REQUEST FOR PROPOSALS
CITY OF DULUTH, MN

Issued May 4, 2023

Lakewood Water Treatment Plant – Standby Power
Design and Bidding Phase

Project No.: 2135

RFP Number: 23-99421

Proposals Due: May 31, 2023
2:00 PM, Local Time

PROJECT OVERVIEW

The City of Duluth is interested in retaining a consultant to provide design and bidding services for a new standby power system at the Lakewood Water Treatment Plant. This facility is located at 8140 Congdon Boulevard on the north shore on Lake Superior, just north of Duluth.

BACKGROUND

The Lakewood Water Treatment Facility is made up of two main facilities, the Pump Station and the Water Treatment Plant. The Lakewood Pump Station was originally constructed in 1895. This facility has undergone several modifications over the past 110 years. The Pump Station includes the lake water intake and pipe, mechanical intake screen and wet well, low lift pumps, high lift pumps, and discharge flow metering.

The Lakewood Water Treatment Plant was constructed in 1975. This facility is a conventional gravity filtration water processing plant. The plant includes rapid mixing, flocculation, sedimentation, filtration, final water storage, backwash water recovery and processing, and sludge storage. An expansion completed in 1992 allows it to provide a maximum of approximately 34 million gallons of treated water per day.

The City of Duluth has accepted a Hazard Mitigation Grant through Homeland Security and Emergency Management Minnesota Department of Public Safety to provide backup power to the City's water treatment plant authorized under the authority of the Robert T. Stafford Disaster Relief and Emergency Assistance Act. Adequate back-up power via generators will be installed, along with burying overhead lines and adding a second transformer for redundancy at the site.

A summary of the proposed work and an estimated cost is attached as "Lakewood Water Treatment Plant Power System Resiliency Improvements Pre-Design Study, November 30, 2020", prepared by MSA Professional Services, Inc.

After the pre-design study was completed, the City of Duluth received comments back from the State Historic Preservation Officer (SHPO) in regards to the proposed location of the new transformer and generator. In response, the City proposed a new location of the equipment in an enclosed building located in the wooded area just west of the pumphouse. This site plan was accepted by SHPO. A summary of the concerns and responses, including a site map, is attached as "Lakewood Water Treatment Facility: NHPA Follow-up, May 19, 2022"

The City of Duluth will provide the following:

- All available building and utility drawings from previous projects.
- Assistance in obtaining other related information in City files pertaining to the project as needed.

GENERAL PROJECT SCOPE

Consulting Engineering Services are expected to include all work necessary to provide final design including plans and specifications and bidding services. Construction services are not included in the proposal and may be solicited in the future.

All work shall be performed in accordance with the most recent version of the City Standard Specifications and Engineering Guidelines (available on the City of Duluth website - https://duluthmn.gov/engineering/.)

SCOPE OF SERVICES

1. Initial Site Visit and Consultations

    a. The Consultant shall meet with City of Duluth representatives to review project scope and complexity, design criteria, related requirements, view existing conditions, gather data from the City engineering files and review the previously prepared reports. Additional consultations shall, where necessary, clarify the technical requirements and objectives of the contract and may be in the form of letters, emails and/or telephone conversations.

    b. The Consultant shall provide documentation of meetings and data provided.

    c. The Consultant shall ascertain the applicability of information provided, review data for completeness, and notify the City of any additional data required. It shall be the responsibility of the Consultant to determine, by site inspection procedures, the reliability of all the existing facility plans. The consultant shall include a survey of the existing facilities including both inside and outside electrical and utilities.

2. Plans and Specifications

    a. The consultant shall prepare construction drawings as necessary to provide for the Lakewood Water Treatment Plant – Standby Power Project as described in the attached memo. These drawings shall include all details, plans and specifications necessary for all work as required.

    b. The specification preparation shall also include appropriate sections for bidding, bonding, agreements, general and special provisions, and other appropriate contract provisions as well. These sections shall be developed in accordance with the City standards, which shall be made available to the consultant.

    c. The drawings shall include all necessary site maps, plans, elevations, sections, details, and notes as needed or necessary to adequately show, explain or describe all features of the project.

3. Cost Estimate

Following the completion of the plans and specifications a quantity takeoff and a detailed itemized construction cost estimate shall be provided.

4. Project Bidding

Upon completion of plans and specifications, the consultant shall provide all documents and services to provide for bidding and award for construction. The consultant shall answer any questions brought up during bidding and attend a pre-bid conference. This design phase shall be considered complete upon award of the project following bidding.

5. Construction Administration
Construction Administration is not included in the proposal.

6. Construction Inspection
Construction Inspection is not included in the proposal.

PROJECT COMPLETION DATES

May 4, 2023	RFP Issued
May 31, 2023	Proposals Due
June 2, 2023	Selection of Consultant
June 12, 2023	Council Approval to Award Contract
October 2, 2023	50% plan submittal
December 4, 2023	Plans submitted for initial City review
January 8, 2024	Plans and Specifications complete
January 24, 2024	Advertise for bids
February 21, 2024	Receive bids
April, 2024	Start Construction
December, 2024	Construction Completion
February, 2025	Submittal of record drawings

QUALIFICATION PROPOSAL CONTENTS

Proposals must be signed by an authorized official. If the official signs the Proposal Cover Sheet attached as Appendix A, this requirement will be met. Proposals must remain valid for 60 days or until a contract is fully executed.

If the City deems it necessary to revise any part of this RFP before the proposal response date, the City will post an addendum to its website at https://www.duluthmn.gov/purchasing/bids-request-for-proposals/ under Current Bids & Projects and the RFP number. Although an email notification will be sent, it is the Consultant's responsibility to periodically check the website for any new information.

The proposal shall be submitted in the following format broken into the 7 sections identified below. Proposals not following the specified format will not be reviewed. No additional sections or appendices are allowed. The proposal shall be limited to 20 pages plus a cover letter (The page limit

includes all resumes. Proposals that exceed this limit will not be reviewed. Dividers and covers are not included in the page limitation). The proposal format shall be as follows:

1. Goals and Objectives
   A restatement of the goals and objectives and the project tasks to demonstrate the responder's view and understanding of the project.

2. Experience
   An outline of the responder's background and experience with similar projects. Project descriptions shall include a list key staff and their role. Within the experience, the consultant should demonstrate and provide proof of competency in the following areas:
   - Multi-phased projects
   - Pump Station Design
   - Water Treatment Design
   - Electrical Control Design

3. Personnel
   Identify personnel to conduct the project and detail their training and work experience. Identify how personnel proposed for this project were involved with the projects listed as experience. Identify a professional engineer registered in the State of Minnesota who will oversee the overall project. No change in personnel assigned to the project will be permitted without approval of the City.

4. Knowledge of Duluth Requirements
   Include a description of the firm's knowledge of City of Duluth utility standards. Include a summary to demonstrate understanding of how the City water system works.

5. Work Plan
   Include a detailed work plan identifying the work tasks to be accomplished and the budget hours to be expended on each task and subtask. The work plan shall be in spreadsheet format and shall list each task and the number of hours for each staff person on that task. The work plan shall also identify the deliverables at key milestones in the project as well as any other services to be provided by the City. The City staff intends to be actively involved with the project and three (3) status meetings held at City Hall are to be contained in the work plan in addition to any data collection or input/review meetings. Do NOT include any costs in the work plan.

6. Work Schedule
   An anticipated work schedule shall also be provided. The work schedule shall identify all key milestone dates.

7. References
   A listing of names, addresses and telephone numbers of at least three (3) references for whom the respondent has performed similar electrical power supply design.

COST PROPOSAL CONTENTS

Provide, in separate envelope, one copy of the cost proposal, clearly marked on the outside "Cost Proposal" along with the responder's official business name and address. Terms of the proposal as stated must be valid for the project length of time.

The consultant must include a not to exceed total project cost, as well as subtotals for design services and bidding and any sub consultant fees. The cost proposal shall include all of the following:

- A cover/transmittal letter
- A breakdown of the hours by task for each employee. This shall be in the same format as the work plan in the Qualifications proposal with the addition of costs.
- Hourly rates for each specific employee proposed. (not general rates by category)
- Identification of anticipated direct expenses and rates for miscellaneous charges such as mileage and copies.
- Identification of any assumption made while developing this cost proposal.
- The Consultant must have the cost proposal/cover letter/transmittal signed by an authorized member of the firm.
- The consultant must not include any cost information within the body of the RFP qualification proposal response.

SELECTION

The proposals will be reviewed by City Staff. The intent of the selection process is to review proposals and make an award based upon qualifications as described herein. A 100-point scale will be used to create the final evaluation recommendations. The factors and weighting on which proposals will be judged are:

	Item	Percent
1	Goals and Objectives	5%
2	Experience	20%
3	Personnel	20%
4	Knowledge of Duluth requirements	5%
5	Work Plan	20%
6	Work Schedule	10%
7	History (completeness and timeliness) of past work with the City of Duluth History completing past projects on budget	5%
8	Project costs/fees	10%
9	Completeness of the proposal	5%

Proposals will be evaluated on a best value basis with 90% qualifications and 10% cost consideration. The review committee will not open the cost proposal until after the qualification points have been awarded. Cost proposals will only be opened for the three top ranked firms.

MANDATORY DISCLOSURES

By submitting a proposal, each Bidder understands, represents, and acknowledges that:

A. Their proposal has been developed by the Bidder independently and has been submitted without collusion with and without agreement, understanding, or planned common course of action with any other vendor or suppliers of materials, supplies, equipment, or services described in the Request for Proposals, designed to limit independent bidding or competition, and that the contents of the proposal have not been communicated by the Bidder or its employees or agents to any person not an employee or agent of the Bidder.

B. There is no conflict of interest. A conflict of interest exists if a Bidder has any interest that would actually conflict, or has the appearance of conflicting, in any manner or degree with the performance of work on the project. If there are potential conflicts, identify the municipalities, developers, and other public or private entities with whom your company is currently, or have been, employed and which may be affected.

C. It is not currently under suspension or debarment by the State of Minnesota, any other state or the federal government.

D. The company is either organized under Minnesota law or has a Certificate of Authority from the Minnesota Secretary of State to do business in Minnesota, in accordance with the requirements in M.S. 303.03

SUBMITTAL DATE

Submit original and four (4) copies in an envelope marked, RFP #23-99421, Lakewood Water Treatment Plant – Standby Power by 2:00 PM Central Time, May 31, 2023 to:

Patrice Stalvig, Purchasing Agent
City Purchasing
Room 120 City Hall
Duluth, MN 55802

CONTACT

All questions concerning the project shall be directed to:

Aaron Soderlund, Senior Engineer
City of Duluth - Engineering Division
411 W. 1st Street, Room 240 City Hall
Duluth, Minnesota 55802-1191
asoderlund@duluthmn.gov
(218) 730-5083

LIMITATIONS

This Request for Proposal does not commit the City of Duluth to award a contract or pay costs incurred in the preparation of the proposal, or to procure a contract for services or supplies.

The Proposal shall not in any way include any restrictions on the City of Duluth. The Consultant shall NOT provide proposed contract language.

The City of Duluth specifically reserves the right to accept or reject any or all proposals, to negotiate with any qualified source, to cancel in part or in its entirety the Request for Proposal, to waive any requirements, to investigate the qualifications of any proposal, to obtain new proposals, or proceed to have the service provided in any way as necessary to serve the best interests of the City of Duluth.

The selected consultant must sign the City of Duluth standard Professional Engineering Services Agreement, a sample of which is available at https://www.duluthmn.gov/purchasing/forms/. Any questions concerning this agreement should be asked PRIOR to proposal submittal. These questions should be directed to Tom Pfeffer in the City Engineering Office, tpfeffer@duluthmn.gov, (218) 730-5104.

All materials submitted in response to this RFP will become property of the City and will become public record after the evaluation process is completed and an award decision made.

Prior to entering into an agreement with the city, the consultant shall furnish proof that it has all legal requirements for transacting business in the State of Minnesota.

APPENDICES

Appendix A: Proposal Cover Sheet
Appendix B: Supplementary Provisions for State and Federally Funded Projects
Appendix C: Byrd Anti-Lobbying Amendment Certification Form – Please submit this form with your proposal.
Appendix D: "Lakewood Water Treatment Plant Power System Resiliency Improvements Pre-Design Study, November 30, 2020"
Appendix E: "Lakewood Water Treatment Facility: NHPA Follow-up, May 19, 2022"

APPENDIX A - PROPOSAL COVER SHEET
CITY OF DULUTH
RFP# 23-99421 RFP for Design Services for Lakewood Water Treatment Plant Standby Power

Bidder Information:	
Bidder Name	
Mailing Address	
Contact Person	
Contact Person's Phone Number	
Contact Person's E-Mail Address	
Federal ID Number	
Authorized Signature	
Name & Title of Authorized Signer	
Email of Authorized Signer	

APPENDIX B TO 23-99421

City of Duluth
Supplementary Provisions – State & Federal Funding
23-99421 Design Svcs for Lakewood Water Treatment Plant Standby Power

1. Disbursements
   a. No money under this Contract shall be disbursed by the City to any Contractor unless the Contractor is in compliance with the Federal Agency requirements with regard to accounting and fiscal matters to the extent they are applicable.
   b. Unearned payments under this Contract may be suspended or terminated upon the Contractor's refusal to accept any additional conditions that may be imposed by the Federal Agency at any time; or if the grant, if applicable, to the City under which this Contract is made is suspended or terminated.

2. Subcontracting Requirements
   a. The Contractor shall include in any subcontract the clauses set forth in these City of Duluth Supplementary Provisions in their entirety and shall also include a clause requiring the subcontractors to include these clauses in any lower tier subcontracts which they may enter into, together with a clause requiring this insertion in any further subcontracts that may in turn be made.
   b. The Contractor shall not subcontract any part of the work covered by this Contract or permit subcontracted work to be further subcontracted without the City's prior written approval of the subcontractors. The City will not approve any subcontractor for work covered by this Contract who is at the time ineligible under the provisions of any applicable regulations issued by a Federal Agency or the Secretary of Labor, United States Department of Labor, to receive an award of such subcontract.

3. Breach of Contract

The City may, subject to the Force Majeure provisions below and in addition to its other rights under the Contract, declare the Contractor in breach of the Contract by written notice thereof to the Contractor, and terminate the Contract in whole or in part, in accordance with Section 4, Termination, for reasons including but not limited to any of the following:

   a. Failure to begin the Work within the time specified in the Contract;
   b. Failure to perform the Work with sufficient labor, equipment, or material to insure the completion of the specified Work in accordance with the Contract terms;
   c. Unsatisfactory performance of the Work;
   d. Failure or refusal to remove material, or remove and replace any Work rejected as defective or unsatisfactory;
   e. Discontinuance of the Work without approval;
   f. Failure to resume the Work, which has been discontinued, within a reasonable time after notice to do so;
   g. Insolvency or bankruptcy;
   h. Failure to protect, to repair, or to make good any damage or injury to property;
   i. Breach of any provision of the Contract;
   j. Misrepresentations made in the Contractor's bid/proposal; or
   k. Failure to comply with applicable industry standards, customs, and practice.

4. Termination

If the Contractor is in breach of the Contract, the City, by written notice to the Contractor, may terminate the Contractor's right to proceed with the Work. Upon such termination, the City may take over the Work and prosecute the same to completion, by contract or otherwise, and the Contractor and its sureties shall be liable to the City for any additional cost incurred by the City in its completion of the Work and they shall also be liable to the City for liquidated damages for any delay in the completion of the Work as provided below. If the Contractor's right to proceed is terminated, the City may take possession of and utilize in completing the Work such materials, tools, equipment, and plant as may be on the site of the Work and necessary therefore.

City shall have the right to terminate this contract immediately without other cause in the event that all or a portion of the funds that the City intends to use to fund its obligations under the contract have their source with the State or Federal government or any agency thereof and said source reduces or eliminates their obligation to provide some or all of the funds previously committed by it to fund City's payment obligations under the Contract. The City agrees that termination hereunder will not relieve the City of its obligation to pay Contractor for Work satisfactorily performed and reasonable costs incurred prior to the effective date.

Notwithstanding anything herein to the contrary, the City may terminate this Contract at any time upon written notice given by the City (for any reason, including the convenience of the City) to the Contractor at least thirty (30) days prior to the effective date of the termination of this Contract. The City agrees that termination hereunder will not relieve the City of its obligation to pay Contractor for Work satisfactorily performed and reasonable costs incurred prior to the effective date of the termination provided that Contractor has not committed a breach of this Contract. Nothing contained in this section shall prevent either party from pursuing or collecting any damages to which it may be entitled by law.

5. Force Majeure.

The right of the Contractor to proceed shall not be terminated nor shall the Contractor be charged with liquidated damages for any delays in the completion of the Work due to any acts of the Government, including controls or restrictions upon or requisitioning of materials, equipment, tools, or labor by reason of war, National Defense, or any other national emergency; any acts of the City; causes not reasonably foreseeable by the parties to this Contract at the time of the execution of the Contract which are beyond the control and without the fault or negligence of the Contractor, including, but not restricted to, acts of God or of the public enemy, acts of another Contractor in their performance of some other contract with the City, fires, floods, epidemics, quarantine restrictions, strikes, freight embargoes, and weather of unusual severity such as hurricanes, tornadoes, cyclones, and other extreme weather conditions; nor to any delay of any Subcontractor occasioned by any of the causes specified above. The Contractor shall promptly notify the City in writing within ten (10) days of the delay. Upon receipt of such notification, the City shall ascertain the facts and the cause of the delay. If, upon the basis of facts and the terms of the Contract, the delay is properly excusable, the City shall extend the time for completing the Work for a period of time commensurate with the period of excusable delay.

6. Contracting with Small and Minority Businesses, Women's Business Enterprises, and Labor Surplus Area Firms.

Per 2 CFR 200.321, prime contractor must take all necessary affirmative steps to assure that minority businesses, women's business enterprises, and labor surplus area firms (collectively referred to as socioeconomic firms) are used when possible. The affirmative steps must include:

a. Placing qualified socioeconomic firms on solicitation lists;

b. Assuring that socioeconomic firms are solicited whenever they are potential sources;

c. Dividing total requirements, when economically feasible, into smaller tasks or quantities to permit

maximum participation by socioeconomic firms;

d. Establishing delivery schedules, where the requirements permit, which encourage participation by socioeconomic firms; and

e. Using the services and assistance, as appropriate, of such organizations as the Small Business Administration and the Minority Business Development Agency of the Department of Commerce.

7. Rights to Inventions Made Under a Contract or Agreement.

For any contracts involving the "substitution of parties, assignment or performance of experimental, developmental, or research work", Contractor shall comply with the requirements of 37 CFR Part 401, ''Rights to Inventions Made by Nonprofit Organizations and Small Business Firms Under Government Grants, Contracts and Cooperative Agreements,'' and any implementing regulations issued by the awarding agency.

8. Clean Air Act and Federal Water Pollution Control Act

Contractor shall comply with all applicable standards, orders or regulations issued pursuant to the Clean Air Act (42 U.S.C. 7401–7671q) and the Federal Water Pollution Control Act as amended (33 U.S.C. 1251–1387). Violations must be reported to the Federal awarding agency and the Regional Office of the Environmental Protection Agency (EPA). Contractor agrees to include this provision in any subcontract exceeding $150,000 that is financed in whole or in part with Federal funds.

9. Energy Standards.

Contractor shall comply with all mandatory standards and policies relating to energy efficiency which are contained in the state energy conservation plan issued in compliance with the Energy Policy and Conservation Act (42 U.S.C. 6201).

10. Suspension and Debarment.

This contract is a covered transaction for purposes of 49 CFR Part 29. As such, the contractor is required to verify that none of the contractor, its principals, as defined at 49 CFR 29.995, or affiliates, as defined at 49 CFR 29.905, are excluded or disqualified as defined at 49 CFR 29.940 and 29.945. The contractor is required to comply with 49 CFR 29, Subpart C and must include the requirement to comply with 49 CFR 29, Subpart C in any lower tier covered transaction it enters into. A contract award must not be made to parties listed on the governmentwide exclusions in the System for Award Management (SAM.gov), in accordance with the OMB guidelines at 2 CFR 180 that implement Executive Orders 12549 (3 CFR part 1986 Comp., p. 189) and 12689 (3 CFR part 19898 Comp., p. 235), "Debarment and Suspension." SAM Exclusions contains the names of parties debarred, suspended, or otherwise excluded by agencies, as well as parties declared ineligible under statutory or regulatory authority other than Executive Order 12549.

11. Byrd Anti-Lobbying Amendment, 31 U.S.C. § 1352 (as amended)

Contractors must certify that that it will not and has not used Federal appropriated funds to pay any person or organization for influencing or attempting to influence an officer or employee of any agency, a member of Congress, officer or employee of Congress, or an employee of a member of Congress in connection with obtaining any Federal contract, grant, or any other award covered by 31 U.S.C. § 1352.

12. Procurement of Recovered Materials

In the performance of this contract, the Contractor shall comply with section 6002 of the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act. This shall include making maximum use of products containing recovered materials as designated by the Environmental Protection Agency (EPA) unless (i) the materials cannot be acquired competitively and within the timeframe required

by the contract performance schedule; (ii) the materials designated by the EPA do not meet contract performance requirements; or (iii) the materials cannot be acquired for a reasonable price. Information about this requirement, along with the list of EPA- designated items, is available at the EPA's Comprehensive Procurement Guidelines web site, https://www.epa.gov/smm/comprehensive-procurement-guideline-cpg-program .

13. Telecommunications and Video Surveillance Services or Equipment

In the performance of this contract, Contractor/Supplier shall comply with Public Law 115-232, Section 889, which prohibits the procurement or use of covered telecommunications equipment or services as a substantial or essential component of any system, or as critical technology as part of any system. As described in Public Law 115-232, section 889, covered telecommunications equipment is telecommunications equipment produced by Huawei Technologies Company or ZTE Corporation (or any subsidiary or affiliate of such entities).

For the purpose of public safety, security of government facilities, physical security surveillance of critical infrastructure, and other national security purposes, use of video surveillance and telecommunications equipment produced by Hytera Communications Corporation, Hangzhou Hikvision Digital Technology Company, or Dahua Technology Company (or any subsidiary or affiliate of such entities) is prohibited.

In addition, telecommunications or video surveillance equipment or services produced or provided by an entity that the Secretary of Defense, in consultation with the Director of the National Intelligence or the Director of the Federal Bureau of Investigation, reasonably believes to be an entity owned or controlled by, or otherwise connected to, the government of a covered foreign country is prohibited.

14. Domestic Preferences for Procurements

As appropriate and to the extent consistent with law, Contractor shall, to the greatest extent practicable under a Federal award, supply and/or use goods, products, or materials produced in the United States (including but not limited to iron, aluminum, steel, cement, and other manufactured products). For purposes of this section, "Produced in the United States" means, for iron and steel products, that all manufacturing processes, from the initial melting stage through the application of coatings, occurred in the United States. "Manufactured products" means items and construction materials composed in whole or in part of non-ferrous metals such as aluminum; plastics and polymer-based products such as polyvinyl chloride pipe; aggregates such as concrete; glass, including optical fiber; and lumber.

Contractors shall include the preceding language in all subcontracts.

15. Changes. To be eligible for FEMA assistance under the non-Federal entity's FEMA grant or cooperative agreement, the cost of the change, modification, change order, or constructive change must be allowable, allocable, within the scope of its grant or cooperative agreement, and reasonable for the completion of project scope. FEMA recommends, therefore, that a non-Federal entity include a changes clause in its contract that describes how, if at all, changes can be made by either party to alter the method, price, or schedule of the work without breaching the contract. The language of the clause may differ depending on the nature of the contract and the end-item procured.

16. Access to Records. The following access to records requirements apply to this contract:

a. The contractor agrees to provide The City of Duluth, the FEMA Administrator, the Comptroller General of the United States, or any of their authorized representatives access to any books, documents, papers, and records of the Contractor which are directly pertinent to this contract for the purposes of making audits, examinations, excerpts, and transcriptions.

b. The Contractor agrees to permit any of the foregoing parties to reproduce by any means whatsoever or to copy excerpts and transcriptions as reasonably needed.

c. The contractor agrees to provide the FEMA Administrator or his/her authorized representatives access to construction or other work sites pertaining to the work being completed under the contract."

17. DHS Seal, Logo, and Flags. The contractor shall not use the DHS seal(s), logos, crests, or reproductions of flags or likenesses of DHS agency officials without specific FEMA pre- approval.

18. Compliance with Federal Law, Regulations, and Executive Orders. This is an acknowledgement that FEMA financial assistance will be used to fund the contract only. The contractor will comply will all applicable federal law, regulations, executive orders, FEMA policies, procedures, and directives.

19. No Obligation by Federal Government. The Federal Government is not a party to this contract and is not subject to any obligations or liabilities to the non-Federal entity, contractor, or any other party pertaining to any matter resulting from the contract.

20. Program Fraud and False or Fraudulent Statements or Related Acts. The contractor acknowledges that 31 U.S.C. Chap. 38 (Administrative Remedies for False Claims and Statements) applies to the contractor's actions pertaining to thiscontract.

APPENDIX C TO 23-99421

BYRD ANTI-LOBBYING AMENDMENT CERTIFICATION
(To be submitted with each bid or offer exceeding $100,000)

The undersigned, [Company] _____ certifies, to the best of his or her knowledge, that:

1. No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of an agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

2. If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form - LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

3. The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by 31, U.S.C. § 1352 (as amended by the Lobbying Disclosure Act of 1995). Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

The Contractor, [Company] _____, certifies or affirms the truthfulness and accuracy of each statement of its certification and disclosure, if any. In addition, the Contractor understands and agrees that the provisions of 31 U.S.C. § 3801 *et seq*., apply to this certification and disclosure, if any.

_____
Signature of Contractor's Authorized Official

_____
Name and Title of Contractor's Authorized Official

_____
Date

November 30, 2020

Eric Shaffer
Chief Utility Engineer
City of Duluth
411 West First Street, RM 211
Duluth, MN 55802

Re: HMA Generator Application Consultant Certification Letter
Lakewood Water Treatment Plant Power System Resiliency Improvements
Pre-Design Study

Dear Mr. Shaffer:

This letter summarizes services provided for the Pre-Design Study for the proposed power system improvements and increased resiliency at the City of Duluth's, Lakewood Water Treatment Plant. The City and MSA have been evaluating operations and needs of Duluth's water system, specifically, the Lakewood water plant since 2010. These efforts are part of a capital improvement plan to address the resiliency of the power supply system at the Lakewood Water Plant. The 2016 storm damaged and interrupted utility power to the Lakewood Water Treatment Plant (WTP) for nearly a day. This event reinforced the need for improved electrical power supply resiliency to this facility.

Enclosed with this letter is supporting documentation required to complete the HMA Generator Application. The following items are included:

- Proposed Site Layout
- Proposed One-Line Diagram
- Certification of the Pre-Design Study
- Generator Sizing
- Generator Equipment Manufacture Specification
- Detailed Pre-Design Cost Estimate

The Lakewood WTP includes multiple structures, some of which are more than a century old, creating unique power supply requirements. As such, this facility depends on medium voltage (2.4kV) and low voltage (480V) power systems. The implementation of the proposed equipment serves essential infrastructure on the WTP campus. The City and MSA evaluated two primary concepts for improving power supply resiliency to the Lakewood Facility. The first option evaluated providing a new 13.8kV standby generator for primary power supply to the WTP facility. The second option evaluated providing redundancy via generated backup power to both the existing secondary 2.4kV and 480V systems, versus providing a single utility level 13.8kV backup power solution.

This Pre-Design Study concludes that the single utility level 13.8kV standby generator system offers no significant cost advantage, does not provide an equal level of redundancy to the facility, and results in higher operation and maintenance costs due to its high voltage nature. The supporting documentation listed above further justifies this conclusion.

Because of this Pre-Design Study, it is recommended that the City of Duluth implement the following measures to improve the resiliency and redundancy of the power supply at the Lakewood WTP:

332 W. Superior Street
Suite 600
Duluth, MN 55802

P (218) 722-3915
TF (800) 777-7380
F (218) 722-4548

www.msa-ps.com

© 2020 MSA Professional Services

1. Provide new underground 13.8kV primary distribution to the WTP and Pump House
2. Provide new 350kW standby diesel fueled engine generator set for the 480V source and plant distribution. The complete system will include automatic power source transfer and asset management.
3. Provide new 1,750kW standby diesel fueled engine generator set for the 2.4kV source and Pump House distribution. The complete system will include automatic power source transfer and asset management.

Engineering Certification

Scott Chilson P.E. of MSA Professional Services provided the development of this Pre-Design Study for the proposed City of Duluth, Lakewood Water Treatment Plant Power System Resiliency project. Refer to **Appendix A** for Professional Engineering Certification.

Proposed Site Layout and Electrical Schematic

A general site layout and electrical one-line schematic were developed during the Pre-Design Study. These diagrams identify the anticipated layout and the required infrastructure to implement the proposed improvements. These diagrams are enclosed in **Appendix B.**

480-Volt Standby Power System Pre-Design

480V power is distributed to all buildings and structures at the Lakewood Facility. Based on historical power usage records, the average low voltage power demand is about 230kW/h. Applying peak demand factors and starting requirements of motors equipment have been considered. The recommended sizing is based on staged loading of the stand-by generator set. The facility SCADA system will be used to automatically control loading of the generator to optimize generator performance and facility capacity. The following is the basis of design:

- Estimated Average Running Power Demand/Load: 230kW / 287.5kVA / 0.8 PF
- Estimated Peak Running Demand/Load: 271.3kW / 336.4kVA / 0.8 PF
- Estimated Peak Load Step: 296.9skW / 380.8 skVA / 0.8 PF
- Recommended Standby Generator Set: Caterpillar 350kW / 437.5kVA / 0.8PF Diesel Fueled Engine Generator Set
    - Diesel Fueled Engine Generator Set
    - Alternator Current Rating: 526.2 amps
    - Temperature Rise: 130-Degree C

Refer to **Appendix C** for sizing report and manufacturer specifications, drawings, and performance documentation.

2400-Volt Standby Power System Pre-Design

The 2400V power is required by equipment located in the Pump House building. The Pump House has three pairs of high capacity pumps: 15 mgd, 24 mgd, and 32 mgd. The basis of design for the proposed standby generator set is the capability to start and run the 15 mgd set of high capacity pumps. In the future, this same generator unit is anticipated to be capable of starting and running the 24 mgd set of pumps following an upgrade of the existing 80% RAVT motor controllers to variable frequency drive motor controllers. The recommended generator sizing assumes single, staged motor starting and does not account for starting multiple motors at one time. The facility SCADA system will be used to automatically control loading of the generator to optimize generator performance and facility capacity. The following is the basis of design:

- Stage 1: Start 250 hp motor controlled by a 80% RVAT
- Stage 2: Start 1000 hp motor controlled by a 80% RVAT
- Estimated Running Demand/Load: 973.0kW / 1081.1kVA / 0.8 PF
- Estimated Peak (Motor Starting) Load Step: 698.1skW / 2,647.7 skVA
- Recommended Standby Generator Set: Caterpillar 1,750KW / 2187.0kVA / 0.8PF
    - Diesel Fueled Engine Generator Set

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- Alternator Current Rating: 303.5 amps
- Temperature Rise: 105-Degree C

Refer to **Appendix D** for sizing report and manufacturer specifications, drawings, and performance documentation.

Service Life of Stand-by Generators, System Components, and Equipment

The number of cycles and/or operating hours typically benchmarks the service life of well-maintained equipment. Life span of industrial generators is expected to exceed 6,000 operating hours. Based on industry standards, the maximum average annual operating hours of a standby generator is typically 200 hour/year. Therefore, the generators proposed for this project are anticipated to have a 30-years or longer service life. This applies to the following:

- 350kW Standby Engine Generator Set is expect to have a minimum service life of 30-years.
- 1,750kW Stand-by Engine Generator Set is expect to have a minimum service life of 30-years

The service life of the proposed switchgear is also anticipated to be at least 30-years. The application of this equipment will match the operations of the standby generators. The gear will not be switching hourly or daily, but weekly or monthly. Therefore, well-maintained switchgear is anticipated to have a minimum 30-years service life. This applies to the following:

- Primary Service and Distribution Switchgear is expect to have a minimum service life of 30-years.
- Automatic Transfer Switch (ATS) is expect to have a minimum service life of 30-years.
- Power Source and Generator Control Switchgear is expect to have a minimum service life of 30-years.

Operations and Maintenance Cost

The following is the estimated Operations and Maintenance Costs for the proposed equipment.

- 350kW Standby Engine Generator
  - Annual Fuel: Not Included
  - Annual Maintenance:
    - Labor = 2 trips/yr. x 4 hours x $350/hr. = 2,800/year
    - Consumables = $2,400/year
  - Load Bank Testing is recommended every 5-years = $2500 per test. Annual cost is $500.

  Annual O&M estimated cost is $5,700
- 1,750kW Standby Engine Generator
  - Annual Fuel: Not Included
  - Bi-Annual Maintenance:
    - Labor = 2 trips/yr. x 4 hours x $350/hr. = 2,800/year
    - Consumables = $3,600/year
  - Load Bank Testing is recommended every 5-years = $5000 per test. Annual cost is $1000.

  Annual O&M estimated cost is $7,400
- Switchgear: It is recommended that the switchgear be cleaned, operationally testing, coordination verification, Infra-Red (IR) tested every 5-years. Assume $3,750 per visit to maintain the Primary Service Gear, ATS, and Power Source and Generator Control Switchgear.

  Annual O&M estimated cost is $750

The estimated total annual O&M costs for the proposed equipment and system is $13,850/year.

Estimated Project Costs

The proposed Lakewood WTP Power System Resiliency Improvements is estimated to cost $7,214,000. This is includes engineering, project management, generator equipment, soft costs, and

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all work and materials to construct a complete and operable standby power system. Detailed cost estimate is located in **Appendix E**.

In conclusion, this letter summarizes the Pre-Design Study evaluations, assumptions, and recommendations for the proposed Lakewood Water Treatment Plant Power System Resiliency Improvements. The recommended improvements will provide enhanced flexibility, increased safety, and a higher level of system resiliency and redundancy to maintain an uninterrupted supply of potable water to the City of Duluth water customers.

Sincerely,
MSA Professional Services, Inc.



Scott R. Chilson, P.E.
Senior Project Engineer

src

enc.

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Appendix A
Professional Engineering Certification

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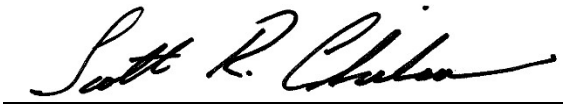
City of Duluth
Lakewood Water Treatment Plant Power System Resilience Improvements
Pre-Design Study

Duluth, St. Louis County, MN

PROFESSIONAL ENGINEERING CERTIFICATION

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Print Name: Scott Chilson

Signature: 

Date: 11-30-2020 License #: 44287

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City of Duluth RFP 23-99421

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Appendix B

Proposed Site Layout and Electrical Schematic

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		NO.	DATE	REVISION	BY
PROJECT DATE: 2020	DRAWN BY: CAR	1	11/2020	PRE-DESIGN	SRC
	DESIGNED BY: SRC	.	.	.	.
	CHECKED BY: ----	.	.	.	.

PLOT DATE: Wednesday, November 25, 2020 4:41:23 PM, G:\00\00616\00616161\CADD\construction documents\00616161 Site Overview.dwg

I HEREBY CERTIFY THAT THIS PLAN, REPORT, OR SPECIFICATION WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.

11/20/2020 (Date) 44287 (License No.)

SCOTT R CHILSON

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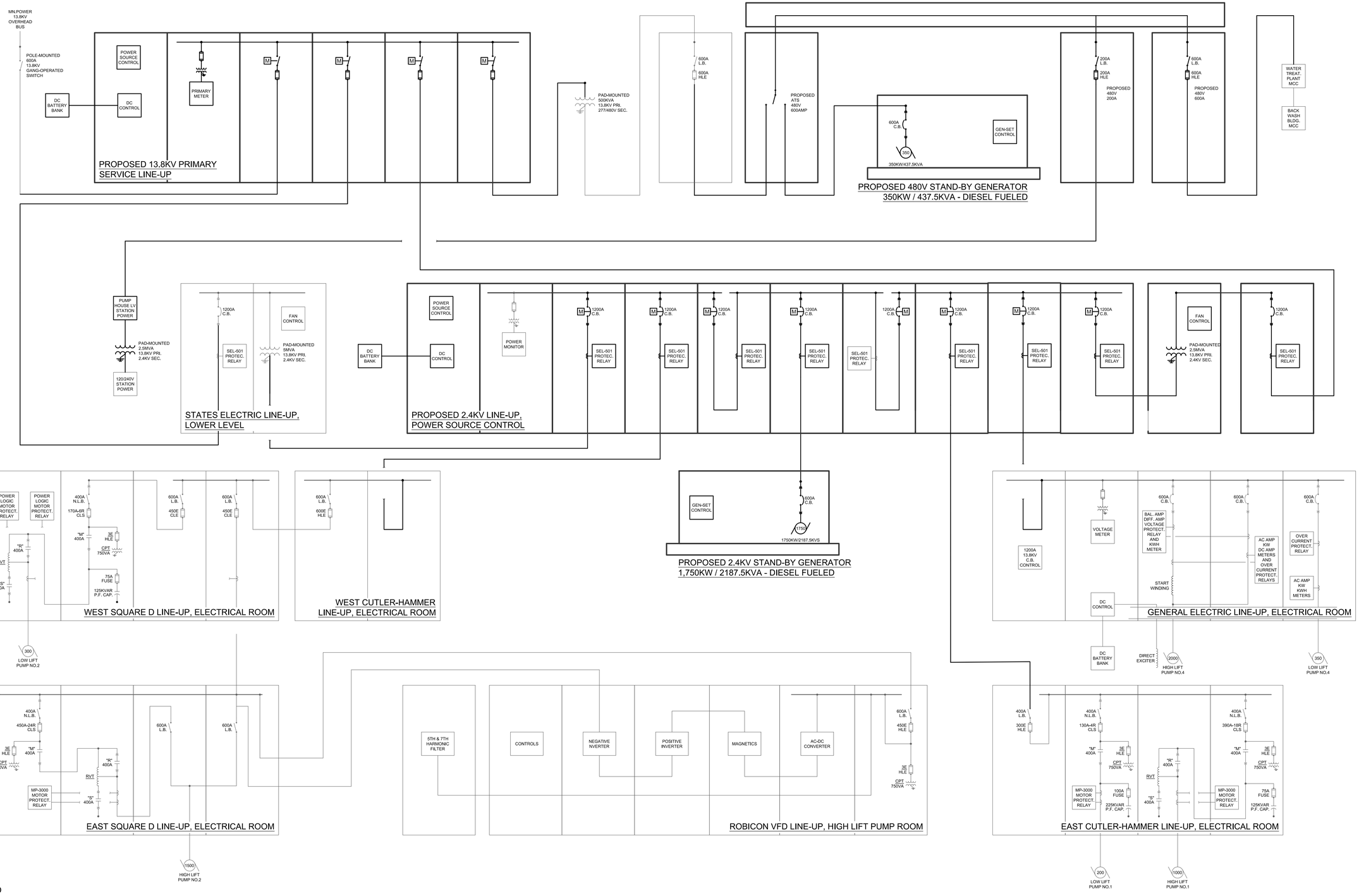
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LAKEWOOD WATER TREATMENT PLANT POWER SYSTEM
CITY OF DULUTH, MINNESOTA
8130 CONGDON BLVD

SITE OVERVIEW

PROJECT NO. 00616161

SHEET 1



		NO.	DATE	REVISION	BY
PROJECT DATE: 2020	DRAWN BY: CAR	1	11/2020	PRE-DESIGN	SRC
	DESIGNED BY: SRC	.	.	.	.
	CHECKED BY: ----	.	.	.	.

PLOT DATE: Monday, November 30, 2020 4:46:18 PM, G:\00\00616\00616161\CADD\construction documents\00616161 One line.dwg

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LAKEWOOD WATER TREATMENT PLANT POWER SYSTEM
CITY OF DULUTH, MINNESOTA
8130 CONGDON BLVD

PROPOSED ONE-LINE

PROJECT NO. 00616161

SHEET 2

Appendix C
480-Volt Standby Power System Information

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Project Sizing Report

Sizing Id	10641891	Electricity Supply	60 Hz 480/277 V
Project Name	Lakewood WTP & Pump House LV 480V stand-by power 616161	Connection	STAR
Customer Name	City of Duluth	Max. Ambient Temperature	77.0 F
Region	U.S.	Altitude	500.0 Ft. A.S.L
Prepared By	Scott Chilson	Humidity	30%
Modified Date	19-Nov-2020		

Load Analysis Summary

Max Transient Load Step	273.6 SkVA / 192.3 SkW
Peak Transient Load Step	380.8 SkVA / 296.9 SkW
Final Running Load	336.4 kVA / 271.3 kW / 0.81 PF
Max Running Non Linear Load	8.6 RkVA
Maximum Running Load	336.4 kVA / 271.3 kW
Selection Criteria	Step 1 Voltage dip restriction

Generator Set

Generator Set Model	(1) of C13		
Model Type		Nameplate Rating	350.0 ekW / 437.5 kVA / 0.8 PF
Voltage Regulator and Slope	IVR 2:1 slope;	Site Output Rating	350 ekW / 437.5 kVA
Feature Code	C13DE50	Rating Type	Standby
Fuel	Diesel	Open / Enclosure	SA Level 1
Sizing Methodology	Conventional	UL Listed	Yes
Capacity Used	77.5%		

Engine

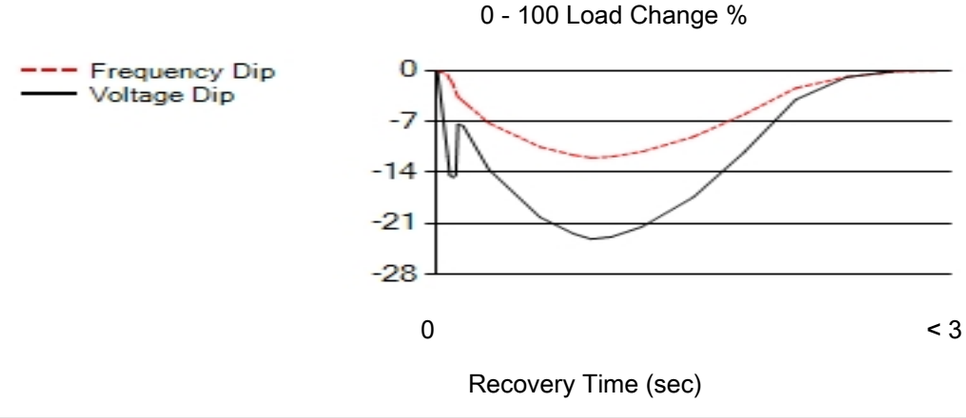
Make/Model	C13	Emissions / Certifications	EPA ESE
Aspiration	TA	Governor	ELEC

Cylinder Configuration	INLINE - 6	Aftercooler Type	ATAAC
Speed	1800 RPM	Displacement	763 Cubic Inch / 13 Liter
Engine Performance Number	EM1692	Bore	130
Fuel Consumption at 100% Load	24.9 gph	Stroke	157
Alternator			
Alternator Type/Frame Size	LC / LC6114B	Insulation Class	H
Alternator Winding Pitch	0.6667	Temperature Rise	130 C
Excitation/Winding Type	SE / RANDOM	Number Of Poles	4
Alternator Arrangement Number	4183863	Number of Leads	12
Subtransient Reactance X"d	0.1348	Rated Amps	526.2

**** See your Caterpillar dealer and/or Spec Sheet for technical information.

***** Package Power Tolerance: +/- 5%

Block Load(Only) Transient Response *			
Load Change %	FDip %	VDip %	Recovery Time (sec)
0 - 25	<5%	<5%	< 3
0 - 50	<5%	7.9	< 3
0 - 75	7.0	13.3	< 3
0 - 100	12.0	23.1	< 3



Transient Performance

Block Load (only) Transient Response values are at factory conditions with a resistive load. This information is representative of a typical Cat generator set, but is not guaranteed. Generator set block load capabilities at site conditions may vary from factory transient response test results due to site altitude, site ambient, and engine to engine variation.

Load Report

Project Name	Lakewood WTP & Pump House LV 480V stand-by power 616161	Electricity Supply	60 Hz 480/277 V
Customer Name	City of Duluth	Rating Type	Standby
Region	U.S.	Max. Ambient Temperature	77.0 F
Prepared By	Scott Chilson	Altitude	500.0 Ft. A.S.L
Modified Date	19-Nov-2020	Humidity	30%
Generator Set Model	(1) of C13	Nameplate Rating	350.0 ekW / 437.5 kVA / 0.8 PF

Load Details		Permitted		Predicted		Transient Inrush		Running		Resultant Peak		Cumulative Running	
Load Step	Load Description	FDip	VDip	FDip	VDip	SkVA	SkW	kVA	kW	SkVA	SkW	kVA	kW
Step 1													
1.1	1x37.50 kVA - Pump House XFMR : Steady State Magnetization, 98% Efficiency, 240V Secondary	-	-			0.0	0.0	1.9	0.2				
1.2	1x5.00 kW - PH Lighting Load: Fluorescent Lighting, Distr. 3-Phase	30%	30%			6.7	5.0	5.3	5.0				
	Adjustment for transformer losses - Pump House XFMR	35%	40%			0.0	0.0	0.1	0.1				
1.3	1x3.20 HP - Influent Screen: NEMA, 3-Phase Motor, Across the line, Loaded, Single Operating Point,	15%	15%			33.5	19.1	3.6	2.8				
	Adjustment for transformer losses - Pump House XFMR	35%	40%			0.0	0.0	0.1	0.1				
1.4	1x2.10 HP - Sump Pump: NEMA, 3-Phase Motor, Across the line, Intermittent, Loaded, Single	15%	15%			22.6	13.8	2.5	1.9				
	Adjustment for transformer losses - Pump House XFMR	35%	40%			0.0	0.0	0	0				
1.5	1x2.10 HP - Vacuum Pump: NEMA, 3-Phase Motor, Across the line, Intermittent, Loaded, Single	15%	15%			22.6	13.8	2.5	1.9				
	Adjustment for transformer losses - Pump House XFMR	35%	40%			0.0	0.0	0	0				
1.6	1x3.20 HP - Condensate Pump: NEMA, 3-Phase Motor, Across the line, Intermittent, Loaded, Single	15%	15%			33.5	19.1	3.6	2.8				
	Adjustment for transformer losses - Pump House XFMR	35%	40%			0.0	0.0	0.1	0.1				
1.7	1x25.00kW - Miscellaneous Load: Miscellaneous, Non-Motor, Linear	15%	15%			31.3	25.0	31.3	25.0				
	Adjustment for transformer losses - Pump House XFMR	35%	40%			0.0	0.0	0.6	0.5				
1.8	1x1.00 HP - Power Gate: NEMA, Single Phase Motor, Cap. Start/Ind. Run, Line 1-2, Intermittent,	15%	15%			9.4	7.5	1.7	1.2				
	Adjustment for transformer losses - Pump House XFMR	35%	40%			0.0	0.0	0	0				

1.9	1x37.50 kVA - WTP L1 - Transformer Load: Steady State Magnetization, 98% Efficiency, 240V	-	-			0.0	0.0	1.9	0.2				
1.10	1x15.00kW - WTP L1 - Miscellaneous Load: Miscellaneous, Non-Motor, Linear	15%	15%			18.8	15.0	18.8	15.0				
	Adjustment for transformer losses - WTP L1 - Transformer Load	35%	40%			0.0	0.0	0.4	0.3				
1.11	1x37.50 kVA - WTP L2 - Transformer Load: Steady State Magnetization, 98% Efficiency, 240V	-	-			0.0	0.0	1.9	0.2				
1.12	1x20.00kW - WTP L2 - Miscellaneous Load: Miscellaneous, Non-Motor, Linear	15%	15%			25.0	20.0	25.0	20.0				
	Adjustment for transformer losses - WTP L2 - Transformer Load	35%	40%			0.0	0.0	0.5	0.4				
1.13	1x25.00 kVA - WTP L -Transformer Load: Steady State Magnetization, 98% Efficiency, 240V	-	-			0.0	0.0	1.3	0.1				
1.14	1x15.00kW - WTP L - Miscellaneous Load: Miscellaneous, Non-Motor, Linear	15%	15%			18.8	15.0	18.8	15.0				
	Adjustment for transformer losses - WTP L -Transformer Load	35%	40%			0.0	0.0	0.4	0.3				
1.15	1x30.00 kVA - WTP LP4B - Transformer Load: Steady State Magnetization, 98% Efficiency, 208V	-	-			0.0	0.0	1.5	0.2				
1.16	1x16.00kW - WTP LP4B - Miscellaneous Load: Miscellaneous, Non-Motor, Linear	15%	15%			20.0	16.0	20.0	16.0				
	Adjustment for transformer losses - WTP LP4B - Transformer Load	35%	40%			0.0	0.0	0.4	0.3				
1.17	1x15.00 kVA - WTP L4A - Transformer Load: Steady State Magnetization, 98% Efficiency, 240V	-	-			0.0	0.0	0.8	0.1				
1.18	1x8.00kW - WTP LP4A - Miscellaneous Load: Miscellaneous, Non-Motor, Linear	15%	15%			10.0	8.0	10.0	8.0				
	Adjustment for transformer losses - WTP L4A - Transformer Load	35%	40%			0.0	0.0	0.2	0.2				
1.19	1x30.00 kVA - Wash Water Building - Transformer Load: Steady State Magnetization, 98% Efficiency,	-	-			0.0	0.0	1.5	0.2				
1.20	1x15.00kW - WTP LP4A - Miscellaneous Load: Miscellaneous, Non-Motor, Linear	15%	15%			18.8	15.0	18.8	15.0				
	Adjustment for transformer losses - Wash Water Building - Transformer Load	35%	40%			0.0	0.0	0.4	0.3				
	Step 1 Total	15%	15%	<5%	10.4%	273.6	192.3	172.9	133.4				
	Total Through Step 1									273.6	192.3	172.9	133.4
Step 2													
2.1	1x5.00 kW - D-2: Resistive, 3-Phase	30%	30%			5.0	5.0	5.0	5.0				
	Step 2 Total	15%	15%	<5%	<5%	5.0	5.0	5.0	5.0				
	Total Through Step 2									173.6	138.4	176.8	138.4
Step 3													
3.1	1x5.00 kW - AHU-1: Resistive, 3-Phase	30%	30%			5.0	5.0	5.0	5.0				

	Step 3 Total	15%	15%	<5%	<5%	5.0	5.0	5.0	5.0				
	Total Through Step 3									177.6	143.4	180.8	143.4
Step 4													
4.1	1x0.50 HP - Alum Pump Three Phase Motor Load: NEMA, 3-Phase Motor, Across the line, Intermittent,	15%	15%			5.3	4.0	0.7	0.5				
	Step 4 Total	15%	15%	<5%	<5%	5.3	4.0	0.7	0.5				
	Total Through Step 4									182.8	147.4	181.5	143.9
Step 5													
5.1	1x0.50 HP - Cooling Pump Phase Motor Load: NEMA, 3-Phase Motor, Across the line, Intermittent,	15%	15%			5.3	4.0	0.7	0.5				
5.2	1x0.50 HP - EF-11: NEMA, 3-Phase Motor, Across the line, Intermittent, Loaded, Single Operating	15%	15%			5.3	4.0	0.7	0.5				
5.3	1x0.50 HP - EF-31: NEMA, 3-Phase Motor, Across the line, Intermittent, Loaded, Single Operating	15%	15%			5.3	4.0	0.7	0.5				
5.4	1x0.50 HP - PRV-5: NEMA, 3-Phase Motor, Across the line, Intermittent, Loaded, Single Operating	15%	15%			5.3	4.0	0.7	0.5				
	Step 5 Total	15%	15%	<5%	<5%	21.2	16.1	3.0	2.1				
	Total Through Step 5									199.4	160.0	184.5	146.0
Step 6													
6.1	1x5.00 HP - EF-41 Three Phase Motor Load: NEMA, 3-Phase Motor, Across the line, Loaded,	15%	15%			33.5	19.1	5.6	4.4				
	Step 6 Total	15%	15%	<5%	<5%	33.5	19.1	5.6	4.4				
	Total Through Step 6									213.3	165.1	190.1	150.4
Step 7													
7.1	1x5.00 HP - EF-21 Three Phase Motor Load: NEMA, 3-Phase Motor, Across the line, Loaded,	15%	15%			33.5	19.1	5.6	4.4				
	Step 7 Total	15%	15%	<5%	<5%	33.5	19.1	5.6	4.4				
	Total Through Step 7									218.9	169.5	195.7	154.9
Step 8													
8.1	1x3.00 HP - EF-1 Three Phase Motor Load: NEMA, 3-Phase Motor, Across the line, Loaded, Single	15%	15%			22.6	13.8	3.5	2.7				
	Step 8 Total	15%	15%	<5%	<5%	22.6	13.8	3.5	2.7				
	Total Through Step 8									214.3	168.6	199.2	157.6
Step 9													

9.1	1x3.00 HP - Boiler Pump: NEMA, 3-Phase Motor, VFD, 110% Current Limit, Single Operating Point, 6	20%	20%			0.3	0.3	3.4	3.0				
	Step 9 Total	15%	15%	<5%	<5%	0.3	0.3	3.4	3.0				
	Total Through Step 9									199.6	160.8	202.5	160.6
Step 10													
10.1	1x7.50 HP - sp-1: NEMA, 3-Phase Motor, Across the line, Loaded, Single Operating Point, NEMA G	30%	30%			44.6	23.6	8.0	6.5				
10.2	1x2.00 HP - sp-3: NEMA, 3-Phase Motor, Across the line, Loaded, Single Operating Point, NEMA K	30%	30%			17.0	10.9	2.5	1.9				
	Step 10 Total	15%	15%	<5%	<5%	61.4	34.5	10.5	8.4				
	Total Through Step 10									258.1	195.0	213.0	169.0
Step 11													
11.1	1x25.00 HP - Rapid Mix: NEMA, 3-Phase Motor, Across the line, Loaded, Single Operating Point	15%	15%			132.5	57.0	24.4	20.7				
	Step 11 Total	15%	15%	<5%	6.1%	132.5	57.0	24.4	20.7				
	Total Through Step 11									333.0	225.9	237.3	189.7
Step 12													
12.1	1x25.00 HP - Rapid Mix: NEMA, 3-Phase Motor, Across the line, Loaded, Single Operating Point	15%	15%			132.5	57.0	24.4	20.7				
	Step 12 Total	15%	15%	<5%	6.1%	132.5	57.0	24.4	20.7				
	Total Through Step 12									356.4	246.6	261.6	210.4
Step 13													
13.1	1x25.00 HP - Rapid Mix: NEMA, 3-Phase Motor, Across the line, Loaded, Single Operating Point	15%	15%			132.5	57.0	24.4	20.7				
	Step 13 Total	15%	15%	<5%	6.1%	132.5	57.0	24.4	20.7				
	Total Through Step 13									380.0	267.3	286.0	231.1
Step 14													
14.1	1x7.50 HP - Floculator: NEMA, 3-Phase Motor, Across the line, Loaded, Single Operating Point,	15%	15%			44.6	23.6	8.0	6.5				
	Step 14 Total	15%	15%	<5%	<5%	44.6	23.6	8.0	6.5				
	Total Through Step 14									324.3	254.6	294.0	237.6
Step 15													

15.1	1x5.00 HP - Floculator: NEMA, 3-Phase Motor, Across the line, Loaded, Single Operating Point,	15%	15%			33.5	19.1	5.6	4.4				
	Step 15 Total	15%	15%	<5%	<5%	33.5	19.1	5.6	4.4				
	Total Through Step 15									322.5	256.6	299.6	242.1
Step 16													
16.1	1x5.00 HP - Floculator: NEMA, 3-Phase Motor, Across the line, Loaded, Single Operating Point,	15%	15%			33.5	19.1	5.6	4.4				
	Step 16 Total	15%	15%	<5%	<5%	33.5	19.1	5.6	4.4				
	Total Through Step 16									328.1	261.0	305.2	246.5
Step 17													
17.1	1x5.00 HP - Floculator: NEMA, 3-Phase Motor, Across the line, Loaded, Single Operating Point,	15%	15%			33.5	19.1	5.6	4.4				
	Step 17 Total	15%	15%	<5%	<5%	33.5	19.1	5.6	4.4				
	Total Through Step 17									333.7	265.4	310.8	251.0
Step 18													
18.1	1x3.00 HP - WWB Sludge Pump 1: NEMA, 3-Phase Motor, Across the line, Loaded, Single Operating	30%	30%			22.6	13.8	3.5	2.7				
	Step 18 Total	15%	15%	<5%	<5%	22.6	13.8	3.5	2.7				
	Total Through Step 18									329.3	264.5	314.4	253.7
Step 19													
19.1	1x2.00 HP - WWB Mixer: NEMA, 3-Phase Motor, Across the line, Loaded, Single Operating Point,	30%	30%			17.0	10.9	2.5	1.9				
	Step 19 Total	15%	15%	<5%	<5%	17.0	10.9	2.5	1.9				
	Total Through Step 19									327.6	264.3	316.8	255.6
Step 20													
20.1	1x10.00 HP - WWB Return Pumps: NEMA, 3-Phase Motor, Across the line, Loaded, Single Operating	30%	30%			59.4	30.3	10.5	8.6				
	Step 20 Total	15%	15%	<5%	<5%	59.4	30.3	10.5	8.6				
	Total Through Step 20									368.8	285.6	327.3	264.2
Step 21													
21.1	1x5.00 HP - WWB Return Pumps: NEMA, 3-Phase Motor, Across the line, Loaded, Single Operating	30%	30%			33.5	19.1	5.6	4.4				
	Step 21 Total	15%	15%	<5%	<5%	33.5	19.1	5.6	4.4				

	Total Through Step 21									355.8	283.0	332.9	268.6
Step 22													
22.1	1x3.00 HP - WWB Floculator: NEMA, 3-Phase Motor, Across the line, Loaded, Single Operating	30%	30%			22.6	13.8	3.5	2.7				
	Step 22 Total	15%	15%	<5%	<5%	22.6	13.8	3.5	2.7				
	Total Through Step 22									351.4	282.1	336.4	271.3
Intermittent Step													
23.1	1x3.20 HP - Condensate Pump: NEMA, 3-Phase Motor, Across the line, Intermittent, Loaded, Single	15%	15%			33.5	19.1	3.6	2.8				
	Adjustment for transformer losses - Pump House XFMR	35%	40%			0.0	0.0	0.1	0.1				
23.2	1x2.10 HP - Vacuum Pump: NEMA, 3-Phase Motor, Across the line, Intermittent, Loaded, Single	15%	15%			22.6	13.8	2.5	1.9				
	Adjustment for transformer losses - Pump House XFMR	35%	40%			0.0	0.0	0	0				
	Step 23 Total	15%	15%	<5%	<5%	56.1	32.9	6.2	4.8				
	Total Through Step 23									380.8	296.9	336.4	271.3
Load Analysis Summary : Generator set meets site requirements													
						Maximum Step				Maximum Peak		Final Running	
						SkVA	SkW			SkVA	SkW	kVA	kW
						273.6	192.3			380.8	296.9	336.4	271.3

Guide Specification

Dealer Information

Name:
Address:
Phone Number:
Prepared By:
Email:

Package Generator Set

1.1 GENERAL

1.1.1 References and Standards

The generator set covered by these specifications shall be designed, tested, rated, assembled and installed in strict accordance with all applicable standards below:

- CSA C22.2 No14
- CSA 282
- CSA 100
- EN61000-6
- EN55011
- FCC Part 15 Subpart B
- ISO8528
- IEC61000
- UL508
- UL2200
- UL142
- Designed to allow for installed compliance to NFPA 37, NFPA 70, NFPA 99 and NFPA 110

1.2 RELATED SECTIONS

1.2.1 Division 3 - Concrete

1.2.2 Division 15 - Mechanical

1.3 WORK INCLUDED

1.3.1 Installation

The work includes supplying and installing a complete integrated generator system. The system consists of agenerator set with related component accessories and automatic transfer switches specified under a separate section.

