNED AND CERTIFIED BY AN ENGINEER.
 - RETAINING WALL TO BE CONSTRUCTED ON HIGHER SIDE PROPERTY
 - HEIGHT OF ALL RETAINING WALLS SHALL BE MEASURED FROM BOTTOM OF WALL AND AT 1.5 METERS BEHIND WALL.
 - SUCCESSIVE WALLS OF 1.0m OR LESS IN HEIGHT SHALL BE CONSIDERED AS A SINGLE WALL WHEN:
 - THE SPACING IS LESS THAN 1.5m BETWEEN TWO WALLS; OR
 - THE GRADING IS GREATER THAN 5% BETWEEN TWO WALLS.

D2 TYPICAL ARMOUR STONE RETAINING WALL S01
SCALE: N.T.S



KEY PLAN

NO	DATE	ISSUED FOR	APPROVED BY
2	23 FEB 2017	TENDER	AY
1	02 DEC 2016	ISSUED FOR 100% REVIEW	AY
0	28 OCT 2016	ISSUED FOR 70% REVIEW	AY

REVISIONS

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PROJECT: **GENERATOR REPLACEMENT AFRICAN RAINFOREST PAVILION**

DRAWING: **GENERATOR PAD & DETAILS**

DATE: 07 OCT 2016 PROJECT NO: 51502
SCALE: AS SHOWN DRAWING NO:
DRAWN BY: AY CHECKED BY: AY
S-01

	Technical Specification Automatic Transfer Switch and Distribution Panel	Revision		Page
		#	Date	
	Specification No. 51502-02	02	02-23-2017	1

	CLIENT: TORONTO ZOO
	PROJECT: GENERATOR REPLACEMENT-AFRICAN RAINFOREST PAVILION

		SIGNATURE	DATE
<i>PREPARED BY:</i>	Kris Lyttle		02-23-2017
<i>REVIEWED BY:</i>	Kris Lyttle		02-23-2017
<i>APPROVED BY:</i>	R. Anthony Warner		02-23-2017

ISSUE/REVISION INDEX

Issue Code	Revision					Revision Details
	No.	Prep. By	Rev. By	App. By	Date	
RR	0	KL	KL	RAW	10-28-2016	Released for Review
RQ	1	KL	BS	RAW	12-01-2016	Released for Tender
RQ	2	KL	KL	RAW	02-23-2017	Released for Tender

Issue Codes: RC = Released for Construction, RD = Released for Design, RF = Released for Fabrication, RI = Released for Information, RP = Released for Purchase, RQ = Released for Quotation, RR = Released for Review and Comments.

Automatic Transfer Switch

1. **GENERAL**

1.1. **General Requirements**

- 1.1.1. ATS must be designed to work satisfactorily between two power sources (normal and stand-by).
- 1.1.2. The ATS must have extremely high reliability. It shall be procured from a reputable supplier offering reliable service.
- 1.1.3. To prevent breakers tripping on high inrush current the ATS shall be a “break-before make” device with minimum one-second neutral position delay.
- 1.1.4. Transient voltage surge suppressor shall be installed on ATS terminal as recommended by the manufacturer to protect the ATS and the downstream equipment.
- 1.1.5. Access to ATS features, must not require an Electricians License.

1.2. **Reference Drawings**

- 1.2.1. VIRTUAL 51502 E-01 Rev. 2
- 1.2.2. VIRTUAL 51502 E-03 Rev. 3

1.3. **Scope**

- 1.3.1. Provide complete factory-assembled power transfer equipment with field-programmable digital electronic controls designed for fully automatic operation and including: surge voltage isolation, voltage sensors on all phases of both power sources, linear operation, permanently attached manual handles, positive mechanical and electrical interlocking, and mechanically-held contacts for both sources.
- 1.3.2. The ATS manufacturer shall warrant transfer switches to provide a single source of responsibility for all the products provided.
- 1.3.3. Once installed, Owner must be provided with manufacturer-recommended training for system users of the complete power package.

1.4. **Codes and Standards**

- 1.4.1. The automatic transfer switch **installation and application** shall conform to the requirements of the following codes and standards:
 - .1 CSA 282 M-05, Emergency Electrical Power Supply for Buildings
 - .2 NFPA70 – National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702.
 - .3 NFPA110 – Emergency and Standby Power Systems. The transfer switch shall meet all requirements for Level 1 systems.
 - .4 IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.
 - .5 NEMA ICS10-1993 – AC Automatic Transfer Switches.
 - .6 CSA C22.2 No.178 ATS
- 1.4.2. The transfer switch **assembly** shall comply with the following standards:
 - .1 CSA C22.2, No. 14 – M91 Industrial Control Equipment.

- .2 UL1008 – Transfer Switches. Transfer switches shall be UL1008 listed. UL1008 transfer switches may be supplied in UL891 enclosures if necessary to meet the physical requirements of the project.
- 1.4.3. The transfer switch manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third-party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.
- 1.5. **Manufacturers**
 - 1.5.1. Equipment specifications for this project are based on microprocessor-based transfer switches. Only approved bidders shall supply equipment provided under this contract.
2. **PRODUCTS**
 - 2.1. **Power Transfer Switch**
 - 2.1.1. Ratings:
 - .1 Refer to the project drawings for specifications on the sizes and types of transfer switch equipment, withstand and closing ratings, number of poles, voltage and ampere ratings, enclosure type, and accessories.
 - .2 Main contacts shall be rated for 240 Volts AC minimum.
 - .3 Transfer switches shall be rated to carry 100 percent of rated current continuously in the enclosure supplied, in ambient temperatures of -40 to +60 degrees C, relative humidity up to 95% (non-condensing), and altitudes up to 10,000 feet (3000M).
 - .4 Transfer switch equipment shall have withstand and closing ratings (WCR) in RMS symmetrical amperes greater than the available fault currents shown on the drawings and at the specified voltage. The transfer switch and its upstream protection shall be coordinated.
 - 2.1.2. Construction:
 - .1 Transfer switches shall be contactor-type, double-throw, electrically and mechanically interlocked, and mechanically held in the source 1 and source 2 positions. The transfer switch shall be specifically designed to transfer to the best available source if it inadvertently stops in a neutral position.
 - .2 Transfer switches shall be equipped with permanently attached manual operating handles and quick-break, quick-make over-center contact mechanisms. Transfer switch shall be equipped with manual operators for service use only under de-energized conditions.
 - .3 Main switch contacts shall be high-pressure silver alloy. Contact assemblies shall have arc chutes for positive arc extinguishing. Arc chutes shall have insulating covers to prevent inter-phase flashover.
 - .4 Transfer switch internal wiring shall be composed of pre-manufactured harnesses that are permanently marked for source and destination. Harnesses shall be connected to the control system by means of locking disconnect plug(s), to allow the control system to be easily disconnected and serviced without disconnecting power from the transfer switch mechanism.
 - .5 **Optional:** Power transfer switch shall be provided with flame-retardant transparent covers to allow viewing of switch contact operation but

prevent direct contact with components that could be operating at line voltage levels.

- .6 Transfer switches designated on the drawings as 3-pole. The neutral pole shall be of the same construction and have the same ratings as the phase poles. All poles shall be switched simultaneously using a common crossbar. Substitute equipment using overlapping neutral contacts is not acceptable.
- .7 Transfer switches that are designated on the drawings as 3-pole shall be provided with a neutral bus and lugs. The neutral bus shall be sized to carry 100% of the current designated on the switch rating.

2.2. **Transfer Switch Control**

2.2.1. Operator Panel:

The transfer switch shall be provided with a control panel to allow the operator to view the status and control operation of the transfer switch. The operator panel shall be provided with the following features and capabilities.

- .1 High-intensity display to indicate the source that the load is connected to (source 1 or source 2); and which source(s) are available. Source available LED indicators shall operate from the control microprocessor (or module) to indicate the true condition of the sources as sensed by the control system.
- .2 High-intensity display to indicate that the transfer switch is “not in auto” (due to control being disabled or due to bypass switch (when used) enabled or in operation) and “Test/Exercise Active” to indicate that the control system is testing or exercising the generator set.
- .3 “OVERRIDE” pushbutton to cause the transfer switch to bypass any active time delays for start, transfer, and re-transfer, and immediately proceed with its next logical operation.
- .4 “TEST” pushbutton to initiate a pre programmed test sequence for the generator set and transfer switch. The transfer switch shall be programmable for test either with load or without load.
- .5 “RESET/LAMP TEST” push-button that will clear any faults present in the control, or simultaneously test all lamps on the panel by lighting them.
- .6 The control system shall continuously log information on the number of hours each source has been connected to the load, the number of times transferred, and the total number of times each source has failed. This information shall be available via a PC-based service tool as well as the operator display panel.
- .7 Security Key Switch or password protection to allow the user to inhibit adjustments, manual operation or testing of the transfer switch unless key is in place and operated. (Note: Manual, Auto & Test selecting switch shall be provided)
- .8 Digital AC meter display panel, to display 3-phase AC Amps, 3-phase AC Volts, Hz, KW load level, and load power factor.
- .9 Front panel with push-button navigation switches. The display shall be clearly visible in both bright (sunlight) and no-light conditions. It shall be visible over an angle of at least 120 degrees. The Alphanumeric display panel shall be capable of providing the following functions and capabilities:

- .1 Display source condition information, including AC voltage for each phase of normal and emergency source, frequency of each source. Voltage for all three phases shall be displayed on a single screen for easy viewing of voltage balance. Line-to-neutral voltages shall be displayed for 4-wire systems.
- .2 Display source status, to indicate source is connected or not connected.
- .3 Display load data, including 3-phase AC voltage, 3-phase AC current, frequency, KW, KVA, and power factor. Voltage and current data for all phases shall be displayed on a single screen.
- .4 The display panel shall allow the operator to view and make the following adjustments in the control system, after entering an access code:
 - .1 Nominal voltage and frequency for the transfer switch.
 - .2 Voltage and frequency sensor operation set points.
 - .3 Current time clock functions.
 - .4 Load sequence functions.
 - .5 Enable or disable control functions in the transfer switch, including program transition.
 - .6 Exercise and load test operation conditions, as well as normal system time delays for transfer time, time delay start, stop, transfer, and re-transfer.
- .5 Display real-time clock data, including date, and time in hours, minutes, and seconds. The real-time clock shall incorporate provisions for automatic daylight savings time and leap-year adjustments. The control shall also log total operating hours for the control system.
- .6 Display service history for the transfer switch. Display source connected hours, to indicate the total number of hours connected to each source. Display number of times transferred, and total number of times each source has failed.
- .7 Display fault history on the transfer switch, including condition, and date and time of fault. Faults to include controller check-sum error, low controller DC voltage, ATS fail-to-close on transfer; ATS fail-to-close on re-transfer, battery charger malfunction, network battery voltage low, and network communications error.
- .8 Facilities for remote signalling alarms to control centre for all shut-down and information alarms.

2.2.2. Internal Controls:

- .1 The transfer switch control system shall be configurable in the field for any operating voltage level up to 480VAC. Provide RMS voltage sensing and metering that is accurate to within plus or minus 1% of nominal voltage level. Frequency sensing shall be accurate to within plus or minus 0.2%. Voltage sensing shall be monitored based on the normal voltage at the site. Systems that utilize voltage monitoring

- based on standard voltage conditions that are not field-configurable are not acceptable.
- .2 Transfer switch voltage sensors shall be close differential type, providing source availability information to the control system based on the following functions:
 - .1 Monitoring all phases of the normal service (source 1) for under-voltage conditions (adjustable for pick-up in a range of 85 to 98% of the normal voltage level and drop-out in a range of 75 to 98% of normal voltage level).
 - .2 Monitoring all phases of the emergency service (source 2) for under-voltage conditions (adjustable for pick-up in a range of 85 to 98% of the normal voltage level and drop-out in a range of 75 to 98% of pick-up voltage level).
 - .3 Monitoring all phases of the normal service (source 1) and emergency service (source 2) for voltage imbalance.
 - .4 Monitoring all phases of the normal service (source 1) and emergency service (source 2) for any phase loss.
 - .5 Monitoring all phases of the normal service (source 1) and emergency service (source 2) for over-voltage conditions (adjustable for drop-out over a range of 105 to 135% of normal voltage, and pick-up at 95-99% of drop-out voltage level).
 - .6 Monitoring all phases of the normal service (source 1) and emergency service (source 2) for over or under-frequency conditions.
 - .3 All transfer switch sensing shall be configurable from a Windows PC-based service tool, to allow setting of levels, and enabling or disabling of features and functions. Selected functions including voltage sensing levels and time delays shall be configurable using the built-in operator control panel. Designs utilizing DIP switches or other electromechanical devices are not acceptable. The transfer control shall incorporate a series of diagnostic LED indicators.
 - .4 The transfer switch shall be configurable to control the operation time from source to source (program transition operation). The control system shall be capable of enabling or disabling this feature, and adjusting the time period to a specific value. A phase band monitor or similar device is not an acceptable alternate for this feature.
 - .5 The transfer switch shall incorporate adjustable time delays from 0-15 seconds); transfer (adjustable in a range from 0-120 seconds); re-transfer (adjustable in a range from 0-30 minutes); and generator stop (cool-down) (adjustable in a range of 0-30 minutes).
 - .6 The transfer switch shall be configurable to accept a relay contact signal and a network signal from an external device to prevent transfer to the generator service.
 - .7 The control system shall be designed and prototype tested for operation in ambient temperatures from -40C to +60C. It shall be designed and tested to comply with the requirements of the noted voltage and RFI/EMI standards.

