# City of Bixby
# Bixby Public Works Authority
# Meeting Agenda

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|---|---|---|
| **Monday, July 24, 2023** | **Immediately Following the City Council Meeting** | **City Hall Municipal Building 116 W. Needles Ave., Bixby, OK 74008** |

**Public comments are limited to items on the agenda. Those wishing to speak on agenda items will need to appear in the City Council Chamber.**

## Call to Order

Chairman

## Roll Call

Shannon Duran, City Clerk

## Consent Agenda

## Secretary's Report

## Consider and Approve:

1) Minutes for the Bixby Public Works Authority Meeting dated 07/10/23.

2) Discuss and/or approve purchase order for chemical purchase and for biosolids handling at the WWTP; total is $210,000.

3) Discuss and/or approve Purchase Orders for FY24 for Water Depts. as follows:
   **Accurate Labs for $20,000** water – DBP, Lead, Copper, Bac-T Testing
   **Core and Main for $75,000** – Plumbing Parts
   **Core and Main for $125,000** – Neptune AMR meter purchase
   **Utility Supply - $25,000** – Plumbing Parts

## Regular Agenda

1) Discussion, consideration, and possible vote for approval of an amendment to the contract with CH2M HILL Engineers, Inc., a subsidiary of Jacobs Engineers, to perform the Operations and Maintenance (O&M) of the Bixby Water Reclamation Facility; total fee is $862,001.

   Bea Aamodt, Public Works Director

2) Discuss and/or approve Change Order #9 for the Bixby Water Reclamation Facility Project for $254,265.

Bea Aamodt, Public Works Director

3) New Business
In accordance with the Open Meeting act, Title 25 O.S. § 311.A.10, new business is defined as any matter not known about or which could not have been reasonably foreseen prior to the time of posting the agenda.

4) Adjournment

**Notice of Posting**

This Notice and Agenda was posted on the bulletin board this day of July 21, 2023, on or before 6:00 p.m., at City Hall, 116 W. Needles Bixby, Oklahoma.

Respectfully Submitted

Shannon Duran
City Clerk

Note: All cell phones and pagers must be turned off or operated silently during all meetings.

21 O.S. Section 280 provides the following: A. It is unlawful for any person, alone or in concert with others and without authorization, to willfully disturb, interfere or disrupt state business, agency operations or any employee, agent, official or representative of the state. B. It is unlawful for any person who is without authority or who is causing any disturbance, interference or disruption to willfully refuse to disperse or leave any property, building or structure owned, leased or occupied by state officials, employees, agents or representatives or used in any manner to conduct state business or operations after proper notice by a peace officer, sergeant-at-arms, or other security personnel. C. Any violation of the provisions of this section shall be a misdemeanor punishable by imprisonment in the county jail for a term Oklahoma Statutes - Title 21. Crimes and Punishments Page 94 of not more than one (1) year, by a fine not exceeding One Thousand Dollars ($1,000.00), or by both such fine and imprisonment. D. For purposes of this section, “disturb, interfere or disrupt” means any conduct that is violent, threatening, abusive, obscene, or that jeopardizes the safety of self or others.

**For Special Accommodations**

Persons who require a special accommodation to participate in this meeting should contact City Clerk, Shannon Duran: 116 West Needles Avenue, Bixby, Oklahoma, 918-366-4430 or email City Clerk, Shannon Duran (sduran@bixbyok.gov), as far in advance as possible and preferably at least 48-hours before the date of the meeting. Persons using a Telecommunication Device for the Deaf may contact Oklahoma Relay at 1-800-722-0353 and voice calls should be made to 1-800-522-8506 to communicate via telephone with hearing telephone users and vice versa.

# Bixby Public Works Authority Meeting Minutes

City Hall Municipal Building
116 W. Needles Ave., Bixby, OK 74008
July 10, 2023 at 6:00 PM

## Call to Order

Mayor Guthrie called the Bixby Public Works Authority Meeting to order at 6:11 p.m.

## Roll Call

Shannon Duran, City Clerk, called the roll, and the following were present:

**Members Present**
Mayor Guthrie
Vice Mayor Founds
Councilor Girard
Councilor Revelis
Councilor Hirshey

**Staff Present**
Jared Cottle, City Manager
Shannon Duran, City Clerk
Phil Frazier, City Attorney
Charles Barnes, Finance Director
OC Walker, City Planner
Mike Butler, Fire Chief
Justin Dowd, City Engineer
Bryan Toney, Public Information Officer

## Consent Agenda

1) Minutes for the Bixby Public Works Authority Meeting 06.26.2023.

2) Consider and/or approve annual renewal of internal and external workorder software package from CivicPlus, Inc. (called SeeClickFix) for FY23 in the amount of $13,040.75. (BPWA portion is $6,520.38)

   Mayor Guthrie said items 1-2 on the Bixby Public Works Authority agenda were up for discussion and consideration.

   Mayor Guthrie asked for a motion to approve items 1 & 2. Vice Mayor Founds made a motion to approve, seconded by Councilor Hirshey. The vote was taken with the following results:

   Carried: 5-0
   Ayes: Founds, Hirshey, Girard, Revelis, Guthrie
   No: 0

## Regular Agenda

1) New Business
   In accordance with the Open Meeting act, Title 25 O.S. § 311.A.10, new business is defined as any matter not known about or which could not have been reasonably foreseen prior to the time of posting the agenda.

   No new business.