1.3.2 Fuel System

The CONTRACTOR shall provide a full tank of diesel fuel for the completion of all testing.

1.3.3 System Test

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A complete system load test shall be performed after all equipment is installed. Guidelines in the Start-up Section.

1.3.4 Requirements, Codes and Regulations

The equipment supplied and installed shall meet the requirements of the NEC and all applicable local codes and regulations. All equipment shall be of new and current production by a MANUFACTURER who has 25 years of experience building this type of equipment. Manufacturer shall be ISO9001 certified.

1.4 SUBSTITUTION

Proposed deviations from the specifications shall be treated as follows:

1.4.1 Substitution Time Requirement

Requests for substitutions shall be made a minimum of ten (10) days prior to bid date. Manufacturers catalog data shall accompany each request and authorized acceptance shall be addenda only.

1.4.2 Substitution Responsibility

The power system has been designed to the specified manufacturer's electrical and physical characteristics. The equipment sizing, spacing, amounts, electrical wiring, ventilation equipment, fuel, and exhaust components have all been sized and designed around CATERPILLAR supplied equipment. Should any substitutions be made, the CONTRACTOR shall bear responsibility for the installation, coordination and operation of the system as well as any engineering and redesign costs, which may result from such substitutions.

1.5 SUBMITTALS

Engine-generator submittals shall include the following information:

A. Factory published specification sheet.

B. Manufacturer's catalog cut sheets of all auxiliary components such as battery charger, control panel, enclosure, etc.

C. Dimensional elevation and layout drawings of the generator set, enclosure and transfer switchgear and related accessories.

D. Weights of all equipment.

E. Concrete pad recommendation, layout and stub-up locations of electrical and fuel systems.

F. Interconnect wiring diagram of complete emergency system, including generator, switchgear, day tank, remote pumps, battery charger, control panel, and remote alarm indications.

G. Engine mechanical data, including heat rejection, exhaust gas flows, combustion air and ventilation air flows, fuel consumption, etc.

H. Generator electrical data including temperature and insulation data, cooling requirements, excitation ratings, voltage regulation, voltage regulator, efficiencies, waveform distortion and telephone influence factor.

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I. Generator resistances, reactances and time constants.

J. Generator locked rotor motor starting curves.

K. Manufacturer's documentation showing maximum expected transient voltage and frequency dips, and recovery time during operation of the generator set at the specified site conditions with the specified loads.

L. Manufacturer's and dealer's written warranty.

1.7 SYSTEM RESPONSIBILITY

1.7.1 Generator Set Distributor

The completed engine generator set shall be supplied by the Manufacturer's authorized distributor only.

1.7.2 Requirements, Codes and Regulations

The equipment supplied and installed shall meet the requirements of NEC and all-applicable local codes and regulations. All equipment shall be new, of current production. There shall be one source responsibility for warranty; parts and service through a local representative with factory trained service personnel.

1.7.3 Automatic Transfer Switch

The automatic transfer switch(es) specified in another section shall be supplied by the generator set manufacturer in order to establish and maintain a single source of system responsibility and coordination.

1.8 WARRANTY

1.8.1 Two Year Standby (ISO 8528-1: ESP) **Generator Set Warranty**

The manufacturer's standard warranty shall in no event be for a period of less than two (2) years from date of initial start-up of the system and shall include repair parts, labor, reasonable travel expense necessary for repairs at the job site, and expendables (lubricating oil, filters, antifreeze, and other service items made unusable by the defect) used during the course of repair. Running hours shall be limited to 500 hours annually for the system warranty by both the manufacturer and servicing distributor. Submittals received without written warranties as specified will be rejected in their entirety.

1.9 PARTS AND SERVICE QUALIFICATIONS

1.9.1 Service Facility

The engine-generator supplier shall maintain 24-hour parts and service capability within 100 miles of the project site. The distributor shall stock parts as needed to support the generator set package for this specific project. The supplier must carry sufficient inventory to cover no less than 80% parts service within 24hrs and 95% within 48 hours.

1.9.2 Service Personnel

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The dealer shall maintain qualified factory trained service personnel.

1.9.3 Product Support

1.9.3.1 Preventive Maintenance Agreement

The authorized Caterpillar dealer shall provide a preventive maintenance agreement using qualified factory trained service personnel, for a period of 1-year minimum. The dealer shall provide genuine Caterpillar parts and filters, shall provide all recommended fluids, dealer labor, travel labor and travel mileage to complete the suggested preventive maintenance as defined in the manufacturer's Operation and Maintenance Manual.

1.9.3.2 Total Maintenance and Repair Agreement

The authorized Caterpillar dealer shall provide a total maintenance and repair agreement using qualified factory trained service personnel for a period of 5 years minimum. The dealer shall provide genuine Caterpillar parts and filters, shall provide all recommended fluids, dealer labor, travel labor and travel mileage to complete the suggested preventive maintenance and overhauls as defined in the manufacturer's Operation and Maintenance Manual. The dealer shall also provide all genuine Caterpillar parts and filters, recommended fluids, dealer labor, travel labor and travel mileage to complete all unscheduled repairs and component replacements during the agreement period.

1.9.3.3 Standby Generator Set Extended Service Coverage

Extended Service Coverage shall be provided for a period of 5 or 10 years, and shall include no deductible. Extended Service Coverage provides for 100 percent of usual and customary parts and labor costs for failures due to defects in materials and workmanship to the "as shipped consist" from the factory, excluding filters, fluids, vee belts, hoses, power take-offs, paint, batteries and clutches. Platinum Extended Service Coverage provides for a rental power unit due to unscheduled failures causing unexpected downtime to the customer in excess of 48 hours from the time of diagnoses. All repairs will be performed by factory trained dealer service personnel, and allows for repairer travel and mileage for all repairs up to 8 hours and 320 miles per incident.

1.9.3.4 Prime Power Extended Service Coverage

Extended Service Coverage shall be provided for a period of 5 or 10 years, and shall include no deductible. Extended Service Coverage provides for 100 percent of usual and customary parts and labor costs for failures due to defects in materials and workmanship to the "as shipped consist" from the factory, excluding filters, fluids, vee belts, hoses, power take-offs, paint, batteries and clutches. All repairs will be performed by factory trained dealer service personnel, and allows for repairer travel and mileage for all repairs up to 8 hours and 320 miles per incident.

1.9.3.5 Extended Service Coverage for Switchgear and/or ATS units

Extended Service Coverage shall be provided for a period of 5 or 10 years, and shall include no deductible. Extended Service Coverage provides for 100 percent of all parts and labor costs for failures due to defects in materials and workmanship to the "as shipped consist" from the factory. All repairs will be performed by factory trained dealer service personnel, and allows for repairer travel and mileage for all repairs up to 8 hours and 320 miles per incident.

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2 PRODUCT SPECIFICATIONS

2.1 GENERAL REQUIREMENTS

2.1.1 Generator set Requirements

The generator set shall be Standby Duty rated at 350 ekW, 437.5 kVA,
1800 RPM, 0.8 power factor, 480 V, 3-Phase,
60 hertz, including radiator fan and all parasitic loads. Generator set shall be sized to operate at the specified load at a maximum ambient of 77F (
25.0C) and altitude of 500.0 feet (152.4 m).

Standby Power Rating:
Power is available for the duration of an emergency outage
Average Power Output = 70% of standby power
Load = Varying
Typical Hours/Year = 200 Hours
Maximum Expected Usage = 500 hours/year
Typical Application = Standby

2.1.2 Material and Parts

All materials and parts comprising the unit shall be new and unused.

2.1.3 Engine

The engine shall be diesel fueled, four (4) cycle, water-cooled, while operating with nominal speed not exceeding 1800 RPM. The engine will utilize in-cylinder combustion technology, as required, to meet applicable EPA non-road mobile regulations and/or the EPA NSPS rule for stationary reciprocating compression ignition engines. Additionally, the engine shall comply with the State Emission regulations at the time of installation/commissioning. Actual engine emissions values must be in compliance with applicable EPA emissions standards per ISO 8178 – D2 Emissions Cycle at specified ekW / bHP rating.
Emissions requirements / certifications of this package:
EPA ESE

2.1.3.1 Engine Governing

2.2 GENERATOR

2.2.1 Generator Specifications

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The synchronous generator shall be a single bearing, self-ventilated, drip-proof design in accordance with NEMA MG 1 and directly connected to the engine flywheel housing with a flex coupling. The generator shall meet performance class G2 of ISO 8528. The excitation system shall be of brushless construction.

2.2.2 Voltage Regulator

2.2.2.1 Automatic Voltage Regulator

The automatic voltage regulator (AVR) shall maintain generator output voltage within +/- 0.5% for any constant load between no load and full load. The regulator shall be a totally solid state design, which includes electronic voltage buildup, over-excitation protection, shall limit voltage overshoot on startup, and shall be environmentally sealed. Voltage regulation shall be selectable to be either volts per hertz or by load adjustment module.

2.2.2.1 Integrated Voltage Regulator (IVR)

The IVR shall maintain generator output voltage within +/- 0.25% for any constant load between no load and full load. The regulator shall be capable of sensing true RMS in three phases of alternator output voltage, or operating in single phase sensing mode. The IVR shall be cable of configuring knee frequency and voltage regulation configurable up to +/-30% .The voltage regulator shall include a VAR/Pfcontrol feature as standard. The regulator shall provide an adjustable dual slope regulation characteristic in order to optimize voltage and frequency response for site conditions. The IVR shall be capable of setpoint adjustment.

2.2.3 Motor Starting

Provide locked rotor motor starting capability of
880.0 skVA at 30% instantaneous voltage dip as defined per NEMA MG 1. Sustained voltage dip data is not acceptable.

2.3 CIRCUIT BREAKER

2.3.1 Circuit Breaker Specifications

Provide a generator mounted 100%BookCirc

circuit breaker, molded case, Qty.( ) _ _ _ amp trip, 3 pole, NEMA 1/IP22. Breaker shall utilize a solid state trip unit. The breaker shall be UL/CSA Listed
and connected to engine/generator safety shutdowns. Breaker shall be housed in an extension terminal box which is isolated from vibrations induced by the generator set. Mechanical type lugs, sized for the circuit breaker feeders shown on drawing, shall be supplied on the load side of breaker.

2.4 CONTROLS – GENERATOR SET MOUNTED (EMCP 4.4)

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Provide a fully solid-state, microprocessor based, generator set control. The control panel shall be designed and built by the engine manufacturer. The control shall provide all operating, monitoring, and control functions for the generator set. The control panel shall provide real time digital communications to all engine and regulator controls via SAE J1939.

2.4.1 Environmental

The generator set control shall be tested and certified to the following environmental conditions:

A. –40°C to +70°C Operating Range
B. 100% condensing humidity, 30°C to 60°C
C. IP22 protection for rear of controller; IP55 when installed in control panel
D. 5% salt spray, 48 hours, +38°C, 36.8V system voltage
E. Sinusoidal vibration 6G's RMS, 24-1000Hz
F. Electromagnetic Capability (89/336/EEC, 91/368/EEC, 93/44/EEC, 93/68/EEC, BS EN 50081-2, 50082-2)
G. Shock: withstand 15G

2.4.2 Functional Requirements

The following functionality shall be integral to the control panel.

A. The control shall include a minimum 5.5 inch, 480 x 320 pixel, white backlit graphical display with text based alarm/event descriptions.
B. The control shall include a minimum of 6-line data display
C. Generator set overview screen displaying critical generator set mechanical and electrical data on a single screen.
D. Audible horn for alarm and shutdown with horn silence switch
E. Standard ISO labeling
F. Multiple language capability
G. Remote start/stop control
H. Local run/off/auto control integral to system microprocessor
I. Cooldown timer
J. Speed adjust
K. Lamp test
L. Emergency stop push button
M. Voltage adjust
N. Voltage regulator V/Hz slope - adjustable
O. Password protected system programming

2.4.3 Digital Monitoring Capability

The controls shall provide the following digital readouts for the engine and generator. All readings shall be indicated in either metric or English units

Engine

A. Engine oil pressure
B. Engine oil temperature
C. Engine coolant temperature
D. Engine RPM
E. Battery volts
F. Engine hours

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G. Engine crank attempt counter
H. Engine successful start counter
I. Service maintenance interval
J. Real time clock
K. Engine exhaust stack temperature
L. Engine main bearing temperature

Generator

A. Generator AC volts (Line to Line, Line to Neutral and Average)
B. Generator AC current (Avg and Per Phase)
C. Generator AC Frequency
D. Generator kW (Total and Per Phase)
E. Generator kVA (Total and Per Phase)
F. Generator kVAR (Total and Per Phase)
G. Power Factor (Avg and Per Phase)
H. Total kW-hr
I. Total kVAR-hr
J. % kW
K. % kVA
L. % kVAR
M. Generator bearing temperature
N. Generator stator winding temperature

2.4.4 Alarms and Shutdowns

The control shall monitor and provide alarm indication and subsequent shutdown for the following conditions. All alarms and shutdowns are accompanied by a time, date, and engine hour stamp that are stored by the control panel for first and last occurrence:

Engine Alarm/Shutdown

A. Low oil pressure alarm/shutdown
B. High coolant temperature alarm/shutdown
C. Loss of coolant shutdown
D. Overspeed shutdown
E. Overcrank shutdown
F. Emergency stop shutdown
G. Low coolant temperature alarm
H. Low battery voltage alarm
I. High battery voltage alarm
J. Control switch not in auto position alarm
K. Battery charger failure alarm
l. ATS remote start wiring failure

Generator Alarm/Shutdown

A. Generator phase sequence
B. Generator over voltage
C. Generator under voltage
D. Generator over frequency
E. Generator under frequency

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F. Generator reverse power (real and reactive)
G. Generator overcurrent ((including inverse definite minimum time. for Normally Inverse, Very Inverse, Extremely Inverse conditions as well as those based on Thermal Damage Curve configurations)
H. Generator current balance

Voltage Regulator Alarm/Shutdown

A. Loss of excitation alarm/shutdown
B. Instantaneous over excitation alarm/shutdown
C. Time over excitation alarm/shutdown
D. Rotating diode failure
E. Loss of sensing
F. Loss of PMG

2.4.5 Inputs and Outputs

Programmable Digital Inputs

The controller shall include the ability to accept programmable digital input signals. The signals may be programmed for either high or low activation using programmable Normally Open or Normally Closed contacts.

Programmable Discrete Outputs

The control shall include the ability to operate seventeen (17) discrete outputs, integral to the controller, which are capable of sourcing up to 200mA.

Integrated PLC Functionality

The panel shall allow the operator to create custom logic functions to provide additional user defined control of the generator set operation.

2.4.6 Maintenance

All engine, voltage regulator, control panel and accessory units shall be accessible through a single electronic service tool. The following maintenance functionality shall be integral to the generator set control

A. Engine running hours display
B. Service maintenance interval (running hours or calendar days)
C. Engine crank attempt counter
D. Engine successful starts counter
E. 40 events are stored in control panel memory
F. Chronological status event log capable of displaying a sequence of event leading up to a generator set shutdown
G. Programmable cycle timer that starts and runs the generator for a predetermined time. The timer shall use 7 user-programmable sequences that are repeated in a 7-day cycle. Each sequence shall have the following programmable set points:

1. Day of week
2. Time of day to start

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3. Duration of cycle

2.4.7 Remote Communications

Remote Communications

The control shall include Modbus TCP communications via Ethernet 10BASE-T and Modbus RTU communications via RS-485 half duplex with configurable baud rates from 2.4k to 57.6k.

Remote Monitoring Software

The control shall provide Monitoring Software with the following functionality

A. Monitor up to eight (8) generator sets, plus ATS and UPS.
B. Provide access to all date and events on generator set communications network
C. Provide remote control capability for the generator set(s)
D. Ability to communicate via Modbus TCP, Modbus RTU or remote modem

2.4.8 Annunciation

Local Annunciator (NFPA 99/110, CSA 282)

Provide a local, control panel mounted, annunciator to meet the requirements of NFPA 110, Level 1.

A. Annunciators shall be networked directly to the generator set control
B. Local Annunciator shall include a lamp test pushbutton, alarm horn and alarm acknowledge pushbutton
C. Provide the following individual light indications for protection and diagnostics:
    1. Overcrank
    2. Low coolant temperature
    3. High coolant temperature warning
    4. High coolant temperature shutdown
    5. Low oil pressure warning
    6. Low oil pressure shutdown
    7. Overspeed
    8. Low coolant level
    9. EPS supplying load
    10. Control switch not in auto
    11. High battery voltage
    12. Low battery voltage
    13. Battery charger AC failure
    14. Emergency stop
    15. Spare (or ATS Remote Start wiring failure)
    16. Spare (or Tier 4 SCR when applicable)

Remote Annunciator (NFPA 99/110, CSA 282)

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Provide a remote annunciator to meet the requirements of NFPA 110, Level 1.

A. The annunciator shall incorporate ring-back capability so that after silencing the initial alarm, any subsequent alarms will sound the horn.
B. Ability to be located up to 4000 ft from the generator set
C. The annunciator shall provide remote annunciation of all points listed below:
    1. Overcrank
    2. Low coolant temperature
    3. High coolant temperature warning
    4. High coolant temperature shutdown
    5. Low oil pressure warning
    6. Low oil pressure shutdown
    7. Overspeed
    8. Low coolant level
    9. EPS supplying load
    10. Control switch not in auto
    11. High battery voltage
    12. Low battery voltage
    13. Battery charger AC failure
    14. Emergency stop
    15. Spare (or ATS Remote Start wiring failure)
    16. Spare (or Tier 4 SCR when applicable)

2.4.9 Sequence of Operations

[Seclect One - Multigen LEXE1408-01 or Single Gen Single Utility LEXE1466-00]
[Select (1of2): Multigen LEXE1408-01]

Description: This sequence describes a system utilizing CAT® EMCP4.4 generator controllers to parallel multiple generators to each other in an island or standby application.

A. Functional Sequence of Operation

1. The EPS Automation shall be provided with the following Modes of Operation:
    a) Automatic/Standby Mode
        1) The automatic transfer switches are in the normal position serving utility power to the loads.
        2) The generator set main breakers are open.
        3) The automation is standing by to act in response to a run request from associated automatic transfer switches.
    b) Emergency Mode
        Entry
        1) Automatic Transfer Switch Run Request is received by all generator controllers
        2) Where applicable, load shed sequence is executed.
        3) All available generators are started.
        4) The first generator up to voltage and frequency is closed to the bus.
        5) Critical loads and load shed priority 1 loads are powered.
        6) The remaining generator sets are synchronized and paralleled to the bus as they come up to voltage and frequency.
        7) As additional generators are paralleled to the emergency bus, Load Shed Priority levels are added, powering their associated loads.

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8) The system will continuously monitor real and reactive power and proportionally share load among all generators on the bus.
9) The system is now in emergency mode.

Exit

1) Automatic transfer switches sense the utility source is within acceptable operational tolerances for a time duration set at the automatic transfer switch.
2) As each automatic transfer switch transfers back to utility power, it removes it's run request from the generator plant.
3) When the last automatic transfer switch has retransferred to the utility and all run requests have been removed from the generator plant, the tie breaker (if present) and all generator set main circuit breakers shall be opened.
4) The generator sets are allowed to run for their programmed cool down period and shut down.
5) The system is returned to automatic/standby mode

2. Load Sense Generator Demand
   a) The controller shall also include logic to automatically sequence the generator sets based on the total load requirement of the system. If the load exceeds a minimum reserve kW threshold, additional generator sets will automatically start, synchronize, and close the generator circuit breaker. If the site load falls below a reserve kW threshold, a generator set will automatically unload, open the generator circuit breaker, and shutdown.

[Select (2of2): Single Gen Single Utility LEXE1466-00]

A. Single Generator Set to Utility Paralleling; The controller shall be capable of automatically synchronizing and paralleling a single generator set to a single utility source, operating in one of seven operating modes. Paralleling functions shall include:

B. Modes of Operation

1. Utility Only (not selectable)
2. This mode identifies the condition when the Utility is feeding the load while the genset is not running.
3. Emergency (not selectable)
4. This mode identifies the condition when the Utility is off line, regardless of the running state of the genset.
5. Peak Lopping Open Transition
6. The Utility (or generator) breaker feeding the load opens, followed by closing of the generator (or Utility) breaker. The load is not powered between these breaker operations.
7. Peak Lopping Closed Transition
8. Transfers load from the Utility (or generator) to the generator (or Utility) by synchronizing the generator to the Utility, closing the open breaker, transferring the load, and then opening the other breaker.
9. Base Load
10. Allows the genset to provide a fixed amount of power to the load, while letting the Utility make up the difference.
11. Import Control
12. Allows the EMCP to limit the amount of power the Utility can provide to the load based on a programmable value, while letting the Generator make up the difference.
13. Export Control
15. Allows the EMCP to feed the load while additionally exporting a fixed amount of power back to the Utility, based on a programmable value.

C. Paralleling Features:

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1. Dead bus arbitration
2. Automatic synchronization
3. Real and reactive load sharing
4. Load shed
5. Load add
6. Power factor control

D. Control Features

1. The paralleling controller shall be capability of operating electrically operated (5 cycle close/open) circuit breakers:
   a) Generator output circuit breaker - generator mounted or supplied in switchgear/switchboard
   b) Utility tie circuit breaker - supplied in switchgear/switchboard

2. Industrial grade equivalent utility and bus protective relaying:
   a) Over/under voltage (27/57)
   b) Over/under frequency (81 O/U)
   c) Reverse power (kW/kVAR)
   d) Current imbalance (46)
   e) Sync check (25)
   f) Bus over/under voltage (27/59)
   g) Bus over/under frequency (81 O/U)
3. The controller shall be capabile of interface to utility protective relays equipped with 0-10 / 4-20mA output for utility kW/kVAR equivalent signal.

2.5 COOLING SYSTEM

2.6 FUEL SYSTEM

2.6.1 Fuel System

The fuel system shall be integral with the engine. In addition to the standard fuel filters provided by the engine manufacturer, there shall also be installed a primary fuel filter/water separator in the fuel inlet line to the engine. All fuel piping shall be black iron or flexible fuel hose rated for this service. No galvanized piping will be permitted. Flexible fuel lines shall be minimally rated for 300 degrees F and 100 psi.

B

2.6.2 Fuel Sub Base Tank

Provide a double wall sub-base tank constructed to meet all local codes and requirements. A fuel tank base of
72 hour capacity shall be provided as an integral part of the enclosure. It shall be contained in a rupture basin with 110% capacity. The tank shall meet UL142 standards. A locking fill cap, a mechanical reading fuel level gauge, low fuel level alarm contact, and fuel tank rupture alarm contact shall be provided.

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2.7 EXHAUST SYSTEM (INDOOR INSTALLATIONS ONLY)

2.7.1 Silencer

2.8 STARTING SYSTEM

2.8.1 Starting Motor

A DC electric starting system with positive engagement shall be furnished. The motor voltage shall be as recommended by the engine manufacturer.

2.8.2 Jacket Water Heater

Jacket water heater shall be provided and shall be sized to insure that genset will start within the specified time period and ambient conditions.

2.8.3 Batteries

Batteries - A lead-acid storage battery set of the heavy-duty diesel starting type shall be provided. Battery voltage shall be compatible with the starting system.

2.8.4 Battery Charger

A current limiting battery charger shall be furnished to automatically recharge batteries. The charger shall be dual charge rate with automatic switching to the boost rate when required. The battery charger shall be mounted on the genset package or inside the genset enclosure/room.

2.9 ENCLOSURE

2.9.1 Attenuated Enclosure (Standard Sound optional)

The complete: Section291A
engine generator set, including generator control panel, engine starting batteries and fuel oil tank, shall be enclosed in a factory assembled, sound attenuated enclosure mounted on the fuel tank base.

A. A weather resistant, sound attenuated enclosure of steel with electrostatically applied powder coated baked polyester paint. The enclosure shall have a resulting sound level of ___dba @____ft with the genset running under full load. It shall consist of a roof, side walls, and end walls. Fasteners shall be either zinc plated or stainless steel.

B. Enclosure Sound Attenuation: Acoustical foam shall be provided between all supports and inside doors and sound baffles on air intake and air discharge.

3 EXECUTION

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3.1 INSTALLATION

Install equipment in accordance with manufacturer's recommendations, the project drawings and specifications, and all applicable codes.

3.2 START-UP AND TESTING

Coordinate all start-up and testing activities with the Engineer and Owner. After installation is complete and normal power is available, the manufacturer's local dealer shall perform the following:

A. Verify that the equipment is installed properly.
B. Check all auxiliary devices for proper operation, including battery charger, jacket water heater(s), generator space heater, remote annunciator, etc.
C. Test all alarms and safety shutdown devices for proper operation and annunciation.
D. Check all fluid levels.
E. Start engine and check for exhaust, oil, fuel leaks, vibrations, etc.
F. Verify proper voltage and phase rotation at the transfer switch before connecting to the load.
G. Connect the generator to building load and verify that the generator will start and run all designated loads.
H. The system shall be tested under full load and monitor the following readings:

1. Oil pressure
2. Coolant temperature
3. Battery charge rate
4. AC volts
5. AC Amperes- all phases
6. Frequency
7. Kilowatts
8. Ambient Temperature

3.3 OPERATION AND MAINTENANCE MANUALS

Provide two (2) sets of operation and maintenance manuals covering the generator, switchgear, and auxiliary components. Include final as-built wiring interconnect diagrams and recommended preventative maintenance schedules.

3.4 TRAINING

3.4.1 On-Site Training

Provide on-site training to instruct the owner's personnel in the proper operation and maintenance of the equipment. Review operation and maintenance manuals, parts manuals, and emergency service procedures.

SUGGESTED SPECIFICATION
For

Caterpillar: Confidential Green

Open Transition Automatic Transfer Switch

(CG)

PRODUCT GUIDE SPECIFICATION

Cat® CG series Automatic Transfer Switches, 30-1200 A, 200-480 Vac

Specifier Notes: This section must be carefully reviewed and edited by the Architect or Engineer to meet the requirements of the project and local building code. Coordinate this section with other specification sections and the Drawings. Delete all "Specifier Notes" after editing this section.

SECTION 26 36 23

AUTOMATIC TRANSFER SWITCHES

Specifier Notes: Delete any information below in Parts 1, 2 or 3 which is not required or relevant for the project. When information is displayed in sets of brackets, select which of the options are desired to remain and remove the brackets.

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes transfer switches rated up to 480Vac, including the following:

1. Automatic Transfer Switches

B. Related Sections include the following:

Specifier Notes: List related products that appear in other Sections. The following are examples only; edit as appropriate.

1. 26 22 00 Low-Voltage Transformers
2. 26 32 00 Packaged Generator Assemblies

1.03 SUBMITTALS

A. Product Data:

1. Submit manufacturer's descriptive literature and product specifications. These shall include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

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B. Drawings:

1. Single-line diagram or schematic of arrangement of ATS unit shall be submitted. Show connections between transfer switch, power sources, and load.
2. Manufacturer's product drawings.
3. As applicable: dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

C. Operation and Maintenance Data:

1. For each type of product include manuals for installation, operation, and maintenance.
2. A quick start guide shall be provided with the product shipment to guide start-up.
3. In addition, documentation shall define features and operating sequences for both automatic and manual operation.

D. Manufacturer and Supplier Qualification Data:

1. The transfer switch manufacturer shall be certified to International Quality Standard (ISO) 9001, with third party certification verifying quality assurance in design/development and production.

2. The manufacturer of the transfer switch shall be the same as the manufacturer of the emergency power source (generator set).

1.04 QUALITY ASSURANCE

A. Transfer switches shall be free of defects in material and workmanship.

B. Transfer switches shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked as suitable for use in emergency, legally required or optional standby use as appropriate for the connected load.

C. Transfer switch applications and installations shall comply with the requirements of the codes and standards listed below. Where required, certified test reports substantiating the compliance shall be submitted upon request.

1. UL 1008 - Standard for Transfer Switch Equipment
2. IEC 60947-6-1 Low-voltage switchgear and control gear – Part 6-1: Multiple function equipment – Transfer switching equipment
3. NFPA 70 - National Electrical Code; particularly, transfer switches shall be suitable for usage in accordance with Articles 517 - Health Care Facilities, 700 - Emergency Systems, 701 - Legally Required Standby Systems, 702 - Optional Standby Systems
4. NFPA 99 - Healthcare Facilities Code
5. NFPA 110 - Standards for Emergency and Standby Power Systems
6. IEEE 241 - Recommended Practice for Electrical Power Systems in Commercial Buildings

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7. IEEE 446 - Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
8. IEEE 602 - Recommended Practice for Electrical Power Systems in Health Care Facilities
9. NEMA ICS 10-2005 - Industrial Control and Systems Part 1: Electromechanical AC Transfer Switch Equipment

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Automatic and Mechanically Held Transfer Switches:

a. Caterpillar

2.02 GENERAL TRANSFER SWITCH PRODUCT REQUIREMENTS

A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer.

B. Fault-Current Closing and Withstand Ratings: UL 1008 WCR ratings must be specifically listed as meeting the requirements for use with protective devices at installation locations, under specified fault conditions. Withstand and closing ratings shall be based on use of the same set of contacts for the withstand test and the closing test.

C. Microcontroller: Shall provide selectable nominal voltages from 200Vac to 480Vac for maximum application flexibility and minimal spare part requirements. Voltage sensing shall be true RMS type and shall be accurate to +/- 1% of nominal voltage. Frequency sensing shall be accurate to +/- 0.5%. The unit shall be capable of operating over a temperature range of -20 to +70 °C and storage from -40 to +70 °C.

D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements and voltage-impulse withstand requirements of IEC 60947-6-1.

E. Electrical Operation: Accomplish by a momentarily energized single solenoid, mechanically and electrically interlocked in both directions.

F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Transfer switches shall be double-throw, electrically and mechanically interlocked, and mechanically held in the Source 1 and Source 2 positions.
2. The contacts shall have the following construction characteristics:

a. Power contactor type construction

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b. Specialized first-touch contact tips with specialized material and design to isolate and dissipate arc to limit wear of the normal fully closed contact point
c. Self-cleaning contact design
d. The contacts shall last the lifetime of the switch
e. Fully enclosed contacts to mitigate dust ingress, and prevent incidental contact by personnel

3. Electrical operation of contacts shall allow high speed transfer between sources in less than 50 ms (< 3 cycles) from signal. Operating transfer speed shall be fixed and not vary depending on the voltage level conditions.
4. The power transfer mechanism shall include provisions for manual operation under load. Manual operation may be electromechanical or mechanical, but must be coordinated with control function.

G. Control: Transfer switch control shall be capable of provisioning communication with the genset control, other switches and remote programming devices over a high-speed network interface.

H. Neutral Switching: Transfer switches designated on the drawings for 3 phase, 4 wire systems as “4-pole”, or single phase systems as “3-pole”, shall be provided with a neutral pole which is switched simultaneously with phase poles.

A. Neutral Terminal: Transfer switches designated on the drawings for 3 phase, 4 wire systems as “3-pole”, or single phase, 3 wire systems as “2-pole” shall be provided with a 100% rated solid neutral bus and lugs, unless otherwise indicated.

B. Enclosures: Shall be available as designated on the drawings as specified below, complying with NEMA ICS 6 and UL 50, unless otherwise indicated.

1. Type 1 for indoor applications
2. Type 12 for indoor applications (drip protection)
3. Type 3R for outdoor applications (rain proof)
4. Type 4 or 4X (stainless steel) for outdoors or uncontrolled environment applications

2.03 AUTOMATIC TRANSFER SWITCHES

A. Comply with [Level 1] [Level 2] equipment according to NFPA 110.

B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

C. Automatic transfer switches (ATS) shall be available in [Open (without stable OFF position)] [and] [Delayed (with stable OFF position)] transition versions in accordance with project drawings.

D. ATS shall be available in version with 2-poles for single phase load, 3 poles and 4 poles for three phase loads, as per indication on single line diagram.

E. ATS shall be available in different frame sizes from 30A to 1200A and selection of size shall be in accordance with project drawings.

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F. Manual Operation: It shall be possible to perform emergency manual operation under load conditions due to quick-make, quick-break action of spring over-center mechanism.

G. In-phase monitor: ATS shall have embedded feature that when enabled by user, allows transfer from Source 1 (S1) to Source 2 (S2) and back only when phases are sufficiently synchronized (phase angle difference between sources within 5 degrees). Load supply transfer is delayed or disabled in conditions that are considered invalid for the application:

1. Phase difference between sources is out of range
2. Phase order between sources is not the same
3. Voltage amplitude is out of range
4. Phase is missing
5. Voltage is asymmetric
6. Frequency is out of range

H. All-in-one Construction: The ATS shall be purpose-built for the application and one seamless unit to guarantee easy and fast installation and reliable operation.

I. The ATS shall be capable of top and bottom feed configurations by allowing easy cable entry from the desired direction of choice, and sufficient wire bending space for typically sized wire.

J. Automatic Transfer Switch Control Functions:

1. Functions managed by ATS control shall include adjustable time-delays, that can be bypassed via HMI key control, communications protocol (optional), or programmable digital I/O (optional):

    a. Override momentary Source 1 Outage adjustable from 0-60 s
    b. Transfer from Source 1 to Source 2 adjustable from 0-60 min
    c. Override momentary Source 2 Outage adjustable from 0-60 s
    d. Transfer from Source 2 to Source 1, adjustable from 0-120 min
    e. Generator stop delay, adjustable from 0-60 min
    f. Center-OFF delay, adjustable from 0-300 s
    g. Pre-transfer delay S1 to S2 adjustable from 0-300 s
    h. Post-transfer delay S1 to S2 adjustable from 0-300 s
    i. Pre-transfer delay S2 to S1 adjustable from 0-300 s
    j. Post-transfer delay S2 to S1 adjustable from 0-300 s
    k. Load shed delay adjustable from 0-60 s
    l. Elevator pre-signal S1 to S2 adjustable from 0-60 s
    m. Elevator post-signal S1 to S2 adjustable from 0-60 s
    n. Elevator pre-signal S2 to S1 adjustable from 0-60 s
    o. Elevator post-signal S2 to S1 adjustable from 0-60 s

2. Functions managed by ATS control shall include undervoltage sensing for each phase of both sources, with the following selectable threshold ranges:

    a. Pick-up: 71-99%
    b. Drop out Voltage: 70-98%
    c. Accuracy: 1%

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3. Functions managed by ATS control shall include overvoltage sensing for each phase of both sources, with the following selectable threshold ranges:

    a. Pick-up: 101-119%
    b. Drop out Voltage: 102-120%
    c. Accuracy: 1%

4. Functions managed by ATS control shall include underfrequency sensing for each phase of both sources, with the following selectable threshold ranges:

    a. Pick-up: 80.5-99.5%
    b. Drop out Voltage: 80-99%
    c. Accuracy: 0.5%

5. Functions managed by ATS control shall include overfrequency sensing for each phase of both sources, with the following selectable threshold ranges:

    a. Pick-up: 100.5-119.5%
    b. Drop out Voltage: 101-120%
    c. Accuracy: 0.5%

6. ATS shall be able to detect the following faults:

    a. No voltage present
    b. Undervoltage
    c. Overvoltage
    d. Phase loss
    e. Voltage unbalance
    f. Invalid frequency
    g. Incorrect phase sequence

K. HMI Characteristics

1. ATS shall be equipped with 3” by 2” graphical LCD HMI display.
2. ATS shall have a display module/HMI mounted to the ATS panel door mounting with one single standard Cat 5/Ethernet/RJ45 cable.
3. ATS shall provide the last 250 events in the display, with time and date.
4. ATS shall be equipped with a large multi-line display and supporting the following languages:

    a. English
    b. French
    c. German
    d. Italian
    e. Spanish
    f. Russian
    g. Chinese
    h. It shall be possible to download more languages if required

5. ATS shall be fully operational even when the HMI is disconnected

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6. ATS HMI shall indicate in an LED one-line diagram which source the load is connected to, and which sources are available.
7. ATS HMI shall indicate via LED when switch in or not in AUTO mode, and whether there are any alarm or warning conditions.
8. ATS HMI shall display system status as a main screen that is the default screen and readily accessible from any menu screen by pressing ESC key. The screen shall clearly show the following:

    a. S1 and S2 status
    b. Which source is connected to load
    c. Current alarms, warnings, or information
    d. Generator start/stop contact status
    e. Time of day
    f. Active time delay and remaining time
    g. Aux power connected

9. ATS HMI shall have an optional main screen that displays line to line and line to neutral (if applicable) voltage.
10. ATS alarms, warnings, and information shall be clearly communicated from the main screen and shall provide meaningful information for detecting and diagnosing system errors that may be preventing load transfer commands from being executed.
11. ATS HMI shall display statistical information (switch diagnostics) to assess the conditions and operational history of the switch:

    a. Total operations
    b. Number of load transfers
    c. Transfer time (last transfer: total time from source failure to close-on alternate source)
    d. Source fail transfers (number of times ATS has transferred due to source failure)
    e. Days energized
    f. Total time on S1
    g. Total time on S2
    h. Time S1 available
    i. Time S2 available
    j. Last generator start
    k. Generator starting time
    l. In-phase time (last transfer: how long it took for sources to sync for transfer)

L. Auxiliary Contacts: ATS shall be offered with A (NC) and B (NO) contacts for position indication rated 6A at 240Vac, with the ability to place four contacts per position of each source.

M. Generator Start/Stop Contacts: One isolated and normally closed, and one isolated and normally open; rated 5A at 250Vac/30Vdc.

N. Standard Digital I/O: Standard (open, ZTG) transition ATS shall include one programmable digital input and one programmable output contact. Delayed transition (ZTGD) ATS shall include two programmable digital inputs and one programmable output contact. The programmable functions shall be possible as stated below:

    1. Input functions:

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a. Emergency Stop (Delayed Transition, ZTGD only)
b. Remote Test on Load
c. Remote Test off Load
d. Inhibit Auto Mode
e. Manual Retransfer
f. Priority S1
g. Priority S2
h. Inhibit Transfer (from primary to secondary)
i. Bypass Running Time Delays
j. Remote Control to S1
k. Remote Control to Off (Delayed Transition, ZTGD only)
l. Remote Control to S2
m. Alarm Reset
n. Manual-Auto Mode

2. Output functions:

a. Alarm/Product Availability (generated when ATS is not capable of auto operation)
b. ATS in Position I
c. ATS in Position O (Delayed Transition, ZTGD only)
d. ATS in Position II
e. Pre-transfer Signal
f. Source 1 Available
g. Source 2 Available
h. Load Shed (to remove non-critical load before transferring to alternate source)

O. Engine-Generator Exerciser: Programmable function starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable between daily or 7, 14, or 28 days. Running periods can be adjustable in minutes. On-load or off-load exercising is selectable.

P. Commit Transfer (Off/On): If set to “On”, Load is transferred to non-priority source after priority source failure even if the priority source returns before the non-priority source is ready to accept the load.

Q. Test: Ability to simulate normal source failure and test on-load or off-load either direct from HMI, Ekip connect software (optional), communications protocol (optional), or digital programmable I/O (optional).

R. Position Indication: reliable indication of contact position shall be visible on the ATS unit via a mechanical indicator directly driven by the switching mechanism

S. Operational Requirements:

1. The complete ATS solution shall be compatible with the following temperature conditions:

a. Operating temperature without derating: -20°C to +40°C
b. Operating temperature with derating: +41°C to +70°C
c. Transportation and storage temperature: -40°C to +70°C

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2. ATS shall be capable of operating in 200 to 480Vac voltage range without additional devices like external voltage transformers.
3. The display module/HMI shall be communicating with the ATS controller via local communication bus and shall be completely isolated from the dangerous line voltages
4. It shall be possible to program the ATS by using 12-24Vdc auxiliary power supply when mains or generator power is not available
5. Generator start time delay shall be adjustable up to maximum 60 secs without using additional batteries, external power supplies or similar accessories

2.04 OPTIONAL FEATURES

A. Connectivity and Communication

1. ATS shall be capable of communicating, without external gateways and data converters, with the following listed communication protocols. Use of two modules/protocols shall be possible.

    a. Modbus RS485
    b. Modbus/TCP
    c. Profibus DP
    d. Profinet
    e. DeviceNet
    f. Ethernet/IP

2. ATS shall have expandable programmable digital I/O, capable of adding up to 6 additional inputs and 6 additional outputs. These shall be capable of any of the I/O functions in section 2.03 N. of this document.
3. Accessorizing with communication or I/O modules shall not take additional space inside the panel

B. Laptop Programming

1. It shall be possible to program the ATS without any power (no mains, generator or auxiliary power supply) via laptop.
2. With optional software and programming module it shall be possible to import and export saved settings files.

C. Aux Power Supply

1. It shall be possible to equip the ATS with a power supply module integrated into the ATS able to supply the unit with 12-24 Vdc auxiliary power to keep the controller, display and connectivity modules alive during power outages

D. Metering

1. ATS shall have power metering capabilities
2. ATS shall have capability to show on panel face: the metering values in numeric format with bright, long-life, LED display.
3. Accuracy shall be: 0.5% Class revenue accuracy to support detailed reporting requirements

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4. The following metering functions shall be available but not limited to:

   a. Current (A); phase and neutral
   b. Voltage (V); L-N and L-L for each pole of S1 and S2
   c. Frequency (Hz)
   d. Power (kW); active, apparent, and reactive

E. Enclosure Heater

1. An enclosure heater with thermostat shall be provided as an optional ATS feature for Type 3R and 4 enclosures.

F. Advanced ATS Controller Features

1. ATS shall have auto configuration feature for automatically detecting the source 1 and source 2 rated voltage, rated frequency, phase distribution system, location of neutral and phase rotation (ABC, ACB)
2. ATS shall have capability to be equipped with real time clock (RTC) with a capacitor back-up to maintain time and date for minimum 48 hours if both source 1 and source 2 become unavailable. RTCs with battery back-up shall not be not allowed.
3. It shall be possible to program the generator to be source 1 or source 2 via the HMI
4. Delayed transition ATS shall have an input for 24Vdc fire fight signal for operating the ATS to OFF-position in case of emergency

2.05 ADDITIONAL REQUIREMENTS

A. Withstand and Closing Ratings

1. The ATS shall be rated according to UL 1008 to withstand and close-on the available RMS symmetrical short circuit current at the provided ATS terminals according to these maximum ratings with specified overcurrent protection on drawings. Minimum UL listed withstand and close into fault ratings shall be as follows:

ATS Rating (A)	Max Voltage (V)	Coordinated breaker WCR (A)
30 - 200	480	30,000
260	480	50,000
400	480	150,000
600	480	200,000
800 - 1200	480	65,000

PART 3–

Specifier are shall be

EXECUTION

Notes: Sections 3.01 – 3.04 suggested sections, and generated by the Engineer.

3.01 INSTALLATION

A. Preparation shall be in accordance with the reviewed product data, final shop drawings and the manufacturer's recommendations.

B. Installation shall be in accordance with manufacturer's instructions and recommendations.

C. Identify components according to Division 26 section "Identification for Electrical Systems".

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3.02 CONNECTION

A. Wiring for the ATS equipment shall be in accordance with manufacturer's instructions.

B. Connections and wiring shall be according to Division 26 section "Low-Voltage Electrical Power Conductors and cables".

3.03 FACTORY TESTS

A. The ATS shall be factory tested prior to shipment to ensure proper mechanical, electrical, and software operation. This shall include at a minimum, 10 load transfer sequences and a dielectric voltage withstand test.

3.04 SERVICE AND SUPPORT

A. Service Representation

1. The ATS manufacturer shall have and maintain a nationwide service organization throughout the United States, on call 24 hours a day, 365 days a year and capable of responding for service with spare parts within 24 hours.
2. The ATS manufacturer shall have, within a 4-hour drive distance of the installation site, service personnel trained and capable of providing service on the complete emergency power system inclusive of both ATS and Generator Set.

B. Serviceability

1. ATS shall have modular construction, enabling:

   a. Field service, including but not limited to: controller, HMI, power module, and/or mechanism unit replacement without requirement for disconnecting the power cabling and removing the ATS from the panel. Replacement of any of these individual components shall be possible in a few minutes or less
   b. Complete mechanism and electronics including solenoid operator, power module, and controller board can be replaced in less than 10 minutes, using only a flathead screwdriver and without removing power cables.