- .8 The control shall have optically-isolated logic inputs, high-isolation transformers for AC inputs, and relays on all outputs, to provide optimum protection from line voltage surges, RFI and EMI.

2.2.3. Control Interface:

- .1 The transfer switch will provide an isolated relay contact for starting of a generator set. The relay shall be normally held open, and close to start the generator set. Output contacts shall be form C, for compatibility with any generator set.
- .2 Provide one set Form C auxiliary contacts on both sides, operated by transfer switch position, rated 10 amps 250 VAC.
- .3 The transfer switch shall provide relay contacts to indicate the following conditions: source 1 available, load connected to source 1, source 2 available, source 2 connected to load.
- .4 The transfer switch shall provide emergency stop push-button.

2.3. **Enclosure**

- 2.3.1. The Enclosure of the Automatic transfer switch shall be of sheet steel construction arranged for free standing mounting, bottom, top, or side-entry as per design drawing and site specific requirements. Enclosures shall be NEMA-12 or higher. The cabinet shall provide code-required wire bend space at point of entry. Manual operating handles and all control switches (other than key-operated switches) shall be accessible to authorized personnel only by opening the key-locking cabinet door. Transfer switches with manual operating handles and/or non key-operated control switches located outside of the cabinet do not meet this specification and are not acceptable.

2.4. **(Operation) Open-transition Sequence of Operation**

- 2.4.1. Transfer switch normally connects an energized prime power source (source 1) to loads and a standby source set (source 2) to the loads when normal source fails. The normal position of the transfer switch is source 1 (connected to the prime source).

3. **EXECUTION**

3.1. **Power Transfer Switch**

- .1 Connections
 - .1 Field control connections shall be made on a common terminal block that is clearly and permanently labelled.
 - .2 Transfer switch shall be provided with AL/CU mechanical lugs sized to accept the full output rating of the switch. Lugs shall be suitable for the number and size of conductors shown on the drawings

3.2. **Open-transition Sequence of Operation**

3.2.1. Generator Set Exercise (Test) with Load Mode

- .1 This section must be modified by the manufacturer based on the site requirements. The control system shall be configurable to test the generator set under load. In this mode, the transfer switch shall control the generator set in the following sequence:

- .1 Transfer switch shall initiate the exercise sequence at a time indicated in the exercise timer program, or when manually initiated by the operator.
- .2 When the control systems senses the generator set at rated voltage and frequency, it shall operate to connect the loads to the generator set by opening the normal source contacts, and closing the alternate source contacts a predetermined time period later. The timing sequence for the contact operation shall be programmable in the controller.
- .3 The generator set shall operate connected to the load for the duration of the exercise period. If the generator set fails during this period, the transfer switch shall automatically reconnect the load to the normal service.
- .4 On completion of the exercise period, the transfer switch shall operate to connect the loads to the normal source by opening the alternate source contacts, and closing the normal source contacts a predetermined time period later. The timing sequence for the contact operation shall be programmable in the controller.
- .5 The transfer switch shall operate the generator set unloaded for a cool down period, and then remove the start signal from the generator set. If the normal power fails at any time when the generator set is running, the transfer switch shall immediately connect the system loads to the generator set.

3.2.2. Generator Set Exercise (Test) Without Load Mode.

The control system shall be configurable to test the generator set without transfer switch load connected. In this mode, the transfer switch shall control the generator set in the following sequence:

- .1 Transfer switch shall initiate the exercise sequence at a time indicated in the exercise timer program, or when manually initiated by the operator.
- .2 When the control systems senses the generator set at rated voltage and frequency, it shall operate the generator set unloaded for the duration of the exercise period.
- .3 At the completion of the exercise period, the transfer switch shall remove the start signal from the generator set. If the normal power fails at any time when the generator set is running, the transfer switch shall immediately connect the system loads to the generator set.

3.3. **Other Requirements**

3.3.1. Factory & Site Testing:

- .1 The transfer switch manufacturer shall perform a complete operational test on the transfer switch prior to shipping from the factory. A certified test report shall be provided. Test process shall include calibration of voltage sensors.
- .2 Site installation shall be done as per the manufacturer recommendations. A test document shall be provided and revised if necessary by the contractor to be suitable for his selection.

- 3.3.2. Service and Support:
- .1 The manufacturer of the transfer switch shall maintain service parts inventory at a central location which is accessible to the service location 24 hours per day, 365 days per year.
 - .2 The transfer switch shall be serviced by a local service organization that is trained and factory-certified in both generator set and transfer switch service. The supplier shall maintain an inventory of critical replacement parts at the local service organization, and in service vehicles. The service organization shall be on call 24 hours per day, 365 days per year.
 - .3 The manufacturer shall maintain model and serial number records of each transfer switch provided for at least 20 years.

3.4. **SHOP DRAWINGS**

1. Shop drawings shall be submitted prior to order of the materials.
2. Shop drawings shall include all installation details
3. Detailed drawings shall be submitted for consultant approval
4. Sequence of operation shall be submitted based on actual site requirements.

Distribution Panel

1. **GENERAL**

1.1. **General**

- 1.1.1. These specifications describe requirements for a complete power conditioning and distribution system, supplying computer grade power to sensitive loads. The specified system shall provide isolation*, distribution, control, and monitoring of AC power. It shall include all equipment to properly interface the AC power source to the intended load.
- 1.1.2. Units without a transformer do not provide isolation.

1.2. **Codes and Standards**

- 1.2.1. The specified system shall be designed, manufactured, tested, and installed in compliance with:
 - .1 American National Standards Institute (ANSI)
 - .2 Canadian Standards Association (CSA)
 - .3 Federal Information Processing Standards Publication 94 (FIPS Pub 94)
 - .4 Institute of Electrical and Electronics Engineers (IEEE)
 - .5 ISO 9001
 - .6 National Electrical Code (NEC - NFPA 70)
 - .7 National Electrical Manufacturers Association (NEMA)
 - .8 National Fire Protection Association (NFPA 75)
 - .9 Underwriters Laboratories (UL)
- 1.2.2. System shall be approved by ESA

- 1.2.3. The system shall be UL listed as a complete system under UL 1950 Standard for Information Technology Equipment (UL listing applies to 60 Hz units only).
- 1.2.4. The specified system shall comply with latest FCC Part 15 EMI emission limits for Class A computing devices and the emission and immunity limits of EN50081-2/EN550022 Class A and EN50082-2.
- 1.2.5. The system shall safely withstand without miss operation or damage:
 - .1 Transient voltage surges on the AC power input as defined by ANSI/IEEE C62.41 for Category B3 locations (high surge exposure industrial and commercial facilities),
 - .2 Electrostatic discharges (ESD) up to 10 kV at any point on the exterior of the unit, and
 - .3 Electromagnetic fields from portable transmitters within 3 feet (1 meter) of the unit.
- 1.3. **System Description**
 - 1.3.1. Electrical Requirements:
 - .1 Input voltage shall be 120/208 volts AC, 60 Hz, three-phase, four-wire-plus-ground, wye configuration.
 - 1.3.2. Environmental Requirements:
 - .1 Storage temperature range shall be -55 to +85°C (-67 to +185°F).
 - .2 Operating temperature range shall be 0 to 40°C (+32 to 104°F).
 - .3 Operation shall be reliable in an environment with 0% to 95% non condensing relative humidity.
 - .4 The audible noise level of the specified system shall be less than the ANSI C89 standard for transformers.
- 1.4. **Documentation**
 - 1.4.1. Equipment Manual:
 - .1 The manufacturer shall furnish an installation manual with installation, start-up, operation, and maintenance instructions for the specified system.
 - 1.4.2. Drawings:
 - .1 Wiring diagrams and drawings details of major components shall be furnished by manufacturer.
 - 1.4.3. Spare Parts:
 - .1 A list of recommended spare parts shall be supplied at the customer's request.
 - 1.4.4. User's List:
 - .1 An in-service user's list shall be furnished upon request.
- 1.5. **Warranty**
 - 1.5.1. The manufacturer shall provide a one-year warranty against defects in material and workmanship for 18 months after initial start-up or 24 months after ship date, whichever occurs first. (Refer to the Warranty Statement for details.)
- 1.6. **Quality Assurance**

- 1.6.1. The specified system shall be factory-tested before shipment. Testing shall include, but shall not be limited to: Quality Control Checks, "Hi-Pot" Test (two times rated voltage plus 1000 volts, per UL requirements), and Metering Calibration Tests. The system shall be designed and manufactured according to world class quality standards. The manufacturer shall be ISO 9001 certified.

2. PRODUCTS

2.1. Components

2.1.1. Frame Construction and Enclosure:

- .1 The frame shall be constructed of welded steel to provide a strong substructure. The enclosure shall be provided with four permanent leveling jacks for final installation. The unit shall have easily removable and interchangeable output cable trays for each panel board to allow matching of the size and number of cable/conduit openings to the site requirements. A minimum of 42 cable/conduit openings shall be provided for each output panel board. All service shall be capable of being performed with access to the front plus a choice of any one side or rear for installation flexibility. Retrofitting additional power distribution cables shall require access to the front of the unit only. A tool shall be required to remove the exterior panels, which access the hazardous voltage area of the unit. To ensure grounding integrity and for static protection and EMI/RFI shielding, the removable exterior panels shall be grounded to the frame by way of stranded copper wire. Hinged double front doors shall provide access to the main input circuit breaker, and to all output circuit breakers. The unit shall be custom-painted to match or accent the Data Processing equipment. The color of the exterior panels shall be [(manufacturer's standard color) (Owner to confirm)].
- .2 The unit shall be naturally convection-cooled. No fans for forced-air cooling system shall be used. The convection cooling method shall allow continuous full-load operation without activation of over-temperature circuits. Heat rejection shall be through a screened protective top, which prohibits entry of foreign material.
- .3 The frame shall be configured to accept future field installation of additional bolt-on distribution sections containing additional panel board and cable tray capacity.

2.1.2. Input Power Connections:

- .1 An input voltage junction box shall be provided for input power connections. Power terminal blocks shall be provided for connection of the input power conductors, and a parity-sized insulated ground conductor. The junction box shall have maximum dimensions of Width, 16 in. (406 mm); Length, 30 in. (762 mm); Height, 6 in. (153 mm).
- .2 A main input cable shall be provided for connection between the specified unit and the input voltage junction box. The cable shall be 10 feet (3m) long, and consist of the appropriate number and size of conductors inside a UL/CSA listed liquid-tight, flexible metal conduit.
- .3 The conductors shall be UL/CSA listed, 90°C minimum insulation, copper conductors sized in accordance with the NEC, based on the main input circuit breaker rating. Both for reliability and per the CSA, no plug-and-receptacle connectors shall be used for the input power cable(s).

2.1.3. Branch Circuit Breakers:


- .1 Each load shall be protected by an individual branch circuit breaker as shown on the plans. Single-pole and three-pole bolt-on type branch breakers up through 200 amperes shall be utilized. Each branch circuit breaker shall provide over current protection and shall clearly indicate the "ON", "OFF", and "TRIPPED" positions. All branch circuit breakers shall have a minimum interrupting capacity as indicated on the drawings. Each branch circuit breaker shall be sized in accordance with the ESA and shall be UL/CSA listed. Branch circuit breakers shall have an associated directory label, located adjacent to the breaker, identifying the branch circuit number and the equipment being served.