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CATERPILLAR ENGINE DIVISION
TECHNICAL COMMUNICATIONS GROUP

Installation Drawing Index
AutoCAD 2015 Format

Installation Drawing No. 5096520 chg 04

OPEN WITH NARROW BASE AND NO TANK

Overall Dimensions:

Length = 3505.30 mm

Width = 1612.60 mm

Height = 2068.40 mm

Engine pricing arrangements found on drawing:

LS1503 chg 02	LS1543 chg 02

Attachment pricing arrangements found on drawing:

LS0259 chg 03	LS1480 chg 00	LS1532 chg 00
LS0261 chg 03	LS1481 chg 00	LS1533 chg 00
LS1335 chg 02	LS1482 chg 00	LS1830 chg 04
LS1336 chg 02	LS1483 chg 02	LS1832 chg 04
LS1337 chg 02	LS1484 chg 02	3711790 chg 00
LS1338 chg 01	LS1485 chg 00	4183863 chg 00
LS1341 chg 04	LS1486 chg 00	4183865 chg 00
LS1343 chg 04	LS1487 chg 00	4183867 chg 00
LS1344 chg 04	LS1488 chg 02	4183871 chg 00
LS1345 chg 02	LS1489 chg 03	4183873 chg 00
LS1346 chg 03	LS1490 chg 00	4183879 chg 00
LS1347 chg 04	LS1491 chg 00	4183881 chg 00
LS1349 chg 02	LS1492 chg 00	4183883 chg 00
LS1350 chg 02	LS1493 chg 02	4183889 chg 00
LS1351 chg 02	LS1494 chg 02	4183891 chg 00
LS1357 chg 03	LS1506 chg 02	4183901 chg 00
LS1358 chg 03	LS1507 chg 00	4183903 chg 00
LS1439 chg 02	LS1521 chg 00	4183913 chg 00
LS1474 chg 00	LS1531 chg 00	

5096520A.dwf = Summary Sheet of LS-1503 Chg 02 Shown. (sheet1)

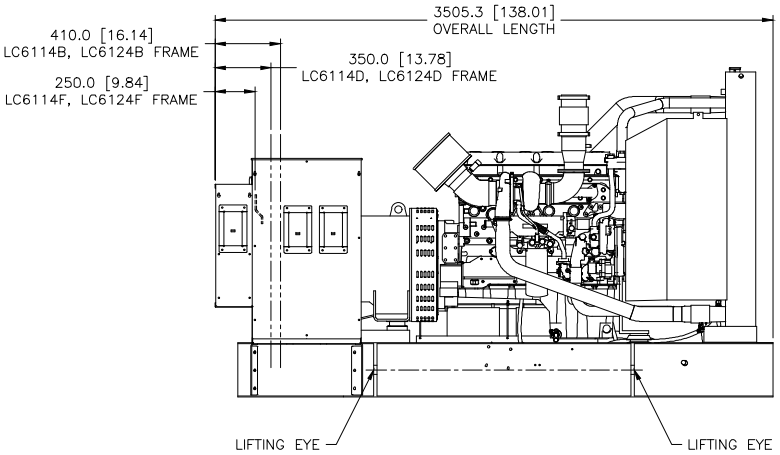
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LS1531 chg 00	LS1484 chg 02	LS1344 chg 04
LS1521 chg 00	LS1483 chg 02	LS1343 chg 04
LS1507 chg 00	LS1439 chg 02	LS1341 chg 04
LS1492 chg 00	LS1351 chg 02	4183903 chg 00
LS1491 chg 00	LS1350 chg 02	4183901 chg 00
LS1490 chg 00	LS1349 chg 02	4183891 chg 00
LS1487 chg 00	LS1345 chg 02	4183889 chg 00
LS1486 chg 00	LS1337 chg 02	4183883 chg 00
LS1485 chg 00	LS1336 chg 02	4183881 chg 00
LS1482 chg 00	LS1335 chg 02	4183879 chg 00
LS1481 chg 00	LS1489 chg 03	4183873 chg 00
LS1480 chg 00	LS1358 chg 03	4183871 chg 00
LS1474 chg 00	LS1357 chg 03	4183867 chg 00
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LS1543 chg 02	LS0261 chg 03	4183863 chg 00
LS1503 chg 02	LS0259 chg 03	3711790 chg 00
LS1506 chg 02	LS1832 chg 04	4183913 chg 00
LS1494 chg 02		

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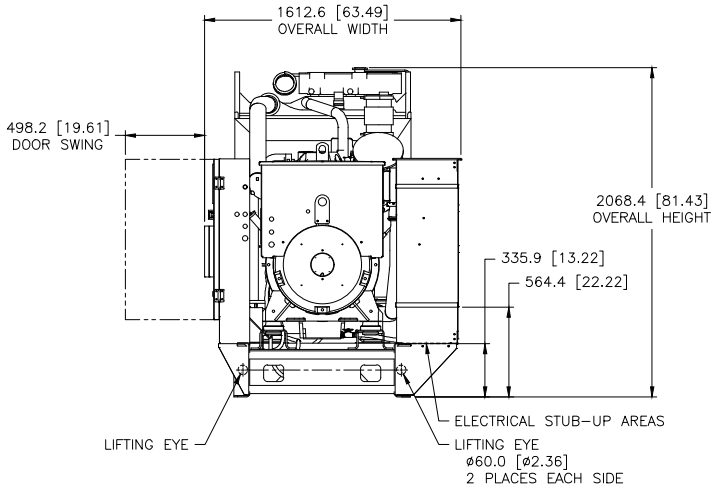
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METRIC 509-6520

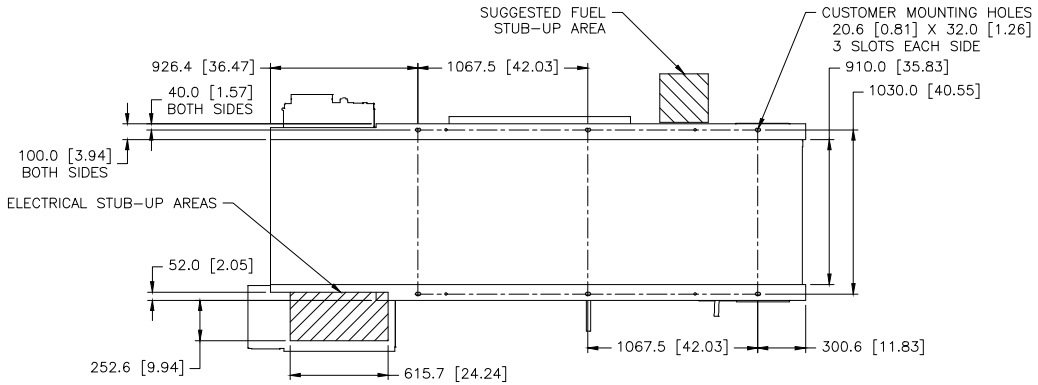
QTY	ENGINE CONNECTIONS	SIZE	SHEET
1	COOLANT DRAIN	ø19.1 [ø0.75] ID	2
1	EXCESS FUEL RETURN	13/16-16 THD	3
1	EXHAUST	ø154.5 [ø6.08]	2
1	FUEL INLET	13/16-16 THD	3
1	FUMES DISPOSAL HOSE	ø32.0 [ø1.26] ID	2
1	OIL DRAIN	ø25.4 [ø1.00] ID	2



RIGHT SIDE VIEW



REAR VIEW



FOOTPRINT
(DIMENSIONED OUTLINE VIEW FROM ABOVE)

PACKAGE LIFTED IN 4 PLACES

PACKAGE SHOWN WITH MORE DETAIL ON SHEET 2

MODEL	TYPE	PRICING AR	BASE
C13	Y	LS-1503 CHG 02	LS-1521 CHG 00
		LS-1543 CHG 02	

1E2966B IDENT
1E2733 DRAWING-AUTOCAD
1E0138W BRAND MARKINGS
1E0013G CONFIDENTIALITY
1E0012A INTERPRETATION
1E0011 INTPR & TOL

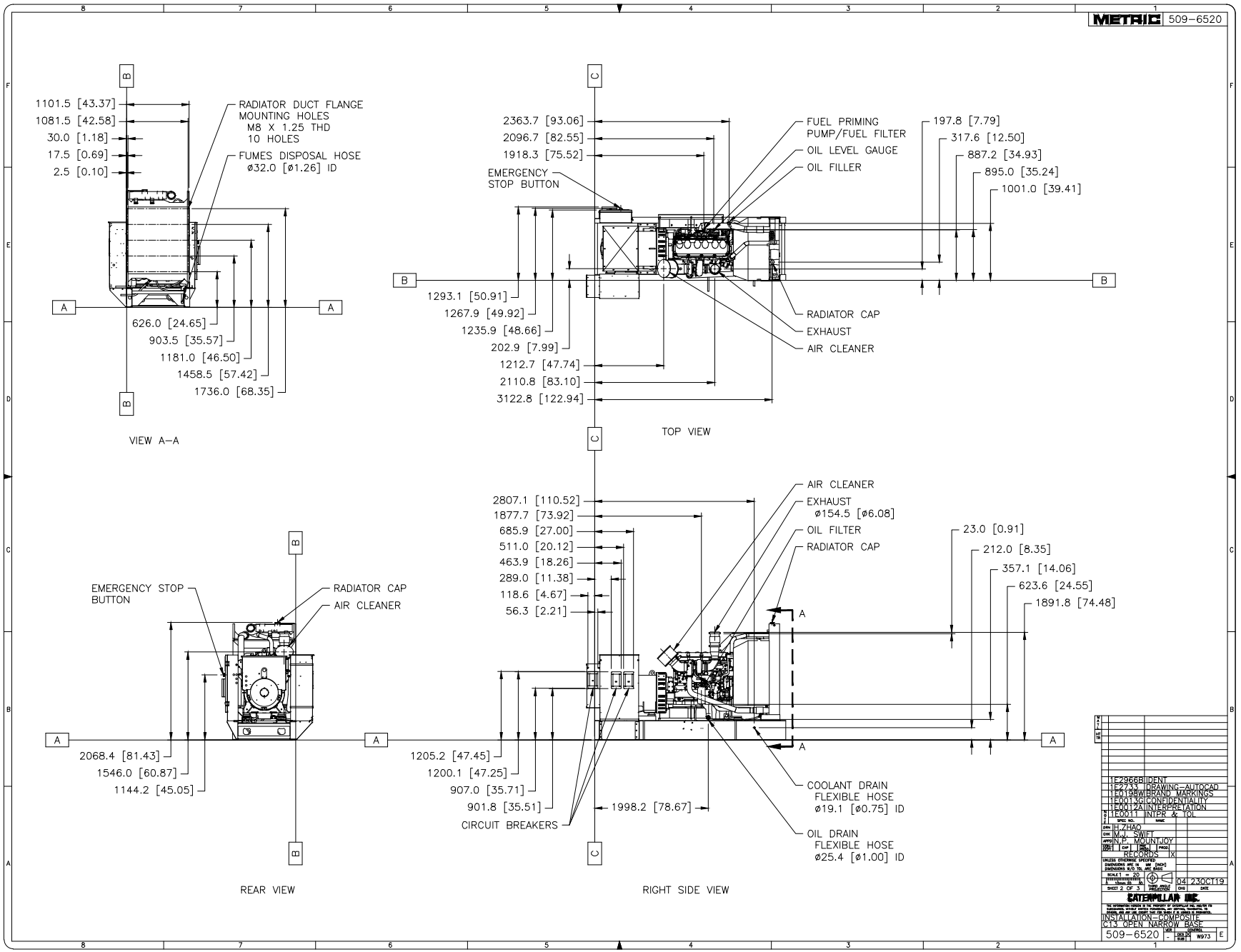
DRN H.ZHAO
CHK M.J. SWIFT
APVD N.P. MOUNTJOY

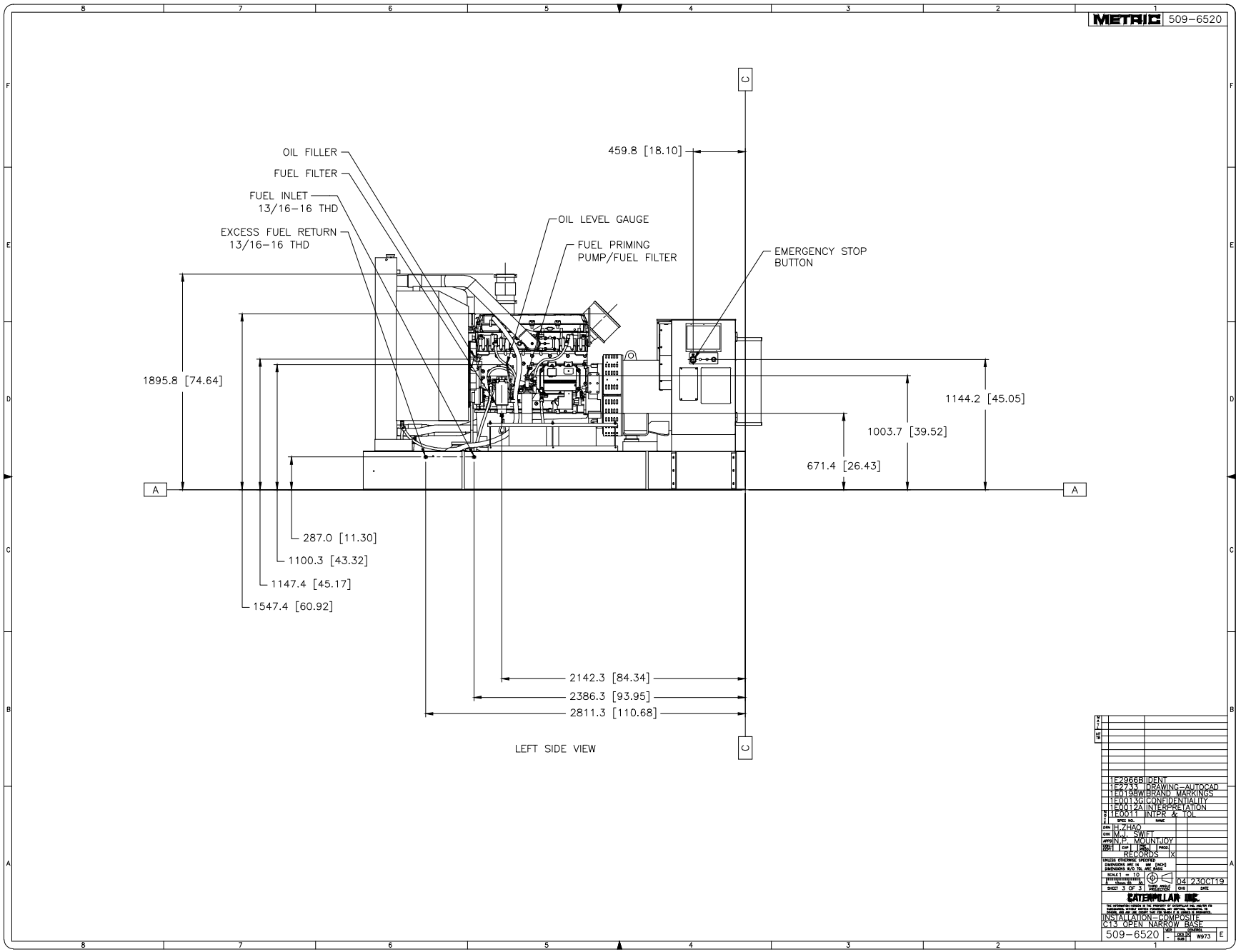
RECORDS

SCALE 1 = 10
SHEET 1 OF 3
04 230CT19

CATERPILLAR INC.

INSTALLATION-COMPOSITE
C13 OPEN NARROW BASE
509-6520 - W973 E


METRIC 509-6520
1101.5 [43.37]
1081.5 [42.58]
30.0 [1.18]
17.5 [0.69]
2.5 [0.10]
RADIATOR DUCT FLANGE MOUNTING HOLES M8 X 1.25 THD 10 HOLES
FUMES DISPOSAL HOSE ø32.0 [ø1.26] ID
626.0 [24.65]
903.5 [35.57]
1181.0 [46.50]
1458.5 [57.42]
1736.0 [68.35]
VIEW A-A
2363.7 [93.06]
2096.7 [82.55]
1918.3 [75.52]
EMERGENCY STOP BUTTON
FUEL PRIMING PUMP/FUEL FILTER
OIL LEVEL GAUGE
OIL FILLER
197.8 [7.79]
317.6 [12.50]
887.2 [34.93]
895.0 [35.24]
1001.0 [39.41]
1293.1 [50.91]
1267.9 [49.92]
1235.9 [48.66]
202.9 [7.99]
1212.7 [47.74]
2110.8 [83.10]
3122.8 [122.94]
RADIATOR CAP
EXHAUST
AIR CLEANER
TOP VIEW
EMERGENCY STOP BUTTON
RADIATOR CAP
AIR CLEANER
2068.4 [81.43]
1546.0 [60.87]
1144.2 [45.05]
REAR VIEW
2807.1 [110.52]
1877.7 [73.92]
685.9 [27.00]
511.0 [20.12]
463.9 [18.26]
289.0 [11.38]
118.6 [4.67]
56.3 [2.21]
AIR CLEANER
EXHAUST ø154.5 [ø6.08]
OIL FILTER
RADIATOR CAP
23.0 [0.91]
212.0 [8.35]
357.1 [14.06]
623.6 [24.55]
1891.8 [74.48]
1205.2 [47.45]
1200.1 [47.25]
907.0 [35.71]
901.8 [35.51]
CIRCUIT BREAKERS
1998.2 [78.67]
COOLANT DRAIN FLEXIBLE HOSE ø19.1 [ø0.75] ID
OIL DRAIN FLEXIBLE HOSE ø25.4 [ø1.00] ID
RIGHT SIDE VIEW
1E2966BIDENT
1E2733 DRAWING-AUTOCAD
1E0136WBRAND MARKINGS
1E0013GICONFIDENTIALITY
1E0012AINTERPRETATION
1E0011 INTPR & TOL
H.ZHAO
M.J. SWIFT
N.P. MOUNTJOY
RECORDS
SCALE 1 = 20
SHEET 2 OF 3
04 23OCT19
CATERPILLAR INC.
INSTALLATION-COMPOSITE
C13 OPEN NARROW BASE
509-6520
W973


METRIC 509-6520
OIL FILLER
FUEL FILTER
FUEL INLET 13/16-16 THD
EXCESS FUEL RETURN 13/16-16 THD
OIL LEVEL GAUGE
FUEL PRIMING PUMP/FUEL FILTER
EMERGENCY STOP BUTTON
459.8 [18.10]
1895.8 [74.64]
1144.2 [45.05]
1003.7 [39.52]
671.4 [26.43]
287.0 [11.30]
1100.3 [43.32]
1147.4 [45.17]
1547.4 [60.92]
2142.3 [84.34]
2386.3 [93.95]
2811.3 [110.68]
LEFT SIDE VIEW
1E2966B IDENT
1E2733 DRAWING-AUTOCAD
1E0136W BRAND MARKINGS
1E0013G CONFIDENTIALITY
1E0012A INTERPRETATION
1E0011 INTPR & TOL
H.ZHAO
M.J. SWIFT
N.P. MOUNTJOY
RECORDS
SCALE 1 = 10
04 230CT19
CATERPILLAR INC.
INSTALLATION-COMPOSITE
C13 OPEN NARROW BASE
509-6520 - W973 E

CATERPILLAR ENGINE DIVISION
TECHNICAL COMMUNICATIONS GROUP

Installation Drawing Index
AutoCAD 2015 Format

Installation Drawing No. 5096524 chg 04

OPEN WITH WIDE BASE AND 1900 GALLON SUB TANK

Overall Dimensions:

Length = 6184.90 mm

Width = 2056.00 mm

Height = 3022.30 mm

Engine pricing arrangements found on drawing:

LS1503 chg 02	LS1543 chg 02

Attachment pricing arrangements found on drawing:

LS0259 chg 03	LS1480 chg 00	LS1531 chg 00
LS0261 chg 03	LS1481 chg 00	LS1532 chg 00
LS1335 chg 02	LS1482 chg 00	LS1533 chg 00
LS1336 chg 02	LS1483 chg 02	LS1830 chg 04
LS1337 chg 02	LS1484 chg 02	LS1832 chg 04
LS1338 chg 01	LS1485 chg 00	3711790 chg 00
LS1341 chg 04	LS1486 chg 00	4183863 chg 00
LS1343 chg 04	LS1487 chg 00	4183865 chg 00
LS1344 chg 04	LS1488 chg 02	4183867 chg 00
LS1345 chg 02	LS1489 chg 03	4183871 chg 00
LS1346 chg 03	LS1490 chg 00	4183873 chg 00
LS1347 chg 04	LS1491 chg 00	4183879 chg 00
LS1349 chg 02	LS1492 chg 00	4183881 chg 00
LS1350 chg 02	LS1493 chg 02	4183883 chg 00
LS1351 chg 02	LS1494 chg 02	4183889 chg 00
LS1357 chg 03	LS1506 chg 02	4183891 chg 00
LS1358 chg 03	LS1508 chg 00	4183901 chg 00
LS1439 chg 02	LS1522 chg 01	4183903 chg 00
LS1474 chg 00	LS1525 chg 00	4183913 chg 00

5096524A.dwf = Summary Sheet of LS-1503 Chg 02 Shown. (sheet1)

LS1487 chg 00	LS1493 chg 02	LS1832 chg 04
LS1490 chg 00	LS1494 chg 02	LS1341 chg 04
LS1491 chg 00	LS1335 chg 02	LS1343 chg 04
LS1492 chg 00	LS1336 chg 02	LS1344 chg 04
LS1525 chg 00	LS1337 chg 02	LS1347 chg 04
LS1531 chg 00	LS1345 chg 02	4183913 chg 00
LS1532 chg 00	LS1506 chg 02	3711790 chg 00
LS1533 chg 00	LS1349 chg 02	4183863 chg 00
LS1485 chg 00	LS1350 chg 02	4183865 chg 00
LS1508 chg 00	LS1351 chg 02	4183867 chg 00
LS1474 chg 00	LS1439 chg 02	4183871 chg 00
LS1480 chg 00	LS1483 chg 02	4183873 chg 00
LS1481 chg 00	LS1484 chg 02	4183879 chg 00
LS1482 chg 00	LS1489 chg 03	4183881 chg 00
LS1486 chg 00	LS0261 chg 03	4183883 chg 00
LS1338 chg 01	LS1346 chg 03	4183889 chg 00
LS1522 chg 01	LS1357 chg 03	4183891 chg 00
LS1503 chg 02	LS1358 chg 03	4183901 chg 00
LS1543 chg 02	LS0259 chg 03	4183903 chg 00
LS1488 chg 02	LS1830 chg 04	

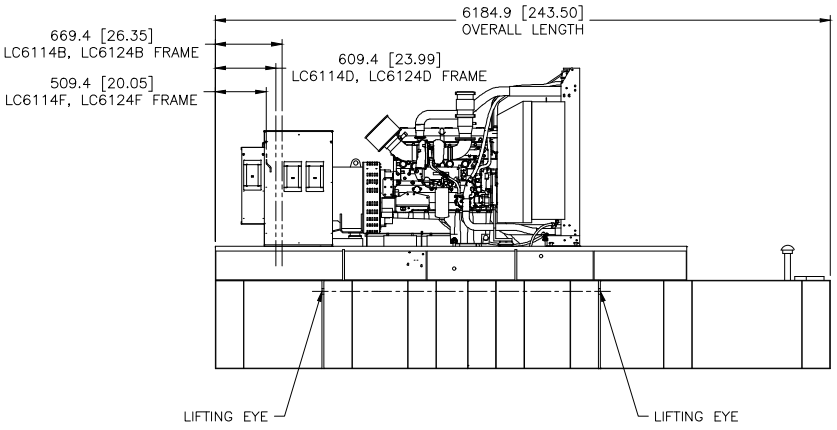
5096524B.dwf = View A-A, Top View, Rear View, & Right Side View of LS-1503 Chg 02 Shown. (sheet2)

5096524C.dwf = View B-B, & Light Side View of LS-1503 Chg 02 Shown. (sheet3)

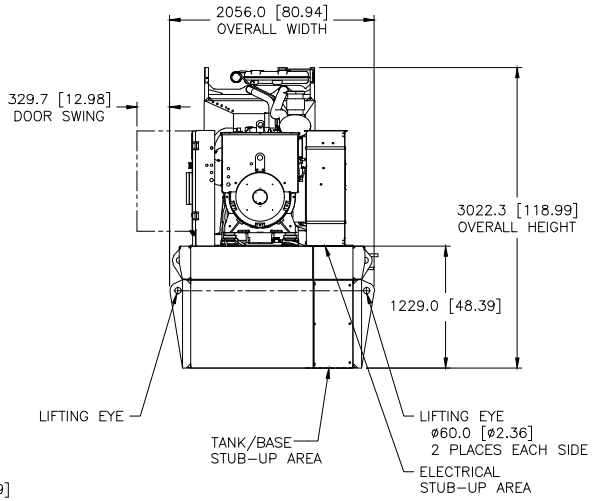
METRIC 509-6524

QTY	ENGINE CONNECTIONS	SIZE	SHEETS
1	COOLANT DRAIN	ø19.1 [0.75] ID	2
1	EXHAUST	ø154.5 [ø6.08]	2
1	OIL DRAIN	ø19.1 [0.75] ID	2

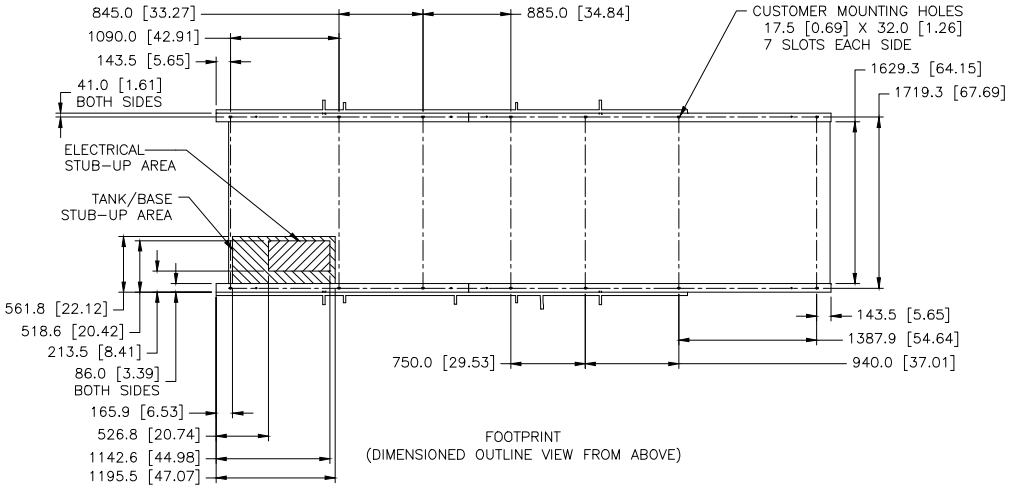
QTY	POSSIBLE TANK CONNECTIONS	SIZE	SHEETS
1	BASIN TANK EMERGENCY VENT	5" NPT THD	3
2	CUSTOMER CONNECTIONS	2" NPTF THD	3
1	FUEL FILLER	4" NPT THD	3
1	MAIN TANK EMERGENCY VENT	5" NPT THD	3
1	SPARE PORT	2" NPT	3



RIGHT SIDE VIEW



REAR VIEW



FOOTPRINT
(DIMENSIONED OUTLINE VIEW FROM ABOVE)

MODEL	TYPE	PRICING AR	FUEL TANK
C13	Y	LS-1503 CHG 02	LS-1525 CHG 00
		LS-1543 CHG 02	

PACKAGE LIFTED IN 4 PLACES

PACKAGE SHOWN WITH MORE DETAIL ON SHEETS 2 & 3

1E2966B IDENT
1E2733 DRAWING-AUTOCAD
1E0198W BRAND MARKINGS
1E0013G CONFIDENTIALITY
1E0012A INTERPRETATION
1E0011 INTPR & TOL

DRN H.ZHAO
CHK M.J. SWIFT
APVD N.P. MOUNTJOY
DATE RECORDS

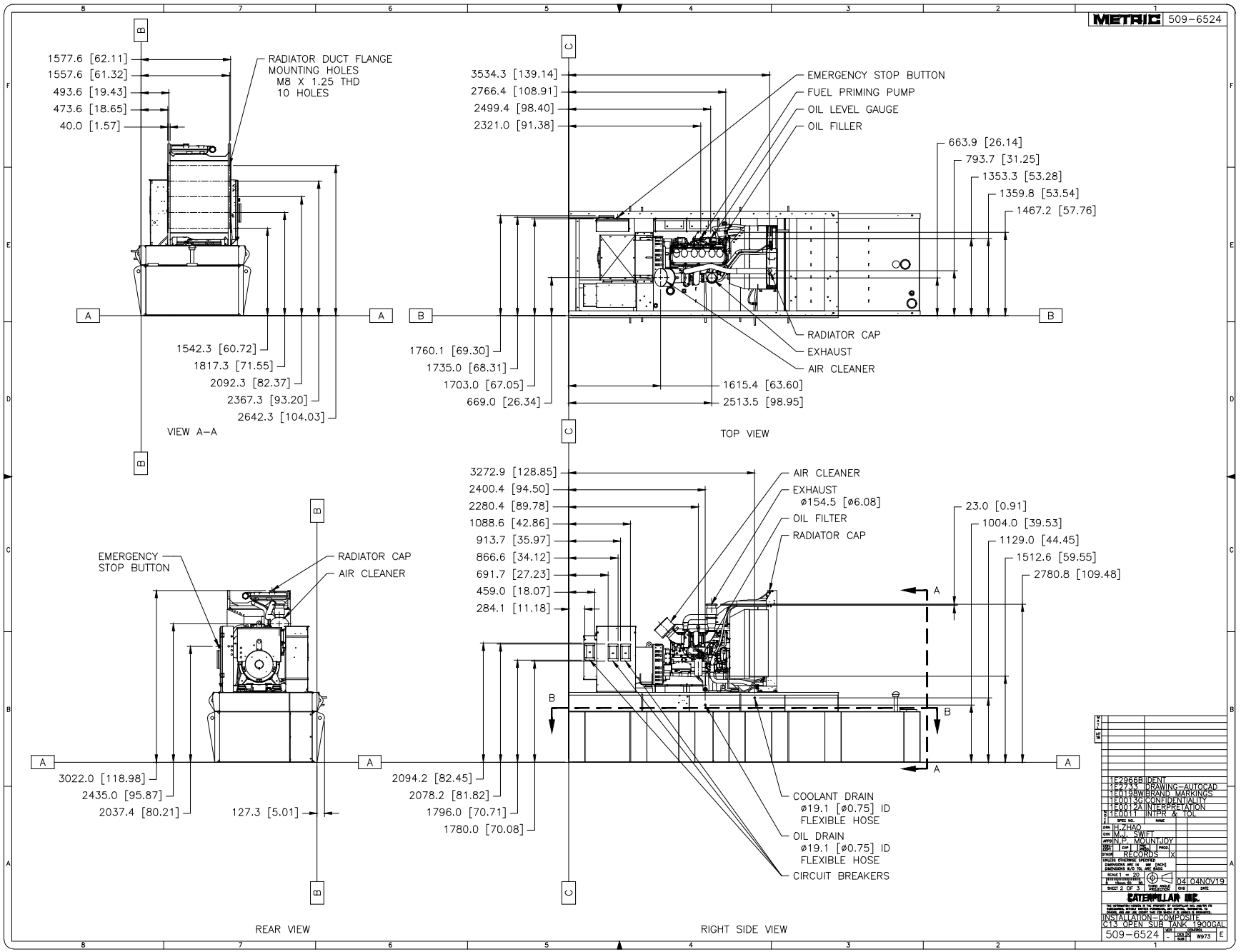
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN MM [INCH] DIMENSIONS N/D TOL APPL BTWEEN

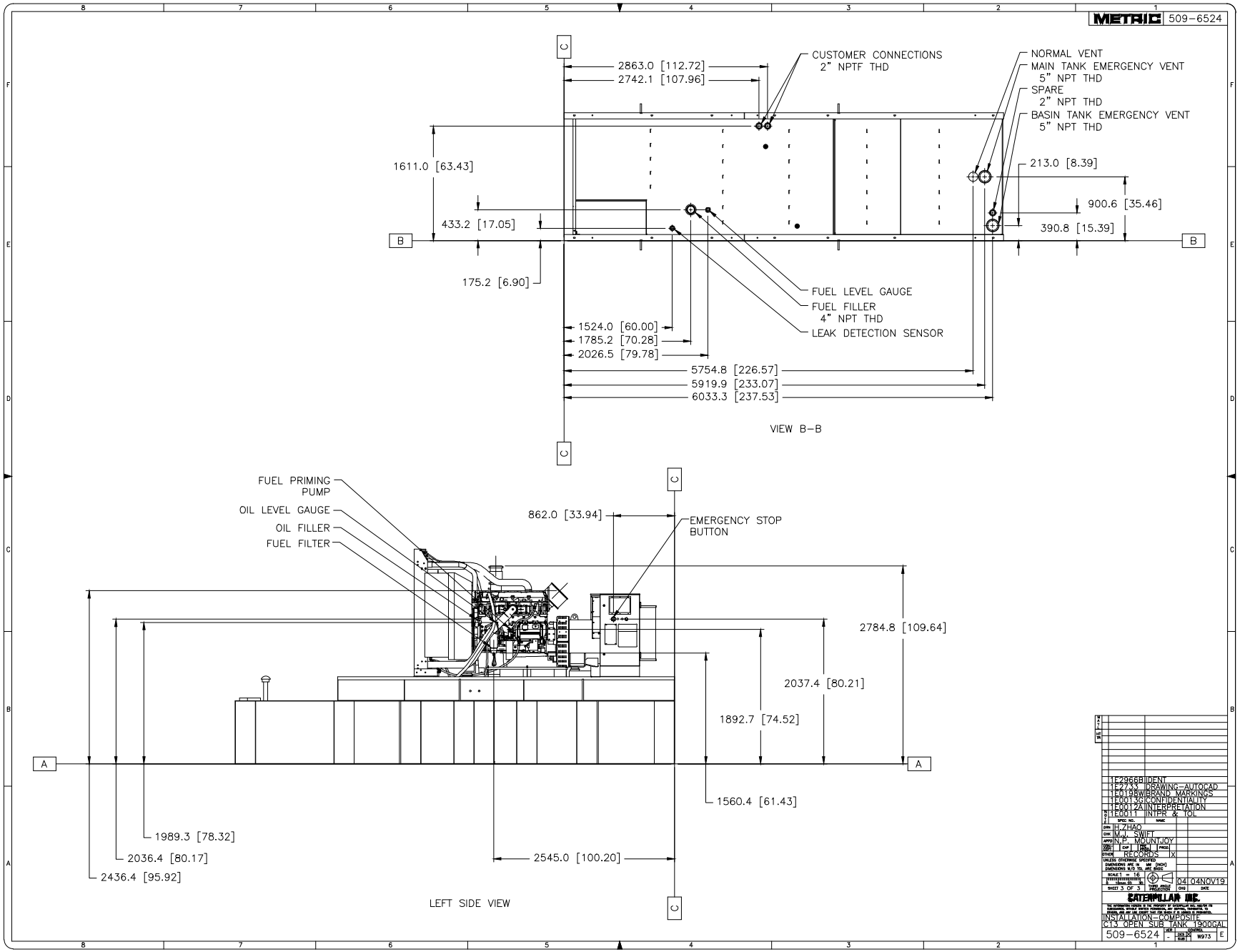
SCALE 1 = 16
WEIGHT/MASS kg
SHEET 1 OF 3
THIRD ANGLE PROJECTION
04 04NOV19
CHG DATE

CATERPILLAR INC.

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INSTALLATION-COMPOSITE
C13 OPEN SUB TANK 1900GAL
509-6524 - DOS 24 SUB 1 W973 E


METRIC 509-6524
1577.6 [62.11]
1557.6 [61.32]
493.6 [19.43]
473.6 [18.65]
40.0 [1.57]
RADIATOR DUCT FLANGE MOUNTING HOLES M8 X 1.25 THD 10 HOLES
1542.3 [60.72]
1817.3 [71.55]
2092.3 [82.37]
2367.3 [93.20]
2642.3 [104.03]
VIEW A-A
3534.3 [139.14]
2766.4 [108.91]
2499.4 [98.40]
2321.0 [91.38]
EMERGENCY STOP BUTTON
FUEL PRIMING PUMP
OIL LEVEL GAUGE
OIL FILLER
663.9 [26.14]
793.7 [31.25]
1353.3 [53.28]
1359.8 [53.54]
1467.2 [57.76]
1760.1 [69.30]
1735.0 [68.31]
1703.0 [67.05]
669.0 [26.34]
RADIATOR CAP
EXHAUST
AIR CLEANER
1615.4 [63.60]
2513.5 [98.95]
TOP VIEW
EMERGENCY STOP BUTTON
RADIATOR CAP
AIR CLEANER
3022.0 [118.98]
2435.0 [95.87]
2037.4 [80.21]
127.3 [5.01]
REAR VIEW
3272.9 [128.85]
2400.4 [94.50]
2280.4 [89.78]
1088.6 [42.86]
913.7 [35.97]
866.6 [34.12]
691.7 [27.23]
459.0 [18.07]
284.1 [11.18]
AIR CLEANER
EXHAUST ø154.5 [ø6.08]
OIL FILTER
RADIATOR CAP
23.0 [0.91]
1004.0 [39.53]
1129.0 [44.45]
1512.6 [59.55]
2780.8 [109.48]
2094.2 [82.45]
2078.2 [81.82]
1796.0 [70.71]
1780.0 [70.08]
COOLANT DRAIN ø19.1 [ø0.75] ID FLEXIBLE HOSE
OIL DRAIN ø19.1 [ø0.75] ID FLEXIBLE HOSE
CIRCUIT BREAKERS
RIGHT SIDE VIEW
1E2966B IDENT
1E2733 DRAWING-AUTOCAD
1E0198W BRAND MARKINGS
1E0013G CONFIDENTIALITY
1E0012A INTERPRETATION
1E0011 INTPR & TOL
H.ZHAO
M.J. SWIFT
N.P. MOUNTJOY
RECORDS
SCALE 1 = 20
SHEET 2 OF 3
04 04NOV19
CATERPILLAR INC.
INSTALLATION-COMPOSITE
C13 OPEN SUB TANK 1900GAL
509-6524
W973
E


METRIC 509-6524
CUSTOMER CONNECTIONS
2" NPTF THD
NORMAL VENT
MAIN TANK EMERGENCY VENT
5" NPT THD
SPARE
2" NPT THD
BASIN TANK EMERGENCY VENT
5" NPT THD
2863.0 [112.72]
2742.1 [107.96]
1611.0 [63.43]
213.0 [8.39]
900.6 [35.46]
433.2 [17.05]
390.8 [15.39]
175.2 [6.90]
FUEL LEVEL GAUGE
FUEL FILLER
4" NPT THD
LEAK DETECTION SENSOR
1524.0 [60.00]
1785.2 [70.28]
2026.5 [79.78]
5754.8 [226.57]
5919.9 [233.07]
6033.3 [237.53]
VIEW B-B
FUEL PRIMING PUMP
OIL LEVEL GAUGE
OIL FILLER
FUEL FILTER
862.0 [33.94]
EMERGENCY STOP BUTTON
2784.8 [109.64]
2037.4 [80.21]
1892.7 [74.52]
1560.4 [61.43]
1989.3 [78.32]
2036.4 [80.17]
2436.4 [95.92]
2545.0 [100.20]
LEFT SIDE VIEW
1E2966B IDENT
1E2733 DRAWING-AUTOCAD
1E0198W BRAND MARKINGS
1E0013G CONFIDENTIALITY
1E0012A INTERPRETATION
1E0011 INTPR & TOL
H.ZHAO
M.J. SWIFT
N.P. MOUNTJOY
RECORDS
SCALE 1 = 16
SHEET 3 OF 3
04 04NOV19
CATERPILLAR INC.
INSTALLATION-COMPOSITE
C13 OPEN SUB TANK 1900GAL
509-6524
W973

CATERPILLAR ENGINE DIVISION
TECHNICAL COMMUNICATIONS GROUP

Installation Drawing Index
AutoCAD 2015 Format

Installation Drawing No. 5096529 chg 04

WEATHER PROOF WITH WIDE BASE AND 1900 GALLON SUB TANK

Overall Dimensions:

Length = 6374.20 mm

Width = 2056.00 mm

Height = 3206.30 mm

Engine pricing arrangements found on drawing:

LS1503 chg 02	LS1543 chg 02

Attachment pricing arrangements found on drawing:

LS0259 chg 03	LS1481 chg 00	LS1531 chg 00
LS0261 chg 03	LS1482 chg 00	LS1532 chg 00
LS1335 chg 02	LS1483 chg 02	LS1533 chg 00
LS1336 chg 02	LS1484 chg 02	LS1534 chg 00
LS1337 chg 02	LS1485 chg 00	LS1830 chg 04
LS1338 chg 01	LS1486 chg 00	LS1832 chg 04
LS1341 chg 04	LS1487 chg 00	3711790 chg 00
LS1343 chg 04	LS1488 chg 02	4183863 chg 00
LS1344 chg 04	LS1489 chg 03	4183865 chg 00
LS1345 chg 02	LS1490 chg 00	4183867 chg 00
LS1346 chg 03	LS1491 chg 00	4183871 chg 00
LS1347 chg 04	LS1492 chg 00	4183873 chg 00
LS1349 chg 02	LS1493 chg 02	4183879 chg 00
LS1350 chg 02	LS1494 chg 02	4183881 chg 00
LS1351 chg 02	LS1506 chg 02	4183883 chg 00
LS1357 chg 03	LS1508 chg 00	4183889 chg 00
LS1358 chg 03	LS1509 chg 00	4183891 chg 00
LS1439 chg 02	LS1510 chg 00	4183901 chg 00
LS1474 chg 00	LS1522 chg 01	4183903 chg 00
LS1480 chg 00	LS1525 chg 00	4183913 chg 00

5096529A.dwf = Summary Sheet of LS-1503 Chg 02 Shown. (sheet1)

LS1487 chg 00	LS1503 chg 02	LS1341 chg 04
LS1490 chg 00	LS1335 chg 02	LS1343 chg 04
LS1492 chg 00	LS1336 chg 02	LS1344 chg 04
LS1532 chg 00	LS1337 chg 02	LS1347 chg 04
LS1509 chg 00	LS1345 chg 02	LS1832 chg 04
LS1508 chg 00	LS1488 chg 02	LS1830 chg 04
LS1525 chg 00	LS1484 chg 02	3711790 chg 00
LS1531 chg 00	LS1483 chg 02	4183913 chg 00
LS1486 chg 00	LS1439 chg 02	4183903 chg 00
LS1485 chg 00	LS1351 chg 02	4183901 chg 00
LS1482 chg 00	LS1350 chg 02	4183891 chg 00
LS1481 chg 00	LS1349 chg 02	4183889 chg 00
LS1480 chg 00	LS1506 chg 02	4183883 chg 00
LS1474 chg 00	LS1494 chg 02	4183881 chg 00
LS1534 chg 00	LS1493 chg 02	4183879 chg 00
LS1533 chg 00	LS0259 chg 03	4183873 chg 00
LS1510 chg 00	LS0261 chg 03	4183871 chg 00
LS1491 chg 00	LS1489 chg 03	4183867 chg 00
LS1338 chg 01	LS1346 chg 03	4183865 chg 00
LS1522 chg 01	LS1358 chg 03	4183863 chg 00
LS1543 chg 02	LS1357 chg 03	

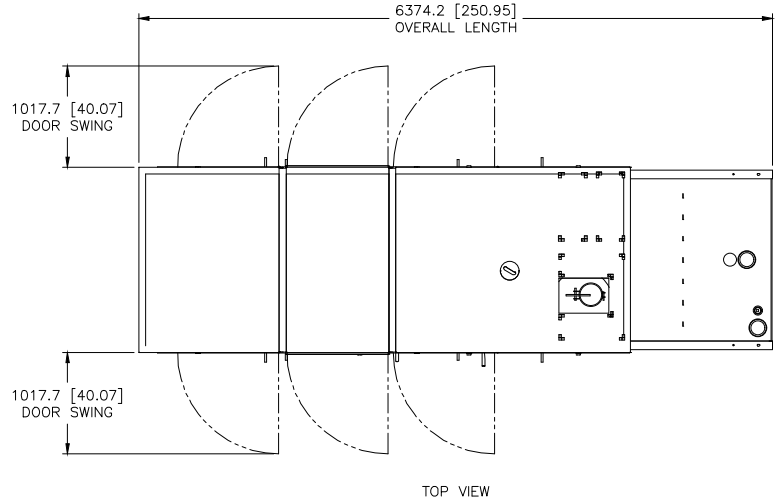
5096529B.dwf = View A-A, Top View, Rear View, & Right Side View of LS-1503 Chg 00 Shown. (sheet2)

5096529C.dwf = Left Side View of LS-1503 Chg 02 Shown. (sheet3)

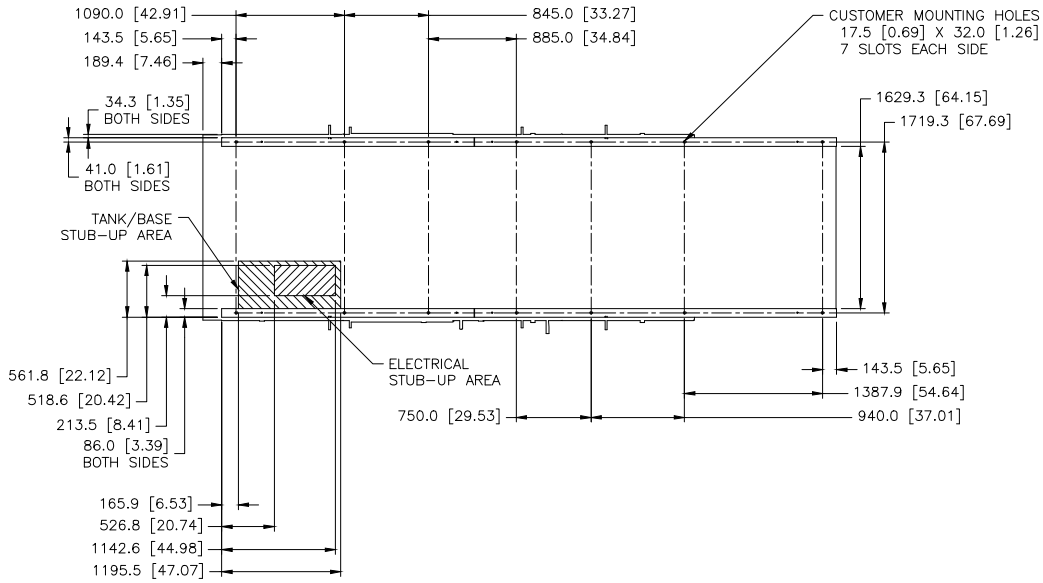
METRIC 509-6529

QTY	ENGINE CONNECTIONS	SIZE	SHEET
1	COOLANT DRAIN	ø19.1 [0.75] ID	2
1	EXHAUST	ø203.0 [ø7.99] OD	2
1	OIL DRAIN	ø19.1 [0.75] ID	2

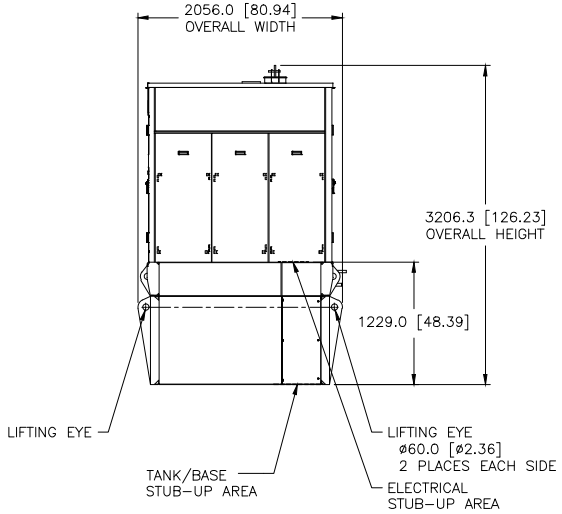
QTY	POSSIBLE TANK CONNECTIONS	SIZE	SHEET
1	BASIN TANK EMERGENCY VENT	5" NPT THD	2
2	CUSTOMER CONNECTIONS	2" NPTF THD	2
1	FUEL FILLER	4" NPT THD	2
1	MAIN TANK EMERGENCY VENT	5" NPT THD	2
1	SPARE PORT	2" NPT THD	2



TOP VIEW



FOOTPRINT
(DIMENSIONED OUTLINE VIEW FROM ABOVE)



REAR VIEW

MODEL	TYPE	PRICING AR	ENCLOSURE	FUEL TANK
C13	Y	LS-1503 CHG 02	LS-1509 CHG 00	LS-1525 CHG 00
		LS-1543 CHG 02	LS-1510 CHG 00	

PACKAGE LIFTED IN 4 PLACES

PACKAGE SHOWN WITH MORE DETAIL ON SHEET 2

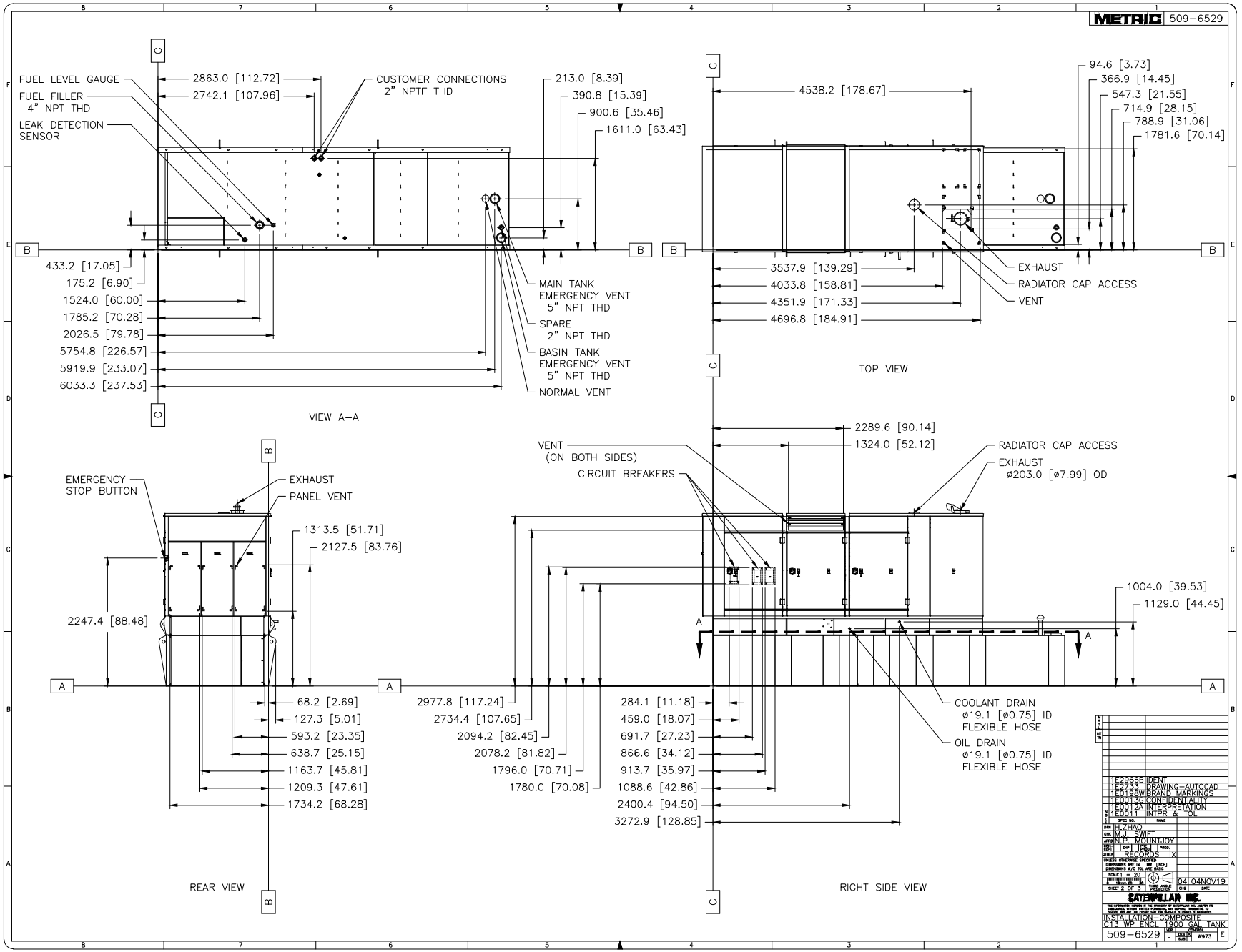
1E2966B IDENT
1E2733 DRAWING-AUTOCAD
1E0198W BRAND MARKINGS
1E0013C CONFIDENTIALITY
1E0012A INTERPRETATION
1E0011 INTPR & TOL

DRN H.ZHAO
CHK M.J. SWIFT
APVD N.P. MOUNTJOY
DATE RECORDS

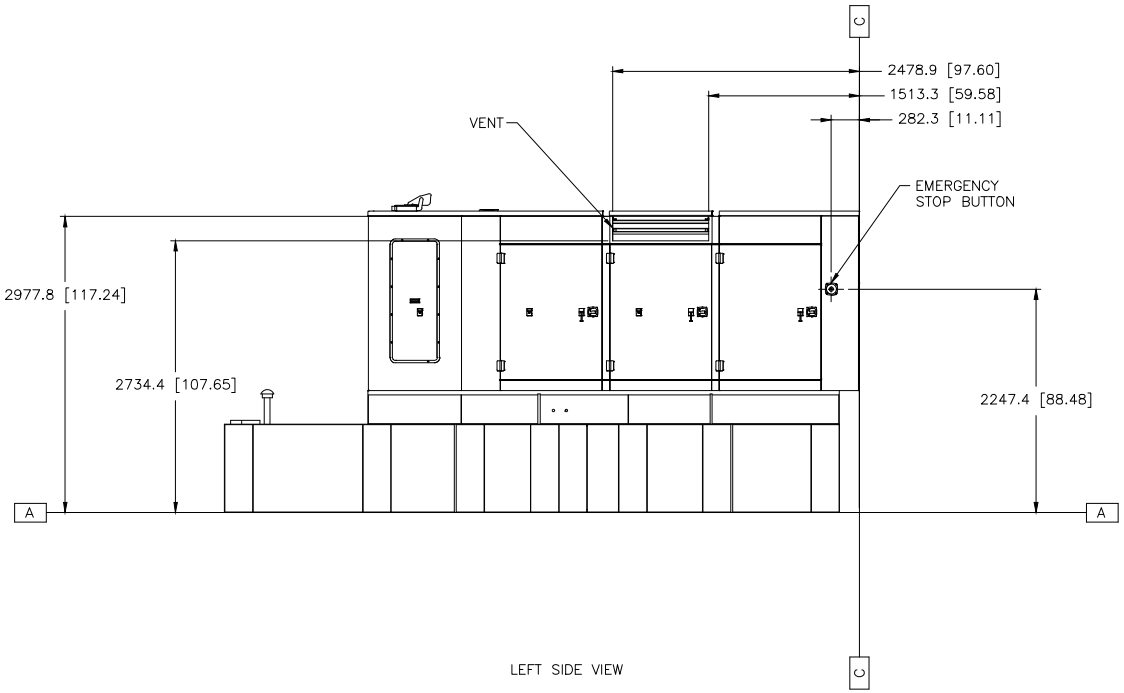
SCALE 1 = 16
SHEET 1 OF 3
04 04NOV19

CATERPILLAR INC.

INSTALLATION-COMPOSITE
C13 WP ENCL 1900 GAL TANK
509-6529 - E


METRIC 509-6529
FUEL LEVEL GAUGE
FUEL FILLER 4" NPT THD
LEAK DETECTION SENSOR
2863.0 [112.72]
2742.1 [107.96]
CUSTOMER CONNECTIONS 2" NPTF THD
213.0 [8.39]
390.8 [15.39]
900.6 [35.46]
1611.0 [63.43]
433.2 [17.05]
175.2 [6.90]
1524.0 [60.00]
1785.2 [70.28]
2026.5 [79.78]
5754.8 [226.57]
5919.9 [233.07]
6033.3 [237.53]
MAIN TANK EMERGENCY VENT 5" NPT THD
SPARE 2" NPT THD
BASIN TANK EMERGENCY VENT 5" NPT THD
NORMAL VENT
VIEW A-A
4538.2 [178.67]
94.6 [3.73]
366.9 [14.45]
547.3 [21.55]
714.9 [28.15]
788.9 [31.06]
1781.6 [70.14]
3537.9 [139.29]
4033.8 [158.81]
4351.9 [171.33]
4696.8 [184.91]
EXHAUST
RADIATOR CAP ACCESS
VENT
TOP VIEW
EMERGENCY STOP BUTTON
EXHAUST
PANEL VENT
1313.5 [51.71]
2127.5 [83.76]
2247.4 [88.48]
68.2 [2.69]
127.3 [5.01]
593.2 [23.35]
638.7 [25.15]
1163.7 [45.81]
1209.3 [47.61]
1734.2 [68.28]
REAR VIEW
2289.6 [90.14]
1324.0 [52.12]
VENT (ON BOTH SIDES)
CIRCUIT BREAKERS
RADIATOR CAP ACCESS
EXHAUST ø203.0 [ø7.99] OD
1004.0 [39.53]
1129.0 [44.45]
2977.8 [117.24]
2734.4 [107.65]
2094.2 [82.45]
2078.2 [81.82]
1796.0 [70.71]
1780.0 [70.08]
284.1 [11.18]
459.0 [18.07]
691.7 [27.23]
866.6 [34.12]
913.7 [35.97]
1088.6 [42.86]
2400.4 [94.50]
3272.9 [128.85]
COOLANT DRAIN ø19.1 [ø0.75] ID FLEXIBLE HOSE
OIL DRAIN ø19.1 [ø0.75] ID FLEXIBLE HOSE
RIGHT SIDE VIEW
1E2966B IDENT
1E2733 DRAWING-AUTOCAD
1E0198W BRAND MARKINGS
1E0013G CONFIDENTIALITY
1E0012A INTERPRETATION
1E0011 INTPR & TOL
H.ZHAO
M.J. SWIFT
N.P. MOUNTJOY
RECORDS
SCALE 1 = 20
SHEET 2 OF 3
04 04NOV19
CATERPILLAR INC.
INSTALLATION-COMPOSITE
C13 WP ENCL 1900 GAL TANK
509-6529 - E
W973

METRIC 509-6529



LEFT SIDE VIEW

1E2966B IDENT
1E2733 DRAWING-AUTOCAD
1E0195W BRAND MARKINGS
1E0013G CONFIDENTIALITY
1E0012A INTERPRETATION
1E0011 INTPR & TOL

DRN	H.ZHAO		
CHK	M.J. SWIFT		
APVD	N.P. MOUNTJOY		
MFG ENG	CHP	MFG ENG	PROG

RECORDS IX

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN MM [INCH] DIMENSIONS W/O TOL ARE BASIC

SCALE 1 = 16

INTERPRETATION OF GEOMETRIC TOLERANCING PER

THIRD ANGLE PROJECTION

SHEET 3 OF 3

04 04NOV19

CHG DATE

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INSTALLATION-COMPOSITE
C13 WP ENCL 1900 GAL TANK

509-6529

USE - | CONTROL DCS 24 SUB 1 | W973 | E

CATERPILLAR ENGINE DIVISION
TECHNICAL COMMUNICATIONS GROUP

Installation Drawing Index
AutoCAD 2015 Format

Installation Drawing No. 5096534 chg 05

SOUND ATTENUATED L1 WITH WIDE BASE AND 1900 GALLON SUB TANK

Overall Dimensions:

Length = 6384.30 mm

Width = 2056.00 mm

Height = 3200.30 mm

Engine pricing arrangements found on drawing:

LS1503 chg 02	LS1543 chg 02

Attachment pricing arrangements found on drawing:

LS0259 chg 03	LS1483 chg 02	LS1531 chg 00
LS0261 chg 03	LS1484 chg 02	LS1532 chg 00
LS1335 chg 02	LS1485 chg 00	LS1533 chg 00
LS1336 chg 02	LS1486 chg 00	LS1536 chg 00
LS1337 chg 02	LS1487 chg 00	LS1542 chg 00
LS1338 chg 01	LS1488 chg 02	LS1830 chg 04
LS1341 chg 04	LS1489 chg 03	LS1832 chg 04
LS1343 chg 04	LS1490 chg 00	3711790 chg 00
LS1344 chg 04	LS1491 chg 00	4183863 chg 00
LS1345 chg 02	LS1492 chg 00	4183865 chg 00
LS1346 chg 03	LS1493 chg 02	4183867 chg 00
LS1347 chg 04	LS1494 chg 02	4183871 chg 00
LS1349 chg 02	LS1506 chg 02	4183873 chg 00
LS1350 chg 02	LS1508 chg 00	4183879 chg 00
LS1351 chg 02	LS1511 chg 00	4183881 chg 00
LS1357 chg 03	LS1512 chg 00	4183883 chg 00
LS1358 chg 03	LS1513 chg 00	4183889 chg 00
LS1439 chg 02	LS1514 chg 00	4183891 chg 00
LS1474 chg 00	LS1519 chg 00	4183901 chg 00
LS1480 chg 00	LS1520 chg 00	4183903 chg 00

LS1481 chg 00	LS1523 chg 01	4183913 chg 00
LS1482 chg 00	LS1525 chg 00	

5096534A.dwf = Summary Sheet of LS-1503 Chg 02 Shown. (sheet1)

LS1491 chg 00	LS1338 chg 01	LS1357 chg 03
LS1474 chg 00	LS1523 chg 01	LS1489 chg 03
LS1480 chg 00	LS1503 chg 02	LS1341 chg 04
LS1481 chg 00	LS1543 chg 02	LS1343 chg 04
LS1482 chg 00	LS1335 chg 02	LS1344 chg 04
LS1485 chg 00	LS1336 chg 02	LS1347 chg 04
LS1486 chg 00	LS1337 chg 02	LS1830 chg 04
LS1487 chg 00	LS1345 chg 02	LS1832 chg 04
LS1490 chg 00	LS1349 chg 02	4183891 chg 00
LS1492 chg 00	LS1350 chg 02	4183901 chg 00
LS1508 chg 00	LS1351 chg 02	4183903 chg 00
LS1511 chg 00	LS1439 chg 02	4183913 chg 00
LS1512 chg 00	LS1483 chg 02	3711790 chg 00
LS1513 chg 00	LS1484 chg 02	4183863 chg 00
LS1514 chg 00	LS1488 chg 02	4183865 chg 00
LS1519 chg 00	LS1493 chg 02	4183867 chg 00
LS1520 chg 00	LS1494 chg 02	4183871 chg 00
LS1525 chg 00	LS1506 chg 02	4183873 chg 00
LS1531 chg 00	LS1358 chg 03	4183879 chg 00
LS1532 chg 00	LS0259 chg 03	4183881 chg 00
LS1533 chg 00	LS0261 chg 03	4183883 chg 00
LS1536 chg 00	LS1346 chg 03	4183889 chg 00
LS1542 chg 00		

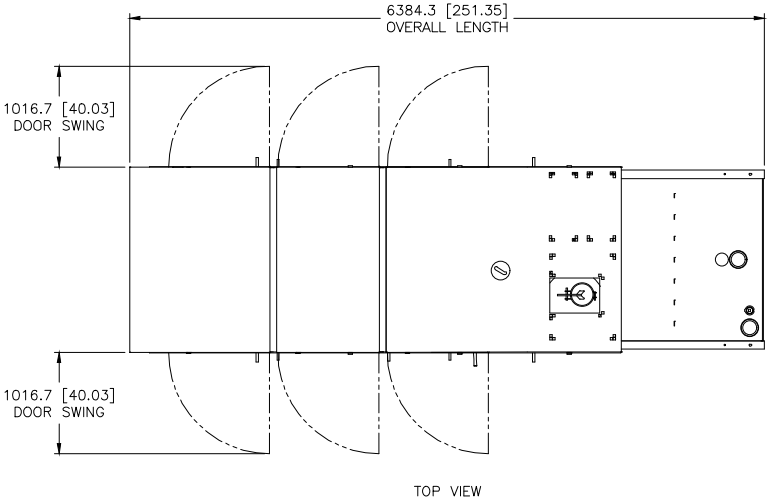
5096534B.dwf = View A-A, Top View, Rear View, & Right Side View of LS-1503 Chg 00 Shown. (sheet2)

5096534C.dwf = Left Side View of LS-1503 Chg 01 Shown. (sheet3)

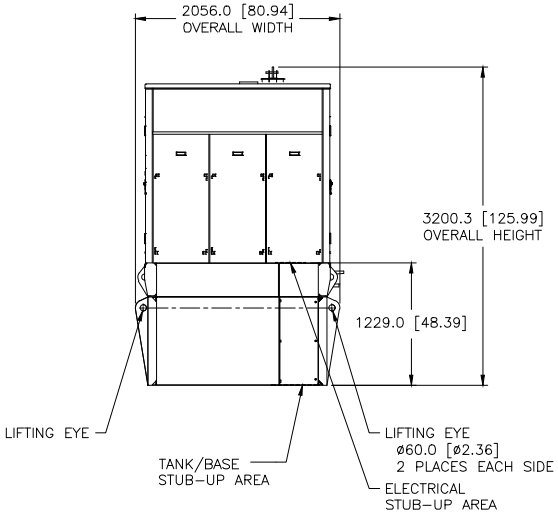
METRIC 509-6534

QTY	ENGINE CONNECTIONS	SIZE	SHEET
1	COOLANT DRAIN	ø19.1 [0.75] ID	2
1	EXHAUST	ø203.0 [ø7.99] OD	2
1	OIL DRAIN	ø19.1 [0.75] ID	2

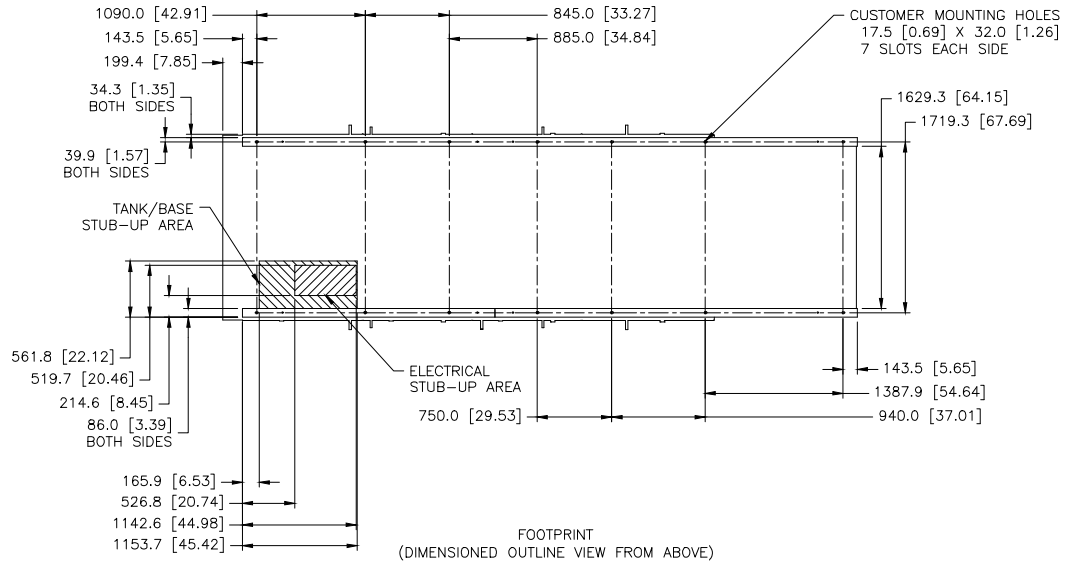
QTY	POSSIBLE TANK CONNECTIONS	SIZE	SHEET
1	BASIN TANK EMERGENCY VENT	5" NPT THD	2
2	CUSTOMER CONNECTIONS	2" NPTF THD	2
1	FUEL FILLER	4" NPT THD	2
1	MAIN TANK EMERGENCY VENT	5" NPT THD	2
1	SPARE PORT	2" NPT THD	2
1	NORMAL VENT	2" NPTF THD	2



TOP VIEW



REAR VIEW



FOOTPRINT
(DIMENSIONED OUTLINE VIEW FROM ABOVE)

MODEL	TYPE	PRICING AR	ENCLOSURE	FUEL TANK
C13	Y	LS-1503 CHG 02	LS-1511 CHG 00 LS-1513 CHG 00 LS-1519 CHG 00	LS-1525 CHG 00
		LS-1543 CHG 02	LS-1512 CHG 00 LS-1514 CHG 00 LS-1520 CHG 00	

PACKAGE LIFTED IN 4 PLACES

PACKAGE SHOWN WITH MORE DETAIL ON SHEET 2

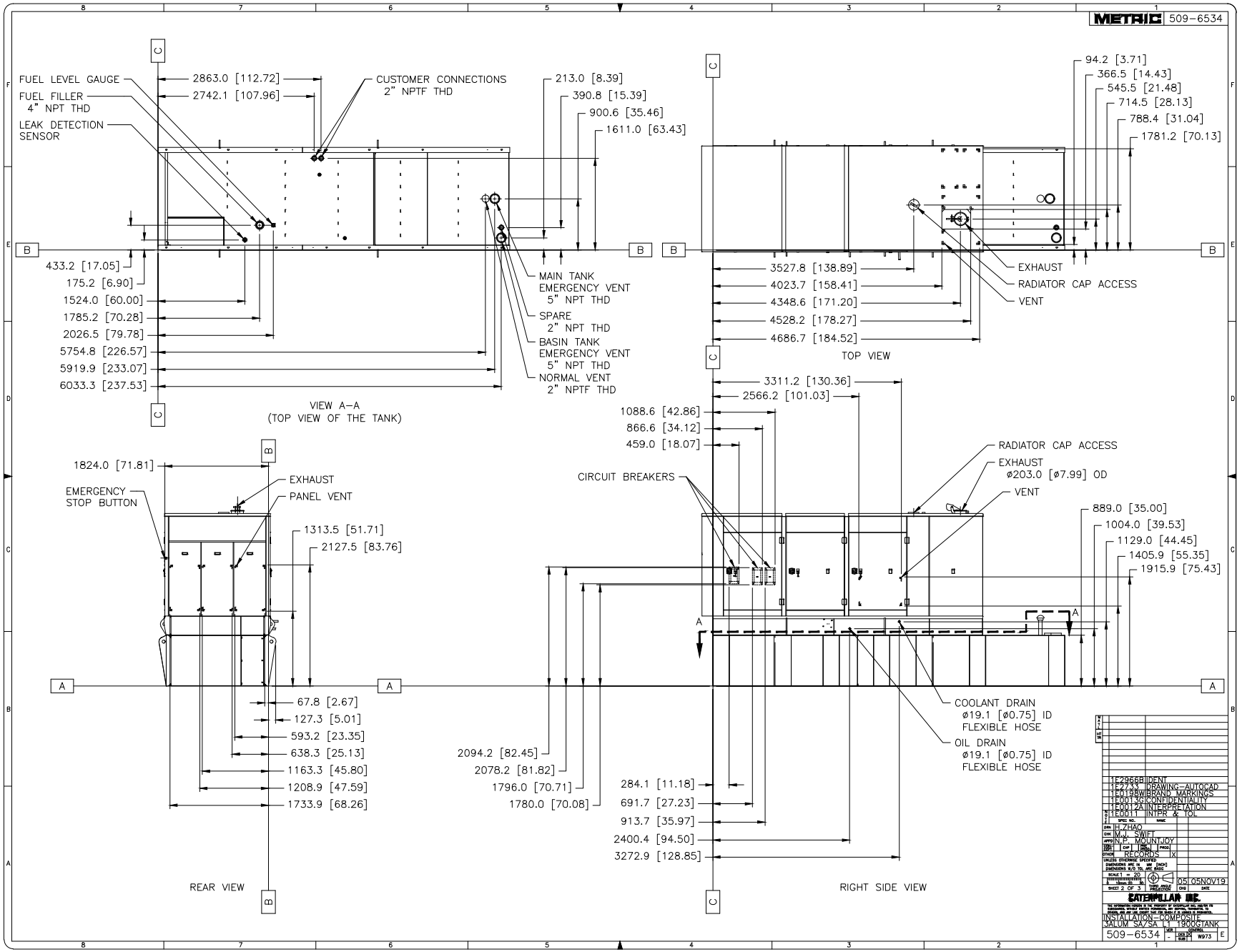
1E2966B IDENT
1E2733 DRAWING-AUTOCAD
1E0198W BRAND MARKINGS
1E0013G CONFIDENTIALITY
1E0012A INTERPRETATION
1E0011 INTPR & TOL

DRN H.ZHAO
CHK M.J. SWIFT
APVD N.P. MOUNTJOY
DATE 05 NOV 19

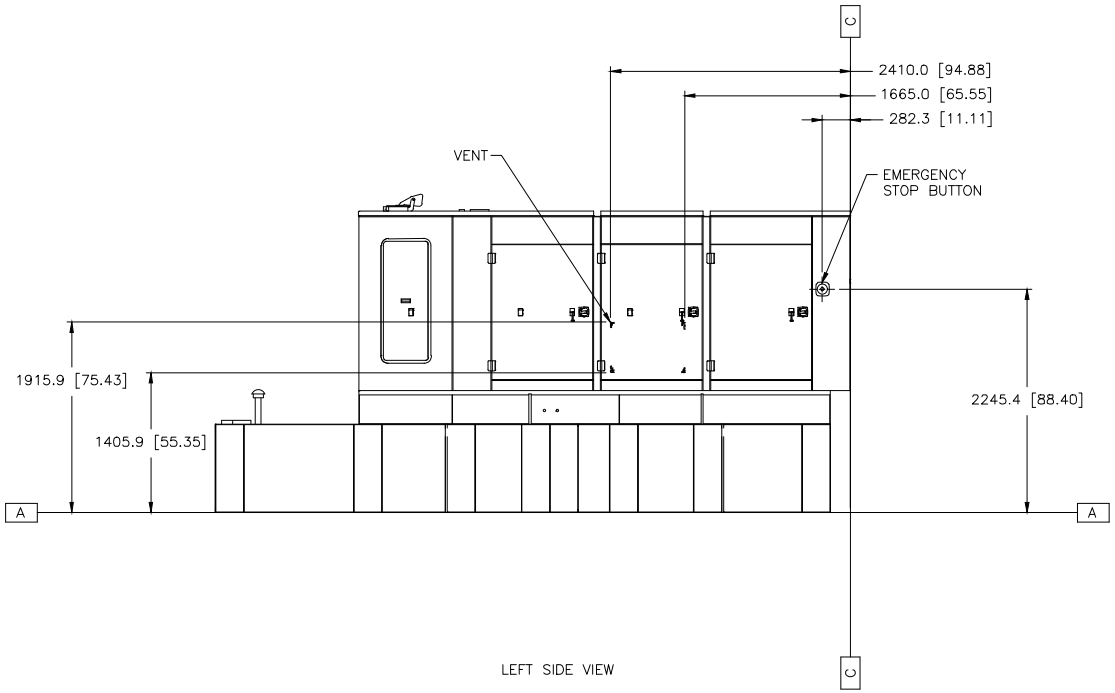
UNLESS OTHERWISE SPECIFIED
SCALE 1 = 16
SHEET 1 OF 3

CATERPILLAR INC.

INSTALLATION-COMPOSITE
C13ALUM SA/SA LT 1900GTANK
509-6534 - W973 E


METRIC 509-6534
FUEL LEVEL GAUGE
FUEL FILLER 4" NPT THD
LEAK DETECTION SENSOR
2863.0 [112.72]
2742.1 [107.96]
CUSTOMER CONNECTIONS 2" NPTF THD
213.0 [8.39]
390.8 [15.39]
900.6 [35.46]
1611.0 [63.43]
433.2 [17.05]
175.2 [6.90]
1524.0 [60.00]
1785.2 [70.28]
2026.5 [79.78]
5754.8 [226.57]
5919.9 [233.07]
6033.3 [237.53]
MAIN TANK EMERGENCY VENT 5" NPT THD
SPARE 2" NPT THD
BASIN TANK EMERGENCY VENT 5" NPT THD
NORMAL VENT 2" NPTF THD
VIEW A-A
(TOP VIEW OF THE TANK)
94.2 [3.71]
366.5 [14.43]
545.5 [21.48]
714.5 [28.13]
788.4 [31.04]
1781.2 [70.13]
3527.8 [138.89]
4023.7 [158.41]
4348.6 [171.20]
4528.2 [178.27]
4686.7 [184.52]
EXHAUST
RADIATOR CAP ACCESS
VENT
TOP VIEW
1824.0 [71.81]
EMERGENCY STOP BUTTON
EXHAUST
PANEL VENT
1313.5 [51.71]
2127.5 [83.76]
67.8 [2.67]
127.3 [5.01]
593.2 [23.35]
638.3 [25.13]
1163.3 [45.80]
1208.9 [47.59]
1733.9 [68.26]
REAR VIEW
3311.2 [130.36]
2566.2 [101.03]
1088.6 [42.86]
866.6 [34.12]
459.0 [18.07]
CIRCUIT BREAKERS
RADIATOR CAP ACCESS
EXHAUST
ø203.0 [ø7.99] OD
VENT
889.0 [35.00]
1004.0 [39.53]
1129.0 [44.45]
1405.9 [55.35]
1915.9 [75.43]
COOLANT DRAIN
ø19.1 [ø0.75] ID
FLEXIBLE HOSE
OIL DRAIN
ø19.1 [ø0.75] ID
FLEXIBLE HOSE
2094.2 [82.45]
2078.2 [81.82]
1796.0 [70.71]
1780.0 [70.08]
284.1 [11.18]
691.7 [27.23]
913.7 [35.97]
2400.4 [94.50]
3272.9 [128.85]
RIGHT SIDE VIEW
1E2966B IDENT
1E2733 DRAWING-AUTOCAD
1E0198W BRAND MARKINGS
1E0013C CONFIDENTIALITY
1E0012A INTERPRETATION
1E0011 INTPR & TOL
H.ZHAO
M.J. SWIFT
N.P. MOUNTJOY
RECORDS
SCALE 1 = 20
SHEET 2 OF 3
05 05NOV19
CATERPILLAR INC.
INSTALLATION-COMPOSITE
JALUM SA/SA LV 1900GTANK
509-6534
W973

METRIC 509-6534



LEFT SIDE VIEW

1E2966B IDENT
1E2733 DRAWING-AUTOCAD
1E0195W BRAND MARKINGS
1E0013G CONFIDENTIALITY
1E0012A INTERPRETATION
1E0011 INTER & TOL

SPEC NO.	NAME
DRN	H.ZHAO
CHK	M.J. SWIFT
APVD	N.P. MOUNTJOY

RECORDS IX

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MM [INCH] | DIMENSIONS W/O TOL ARE BASIC

SCALE 1 = 16 | WEIGHT (KG) | THIRD ANGLE PROJECTION | CHG 05 | DATE 05NOV19

SHEET 3 OF 3

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INSTALLATION-COMPOSITE
SALUM SA/SA LT 1900GTANK

509-6534 | VER - | DOC TYP SUB | GENERAL W973 | E

GENERATOR DATA

GENERATOR DATA

Selected Model

Engine	C13	**Generator Frame:**	LC6114B	**Genset Rating(kW):**	350.0	**Line Voltage:**	480
Fuel	Diesel	**Generator Arrangement:**	4183863	**Genset Rating(kVA):**	437.5	**Phase Voltage:**	277.0
Frequency	60	**Excitation Type:**	Self Excited	**Pwr.Factor:**	0.8	**Rated Current:**	526.2
Duty	STANDBY	**Connection:**	SERIES STAR	**Application:**	EPG	**Status:**	Current
						Version:	41764 /42159 /42423 /1256

Spec Information

Generator Specification

Frame:	LC6114B	**Type**	LC	**No.of Bearings:**	1
Winding Type:	RANDOM WOUND			**Flywheel:**	14.0
Connection:	SERIES STAR			**Housing:**	1
Phases	3			**No.of Leads:**	12
Poles:	4			**Wires per Lead:**	2
Sync Speed:	1800			**Generator Pitch:**	0.6667

Generator Efficiency

Per Unit Load	kW	Efficiency %
0.25	87.5	90.2
0.5	175.0	93.2
0.75	262.5	93.7
1.0	350.0	93.5

Reactances	Per Unit	Ohms
SUBTRANSIENT - DIRECT AXIS X" d	0.1348	0.0710
SUBTRANSIENT - QUADRATURE AXIS X"q	0.1829	0.0963
TRANSIENT - SATURATED X'd	0.1927	0.1015
SYNCHRONOUS - DIRECT AXIS X'd	3.3496	1.7640
SYNCHRONOUS - QUADRATURE AXIS X'q	2.0098	1.0584
NEGATIVE SEQUENCE X'2	0.1584	0.0834
ZERO SEQUENCE X'0	0.0095	0.0050

Time Constants	Seconds
OPEN CIRCUIT TRANSIENT - DIRECT AXIS T'd0	1.7380
SHORT CIRCUIT TRANSIENT - DIRECT AXIS T'd	0.1000
OPEN CIRCUIT SUBSTRANSIENT - DIRECT AXIS T"d0	0.0130
SHORT CIRCUIT SUBSTRANSIENT - DIRECT AXIS T"d	0.0100
OPEN CIRCUIT SUBSTRANSIENT - QUADRATURE AXIS T"q0	0.1100
SHORT CIRCUIT SUBSTRANSIENT - QUADRATURE AXIS T"q	0.0100
EXCITER TIME CONSTANT Te	0.0300
ARMATURE SHORT CIRCUIT Ta	0.0150

Short Circuit Ratio:0.38	Stator Resistance=0.0163Ohms	Field Resistance=0.768Ohms

Voltage Regulation

Voltage level adjustment:+/-	**5.0%**
Voltage regulation,steady state:+/-	**0.5%**
Voltage regulation with 3% speed change: +/-	**0.5%**
Waveform deviation line - line, no load: less than	**2.0%**
Telephone influence factor: less than	**50%**

Generator Excitation

	No Load	Full Load, Series	(rated)pf Parallel
Excitation Voltage:	17.21Volts	79.65Volts	Volts
Excitation Current:	1.0Amps	3.81Amps	Amps

GENERATOR DATA

Selected Model

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Fuel	Diesel	**Generator Arrangement:**	4183863	**Genset Rating(kVA):**	437.5	**Phase Voltage:**	277.0
Frequency	60	**Excitation Type:**	Self Excited	**Pwr.Factor:**	0.8	**Rated Current:**	526.2
Duty	STANDBY	**Connection:**	SERIES STAR	**Application:**	EPG	**Status:**	Current
						Version:	41764 /42159 /42423 /1256

Generator Mechanical Information

Center Of Gravity

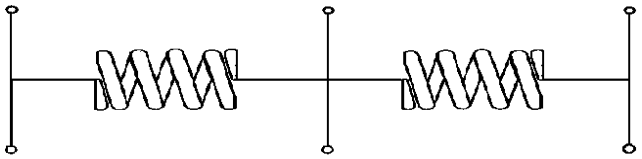
Dimension X	-431.0mm	-17.0IN.
Dimension Y	0.0mm	0.0IN.
Dimension Z	0.0mm	0.0IN.

* 'X' is measured from driven end of generator and parallel to rotor.Towards engine fan is positive.See General Information for details
* 'Y' is measured vertically from rotor center line.Up is positive
* 'Z' is measured to left and right of rotor center line.To the right is positive.

Generator WT =	996Kg 2,196LB	* Rotor WT =	387Kg 853LB	* Stator WT=	609Kg 1,343LB

Rotor Balance =	0.0508mm deflection PTP
Overspeed Capacity =	125%of synchronous speed

Generator Torsional Data



J1= Coupling and Fan | **J2= Rotor TOTAL J = J1+J2+J3** | **J3= Exciter End**

K1=Shaft Stiffness between J1+J2(Diameter1) | **K2=Shaft Stiffness between J2+J3(Diameter2)**

J1	K1	Min Shaft Dia 1	J2	K2	Min Shaft Dia 2	J3
17.1LB IN.s²	55.5MLB IN./rad	4.5IN.	35.4LB IN.s²	40.8MLB IN./rad	4.3IN.	1.5IN.s²
1.93N m s²	6.27MN m/rad	115.0mm	4.0N m s²	4.61m/rad	110.0mm	0.17N m s²

Total J
54.0LB IN.s²
6.1N m s²

GENERATOR DATA

Selected Model

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Duty	STANDBY	**Connection:**	SERIES STAR	**Application:**	EPG	**Status:**	Current
						Version:	41764 /42159 /42423 /1256

Generator Cooling Requirements - Temperature -Insulation Data

Cooling Requirements:		**Temperature Data:**	(Ambient 40.0°C)
Heat Dissipated:	24.3kW	**Stator Rise:**	130.0°C
Air Flow:	66.0m³/min	**Rotor Rise:**	130.0°C

Insulation Class:H

Insulation Reg. as shipped:100.0 M Ω minimum at 40 °C

Thermal Limits of Generator

Frequency:	60.0Hz
Line to Line Voltage:	480.0Volts
B BR 80/40	384.0kVA
F BR -105/40	436.8kVA
H BR - 125/40	480.0kVA
F PR - 130/40	480.0kVA
H PR - 150/40	508.8kVA
H PR27 - 163/27	528.0kVA

GENERATOR DATA

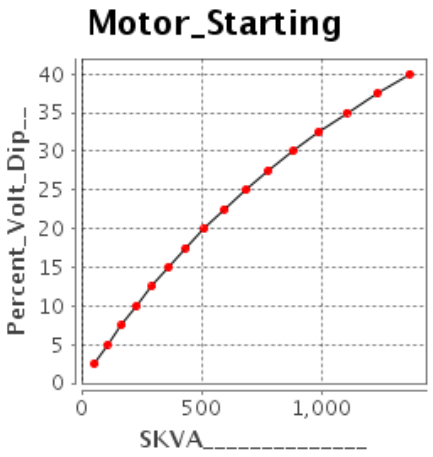
Selected Model

Engine	C13	**Generator Frame:**	LC6114B	**Genset Rating(kW):**	350.0	**Line Voltage:**	480
Fuel	Diesel	**Generator Arrangement:**	4183863	**Genset Rating(kVA):**	437.5	**Phase Voltage:**	277.0
Frequency	60	**Excitation Type:**	Self Excited	**Pwr.Factor:**	0.8	**Rated Current:**	526.2
Duty	STANDBY	**Connection:**	SERIES STAR	**Application:**	EPG	**Status:**	Current
						Version:	41764 /42159 /42423 /1256

Starting Capability and Current Decrement

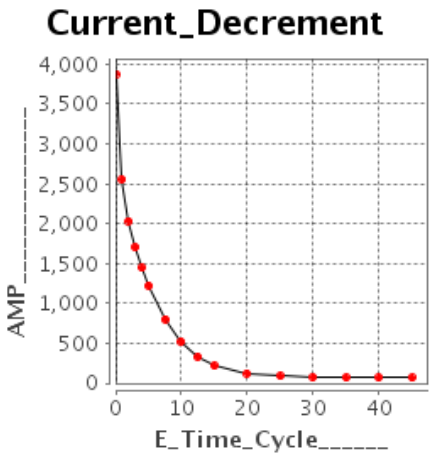
Motor Starting Capability (0.6 pf)

SKVA	Percent Volt Dip
53	2.5
108	5.0
166	7.5
228	10.0
293	12.5
362	15.0
435	17.5
513	20.0
596	22.5
684	25.0
779	27.5
880	30.0
988	32.5
1,105	35.0
1,232	37.5
1,369	40.0



Current Decrement Data

E Time Cycle	AMP
0.0	3,877
1.0	2,556
2.0	2,035
3.0	1,705
4.0	1,444
5.0	1,223
7.5	803
10.0	520
12.5	329
15.0	217
20.0	121
25.0	88
30.0	75
35.0	70
40.0	68
45.0	67



GENERATOR DATA

Instantaneous 3 Phase Fault Current: 3877.0Amps
Instantaneous Line- Line Fault Current: 3089.0Amps
Instantaneous Line- Neutral Fault Current: 5181.0Amps

GENERATOR DATA

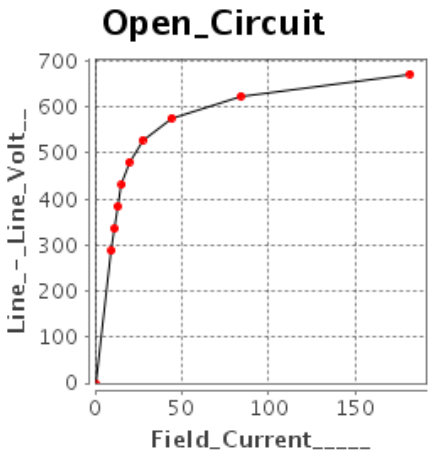
Selected Model

Engine	C13	**Generator Frame:**	LC6114B	**Genset Rating(kW):**	350.0	**Line Voltage:**	480
Fuel	Diesel	**Generator Arrangement:**	4183863	**Genset Rating(kVA):**	437.5	**Phase Voltage:**	277.0
Frequency	60	**Excitation Type:**	Self Excited	**Pwr.Factor:**	0.8	**Rated Current:**	526.2
Duty	STANDBY	**Connection:**	SERIES STAR	**Application:**	EPG	**Status:**	Current
						Version:	41764 /42159 /42423 /1256

Generator Output Characteristic Curves

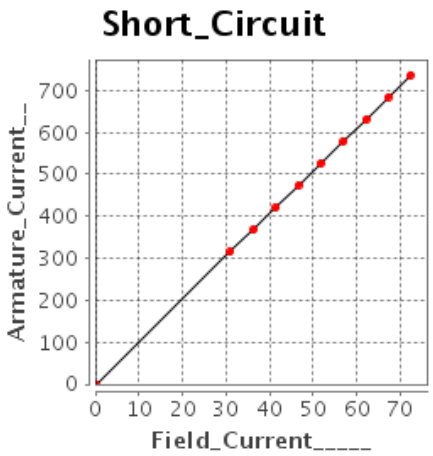
Open Circuit Curve

Field Current	Line - Line Volt
0.0	0
9.4	288
11.1	336
13.0	384
15.5	432
19.6	480
27.3	528
44.2	576
84.2	624
181.6	672



Short Circuit Curve

Field Current	Armature Current
0.0	0
31.0	316
36.2	368
41.4	421
46.6	474
51.7	526
56.9	579
62.1	631
67.2	684
72.4	737



GENERATOR DATA

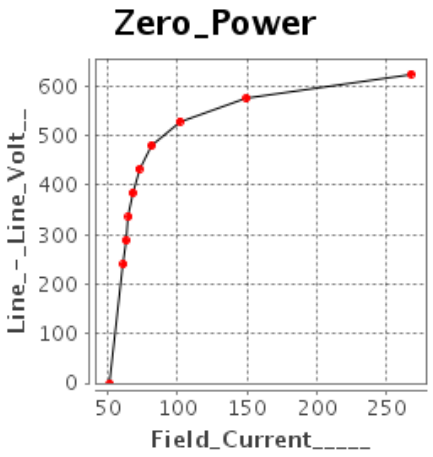
Selected Model

Engine	C13	**Generator Frame:**	LC6114B	**Genset Rating(kW):**	350.0	**Line Voltage:**	480
Fuel	Diesel	**Generator Arrangement:**	4183863	**Genset Rating(kVA):**	437.5	**Phase Voltage:**	277.0
Frequency	60	**Excitation Type:**	Self Excited	**Pwr.Factor:**	0.8	**Rated Current:**	526.2
Duty	STANDBY	**Connection:**	SERIES STAR	**Application:**	EPG	**Status:**	Current
						Version:	41764 /42159 /42423 /1256

Generator Output Characteristic Curves

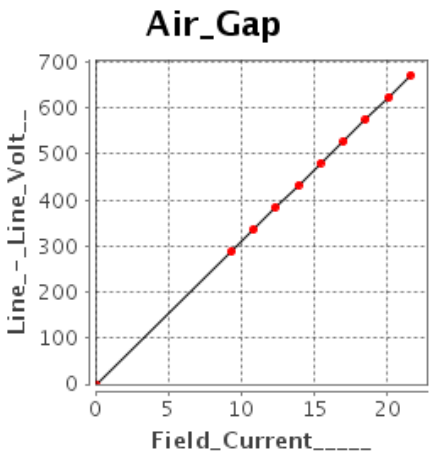
Zero Power Factor Curve

Field Current	Line - Line Volt
51.7	0
61.3	240
63.0	288
65.1	336
67.8	384
72.4	432
81.4	480
101.5	528
149.6	576
267.1	624



Air Gap Curve

Field Current	Line - Line Volt
0.0	0
9.3	288
10.8	336
12.3	384
13.9	432
15.4	480
17.0	528
18.5	576
20.1	624
21.6	672

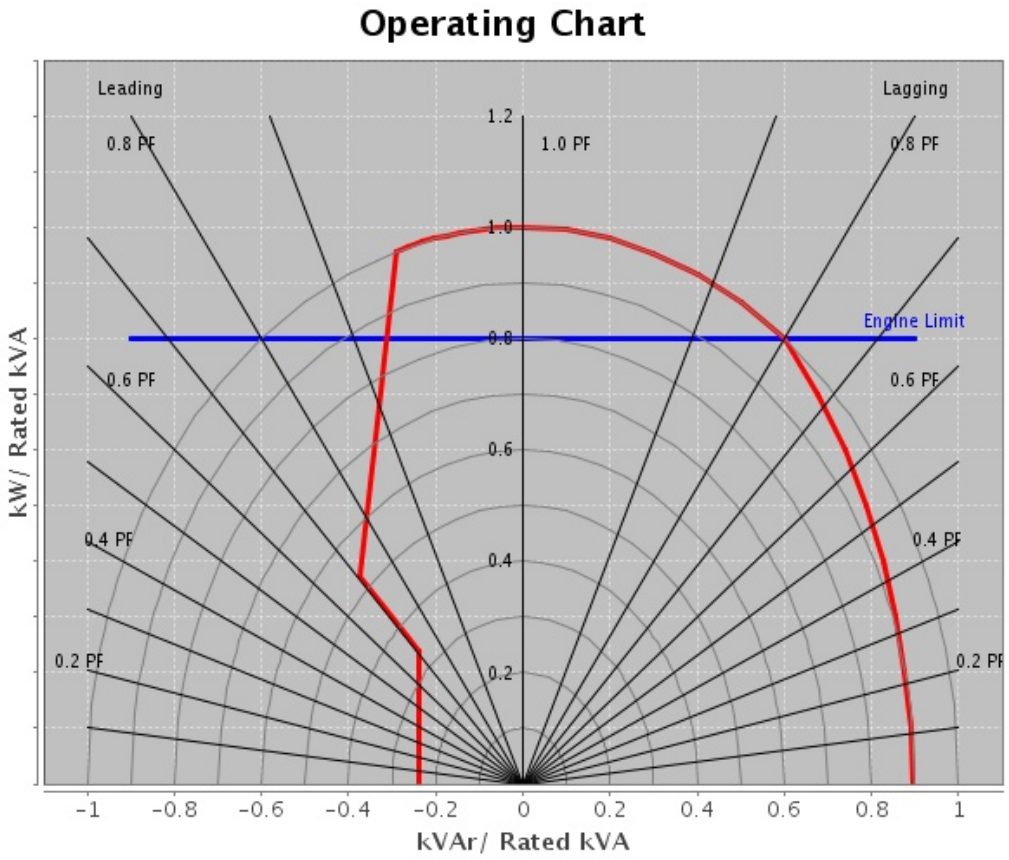


GENERATOR DATA

Selected Model

Engine	C13	**Generator Frame:**	LC6114B	**Genset Rating(kW):**	350.0	**Line Voltage:**	480
Fuel	Diesel	**Generator Arrangement:**	4183863	**Genset Rating(kVA):**	437.5	**Phase Voltage:**	277.0
Frequency	60	**Excitation Type:**	Self Excited	**Pwr.Factor:**	0.8	**Rated Current:**	526.2
Duty	STANDBY	**Connection:**	SERIES STAR	**Application:**	EPG	**Status:**	Current
						Version:	41764 /42159 /42423 /1256

Reactive Capability Curve



GENERATOR DATA

Selected Model

Engine	C13	**Generator Frame:**	LC6114B	**Genset Rating(kW):**	350.0	**Line Voltage:**	480
Fuel	Diesel	**Generator Arrangement:**	4183863	**Genset Rating(kVA):**	437.5	**Phase Voltage:**	277.0
Frequency	60	**Excitation Type:**	Self Excited	**Pwr.Factor:**	0.8	**Rated Current:**	526.2
Duty	STANDBY	**Connection:**	SERIES STAR	**Application:**	EPG	**Status:**	Current
						Version:	41764 /42159 /42423 /1256

General Information

GENERATOR INFORMATION (DM7900)

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1. Motor Starting
Motor starting curves are obtained in accordance with IEC60034, and are displayed at 0.6 power factor.

2. Voltage Dip
Prediction of the generator synchronous voltage dip can be made by consulting the plot for the voltage dip value that corresponds to the desired motor starting kVA value.

3. Definitions
A) Generator Keys
Frame: abbreviation of generator frame size
Freq: frequency in hertz.
PP/SB: prime/standby duty respectively
Volts: line - line terminal voltage
kW: rating in electrical kilo watts
Model: engine sales model

B) Generator Temperature Rise
The indicated temperature rises are the IEC/NEMA limits for standby or prime power applications. The quoted rise figures are maximum limits only and are not necessarily indicative of the actual temperature rise of a given machine winding.

C) Centre of Gravity
The specified centre of gravity is for the generator only. For single bearing, and two bearing close coupled generators, the center of gravity is measured from the generator/engine flywheel-housing interface and from the centreline of the rotor Shaft.

For two bearing, standalone generators, the center of gravity is measured from the end of the rotor shaft and from the centerline of the rotor shaft.

D) Generator Current Decrement Curves
The generator current decrement curve indicates the generator armature current arising from a symmetrical three-phase fault at the generator terminals. Generators equipped with AREP or PMG excitation systems will sustain 300% of rated armature current for 10 seconds.

E) Generator Efficiency Curves
The efficiency curve is displayed for the generator only under the given conditions of rating, voltage, frequency and power factor. This is not the overall generating set efficiency curve.

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PERFORMANCE DATA[EM1692]

November 20, 2020

Performance Number: EM1692 **Change Level: 02**

SALES MODEL:	C13	**COMBUSTION:**	DIRECT INJECTION
BRAND:	CAT	**ENGINE SPEED (RPM):**	1,800
ENGINE POWER (BHP):	539	**HERTZ:**	60
GEN POWER WITH FAN (EKW):	350.0	**FAN POWER (HP):**	20.1
COMPRESSION RATIO:	16.3	**ADDITIONAL PARASITICS (HP):**	9.3
RATING LEVEL:	STANDBY	**ASPIRATION:**	TA
PUMP QUANTITY:	1	**AFTERCOOLER TYPE:**	ATAAC
FUEL TYPE:	DIESEL	**AFTERCOOLER CIRCUIT TYPE:**	JW+OC, ATAAC
MANIFOLD TYPE:	DRY	**INLET MANIFOLD AIR TEMP (F):**	120
GOVERNOR TYPE:	ELEC	**JACKET WATER TEMP (F):**	192.2
ELECTRONICS TYPE:	ADEM4	**TURBO CONFIGURATION:**	SINGLE
CAMSHAFT TYPE:	STANDARD	**TURBO QUANTITY:**	1
IGNITION TYPE:	CI	**TURBOCHARGER MODEL:**	GTA5002BS 1.60A/R
INJECTOR TYPE:	EUI	**CERTIFICATION YEAR:**	2015
REF EXH STACK DIAMETER (IN):	5	**PISTON SPD @ RATED ENG SPD (FT/MIN):**	1,854.3
MAX OPERATING ALTITUDE (FT):	1,640		

INDUSTRY	SUBINDUSTRY	APPLICATION
ELECTRIC POWER	STANDARD	PACKAGED GENSET

General Performance Data

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	BRAKE MEAN EFF PRES (BMEP)	BRAKE SPEC FUEL CONSUMPTN (BSFC)	VOL FUEL CONSUMPTN (VFC)	INLET MFLD PRES	INLET MFLD TEMP	EXH MFLD TEMP	EXH MFLD PRES	ENGINE OUTLET TEMP
EKW	%	BHP	PSI	LB/BHP-HR	GAL/HR	IN-HG	DEG F	DEG F	IN-HG	DEG F
350.0	100	539	311	0.328	24.9	47.8	120.5	1,271.9	31.8	1,062.6
315.0	90	484	279	0.337	23.0	44.8	120.8	1,258.4	29.9	1,046.0
280.0	80	431	248	0.363	22.0	46.4	123.8	1,254.4	31.2	1,031.0
262.5	75	405	234	0.374	21.4	46.1	123.3	1,248.8	31.0	1,021.9
245.0	70	380	219	0.380	20.3	43.8	120.1	1,236.3	29.3	1,010.2
210.0	60	330	190	0.389	18.1	38.2	113.7	1,198.6	25.6	980.6
175.0	50	281	162	0.396	15.7	31.3	107.2	1,144.4	21.4	942.7
140.0	40	233	134	0.397	13.0	22.4	100.5	1,073.3	16.3	897.1
105.0	30	184	106	0.397	10.3	13.7	93.7	976.6	11.3	834.1
87.5	25	160	92	0.398	9.0	9.7	90.2	917.7	9.1	795.4
70.0	20	134	78	0.403	7.6	6.4	86.8	850.2	7.3	749.4
35.0	10	83.0	48	0.443	5.2	2.6	83.6	670.2	5.3	599.4

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	COMPRESSOR OUTLET PRES	COMPRESSOR OUTLET TEMP	WET INLET AIR VOL FLOW RATE	ENGINE OUTLET WET EXH GAS VOL FLOW RATE	WET INLET AIR MASS FLOW RATE	WET EXH GAS MASS FLOW RATE	WET EXH VOL FLOW RATE (32 DEG F AND 29.98 IN HG)	DRY EXH VOL FLOW RATE (32 DEG F AND 29.98 IN HG)
EKW	%	BHP	IN-HG	DEG F	CFM	CFM	LB/HR	LB/HR	FT3/MIN	FT3/MIN
350.0	100	539	53	326.0	881.1	2,619.7	3,862.0	4,038.9	846.1	761.4
315.0	90	484	49	313.8	855.8	2,508.3	3,729.7	3,893.1	819.1	739.9
280.0	80	431	51	320.2	878.5	2,549.2	3,839.9	3,996.2	840.8	764.1
262.5	75	405	51	319.5	878.6	2,530.2	3,841.4	3,992.9	839.7	765.1
245.0	70	380	48	311.2	857.9	2,439.7	3,742.1	3,886.3	816.0	744.9
210.0	60	330	42	288.4	801.9	2,220.3	3,481.1	3,609.6	758.0	694.1
175.0	50	281	35	257.7	727.0	1,950.9	3,138.9	3,250.2	684.0	628.2
140.0	40	233	25	214.8	622.6	1,616.8	2,672.7	2,765.1	585.9	540.0
105.0	30	184	16	170.6	517.7	1,277.3	2,206.8	2,279.9	485.4	449.0
87.5	25	160	12	150.2	470.9	1,117.8	1,999.7	2,063.2	437.9	405.9
70.0	20	134	8	132.3	431.9	973.5	1,827.1	1,881.3	395.9	367.9
35.0	10	83.0	4	109.2	390.5	759.0	1,643.9	1,680.7	352.4	332.1

Heat Rejection Data

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	REJECTION TO JACKET WATER	REJECTION TO ATMOSPHERE	REJECTION TO EXH	EXHAUST RECOVERY TO 350F	FROM OIL COOLER	FROM AFTERCOOLER	WORK ENERGY	LOW HEAT VALUE ENERGY	HIGH HEAT VALUE ENERGY

PERFORMANCE DATA[EM1692]

November 20, 2020

EKW	%	BHP	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN
350.0	100	539	8,221	2,747	20,731	12,456	2,887	3,178	22,859	54,199	57,735
315.0	90	484	7,677	2,692	19,528	11,690	2,665	2,883	20,512	50,027	53,291
280.0	80	431	7,354	2,887	19,493	11,693	2,551	3,019	18,269	47,897	51,023
262.5	75	405	7,140	2,948	19,197	11,505	2,474	3,018	17,180	46,452	49,483
245.0	70	380	6,842	2,890	18,397	10,985	2,355	2,864	16,104	44,213	47,098
210.0	60	330	6,231	2,840	16,468	9,709	2,099	2,436	13,997	39,401	41,972
175.0	50	281	5,606	2,763	14,165	8,183	1,818	1,892	11,926	34,126	36,352
140.0	40	233	5,098	2,565	11,424	6,395	1,509	1,223	9,874	28,335	30,184
105.0	30	184	4,540	2,136	8,708	4,636	1,194	679	7,809	22,410	23,872
87.5	25	160	4,185	1,844	7,473	3,846	1,037	480	6,765	19,475	20,746
70.0	20	134	3,761	1,539	6,355	3,130	885	333	5,703	16,607	17,691
35.0	10	83.0	2,657	1,328	4,333	1,713	600	168	3,518	11,270	12,005

Emissions Data

RATED SPEED POTENTIAL SITE VARIATION: 1800 RPM

GENSET POWER WITH FAN		**EKW**	**350.0**	**262.5**	**175.0**	**87.5**	**35.0**
PERCENT LOAD		**%**	**100**	**75**	**50**	**25**	**10**
ENGINE POWER		**BHP**	**539**	**405**	**281**	**160**	**83.0**
TOTAL NOX (AS NO2)		G/HR	2,622	929	521	537	363
TOTAL CO		G/HR	1,341	1,037	1,009	1,039	764
TOTAL HC		G/HR	15	28	41	48	79
PART MATTER		G/HR	102.3	100.4	101.1	54.5	37.3
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	2,456.7	991.6	766.7	1,466.5	1,550.9
TOTAL CO	(CORR 5% O2)	MG/NM3	1,247.2	1,104.7	1,479.3	2,911.7	3,253.4
TOTAL HC	(CORR 5% O2)	MG/NM3	11.7	26.0	51.8	110.6	347.1
PART MATTER	(CORR 5% O2)	MG/NM3	76.8	90.9	126.6	114.8	157.0
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,197	483	373	714	755
TOTAL CO	(CORR 5% O2)	PPM	998	884	1,183	2,329	2,603
TOTAL HC	(CORR 5% O2)	PPM	22	48	97	206	648
TOTAL NOX (AS NO2)		G/HP-HR	4.95	2.31	1.86	3.38	4.39
TOTAL CO		G/HP-HR	2.53	2.58	3.61	6.54	9.23
TOTAL HC		G/HP-HR	0.03	0.07	0.15	0.30	0.95
PART MATTER		G/HP-HR	0.19	0.25	0.36	0.34	0.45
TOTAL NOX (AS NO2)		LB/HR	5.78	2.05	1.15	1.18	0.80
TOTAL CO		LB/HR	2.96	2.29	2.22	2.29	1.68
TOTAL HC		LB/HR	0.03	0.06	0.09	0.11	0.17
PART MATTER		LB/HR	0.23	0.22	0.22	0.12	0.08

RATED SPEED NOMINAL DATA: 1800 RPM

GENSET POWER WITH FAN		**EKW**	**350.0**	**262.5**	**175.0**	**87.5**	**35.0**
PERCENT LOAD		**%**	**100**	**75**	**50**	**25**	**10**
ENGINE POWER		**BHP**	**539**	**405**	**281**	**160**	**83.0**
TOTAL NOX (AS NO2)		G/HR	2,428	860	482	497	337
TOTAL CO		G/HR	717	555	540	556	408
TOTAL HC		G/HR	8	15	21	25	42
TOTAL CO2		KG/HR	253	216	158	90	52
PART MATTER		G/HR	52.4	51.5	51.9	27.9	19.1
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	2,274.7	918.1	709.9	1,357.9	1,436.0
TOTAL CO	(CORR 5% O2)	MG/NM3	666.9	590.8	791.1	1,557.0	1,739.8
TOTAL HC	(CORR 5% O2)	MG/NM3	6.2	13.7	27.4	58.5	183.6
PART MATTER	(CORR 5% O2)	MG/NM3	39.4	46.6	64.9	58.9	80.5
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,108	447	346	661	699
TOTAL CO	(CORR 5% O2)	PPM	534	473	633	1,246	1,392
TOTAL HC	(CORR 5% O2)	PPM	12	26	51	109	343
TOTAL NOX (AS NO2)		G/HP-HR	4.58	2.14	1.73	3.13	4.07
TOTAL CO		G/HP-HR	1.35	1.38	1.93	3.50	4.93
TOTAL HC		G/HP-HR	0.01	0.04	0.08	0.16	0.50
PART MATTER		G/HP-HR	0.10	0.13	0.19	0.18	0.23
TOTAL NOX (AS NO2)		LB/HR	5.35	1.90	1.06	1.10	0.74
TOTAL CO		LB/HR	1.58	1.22	1.19	1.22	0.90
TOTAL HC		LB/HR	0.02	0.03	0.05	0.06	0.09
TOTAL CO2		LB/HR	559	476	348	198	115
PART MATTER		LB/HR	0.12	0.11	0.11	0.06	0.04
OXYGEN IN EXH		%	7.5	9.4	10.6	12.0	14.5
DRY SMOKE OPACITY		%	2.1	1.9	1.6	3.7	2.2
BOSCH SMOKE NUMBER			1.33	1.27	1.05	1.98	1.39

Regulatory Information

EPA EMERGENCY STATIONARY		2011 - ----		
GASEOUS EMISSIONS DATA MEASUREMENTS PROVIDED TO THE EPA ARE CONSISTENT WITH THOSE DESCRIBED IN EPA 40 CFR PART 60 SUBPART IIII AND ISO 8178 FOR MEASURING HC, CO, PM, AND NOX. THE "MAX LIMITS" SHOWN BELOW ARE WEIGHTED CYCLE AVERAGES AND ARE IN COMPLIANCE WITH THE EMERGENCY STATIONARY REGULATIONS.				
Locality	**Agency**	**Regulation**	**Tier/Stage**	**Max Limits - G/BKW - HR**
U.S. (INCL CALIF)	EPA	STATIONARY	EMERGENCY STATIONARY	CO: 3.5 NOx + HC: 4.0 PM: 0.20

Altitude Derate Data

ALTITUDE CORRECTED POWER CAPABILITY (BHP)

AMBIENT OPERATING TEMP (F)	30	40	50	60	70	80	90	100	110	120	130	140	NORMAL
ALTITUDE (FT)													
0	539	539	539	539	539	539	539	539	539	531	522	513	539
1,000	539	539	539	539	539	539	539	530	520	511	503	494	539
2,000	539	539	539	539	539	529	519	510	501	492	484	476	537
3,000	539	539	539	528	518	509	500	491	482	474	466	458	521
4,000	539	529	518	508	499	490	481	472	464	456	448	441	504
5,000	519	508	499	489	480	471	462	454	446	438	431	424	488
6,000	499	489	479	470	461	453	444	436	429	421	414	407	473
7,000	479	470	461	452	443	435	427	419	412	405	398	391	457
8,000	461	451	443	434	426	418	410	403	396	389	383	376	442
9,000	442	434	425	417	409	401	394	387	380	374	367	361	428
10,000	425	416	408	400	393	385	378	372	365	359	353	347	414
11,000	408	399	392	384	377	370	363	357	350	344	338	333	400
12,000	391	383	376	368	361	355	348	342	336	330	325	319	386
13,000	375	367	360	353	347	340	334	328	322	317	311	306	373
14,000	359	352	345	339	332	326	320	314	309	303	298	293	360
15,000	344	337	331	324	318	312	307	301	296	291	286	281	348

Cross Reference

Test Spec	Setting	Engine Arrangement	Engineering Model	Engineering Model Version	Start Effective Serial Number	End Effective Serial Number
0K9331	PP7708	4343726	PG045	LS	PW300001	
0K9331	PP7708	5066872	PG045	LS	PW300001	

Performance Parameter Reference

Parameters Reference:DM9600-12

PERFORMANCE DEFINITIONS

PERFORMANCE DEFINITIONS DM9600
APPLICATION:
Engine performance tolerance values below are representative of a typical production engine tested in a calibrated dynamometer test cell at SAE J1995 standard reference conditions. Caterpillar maintains ISO9001:2000 certified quality management systems for engine test Facilities to assure accurate calibration of test equipment. Engine test data is corrected in accordance with SAE J1995. Additional reference material SAE J1228, J1349, ISO 8665, 3046-1:2002E, 3046-3:1989, 1585, 2534, 2288, and 9249 may apply in part or are similar to SAE J1995. Special engine rating request (SERR) test data shall be noted.
PERFORMANCE PARAMETER TOLERANCE FACTORS:
Power +/- 3%
Torque +/- 3%

Exhaust stack temperature +/- 8%
Inlet airflow +/- 5%
Intake manifold pressure-gage +/- 10%
Exhaust flow +/- 6%
Specific fuel consumption +/- 3%
Fuel rate +/- 5%
Specific DEF consumption +/- 3%
DEF rate +/- 5%
Heat rejection +/- 5%
Heat rejection exhaust only +/- 10%
Heat rejection CEM only +/- 10%
Heat Rejection values based on using treated water.
Torque is included for truck and industrial applications, do not use for Gen Set or steady state applications.
On C7 - C18 engines, at speeds of 1100 RPM and under these values are provided for reference only, and may not meet the tolerance listed.
These values do not apply to C280/3600. For these models, see the tolerances listed below.
C280/3600 HEAT REJECTION TOLERANCE FACTORS:
Heat rejection +/- 10%
Heat rejection to Atmosphere +/- 50%
Heat rejection to Lube Oil +/- 20%
Heat rejection to Aftercooler +/- 5%
TEST CELL TRANSDUCER TOLERANCE FACTORS:
Torque +/- 0.5%
Speed +/- 0.2%
Fuel flow +/- 1.0%
Temperature +/- 2.0 C degrees
Intake manifold pressure +/- 0.1 kPa
OBSERVED ENGINE PERFORMANCE IS CORRECTED TO SAE J1995 REFERENCE AIR AND FUEL CONDITIONS.
REFERENCE ATMOSPHERIC INLET AIR
FOR 3500 ENGINES AND SMALLER
SAE J1228 AUG2002 for marine engines, and J1995 JAN2014 for other engines, reference atmospheric pressure is 100 KPA (29.61 in hg), and standard temperature is 25deg C (77 deg F) at 30% relative humidity at the stated aftercooler water temp, or inlet manifold temp.
FOR 3600 ENGINES
Engine rating obtained and presented in accordance with ISO 3046/1 and SAE J1995 JANJAN2014 reference atmospheric pressure is 100 KPA (29.61 in hg), and standard temperature is 25deg C (77 deg F) at 30% relative humidity and 150M altitude at the stated aftercooler water temperature.
MEASUREMENT LOCATION FOR INLET AIR TEMPERATURE
Location for air temperature measurement air cleaner inlet at stabilized operating conditions.
REFERENCE EXHAUST STACK DIAMETER
The Reference Exhaust Stack Diameter published with this dataset is only used for the calculation of Smoke Opacity values displayed in this dataset. This value does not necessarily represent the actual stack diameter of the engine due to the variety of exhaust stack adapter options available. Consult the price list, engine order or general dimension drawings for the actual stack diameter size ordered or options available.
REFERENCE FUEL
DIESEL
Reference fuel is #2 distillate diesel with a 35API gravity;
A lower heating value is 42,780 KJ/KG (18,390 BTU/LB) when used at 15 deg C (59 deg F), where the density is 850 G/Liter (7.0936 Lbs/Gal).
GAS
Reference natural gas fuel has a lower heating value of 33.74 KJ/L (905 BTU/CU Ft). Low BTU ratings are based on 18.64 KJ/L (500 BTU/CU FT) lower heating value gas. Propane ratings are based on 87.56 KJ/L (2350 BTU/CU Ft) lower heating value gas.
ENGINE POWER (NET) IS THE CORRECTED FLYWHEEL POWER (GROSS) LESS EXTERNAL AUXILIARY LOAD
Engine corrected gross output includes the power required to drive standard equipment; lube oil, scavenge lube oil, fuel transfer, common rail fuel, separate circuit aftercooler and jacket water pumps. Engine net power available for the external (flywheel) load is calculated by subtracting the sum of auxiliary load from the corrected gross flywheel out put power. Typical auxiliary loads are radiator cooling fans, hydraulic pumps, air compressors and battery charging alternators. For Tier 4 ratings additional Parasitic losses would also include Intake, and Exhaust Restrictions.
ALTITUDE CAPABILITY
Altitude capability is the maximum altitude above sea level at standard temperature and standard pressure at which the engine could develop full rated output power on the current performance data set.
Standard temperature values versus altitude could be seen on TM2001.
When viewing the altitude capability chart the ambient temperature is the inlet air temp at the compressor inlet.