3. **EXECUTION**

- 3.1. Factory start-up, preventive maintenance, and full service for the specified system shall be available and included upon Owner request. The manufacturer shall directly employ a nationwide service organization of factory-trained field service personnel dedicated to the start-up, maintenance, and repair of the manufacturer's power equipment. The manufacturer shall maintain a national dispatch center 24 hours per day, 365 days per year, to minimize service response time and to maximize availability of qualified service personnel.

END OF SECTION

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	CLIENT: TORONTO ZOO PROJECT: GENERATOR REPLACEMENT-AFRICAN RAINFOREST PAVILION
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		SIGNATURE	DATE
<i>PREPARED BY:</i>	Kris Lyttle		02-23-2017
<i>REVIEWED BY:</i>	Kris Lyttle		02-23-2017
<i>APPROVED BY:</i>	R. Anthony Warner		02-23-2017

ISSUE/REVISION INDEX

Issue Code	Revision					Revision Details
	No.	Prep. By	Rev. By	App. By	Date	
RR	0	KL	KL	RAW	10-28-2016	Released for Review
RQ	1	KL	BS	RAW	12-01-2016	Released for Tender
RQ	2	KL	KL	RAW	02-23-2017	Released for Tender

Issue Codes: RC = Released for Construction, RD = Released for Design, RF = Released for Fabrication, RI = Released for Information, RP = Released for Purchase, RQ = Released for Quotation, RR = Released for Review and Comments.

1. **GENERAL**

1.1. **Summary**

1.1.1. This section includes requirements for a motor control center (MCC) and all required control devices as shown on the drawing and specified to be part of the MCC equipment.

1.1.2. The MCC shall be 208/120V, 3-Phase, 4-Wire, 60 Hz, unless otherwise indicated on the drawing.

1.2. **Reference Drawings**

1.2.1. VIRTUAL 51502 E-01 Rev. 2

1.2.2. VIRTUAL 51502 E-03 Rev. 3

1.3. **Submittals**

1.3.1. Submit with the delivery of the MCC an Installation and Maintenance Manual and one (1) copy of the manufacturer's drawings per shipping block.

1.4. **Regulatory Requirements**

1.4.1. The MCC must conform to Underwriters Laboratories (UL) 845, current revision, CSA, EEMAC, NEMA ICS-18, the latest version of the National Electrical Code, and the Canadian Electrical Code. The MCC must be manufactured in an ISO 900-certified facility. Submit with the delivery of the MCC an Installation and Maintenance Manual and one (1) copy of the manufacturer's drawings per shipping block.

1.5. **Packing and Shipping**

1.5.1. The MCC shall be separated into shipping blocks no more than three vertical sections each. Shipping blocks shall be shipped on their sides to permit easier handling at the jobsite. Each shipping block shall include a removable lifting angle, which will allow an easy means of attaching an overhead crane or other suitable lifting equipment.

1.6. **Storage**

1.6.1. Submit with the delivery of the MCC an Installation and Maintenance Manual and one (1) copy of the manufacturer's drawings per shipping block. If the MCC cannot be placed into service reasonably soon after its receipt, store it in a clean, dry and ventilated building free from temperature extremes. Acceptable storage temperatures are from 0° C (32° F) to 40° C (104° F).

1.7. **Warranty**

1.7.1. The MCC shall be warranted to be free from defects in materials and workmanship for a period of eighteen (18) months from date of invoice from manufacturer or authorized sales channel.

2. **PRODUCTS**

2.1. **Manufacturers**

2.1.1. Shall be Square-D, Eaton (Cutler-Hammer), Allen-Bradley, or approved equal.

2.1.2. Any additions to be made on MCCs shall be the same as the original manufacturer.

2.2. **Materials**

2.2.1. Steel material shall comply with UL 845 and CSA requirements.

2.2.2. Each MCC shall consist of one or more vertical sections of heavy gauge steel bolted together to form a rigid, free-standing assembly. A removable 7-gauge structural steel lifting angle shall be mounted full width of the MCC shipping block at the top. Removable 7 gauge bottom channel sills shall be mounted underneath front and rear of the vertical sections extending the full width of the shipping block. Vertical sections made of welded side-frame assembly formed from a minimum of 12 gauge steel. Internal reinforcement structural parts shall be of 12 and 14 gauge steel to provide a strong, rigid assembly. The entire assembly shall be constructed and packaged to withstand normal stresses included in transit and during installation.

2.3. **Finish**

2.3.1. Steel material shall comply with UL 845 and CSA requirements.

2.3.2. All steel parts shall be provided with UL and CSA listed acrylic/alkyd baked enamel paint finish or TGIC Powder Coat, except plated parts used for ground connections. All painted parts shall undergo a multi-stage treatment process, followed by the finishing paint coat. Pre-treatment shall include:

.1 Hot alkaline

.2 Iron phosphate treatment to improve adhesion and corrosion resistance.

The paint shall be applied using an electro-deposition process to ensure a uniform paint coat with high adhesion. The standard paint finish shall be tested to UL 50 per ASTM B117 (5% STM Salt Spray) with no greater than 0.125 in (3 mm) loss of paint from a scribed line. Paint color shall be #49 medium light gray per ANSI standard Z55.1-967 (60-70 gloss) on all surfaces unless specified otherwise. Control station plates and escutcheon plates shall be painted a contrasting gray. All unit interior saddles shall be painted white for better visibility inside the unit.

2.4. **Structures**

2.4.1. Structures shall be totally enclosed, dead-front, free-standing assemblies. Structures shall be capable of being bolted together to form a single assembly.

2.4.2. The overall height of the MCC shall not exceed 90 in (2286 mm) (not including base channel or lifting angle). Base channels, of 1.5 in (38 mm) in height, and lifting angles, of 3 in (76 mm) in height, shall be removable. The total width of one section shall be 20 in (508 mm); (widths of 25 in (630 mm), 30 in (760 mm), and 35 in (890mm) can be used for larger devices). Verification shall be made of existing space prior to installation of new MCC.

2.4.3. Structures shall be NEMA/EEMAC type 1A (gasketed general purpose).

2.4.4. Each 20 in. (508 mm) wide standard section shall have all the necessary hardware and bussing for modular plug-on units to be added and moved around. All unused space shall be covered by hinged blank doors or appropriate cover plate and equipped to accept future units. Vertical bus openings shall be covered by manual bus shutters.

2.4.5. Each section shall include a top plate (single piece or two-piece). NEMA/EEMAC type 12 shall also include a bottom plate. Top and bottom plates shall be removable for ease in cutting conduit entry openings.

2.5. **Wire-ways**

2.5.1. Structures shall contain a minimum 12 in (305 mm) high horizontal wireway at the top of each section and a minimum 6 in (152 mm) high horizontal wireway at the bottom of each section. These wireways shall run the full length of MCC

to allow room for power and control cable to connect between units in different sections.

- 2.5.2. A full-depth vertical wireway shall be provided in each MCC section that accepts modular plug-on units. The vertical wireway shall connect with both the top and bottom horizontal wireway. The vertical wireway shall be 4 in. (102 mm) wide minimum with a separate hinged door. A minimum of 60 in.² (387 cm²) of cabling space should be available for 15-inch-deep sections and 80 in.² (516 cm²) of cabling space available for 20-inch-deep sections. Access to the wireways shall not require opening control unit doors. Structures that house a single, full section control unit are not required to have vertical wireways. Those control units must open directly into the MCC horizontal wireways.

2.6. **Barriers**

- 2.6.1. All power bussing and splice connections shall be isolated from the unit compartments and the wireways. The horizontal bus shall be mounted onto a glass-filled polyester support assembly that braces the bus against the forces generated during a short circuit. The horizontal bus shall be isolated from the top horizontal wireway by a two-piece rigid non-conductive barrier. The barrier design shall allow qualified personnel to slide the barriers both left and right, to allow access to the bus and connections for maintenance without having to remove the barrier. Barrier sliding shall occur via an upper and lower track system.
- 2.6.2. The vertical bus shall be housed in a molded glass-filled polyester support that provides bus insulation and braces the bus against the forces generated during a short-circuit. These supports shall have openings every 3 in (75 mm) for unit stab-on connections. Each opening shall be provided with a manual shutter to close off the stab opening. These shutters shall be attached to the structure so that when they are removed (to allow a stab connection) they are retained in the structure and are readily accessible for use should a plug-in unit be removed from the MCC.
- 2.6.3. Barriers shall be provided in the vertical structure and unit designs to prevent the contact of any energized bus or terminal by a fishtape inserted through the conduit or wireway areas.

2.7. **Bussing**

- 2.7.1. All bussing and connectors shall be tin-plated copper.
- 2.7.2. The main horizontal bus shall be rated at minimum 500 A continuous and shall extend the full length of the MCC. Bus ratings shall be based on 65° C maximum temperature rise in a 40° C ambient. Provisions shall be provided for splicing additional sections onto either end of the MCC.
- 2.7.3. The horizontal bus splice bars shall be pre-assembled into a captive bus stack. This bus stack is installed into the end of the MCC power bus to allow the installation of additional sections. The main bus splice shall utilize four bolts, two on each side of the bus split, for each phase. Additional bolts must not be required when splicing higher amperage bus. The splice bolts shall secure to self clenching nuts installed in the bus assembly. It shall be possible to maintain any bus connection with a single tool. Each section that accepts plug-in units shall be provided with a vertical bus for distributing power from the main bus to the individual plug-in starter units. This bus shall be of the same material and plating as the main bus, and shall be rated as specified. The vertical bus shall be connected directly to the horizontal bus stack without the use of risers or other intervening connectors. It shall be possible to maintain the vertical to horizontal bus connection with a single tool. "Nut and bolt" bus connections to the power

bus shall not be permitted. When a back-to-back unit arrangement is utilized, separate vertical bus shall be provided for both the front and rear units. A tin-plated copper ground bus shall be provided that runs the entire length of the MCC. The ground bus shall be 0.25 in (6.0 mm) x 1.0 in (25 mm) and be rated as specified on the drawings. A compression lug shall be provided in the MCC for a 4/0-250 kcmil ground conductor. The ground bus shall be provided with (6) 0.38 in (10 mm) holes for each vertical section to accept customer-supplied ground lugs for any loads requiring a ground conductor. Each vertical section shall have a copper vertical ground bus that is connected to the horizontal ground bus. This vertical ground bus shall be installed so that the plug-in units engage the ground bus prior to engagement of the power stabs and shall disengage only after the power stabs are disconnected upon removal of the plug-in unit.

- 2.7.4. The system shall be rated for an available short circuit capacity of 65000 A RMS Symmetrical Amperes.

2.8. **Typical Unit Construction**

- 2.8.1. Units with circuit breaker disconnects through 400 A frame, and fusible switch disconnects through 400 A, shall connect to the vertical bus through a spring-reinforced stab-on connector. Units with larger disconnects shall be connected directly to the main horizontal bus with appropriately sized cable or riser bus.

- 2.8.2. All conducting parts on the line side of the unit disconnect shall be shrouded by a suitable insulating material to prevent accidental contact with those parts.

- 2.8.3. Unit mounting shelves shall include hanger brackets to support the unit weight during installation and removal. All plug-on units shall use a twin-handle camming lever located at the top of the bucket to rack in and out the plug-on unit. The cam lever shall work in conjunction with the hanger brackets to ensure positive stab alignment.

- 2.8.4. A lever handle operator must be provided on each disconnect. With the unit stabs engaged onto the vertical phase bus and the unit door closed, the handle mechanism shall allow complete ON/OFF control of the unit. All circuit breaker operators shall include a separate TRIPPED position to clearly indicate a circuit breaker trip condition. It shall be possible to reset a tripped circuit breaker without opening the control unit door. Clear indication of disconnect status shall be provided, by adhering to the following operator handle positions:

- .1 Handle "On" position must be up or to the left and within 45 degrees of being parallel to the face of the equipment.
- .2 Handle "Off" position must be down or to the right and within 45 degrees of being parallel to the face of the equipment. The minimum separation between the "On" and "Off" positions shall be 90 degrees.
- .3 On Circuit Breaker disconnects, the handle "Tripped" position must be perpendicular to the face of the equipment +/- 30 degrees. Minimum separation between "On" and "Tripped" shall be 30 degrees. Minimum separation between "Tripped" and "Off" shall be 45 degrees.
- .4 A mechanical interlock shall prevent the operator from opening the unit door when the disconnect is in the ON position. Another mechanical interlock shall prevent the operator from placing the disconnect in the ON position while the unit door is open. It shall be possible for authorized personnel to defeat these interlocks.
- .5 A non-defeatable interlock shall be provided to prevent installing or removing a plug-on unit unless the disconnect is in the OFF position.