PERFORMANCE DATA[EM1692]

Engines with ADEM MEUI and HEUI fuel systems operating at conditions above the defined altitude capability derate for atmospheric pressure and temperature conditions outside the values defined, see TM2001.
Mechanical governor controlled unit injector engines require a setting change for operation at conditions above the altitude defined on the engine performance sheet. See your Caterpillar technical representative for non standard ratings.
REGULATIONS AND PRODUCT COMPLIANCE
TMI Emissions information is presented at 'nominal' and 'Potential Site Variation' values for standard ratings. No tolerances are applied to the emissions data. These values are subject to change at any time. The controlling federal and local emission requirements need to be verified by your Caterpillar technical representative.
Customer's may have special emission site requirements that need to be verified by the Caterpillar Product Group engineer.
EMISSION CYCLE LIMITS:
Cycle emissions Max Limits apply to cycle-weighted averages only. Emissions at individual load points may exceed the cycle-weighted limit.
EMISSIONS DEFINITIONS:
Emissions : DM1176
EMISSION CYCLE DEFINITIONS
1. For constant-speed marine engines for ship main propulsion, including,diesel-electric drive, test cycle E2 shall be applied, for controllable-pitch propeller sets
test cycle E2 shall be applied.
2. For propeller-law-operated main and propeller-law-operated auxiliary engines the test cycle E3 shall be applied.
3. For constant-speed auxiliary engines test cycle D2 shall be applied.
4. For variable-speed, variable-load auxiliary engines, not included above, test cycle C1 shall be applied.
HEAT REJECTION DEFINITIONS:
Diesel Circuit Type and HHV Balance : DM9500
HIGH DISPLACEMENT (HD) DEFINITIONS:
3500: EM1500
RATING DEFINITIONS:
Agriculture : TM6008
Fire Pump : TM6009
Generator Set : TM6035
Generator (Gas) : TM6041
Industrial Diesel : TM6010
Industrial (Gas) : TM6040
Irrigation : TM5749
Locomotive : TM6037
Marine Auxiliary : TM6036
Marine Prop (Except 3600) : TM5747
Marine Prop (3600 only) : TM5748
MSHA : TM6042
Oil Field (Petroleum) : TM6011
Off-Highway Truck : TM6039
On-Highway Truck : TM6038
SOUND DEFINITIONS:
Sound Power : DM8702
Sound Pressure : TM7080
Date Released : 07/10/19

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Appendix D
2400-Volt Standby Power System Information

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Project Sizing Report

Sizing Id	10641796	Electricity Supply	60 Hz 4160/2402 V
Project Name	Lakewood Pump House "No.1 Pumps"	Connection	STAR
Customer Name	City of Duluth	Max. Ambient Temperature	77.0 F
Region	U.S.	Altitude	500.0 Ft. A.S.L
Prepared By	Scott Chilson	Humidity	30%
Modified Date	20-Nov-2020		

Load Analysis Summary

Max Transient Load Step	2,509.6 SkVA / 501.9 SkW
Peak Transient Load Step	2,647.7 SkVA / 698.1 SkW
Final Running Load	1,081.1 kVA / 973.0 kW / 0.90 PF
Max Running Non Linear Load	0.0 RkVA
Maximum Running Load	1,081.1 kVA / 973.0 kW
Selection Criteria	Step 2 Voltage dip restriction

Generator Set

Generator Set Model	(1) of 3512 C		
Model Type		Nameplate Rating	1,750.0 ekW / 2,187.0 kVA / 0.8 PF
Voltage Regulator and Slope	CDVR 2:1 slope;	Site Output Rating	1,750 ekW / 2,187 kVA
Feature Code	512DRC7	Rating Type	Standby
Fuel	Diesel	Open / Enclosure	Open
Sizing Methodology	Conventional	UL Listed	No
Capacity Used	55.6%		

Engine

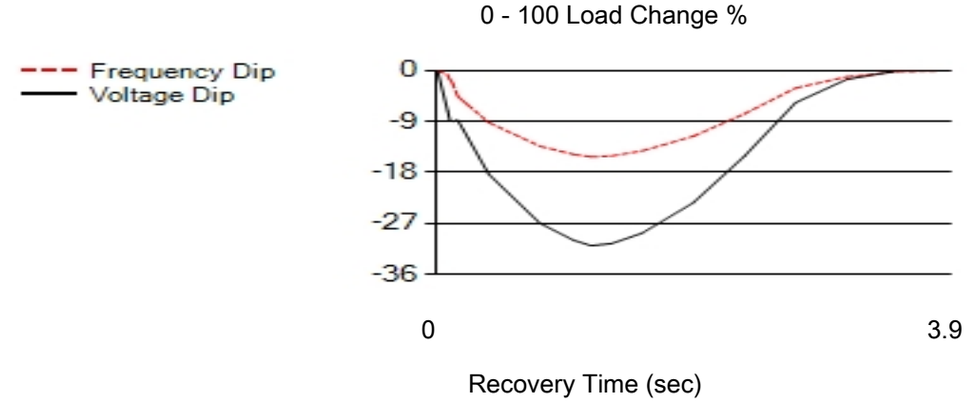
Make/Model	3512 C	Emissions / Certifications	EPA ESE
Aspiration	TA	Governor	ADEM3

Cylinder Configuration	VEE - 12	Aftercooler Type	ATAAC
Speed	1800 RPM	Displacement	3,574 Cubic Inch / 59 Liter
Engine Performance Number	EM1787	Bore	170
Fuel Consumption at 100% Load	121.8 gph	Stroke	215
Alternator			
Alternator Type/Frame Size	SR5 / 1668	Insulation Class	H
Alternator Winding Pitch	0.6667	Temperature Rise	105 C
Excitation/Winding Type	PM / FORM	Number Of Poles	4
Alternator Arrangement Number	2523968	Number of Leads	6
Subtransient Reactance X"d	0.1045	Rated Amps	303.5

**** See your Caterpillar dealer and/or Spec Sheet for technical information.

***** Package Power Tolerance: +/- 5%

Block Load(Only) Transient Response *			
Load Change %	FDip %	VDip %	Recovery Time (sec)
0 - 25	<5%	<5%	< 3
0 - 50	5.2	10.1	< 3
0 - 75	10.3	20.7	< 3
0 - 100	15.2	30.9	3.9



Transient Performance

Block Load (only) Transient Response values are at factory conditions with a resistive load. This information is representative of a typical Cat generator set, but is not guaranteed. Generator set block load capabilities at site conditions may vary from factory transient response test results due to site altitude, site ambient, and engine to engine variation.

Load Report

Project Name	Lakewood Pump House "No.1 Pumps"	Electricity Supply	60 Hz 4160/2402 V
Customer Name	City of Duluth	Rating Type	Standby
Region	U.S.	Max. Ambient Temperature	77.0 F
Prepared By	Scott Chilson	Altitude	500.0 Ft. A.S.L
Modified Date	20-Nov-2020	Humidity	30%
Generator Set Model	(1) of 3512 C	Nameplate Rating	1,750.0 ekW / 2,187.0 kVA / 0.8 PF

Load Details		Permitted		Predicted		Transient Inrush		Running		Resultant Peak		Cumulative Running	
Load Step	Load Description	FDip	VDip	FDip	VDip	SkVA	SkW	kVA	kW	SkVA	SkW	kVA	kW
Step 1													
1.1	1x250.00 HP - Low Lift Pump No.1: NEMA, 3-Phase Motor, Autotransformer 65%, Single Operating Point	15%	15%			559.8	134.4	218.0	196.2				
	Step 1 Total	15%	15%	<5%	<5%	559.8	134.4	218.0	196.2				
	Total Through Step 1									559.8	134.4	218.0	196.2
Step 2													
2.1	1x1,000.00 HP - High Lift Pump No.1***: NEMA, 3-Phase Motor, Autotransformer 65%, Single	15%	15%			2,509.7	501.9	863.1	776.8				
	Step 2 Total	15%	15%	<5%	13.5%	2,509.6	501.9	863.1	776.8				
	Total Through Step 2									2,647.7	698.1	1,081.1	973.0
Load Analysis Summary : Generator set meets site requirements													
						Maximum Step				Maximum Peak		Final Running	
						SkVA	SkW			SkVA	SkW	kVA	kW
						2,509.6	501.9			2,647.7	698.1	1,081.1	973.0

Guide Specification

Dealer Information

Name:
Address:
Phone Number:
Prepared By:
Email:

Package Generator Set

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Controls and Instrumentation, System Commissioning and Division 01 Specification Sections, apply to this section.

1.2 SUMMARY

A. This section includes packaged engine-generator sets for [emergency power] [standby power] [prime power] [continuous power] with the following features:

1. Diesel engine
2. [Unit mounted] [Remote mounted] cooling system
3. [Unit mounted] [Remote mounted] control and monitoring with connections to building BMS
4. Performance requirements for sensitive loads
5. Fuel system
6. Load banks
7. Outdoor enclosure
8. Exhaust
9. Mounting
10. Air make-up system

B. Related Sections include the following:

1. [List related sections here]

1.3 DEFINITIONS

A. [List related definitions here]

1.4 REFERENCES

A. The generator set and all components shall be designed, manufactured, and tested in accordance with the latest applicable standards as follows:

1. National Electric Code (NEC) – National Fire Protection Association (NFPA) 70

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2. NFPA 99, NFPA 110
3. American National Standards Institute (ANSI)
4. Underwriters Laboratories (UL)
5. Institute of Electrical and Electronics Engineers (IEEE)
6. [List additional codes and standards here]

1.5 ACTION SUBMITTALS

A. Bill of Materials: A listing shall include all panels, racks, instruments, components, and devices provided under this section

B. Product Data: For each type of package engine generator indicated. Drawings and descriptive (catalog) data and brochures of each item of equipment including technical data sheets for the engine and generator

1. Diesel engine data
    a. Manufacturer
    b. Model
    c. Revolutions per minute (RPM)
    d. Rated capacity brake horsepower (bhp)
    e. Make and model of governor
    f. Piston displacement (cubic inches)
    g. Fuel consumption rate in gallons per hour at:
        1) Full load
        2) 3/4 load
        3) 1/2 load
2. Generator data
    a. Manufacturer
    b. Model
    c. Rated kVA
    d. Rated kW
    e. Voltage
    f. Temperature rise above 40°C ambient at rated output with 0.8 power factor
    g. Motor starting capability (skVA) at 30% instantaneous voltage dip (motor starting at 90% rated voltage will not be accepted)
    h. Generator efficiency including excitation losses at:
        1) Full load
        2) 3/4 load
        3) 1/2 load

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3. Package data
    a. Overall length, width, and height
    b. Weight of complete skid mounted unit
    c. Exhaust pipe size
    d. Air flow (in cubic feet per minute) of air required for combustion and ventilation
    e. Heat rejection to the atmosphere of the engine and generator in BTU/hr
    f. Cooling air volume required
    g. Emissions certification
    h. Sound data
4. Engine-generator unit and accessories to include:
    a. Enclosure
    b. Accessory sub-panel & transformer
    c. Control panels
    d. Voltage regulator
    e. Fuel system
    f. Exhaust system
    g. Batteries
    h. Battery charger
    i. Jacket water heater
5. Generator circuit breaker
    a. Catalog data
    b. Recommended trip settings for all adjustable settings
    c. Short circuit interrupt ratings

C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
    1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
    2. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and vibration isolation bases.
    3. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
    4. Wiring Diagrams: Power, signal, and control wiring.

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1.6 INFORMATIONAL SUBMITTALS

A. Sizing calculation: Generator supplier to submit a project specific sizing calculation for engineering review and approval. Loading as shown on the electrical drawings.

B. Manufacturer Seismic Qualification Certification: Submit IBC certification that engine-generator set, batteries, battery racks, accessories, and components will withstand seismic forces defined in Division 26 Section “Vibration and Seismic Controls for Electrical Systems.” Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

   a. The term “withstand” means “the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event.”

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements

C. Qualification Data: For installer, manufacturer, and testing agency

D. Source quality-control test reports

1. Certified summary of prototype-unit test report.

2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.

3. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.

4. Report of sound generation.

5. [For installations in the United States] Factory EPA Certificate showing compliance with applicable federal regulations.

6. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

E. Field quality control test report

F. Warranty: Special warranty specified in this Section

G. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.

1.7 MAINTENANCE MATERIAL

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents

1. Fuses: One for every ten of each type and rating, minimum one fuse of each type.

2. Filters: One set each of lubricating oil, fuel, and combustion air filters

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1.8 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

1. Maintenance Proximity: Not more than four (4) hours' normal travel time from Installer's place of business to Project site.

2. Engineering Responsibility: Preparation of data for vibration isolators and seismic restraints of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

B. Manufacturer Qualifications: A qualified manufacturer with a minimum of 25 years' experience building the specified products. The manufacture shall maintain, 30 miles of Project site, a factory authorized and trained service center capable of providing training, parts, and emergency maintenance repairs.

C. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with ASME B15.1.

F. Comply with NFPA 37.

G. Comply with NFPA 70.

H. Comply with NFPA 99.

I. Comply with NFPA 110 requirements for Level 1 and Level 2 emergency / legally required power supply systems.

J. Listed to UL 2200 (600V generator output and below)

K. Exhaust Emissions: Comply with applicable federal, state, and local emissions requirements at the time of installation and commissioning.

L. Sound emissions: Comply with applicable local sound requirements

1.9 PROJECT CONDITIONS

A. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: Minus 25°C to plus 50 °C.

2. Altitude: Sea level to 3000 ft.

1.10 WARRANTY

A. Two Year Standby / Mission Critical Generator Set Warranty

1. The manufacturer's standard warranty shall in no event be for a period of less than two (2) years from date of initial start-up of the system and shall include repair parts, labor, reasonable travel expense necessary for repairs at the job site, and expendables (lubricating oil, filters, antifreeze, and other service items made unusable by the defect) used during the course of repair. Running hours shall be limited to 500 hours annually for the system warranty by both

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the manufacturer and servicing distributor. Submittals received without written warranties as specified will be rejected in their entirety.

2. Warranty shall include a temporary generator set in the event a warrantable repair will take more than 48 hours. Selling dealer must have a minimum of 100 units in its rental fleet to assure a temporary unit is available if needed. Provide documentation as such.

B. Standby / Mission Critical Generator Set Extended Service Coverage

1. Extended Service Coverage shall be provided for [5 year/2500 hours] [10 year/5000 hour] and shall include no deductible. Extended Service Coverage provides for 100 percent of usual and customary parts and labor costs for failures due to defects in materials and workmanship to the "as shipped consist" from the factory, excluding filters, fluids, vee belts, hoses, power take-offs, paint, batteries and clutches. Platinum Extended Service Coverage provides for a rental power unit due to unscheduled failures causing unexpected downtime to the customer in excess of 48 hours from the time of diagnoses. All repairs will be performed by factory trained dealer service personnel, and allows for repairer travel and mileage for all repairs up to 8 hours and 320 miles per incident.

B. Prime Power / Continuous Extended Service Coverage

1. Extended Service Coverage shall be provided for [2 year / 4000 hour] [2 year / 6000 hour] [2 year / 12000 hour] [2 year / 16000 hour] [5 year / 10000 hour] [5 year / 15000 hour] [5 year / 25000 hour] and shall include no deductible. Extended Service Coverage provides for 100 percent of usual and customary parts and labor costs for failures due to defects in materials and workmanship to the "as shipped consist" from the factory, excluding filters, fluids, vee belts, hoses, power take-offs, paint, batteries and clutches. All repairs will be performed by factory trained dealer service personnel, andallows for repairer travel and mileage for all repairs up to 8 hours and 320 miles per incident.

1.11 MAINTENANCE SERVICE

A. The engine generator supplier shall maintain 24 hour parts and service capability within [100 miles] [250 miles] of the project site. The distributor shall stock parts as needed to support the generator set package for this specific project. The distributor shall carry sufficient inventory to cover no less than 80% of the parts service within 24 hours and 95% within 48 hours.

B. Initial Maintenance Service: Beginning at Acceptance, provide 12 months' full maintenance by certified employees of manufacturer's designated service organization. Include semi-annual exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.B:P

C. Preventive Maintenance Agreement: The authorized manufacturer's dealer shall provide a preventive maintenance agreement using qualified factory trained service personnel, for a period of [1-year] [5-year] minimum. The dealer shall provide genuine Caterpillar parts and filters, shall provide all recommended fluids, dealer labor, travel labor and travel mileage to complete the suggested preventive maintenance as defined in the manufacturer's Operation and Maintenance Manual.B:P***B:T

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C. Total Maintenance and Repair Agreement: The authorized Caterpillar dealer shall provide a total maintenance and repair agreement using qualified factory trained service personnel for a period of 5 years minimum. The dealer shall provide genuine Caterpillar parts and filters, shall provide all recommended fluids, dealer labor, travel labor and travel mileage to complete the suggested preventive maintenance and overhauls as defined in the manufacturer's Operation and Maintenance Manual. The dealer shall also provide all genuine Caterpillar parts and filters, recommended fluids, dealer labor, travel labor and travel mileage to complete all unscheduled repairs and component replacements during the agreement period.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide product by one of the following:

1. Caterpillar Inc.

2.

B.Basis-of-Design Product: Subject to compliance with requirements, provide a Cat 1750 kW diesel generator set. The power system has been designed to the specified manufacturer's electrical and physical characteristics. The equipment sizing, spacing, amounts, electrical wiring, ventilation equipment, fuel, and exhaust components have all been sized and designed around Caterpillar supplied equipment. Should any substitutions be made, the CONTRACTOR shall bear responsibility for the installation, coordination and operation of the system as well as any engineering and redesign costs, which may result from such substitutions.

2.2 ENGINE-GENERATOR SET

A. New, 2018-2021 manufactured, factory assembled and tested engine-generator set.

B.The electric power generating system shall consist of [quantity] 1750 kW, 2187.0 kVA, 6912.4 skVA @ 30% instantaneous voltage dip, 0.8 power factor, 4160 volts, Wye connected, 3-Phase, 4 wire, 60 hertz generator systems. Motor starting at 90% rated sustained voltage will not be accepted. Generator set shall be rated for Standby applications with typical usage of 500 hours per year.

D. Engine power shall not derate up to 50°C at sea level and shall be capable of providing 1750 kW, at 77°F (25.0°C) and altitude of 500.0 feet (152.4 m).

E. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation, with provisions for lifting attachments.

1. Rigging diagram shall be permanently attached to the generator set package to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity

F. Capacities and Characteristics:

1. Power Output Ratings: 1750 ekW / 2187.0 kVA

2. Output Connections: 4160 volt three-phase, four wire

G. Nameplates: For each major system component, identify manufacturer's name, model, and serial number of component

H. Generator set performance:

1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.

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2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.

3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.

4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.

5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.

6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.

7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.

8. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.3 ENGINE

A. Fuel: Fuel oil, Grade DF-2 ULS type

B. Rated engine speed: 1800 RPM

C. Lubrication system: The following items are mounted on engine or base rails:

1. Filter and strainer: Oil filters rated to remove 90% of particles 5 micrometers and smaller while passing full flow

2. Lube oil pump

3. Oil level regulator

4. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassemble and without use of pumps, siphons, special tools, or appliances

D. Engine Fuel System:

1. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.

2. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.

3. Provide water separator and fuel filters. Fuel filters shall have isolation valve for changing of filters during engine operation.

E. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity. Heater shall include a circulation pump. Provide isolation valves that allow for change out of the heater without having to drain the entire system.

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F. Governor: Shall provide isochronous control, with provisions to interface with load share modules and / or remote switchgear. The engine governor shall be an electronic Engine Control Module (ECM) with 24-volt DC Electric Actuator. The ECM shall be enclosed in an environmentally sealed, die-cast aluminum housing which isolates and protects electronic components from moisture and dirt contamination. The ECM shall adjust fuel delivery per exhaust smoke, altitude and cold mode limits. In the event of a DC power loss, the forward acting actuator will move to the minimum fuel position.

G. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame, radiator duct flange and integral engine-driven coolant pump.

1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.

2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 100 percent load condition to an ambient temperature of [104°F / 40°C] [122°F / 50°C] ambient. Radiator shall be capable of providing cooling for an external restriction of 1.0 inch of water column.

3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.

4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.

6. Rating: 50-psig (345-kPa) maximum working pressure with coolant at 180°F (82°C), and non-collapsible under vacuum.

7. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

8. Integral fuel oil cooler shall be provided as required by the OEM.

H. Muffler / Silencer:

1. Provide a minimum critical grade exhaust silencer with valved condensate drain that extends beyond the depth of the insulation, and of the appropriate size for use with the engine. The silencer shall have inlet and outlets configured as required to meet the project exhaust system design with a 12 inch water column maximum pressure drop. Flexible, full length stainless steel connector/wye shall be furnished as required between the silencer and the engine exhaust outlet(s). The generator set manufacturer shall furnish all appropriate fittings, flanges, etc., as required between the engine and the silencer.

2. For indoor applications, the silencer shall be turned over to the mechanical contractor for mounting, installation and insulating per the project contract documents.

3. For outdoor enclosed applications, the exhaust silencer shall be mounted and insulated within the enclosure and pre-piped to the generator and exhaust stack.

I. Air Intake Filter: Heavy duty dual element, engine mounted air cleaners with replaceable dry-filter elements, “blocked filter” visual indicator

J. Starting System: 24 VDC electric with negative ground

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1. Dual cranking motor: Dual electric starters that automatically engage and release from engine flywheel without binding.

2. Cranking cycle: as required by NFPA 110 for system level Type 1

3. Battery: Oversize (10%) capacity to accommodate starting within ambient temperature range specified in Part 1 “Project Conditions” Article to provide specified cranking cycle at least three times without recharging.

4. Battery Cable: Size as recommended by engine manufacturer for cable length required as per site conditions to be field verified by manufacturer’s representative prior to order. Include required interconnecting conductors and connection accessories.

5. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.

6. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:

   a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.

   b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from -40°C to +60°C to prevent overcharging at high temperatures and undercharging at low temperatures.

   c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to ±10%.

   d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.

   e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.

   f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.4 FUEL OIL STORAGE

A. As required for specific installation per all local codes and regulations.

2.5 CONTROLS AND MONITORING

A. Provide a fully solid-state, microprocessor based, generator set controller. The control panel shall be designed and built by the engine manufacturer. The controller shall provide all operating, monitoring, and control functions for the generator set. The control panel shall provide real time digital communications to all engine and regulator controls via secure communication network.

B. Mounting (select one):

1. (For generators < 5kV) The control panel shall have the option be mounted on the generator set and include all interconnecting cables and harnesses to allow it to be remotely located within 20 meters of generator set.

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1. (For generators > 5 kV) The control panel shall include all interconnecting cables and harnesses to allow it to be mounted within 20 meters of generator set.

C. Environmental

1. The generator set controller shall be tested and certified to the following environmental conditions:

   a. -40°C to +70°C Operating Range

   b. 100% condensing humidity, 30°C to 60°C

   c. IP22 protection for rear of controller; IP55 when installed in control panel

   d. 5% salt spray, 48 hours, +38°C, 36.8V system voltage

   e. Sinusoidal vibration 4.3G's RMS, 24-1000Hz

   f. Electromagnetic Capability (89/336/EEC, 91/368/EEC, 93/44/EEC, 93/68/EEC, BS EN 50081-2, 50082-2)

   g. Shock: withstand 15G

D. Functional Requirements: The following functionality shall be integral to the control panel.

1. The control shall include a minimum 33 x 132 pixel, 24mm x 95mm, positive image, transflective LCD display with text based alarm/event descriptions.

2. The control shall include a minimum of 3-line data display

3. Audible horn for alarm and shutdown with horn silence switch

4. Standard ISO labeling

5. Multiple language capability

6. Remote start/stop control

7. Local run/off/auto control integral to system microprocessor

8. Cooldown timer

9. Speed adjust

10. Lamp test

11. Emergency stop push button

12. Voltage adjust

13. Voltage regulator V/Hz slope - adjustable

14. Password protected system programming

E. Digital Monitoring Capability: The controls shall provide the following digital readouts for the engine and generator. All readings shall be indicated in either metric or English units.

1. Engine

   a. Engine oil pressure

   b. Engine oil temperature

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c. Engine coolant temperature

d. Engine RPM

e. Battery volts

f. Engine hours

g. Engine crank attempt counter

h. Engine successful start counter

i. Service maintenance interval

j. Real time clock

k. Engine exhaust stack temperature

l. Engine main bearing temperature

2. Generator

a. Generator AC volts (Line to Line, Line to Neutral and Average.

b. Generator AC current (Avg and Per Phase.

c. Generator AC Frequency

d. Generator kW (Total and Per Phase.

e. Generator kVA (Total and Per Phase.

f. Generator kVAR (Total and Per Phase.

g. Power Factor (Avg and Per Phase.

h. Total kW-hr

i. Total kVAR-hr

j. % kW

k. % kVA

l. % kVAR

m. Generator bearing temperature

n. Generator stator winding temperature

o. Real (kW. Load Histogram – which tracks time that the generator kW is within predefined ranges

F. Alarms and Shutdowns: The control shall monitor and provide alarm indication and subsequent shutdown for the following conditions. All alarms and shutdowns are accompanied by a time, date, and engine hour stamp that are stored by the control panel for first and last occurrence:

1. Engine Alarm/Shutdown

a. Low oil pressure alarm/shutdown

b. High coolant temperature alarm/shutdown

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c. Loss of coolant shutdown

d. Overspeed shutdown

e. Overcrank shutdown

f. Emergency stop shutdown

g. Low coolant temperature alarm

h. Low battery voltage alarm

i. High battery voltage alarm

j. Control switch not in auto position alarm

k. Battery charger failure alarm

l. ATS remote start wiring failure

2. Generator Alarm/Shutdown

a. Generator phase sequence

b. Generator over voltage

c. Generator under voltage

d. Generator over frequency

e. Generator under frequency

f. Generator reverse power (real and reactive.

g. Generator overcurrent (including inverse definite minimum time. for Normally Inverse, Very Inverse, Extremely Inverse conditions as well as those based on Thermal Damage Curve configurations

h. Generator current balance

3. Voltage Regulator Alarm/Shutdown

a. Loss of excitation alarm/shutdown

b. Instantaneous over excitation alarm/shutdown

c. Time over excitation alarm/shutdown

d. Rotating diode failure

e. Loss of sensing

f. Loss of PMG

G. Inputs and Outputs

1. Programmable Digital Inputs. The Controller shall include the ability to accept programmable digital input signals. The signals may be programmed for either high or low activation using programmable Normally Open or Normally Closed contacts.

2. Programmable Relay Outputs. The control shall include the ability to operate programmable relay output signals, integral to the controller. The output relays shall be rated for 2A @ 30VDC

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and consist of six (6) Form A (Normally Open) contacts and two (2) Form C (Normally Open & Normally Closed) contacts.

3. Programmable Discrete Outputs. The control shall include the ability to operate two (2) discrete outputs, integral to the controller, which are capable of sinking up to 300mA per input.

4. Integrated PLC Functionality. The panel shall allow the operator to create custom logic functions to provide additional user defined control of the generator set operation.

H. Accessibility and Maintenance

1. All engine, voltage regulator, control panel and accessory units shall be accessible through a single electronic service tool. The following maintenance functionality shall be integral to the generator set control:

a. Engine running hours display

b. Service maintenance interval (running hours or calendar days)

c. Engine crank attempt counter

d. Engine successful starts counter

e. 40 events are stored in control panel memory

f. Programmable cycle timer that starts and runs the generator for a predetermined time. The timer shall use 7 user-programmable sequences that are repeated in a 7-day cycle. Each sequence shall have the following programmable set points:

1) Day of week

2) Time of day to start

3) Duration of cycle

I. Remote Communications

1. Remote Communications. The control shall include Modbus RTU communications as standard via RS-485 half duplex with configurable baud rates from 2.4k to 57.6k.

2. Remote Monitoring Software. The control shall provide Monitoring Software with the following functionality

a. Monitor up to eight (8) generator sets, plus Cat automatic transfer switches.

b. Provide access to all date and events on generator set communications network

c. Provide remote control capability for the generator set(s)

d. Ability to communicate via Modbus RTU or remote modem

J. Local and Remote Annunciation

1. Local Annunciator (NFPA 99/110, CSA 282). Provide a local, control panel mounted, annunciator to meet the requirements of NFPA 110, Level 1.

a. Annunciators shall be networked directly to the generator set control

b. Local Annunciator shall include a lamp test pushbutton, alarm horn and alarm acknowledge pushbutton

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c. Provide the following individual light indications for protection and diagnostics:

1) Overcrank

2) Low coolant temperature

3) High coolant temperature warning

4) High coolant temperature shutdown

5) Low oil pressure warning

6) Low oil pressure shutdown

7) Overspeed

8) Low coolant level

9) EPS supplying load

10) Control switch not in auto

11) High battery voltage

12) Low battery voltage

13) Battery charger AC failure

14) Emergency stop

15) Spare (or ATS Remote Start wiring failure)

16) Spare (or Tier 4 SCR when applicable)

2. Remote Annunciator (NFPA 99/110, CSA 282). Provide a remote annunciator to meet the requirements of NFPA 110, Level 1.

a. The annunciator shall provide remote annunciation of all points stated above and shall incorporate ring-back capability so that after silencing the initial alarm, any subsequent alarms will sound the horn. Ability to be located up to 4000 ft from the generator set without the use of a data repeater.

K. Telematics and Data Monitoring

1. There shall be a monitoring and data management system available on a 24/7/365 basis, which interfaces with the asset (generator set, switchgear, etc.) via a cellular or Ethernet connection.

a. The system shall monitor the asset continually.

1) It shall provide automated alert notification via text message and/or e-mail. These alerts shall also be displayed by a web-based system which will be updated automatically.

2) Asset functions being monitored will be displayed by a web-based system which will be updated automatically.

3) Asset monitoring allows for remote troubleshooting to upkeep asset health and performance.

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b. Continual monitoring offers various status updates, including reports of an asset's basic engine and electrical parameters and historical performance.

2. The web-based software shall be secure, requiring a registered user name and password structure for access.

a. Data Privacy Principles of the remote monitoring system are as follows:

1) The manufacturer shall be transparent about data collection

2) The manufacturer shall protect the data collected

3) The manufacturer shall respect the data rights of others

4. Subscription shall include the ability to remotely access equipment information with proactive equipment service and operation recommendations from a manufacturer's advisor.

5. The telematics hardware and remote monitoring user interface shall be an end-to-end system designed with multi-layer security controls and safeguards, to protect against unauthorized access and disclosure.

a) High level security safeguards include, but not limited to:

1) Cryptographic security controls to protect against unauthorized device software changes.

2) Encrypted and authenticated remote connection.

3) Only an outbound remote connection, initiated by the device, is allowed. Device shall not participate in or responds to general internet traffic.

4) Manufacturer's corporate IT infrastructure secured utilizing generally accepted information security principles and practices.

5) Secure web application connection with user login authentication and role based access controls.

b) Security Principles of the remote monitoring system shall be as follows:

1) Dedicated cybersecurity program and team

2) Risk-based approach to multi-layers cybersecurity

3) Proactively about cybersecurity

4) Response and Remediation to Cyber incidence

5) Training and awareness

6. The system will offer the user the option of having alarms and/or events handled by an expert advisor trained by the manufacturer. The advisor shall follow a user-defined procedure for handling alarms and/or events.

2.6 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other generator-set

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protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector shall perform the following functions:

1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.

2. Under single or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.

3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the generator set.

4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

B. (Optional) Ground-Fault Protection: Comply with NFPA 70, signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications.

C. Generator Circuit Breaker(s): UL Listed Molded-case, electronic-trip type; 100 percent rated; complying with UL 489. Circuit breaker shall be unit mounted. Stand-alone circuit breaker structures will not be accepted.

1. Tripping Characteristics: LSIG; Adjustable long-time and short-time delay and instantaneous and ground fault.

2. Trip Settings: Selected to coordinate with generator thermal damage curve.

3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.

4. Mounting: Integrated with gen-set. Cable entry to be coordinated with paralleling gear and enclosure.

2.7 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

Note to spec writer: Details on the generator can be found in the Data & Reports section of SpecSizer

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H insulation. Windings shall be of the [form] [random] wound type. Temperature rise shall not exceed [80°C] [105°C] [125°C] [130°C] [150°C] over 40°C ambient temperature. Alternator shall be model [ ]

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

F. Enclosure: Drip proof.

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G. Instrument Transformers: Mounted within generator enclosure.

H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.

1. Voltage adjustment on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.

I. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

J. Windings: [Two-thirds] pitch stator winding and fully linked amortisseur winding.

K. Subtransient Reactance: [ ] percent or less.

2.8 VIBRATION ISOLATION DEVICES (pick one)

A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

1. Material: Bridge-bearing neoprene, complying with AASHTO M 251.

2. Durometer Rating: 60* (*to be confirmed by manufacturer based on final selection of vibration isolation system.)

3. Number of Layers: up to Four (determined by manufacturer based on final vibration isolator assembly design)

A. Restrained Spring Isolators: Freestanding, steel, open-spring isolators.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.

2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of required deflection at rated load.

4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.9 ENCLOSURE

A. Attenuated Enclosure (Standard Sound optional)

1. The complete diesel engine generator set, including generator control panel, engine starting batteries and fuel oil tank, shall be enclosed in a factory assembled, sound attenuated enclosure mounted on the fuel tank base.

a. A weather resistant, sound attenuated enclosure of steel with electrostatically applied powder coated baked polyester paint. The enclosure shall have a resulting sound level of

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___dba @____ft with the genset running under full load. It shall consist of a roof, side walls, and end walls. Fasteners shall be either zinc plated or stainless steel.

b.Enclosure Sound Attenuation: Acoustical foam shall be provided between all supports and inside doors and sound baffles on air intake and air discharge.

2.10 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer. Provide owner color selection chart

2.11 SOURCE QUALITY CONTROL

A Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.

B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Reference system Commissioning Specifications for additional requirements. Include, at a minimum, the following tests:

1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.

2. Full load run.

3. Maximum power.

4. Voltage regulation.

5. Transient and steady-state governing.

6. Single-step load pickup.

7. Safety shutdown.

8. Provide 30 days' advanced notice of tests and for observation of tests by Owner's representative.

9. (Additional testing requirements may be added here)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.

B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

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3.2 INSTALLATION

A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions, NFPA 110 and all local codes

B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

C. Install packaged engine generator with restrained spring isolators having a minimum deflection of 1 inch.

D. Install Schedule 40, black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet. Flexible connectors and steel piping materials and installation requirements are specified in Division 23

1. Install condensate drain piping to muffler drain outlet full size of drain connection with a shutoff valve, stainless-steel flexible connector, and Schedule 40, black steel pipe with welded joints. Flexible connectors and piping materials and installation requirements are specified in Division 23 Section "Hydronic Piping."

E. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted. Electrical wiring includes but is not limited to battery chargers, heaters, control power, load bank, grounding, remote annunciator panels, paralleling gear, remote control panels, etc. Contractor to include as part of their scope of work, wall wiring and empty conduit indicated on contract drawings, specified herein, indicated/noted on approved manufacturers shop drawings and as required to provide a fully functional system.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Division 23 Sections. Drawings indicate general arrangement of piping and specialties.

B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.

C. Connect cooling-system water piping to engine-generator set and with single braid corrosion resistant type 302 stainless steel wire braid and compression fittings.

D. Connect engine exhaust pipe to engine with stainless steel flexible connector.

E. Connect fuel piping to engines with a gate valve and union and stainless steel flexible connector. Provide all required fire safe-off and solenoid valves.

F. Connect to BMS, coordinate with controls contractor.

G. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

H. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 IDENTIFICATION

A. Identify system components according to Division 23 Section "Identification for HVAC Piping and Equipment" and Division 26 Section "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

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A. Field Testing: If factory service technicians cannot provide the field testing specified as part of manufacturer's start-up, this contractor shall engage a qualified factory certified and authorized testing agency to perform tests and inspections and prepare test reports required by manufacturer.

B. Manufacturer's Field Service: Contractor to include field services of factory-authorized service representatives to provide start-up testing as well as to assist in 3rd party system commissioning as specified under the system commissioning specifications. Testing will not be concurrent so multiple travel days shall be included as per the approved schedule.

C. Perform tests and inspections and prepare test reports.

D. Tests and Inspections:

1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters. Generators shall be tested individually and in parallel.

2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.

3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions.

   a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.

   b. Test for contact integrity of all connectors.

   c. Verify acceptance of charge for each element of the battery after discharge.

   d. Verify that measurements are within manufacturer's specifications.

4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.

5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.

6. Exhaust Emissions Test: Comply with applicable government test criteria to confirm adherence to EPA Tier rating.

7. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.

8. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.

9. "Pull the Plug Test": Automatic start-up by means of simulated power outage to test remote-automatic starting, transfer of the load, and automatic shutdown. Prior to this test, all transfer switch timers shall be adjusted for proper system coordination. Engine coolant temperature, oil pressure, and battery charge level along with generator set voltage, amperes, and frequency shall be monitored throughout the test.

E. Coordinate tests with tests for transfer switches and run them concurrently.

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F. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.

G. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

H. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

I. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

J. Remove and replace malfunctioning units and retest as specified above.

K. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

L. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators, load bank and associated paralleling gear operations. Refer to Division 01 Section "Demonstration and Training."

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CATERPILLAR ENGINE DIVISION
TECHNICAL COMMUNICATIONS GROUP

Installation Drawing Index
AutoCAD 2015 Format

Installation Drawing No. 5218329 chg 03

3512C HD LV 60HZ

Overall Dimensions:

Length = 6178.20 mm

Width = 2281.20 mm

Height = 2794.00 mm

Engine pricing arrangements found on drawing:

LF2925 chg 03	LF3417 chg 02

Attachment pricing arrangements found on drawing:

LF1319 chg 01	LF2844 chg 02	3752296 chg 01
LF1344 chg 00	LF2849 chg 00	4734535 chg 00
LF1349 chg 00	LF3053 chg 00	4915856 chg 02
LF1870 chg 02	LF3359 chg 00	4915896 chg 02
LF2672 chg 00	2832549 chg 00	4915899 chg 01
LF2722 chg 02	3117115 chg 01	5167990 chg 01
LF2728 chg 00	3256244 chg 00	5190618 chg 01
LF2838 chg 01	3675169 chg 00	

5218329A.dwf = Summary Sheet of LF-2925 Chg 03 W/Attachments Shown. (sheet1)

PA and Part Numbers found on this sheet:

LF2672 chg 00	LF3417 chg 02	3675169 chg 00
LF3359 chg 00	LF2722 chg 02	5167990 chg 01
LF2849 chg 00	LF2844 chg 02	4915899 chg 01
LF1344 chg 00	LF1870 chg 02	3752296 chg 01
LF2728 chg 00	LF2925 chg 03	3117115 chg 01
LF3053 chg 00	3256244 chg 00	5190618 chg 01
LF1349 chg 00	2832549 chg 00	4915896 chg 02
LF2838 chg 01	4734535 chg 00	4915856 chg 02
LF1319 chg 01		

5218329B.dwf = Right Side View of LF-2925 Chg 03 W/Attachments Shown. (sheet2)

5218329C.dwf = Front View of LF-2925 Chg 03 W/Attachments Shown. (sheet3)

5218329D.dwf = Left Side View of LF-2925 Chg 03 W/Attachments Shown. (sheet4)

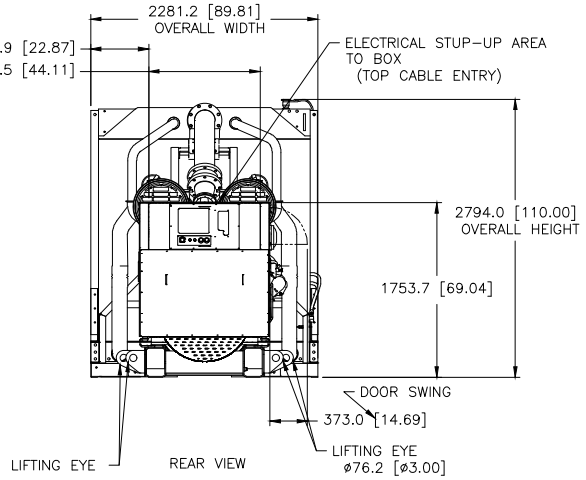
5218329E.dwf = Rear View of LF-2925 Chg 03 W/Attachments Shown. (sheet5)

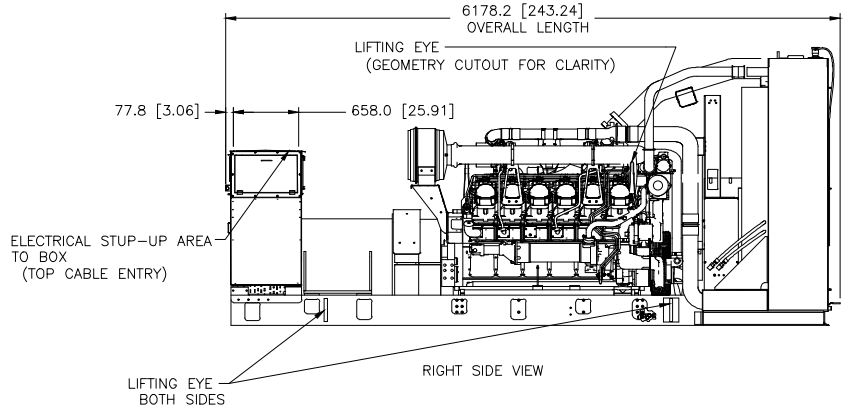
5218329F.dwf = Top View of LF-2925 Chg 03 W/Attachments Shown. (sheet6)

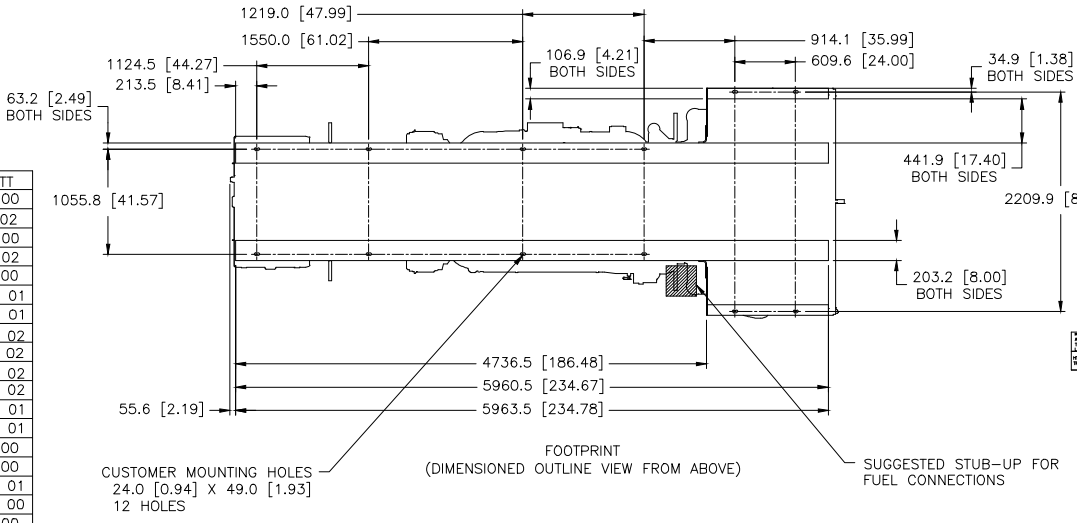
5218329G.dwf = Detail of Terminal Strip Connections; Detail of Exhaust; Detail of Mounting GP Isolator. (sheet7)

METRIC 521-8329

QTY	CONNECTION	SIZE	SHEETS
1	FUEL INLET	3/4-14 NPSM	2,5
1	EXCESS FUEL RETURN	1 3/16-12 THD	2,5
1	EXHAUST	DETAIL	4,6,7
2	FUMES DISPOSAL HOSE	ø57.2 [ø2.25] OD	4,5
1	OIL DRAIN	1 3/16-12 THD	2,5
1	RADIATOR DRAIN	1/2-14 NPT	2,3,4







MODEL	TYPE	PRICING AR	MANDATORY ATT
3512C	–	LF-2925 CHG 03 LF-3417 CHG 02	LF-2672 CHG 00 LF-2722 CHG 02 LF-2830 CHG 00 LF-2844 CHG 02 LF-2849 CHG 00 491-5899 CHG 01 491-5899 CHG 01 491-5896 CHG 02 491-5896 CHG 02 491-5856 CHG 02 491-5856 CHG 02 375-2296 CHG 01 311-7115 CHG 01 LF-1344 CHG 00 LF-2728 CHG 00 519-0618 CHG 01 325-6244 CHG 00 LF-3053 CHG 00 LF-1870 CHG 02 283-2549 CHG 00 473-4535 CHG 00 367-5169 CHG 00 LF-1319 CHG 01 LF-1349 CHG 00

PACKAGE LIFTED IN 3 PLACES WITH RADIATOR INSTALLED

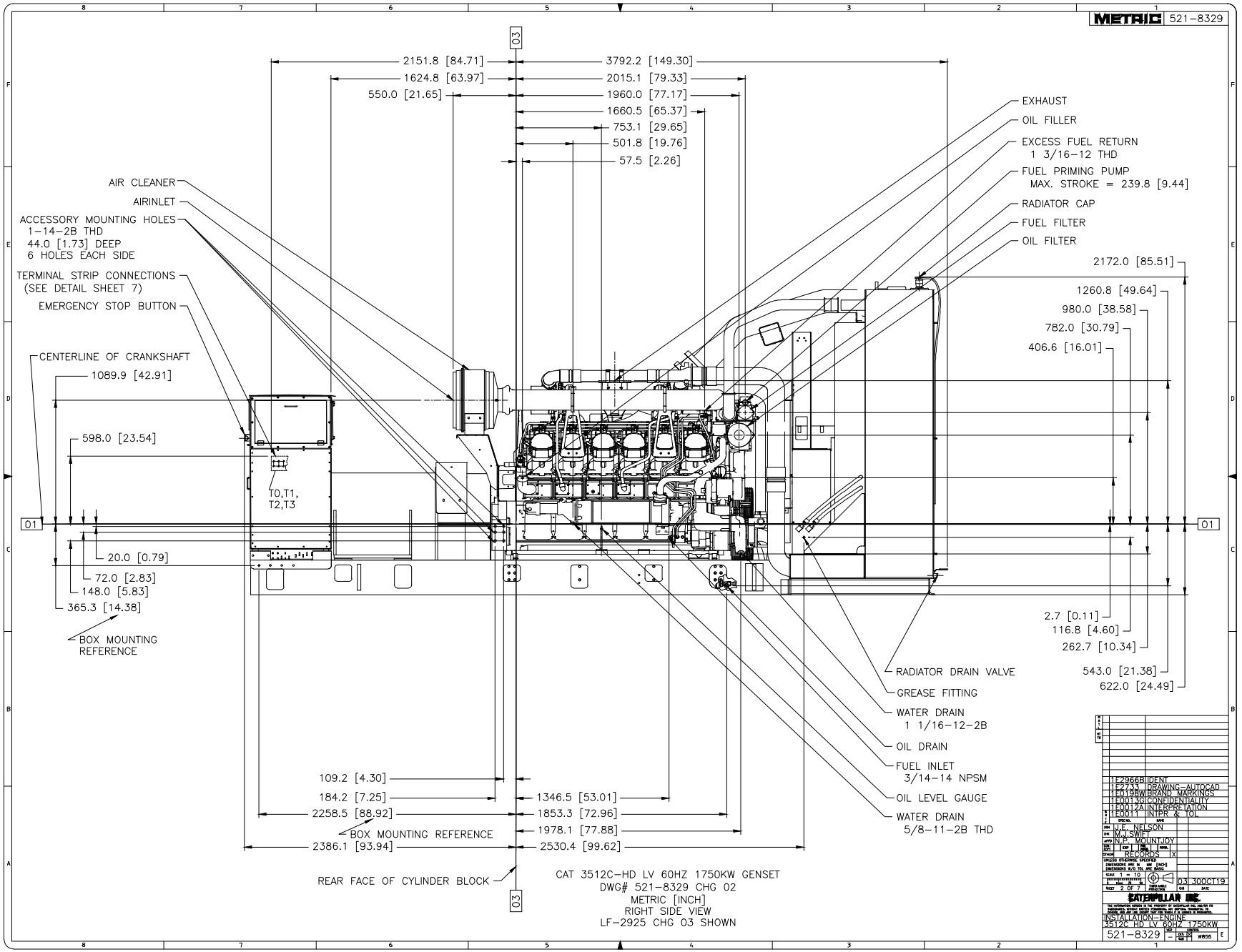
PACKAGE SHOWN WITH MORE DETAIL ON FOLLOWING SHEETS