- .6 The plug-in unit shall have a grounded stab-on connector which engages the vertical ground bus prior to, and releases after, the power bus stab-on connectors.
- .7 Provisions shall be provided for locking all disconnects in the OFF position with up to three padlocks.
- .8 Handle mechanisms shall be located on the left side to encourage operators to stand to the left of the unit being switched.
- .9 Unit construction shall combine with the vertical wireway isolation barrier to provide a fully compartmentalized design.

2.9. **Components for Typical Units**

2.9.1. **Combination Starters**

- .1 All combination starters shall use a unit disconnect as described in specification 2.08. Magnetic starters shall be furnished in all combination starter units. All starters shall utilize NEMA/EEMAC rated contactors. Starters shall be provided with a three-pole, external manual reset, overload relay for solid state thermal overload units.
- .2 When provided, control circuit transformers shall include two primary protection fuses and one secondary fuse (in the non-ground secondary conductor). The transformer shall be sized to accommodate the contactor(s) and all connected control circuit loads. The transformer rating shall be fully visible from the front when the unit door is opened.
- .3 When a unit control circuit transformer is not provided, the disconnect shall include an electrical interlock for disconnection of externally powered control circuits.
- .4 Auxiliary control circuit interlocks shall be provided where indicated. Auxiliary interlocks shall be field convertible to normally open or normally closed operation.
- .5 NEMA/EEMAC Size 1-4 starters shall be mounted directly adjacent to the wireway so that power wiring (motor leads) shall connect directly to the starter terminals without the use of interposing terminals. Larger starters shall be arranged so that power wiring may exit through the bottom of the starter cubical without entering the vertical wireway.

2.9.2. **Terminal Blocks**

- .1 When Type B wiring is specified, all starter units shall be provided with unit control terminal blocks.
- .2 Terminal blocks shall be the pull-apart type with a minimum rating of 250 volt and 10 amps. All current carrying parts shall be tin plated. Terminals shall be accessible from inside the unit when the unit door is opened. Terminal blocks shall be DIN rail mounted with the stationary portion of the block secured to the unit bottom plate. The stationary portion shall be used for factory connections, and shall remain attached to the unit when removed. The terminals used for field connections shall face forward so they can be wired without removing the unit or any of its components.
- .3 When Type C wiring is specified, all starter units shall be provided with unit control terminal blocks as described for Type B wiring along with power terminal blocks for size 1-3 units. An additional set of terminal blocks shall be provided in a terminal compartment located in each section. These terminal blocks shall be pre-wired to the unit

terminals so that all field control connections can be made at the terminal compartments.

2.9.3. Nameplates

- .1 Shall be engraved phenolic nameplates for each MCC and unit compartment.
- .2 Shall be gray background with white letters, measuring a minimum of 1.5 in (38 mm) H x 6.25 in (159 mm) W total outside dimensions.

2.9.4. Pilot Device Panel

- .1 Each combination starter unit shall be provided with a hinged/removable control station plate, which can accommodate up to five 22 mm pilot devices or three 30 mm pilot devices.

2.10. Six-inch Unit Construction

- 2.10.1. Units with circuit breaker disconnects through 250 A frame and fusible switch disconnects through 100 A shall connect to the vertical bus through a spring-reinforced, stab-on connector. Stabs on all plug-on units shall be cable connected to the unit disconnect. Six-inch fusible units shall accept Class J fuses only.
- 2.10.2. All conducting parts on the line side of the unit disconnect shall be shrouded by a suitable insulating material.
- 2.10.3. Unit mounting shelves shall include hanger brackets to support the unit weight during installation and removal. All six inch plug-on units shall be installable without the assistance of a camming device so as to allow maximum accessibility with the unit installed.
- 2.10.4. A lever handle operator must be provided on each disconnect. With the unit stabs engaged into the vertical phase bus and the unit door closed, the handle mechanism shall allow complete ON/OFF control of the unit disconnect with clear indication of the disconnects status. All circuit breaker operators shall include a separate TRIPPED position to clearly indicate a circuit breaker trip condition. It shall be possible to reset a tripped circuit breaker without opening the control unit door.
 - .1 A mechanical interlock shall prevent an operator from opening the unit door when the disconnect is in the ON position. Another mechanical interlock shall prevent an operator from placing the disconnect in the ON position while the door is open. It shall be possible for authorized personnel to defeat these interlocks.
 - .2 A non-defeatable interlock shall be provided between the handle operator and the structure to prevent installing or removing a plug-on unit unless the disconnect is in the OFF position. The plug-on unit shall have a grounded stab-on connector which engages the vertical ground bus prior to, and releases after, the power bus stab-on connectors.
- 2.10.5. Provisions shall be made for locking all disconnects in the OFF position with up to three padlocks.
- 2.10.6. Handle mechanisms shall be located on the bottom left side of the unit and operate horizontally to encourage operators to stand to the left of the unit being switched.
- 2.10.7. Unit construction shall combine with the vertical wire-way isolation barrier to provide a fully-compartmentalized design.

2.10.8. Up to a maximum of twelve six inch units can be installed per vertical section without placement restrictions in new or existing applications.

2.11. **Components for Six-inch Units**

2.11.1. **Six Inch Combination Starters**

- .1 All six inch combination starters shall use a unit disconnect as described in specification 2.10. All starters shall use NEMA/EEMAC-rated contactors. Starter units shall be provided with a 3-pole, external manual reset, overload relay for solid state (NEMA rated units only) motor overload protection.
- .2 When provided, control circuit transformers shall include two primary protection fuses and one secondary fuse (in the non-ground secondary conductor.) The transformer shall be sized to accommodate the contactor(s) and all connected control circuit loads.
- .3 When a unit control circuit transformer is not provided, the disconnect shall include an electrical interlock for disconnection of externally powered control circuits.
- .4 Auxiliary control circuit interlocks shall be provided where indicated. For NEMA rated starters, auxiliary interlocks shall be field convertible to normally open or normally closed operation.
- .5 NEMA/EEMAC Size 1 starters shall be mounted directly adjacent to the wireway so that power wiring (motor leads) will connect directly to the starter terminals.

2.11.2. **Terminal Blocks for Six-inch Units**

- .1 All starter units shall be provided with unit control terminal blocks.
- .2 Terminal blocks shall be pull-apart type, 250 V, and rated for 10 amperes. All current-carrying parts shall be tin-plated. Terminals shall be accessible from inside the unit when the unit door is opened. The stationary portion of the terminal block shall be used for factory connections and will remain attached to the unit when the portion used for field connections is removed. The terminals used for field connections shall be accessible so they can be wired without removing the unit or any of its components.

2.11.3. **Nameplates**

- .1 Engraved phenolic nameplates shall be provided for each MCC and unit compartment. Each nameplate shall have a gray background, white lettering, and measure a minimum of 1.5 in H x 6.25 in W (38 mm H x 150 mm W) total outside dimensions.

2.11.4. **Pilot Device Control Panel**

- .1 Each unit to be provided with a control panel for up to a maximum of four pilot devices. Control panel to be removable by loosening two semi-captive fasteners for customer access

2.12. **Quality Control**

- .1 The entire MCC shall go through a quality inspection before shipment. This inspection will include:
 - .1 Physical inspection to include:
 - a. Structure


- b. Electrical conductors, including:
 - i. Bussing
 - ii. General wiring
 - iii. Units
- .2 Electrical Tests
 - a. General electrical tests include:
 - i. Power circuit phasing
 - ii. Control Circuit wiring
 - iii. Instrument transformers
 - iv. Meters
 - v. Ground fault system
 - vi. Device electrical operation
 - b. AC dielectric tests shall be performed on the power circuit
- .3 Markings/Labels, include:
 - a. Instructional type:
 - b. Underwriters Laboratory (UL)/Canadian Standards Association (CSA).
 - c. Inspector's stamp


3. **EXECUTION**




3.1. **Location**

- 3.1.1. Motor control centers are not to be placed in hazardous locations. The area chosen shall be well ventilated and totally free from humidity, dust and dirt. The temperature of the area shall be no less than 0° C (32° F) and no greater than 40°C (104° F). For indoor locations, protection must be provided to prevent moisture entering the enclosure.
- 3.1.2. Motor control centers shall be located in an area with a minimum of 3 ft (915 mm) of free space in front of front-of-board construction. An additional 3 ft (915 mm) should be allowed in the rear of back-to-back construction. This free space will give adequate room to remove and install units. A minimum of 0.5 in (13 mm) space should be provided between the back of front-of-board MCCs and a wall, 6 in (152mm) required for damp locations).
- 3.1.3. The motor control centers shall be assembled in the factory on a smooth level surface so that all sections are properly aligned. A similar smooth and level surface shall be provided for installation. An uneven foundation will cause misalignment of shipping blocks, units, and doors. The surface under a MCC shall be of a non-combustible material unless bottom plates are installed in each vertical section.

END OF SECTION

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	Specification No. 51502-01	02	02-23-2017	1

	CLIENT: TORONTO ZOO
	PROJECT: GENERATOR REPLACEMENT-AFRICAN RAINFOREST PAVILION

		SIGNATURE	DATE
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ISSUE/REVISION INDEX

Issue Code	Revision					Revision Details
	No.	Prep. By	Rev. By	App. By	Date	
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RQ	1	KL	BS	RAW	12-01-2016	Released for Tender
RQ	2	KL	KL	RAW	02-23-2017	Released for Tender

Issue Codes: RC = Released for Construction, RD = Released for Design, RF = Released for Fabrication, RI = Released for Information, RP = Released for Purchase, RQ = Released for Quotation, RR = Released for Review and Comments.

1. GENERAL

1.1. Summary

- 1.1.1. This specification covers the installation and commissioning of enclosed stand-by power generators and associated equipment.
- 1.1.2. The stand-by generator set must meet the continuous rating criteria of ISO standards 8528.1.
- 1.1.3. The manufacturer shall provide a written certification that the selected generator set can support the listed load at the site condition for an indefinite duration.
- 1.1.4. Generator control unit must be able to be interfaced with remote monitoring and manual control system in conjunction with any applicable synchronization parallel units.
- 1.1.5. To avoid harmful vibrations in the system itself or to the supporting structure, suitable vibration dampers both between engine/alternator and base frame and between base frame and support shall be provided.
- 1.1.6. Generator shall be housed in weatherproof, acoustic-attenuated enclosure located outdoor on a reinforced concrete pad with 1" thick reinforced rubber shims under the fixing points to prevent the base tank from coming into contact with the concrete pad. If the diesel alternator set is driven by a direct air-cooled diesel engine requiring large quantities of cooling air, an additional fan may be required in the supply air duct to compensate for the pressure loss from filters, sound attenuators, and weather louvers.

1.2. Reference Drawings

- 1.2.1. VIRTUAL 51502 E-01 Rev. 2
- 1.2.2. VIRTUAL 51502 E-03 Rev. 3

1.3. Design Criteria

- 1.3.1. Design all equipment suitable to meet the following criteria:
 - 1.3.1.1. Output Power: 400kW/500kVA
 - 1.3.1.2. Voltage: 208/120V
 - 1.3.1.3. Frequency: 60Hz
 - 1.3.1.4. Phase/Wire: 3, 4
 - 1.3.1.5. Power Factor: 0.8
 - 1.3.1.6. Load harmonic content: 5% THD
 - 1.3.1.7. Maximum rotational speed: 1800RPM
 - 1.3.1.8. Duty rating: full load continuous plus 10% overload for one (1) hour in every twelve (12) hour period
 - 1.3.1.9. Performance: automatic
 - 1.3.1.10. 72hr. Fuel tank capacity
 - 1.3.1.11. Elevation above sea level: 152m
 - 1.3.1.12. Ambient temperature: 40°C
 - 1.3.1.13. Relative humidity: 60%
- 1.3.2. Units must be designed to start and attain settled voltage and frequency limits and accept 100% rated load with voltage and frequency settling to the specified steady state bands, and within fifteen (15) seconds for any temperature from 0°C to 40°C.

- 1.3.3. Complete and submit the Diesel Generator Information Form for approval of the Engineer prior to the preparation and submittal of shop drawings within ten (10) working days of award of the contract

1.4. Scope

- 1.4.1. The stand-by diesel alternator and all its associated equipment including the Diesel Alternator Control Panel shall be located in its own dedicated enclosure.
- 1.4.2. Torsion resistant steel frame of welded construction shall be the basis of the enclosure structure in accordance with manufacturer calculations. Details must be submitted for Owner' approval.
- 1.4.3. The enclosure shall be of the "skin-tight" type (complying with CSA 282-05). If the enclosure total width exceeds Ministry of Transportation permits, waivers must be submitted as per Owners' engineering rules.
- 1.4.4. Enclosure shall be suitable for cold weather generator starting. The temperature inside the enclosure shall be maintained at not less than 10° C at all times. Provide an adequate space heater inside the enclosure, if required. The entire package shall be listed under UL2200 and shall comply with the requirements of the Ontario Electrical Code / Or the provincial code where the generator will be installed. The enclosure, including all access doors, shall be water and dust tight.
- 1.4.5. Under the conditions of operation the air temperature in the enclosure shall be limited to 50 degrees centigrade and all electrical and electronic components as well as the diesel engine are to be rated to operate at the maximum temperature in the enclosure.
- 1.4.6. The enclosure shall have hinged, lockable doors for easy access during service/maintenance. Enclosure roof shall be cambered to prevent accumulation of precipitation. Provide rodent screen to limit access of rodents into the enclosure. All electrical power and control interconnections shall be made within the perimeter of the enclosure.
- 1.4.7. All sheet-metal shall be primed for corrosion protection and finish painted with the Owners' approved color using a two step electro-coating paint process. All surfaces of all metal parts shall be primed and painted. Enclosure shall be constructed of minimum 12 gauge steel for framework and 14 gauge steel for panels. All hardware and hinges shall be stainless steel. The expected lifetime of the enclosure in service shall be not less than twenty years.
- 1.4.8. All access doors shall be provided with door-open alarm contacts. An open door shall cause an alarm signal.
- 1.4.9. A factory-mounted exhaust silencer shall be installed inside the enclosure. The exhaust shall exit the enclosure through a rain collar and terminate with a rain cap. Exhaust connections to the generator set shall be through seamless flexible connections.
- 1.4.10. The enclosure shall include the following maintenance provisions:
 - 1.4.10.1. Flexible coolant and lubricating oil drain lines, that extend to the exterior of the enclosure, with internal drain valves
 - 1.4.10.2. External radiator fill provision
- 1.4.11. Provide an emergency stop switch that is protected from accidental activation.
- 1.4.12. Provide motorized louvers to minimize air flow through the enclosure when generator set is not operating. Louvers shall include provisions to prevent accumulation of debris, including ice or snow that might prevent operation.
- 1.4.13. Inlet ducts shall include rain hoods.
- 1.4.14. Provide a factory mounted and wired electrical distribution panel to serve the generator set and enclosure. The provisions required include:

- 1.4.14.1. Distribution panel board connected to load side of system distribution. Panel size must be confirmed by the supplier.
- 1.4.14.2. Two duplex GFCI receptacles, one inside the enclosure, and a weatherproof receptacle on the outside of the enclosure.
- 1.4.14.3. AC/DC lamps mounted in vapour tight fixtures.
- 1.4.15. Factory-wired normal AC service from the panel board to the engine coolant and alternator heaters, and battery charger.
- 1.4.16. The generator set shall be provided with a sound-attenuated housing which allows the generator set to operate at full rated load in an ambient temperature of up to 104°F. The enclosure shall reduce the sound level of the generator set while operating at full rated load to a maximum of 65 dBA or less to meet the requirements of “MOE” and local municipality at any location 7 meters from the generator set in a free field environment.
- 1.4.17. The enclosure shall be insulated with non-hydroscopic materials.
- 1.4.18. Provide a double-walled, steel construction sub-base fuel tank for the generator set, sized for full load (100%) operation for 72 hours.
- 1.4.19. The sub-base fuel tank shall be UL142 listed and labelled. Installation shall be in compliance with NFPA37. The fuel tank shall include the following features:
 - 1.4.19.1. Emergency tank and basin vents.
 - 1.4.19.2. Mechanical level gauge.
 - 1.4.19.3. Fuel supply and return lines, connected to generator set with flexible fuel lines as recommended by the engine manufacturer and in compliance to UL2200 and NFPA 37 requirements.
 - 1.4.19.4. Leak detection provisions, wired to the generator set control for local and remote alarm indication.
 - 1.4.19.5. High and low level float switches to indicate fuel level. Wire switches to generator control for local and remote indication of fuel level.
 - 1.4.19.6. Basin drain.
 - 1.4.19.7. Integral lifting provisions.
 - 1.4.19.8. The tank refilling pump set shall be arranged such that refilling can be done via a fixed piping system from outside the enclosure.
- 1.4.20. Complete design drawings shall be submitted and approved by Owner, local municipality and MOI before the generator is installed.
- 1.4.21. A steel platform with stair access shall be erected around the generator to facilitate the servicing of the generator when it is installed on base tank if required. The platform, placed a minimum of 6” below the enclosure, shall have a minimum width of 42” or wider if necessary to permit the full 180° opening of the service access doors. A minimum 30” platform shall link both sides. The platform deck and stairs treads shall be made with 13 gauge pre-galvanized metal “safety Grip channels”. The grating of the platform should be such that it provides safe and secure walking around the perimeter of the generator enclosure and does not allow for the accumulation of snow.
- 1.4.22. The Generator must have a movable light that is powered off the generator batteries. The light must be bright enough and movable enough to view the generator and associated components. It is to be hard wired in to the DC wiring of the batteries and the bulb or fluorescent tube must be easy to replace. The generator supplier shall obtain all approvals and permits from MOE and local municipality before installing the new generator and provide a copy of the approval to the Owner.

- 1.4.23. Provide factory test start up by a supplier authorized by the manufacturer, and on-site testing of the system.
- 1.4.24. The generator set manufacturer shall warrant all equipment provided under this section so that there is one source for warranty and product service. Technicians specifically trained and certified by the manufacturer to support the product and employed by the generator set supplier shall service the generator sets.

1.5. Codes and Standards

- 1.5.1. The generator set and its installation and on-site testing shall conform to the requirements of the following codes and standards:
 - 1.5.1.1. CSA C282-00, 2005 Electrical Power Supply for Buildings
 - 1.5.1.2. IEC8528 part 4. Control Systems for Generator Sets
 - 1.5.1.3. IEEE446 – Recommended Practice for Emergency and prime Power Systems for Commercial and Industrial Applications
 - 1.5.1.4. NEMA ICS10-1993 – AC Generator sets
 - 1.5.1.5. NFPA70 – National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702.
 - 1.5.1.6. NFPA110 – Emergency and prime Power Systems. The generator set shall meet all requirements for Level 1 systems. Level 1 prototype tests required by this standard shall have been performed on a complete and functional unit, component level type tests will not substitute for this requirement.
 - 1.5.1.7. UL2200. The generator set shall be listed to UL2200 or submit to an independent third party certification process to verify compliance as installed.
 - 1.5.1.8. Ontario/ National Building Codes
 - 1.5.1.9. Section 260000 – Electrical general requirements
 - 1.5.1.10. Ontario Electrical Safety Code 24th edition
- 1.5.2. The generator set manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

1.6. Acceptable Manufacturers

- 1.6.1. Suppliers should be manufacturers of generators or their Authorized distributors in Ontario. Approved manufactures of generator engines are Cummins, CAT, John Deere, Doosan, FTP, Mitsubishi, Volvo, or approved equals by the Owner.

1.7. Suitability

- 1.7.1. The Tenderer shall ensure that all equipment is well suited for its intended purpose, is of modern design and is compatible with other equipment with which it will be used in conjunction.
- 1.7.2. In regard to the motor-related loads, these may present a load having a relatively high content of harmonics superimposed on the fundamental frequency, and the generator voltage regulator must be designed accordingly to avoid hunting.
- 1.7.3. The tenderer shall ensure that the equipment offered will in every respect be suitable for operation in the low and high temperature, humidity and other conditions to be expected at site.
- 1.7.4. The Contractor shall obtain the approval of the generator manufacturer to the proposed loading on the diesel engines.

- 1.7.5. Diesel engine shall be sized to account for site elevation and temperature. De-rating must be approved by the Owner.
- 1.7.6. The Contractor shall formally advise the Owner what percentage of de-rated capacity at the site is available for future extensions.
- 1.7.7. Mismatch between the Diesel rating and the Alternator rating must be avoided.
- 1.7.8. Owner reserves the right to approve all designs and drawings prior to the commencement of procurement.
- 1.7.9. Approval given by Owner - or its representative - does not, however, relieve the Contractor of any of his responsibility.

2. PRODUCTS

2.1. Assembly

- 2.1.1. Provide the following items plus such other items as necessary to make the unit complete as implied or intended:
 - 2.1.1.1. Diesel Engine
 - 2.1.1.2. Diesel Engine Accessories
 - 2.1.1.3. Base-plate and Drip Pan
 - 2.1.1.4. Vibration Isolators
 - 2.1.1.5. Governor
 - 2.1.1.6. Engine Exhaust System
 - 2.1.1.7. Engine Cooling System
 - 2.1.1.8. Engine Ventilating System
 - 2.1.1.9. Starting Motor(s)
 - 2.1.1.10. Batteries and Rack
 - 2.1.1.11. Battery Charger
 - 2.1.1.12. Generator and Exciter
 - 2.1.1.13. Voltage Regulator and Accessories
 - 2.1.1.14. Spares and Accessories

2.2. Mounting

- 2.2.1. Connect engine flywheel housing rigidly to generator stator housing with SAE adapter. Mount unit on a common, heavy duty fabricated steel base-plate. Design and materials of base-plate must be approved by engine manufacturer and the Engineer
- 2.2.2. Base-plate of sufficient rigidity to maintain alignment of engine-generator shafts and frames under all conditions incident to shipping, installation and service.
- 2.2.3. Machine engine-generator feet and base-plate sole plates parallel and true. Shimming to be steel type and only permitted underneath the generator feet
- 2.2.4. Support base-plate on spring type isolating fixtures from welded side brackets located in such a manner that bottom of base-plate will be approximately 25mm above supporting floor. Isolators shall have cast iron housings and be complete with levelling bolts, adjustable oil proof snubbers and minimum 6mm sound pads. Isolation efficiency to be not less than 95%.

- 2.2.5. Determine quantity and location of isolators in such a manner that each isolator will carry equal proportion of weight and that the pressure exerted on the floor by each isolator does not exceed 345kPa.
- 2.2.6. Isolators shall be shipped loose for installation at project site.

2.3. Diesel Engine

- 2.3.1. Full diesel, heavy duty, cold start, liquid cooled, vertical in-line or vee, and current manufacture of a type and size that has been in service as a prime mover for electric power generation for not less than two (2) years. Exhaust-driven turbo-supercharged engine acceptable providing Brake Mean Effective Pressure (BMEP) at rated output does not exceed 1800kPa. Mechanically driven superchargers not acceptable.
- 2.3.2. Engine shall have a minimum of six (6) cylinders.
- 2.3.3. Engine with auxiliary starting aids (ie: glow plug assist start) not acceptable
- 2.3.4. Equip engine air intakes with dry type heavy duty air cleaners located close to the inlet manifold. Cleaner element to be directly replaceable.
- 2.3.5. Provide engine wiring in liquid-tight conduit and fittings with insulated bushings. Use stranded, minimum No. 14 AWG, TEW 105°C and coloured coded wires. Terminate wiring with coded, insulated terminals flanged fork type. Terminal blocks heavy duty, screw type. Wire markers of slip on oil proof type. Junction boxes on unit of liquid-tight type. Maximum of two (2) wires per terminal block.
- 2.3.6. Provide high quality lubricating oil pressure gauge, lubricating oil temperature gauge, coolant temperature gauge, thermocouple exhaust pyrometer and other standard gauges and instruments. Calibrate and scale gauges and instrument in both metric and imperial units and symbols. Oil temperature sensors to be mounted on engine full flow pressure line. Hoses or tubing for gauges shall be high pressure reinforced type.
- 2.3.7. Mount unit accessories, including gauges, instruments, and protective sensors, in such a manner that machine vibrations are isolated or damped.
- 2.3.8. Dynamically balance complete engine flywheel generator arrangement after assembly. Guarantee no torsional or other harmful vibrations within 10% above or below rated speed of unit, when operating unloaded or connected to any load within its rating. Cyclic irregularity to be no greater than 1/250.
- 2.3.9. Provide engine flywheel with graduated marking around its periphery to facilitate fuel injection and valve timing. Unit must not experience vibration or displacement greater than 6mils or a velocity greater than 1.0cm/sec measured over a spectrum of 100Hz to 10,000Hz. Measurements shall be taken at NL, 25%, 50%, 75% and 100% full load.
- 2.3.10. Provide removable wet type cylinder liners. Furnish cylinder head with removable valve seat insert and guides.
- 2.3.11. Provide personnel safety guards for exposed moving parts and exhaust manifolds. Provide platform for servicing upper part of engine where applicable.