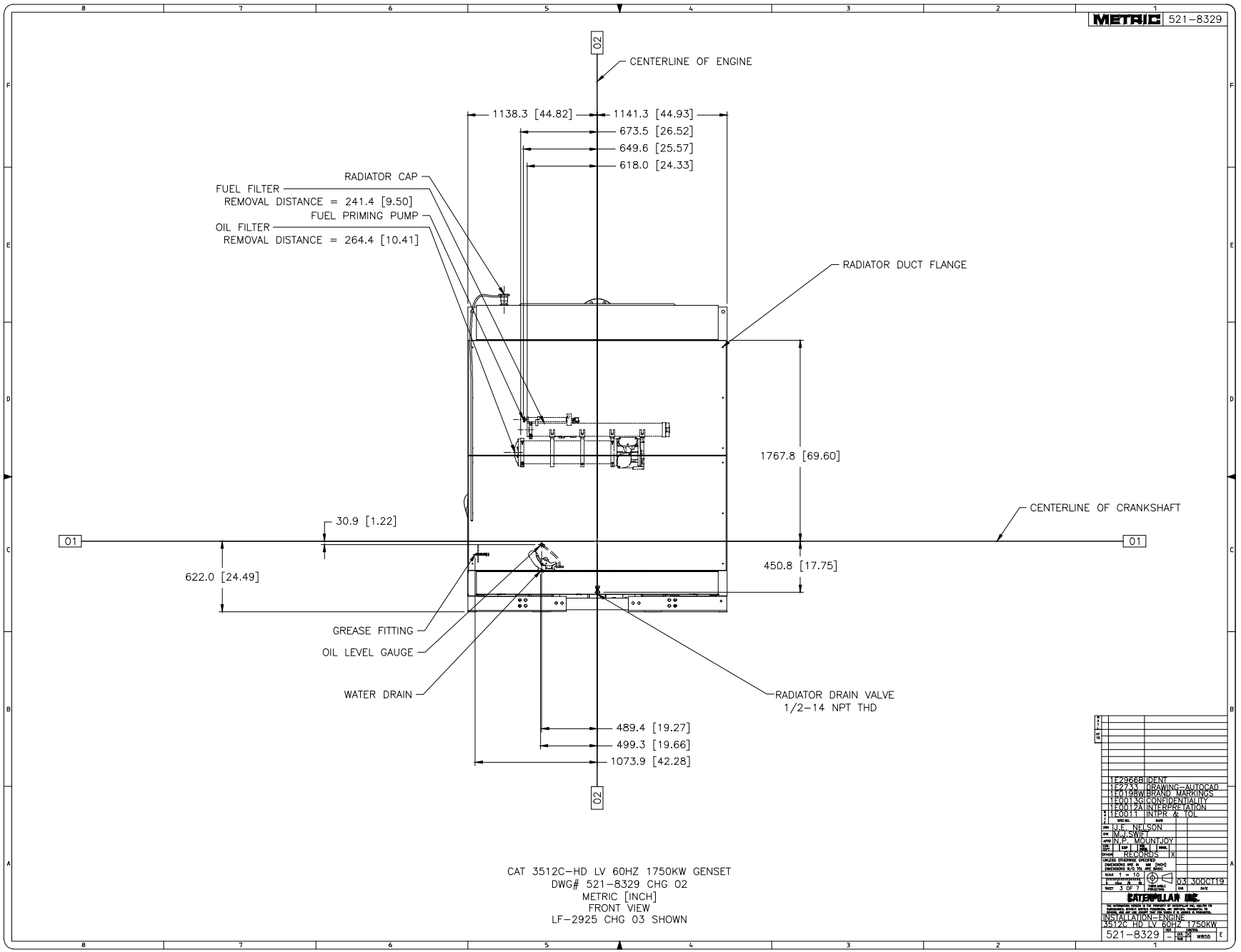
1E2966B IDENT
1E2733 DRAWING-AUTOCAD
1E0136W BRAND MARKINGS
1E0013G CONFIDENTIALITY
1E0012A INTERPRETATION
1E0011 INTPR & TOL

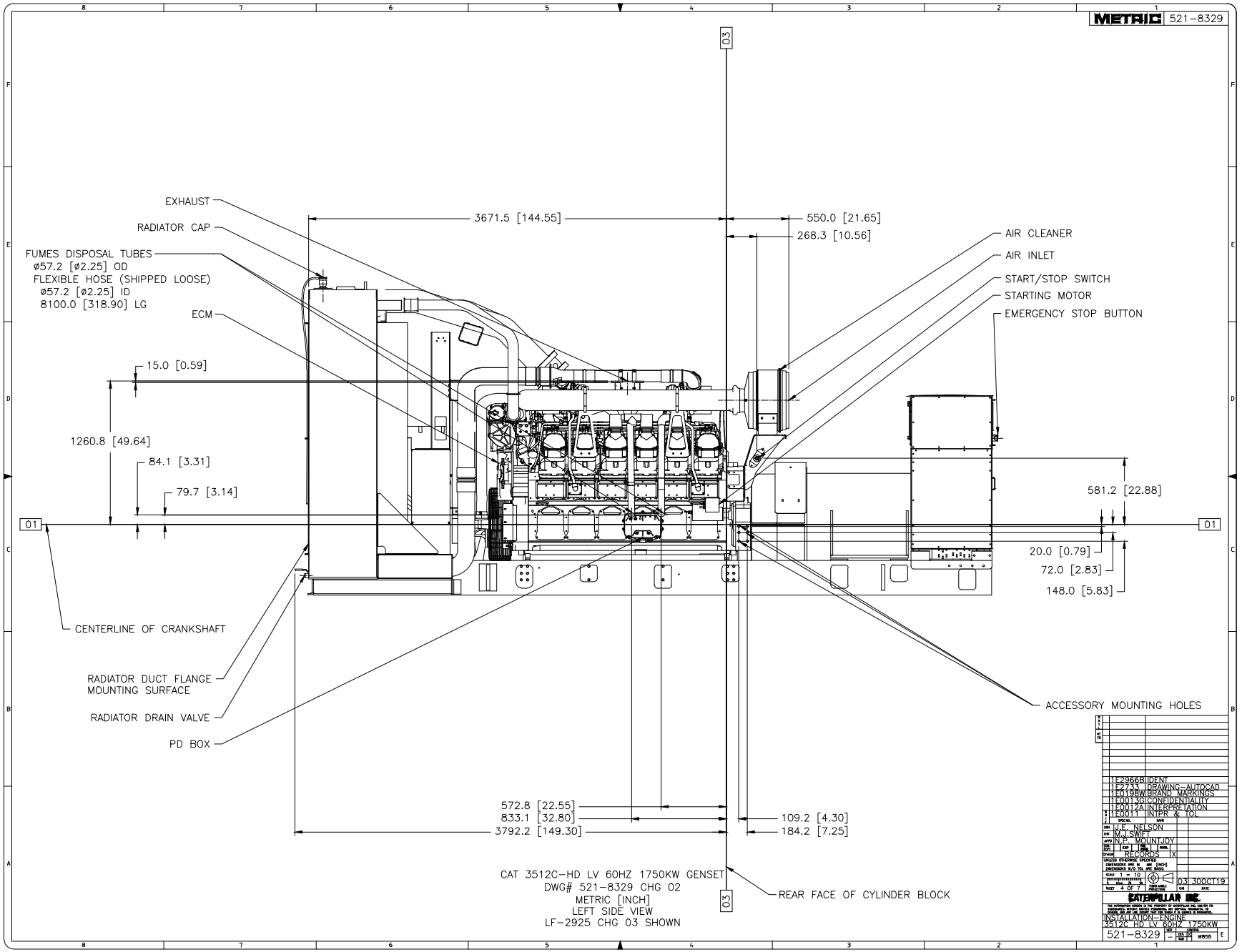
DRN J.E. NELSON
CH M.J.SWIFT
APPR N.P. MOUNTJOY
DATE RECORDS IX
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN mm (INCH) DIMENSIONS W/O TOL ARE BASIC
SCALE 1 = 16
INTERPRETATION 4
SHEET 1 OF 7
03 30OCT19

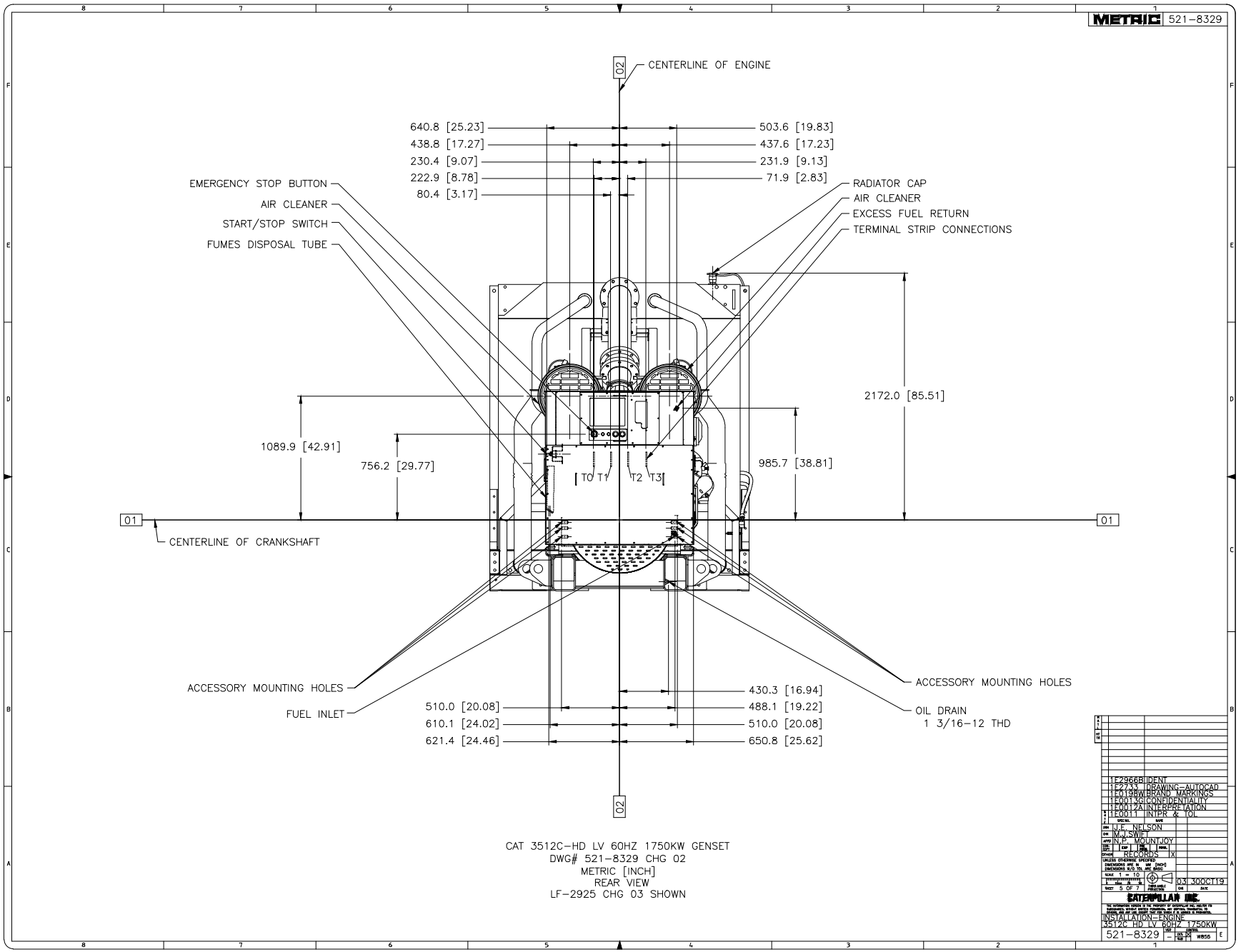
CATERPILLAR INC.

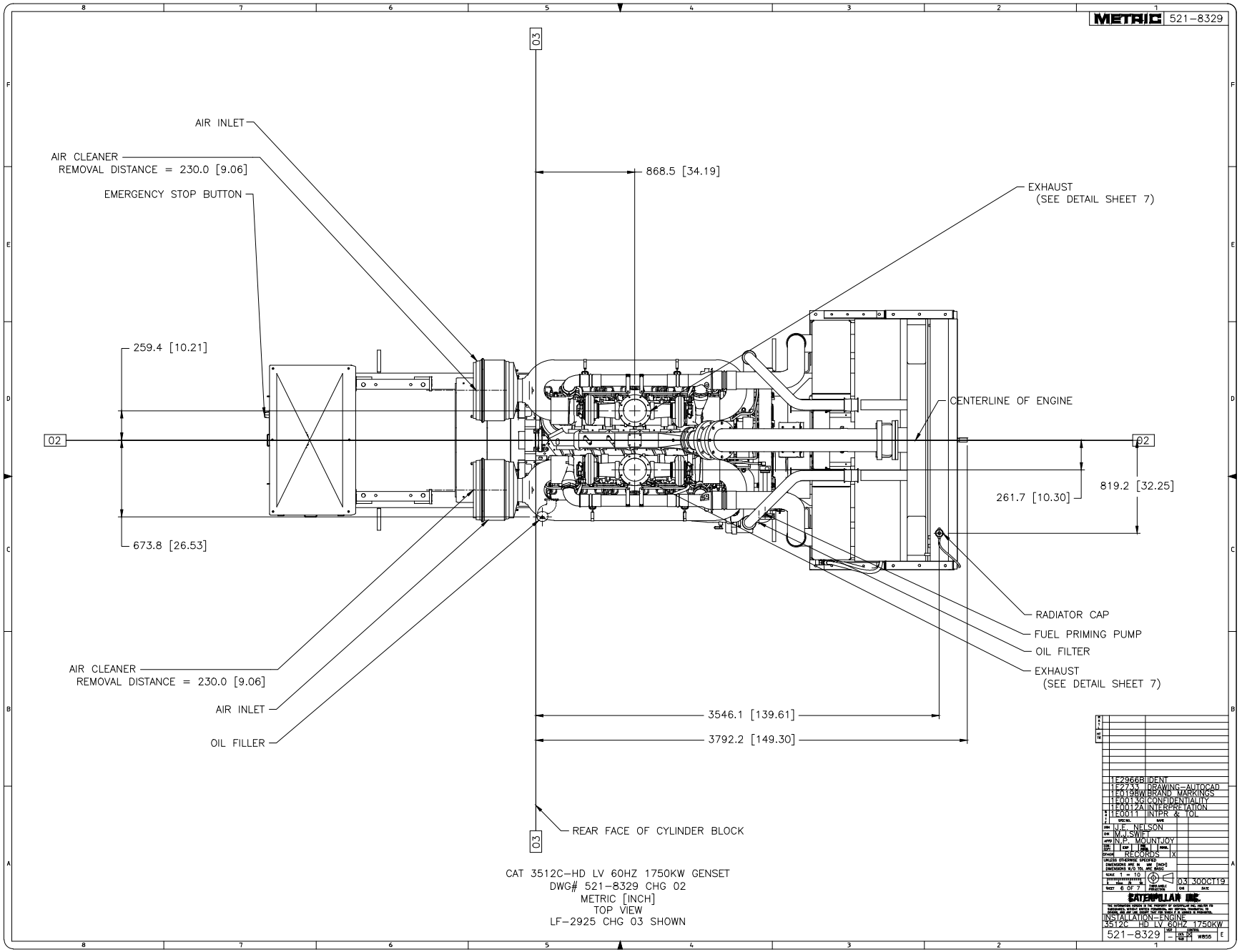
INSTALLATION-ENGINE
3512C HD LV 60 HZ 1750KW
521-8329 – W855


METRIC 521-8329
2151.8 [84.71]
1624.8 [63.97]
550.0 [21.65]
3792.2 [149.30]
2015.1 [79.33]
1960.0 [77.17]
1660.5 [65.37]
753.1 [29.65]
501.8 [19.76]
57.5 [2.26]
AIR CLEANER
AIRINLET
ACCESSORY MOUNTING HOLES
1-14-2B THD
44.0 [1.73] DEEP
6 HOLES EACH SIDE
TERMINAL STRIP CONNECTIONS
(SEE DETAIL SHEET 7)
EMERGENCY STOP BUTTON
CENTERLINE OF CRANKSHAFT
1089.9 [42.91]
598.0 [23.54]
T0,T1,
T2,T3
20.0 [0.79]
72.0 [2.83]
148.0 [5.83]
365.3 [14.38]
BOX MOUNTING
REFERENCE
EXHAUST
OIL FILLER
EXCESS FUEL RETURN
1 3/16-12 THD
FUEL PRIMING PUMP
MAX. STROKE = 239.8 [9.44]
RADIATOR CAP
FUEL FILTER
OIL FILTER
2172.0 [85.51]
1260.8 [49.64]
980.0 [38.58]
782.0 [30.79]
406.6 [16.01]
2.7 [0.11]
116.8 [4.60]
262.7 [10.34]
543.0 [21.38]
622.0 [24.49]
RADIATOR DRAIN VALVE
GREASE FITTING
WATER DRAIN
1 1/16-12-2B
OIL DRAIN
FUEL INLET
3/14-14 NPSM
OIL LEVEL GAUGE
WATER DRAIN
5/8-11-2B THD
109.2 [4.30]
184.2 [7.25]
2258.5 [88.92]
2386.1 [93.94]
1346.5 [53.01]
1853.3 [72.96]
1978.1 [77.88]
2530.4 [99.62]
BOX MOUNTING REFERENCE
REAR FACE OF CYLINDER BLOCK
03
01
CAT 3512C-HD LV 60HZ 1750KW GENSET
DWG# 521-8329 CHG 02
METRIC [INCH]
RIGHT SIDE VIEW
LF-2925 CHG 03 SHOWN
1E2966B IDENT
1F2733 DRAWING-AUTOCAD
1E0136W BRAND MARKINGS
1E0013G CONFIDENTIALITY
1E0012A INTERPRETATION
1E0011 INTPR & TOL
J.E. NELSON
M.J. SWIFT
N.P. MOUNTJOY
RECORDS
03 30OCT19
SHEET 2 OF 7
CATERPILLAR INC.
INSTALLATION-ENGINE
3512C HD LV 60HZ 1750KW
521-8329
WB55

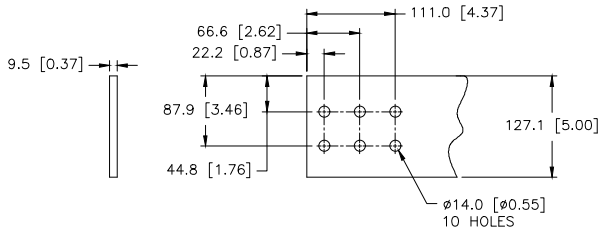

METRIC 521-8329
02
CENTERLINE OF ENGINE
1138.3 [44.82]
1141.3 [44.93]
673.5 [26.52]
649.6 [25.57]
618.0 [24.33]
RADIATOR CAP
FUEL FILTER
REMOVAL DISTANCE = 241.4 [9.50]
FUEL PRIMING PUMP
OIL FILTER
REMOVAL DISTANCE = 264.4 [10.41]
RADIATOR DUCT FLANGE
1767.8 [69.60]
CENTERLINE OF CRANKSHAFT
30.9 [1.22]
01
01
622.0 [24.49]
450.8 [17.75]
GREASE FITTING
OIL LEVEL GAUGE
WATER DRAIN
RADIATOR DRAIN VALVE
1/2-14 NPT THD
489.4 [19.27]
499.3 [19.66]
1073.9 [42.28]
02
CAT 3512C-HD LV 60HZ 1750KW GENSET
DWG# 521-8329 CHG 02
METRIC [INCH]
FRONT VIEW
LF-2925 CHG 03 SHOWN
1E2966B IDENT
1F2733 DRAWING-AUTOCAD
1E0136W BRAND MARKINGS
1E0013G CONFIDENTIALITY
1E0012A INTERPRETATION
1E0011 INTPR & TOL
J.E. NELSON
M.J. SWIFT
N.P. MOUNTJOY
RECORDS
SCALE 1 = 10
SHEET 3 OF 7
03 30OCT19
CATERPILLAR INC.
INSTALLATION-ENGINE
3512C HD LV 60HZ 1750KW
521-8329
WB55


METRIC 521-8329
EXHAUST
RADIATOR CAP
FUMES DISPOSAL TUBES
ø57.2 [ø2.25] OD
FLEXIBLE HOSE (SHIPPED LOOSE)
ø57.2 [ø2.25] ID
8100.0 [318.90] LG
ECM
3671.5 [144.55]
550.0 [21.65]
268.3 [10.56]
AIR CLEANER
AIR INLET
START/STOP SWITCH
STARTING MOTOR
EMERGENCY STOP BUTTON
15.0 [0.59]
1260.8 [49.64]
84.1 [3.31]
79.7 [3.14]
581.2 [22.88]
20.0 [0.79]
72.0 [2.83]
148.0 [5.83]
CENTERLINE OF CRANKSHAFT
RADIATOR DUCT FLANGE MOUNTING SURFACE
RADIATOR DRAIN VALVE
PD BOX
ACCESSORY MOUNTING HOLES
572.8 [22.55]
833.1 [32.80]
3792.2 [149.30]
109.2 [4.30]
184.2 [7.25]
REAR FACE OF CYLINDER BLOCK
CAT 3512C-HD LV 60HZ 1750KW GENSET
DWG# 521-8329 CHG 02
METRIC [INCH]
LEFT SIDE VIEW
LF-2925 CHG 03 SHOWN
03
01
1E2966B IDENT
1E2733 DRAWING-AUTOCAD
1E0136W BRAND MARKINGS
1E0013G CONFIDENTIALITY
1E0012A INTERPRETATION
1E0011 INTPR & TOL
J.E. NELSON
M.J. SWIFT
N.P. MOUNTJOY
RECORDS
UNLESS OTHERWISE SPECIFIED
SCALE 1 = 10
SHEET 4 OF 7
03 300CT19
CATERPILLAR INC.
INSTALLATION-ENGINE
3512C HD LV 60HZ 1750KW
521-8329
WB55

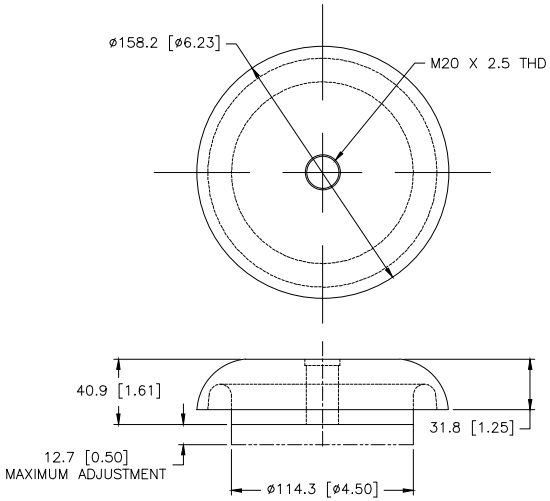

METRIC 521-8329
02
CENTERLINE OF ENGINE
640.8 [25.23]
438.8 [17.27]
230.4 [9.07]
222.9 [8.78]
80.4 [3.17]
503.6 [19.83]
437.6 [17.23]
231.9 [9.13]
71.9 [2.83]
EMERGENCY STOP BUTTON
AIR CLEANER
START/STOP SWITCH
FUMES DISPOSAL TUBE
RADIATOR CAP
AIR CLEANER
EXCESS FUEL RETURN
TERMINAL STRIP CONNECTIONS
2172.0 [85.51]
1089.9 [42.91]
756.2 [29.77]
985.7 [38.81]
T0 T1 T2 T3
01
01
CENTERLINE OF CRANKSHAFT
ACCESSORY MOUNTING HOLES
FUEL INLET
ACCESSORY MOUNTING HOLES
OIL DRAIN
1 3/16-12 THD
430.3 [16.94]
510.0 [20.08]
488.1 [19.22]
610.1 [24.02]
510.0 [20.08]
621.4 [24.46]
650.8 [25.62]
02
CAT 3512C-HD LV 60HZ 1750KW GENSET
DWG# 521-8329 CHG 02
METRIC [INCH]
REAR VIEW
LF-2925 CHG 03 SHOWN
1E2966B IDENT
1F2733 DRAWING-AUTOCAD
1E0136W BRAND MARKINGS
1E0013G CONFIDENTIALITY
1E0012A INTERPRETATION
1E0011 IN1PR & TOL
J.E. NELSON
M.J. SWIFT
N.P. MOUNTJOY
RECORDS
SCALE 1 = 10
SHEET 5 OF 7
03 30OCT19
CATERPILLAR INC.
INSTALLATION-ENGINE
3512C HD LV 60HZ 1750KW
521-8329
W855


METRIC 521-8329
AIR INLET
AIR CLEANER
REMOVAL DISTANCE = 230.0 [9.06]
EMERGENCY STOP BUTTON
868.5 [34.19]
EXHAUST
(SEE DETAIL SHEET 7)
259.4 [10.21]
CENTERLINE OF ENGINE
02
02
261.7 [10.30]
819.2 [32.25]
673.8 [26.53]
RADIATOR CAP
FUEL PRIMING PUMP
OIL FILTER
EXHAUST
(SEE DETAIL SHEET 7)
AIR CLEANER
REMOVAL DISTANCE = 230.0 [9.06]
AIR INLET
OIL FILLER
3546.1 [139.61]
3792.2 [149.30]
03
03
REAR FACE OF CYLINDER BLOCK
CAT 3512C-HD LV 60HZ 1750KW GENSET
DWG# 521-8329 CHG 02
METRIC [INCH]
TOP VIEW
LF-2925 CHG 03 SHOWN
1E2966B IDENT
1E2733 DRAWING-AUTOCAD
1E0136W BRAND MARKINGS
1E0013C CONFIDENTIALITY
1E0012A INTERPRETATION
1E0011 IN1PR & TOL
J.E. NELSON
M.J. SWIFT
N.P. MOUNTJOY
RECORDS
03 30OCT19
SHEET 6 OF 7
CATERPILLAR INC.
INSTALLATION-ENGINE
3512C HD LV 60HZ 1750KW
521-8329
WB55

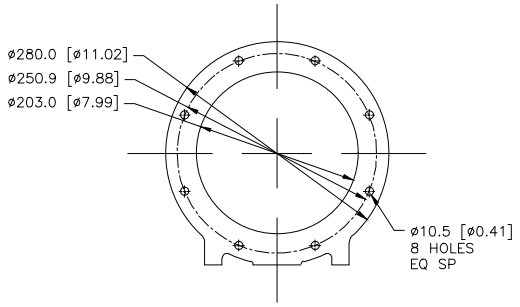
METRIC 521-8329



DETAIL OF TERMINAL STRIP CONNECTIONS
(T0, T1, T2, T3)
SCALE 1=2



DETAIL OF MOUNTING GP ISOLATOR
(SHIPPED LOOSE)
SCALE 1=1



DETAIL OF EXHAUST
SCALE 1=2

1E2966B IDENT
1F2733 DRAWING-AUTOCAD
1F0136W BRAND MARKING
1E0013G CONFIDENTIALITY
1E0012A INTERPRETATION
1E0011 INTPR & TOL

DRN J.E. NELSON
CHK M.J. SWIFT
APVD N.P. MOUNTJOY

RECORDS IX

SCALE 1 = 10
SHEET 7 OF 7
03 30OCT19

CATERPILLAR INC.

INSTALLATION-ENGINE
3512C HD LV 60HZ 1750KW
521-8329 - E

METRIC 491-3960

SHEET	DESCRIPTION
1	NOTES & SHEET INDEX
2	ABBREVATIONS & SYMBOLS
3	COMPONENT LAYOUT - SHEET 1 OF 2
4	COMPONENT LAYOUT - SHEET 2 OF 2
5	CUSTOMER INTERCONNECTS - SHEET 1 OF 5
6	CUSTOMER INTERCONNECTS - SHEET 2 OF 5
7	CUSTOMER INTERCONNECTS - SHEET 3 OF 5
8	CUSTOMER INTERCONNECTS - SHEET 4 OF 5
9	CUSTOMER INTERCONNECTS - SHEET 5 OF 5
10	MGDL NETWORK - SHEET 1 OF 4
11	MGDL NETWORK - SHEET 2 OF 4
12	MGDL NETWORK - SHEET 3 OF 4
13	MGDL NETWORK - SHEET 4 OF 4
14	WIRING LAYOUT - SHEET 1 OF 3
15	WIRING LAYOUT - SHEET 2 OF 3
16	WIRING LAYOUT - SHEET 3 OF 3

SHEET 5 - NOTE A: ANALOG INPUTS 1,2 & 3 CAN BE CONNECTED WITH FOLLOWING TYPE OF SENSOR PWM TYPE, RESISTIVE, VOLTAGE SENDERS OR CURRENT SENDERS

SHEET 14,15 & 16 - NOTE B: JUMPER FOR ENCLOSURE ESTOP. REMOVE TERMINAL BLOCK BRIDGE WHEN ENCLOSURE ESTOP IS IMPLEMENTED

SHEET 8 - NOTE C: ADD JUMPER TO PARALLELING GENSET ONE. SUBSEQUENT GENSETS REQUIRE NO JUMPER.

SHEET 9 - NOTE D: USE THE EXISTING RESISTOR ON THE DC TERMINAL BLOCK

ALL CUSTOMER WIRE SIZES ARE 16 AWG/1.0sq mm MIN, 600V STRANDED WIRE, UNLESS OTHERWISE SPECIFIED.

MAT		
HT TR		
	1E0198W	BRAND MARKINGS
	1E0013Y	CONFIDENTIALITY
	1E0012A	INTERPRETATION
NOTE	1E0011	INTPR & TOL
	Caterpillar: Confidential Yellow	
	PROD.	OTHER RECORDS

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN mm DIMENSIONS W/O TOL ARE BASIC

VERSION TYPE: PRIMARY X / SECONDARY

THIRD ANGLE PROJECTION

SHEET 1 OF 16

DWG CONTROL W944

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DIAGRAM-WIRING (MODULAR CONTROLS)

491-3960 VER - CHG 00 D

ABBREVIATIONS

52G	GENERATOR CIRCUIT BREAKER
AC	ALTERNATING CURRENT
ADEM	ADVANCED DIESEL ENGINE MANAGEMENT
AI	ANALOG INPUT
AUX	AUXILIARY
BATT-	BATTERY NEGATIVE
BATT+	BATTERY POSITIVE
C	COMMON
CAN	CONTROLLER AREA NETWORK
CB	CIRCUIT BREAKER
CDL	CAT DATA LINK
CR	CONTROL RELAY
CS	CONTROL SIGNAL
CT	CURRENT TRANSFORMER
CW	CLOCKWISE
DC	DIRECT CURRENT
DI	DIGITAL INPUT
DIO	DIGITAL INPUT/OUTPUT
DO	DIGITAL OUTPUT
ECM	ELECTRONIC CONTROL MODULE
ECMR	ELECTRONIC CONTROL MODULE RELAY
EM	EXCITATION MODULE
EMCP	ELECTRONIC MODULAR CONTROL PANEL
ESPB	EMERGENCY STOP PUSH BUTTON
F	FUSE
GEN	GENERATOR
GND	GROUND
IE	INTERNAL EXCITATION
L	LAMP
LS	LAMP SWITCH
LSM	LOAD SHARE MODULE
LV	LOW VOLTAGE
MPU	MAGNETIC PICKUP
N	NEUTRAL
NC	NORMALLY CLOSED
N/C	NO CONNECTION
NFPA	NATIONAL FIRE PROTECTION AGENCY
NO	NORMALLY OPEN
OPT	OPTIONAL
P	PUMP
PMG	PERMANENT MAGNET GENERATOR
POT	POTENTIOMETER
PS	POWER SUPPLY
PT	POTENTIAL TRANSFORMER
PWM	PULSE WIDTH MODULATION
PWR	POWER
RES	RESISTOR
RO	RELAY OUTPUT
RTD	RESISTANCE TEMPERATURE DETECTOR
RTN	RETURN
SPD	SPEED
SPDR	SHORE POWER DISCONNECT RELAY
STRP	SHUNT TRIP
TR	TRIP RELAY
V	VOLTS

WIRE COLOR

RD	RED
WH	WHITE
OR	ORANGE
YL	YELLOW
CL	CLEAR
BK	BLACK
GY	GRAY
CU	COPPER
BR	BROWN
GN	GREEN
BU	BLUE
GN_YL	GREEN/YELLOW
VI	VIOLET
BK_WH	BLACK/WHITE

LAMP COLOR

R	RED
G	GREEN
Y	YELLOW
A	AMBER
W	WHITE
O	ORANGE
B	BLUE

LINE STYLES

STANDARD WIRING

CUSTOMER SUPPLIED WIRING

SHIELDED CABLE

TWISTED PAIR

CIRCUIT BREAK

WIRE CONNECTION

CIRCUITS NOT CONNECTED

OR — CIRCUIT CONNECTED

COMPONENT CALLOUT

SYMBOLS

RELAY CONTACT (NORMALLY OPEN)

RELAY CONTACT (NORMALLY CLOSED)

GROUND

LAMP

XX AMPS — FUSE

DIODE

HEATING ELEMENT

RELAY COIL

PUMP MOTOR

EMERGENCY STOP PUSH BUTTON

SWITCH CONTACT (NORMALLY OPENED)

SWITCH CONTACT (NORMALLY CLOSED)

TOGGLE SWITCH

20A — CIRCUIT BREAKER (2 POLE)

TERMINAL BOARD POINT

PIN

SOCKET

POTENTIOMETER

3-WIRE RTD

2-WIRE RTD

TEMPERATURE SWITCH (NORMALLY CLOSED)

CURRENT TRANSFORMER

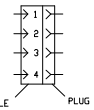
EXCITER COIL



TERMINATING RESISTOR



BATTERY CHARGER



MULTI-PIN CONNECTOR

RECEPTACLE PLUG

ABBREVIATIONS & SYMBOLS
FOR NOTES SEE SHEET 1

	1E0198W	BRAND MARKINGS
	1E0013Y	CONFIDENTIALITY
	1E0012A	INTERPRETATION
NOTE	1E0011	INTPR & TOL
	Caterpillar: Confidential Yellow	
	PROD.	OTHER RECORDS

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN mm DIMENSIONS W/O TOL ARE BASIC

VERSION TYPE: PRIMARY X / SECONDARY

THIRD ANGLE PROJECTION

SHEET 2 OF 16

DWG CONTROL W944

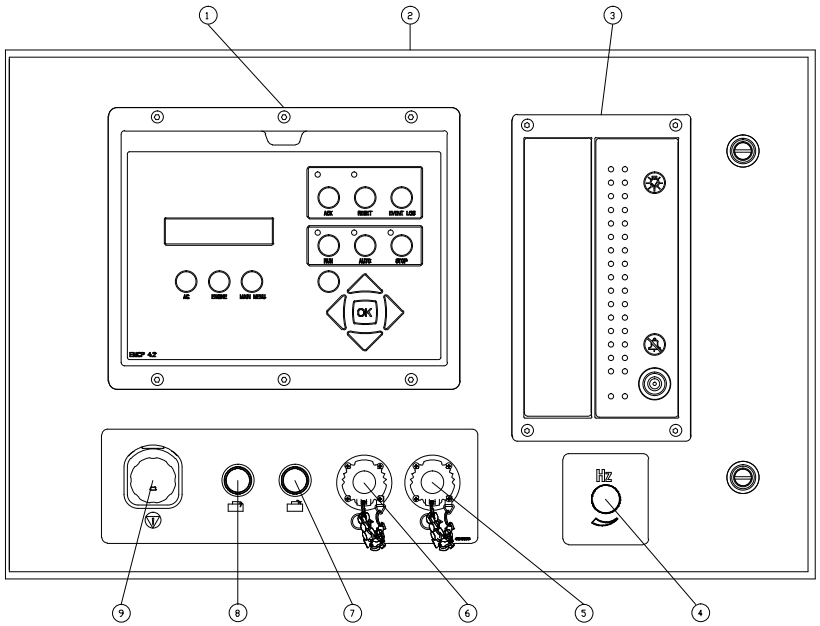
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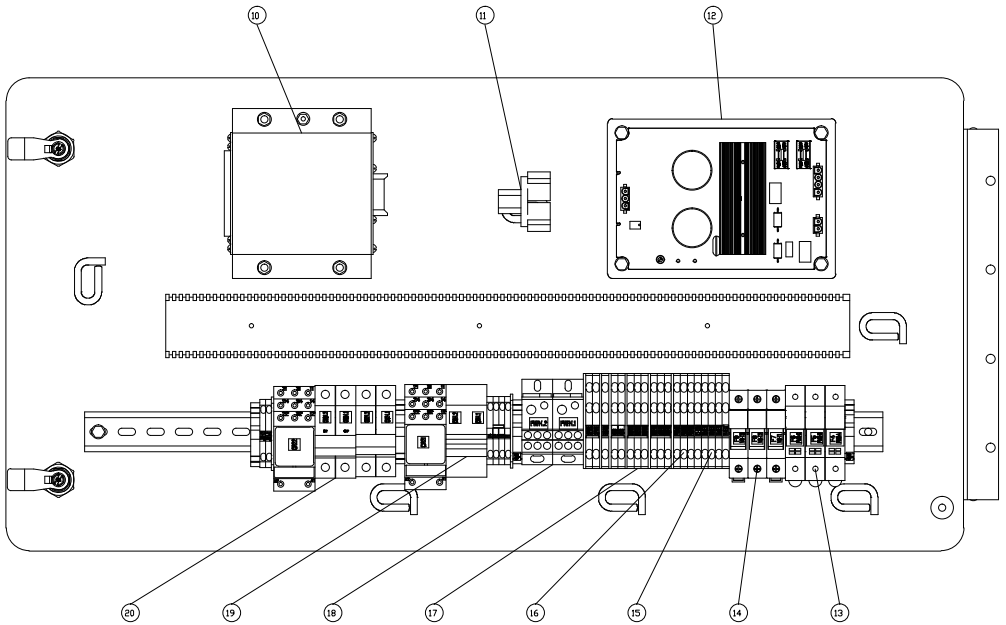
DIAGRAM-WIRING
(MODULAR CONTROLS)

491-3960 VER - CHG 00 D

METRIC 491-3960



FRONT VIEW OF EMCP PANEL



REAR MOUNTED VOLTAGE REGULATOR PANEL

1. EMCP 4
2. EMCP 4 PANEL
3. RS-485 ANNUNCIATOR (OPTIONAL)
4. SPEED/Hz ADJUST (OPTIONAL)
5. SERVICE TOOL CONNECTOR #2 (CAN2: EXPANSION MODULES, RTD AND DID)
6. SERVICE TOOL CONNECTOR #1 (CDL& CAN1: ADEM, EMCP, THERMOCOUPLE, TELEMATICS)
7. CIRCUIT BREAKER CLOSE PUSH BUTTON (RED LIGHT)
8. CIRCUIT BREAKER TRIP PUSH BUTTON (GREEN LIGHT)
9. EMERGENCY STOP PUSH BUTTON
10. RTD MODULE (OPTIONAL)
11. CAN 2 TEE CONNECTOR
12. IVR MODULE (EM10/EM15)
13. PMG FUSING
14. VOLTAGE SENSING FUSING
15. CURRENT SENSING
16. PWM (IVR MODULE CONTROL SIGNAL)
17. 24VDC TERMINAL STRIP
18. CUSTOMER SHORE POWER CONNECTION
19. SPACE HEATER CONTROLS (OPTIONAL)
20. JACKET WATER HEATER CONTROLS (OPTIONAL)

COMPONENT LAYOUT - SHEET 1 OF 2

FOR NOTES SEE SHEET 1

1E0198W	BRAND MARKINGS
1E0013Y	CONFIDENTIALITY
1E0012A	INTERPRETATION
1E0011	INTPR & TOL

Caterpillar: Confidential Yellow

PROD. OTHER RECORDS

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN mm DIMENSIONS W/O TOL ARE BASIC

VERSION TYPE: PRIMARY X, SECONDARY

THIRD ANGLE PROJECTION

SHEET 3 OF 16

DWG CONTROL W983

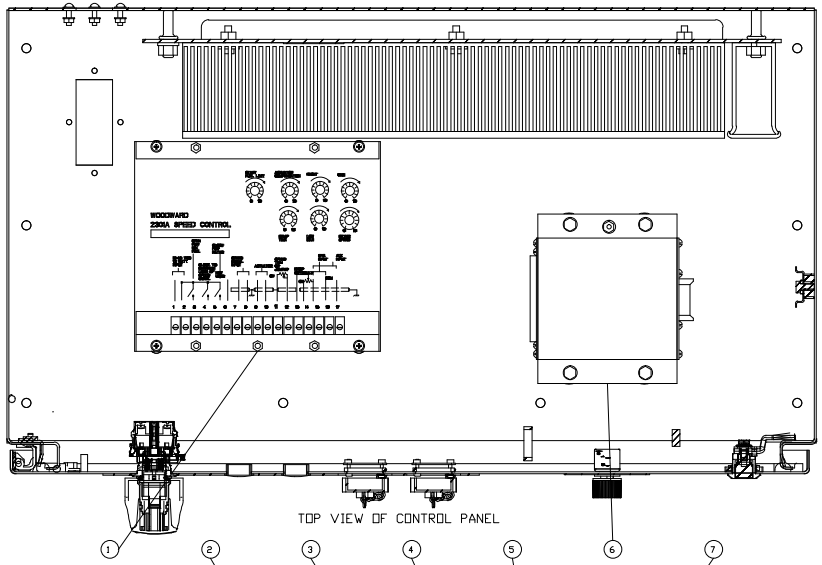
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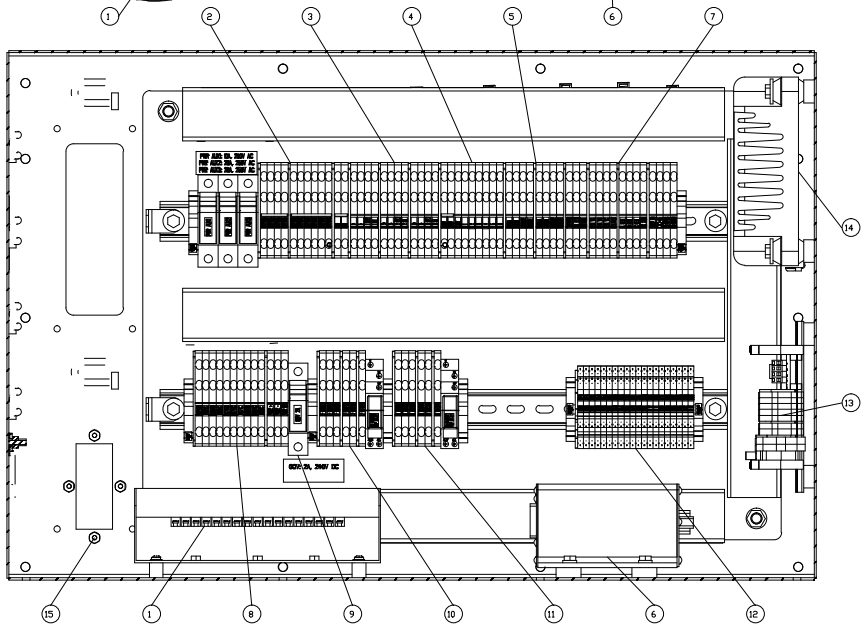
DIAGRAM-WIRING (MODULAR CONTROLS)

491-3960 VER - CHG 00 D

METRIC 491-3960



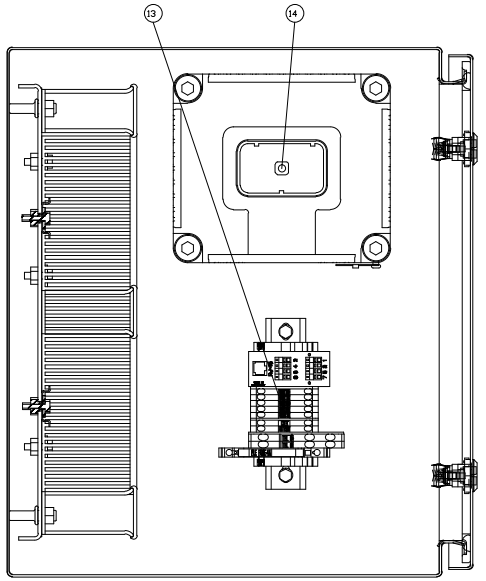
TOP VIEW OF CONTROL PANEL



FRONT VIEW OF EMCP PANEL (DOOR REMOVED)

1. 2301A GOVERNOR (3500 MUI ONLY)
2. 24VDC TERMINAL STRIP
3. ANALOG INPUTS
4. DIGITAL INPUTS
5. RS485 REMOTE ANNUNCIATOR TERMINAL BOARD POINTS
6. DIO MODULE (OPTIONAL)
7. VOLTAGE AND CURRENT SENSING
8. RELAY OUTPUTS
9. 2301A GOVERNOR DC FUSE (3500 MUI ONLY)
10. CIRCUIT BREAKER 1 CONTROLS (OPTIONAL)
11. CIRCUIT BREAKER 2 CONTROLS (OPTIONAL)
12. DIO MODULE TERMINAL STRIP (OPTIONAL)
13. CAT CONNECT TERMINAL STRIP
14. CAT CONNECT CONTROLLER
15. ENGINE INTERFACE HARNESS CONNECTION

LEFT SIDE VIEW OF EMCP PANEL



COMPONENT LAYOUT - SHEET 2 OF 2

FOR NOTES SEE SHEET 1

1E0198W	BRAND MARKINGS
1E0013Y	CONFIDENTIALITY
1E0012A	INTERPRETATION
1E0011	INTPR & TOL

NOTE: Caterpillar: Confidential Yellow

PROD. | OTHER RECORDS

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN mm DIMENSIONS W/O TOL ARE BASIC

VERSION TYPE: PRIMARY X / SECONDARY

THIRD ANGLE PROJECTION

SHEET 4 OF 16

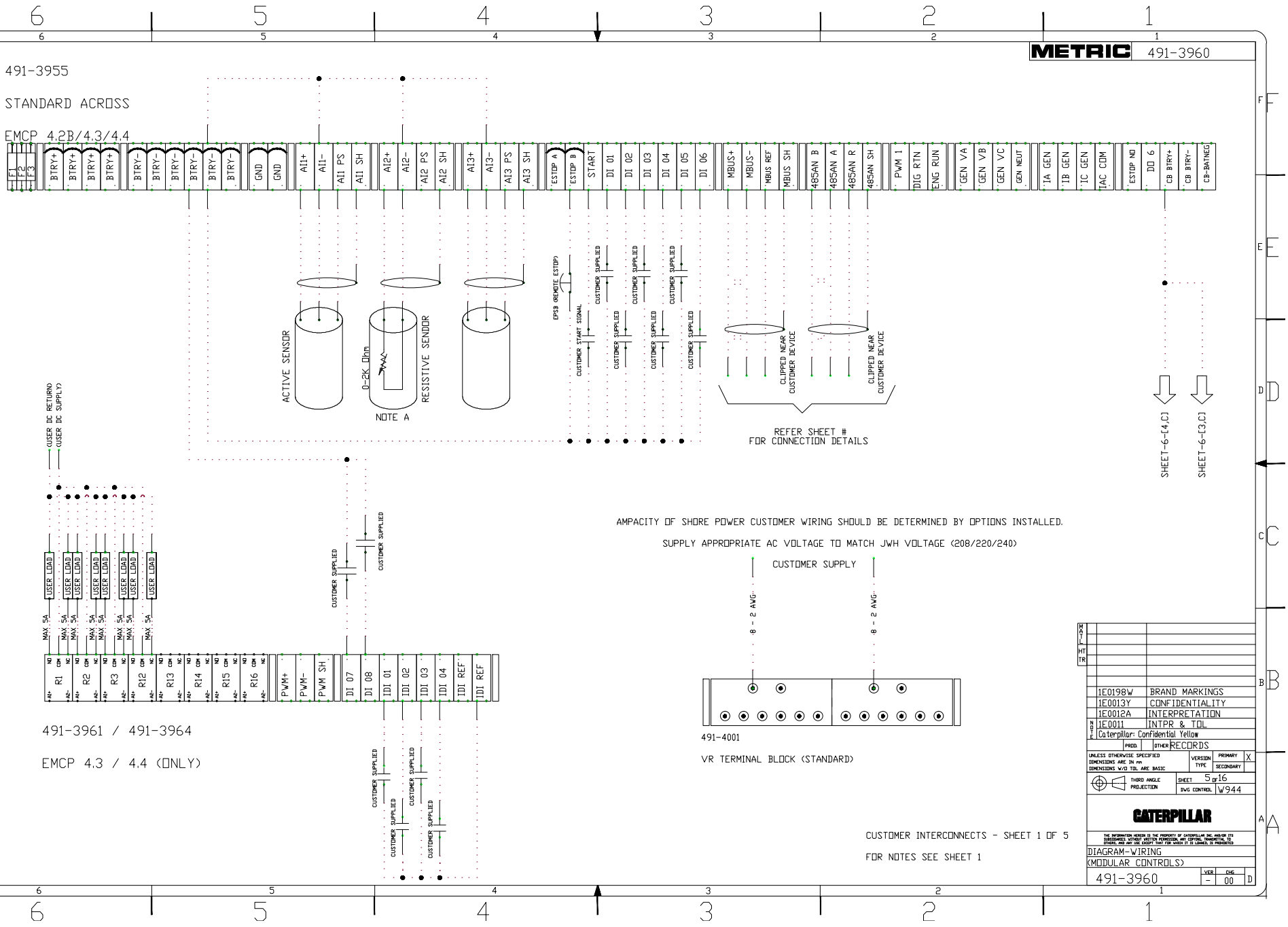
DWG CONTROL W983

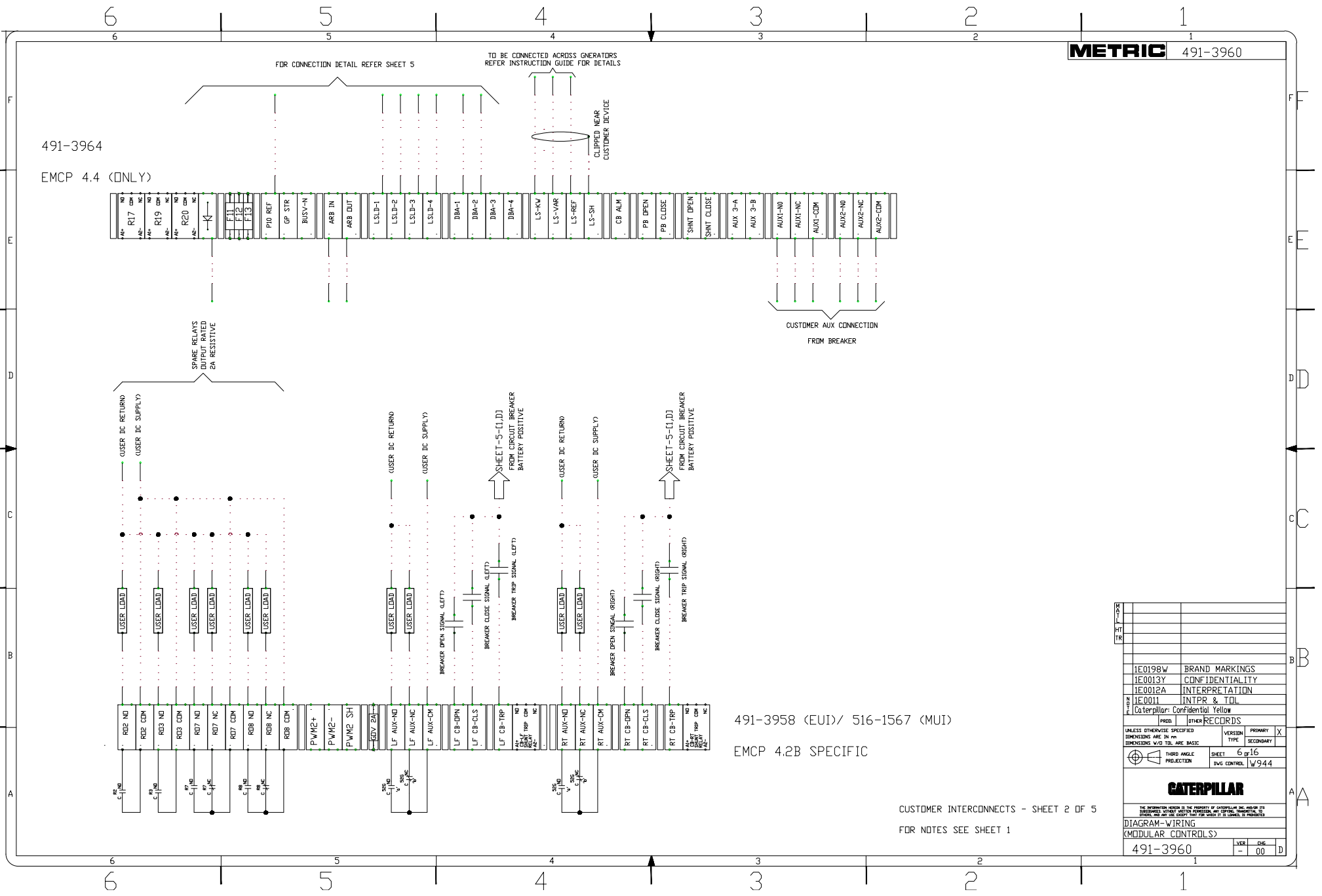
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DIAGRAM-WIRING (MODULAR CONTROLS)