2.4. Jacket Water Cooling System

- 2.4.1. This assembly covers a locally mounted radiator situated on the engine base with an engine driven fan and a totally enclosed water system.
- 2.4.2. Pusher fan to be driven from the engine with V-belt(s).
- 2.4.3. Radiator, mounted on set base, amply sized to cool the engine under full load and overload conditions in an ambient of 30° C complete with radiator inlet cowling and outlet ducting flange.

- 2.4.4. Flexible canvas boot for mounting on the front of the radiator, flanged on both sides, length 100 mm minimum.
- 2.4.5. Engine driven water circulating pump.
- 2.4.6. Temperature regulating valve with bypass feature, located in cylinder head water outlet.
- 2.4.7. Water pipes, flexible hoses, etc. drain cocks to permit the complete system to be drained.
- 2.4.8. Safety protection guards around all moving parts.
- 2.4.9. First filling of water/antifreeze suitable for -40° C.
- 2.4.10. Unit mounted radiator fan to be rated for 8500 CFM, 0.50" SP.

2.5. Fluids

- 2.5.1. Engine Jacket Fluid Mix
 - 2.5.1.1. The Contractor shall supply all necessary Ethylene Glycol/Water at a 50/50 concentration by volume until equipment is commissioned.
 - 2.5.1.2. Engine Jacket Water Coolant
 - 2.5.1.2.1. Long life ethylene glycol complete with additives.
 - 2.5.1.2.2. Shop drawings must be submitted for approval by the engine manufacturer.
 - 2.5.1.2.3. Ethylene Glycol to be heavy duty suitable for use with the engine comprising the genset package.

2.6. Lubrication System

- 2.6.1. Provide a full pressure lubricating system complete with duplex filters and oil cooler.
- 2.6.2. Oil pump shall be engine driven gear type complete with strainer.
- 2.6.3. Equip filters with automatic by-pass valve and full flow filter elements conveniently located for servicing and directly replaceable. Cooler to have sufficient capacity to maintain oil temperature within 93°C with unit operating at rated load under conditions specified.
- 2.6.4. Equip engine oil sump with oil drain pipe, gate valve and pipe cap. Permit complete drainage in a convenient manner. Extend 75mm beyond base plate.
- 2.6.5. Operational requirements are such that unit may lay idle for periods up to one (1) month and then be required to start and assume full rated load within the specified (fifteen (15) seconds) time period. To protect service life of engine components, provide an electrical motor driven, integrally mounted, gear type oil priming pump with interval timer and breaker type combination starter. Starter mounted in control panel. Lubrication oil pressure switch to stop priming pump when engine is running. Where pump is not being provided, submit a letter with Tender certifying that oil pump is not required for these conditions and will not detract from the service life of engine components.
- 2.6.6. All gensets rated greater than 750kW to have pre-lube pumps and fuel cooler.
- 2.6.7. All metallic oil hoses shall be of the steel reinforced rubber type with crimped or swaged end fittings.
- 2.6.8. First on site replacement of lubricating oil to be shipped loose in containers. Upon completion of commissioning engine, oil is to be replaced. Used oil to be disposed of by the Contractor.

2.7. Fuel System

- 2.7.1. Provide a complete fuel system including an integral fuel lift pump and duplex filters.

Filter elements to be directly replaceable.

- 2.7.2. Fuel pump to have minimum suction lift capability of 1.0m.
- 2.7.3. Bring fuel supply and return lines to extreme forward part of base-plate with drop ear elbows to be affixed thereto. Connect the other end of each elbow with 1m of flexible neoprene hose
- 2.7.4. Flexible connectors, bronze corrugated type for the suction and return lines, located in a horizontal plane and secured at one end to the engine base. Equal to "United Flexible" type BA.
- 2.7.5. All non-metallic fuel hoses shall be of the steel reinforced rubber type with crimped or swaged end fitting.
- 2.7.6. Fuel system to include a fuel filter/water separator ie: Racor or equal.
- 2.7.7. All fuel piping to be schedule 40, carbon steel with welded construction.

2.8. Exhaust System

- 2.8.1. Provide a complete exhaust system including combustion exhaust silencer with condensate drain, plug and flanged couplings; stainless steel, corrugated expansion joints, of suitable length, to absorb both vertical and horizontal expansion; all flanges, bolts, gaskets, adjustable hangers and pipe and pipe- thimble to permit projection of pipe 1m beyond wall. Exhaust tail pipe end to be cut at 45 degree angle and terminate in bird screen if mounted horizontally, or equipped with a rain guard if mounted vertically. All interior exhaust piping and silencer shall be insulated.
- 2.8.2. Arrange exhaust system to suit openings. Where schedule of dimensions does not indicate location of opening, arrange exhaust run best suited to the engine.
- 2.8.3. Provide exhaust pyrometers located on common exhaust manifold or two (2) pyrometers on separate manifolds. Pyrometer range to include temperature at 110% load.
- 2.8.4. Exhaust piping shall be schedule 10, Type 304L; stainless steel.
- 2.8.5. All pipe connectors shall be Vanstone-type flanges with 125 – 150lb. Backing rings and 950°F gaskets.
- 2.8.6. Piping inside enclosure shall be securely supported. Bolts shall be positively locked to prevent loosening through vibration and/or creating any twisting/flexing load on the turbocharger.
- 2.8.7. Flexible connection at engine
 - 2.8.7.1. Exhaust flexible connection, T321 stainless steel, bellows type of appropriate length, ANSI flanges for connecting to the exhaust manifold.
 - 2.8.7.2. Approved Suppliers:
 - 2.8.7.2.1. Flexonics
 - 2.8.7.2.2. Silex
 - 2.8.7.2.3. Approved equal
- 2.8.8. Exhaust silencers
 - 2.8.8.1. One (1) silencer per cylinder bank (total of two for vee-type engines) shall be provided to attenuate both high and low frequency noise.
 - 2.8.8.2. Silencers to be rated for 510°C temperature.
 - 2.8.8.3. Silencers to be provided with flanges and port orientation as required.
 - 2.8.8.4. Hospital grade plus providing attenuation of 35-50 dBA across

the audible range of the frequency spectrum 63 to 600Hz.

2.8.8.5. Provide a 12mm drain piped to a discharge point using copper tubing. Tubing to be terminated with a ball valve as directed by the Engineer.

2.8.8.6. Finish: 510°C high temperature paint

2.8.8.7. Acceptable Suppliers:

2.8.8.7.1. Silex

2.8.8.7.2. Approved equal

2.8.9. Insulation

2.8.9.1. Interior exhaust piping and silencers to be insulated with 50mm of calcium silicate to limit surface temperature to 82°C at an ambient temperature of 27°F.

2.8.9.2. Insulation to be moulded for pipe application.

2.8.9.3. Insulation temperature limit: 650°C

2.8.9.4. Outer shell: Aluminized sheet steel.

2.8.9.5. Approved suppliers:

2.8.9.5.1. Manville Thermo – 12/Blue Insulation

2.8.9.5.2. Approved equal

2.8.10. Exhaust Enclosure Penetration Sleeve

2.8.10.1. Sleeve shall be of insulated type, ULC-listed for exhaust pipe transition through enclosure wall.

2.8.10.2. Approved Suppliers:

2.8.10.2.1. Silex

2.8.10.2.2. Approved equal

2.8.11. Exhaust Manifold(s) Insulation

2.8.11.1. Insulation shall be fabricated using Firwin 1200 insulating blanket

2.8.11.2. Thickness: 25mm.

2.9. Engine Coolant Heater

2.9.1. Provide engine coolant heater complete with 20°C to 60°C adjustable immersion type thermostat. Size heater to maintain coolant at 40°C in an ambient temperature of 0°C.

2.9.2. Obtain circulation of heated coolant on thermosyphon principle. However, if this does not provide sufficient circulation to avoid hot spots in the system, provide electrical motor driven circulating pump to operate automatically when heater is energized. Motor to be 120V single phase splash-proof type complete with breaker type combination starter. Starter to be mounted in control panel.

2.9.3. Heater and aquastat to be Kim Hotstart or equivalent.

2.9.4. The Contractor shall coordinate block heater kW, voltage, Ph.

2.10. Speed Governor

2.10.1. Provide full electronic governor with speed changer and dry type actuator. Governing system shall be in accordance with ISO 3046/4-1978(E).

- 2.10.2. Governor shall provide the following features:
- 2.10.2.1. Ten (10) turn locking type manual speed adjustment
 - 2.10.2.2. Speed regulation, steady state, no-load to full load and vice versa: $\pm 0.25\%$.
 - 2.10.2.3. Transient peak, no-load to full-load and vice versa $\pm 10\%$.
 - 2.10.2.4. Recovery time to steady state condition on application of full load from no load shall not exceed three (3) seconds.
 - 2.10.2.5. Frequency shall be externally adjustable from zero to 5% while engine is running.
 - 2.10.2.6. Class A accuracy.
 - 2.10.2.7. Acceptable Manufacturers:
 - 2.10.2.7.1. Woodward
 - 2.10.2.7.2. BarberColeman
 - 2.10.2.7.3. Approved equal

2.11. Starting System

- 2.11.1. Provide a complete starting system, 24VDC, including cranking starting motor(s), batteries, battery stand, heavy-duty battery cables and battery charger.
- 2.11.2. Provide positive engaging type cranking motor(s). Cranking motor and flywheel ring gear arrangements which may permit tooth to tooth abutment not acceptable
- 2.11.3. Provide lead acid battery, type 80 with sufficient capacity in an ambient room temperature of 0°C to crank the unit at engine manufacturer's recommended cranking starting speed for a period of three (3) minutes. Voltage measured at starting motor terminals at end of three (3) minutes cranking, with cranking current flowing, to be not less than 1.75V per cell. Size battery on the basis of engine and battery manufacturer's published data. Batteries to be dry-charged, specific gravity of electrolyte 1.220 when fully charged at 27°C. Battery termination shall be bolt-on or study type. Terminals and all exposed electrical connections shall be protected from accidental short circuit by falling conductive objects on the battery. Such protection shall be transparent.
- 2.11.4. Provide battery stand coated with acid resistant paint and fabricated from angle irons with 20mm plywood bottom and heavy duty casters for ease of movement.
- 2.11.5. Provide battery charger with 120VAC input and output equal to 1.20 of the ampere-hour capacity of the battery based on a eight (8) hour rate. Output voltage ripple shall be 3% or less. Provide an AC input circuit breaker and a twenty four (24) hour terminating equalizer timer with approximately 4m of connecting cord and permanent connectors for connecting to battery terminals. Provide five (5) spare fuses inside charger panel. Charger to be CSA approved.
- 2.11.6. Provide necessary heavy duty, maintenance free battery cables and connectors. Select cable wire size on the basis of allowing not more than 5% voltage drop at time of peak load. Cable length to be sufficient to allow battery to be located on either side of the engine.

2.12. Generator

- 2.12.1. Provide generator, drip proof, single bearing and close coupled to engine with SAE housing. Generator to have a full amortisseur winding, direct connected brush less exciter with easily removable bolt-on diodes with surge protection, and meet or exceed EEMAC MG1-22 and current IEEE Standards.
- 2.12.2. Maximum deviation of open circuit terminal voltage waveform not to exceed 5%.

- 2.12.3. Provide Permanent Magnet Generator (PMG) for generator short circuit sustaining capability not less than 2.4 times rated current.
- 2.12.4. Generator winding insulation shall be Class F; winding temperature rise not to exceed 105°C as measured by resistance in an ambient temperature of 40°C.
- 2.12.5. Identify generator windings with metal tags. Bring windings to insulated terminals in a metal junction box mounted on the side or top of generator. Size junction box to permit mounting of engine and generator low voltage controls and wiring terminals blocks. Provide barrier in junction box to separate low and high voltage wiring.
- 2.12.6. Design equipment to minimize Radio Frequency Interference (RFI) under all operating conditions. Balanced Telephone Influence Factor (TIF) to meet or better requirements of EEMAC Standard MG1-22.43.

2.13. Voltage Regulator

- 2.13.1. Provide a voltage regulation system complete with auto/manual control module. Voltage regulator shall be capable of withstanding continuous vibration, 15 shock and temperature up to 50°C while maintaining accuracy to $\pm 1\%$.
- 2.13.2. Steady-state voltage regulation not to exceed 1%. Transient voltage regulation, when full load is applied or removed, not to exceed 10% when measured by oscilloscope or high speed strip chart recorder with recovery time to steady-state less than three (3) seconds.
- 2.13.3. The automatic voltage regulator shall be a Basler SSR63-12 AVR or approved equal.
- 2.13.4. AVR to have following features:
 - 2.13.4.1. Regulation: $\pm 1.0\%$, steady state, NL to FL.
 - 2.13.4.2. Sensing: single phase, 120V AC, 60Hz.
 - 2.13.4.3. External voltage adjust range: $\pm 10\%$ of nominal voltage.
 - 2.13.4.4. Built in EMI interface suppression and built in under frequency control for 60Hz operation. Under frequency roll off which shall reduce output voltage in proportion to frequency below a threshold to 54Hz.
 - 2.13.4.5. Operating Temperature: -40°C to 60°C.
 - 2.13.4.6. AVR to be located in control cubicle. **NOTE:** if additional field resistance is required, locate resistor in switchgear/control cubicle.
 - 2.13.4.7. Recovery time from load change to steady state regulation better than two (2) seconds.
 - 2.13.4.7.1. NL to 25% load
 - 2.13.4.7.2. NL to 50% load
 - 2.13.4.7.3. NL to 75% load
 - 2.13.4.7.4. NL to 100% load

2.14. Control Panel

- 2.14.1. Panel shall be microprocessor based and genset mounted.
- 2.14.2. Design and construct panel to withstand strains, jars, vibrations and other conditions incident to shipping, storage, installation and service.
- 2.14.3. Panel to be CSA certified. Mount a nameplate bearing CSA monogram in a prominent position on panel.
- 2.14.4. Engine controller to include an operator interface keypad and LCD/LED display to suit status monitoring of the unit and manipulation of the generator operating parameters.
- 2.14.5. Identify all instruments and controls with lamicoid or metal engraved nameplates fastened by rivets or screws for permanent identification. All items mounted on panel door shall also be identified with nameplates. Nameplates shall not be attached to removable items such as relays and wire way covers.
- 2.14.6. Factory wire panel completely. Use stranded, minimum No.14 AWG, TEW 105°C and coloured for control wiring. Use No.14 AWG for CT secondary connections:
 - 2.14.6.1. Blue – DC control
 - 2.14.6.2. Red – AC control
 - 2.14.6.3. Black – PT secondary connections
 - 2.14.6.4. Orange – CT secondary connections
 - 2.14.6.5. Green – Non-current carrying ground
 - 2.14.6.6. White – Current carrying ground
 - 2.14.6.7. Yellow – Interlock
 - 2.14.6.8. Brown – Generator excitation system
- 2.14.7. Code wiring at each wire end with permanent, non-aging slip on markers. Support and run wiring neatly. Protect wiring from mechanical damage by grommets and shields.
- 2.14.8. Terminal blocks to be coded, clamp type, serrated for positive grip and of tough, non-brittle, unbreakable nylon, MTE size 3,453/0 or equivalent. For current transformer secondary circuits, provide terminals blocks of dual connector type, Electrovert 9060 or equal. Provide test block for current transformer secondary connections.
- 2.14.9. Supply loose two (2) sets of wiring markers for each external wiring connection. Markers shall be contained in a plastic bag and secured inside the panel.
- 2.14.10. Direct inter-panel connection not permitted, use terminal blocks.

2.15. Controller

- 2.15.1. The engine generator controller shall be microprocessor based and shall contain the following basic features: automatic and manual start/stop control modes, monitoring and control of essential engine generator set parameters and automatic shutdown and/or alarm status of specified protection fault circuits. The automatic operation mode shall have provisions for accepting an automatic starting/stopping signal from a remote device. Alarm and shutdown fault circuits provided shall meet CSA 282 building code standards and NFPA 110 level 1 regulatory standards. The following alarm and shutdown fault circuits shall be provided (but not be limited to):

1	Low oil pressure	Shutdown
2	High engine temperature	Shutdown
3	Low coolant level	Shutdown

4	Low fuel level	Alarm
5	Over-crank	Shutdown
6	Over-speed	Shutdown
7	Loss of speed	Shutdown
8	Low battery voltaae	Alarm
9	High battery voltage	Alarm
10	Weak battery	Alarm
11	Low oil pressure	Alarm
12	High engine temperature	Alarm
13	Low enaine temperature	Alarm
14	Reverse power	Shutdown
15	Under-voltage	Shutdown
16	Over-voltaae	Shutdown
17	Under-frequency	Shutdown
18	Over-frequency	Shutdown
19	Breaker tripped	Shutdown
20	Fail to Sync	Alarm
21	Emen encv stop	Shutdown
22	Switch not in auto	Alarm
23	Spare	Shutdown
24	Spare	Shutdown

- 2.15.2. Individual contacts shall be provided for each alarm/shutdown fault circuit. Contacts shall be user configurable for open or close upon initiation of the fault. Fault contacts shall be factory configured for "close on fail". Contacts shall be rated 0.5AAC 120VAC, 1.0ADC 30VDC resistive, maximum.
- 2.15.3. The controller shall include an operator interface to provide access to security password system for access to all programming functions. Specific password levels shall be provided for "read only", "read/write" and "master". All programming set points for voltage, frequency and time delays shall be software programmable from the front panel mounted keypad, and all parameters shall be displayed in alpha numeric format via a door mounted liquid crystal display (LCD) screen. The following parameters shall be displayable:
- 2.15.3.1. Generator AC digital metering (3 phase V, A, F)
 - 2.15.3.2. Timer countdown display
 - 2.15.3.3. Operating status/switch position
 - 2.15.3.4. Alarm/Shutdown fault display
 - 2.15.3.5. Engine Hour Meter
 - 2.15.3.6. Engine Oil Pressure (kPa)
 - 2.15.3.7. Engine Oil Temperature (°C)
 - 2.15.3.8. Engine Coolant Temperature (°C)
 - 2.15.3.9. Exhaust Gas Temperature (°C). Note: this shall be dual-scale for vee engines.
 - 2.15.3.10. Engine RPM (Tachometer)
 - 2.15.3.11. Battery Voltage
- 2.15.4. Generator AC digital metering shall be integral to the engine generator controller and the Multifunction Generator Protection relay (they shall have an accuracy of+/- 1%). The digital

metering shall be fully programmable from the front panel display. Programming for voltage and current PT/CT ratios and software calibration shall be provided for all input ranges. The following generator output AC parameters shall be monitored and displayed:

- 2.15.4.1. AC Voltage - 3 phase (line to line, line to neutral, and average)
- 2.15.4.2. AC Current - 3 phase (individual phases and average)
- 2.15.4.3. AC Frequency (resolution to 0.1Hz)
- 2.15.5. Digital display of Engine parameters shall be provided by the engine generator controller. Engine oil pressure and engine temperature shall be monitored and shall be displayed in metric or imperial engineering units. Oil pressure and temperature senders shall be supplied for mounting on the engine generator set.
- 2.15.6. Long life LED type pilot lights shall be provided on the engine generator controller to indicate general operating conditions as follows:
 - 2.15.6.1. Common Alarm (Flashing-Amber)
 - 2.15.6.2. Common Shutdown (Flashing-Red)
 - 2.15.6.3. System Ready (Green)
 - 2.15.6.4. Speed Signal Present (Green)
- 2.15.7. The engine generator controller shall contain the following protective functions utilizing analog input signals:
 - 2.15.7.1. (27/59) three phase under/over voltage protection shall be provided for the engine generator. The under/over voltage protection function shall be programmable as follows:
 - 2.15.7.1.1. Under voltage pick-up 70-100% of nominal, factory set at 90%
 - 2.15.7.1.2. Under voltage dropout 70-100% of nominal, factory set at 80%.
 - 2.15.7.1.3. Under voltage delay 0 -10 seconds, factory set at 3 seconds.
 - 2.15.7.1.4. Over voltage pick-up 100 - 130% of nominal, factory set at 110%.
 - 2.15.7.1.5. Over voltage dropout 100 - 130% of nominal, factory set at 108%.
 - 2.15.7.1.6. Over voltage delay 0 - 10 seconds, factory set at 2 seconds.
 - 2.15.7.2. (81 O/U) over/under frequency protection shall be provided for the engine generator. The over/under frequency protection function shall be programmable as follows:
 - 2.15.7.2.1. Under frequency set-point 70-100% of nominal, factory set at 90%.
 - 2.15.7.2.2. Under frequency set-point 70-100% of nominal, factory set at 90%.
 - 2.15.7.2.3. Over frequency set-point 100-130% of nominal, factory set at 100%.
 - 2.15.7.2.4. Over frequency delay 0 - 10 seconds, factory set at 2 seconds.
 - 2.15.7.3. (51) three phase over current alarm protection shall be provided for the engine generator. The over current protection function shall be programmable as follow:
 - 2.15.7.3.1. Over current set-point 100-150% of nominal, factory set at 110%.
 - 2.15.7.3.2. Over current delay 0 - 10 seconds, factory set a 5 seconds.
 - 2.15.7.4. Low/High battery voltage protection shall be provided for the control system. The protection function shall be programmable as follows:
 - 2.15.7.4.1. Low battery voltage set point 50-100% of nominal, factory set at 12.8Vdc (12Vdc systems) or 25.6Vdc (24Vdc systems).

- 2.15.7.4.2. Low battery voltage delay 0-300 seconds, factory set at 120 seconds.
- 2.15.7.4.3. High battery voltage set-point 100-130% of nominal, factory set at 15.2Vdc (12Vdc systems); 30.4Vdc (24Vdc systems).
- 2.15.7.4.4. High battery voltage delay 0-300 seconds, factory set at 10 seconds.
- 2.15.7.5. Weak battery sensing shall be provided to detect a low capacity engine starting battery system. This function shall be programmable as follows:
 - 2.15.7.5.1. Weak battery set-point 50-100% of nominal, factory set at 8.0Vdc (12Vdc systems); 18.0Vdc (24Vdc systems).
 - 2.15.7.5.2. Weak battery transient delay 0-300 seconds, factory set at 3 seconds.
- 2.15.8. Diagnostic LED's shall be provided on the rear of engine generator control module to allow simple visual indication of operating status or mode. Individual LED's shall be provided for the following functions:
 - 2.15.8.1. Watchdog (CPU running)
 - 2.15.8.2. Remote start signal activated
 - 2.15.8.3. Crank output energized
 - 2.15.8.4. Run output energized
 - 2.15.8.5. Common fail alarm activated
- 2.15.9. The engine generator controller shall have an audible alarm feature to signal shutdown and alarm conditions.
- 2.15.10. The engine generator controller shall include the following operator control functions:
 - 2.15.10.1. Operation Mode (Auto/Off/Manual/Load Test)
 - 2.15.10.2. Programming (Enter/Exit/Value Increment/Decrement)
 - 2.15.10.3. Lamp Test
 - 2.15.10.4. Fault Reset
 - 2.15.10.5. Alarm Horn Silence
 - 2.15.10.6. Emergency Stop
- 2.15.11. The engine generator controller shall provide cycle cranking control logic with programmable number of crank attempts (Adj. 1-99, factory set at 3 attempts) crank period time (Adj. 0-99 sec, factory set at 15 sec) and rest period time (Adj. 0-99 sec, factory set at 10 sec).
- 2.15.12. Engine control logic shall include the following sensing and protection circuits:
 - 2.15.12.1. Loss of speed signal sensing shutdown.
 - 2.15.12.2. Starter re-engage sensing control (to re-engage starter motor upon initial failure to engage).
 - 2.15.12.3. Run output fail safe selection (to prevent engine starting if speed signal is not present).
- 2.15.13. Programmable output function contacts shall be provided by the engine generator controller. Contacts shall be type Form C, rated 10A, 240V AC, 30V DC resistive, maximum.
 - 2.15.13.1. The following programmable output control functions shall be

available for specific system applications:

- 2.15.13.1.1. Energize to stop
- 2.15.13.1.2. Over current
- 2.15.13.1.3. Cycle lube
- 2.15.13.1.4. Engine run - Provide minimum of six (6) dry contacts.
- 2.15.13.1.5. System ready
- 2.15.13.1.6. Oil bypass delay expired
- 2.15.13.1.7. Air flap
- 2.15.13.1.8. Common fail
- 2.15.13.1.9. Preheat
- 2.15.13.1.10. Common alarm
- 2.15.13.1.11. ATS test
- 2.15.13.1.12. Genset selector switch in auto
- 2.15.13.1.13. Common shutdown

2.15.14. A time delay on engine start shall be provided to delay the engine start signal. The time delay shall be programmable 0-60 seconds, factory set at 2 seconds.