491-3960 VER - CHG 00 D

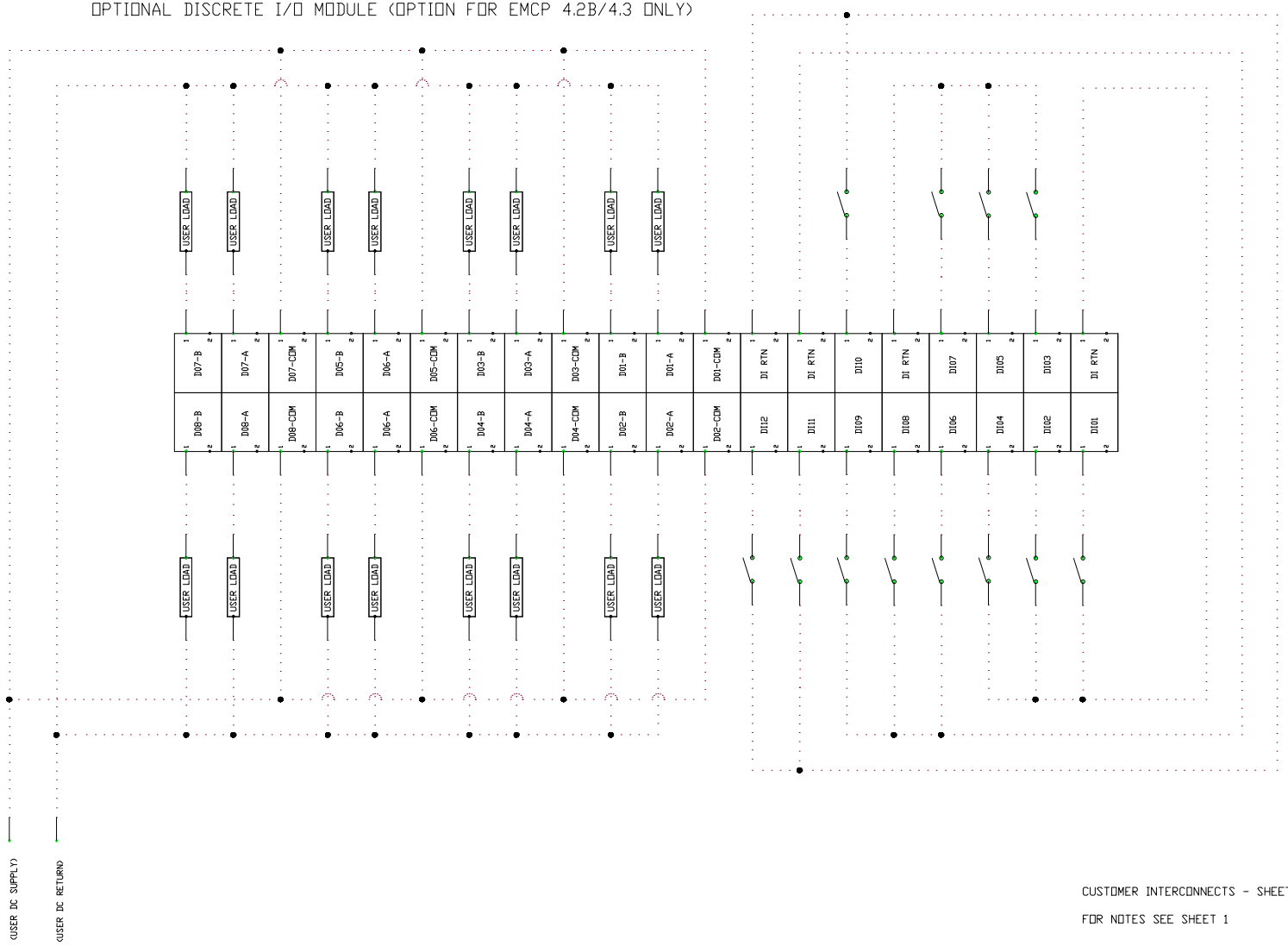

METRIC 491-3960
491-3955
STANDARD ACROSS
EMCP 4.2B/4.3/4.4
F1 F2 F3
BTRY+ BTRY+ BTRY+ BTRY+
BTRY- BTRY- BTRY- BTRY- BTRY- BTRY-
GND GND
AI1+ AI1- AI1 PS AI1 SH
AI2+ AI2- AI2 PS AI2 SH
AI3+ AI3- AI3 PS AI3 SH
ESTOP A ESTOP B START
DI 01 DI 02 DI 03 DI 04 DI 05 DI 06
MBUS+ MBUS- MBUS REF MBUS SH
485AN B 485AN A 485AN R 485AN SH
PWM 1 DIG RTN ENG RUN
GEN VA GEN VB GEN VC GEN NEUT
IA GEN IB GEN IC GEN IAC COM
ESTOP NO DO 6 CB BTRY+ CB BTRY- CB-BATNEG
ACTIVE SENSOR
0-2K Ohm
RESISTIVE SENDOR
NOTE A
EPSD (REMOTE ESTOP)
CUSTOMER START SIGNAL
CUSTOMER SUPPLIED
CLIPPED NEAR CUSTOMER DEVICE
REFER SHEET # FOR CONNECTION DETAILS
SHEET-6-[4,C]
SHEET-6-[3,C]
(USER DC RETURN)
(USER DC SUPPLY)
USER LOAD
MAX 5A
R1 R2 R3 R12 R13 R14 R15 R16
NO COM NC
PWM+ PWM- PWM SH
DI 07 DI 08 IDI 01 IDI 02 IDI 03 IDI 04 IDI REF IDI REF
491-3961 / 491-3964
EMCP 4.3 / 4.4 (ONLY)
AMPACITY OF SHORE POWER CUSTOMER WIRING SHOULD BE DETERMINED BY OPTIONS INSTALLED.
SUPPLY APPROPRIATE AC VOLTAGE TO MATCH JWH VOLTAGE (208/220/240)
CUSTOMER SUPPLY
8 - 2 AWG
491-4001
VR TERMINAL BLOCK (STANDARD)
CUSTOMER INTERCONNECTS - SHEET 1 OF 5
FOR NOTES SEE SHEET 1
1E0198W BRAND MARKINGS
1E0013Y CONFIDENTIALITY
1E0012A INTERPRETATION
1E0011 INTPR & TOL
Caterpillar: Confidential Yellow
PROD OTHER RECORDS
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN mm DIMENSIONS W/O TOL ARE BASIC
VERSION TYPE PRIMARY X SECONDARY
THIRD ANGLE PROJECTION
SHEET 5 OF 16
DWG CONTROL W944
CATERPILLAR
DIAGRAM-WIRING (MODULAR CONTROLS)
491-3960
VER - CHG 00 D


METRIC 491-3960
FOR CONNECTION DETAIL REFER SHEET 5
TO BE CONNECTED ACROSS GNERATORS REFER INSTRUCTION GUIDE FOR DETAILS
CLIPPED NEAR CUSTOMER DEVICE
491-3964
EMCP 4.4 (ONLY)
R17 R19 R20
F11 F12 F13
PIO REF
GP STR
BUSV-N
ARB IN
ARB OUT
LSLD-1
LSLD-2
LSLD-3
LSLD-4
DBA-1
DBA-2
DBA-3
DBA-4
LS-KW
LS-VAR
LS-REF
LS-SH
CB ALM
PB OPEN
PB CLOSE
SHNT OPEN
SHNT CLOSE
AUX 3-A
AUX 3-B
AUX1-NO
AUX1-NC
AUX1-COM
AUX2-NO
AUX2-NC
AUX2-COM
CUSTOMER AUX CONNECTION FROM BREAKER
SPARE RELAYS OUTPUT RATED 2A RESISTIVE
(USER DC RETURN)
(USER DC SUPPLY)
USER LOAD
R02 NO
R02 COM
R03 NO
R03 COM
R07 NO
R07 NC
R07 COM
R08 NO
R08 NC
R08 COM
PWM2+
PWM2-
PWM2 SH
EGV 2A
LF AUX-NO
LF AUX-NC
LF AUX-CM
LF CB-OPN
LF CB-CLS
LF CB-TRP
SHEET-5-(1,D) FROM CIRCUIT BREAKER BATTERY POSITIVE
BREAKER OPEN SIGNAL (LEFT)
BREAKER CLOSE SIGNAL (LEFT)
BREAKER TRIP SIGNAL (LEFT)
RT AUX-NO
RT AUX-NC
RT AUX-CM
RT CB-OPN
RT CB-CLS
RT CB-TRP
BREAKER OPEN SIGNAL (RIGHT)
BREAKER CLOSE SIGNAL (RIGHT)
BREAKER TRIP SIGNAL (RIGHT)
491-3958 (EUI)/ 516-1567 (MUI)
EMCP 4.2B SPECIFIC
CUSTOMER INTERCONNECTS - SHEET 2 OF 5
FOR NOTES SEE SHEET 1
1E0198W BRAND MARKINGS
1E0013Y CONFIDENTIALITY
1E0012A INTERPRETATION
1E0011 INTPR & TOL
Caterpillar: Confidential Yellow
PROD OTHER RECORDS
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN mm DIMENSIONS W/O TOL ARE BASIC
VERSION TYPE PRIMARY X SECONDARY
THIRD ANGLE PROJECTION
SHEET 6 OF 16
DWG CONTROL W944
CATERPILLAR
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DIAGRAM-WIRING (MODULAR CONTROLS)
491-3960
VER - CHG 00 D

METRIC 491-3960

361-1642

OPTIONAL DISCRETE I/O MODULE (OPTION FOR EMCP 4.2B/4.3 ONLY)



CUSTOMER INTERCONNECTS - SHEET 3 OF 5

FOR NOTES SEE SHEET 1

1E0198W	BRAND MARKINGS
1E0013Y	CONFIDENTIALITY
1E0012A	INTERPRETATION
1E0011	INTPR & TOL

Caterpillar: Confidential Yellow

PROD. OTHER RECORDS

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN mm DIMENSIONS W/O TOL ARE BASIC

VERSION TYPE: PRIMARY X / SECONDARY

THIRD ANGLE PROJECTION

SHEET 7 OF 16

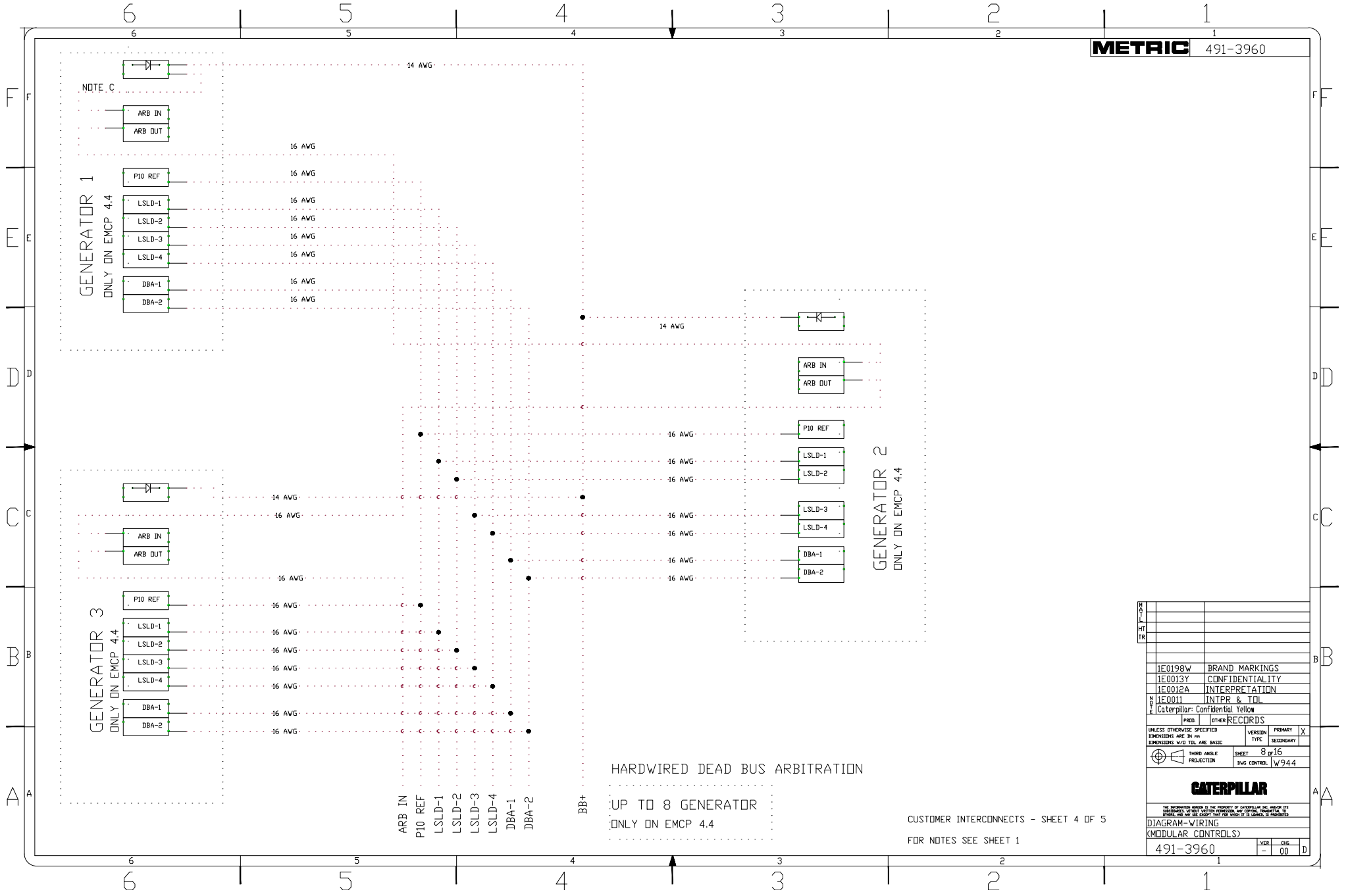
DWG CONTROL W944

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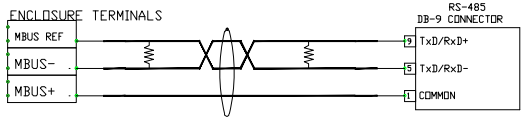
DIAGRAM-WIRING
(MODULAR CONTROLS)

491-3960 VER - CHG 00 D


METRIC 491-3960
NOTE C
ARB IN
ARB OUT
P10 REF
LSLD-1
LSLD-2
LSLD-3
LSLD-4
DBA-1
DBA-2
GENERATOR 1
ONLY ON EMCP 4.4
GENERATOR 2
ONLY ON EMCP 4.4
GENERATOR 3
ONLY ON EMCP 4.4
14 AWG
16 AWG
ARB IN
P10 REF
LSLD-1
LSLD-2
LSLD-3
LSLD-4
DBA-1
DBA-2
BB+
HARDWIRED DEAD BUS ARBITRATION
UP TO 8 GENERATOR
ONLY ON EMCP 4.4
CUSTOMER INTERCONNECTS - SHEET 4 OF 5
FOR NOTES SEE SHEET 1
1E0198W BRAND MARKINGS
1E0013Y CONFIDENTIALITY
1E0012A INTERPRETATION
1E0011 INTPR & TDL
Caterpillar: Confidential Yellow
PROD. OTHER RECORDS
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN mm DIMENSIONS W/O TOL ARE BASIC
VERSION TYPE PRIMARY X SECONDARY
THIRD ANGLE PROJECTION
SHEET 8 OF 16
DWG CONTROL W944
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DIAGRAM-WIRING
(MODULAR CONTROLS)
491-3960
VER - CHG 00 D

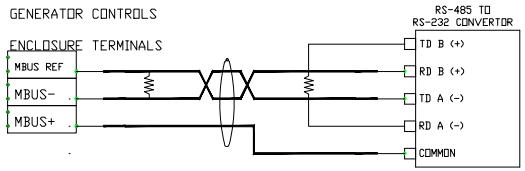
OPTIONAL MODBUS

POSSIBLE WIRING CONFIGURATION WITH RS485 DEVICE (TYPICAL)
GENERATOR CONTROLS

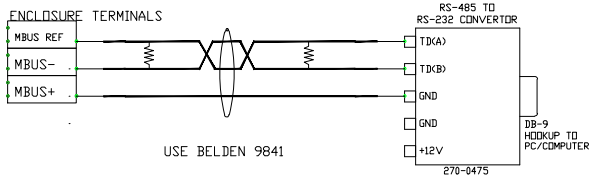


POSSIBLE WIRING CONFIGURATION WITH RS485 TO RS-232 CONVERTOR (TYPICAL)

GENERATOR CONTROLS



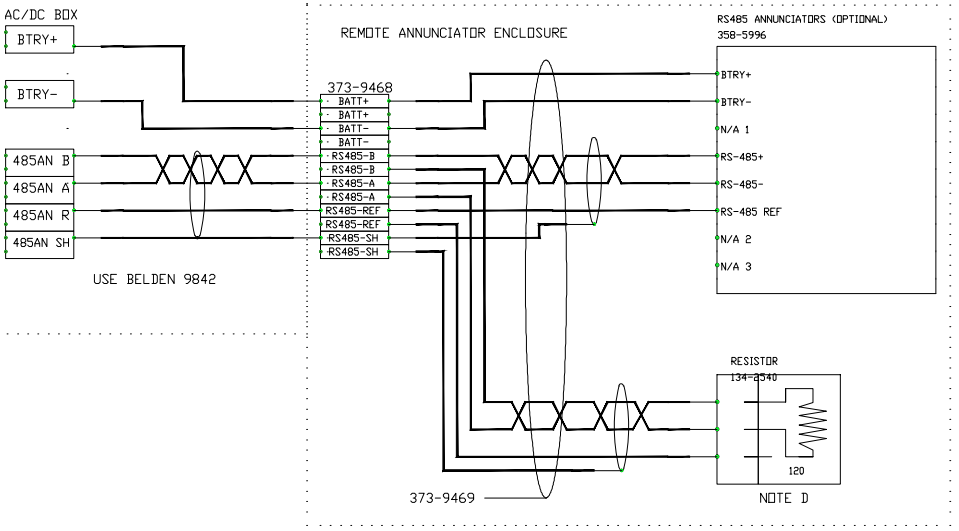
GENERATOR CONTROLS



USE BELDEN 9841

FOR MULTIPOINT NETWORK TERMINATE WITH 120 Ohm RESISTOR AT THE ENDS OF THE NETWORK

OPTIONAL REMOTE RS485 ANNUNCIATOR



CUSTOMER INTERCONNECTS - SHEET 5 OF 5

FOR NOTES SEE SHEET 1

1E0198W	BRAND MARKINGS
1E0013Y	CONFIDENTIALITY
1E0012A	INTERPRETATION
1E0011	INTPR & TOL

Caterpillar: Confidential Yellow

PROD | OTHER RECORDS

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN mm DIMENSIONS W/O TOL ARE BASIC

VERSION TYPE: PRIMARY X | SECONDARY

THIRD ANGLE PROJECTION

SHEET 9 OF 16

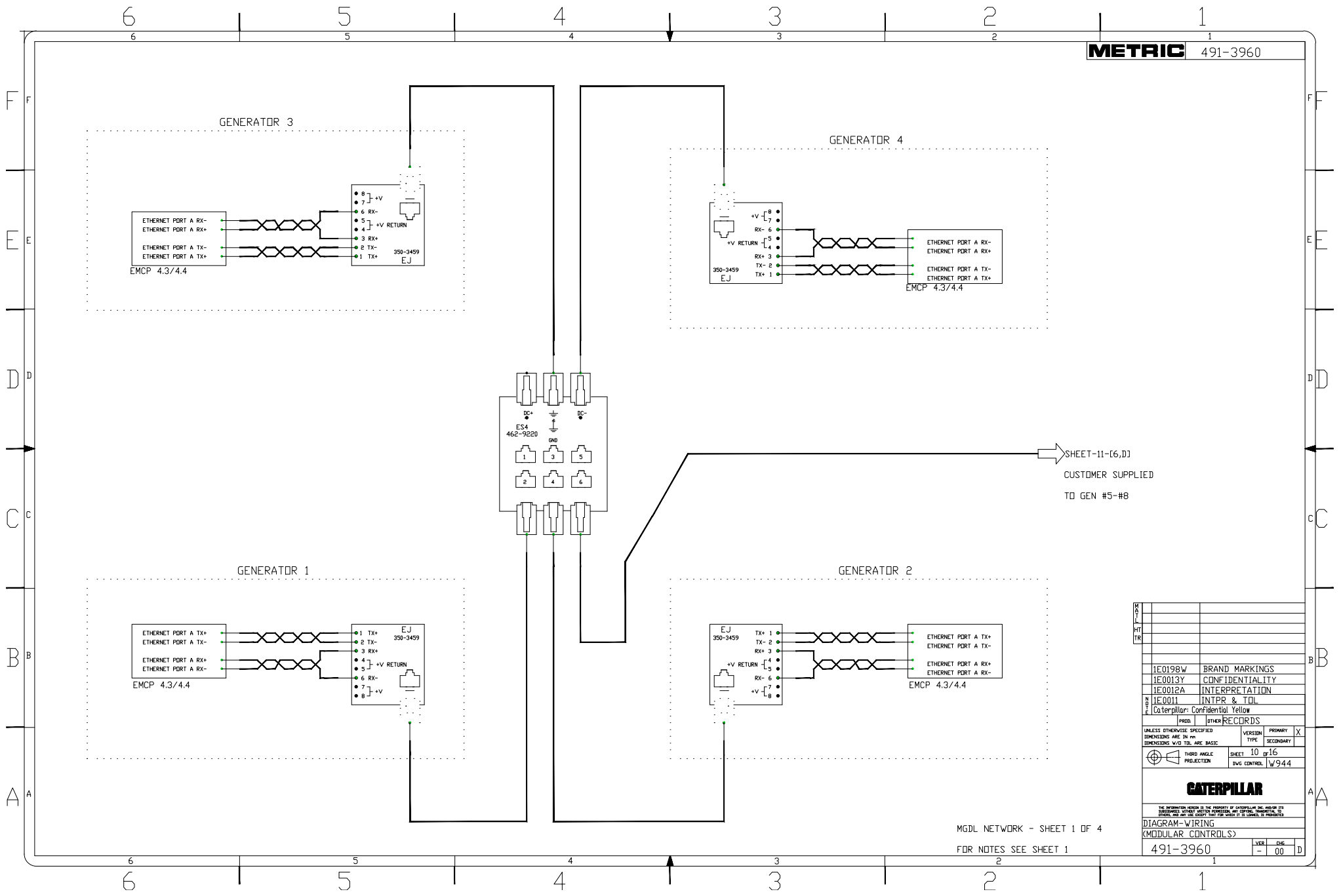
DWG CONTROL W944

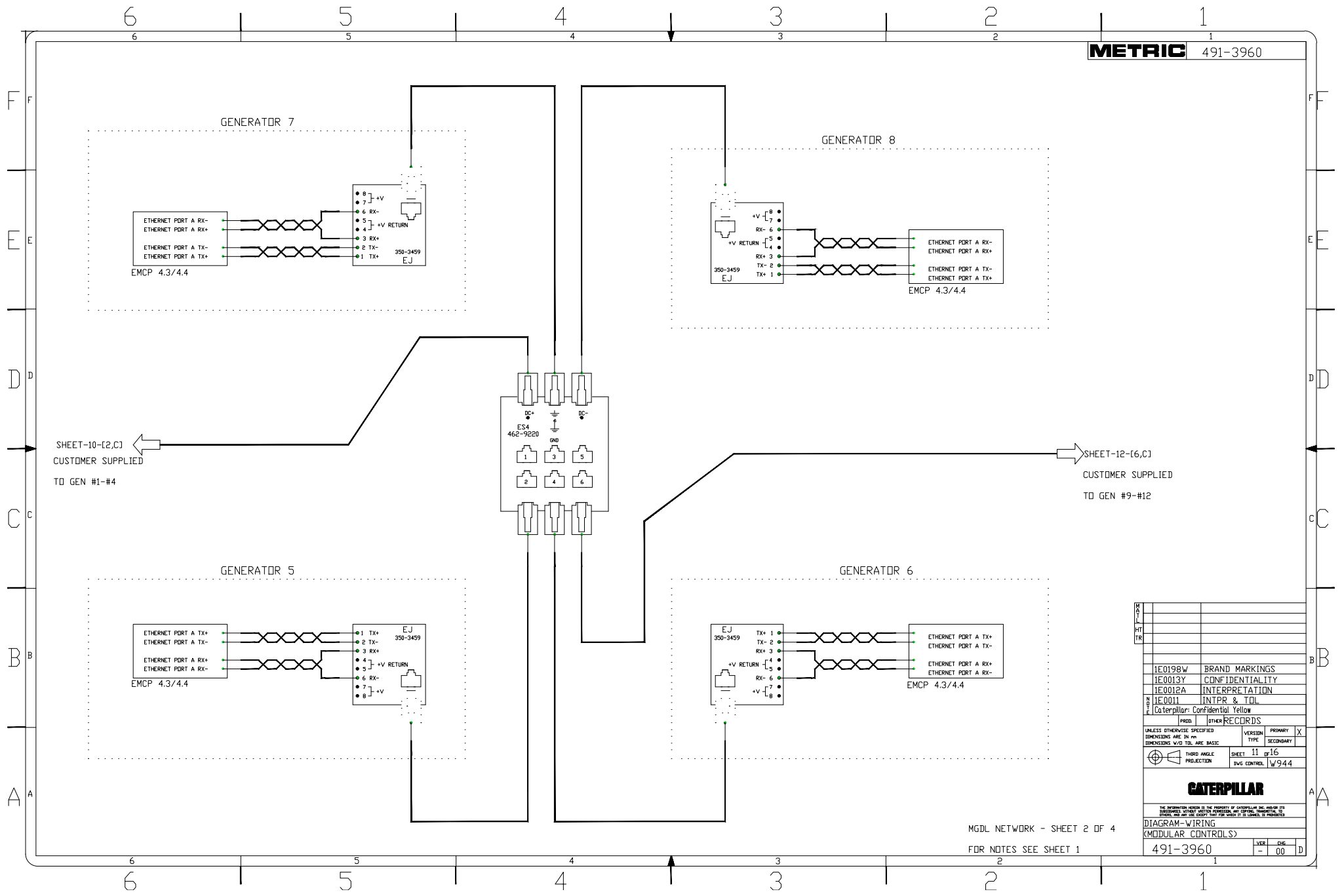
CATERPILLAR

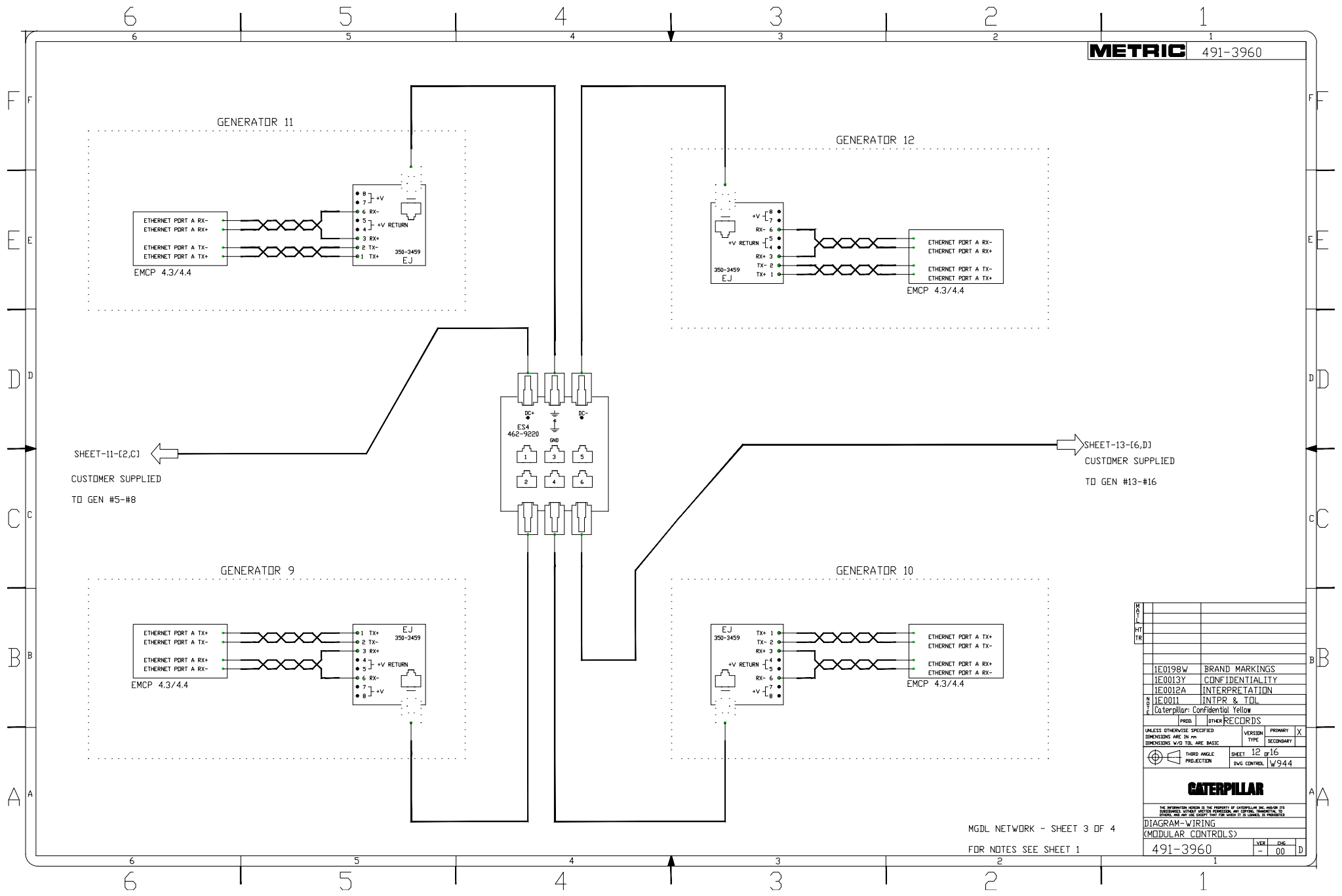
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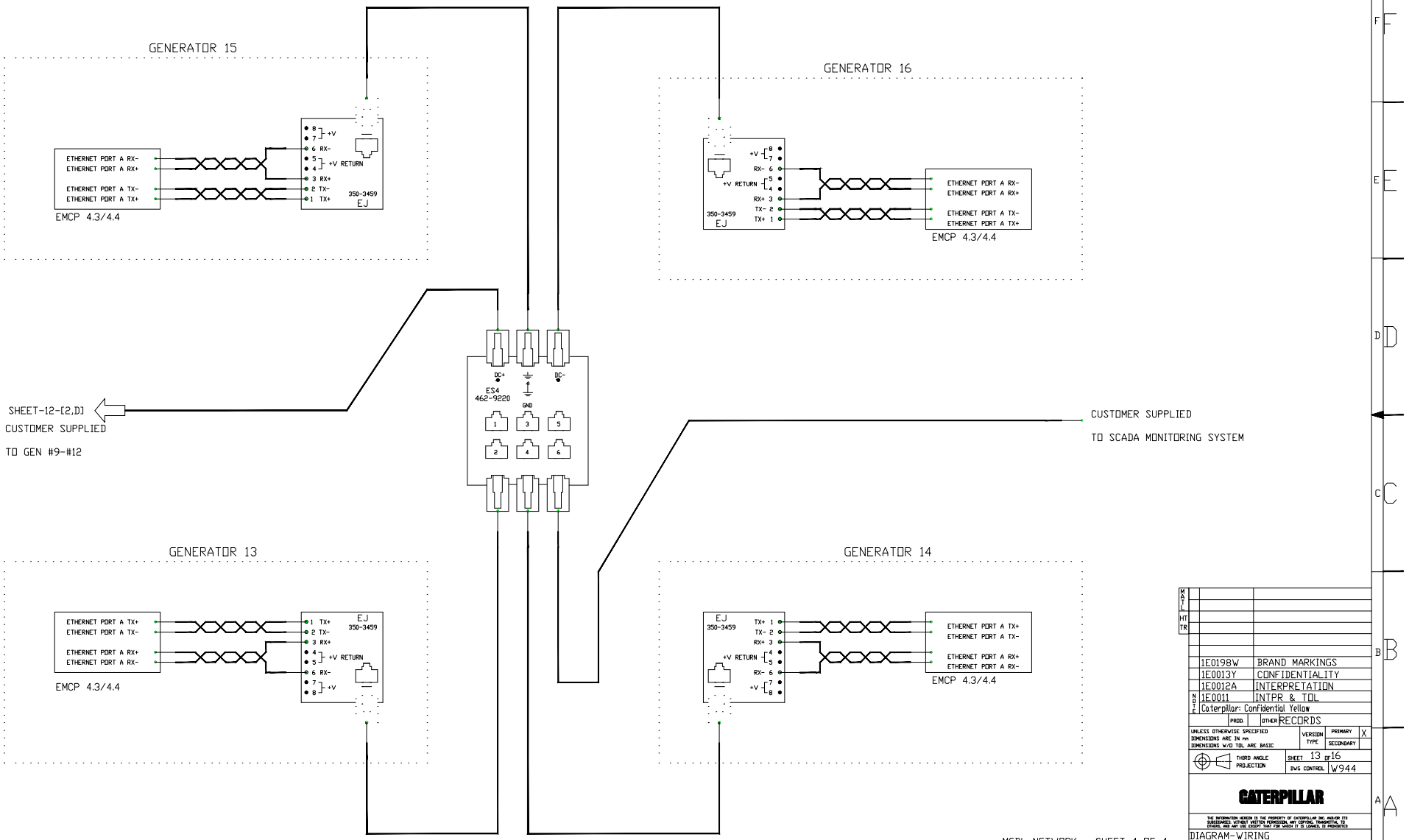
DIAGRAM-WIRING
(MODULAR CONTROLS)

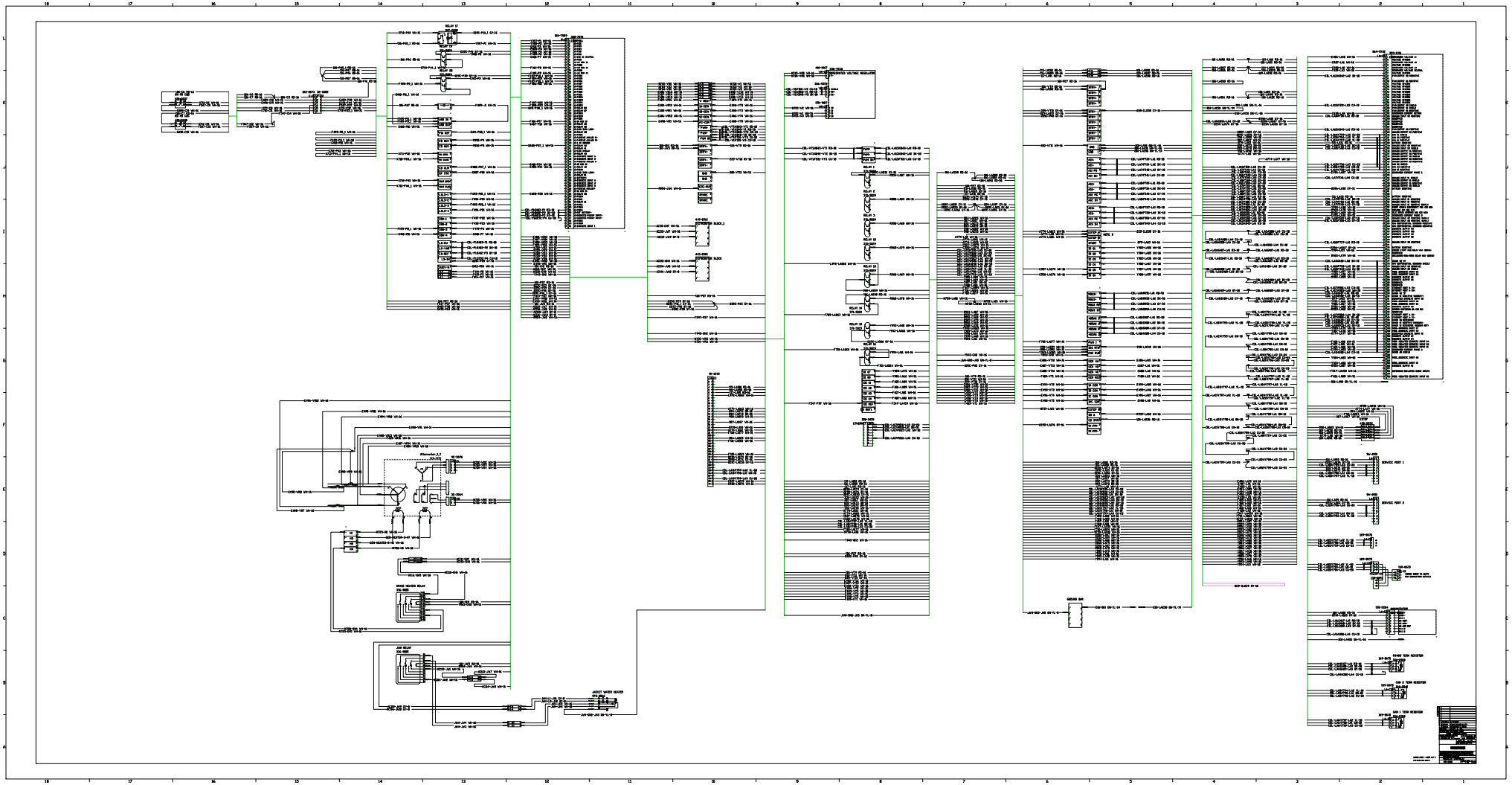
491-3960 VER - CHG 00 D

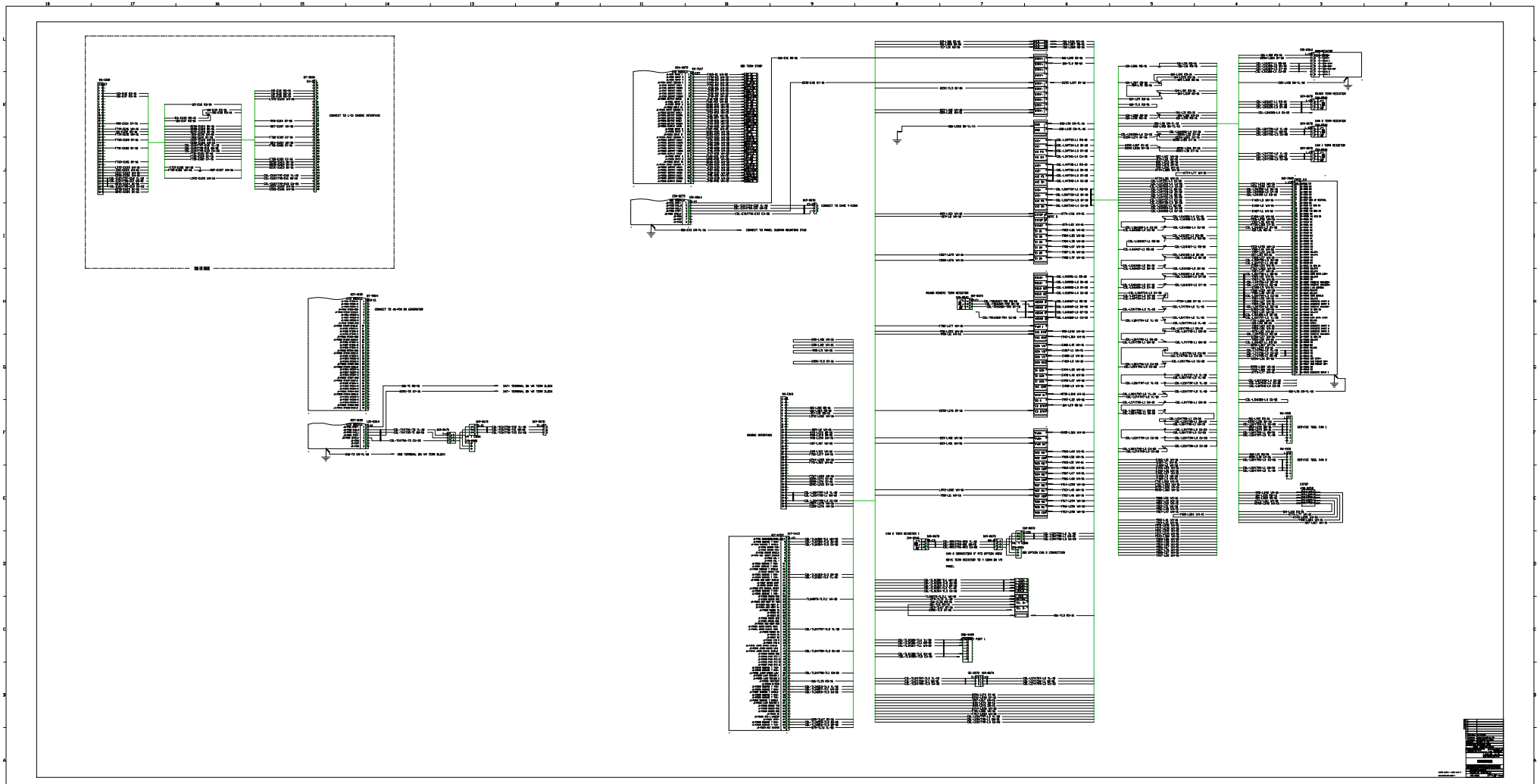

METRIC 491-3960
GENERATOR 3
ETHERNET PORT A RX-
ETHERNET PORT A RX+
ETHERNET PORT A TX-
ETHERNET PORT A TX+
EMCP 4.3/4.4
+V
+V RETURN
RX-
RX+
TX-
TX+
350-3459
EJ
GENERATOR 4
EMCP 4.3/4.4
ES4
462-9220
DC+
DC-
GND
SHEET-11-[6,D]
CUSTOMER SUPPLIED
TO GEN #5-#8
GENERATOR 1
GENERATOR 2
MGDL NETWORK - SHEET 1 OF 4
FOR NOTES SEE SHEET 1
1E0198W BRAND MARKINGS
1E0013Y CONFIDENTIALITY
1E0012A INTERPRETATION
1E0011 INTPR & TDL
Caterpillar: Confidential Yellow
PROD
OTHER RECORDS
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN mm DIMENSIONS W/O TOL ARE BASIC
VERSION TYPE PRIMARY X SECONDARY
THIRD ANGLE PROJECTION
SHEET 10 OF 16
DWG CONTROL W944
CATERPILLAR
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DIAGRAM-WIRING
(MODULAR CONTROLS)
491-3960
VER - CHG 00 D


METRIC 491-3960
GENERATOR 7
ETHERNET PORT A RX-
ETHERNET PORT A RX+
ETHERNET PORT A TX-
ETHERNET PORT A TX+
EMCP 4.3/4.4
8 +V
7
6 RX-
5 +V RETURN
4
3 RX+
2 TX-
1 TX+
350-3459
EJ
GENERATOR 8
+V RETURN
RX- 6
RX+ 3
TX- 2
TX+ 1
350-3459
EJ
EMCP 4.3/4.4
DC+
DC-
ES4
462-9220
GND
1
3
5
2
4
6
SHEET-10-[2,C]
CUSTOMER SUPPLIED
TO GEN #1-#4
SHEET-12-[6,C]
CUSTOMER SUPPLIED
TO GEN #9-#12
GENERATOR 5
ETHERNET PORT A TX+
ETHERNET PORT A TX-
ETHERNET PORT A RX+
ETHERNET PORT A RX-
EMCP 4.3/4.4
1 TX+
2 TX-
3 RX+
4
5 +V RETURN
6 RX-
7
8 +V
EJ
350-3459
GENERATOR 6
EJ
350-3459
TX+ 1
TX- 2
RX+ 3
+V RETURN
RX- 6
+V
EMCP 4.3/4.4
MGDL NETWORK - SHEET 2 OF 4
FOR NOTES SEE SHEET 1
1E0198W BRAND MARKINGS
1E0013Y CONFIDENTIALITY
1E0012A INTERPRETATION
1E0011 INTPR & TDL
Caterpillar: Confidential Yellow
PROD. OTHER RECORDS
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN mm DIMENSIONS W/O TOL ARE BASIC
VERSION TYPE PRIMARY X SECONDARY
THIRD ANGLE PROJECTION
SHEET 11 OF 16
DWG CONTROL W944
CATERPILLAR
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DIAGRAM-WIRING
(MODULAR CONTROLS)
491-3960
VER - CHG 00 D


METRIC 491-3960
GENERATOR 11
ETHERNET PORT A RX-
ETHERNET PORT A RX+
ETHERNET PORT A TX-
ETHERNET PORT A TX+
+V
+V RETURN
RX-
RX+
TX-
TX+
350-3459
EJ
EMCP 4.3/4.4
GENERATOR 12
EMCP 4.3/4.4
DC+
DC-
GND
ES4
462-9220
SHEET-11-[2,C]
CUSTOMER SUPPLIED
TO GEN #5-#8
SHEET-13-[6,D]
CUSTOMER SUPPLIED
TO GEN #13-#16
GENERATOR 9
EMCP 4.3/4.4
GENERATOR 10
EMCP 4.3/4.4
MGDL NETWORK - SHEET 3 OF 4
FOR NOTES SEE SHEET 1
1E0198W BRAND MARKINGS
1E0013Y CONFIDENTIALITY
1E0012A INTERPRETATION
1E0011 INTPR & TOL
Caterpillar: Confidential Yellow
PROD. OTHER RECORDS
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN mm DIMENSIONS W/O TOL ARE BASIC
VERSION TYPE PRIMARY SECONDARY
THIRD ANGLE PROJECTION
SHEET 12 OF 16
DWG CONTROL W944
CATERPILLAR
DIAGRAM-WIRING
(MODULAR CONTROLS)
491-3960
VER - CHG 00 D


METRIC 491-3960
GENERATOR 15
ETHERNET PORT A RX-
ETHERNET PORT A RX+
ETHERNET PORT A TX-
ETHERNET PORT A TX+
EMCP 4.3/4.4
+V
+V RETURN
RX-
RX+
TX-
TX+
350-3459
EJ
GENERATOR 16
EMCP 4.3/4.4
SHEET-12-[2,D]
CUSTOMER SUPPLIED
TO GEN #9-#12
DC+
DC-
GND
ES4
462-9220
CUSTOMER SUPPLIED
TO SCADA MONITORING SYSTEM
GENERATOR 13
GENERATOR 14
MGDL NETWORK - SHEET 4 OF 4
FOR NOTES SEE SHEET 1
1E0198W BRAND MARKINGS
1E0013Y CONFIDENTIALITY
1E0012A INTERPRETATION
1E0011 INTPR & TDL
Caterpillar: Confidential Yellow
PROD. OTHER RECORDS
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN mm DIMENSIONS W/O TOL ARE BASIC
VERSION TYPE PRIMARY SECONDARY
THIRD ANGLE PROJECTION
SHEET 13 OF 16
DWG CONTROL W944
CATERPILLAR
DIAGRAM-WIRING (MODULAR CONTROLS)
491-3960
VER - CHG 00 D







PERFORMANCE DATA[EM1787]

November 20, 2020

Performance Number: EM1787 **Change Level: 02**

SALES MODEL:	3512C	**COMBUSTION:**	DIRECT INJECTION
BRAND:	CAT	**ENGINE SPEED (RPM):**	1,800
ENGINE POWER (BHP):	2,584	**HERTZ:**	60
GEN POWER WITH FAN (EKW):	1,750.0	**FAN POWER (HP):**	114.0
COMPRESSION RATIO:	14.7	**ASPIRATION:**	TA
RATING LEVEL:	STANDBY	**AFTERCOOLER TYPE:**	ATAAC
PUMP QUANTITY:	1	**AFTERCOOLER CIRCUIT TYPE:**	JW+OC, ATAAC
FUEL TYPE:	DIESEL	**INLET MANIFOLD AIR TEMP (F):**	122
MANIFOLD TYPE:	DRY	**JACKET WATER TEMP (F):**	210.2
GOVERNOR TYPE:	ADEM3	**TURBO CONFIGURATION:**	PARALLEL
ELECTRONICS TYPE:	ADEM3	**TURBO QUANTITY:**	4
CAMSHAFT TYPE:	STANDARD	**TURBOCHARGER MODEL:**	GTB5518BN-52T-1.12
IGNITION TYPE:	CI	**CERTIFICATION YEAR:**	2016
INJECTOR TYPE:	EUI	**CRANKCASE BLOWBY RATE (FT3/HR):**	2,581.2
FUEL INJECTOR:	3920221	**FUEL RATE (RATED RPM) NO LOAD (GAL/HR):**	8.3
UNIT INJECTOR TIMING (IN):	64.34	**PISTON SPD @ RATED ENG SPD (FT/MIN):**	2,539.4
REF EXH STACK DIAMETER (IN):	10		
MAX OPERATING ALTITUDE (FT):	2,789		

INDUSTRY	SUBINDUSTRY	APPLICATION
ELECTRIC POWER	STANDARD	PACKAGED GENSET
OIL AND GAS	LAND PRODUCTION	PACKAGED GENSET

General Performance Data

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	BRAKE MEAN EFF PRES (BMEP)	BRAKE SPEC FUEL CONSUMPTN (BSFC)	VOL FUEL CONSUMPTN (VFC)	INLET MFLD PRES	INLET MFLD TEMP	EXH MFLD TEMP	EXH MFLD PRES	ENGINE OUTLET TEMP
EKW	%	BHP	PSI	LB/BHP-HR	GAL/HR	IN-HG	DEG F	DEG F	IN-HG	DEG F
1,750.0	100	2,584	318	0.334	121.8	77.0	121.0	1,175.8	59.3	848.4
1,575.0	90	2,337	288	0.328	108.2	67.5	113.7	1,114.3	50.7	818.1
1,400.0	80	2,090	257	0.333	98.1	60.7	111.4	1,092.4	45.4	811.3
1,312.5	75	1,967	242	0.336	93.0	56.7	111.7	1,087.7	42.4	814.6
1,225.0	70	1,843	227	0.338	87.9	52.4	111.7	1,083.0	39.2	818.8
1,050.0	60	1,596	197	0.345	77.7	44.3	105.9	1,058.2	33.5	815.5
875.0	50	1,349	166	0.359	68.2	37.8	103.9	1,037.6	29.0	814.7
700.0	40	1,102	136	0.375	58.3	30.6	102.2	1,007.7	24.0	809.4
525.0	30	855	105	0.395	47.6	22.5	101.6	962.4	18.6	795.4
437.5	25	732	90	0.405	41.8	18.1	100.5	923.2	15.8	773.8
350.0	20	608	75	0.415	35.6	13.6	98.0	856.7	13.1	725.1
175.0	10	361	44	0.459	23.4	6.6	93.3	657.2	8.5	584.4

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	COMPRESSOR OUTLET PRES	COMPRESSOR OUTLET TEMP	WET INLET AIR VOL FLOW RATE	ENGINE OUTLET WET EXH GAS VOL FLOW RATE	WET INLET AIR MASS FLOW RATE	WET EXH GAS MASS FLOW RATE	WET EXH VOL FLOW RATE (32 DEG F AND 29.98 IN HG)	DRY EXH VOL FLOW RATE (32 DEG F AND 29.98 IN HG)
EKW	%	BHP	IN-HG	DEG F	CFM	CFM	LB/HR	LB/HR	FT3/MIN	FT3/MIN
1,750.0	100	2,584	82	431.5	5,708.8	14,299.5	24,664.1	25,528.8	5,374.9	4,942.5
1,575.0	90	2,337	72	384.4	5,329.7	12,802.2	22,634.3	23,401.8	4,926.0	4,539.5
1,400.0	80	2,090	65	361.8	4,977.4	11,856.5	21,095.6	21,791.5	4,586.7	4,233.1
1,312.5	75	1,967	61	351.5	4,730.4	11,327.5	20,108.8	20,768.8	4,370.6	4,036.2
1,225.0	70	1,843	56	340.5	4,469.4	10,773.6	19,062.1	19,685.8	4,143.3	3,828.6
1,050.0	60	1,596	48	310.4	4,060.6	9,715.3	17,236.6	17,787.8	3,745.9	3,466.7
875.0	50	1,349	41	283.9	3,718.9	8,836.9	15,714.6	16,198.6	3,409.3	3,162.4
700.0	40	1,102	33	249.4	3,342.6	7,825.5	13,990.0	14,403.8	3,031.8	2,816.9
525.0	30	855	25	214.0	2,863.7	6,632.4	11,981.6	12,320.2	2,598.2	2,420.4
437.5	25	732	20	195.1	2,608.7	5,926.7	10,940.9	11,237.8	2,362.4	2,205.2
350.0	20	608	16	174.0	2,352.0	5,124.7	9,892.8	10,146.1	2,126.8	1,990.7
175.0	10	361	8	133.4	1,967.8	3,754.6	8,233.2	8,398.3	1,768.1	1,674.1

Heat Rejection Data

PERFORMANCE DATA[EM1787]

November 20, 2020

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	REJECTION TO JACKET WATER	REJECTION TO ATMOSPHERE	REJECTION TO EXH	EXHAUST RECOVERY TO 350F	FROM OIL COOLER	FROM AFTERCOOLER	WORK ENERGY	LOW HEAT VALUE ENERGY	HIGH HEAT VALUE ENERGY
EKW	%	BHP	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN
1,750.0	100	2,584	33,968	7,341	99,777	53,677	14,107	31,457	109,593	264,853	282,135
1,575.0	90	2,337	32,065	6,764	87,199	46,069	12,528	25,317	99,116	235,211	250,559
1,400.0	80	2,090	29,540	6,560	80,772	42,211	11,365	21,679	88,641	213,375	227,298
1,312.5	75	1,967	27,801	6,507	77,997	40,524	10,776	19,782	83,403	202,321	215,522
1,225.0	70	1,843	26,083	6,453	75,105	38,764	10,186	17,898	78,165	191,236	203,714
1,050.0	60	1,596	24,224	6,210	67,344	34,747	9,003	14,438	67,689	169,032	180,061
875.0	50	1,349	21,892	6,017	61,151	31,548	7,899	11,636	57,213	148,309	157,986
700.0	40	1,102	21,273	5,838	52,785	27,688	6,755	8,361	46,737	126,831	135,106
525.0	30	855	18,808	5,483	44,114	22,905	5,518	5,392	36,261	103,591	110,350
437.5	25	732	17,424	5,180	39,077	19,830	4,843	4,140	31,024	90,930	96,864
350.0	20	608	16,617	4,814	32,185	15,766	4,122	3,017	25,786	77,386	82,436
175.0	10	361	14,061	3,965	19,447	8,030	2,707	1,311	15,310	50,815	54,131

Sound Data

SOUND PRESSURE DATA FOR THIS RATING CAN BE FOUND IN PERFORMANCE NUMBER - DM8779.