2.15.15. A time delay for engine cool-down shall be provided which delays engine stopping. The time delay shall be programmable 0-30 minutes, factory set at 5 minutes.

2.15.16. A lamp test function to test all LED lights and the LCD display shall be provided with the engine generator controller.

2.15.17. Remote communication of all status points (alarms, shutdowns, switch position) and all measured analog values. Remote control and supported. Communication shall be via RS422/485 port located on the engine generator controllers. The RS422/485 shall allow all engine controllers to be interconnected together to form a common communication link. A common communication module shall support ModbusR or Allen Bradley DH485 or AB Device Net software protocol for interconnection into the Plant SCADA system.

2.16. Engine Wiring and Terminal Box

2.16.1. Provide heat and oil resistant wire from the safety switches and control devices. Run the wire neatly in a harness, secure to the engine and terminate at the engine terminal box.

2.16.2. Provide a CSA enclosure 5 for the engine terminal box with a numbered terminal strip to correspond with the schematic diagram. Provide a separate junction box for the 120V and 24V DC circuits.

2.17. Tools

2.17.1. Supply suitable engine barring device and the battery manufacturer's standard set of tools for battery service. Battery service tools to include as a minimum, hydrometer, one (1) plastic bottle for topping up purposes and one (1) insulated battery terminal wrench.

2.17.2. Provide a complete set of specialized tools required for the proper care, adjustment and maintenance of equipment supplied

2.18. Signs

- 2.18.1. Provide at the front top of each panel and on each generator junction box, a lamacoid or metal engraved identification nameplate.

2.19. Finishing and Painting

- 2.19.1. Properly clean, finish and paint equipment with a smooth and durable finish. Use grey gloss 501.108 except inside of panel to be painted with white gloss 513- 101 in accordance with CGSB 1-GP-12c schedule of paint colours.
- 2.19.2. Provide one half-pint can of grey gloss 501.108 paint.
- 2.19.3. Paint the complete equipment, except finished and machined parts also special items listed below:
 - 2.19.3.1. One (1) coat of primer, red lead, iron oxide, oil alkyd, heat resistant 0.04 -0.05mm dry
 - 2.19.3.2. One (1) top coat of enamel, light equipment fray, alkyd gloss, heat resistant, 0.05 - 0.08mm minimum.
- 2.19.4. Protect data labels on all equipment while painting and ensure labels are legible.
- 2.19.5. Coat liberally, all finished and machined parts with petroleum or wax base, for temporary protective coating.
- 2.19.6. Paint protective guards on the set **red**.
- 2.19.7. Finish the control panel white on the inside and light grey on the outside unless otherwise noted.
- 2.19.8. Finish the exhaust silencer and flexible connector with aluminium silicone alkyd paint, heat resistant to approximately 650°C.
- 2.19.9. If the Supplier recommends his/her standard paint and finishes, he/she may offer these as an alternative with full details and the adjustment in price.

2.20. Workmanship

- 2.20.1. Manufacture and construct the equipment with new materials, and in the best workmanship manner.
- 2.20.2. Give particular attention to freedom from blemishes, defects, burrs and sharp edges; accuracy of dimensions and marking of parts and assemblies; thoroughness of welding, brazing, painting and wiring, alignment of parts and tightness of assembly screws and bolts.

3. EXECUTION

3.1. Packing

- 3.1.1. Comply with the requirements of Section 01610 - Basic Product Requirements.
- 3.1.2. Protect the equipment against corrosion, dampness, heavy rain, etc. Also, provide adequate protection against damage or loss of components from the time the equipment leaves the manufacturer's factory until received at the destination. Ensure packing is acceptable to the transportation companies.
- 3.1.3. Include heavy duty plastic sheet or bags to cover components vulnerable to construction dust. Tag this packing suitably to instruct the Contractor to leave this protection in place (where practical) until construction and clean up is complete.
- 3.1.4. Arrange the engine for shipment and suitably tagged with warning labels.

- 3.1.4.1. Tag the engine sump that the lube oil to be replaced at commissioning.
- 3.1.4.2. Tag the radiator, etc, to show that the coolant includes antifreeze.
- 3.1.5. Provide in each manual, a complete inventory of all spare parts, tools and accessories, a copy to accompany the shipment and a copy forwarded to the Engineer and /or Site Engineer.
- 3.1.6. Do not ship the equipment from the plant except by prior agreement with the Engineer and the purchaser.
- 3.1.7. Arrange the shipment on the transport to facilitate off-loading by the Contractor's crane or skids at the job site.

3.2. Warranty

- 3.2.1. Provide a written guarantee signed and issued in the name of the Owner stating that the complete assembly consisting of the diesel generator unit and all equipment and accessories is guaranteed against defects and malfunction for a period of one (1) year from the date of project substantial completion or two (2) years from the date of factory delivery whichever is the lesser

3.3. Spares

- 3.3.1. For panels provide the following:
 - 3.3.1.1. One (1) spare control circuit breaker per rating.
 - 3.3.1.2. Twenty four (24) spare indicating light bulbs per rating.
 - 3.3.1.3. One (1) spare control relay and socket per rating and contact arrangement.
 - 3.3.1.4. One (1) spare contactor operating coil.
- 3.3.2. Provide for the generator unit, a standard set of engine manufacturer's spare parts for one (1) year normal operation 1,000 operating hours. Spares to include as a minimum:
 - 3.3.2.1. Six (6) fuel filter elements for each type of fuel filter/water separator.
 - 3.3.2.2. Six (6) lubricating oil filter elements .
 - 3.3.2.3. Three (3) air cleaner elements .
 - 3.3.2.4. One (1) injector assembly
 - 3.3.2.5. One (1) set of drive belts.
- 3.3.3. Where metric size nuts and bolts are used, provide one (1) set of sockets complete with ratchet handle and set of combination wrenches, to fit all sizes used.
- 3.3.4. Provide conclusive evidence that a Canadian distributor has been established

3.4. Acceptance (shop) Tests

- 3.4.1. General: Before acceptance, assemble and set up the unit, complete with specified equipment, for tests at the supplier's plant. Tests shall be witnessed by the Engineer on a date mutually agreed on. Provide suitable test area with adjustable loading facilities. Supplier shall ensure that the engine has run in sufficiently prior to load test, all test forms filled in, system debugged and recorders connected.

- 3.4.2. Examination of product: a complete mechanical and electrical examination to determine compliance with specification and drawings with respect to materials, workmanship, dimensions and marking.
- 3.4.3. Non-operational tests and checks: perform following test and checks before starting the unit:
- .1 Shaft alignment, end float, angular and parallel
 - .2 Cold resistance of generator windings
 - .3 Belt tensioning
 - .4 Equipment grounds
 - .5 Electrical wiring
 - .6 All grease lubricating points
 - .7 Personnel safety guards
 - .8 Air cleaner
 - .9 Coolant
 - .10 Lubricating oil type and level
 - .11 Type of fuel
 - .12 Vibration isolator adjustment
 - .13 Temperature and pressure sensors
 - .14 Engine exhaust system
 - .15 Tools
 - .16 Spares
- 3.4.4. Operation test and check: on completion of paragraph 3.4.3.13, start the unit cold. Provide multi-channel recorder and record the following:
- 3.4.4.1. Time for unit to start and reach settled voltage and frequency
 - 3.4.4.2. Time from initiation of start to full load application, with voltage and frequency settled.
 - 3.4.4.3. Voltage and frequency transient and steady state limits for full load to no load, ~~44~~ load to no load, 3/4 load to no load, 1/2 load to no load, 1/4 load to no load and vice versa. Measure machine vibration levels under the same load conditions.
 - 3.4.4.4. Record battery voltage drop during cranking.
- 3.4.5. Protection and control demonstration: on completion of paragraph 3.4.3.13, demonstrate the following:
- 3.4.5.1. Overheat protection
 - 3.4.5.2. Low oil pressure protection
 - 3.4.5.3. Cranking cut out
 - 3.4.5.4. Over crank protection (3 tries)
 - 3.4.5.5. Over speed protection
 - 3.4.5.6. Under and over frequency
 - 3.4.5.7. Under and over voltage

- 3.4.5.8. Electrical fault protection:
 - 3.4.5.8.1. Failure to close breaker
 - 3.4.5.8.2. Failure to build up voltage
- 3.4.5.9. All control functions
- 3.4.6. Load tests: load test the unit for four (4) hour at full rated load and a further one hour at 110% rated load in ambient room temperature of 40°C. Take following data at the start of load test and every 15mins interval thereafter:
 - 3.4.6.1. Frequency
 - 3.4.6.2. Voltage
 - 3.4.6.3. Current
 - 3.4.6.4. Kilowatts
 - 3.4.6.5. Generator winding temperature
 - 3.4.6.6. Generator frame temperature
 - 3.4.6.7. Engine coolant temperature
 - 3.4.6.8. Oil temperature and pressure
 - 3.4.6.9. Manifold pressure
 - 3.4.6.10. Ambient room temperature
 - 3.4.6.11. Generator cooling air outlet temperature
 - 3.4.6.12. Exciter field current and voltage
 - 3.4.6.13. Vibration displacement
 - 3.4.6.14. Ambient air temperature inside panel with all doors closed
- 3.4.7. Miscellaneous: provide an accurate means for determining fuel and lubricating oil consumption. Provide strip chart recorders for monitoring frequency, voltage and load. Recorder shall have a selection of speeds to allow accurate measurement of voltage, frequency and time during the tests. The recorder shall have been calibrated by the recorder manufacturer (or designated representative) within three (3) months of the factory testing.
- 3.4.8. Interpretation of ambient room temperature: consider ambient room temperature as that temperature, which is the lowest temperature registered out of a group of three (3) thermometers when placed in engine room as follows:
 - 3.4.8.1. One (1) thermometer located on each side of the engine block, approximately two-thirds of the length of the block back from front (radiator) end of block, 900mm out from block and at a height equal to height of block. A third thermometer located over end of exciter on the unit centre line, approximately 150mm above top of exciter.
 - 3.4.8.2. Take the thermometer showing the lowest temperature to give true ambient air temperature. Adjust temperature to maintain this thermometer at 40°C during heat test.
- 3.4.9. Demonstrate that all generator status and alarm information is accessible via the communications link to the engine generator controller.
- 3.4.10. Voltage and frequency regulation tests: on completion of load tests take the hot resistance reading of generator windings. Subject the unit to hot voltage and frequency regulation tests for full load to no load, 4/4 load to no load, 3/4 load to no load, 1/2 load to

no load, 1/4 load to no load and vice versa.

- 3.4.11. Panel performance and functions: check sequence of operation under service conditions. Make provision for supplying and connecting required levels of voltage for primary circuits. Test over-current relays by impressing current in secondary circuits.
- 3.4.12. Additional tests: perform any tests, consistent with the contract, which the Engineer may require to satisfy himself of the adequacy and satisfactory operation of the unit.
- 3.4.13. Supplier shall record all test data on the appendix forms, recording charts and manufacturers' test forms and be complete with diagrams and description of test results, deficiencies and corrective action. Test data sheets shall be signed by the Supplier.

3.5. Acceptable (Site) Tests

- 3.5.1. All testing identified in Shop Testing is to be repeated on site.

3.6. Commissioning

- 3.6.1. When the Contractor has completed his installation work and before any equipment is operated, he shall instruct the Supplier to commission the equipment. The Supplier is to provide the services of a skilled technical representative for a minimum period of two (2) days (16 hours) at site to carry out the following work as a minimum requirement:
 - 3.6.1.1. Check the installation as to its workmanship.
 - 3.6.1.2. Check the operation of the set as per Item 3.4.
 - 3.6.1.3. Check that the operation of the engine cooling equipment is satisfactory.
 - 3.6.1.4. Check the interconnecting wiring of the engine safety devices.
 - 3.6.1.5. Perform further tests as directed the Engineer.
 - 3.6.1.6. Instruct the plant personnel in the operation and service of the equipment.
 - 3.6.1.7. This Contractor to supply all fuel required for Commissioning. On completion of commissioning the Contractor shall supply full day tank(s) of #2 Diesel Fuel.

END OF SECTION