Emissions Data

RATED SPEED POTENTIAL SITE VARIATION: 1800 RPM

GENSET POWER WITH FAN		EKW	1,750.0	1,312.5	875.0	437.5	175.0
PERCENT LOAD		%	100	75	50	25	10
ENGINE POWER		BHP	2,584	1,967	1,349	732	361
TOTAL NOX (AS NO2)		G/HR	15,917	10,494	5,434	2,339	2,030
TOTAL CO		G/HR	2,411	2,668	1,954	1,483	1,675
TOTAL HC		G/HR	406	334	309	319	386
PART MATTER		G/HR	187.3	188.7	209.2	123.5	105.3
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	2,869.0	2,484.4	1,737.4	1,263.3	2,116.8
TOTAL CO	(CORR 5% O2)	MG/NM3	435.9	631.7	628.8	808.2	1,734.4
TOTAL HC	(CORR 5% O2)	MG/NM3	63.4	68.3	87.1	148.5	344.6
PART MATTER	(CORR 5% O2)	MG/NM3	28.4	37.8	58.3	53.3	96.5
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,398	1,210	846	615	1,031
TOTAL CO	(CORR 5% O2)	PPM	349	505	503	647	1,388
TOTAL HC	(CORR 5% O2)	PPM	118	128	162	277	643
TOTAL NOX (AS NO2)		G/HP-HR	6.18	5.34	4.03	3.20	5.62
TOTAL CO		G/HP-HR	0.94	1.36	1.45	2.03	4.64
TOTAL HC		G/HP-HR	0.16	0.17	0.23	0.44	1.07
PART MATTER		G/HP-HR	0.07	0.10	0.16	0.17	0.29
TOTAL NOX (AS NO2)		LB/HR	35.09	23.14	11.98	5.16	4.47
TOTAL CO		LB/HR	5.31	5.88	4.31	3.27	3.69
TOTAL HC		LB/HR	0.89	0.74	0.68	0.70	0.85
PART MATTER		LB/HR	0.41	0.42	0.46	0.27	0.23

RATED SPEED NOMINAL DATA: 1800 RPM

GENSET POWER WITH FAN		EKW	1,750.0	1,312.5	875.0	437.5	175.0
PERCENT LOAD		%	100	75	50	25	10
ENGINE POWER		BHP	2,584	1,967	1,349	732	361
TOTAL NOX (AS NO2)		G/HR	13,264	8,745	4,528	1,949	1,691
TOTAL CO		G/HR	1,339	1,482	1,086	824	931
TOTAL HC		G/HR	305	251	233	240	290
TOTAL CO2		KG/HR	1,284	980	714	432	245
PART MATTER		G/HR	133.8	134.8	149.4	88.2	75.2
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	2,390.9	2,070.4	1,447.9	1,052.8	1,764.0
TOTAL CO	(CORR 5% O2)	MG/NM3	242.2	350.9	349.3	449.0	963.6
TOTAL HC	(CORR 5% O2)	MG/NM3	47.7	51.4	65.5	111.7	259.1
PART MATTER	(CORR 5% O2)	MG/NM3	20.3	27.0	41.6	38.0	68.9
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,165	1,008	705	513	859
TOTAL CO	(CORR 5% O2)	PPM	194	281	279	359	771
TOTAL HC	(CORR 5% O2)	PPM	89	96	122	208	484
TOTAL NOX (AS NO2)		G/HP-HR	5.15	4.45	3.36	2.67	4.68

TOTAL CO	G/HP-HR	0.52	0.75	0.81	1.13	2.58
TOTAL HC	G/HP-HR	0.12	0.13	0.17	0.33	0.80
PART MATTER	G/HP-HR	0.05	0.07	0.11	0.12	0.21
TOTAL NOX (AS NO2)	LB/HR	29.24	19.28	9.98	4.30	3.73
TOTAL CO	LB/HR	2.95	3.27	2.39	1.82	2.05
TOTAL HC	LB/HR	0.67	0.55	0.51	0.53	0.64
TOTAL CO2	LB/HR	2,830	2,161	1,575	953	540
PART MATTER	LB/HR	0.30	0.30	0.33	0.19	0.17
OXYGEN IN EXH	%	10.0	10.7	11.5	12.7	15.0
DRY SMOKE OPACITY	%	2.1	2.8	3.6	2.9	3.0
BOSCH SMOKE NUMBER		0.73	1.02	1.31	1.05	1.10

Regulatory Information

EPA EMERGENCY STATIONARY		**2011 - ----**		
GASEOUS EMISSIONS DATA MEASUREMENTS PROVIDED TO THE EPA ARE CONSISTENT WITH THOSE DESCRIBED IN EPA 40 CFR PART 60 SUBPART IIII AND ISO 8178 FOR MEASURING HC, CO, PM, AND NOX. THE "MAX LIMITS" SHOWN BELOW ARE WEIGHTED CYCLE AVERAGES AND ARE IN COMPLIANCE WITH THE EMERGENCY STATIONARY REGULATIONS.				
Locality	**Agency**	**Regulation**	**Tier/Stage**	**Max Limits - G/BKW - HR**
U.S. (INCL CALIF)	EPA	STATIONARY	EMERGENCY STATIONARY	CO: 3.5 NOx + HC: 6.4 PM: 0.20

Altitude Derate Data

ALTITUDE CORRECTED POWER CAPABILITY (BHP)

AMBIENT OPERATING TEMP (F)	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**	**110**	**120**	**130**	**140**	**NORMAL**
ALTITUDE (FT)													
0	2,584	2,584	2,584	2,584	2,584	2,584	2,584	2,584	2,584	2,584	2,584	2,532	2,584
1,000	2,584	2,584	2,584	2,584	2,584	2,584	2,584	2,584	2,584	2,554	2,510	2,469	2,584
2,000	2,584	2,584	2,584	2,584	2,584	2,584	2,584	2,550	2,505	2,462	2,420	2,380	2,584
3,000	2,565	2,565	2,565	2,565	2,565	2,549	2,503	2,458	2,415	2,373	2,333	2,294	2,565
4,000	2,477	2,477	2,477	2,477	2,477	2,456	2,412	2,368	2,327	2,287	2,248	2,211	2,477
5,000	2,392	2,392	2,392	2,392	2,392	2,366	2,323	2,282	2,242	2,203	2,166	2,130	2,392
6,000	2,310	2,310	2,310	2,310	2,310	2,279	2,238	2,198	2,159	2,122	2,086	2,051	2,310
7,000	2,231	2,231	2,231	2,231	2,231	2,194	2,154	2,116	2,079	2,043	1,938	1,680	2,231
8,000	2,156	2,156	2,156	2,156	2,152	2,112	2,074	2,037	2,001	1,783	1,576	1,370	2,156
9,000	2,083	2,083	2,083	2,083	2,071	2,033	1,996	1,960	1,680	1,499	1,292	1,137	2,083
10,000	2,013	2,013	2,013	2,013	1,992	1,956	1,809	1,602	1,395	1,214	1,085	982	2,013
11,000	1,945	1,945	1,945	1,945	1,916	1,705	1,525	1,292	1,163	1,034	930	853	1,945
12,000	1,880	1,880	1,880	1,835	1,628	1,421	1,214	1,085	982	904	827	749	1,880
13,000	1,818	1,818	1,731	1,525	1,318	1,163	1,034	930	853	775	724	698	1,818
14,000	1,758	1,628	1,421	1,240	1,111	1,008	904	827	749	724	672	646	1,705
15,000	1,550	1,344	1,163	1,059	956	853	801	749	698	672			1,473

Cross Reference

Test Spec	**Setting**	**Engine Arrangement**	**Engineering Model**	**Engineering Model Version**	**Start Effective Serial Number**	**End Effective Serial Number**
4577181	LL1863	4994641	PG041	LS	RRL00001	
4577181	LL1863	5157730	PG041	-	LYP00001	

Supplementary Data

Type	**Classification**	**Performance Number**
SOUND	SOUND PRESSURE	DM8779

Performance Parameter Reference

Parameters Reference:DM9600-12

PERFORMANCE DEFINITIONS

PERFORMANCE DEFINITIONS DM9600
APPLICATION:
Engine performance tolerance values below are representative of a typical production engine tested in a calibrated dynamometer test cell at SAE J1995 standard reference conditions. Caterpillar maintains ISO9001:2000 certified quality management systems for engine test Facilities to assure accurate calibration of test equipment. Engine test data is corrected in accordance with SAE J1995. Additional reference material SAE J1228, J1349, ISO 8665, 3046-1:2002E, 3046-3:1989, 1585, 2534, 2288, and 9249 may apply in part or are similar to SAE J1995. Special engine rating request (SERR) test data shall be noted.
PERFORMANCE PARAMETER TOLERANCE FACTORS:
Power +/- 3%
Torque +/- 3%
Exhaust stack temperature +/- 8%
Inlet airflow +/- 5%
Intake manifold pressure-gage +/- 10%
Exhaust flow +/- 6%
Specific fuel consumption +/- 3%
Fuel rate +/- 5%
Specific DEF consumption +/- 3%
DEF rate +/- 5%
Heat rejection +/- 5%
Heat rejection exhaust only +/- 10%
Heat rejection CEM only +/- 10%
Heat Rejection values based on using treated water.
Torque is included for truck and industrial applications, do not use for Gen Set or steady state applications.
On C7 - C18 engines, at speeds of 1100 RPM and under these values are provided for reference only, and may not meet the tolerance listed.
These values do not apply to C280/3600. For these models, see the tolerances listed below.
C280/3600 HEAT REJECTION TOLERANCE FACTORS:
Heat rejection +/- 10%
Heat rejection to Atmosphere +/- 50%
Heat rejection to Lube Oil +/- 20%
Heat rejection to Aftercooler +/- 5%
TEST CELL TRANSDUCER TOLERANCE FACTORS:
Torque +/- 0.5%
Speed +/- 0.2%
Fuel flow +/- 1.0%
Temperature +/- 2.0 C degrees
Intake manifold pressure +/- 0.1 kPa
OBSERVED ENGINE PERFORMANCE IS CORRECTED TO SAE J1995 REFERENCE AIR AND FUEL CONDITIONS.
REFERENCE ATMOSPHERIC INLET AIR
FOR 3500 ENGINES AND SMALLER
SAE J1228 AUG2002 for marine engines, and J1995 JAN2014 for other engines, reference atmospheric pressure is 100 KPA (29.61 in hg), and standard temperature is 25deg C (77 deg F) at 30% relative humidity at the stated aftercooler water temp, or inlet manifold temp.
FOR 3600 ENGINES
Engine rating obtained and presented in accordance with ISO 3046/1 and SAE J1995 JANJAN2014 reference atmospheric pressure is 100 KPA (29.61 in hg), and standard temperature is 25deg C (77 deg F) at 30% relative humidity and 150M altitude at the stated aftercooler water temperature.
MEASUREMENT LOCATION FOR INLET AIR TEMPERATURE
Location for air temperature measurement air cleaner inlet at stabilized operating conditions.
REFERENCE EXHAUST STACK DIAMETER
The Reference Exhaust Stack Diameter published with this dataset is only used for the calculation of Smoke Opacity values displayed in this dataset. This value does not necessarily represent the actual stack diameter of the engine due to the variety of exhaust stack adapter options available. Consult the price list, engine order or general dimension drawings for the actual stack diameter size ordered or options available.
REFERENCE FUEL
DIESEL
Reference fuel is #2 distillate diesel with a 35API gravity;
A lower heating value is 42,780 KJ/KG (18,390 BTU/LB) when used at 15 deg C (59 deg F), where the density is
850 G/Liter (7.0936 Lbs/Gal).
GAS
Reference natural gas fuel has a lower heating value of 33.74 KJ/L (905 BTU/CU Ft). Low BTU ratings are based on 18.64 KJ/L (500

BTU/CU FT) lower heating value gas. Propane ratings are based on 87.56 KJ/L (2350 BTU/CU Ft) lower heating value gas.
ENGINE POWER (NET) IS THE CORRECTED FLYWHEEL POWER (GROSS) LESS EXTERNAL AUXILIARY LOAD
Engine corrected gross output includes the power required to drive standard equipment; lube oil, scavenge lube oil, fuel transfer, common rail fuel, separate circuit aftercooler and jacket water pumps. Engine net power available for the external (flywheel) load is calculated by subtracting the sum of auxiliary load from the corrected gross flywheel out put power. Typical auxiliary loads are radiator cooling fans, hydraulic pumps, air compressors and battery charging alternators. For Tier 4 ratings additional Parasitic losses would also include Intake, and Exhaust Restrictions.
ALTITUDE CAPABILITY
Altitude capability is the maximum altitude above sea level at standard temperature and standard pressure at which the engine could develop full rated output power on the current performance data set.
Standard temperature values versus altitude could be seen on TM2001.
When viewing the altitude capability chart the ambient temperature is the inlet air temp at the compressor inlet.
Engines with ADEM MEUI and HEUI fuel systems operating at conditions above the defined altitude capability derate for atmospheric pressure and temperature conditions outside the values defined, see TM2001.
Mechanical governor controlled unit injector engines require a setting change for operation at conditions above the altitude defined on the engine performance sheet. See your Caterpillar technical representative for non standard ratings.
REGULATIONS AND PRODUCT COMPLIANCE
TMI Emissions information is presented at 'nominal' and 'Potential Site Variation' values for standard ratings. No tolerances are applied to the emissions data. These values are subject to change at any time. The controlling federal and local emission requirements need to be verified by your Caterpillar technical representative.
Customer's may have special emission site requirements that need to be verified by the Caterpillar Product Group engineer.
EMISSION CYCLE LIMITS:
Cycle emissions Max Limits apply to cycle-weighted averages only. Emissions at individual load points may exceed the cycle-weighted limit.
EMISSIONS DEFINITIONS:
Emissions : DM1176
EMISSION CYCLE DEFINITIONS
1. For constant-speed marine engines for ship main propulsion, including,diesel-electric drive, test cycle E2 shall be applied, for controllable-pitch propeller sets
test cycle E2 shall be applied.
2. For propeller-law-operated main and propeller-law-operated auxiliary engines the test cycle E3 shall be applied.
3. For constant-speed auxiliary engines test cycle D2 shall be applied.
4. For variable-speed, variable-load auxiliary engines, not included above, test cycle C1 shall be applied.
HEAT REJECTION DEFINITIONS:
Diesel Circuit Type and HHV Balance : DM9500
HIGH DISPLACEMENT (HD) DEFINITIONS:
3500: EM1500
RATING DEFINITIONS:
Agriculture : TM6008
Fire Pump : TM6009
Generator Set : TM6035
Generator (Gas) : TM6041
Industrial Diesel : TM6010
Industrial (Gas) : TM6040
Irrigation : TM5749
Locomotive : TM6037
Marine Auxiliary : TM6036
Marine Prop (Except 3600) : TM5747
Marine Prop (3600 only) : TM5748
MSHA : TM6042
Oil Field (Petroleum) : TM6011
Off-Highway Truck : TM6039
On-Highway Truck : TM6038
SOUND DEFINITIONS:
Sound Power : DM8702
Sound Pressure : TM7080
Date Released : 07/10/19

GENERATOR DATA

GENERATOR DATA

Selected Model

Engine	3512	**Generator Frame:**	1668	**Genset Rating(kW):**	1750.0	**Line Voltage:**	4160
Fuel	Diesel	**Generator Arrangement:**	2523968	**Genset Rating(kVA):**	2187.0	**Phase Voltage:**	2402.0
Frequency	60	**Excitation Type:**	Permanent Magnet	**Pwr.Factor:**	0.8	**Rated Current:**	303.5
Duty	STANDBY	**Connection:**	SERIES STAR	**Application:**	EPG	**Status:**	Current
						Version:	41205 /40304 /42472 /10923

Spec Information

Generator Specification

Frame:	1668	**Type**	SR5	**No.of Bearings:**	2
Winding Type:	FORM WOUND			**Flywheel:**	21.0
Connection:	SERIES STAR			**Housing:**	00
Phases	3			**No.of Leads:**	6
Poles:	4			**Wires per Lead:**	2
Sync Speed:	1800			**Generator Pitch:**	0.6667

Generator Efficiency

Per Unit Load	kW	Efficiency %
0.25	437.5	91.7
0.5	875.0	94.7
0.75	1312.5	95.6
1.0	1750.0	95.7

Reactances	Per Unit	Ohms
SUBTRANSIENT - DIRECT AXIS X" d	0.1045	0.8270
SUBTRANSIENT - QUADRATURE AXIS X"q	0.1307	1.0337
TRANSIENT - SATURATED X'd	0.1887	1.4928
SYNCHRONOUS - DIRECT AXIS X'd	1.9734	15.6120
SYNCHRONOUS - QUADRATURE AXIS X'q	1.1842	9.3684
NEGATIVE SEQUENCE X'2	0.1176	0.9304
ZERO SEQUENCE X'0	0.0246	0.1948

Time Constants	Seconds
OPEN CIRCUIT TRANSIENT - DIRECT AXIS T'd0	1.7700
SHORT CIRCUIT TRANSIENT - DIRECT AXIS T'd	0.1990
OPEN CIRCUIT SUBSTRANSIENT - DIRECT AXIS T"d0	0.0340
SHORT CIRCUIT SUBSTRANSIENT - DIRECT AXIS T"d	0.0190
OPEN CIRCUIT SUBSTRANSIENT - QUADRATURE AXIS T"q0	0.1310
SHORT CIRCUIT SUBSTRANSIENT - QUADRATURE AXIS T"q	0.0170
EXCITER TIME CONSTANT Te	0.0940
ARMATURE SHORT CIRCUIT Ta	0.0390

Short Circuit Ratio:0.55	Stator Resistance=0.1033Ohms	Field Resistance=0.52Ohms

Voltage Regulation

Voltage level adjustment:+/-	**5.0%**
Voltage regulation,steady state:+/-	**0.5%**
Voltage regulation with 3% speed change: +/-	**0.5%**
Waveform deviation line - line, no load: less than	**2.0%**
Telephone influence factor: less than	**50%**

Generator Excitation

	No Load	Full Load, Series	(rated)pf Parallel
Excitation Voltage:	14.0Volts	47.0Volts	Volts
Excitation Current:	1.4Amps	3.87Amps	Amps

GENERATOR DATA

Selected Model

Engine	3512	**Generator Frame:**	1668	**Genset Rating(kW):**	1750.0	**Line Voltage:**	4160
Fuel	Diesel	**Generator Arrangement:**	2523968	**Genset Rating(kVA):**	2187.0	**Phase Voltage:**	2402.0
Frequency	60	**Excitation Type:**	Permanent Magnet	**Pwr.Factor:**	0.8	**Rated Current:**	303.5
Duty	STANDBY	**Connection:**	SERIES STAR	**Application:**	EPG	**Status:**	Current
						Version:	41205 /40304 /42472 /10923

Generator Mechanical Information

Center Of Gravity

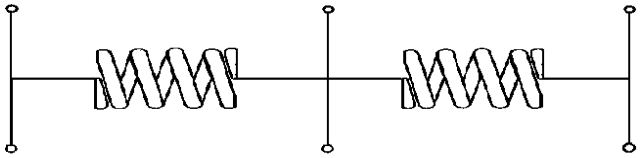
Dimension X	-1110.0mm	-43.7IN.
Dimension Y	0.0mm	0.0IN.
Dimension Z	0.0mm	0.0IN.

* 'X' is measured from driven end of generator and parallel to rotor.Towards engine fan is positive.See General Information for details
* 'Y' is measured vertically from rotor center line.Up is positive
* 'Z' is measured to left and right of rotor center line.To the right is positive.

Generator WT =	4780Kg	* Rotor WT =	1718Kg	* Stator WT=	2175Kg
	10,538LB		3,788LB		4,795LB

Rotor Balance =	0.0508mm deflection PTP
Overspeed Capacity =	125%of synchronous speed

Generator Torsional Data



J1= Coupling and Fan | **J2= Rotor TOTAL J = J1+J2+J3** | **J3= Exciter End**

K1=Shaft Stiffness between J1+J2(Diameter1) | **K2=Shaft Stiffness between J2+J3(Diameter2)**

J1	**K1**	**Min Shaft Dia 1**	**J2**	**K2**	**Min Shaft Dia 2**	**J3**
43.8LB IN.s²	65.9MLB IN./rad	8.9IN.	381.5LB IN.s²	138.1MLB IN./rad	5.5IN.	8.4IN.s²
4.95N m s²	7.45MN m/rad	225.0mm	43.1N m s²	15.6m/rad	140.0mm	0.95N m s²

Total J

433.7LB IN.s²

49.0N m s²

GENERATOR DATA

Selected Model

Engine	3512	**Generator Frame:**	1668	**Genset Rating(kW):**	1750.0	**Line Voltage:**	4160
Fuel	Diesel	**Generator Arrangement:**	2523968	**Genset Rating(kVA):**	2187.0	**Phase Voltage:**	2402.0
Frequency	60	**Excitation Type:**	Permanent Magnet	**Pwr.Factor:**	0.8	**Rated Current:**	303.5
Duty	STANDBY	**Connection:**	SERIES STAR	**Application:**	EPG	**Status:**	Current
						Version:	41205 /40304 /42472 /10923

Generator Cooling Requirements - Temperature -Insulation Data

Cooling Requirements:		**Temperature Data:**	(Ambient 40.0°C)
Heat Dissipated:	78.6kW	**Stator Rise:**	105.0°C
Air Flow:	168.0m³/min	**Rotor Rise:**	105.0°C

Insulation Class:H

Insulation Reg. as shipped:100.0 M Ω minimum at 40 °C

Thermal Limits of Generator

Frequency:	60.0Hz
Line to Line Voltage:	4160.0Volts
B BR 80/40	2000.0kVA
F BR -105/40	2275.0kVA
H BR - 125/40	2500.0kVA
F PR - 130/40	2500.0kVA
H PR - 150/40	2650.0kVA
H PR27 - 163/27	2750.0kVA

GENERATOR DATA

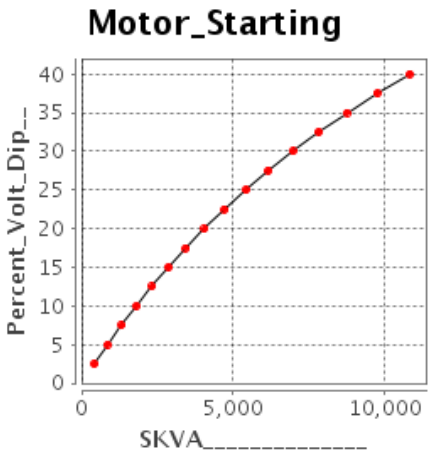
Selected Model

Engine	3512	**Generator Frame:**	1668	**Genset Rating(kW):**	1750.0	**Line Voltage:**	4160
Fuel	Diesel	**Generator Arrangement:**	2523968	**Genset Rating(kVA):**	2187.0	**Phase Voltage:**	2402.0
Frequency	60	**Excitation Type:**	Permanent Magnet	**Pwr.Factor:**	0.8	**Rated Current:**	303.5
Duty	STANDBY	**Connection:**	SERIES STAR	**Application:**	EPG	**Status:**	Current
						Version:	41205 /40304 /42472 /10923

Starting Capability and Current Decrement

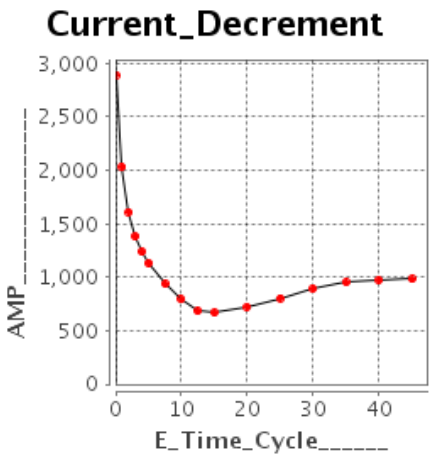
Motor Starting Capability (0.4 pf)

SKVA	Percent Volt Dip
417	2.5
855	5.0
1,318	7.5
1,806	10.0
2,322	12.5
2,868	15.0
3,447	17.5
4,063	20.0
4,718	22.5
5,417	25.0
6,164	27.5
6,965	30.0
7,824	32.5
8,750	35.0
9,750	37.5
10,834	40.0



Current Decrement Data

E Time Cycle	AMP
0.0	2,892
1.0	2,032
2.0	1,611
3.0	1,382
4.0	1,237
5.0	1,132
7.5	938
10.0	791
12.5	682
15.0	668
20.0	724
25.0	804
30.0	893
35.0	951
40.0	972
45.0	981



GENERATOR DATA

Instantaneous 3 Phase Fault Current: 2892.0Amps
Instantaneous Line- Line Fault Current: 2357.0Amps
Instantaneous Line- Neutral Fault Current: 3676.0Amps

GENERATOR DATA

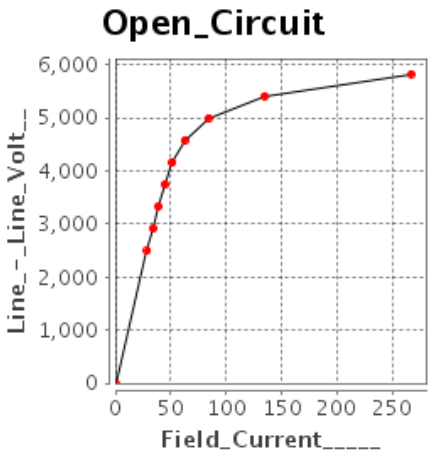
Selected Model

Engine	3512	**Generator Frame:**	1668	**Genset Rating(kW):**	1750.0	**Line Voltage:**	4160
Fuel	Diesel	**Generator Arrangement:**	2523968	**Genset Rating(kVA):**	2187.0	**Phase Voltage:**	2402.0
Frequency	60	**Excitation Type:**	Permanent Magnet	**Pwr.Factor:**	0.8	**Rated Current:**	303.5
Duty	STANDBY	**Connection:**	SERIES STAR	**Application:**	EPG	**Status:**	Current
						Version:	41205 /40304 /42472 /10923

Generator Output Characteristic Curves

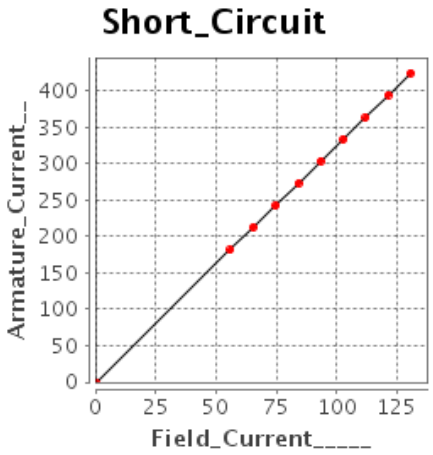
Open Circuit Curve

Field Current	Line - Line Volt
0.0	0
28.9	2,496
33.8	2,912
38.9	3,328
44.6	3,744
51.6	4,160
62.4	4,576
84.0	4,992
134.9	5,408
266.7	5,824



Short Circuit Curve

Field Current	Armature Current
0.0	0
56.0	182
65.4	213
74.7	243
84.1	273
93.4	304
102.8	334
112.1	364
121.4	395
130.8	425



GENERATOR DATA

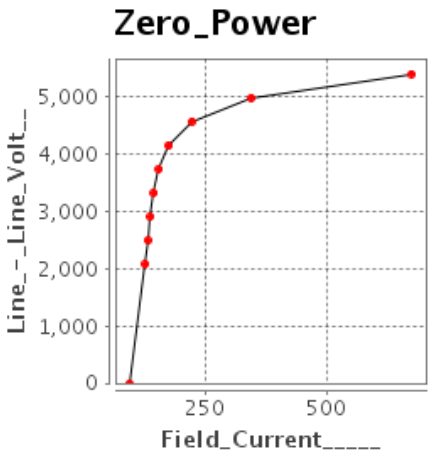
Selected Model

Engine	3512	**Generator Frame:**	1668	**Genset Rating(kW):**	1750.0	**Line Voltage:**	4160
Fuel	Diesel	**Generator Arrangement:**	2523968	**Genset Rating(kVA):**	2187.0	**Phase Voltage:**	2402.0
Frequency	60	**Excitation Type:**	Permanent Magnet	**Pwr.Factor:**	0.8	**Rated Current:**	303.5
Duty	STANDBY	**Connection:**	SERIES STAR	**Application:**	EPG	**Status:**	Current
						Version:	41205 /40304 /42472 /10923

Generator Output Characteristic Curves

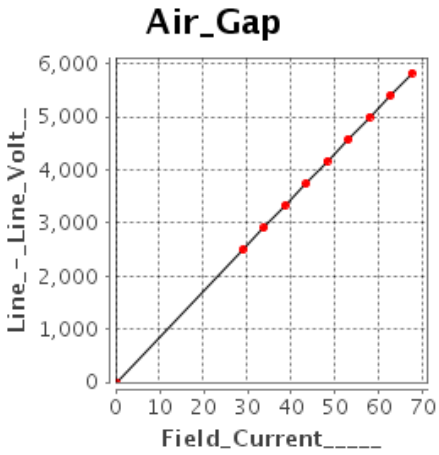
Zero Power Factor Curve

Field Current	Line - Line Volt
93.4	0
126.0	2,080
131.2	2,496
136.9	2,912
143.8	3,328
154.3	3,744
174.6	4,160
222.1	4,576
344.8	4,992
674.5	5,408



Air Gap Curve

Field Current	Line - Line Volt
0.0	0
28.9	2,496
33.7	2,912
38.5	3,328
43.3	3,744
48.1	4,160
52.9	4,576
57.7	4,992
62.5	5,408
67.4	5,824

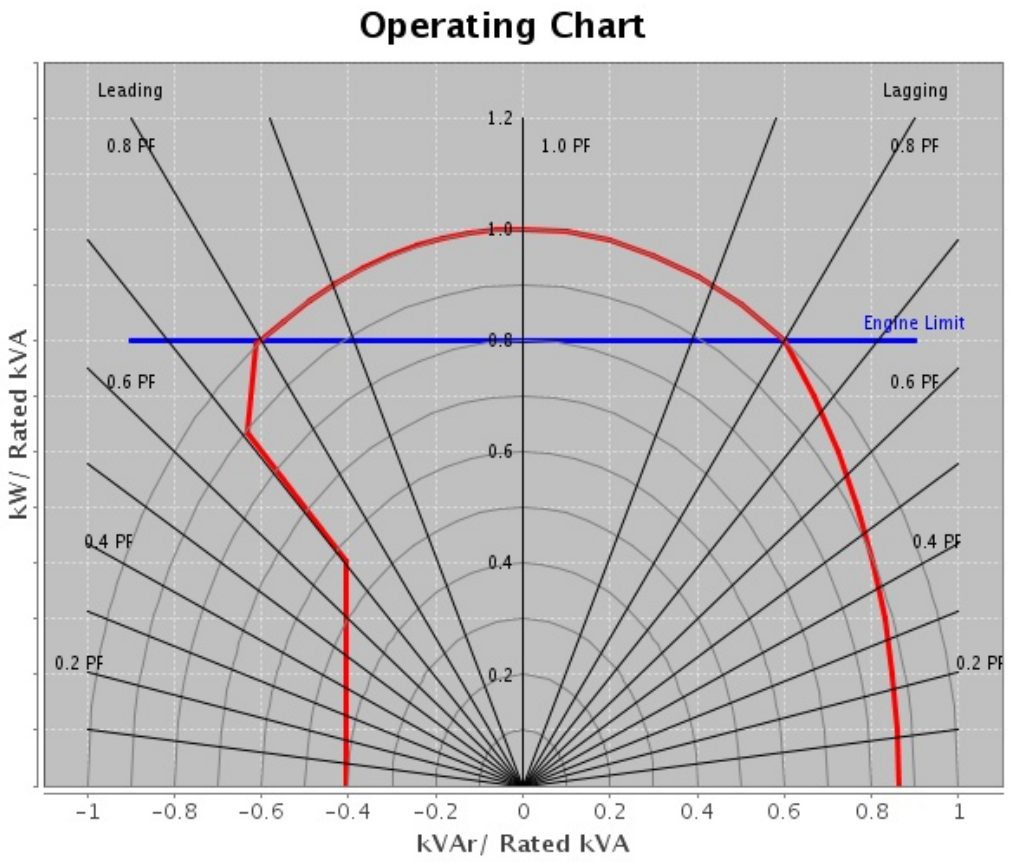


GENERATOR DATA

Selected Model

Engine	3512	**Generator Frame:**	1668	**Genset Rating(kW):**	1750.0	**Line Voltage:**	4160
Fuel	Diesel	**Generator Arrangement:**	2523968	**Genset Rating(kVA):**	2187.0	**Phase Voltage:**	2402.0
Frequency	60	**Excitation Type:**	Permanent Magnet	**Pwr.Factor:**	0.8	**Rated Current:**	303.5
Duty	STANDBY	**Connection:**	SERIES STAR	**Application:**	EPG	**Status:**	Current
						Version:	41205 /40304 /42472 /10923

Reactive Capability Curve



GENERATOR DATA

Selected Model

Engine	3512	**Generator Frame:**	1668	**Genset Rating(kW):**	1750.0	**Line Voltage:**	4160
Fuel	Diesel	**Generator Arrangement:**	2523968	**Genset Rating(kVA):**	2187.0	**Phase Voltage:**	2402.0
Frequency	60	**Excitation Type:**	Permanent Magnet	**Pwr.Factor:**	0.8	**Rated Current:**	303.5
Duty	STANDBY	**Connection:**	SERIES STAR	**Application:**	EPG	**Status:**	Current
						Version:	41205 /40304 /42472 /10923

General Information

DM7825 Caterpillar SR5 Generators (50 Hz, 60 Hz)
Data for 1400, 1600, 1700, 1800 and 1900 frames Caterpillar SR5 generators built by Leroy Somer - USA and Leroy Somer □ France.

Refer to DM7821 for explanation of all generator data in Technical Marketing Information (TMI) except generator efficiency for which the explanation is given below.

GENERATOR EFFICIENCY
Generator efficiency is the percentage of engine flywheel (or other prime mover) power that is converted into electrical output. The generator efficiency shown is calculated by the summation of all losses method, and is determined in accordance with the IEC Standard 60034. The efficiency considers only the generator. There is no consideration of engine or parasitic losses here.

Refer to DM7829 for low and medium voltage protective setting values a nd limits.

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Content Owner:Alan Scott
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Appendix E
Detailed Cost Estimate

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Electrical Resiliency Project
Pre-Design Cost Estimate
Lakewood Water Treatment Plant and Pump Station
City of Duluth, MN
30-Nov-20
City Project Number: TBD
MSA Project Number: 00616161

Division	ITEM	QUANTITY	UNIT	UNIT PRICE	UNIT TOTAL COST	ITEM TOTAL COST	COMMENTS	GMA LINE ITEM BUDGET CATEGORY
0	PROCURMENT AND CONTRACTING REQUIPMENTS				$ 4,445,000	$ 577,850	$4,445,000 is sum of Unit Costs in Division 2-44	NA
	Contract Administration	1	%	$ 4,445,000	$ 44,450		Unit Price is equal to $4,041,000 is sum of Unit Costs in Division 2-44	Contract Labor
	General Contractor Mark-up	10	%	$ 4,445,000	$ 444,500		Unit Price is equal to $4,041,000 is sum of Unit Costs in Division 2-44	Contract Labor
	Bond	1	%	$ 4,445,000	$ 44,450		Unit Price is equal to $4,041,000 is sum of Unit Costs in Division 2-44	Contract Labor
	Insurance	1	%	$ 4,445,000	$ 44,450		Unit Price is equal to $4,041,000 is sum of Unit Costs in Division 2-44	Contract Labor
1	GERNERAL REQUIREMENTS					$ 133,350		
	Project Management	1	%	$ 4,445,000	$ 44,450		Unit Price is equal to $4,041,000 is sum of Unit Costs in Division 2-44	Contract Labor
	Mobilization/Demobilization	1	%	$ 4,445,000	$ 44,450		Unit Price is equal to $4,041,000 is sum of Unit Costs in Division 2-44	Contract Labor
	Permits	1	%	$ 4,445,000	$ 44,450		Unit Price is equal to $4,041,000 is sum of Unit Costs in Division 2-44	Contract Labor
2	EXISITNG CONDITIONS					$ 2,000		
	Clear and Grub	1	LS	$ 2,000	$ 2,000			
3	CONCRETE					$ 24,500		
	Form and Pour Primary Switch Pad	1	LS	$ 3,500	$ 3,500			Concrete Work/Pad
	Form and Pour WTP Generator Pad	1	LS	$ 5,000	$ 5,000			Concrete Work/Pad
	Form and Pour WTP Gear Pad	1	LS	$ 3,500	$ 3,500			Concrete Work/Pad
	Form and Pour New XFMR Base and secondary containment curb on the existing on the back of the building	1	LS	$ 7,500	$ 7,500			Concrete Work/Pad
	Form and XFMR Switch Pad	0	LS	$ 3,500	$ -		Included in the Div 13	
	Form and Pour Power Source Line-Up Pad	0	LS	$ 3,500	$ -		Included in the Div 13	
	Form and Pour Pump House Generator Pad	1	LS	$ 5,000	$ 5,000			Concrete Work/Pad
4	MASONRY					$ 3,500		
	Minor Wall Repair	1	LS	$ 3,500	$ 3,500			Concrete Work/Pad
5	METALS					$ 7,500		
	Misc. Metals for Racks and supports	1	LS	$ 7,500	$ 7,500			Supplies
6	WOOD, PLASTICS, AND COMPOSITES							
	No work included	0	LS	$ -	$ -			
7	THERMAN AND MOISTURE PROTECTION							
	No work included	0	EA	$ -	$ -			
8	OPENINGS					$ -		
	No work included	0	EA	$ -	$ -			
9	FINISHES					$ 3,000		
	General Touch-up Painting	1	LS	$ 3,000	$ 3,000			Installation
10	SPECIALIES					$ 750		
	Misc. Signage	1	LS	$ 750	$ 750			Supplies
13	SPECIAL CONSTRUCTION					$ 252,000		
	24 x 30 Primary Line Up Building (Un-Heated masonry walls)	720	SF	$ 350	$ 252,000			Concrete Work/Pad
22	PLUMBING					$ -		
	No work included		LS		$ -			
23	HVAC					$ -		
	No work included	0	LS	$ -	$ -			
26	ELECTRICAL					$ 4,091,550		
	SCADA Contractor Allowance (Primex)	1	LS	$ 40,000	$ 40,000			Installation
	Power System Study	1	LS	$ 20,000	$ 20,000			Installation
	3rd Party Commissioning and Coordination	1	LS	$ 20,000	$ 20,000			Installation
	Electrical Construction	35	%	$ 2,968,000	$ 1,038,800.00		Unit Price is sum of Division 26 items below	Installation
	EC Equipment Mark Up on Service Line-up	10	%	$ 145,000	$ 14,500			Delivery
	EC Equipment Mark Up on WTP ATS	10	%	$ 7,500	$ 750			Delivery
	EC Equipment Mark Up on WTP Generator	10	%	$ 105,000	$ 10,500			Delivery
	EC Equipment Mark Up on Power Source Line-up	10	%	$ 700,000	$ 70,000			Delivery
	EC Equipment Mark Up on Power Source Line-up	10	%	$ 725,000	$ 72,500			Delivery
	Extend Primary Service UG Service Drop	100	LF	$ 100	$ 10,000			Wiring
	Service Line-up	1	LS	$ 145,000	$ 145,000			Generator Equipment
	CT's and Power Monitoring Instruments	1	LS	$ 25,000	$ 25,000			Generator Equipment
	DC Power with exterior Enclosure	1	LS	$ 25,000	$ 25,000			Generator Equipment
	240VAC Feeder	1	LS	$ 2,500	$ 2,500			Wiring
	Instrument Wiring back to the SCADA Control Panel	1	LS	$ 2,500	$ 2,500			Wiring
	Demo Existing 13.8kV OHE	1	LS	$ 10,000	$ 10,000			Wiring
	UG Branch Feeder to WTP XFMR	100	LF	$ 100	$ 10,000			Wiring
	Concrete Encased 13.8 KV UGE Branch Feeders	500	LF	$ 700	$ 350,000			Wiring
	Electrical MH's	4	LS	$ 10,000	$ 40,000			Wiring
	WTP Power Improvements							
	NEMA 4x 600 amp ATS	1	LS	$ 7,500	$ 7,500			Generator Equipment
	350 KW Diesel Fueled Generator with Enclosure, Sub fuel tank, and Access Platforms	1	LS	$ 105,000	$ 105,000			Generator Equipment
	Feeder from Gen-set to ATS	50	LF	$ 100	$ 5,000			Wiring
	240VAC Feeder	1	LS	$ 2,500	$ 2,500			Wiring
	Instrument Wiring back to the SCADA Control Panel	1	LS	$ 2,500	$ 2,500			Installation
	200 amp safety Switch	1	LS	$ 4,000	$ 4,000			Supplies
	Concrete Encased 480V UGE Branch Feeder to Pump House	500	LF	$ 100	$ 50,000			Wiring
	600 amp safety Switch	1	LS	$ 4,000	$ 4,000			Supplies
	480V Feeder connection via tap and tapping box to MCC-1	1	LS	$ 4,000	$ 4,000			Supplies
	Pump House 480V Power Supply							
	Interior Feeder	1	LS	$ 4,000	$ 4,000			Wiring
	200 amp 480V PP	1	LS	$ 4,000	$ 4,000			Supplies
	35.7 KVA 480-240/120 XFMR	1	LS	$ 4,000	$ 4,000			Supplies
	Connection to existing house power system	1	LS	$ 2,500	$ 2,500			Supplies
	Pump House 2400V Power Supply							
	Source Control Line Up with Generator Control	1	LS	$ 700,000	$ 700,000			Generator Equipment
	DC Power with exterior Enclosure	1	LS	$ 25,000	$ 25,000			Generator Equipment
	1750 KW Diesel Fueled Generator with Enclosure, Sub fuel tank, and Access	1	LS	$ 725,000	$ 725,000			Generator Equipment
	Feeder from Gen-set to ATS	50	LF	$ 100	$ 5,000			Wiring
	240VAC Feeder	1	LS	$ 2,500	$ 2,500			Wiring
	Instrument Wiring back to the SCADA Control Panel	1	LS	$ 2,500	$ 2,500			Wiring
	Secondary XFMR Disconnect and 5000 kVA Transformer	1	LS	$ 435,000	$ 435,000			Generator Equipment
	Feeder from XFMR No.1 to Source Control Line Up	60	LF	$ 150	$ 9,000			Wiring
	Feeder from XFMR No.2 to Source Control Line Up	60	LF	$ 150	$ 9,000			Wiring
	Branch Feeder from Source Control Line Up to existing No.1 Motor Control Gear	150	LF	$ 150	$ 22,500			Wiring
	Branch Feeder from Source Control Line Up to existing No.2 Motor Control Gear	150	LF	$ 150	$ 22,500			Wiring
	Branch Feeder from Source Control Line Up to existing No.3 Motor Control Gear	150	LF	$ 150	$ 22,500			Wiring
	Exterior Light Pole	2	EA	$ 2,500	$ 5,000			Supplies

Electrical Resiliency Project
Pre-Design Cost Estimate
Lakewood Water Treatment Plant and Pump Station
City of Duluth, MN
30-Nov-20
City Project Number: TBD
MSA Project Number: 00616161

Division	ITEM	QUANTITY	UNIT	UNIT PRICE	UNIT TOTAL COST	ITEM TOTAL COST	COMMENTS	GMA LINE ITEM BUDGET CATEGORY
	31 EARTHWORK					$ 8,000		
	Erosion Control	1	LS	$ 2,500	$ 3,000			Concrete Work/Pad
	Grading	1	LS	$ 5,000	$ 5,000			Concrete Work/Pad
	32 EXTERIOR IMPROVEMENTS					$ 52,500		
	Bollards	30	LS	$ 1,000	$ 30,000			Concrete Work/Pad
	Turf Restoration	1	LS	$ 5,000	$ 5,000			Concrete Work/Pad
	Security Fence	1	LS	$ 7,500	$ 7,500			Concrete Work/Pad
	Open Cut Congdon BLVD (Restoration and Traffic Control)	1	LS	$ 10,000	$ 10,000			Installation
	33 UTILITIES					$ -		
	No work included	0	LS	$ -	$ -			
	40 PROCESS INTEGRATION					$ -		
	No work included	0	EA	$ -	$ -			
	41 MATERIALS PROCESSING AND HANDING EQUIPMENT					$ -		
	No work included	0	EA	$ -	$ -			
	44 POLUTION CONTROL EQUIPMENT					$ -		
	No work included	0	EA	$ -	$ -			
	ESTIMATED CONSTRUCTION SUB-TOTAL:					$ 5,157,000		
	Engineering (Pre-Design, Preliminary Design, Design, Bidding, and Construction Services):		18%	$ 5,157,000		$ 929,000	Unit Price is equal to the Estimated Construction Sub-Total	50% Pre-Award Costs and 50% Contract Labor
	SUB-TOTAL:					$ 6,086,000		
	Construction Contingency		15%	$ 5,157,000	$ 774,000	$ 774,000	Unit Price is equal to the Estimated Construction Sub-Total	Construction Contingency
	Allowance and Fee from MN Power					$ 10,000		Allowance and Fee from MN Power
	SUB-TOTAL:					$ 6,870,000		
	Owner Project Management		5%	$ 6,870,000	$ 344,000	$ 344,000	Unit Price is equal to the Sub-Total	Project Management
	TOTAL:					$ 7,214,000		

Notes:
1 Prices do not include AIS or Buy American requirements
2 Sub-total and Total are rounded up to the nearest $1,000
3 Based on 2020 Costs

I hereby certify that the plan was prepare by me or under my direct supervision and that I am a duly licensed Professional Engineer under the laws of the State of Minnesota.

Scott R. Chilson Reg. NO. 44287 Date: 11/30/2020

DEPARTMENT OF ADMINISTRATION
STATE HISTORIC PRESERVATION OFFICE

September 8, 2022 **VIA EMAIL ONLY**

Duane Castaldi
Regional Environmental Officer
FEMA, Region V
U.S. Dept. of Homeland Security
536 South Clark Street, Floor 6
Chicago, IL 60605

RE: BRIC 4513.4
Duluth Water Treatment Plant Power Backup
8130 Congdon Boulevard
Duluth, Saint Louis County
SHPO Number: 2022-0649

Dear Mr. Castaldi,

Thank you for continuing consultation regarding the above-referenced undertaking. Information received in our office on July 20, 2022 has been reviewed pursuant to the responsibilities given the State Historic Preservation Officer by Section 106 of the National Historic Preservation Act (54 U.S.C. § 306108), its implementing federal regulations, "Protection of Historic Properties" (36 CFR Part 800), and per the Section 106 Programmatic Agreement (PA) executed in 2014 among the Federal Emergency Management Agency (FEMA), our office, and the Minnesota Division of Homeland Security.

On May 18, 2022 we wrote to your agency providing comments on efforts to identify properties within the undertaking's Area of Potential Effect and disagreement your No Adverse Effect for the federal undertaking. We appreciate your agency's consideration of our comments in pursuing a modified design for the proposed undertaking in an effort to avoid adverse effects to historic properties.

We have now completed a review of your submission dated July 20, 2022 which presents the documentation associated with the revised scope of work for the federal undertaking (*Documentation Continuing and Concluding Section 106 Consultation for a FEMA-Funded Undertaking*, dated 7/20/2022). Our comments are provided below.

Define Federal Undertaking and Area of Potential Effect
We understand from the July 20th submission that the revised federal undertaking involves funding from your agency to improve operation and resiliency at the Lakewood Water Treatment Plant which includes:

- Installation of a new generator and additional equipment adjacent to the addition (1989) to the Water Treatment Building and Backwash Building (1975), as well as relocation of utility lines from overhead to underground, north of Congdon Boulevard; and
- Installation of an electrical equipment building, two transformers, a generator, and an access driveway on a vacant site south of Congdon Boulevard and to the west of the Lakewood Pump House complex.

We agree that your agency's definition of an Area of Potential Effect (APE), as described in narrative and documented on Figure 57 of your July 20th submission, is appropriate to our understanding of the nature and magnitude of the federal undertaking and takes into account its potential direct and indirect effects.

Historic Property Identification Efforts

Archaeology

Taking into consideration the additional areas within the revised scope that will experience ground disturbance, we agree with the agency conclusion that there are no recorded archaeological sites in the APE and that the likelihood of intact archaeological sites is low at this location. Therefore, we agree with the agency determination that an archaeological field survey is not warranted for the undertaking as it is currently proposed.

Historic/Architectural

As indicated in our previous letter, although the evaluation of this property is outdated, we do agree with the agency determination that the **Lakewood Pump House and Surge Valve Building** [SL-DUL-0455] is a historic property eligible for listing in the National Register of Historic Places (NRHP). As acknowledged in your recent letter, this property is also a local landmark as designated by the City of Duluth.

Also, as discussed in our previous letter, absent a formal intensive level survey and evaluation meeting the Secretary of the Interior's *Standards for Identification* and *Evaluation*, it is our opinion that the associated historical significance supports your agency's determination and we will consider the **Water Treatment Building and Backwash Building** [SHPO Inventory Number Pending] a historic property *eligible* for listing in the NRHP for purposes of completing Section 106 review of this federal undertaking only. We agree that this property is likely part of a larger, potential Lakewood Water Treatment Plant Historic District which also includes the Lakewood Pump House, Surge Valve Building, and surrounding landscape.

Assessment and Finding of Effect

In order for our office to agree with the agency finding that the proposed undertaking will avoid adverse effects, the proposed modifications within or directly adjacent to the historic property boundary must be designed appropriately. Typically, this means treatment and design consistent with the Secretary of the Interior's *Standards for Rehabilitation* (Standards) and associated guidelines.

Our May 18th letter indicated that the proposed new equipment placement on the north and east of the Water Treatment Building is appropriate per the Standards. We understand by your July 20th submission that the scope in this area has not changed, therefore our comment is still valid.

Based upon information provided in your July 20th submission, we agree with the agency determination that the size, scale, and new location proposed for the above-ground equipment and structures, which will be in a wooded area to the west of the Lakewood Pump House and Surge Valve Building, meets the Standards and will not adversely affect the historic property.

Therefore, we concur with your agency's finding that the federal undertaking, as it is currently proposed, will have **no adverse effect** on historic properties provided that the condition listed in your July 20th submission is met.

Consulting Party and Public Participation
Thank you for providing a summary of consultation that your agency has had with the Fond du Lac Band of Lake Superior Chippewa and the Duluth Heritage Preservation Commission since our May 18th comment letter was issued.

Implementation of the undertaking in accordance with this finding, as documented, fulfills your agency's responsibilities under Section 106. If your agency receives written objection to the finding of effect from a consulting party or the public following issuance of this comment letter, then your agency will need to notify our office of the disagreement pursuant to 36 CFR § 800.5 (c)(2)(i). If your agency does not carry out the undertaking as proposed, including, but not limited to, a situation where design changes to the currently proposed project diverts substantially from what was presented at the time of this review, or design changes involving undisturbed ground are made for the undertaking following completion of this review, then your agency will need to reopen Section 106 consultation with our office and others pursuant to 36 CFR § 800.5(d)(1).

If you have any questions regarding our review of this undertaking, please contact me at (651) 201-3290 or sarah.beimers@state.mn.us.

Sincerely,

Sarah J. Beimers
Environmental Review Program Manager

Cc via email:
Stephen Robertson, City of Duluth
Nick Dorochoff, FEMA