2) Adjournment

   Mayor Guthrie adjourned the meeting at 6:11 p.m.

_____
Mayor

_____
City Clerk

# CONSENT AGENDA ITEM COMMENTARY

ITEM TITLE: Discuss and/or approve purchase order for chemicals and for biosolids handling for the WWTP; total is $210,000

INITIATOR: Bea Aamodt, Director

STAFF INFORMATION SOURCE: Bea Aamodt, Director

BACKGROUND: In order to control cost, the City will be buying chemicals for the WWTP and paying directly for biosolids disposal. Initially, the solids handling will be performed by an outside contractor, but the City will be purchasing a dump truck to have Jacobs' Staff deliver the solids to the landfill for the upcoming years.

EXHIBITS: None

KEY ISSUE: WWTP O&M Expenditures

COUNCIL ACTION: Approve

RECOMMENDATION: Approve

ITEM NO: _____

MEETING DATE: 07-24-2023

MEETING: BPWA

# CONSENT AGENDA ITEM COMMENTARY

ITEM TITLE: Discuss and/or approve Purchase Orders for FY24 for Water Depts. as follows:

- **Accurate Labs for $20,000** water – DBP, Lead, Copper, Bac-T Testing
- **Core and Main for $75,000** – Plumbing Parts
- **Core and Main for $125,000** – Neptune AMR meter purchase
- **Utility Supply - $25,000** – Plumbing Parts

INITIATOR: Bea Aamodt, PW Director

STAFF INFORMATION SOURCE: Erik Dye, Field Operations Manager

BACKGROUND:

Tulsa County and Accurate Labs Submitted quotes for Water testing.

Core and Main is a sole source purchase for AMR

EXHIBITS: None

KEY ISSUE: Approval of PO for recurrent expenses

COUNCIL ACTION: Approve or deny

RECOMMENDATION: Approve

ITEM NO: _____

MEETING DATE: 07-24-23

MEETING: BPWA

# REGULAR AGENDA ITEM COMMENTARY

ITEM TITLE: Discuss and/or approve amendment to the contract with CH2M HILL Engineers, Inc., a subsidiary of Jacobs Engineers to perform the Operations and Maintenance (O&M) of the Bixby Water Reclamation Facility; total fee is $862,001

INITIATOR: Bea Aamodt, Director

STAFF INFORMATION SOURCE: Bea Aamodt, Director

BACKGROUND: On April 14th, 2021, a selection committee consisting of City Staff and Council members unanimously selected CH2M HILL Engineers, Inc.to negotiate a contract for the Operations and Maintenance of the Bixby Water Reclamation Facility. The 10-yr renewable O&M contract was awarded on June 14, 2021, which included the FY22 and FY23 fee schedules. Beginning on FY24, the annual O&M fees will be negotiated before budget each year and it will be based on previous year's actual expenditures.

Staff has reviewed expenditures and negotiated a fee with Jacobs for FY24. The contract language has been amended to add an additional FTE position and to further clarify terms.

Jacobs provides the following services:

- Staff the Project with enough qualified employees who possess the managerial, administrative, and technical skills to perform the services specified in this Agreement.
- Operate, maintain and/or monitor and staff the Project seven (7) days per week, eight (8) hours per day. Contractor shall be responsive to alarms and emergency calls 24 hours per day, 7 days per week.
- Furnish and pay all cost incurred in normal Project operations except as otherwise included as Owner's Responsibilities.
- Within the design capacity and capability of the Wastewater Treatment Plant (the "WW Plant"), manage, operate, and maintain the WW Plant so that effluent discharged from the WW Plant meets Applicable Law.
- Within the design capacity and capability of the Project, manage, operate, and maintain the sanitary sewer collection system lift stations to maintain free flowing conditions and minimize overflows. Inspect and clean lift stations.
- Initiate outreach program to increase public awareness of the grease trap program requirements, the need for the program and the importance of maintaining the system. The program will include designing and printing flyers, providing online Q&A site and ongoing telephone support.
- Routine inspections of permitted users as needed to review manifest and trap conditions.

- Inspections conducted in response to grease interference in the collection system.

EXHIBITS: Amendment 1 to O&M Contract WWTP, Original Contract

KEY ISSUE: Contract Agreement

COUNCIL ACTION: Approve

RECOMMENDATION: Approve

ITEM NO: _____

MEETING DATE: 07-24-2023

MEETING: BPWA

**AMENDMENT NO. 1**

**to the**

**AGREEMENT FOR OPERATIONS, MAINTENANCE and**

**MANAGEMENT SERVICES**

**for the**

**BIXBY PUBLIC WORKS AUTHORITY**

This **Amendment No. 1** (the "Amendment") to the Agreement for Operations, Maintenance and Management Services for the Bixby Public Works Authority (the "Agreement") is made effective as of this ____ day of _____ 2023 by and between the **Bixby Public Works Authority** (hereinafter "Owner") and **CH2M Hill Engineers, Inc.** (hereinafter "Contractor"), collectively referred to herein as the "Parties".

NOW THEREFORE, Owner and Contractor agree to amend the Agreement as follows:

1. Article 1.14, "Maintenance", under Article 1 - DEFINITIONS, is hereby deleted in its entirety and replaced with the following:

   1.14 "Maintenance" means routine and/or repetitive activities that may include but not be limited to maintaining warranties, ensuring inspections of equipment, cleaning and lubricating equipment as necessary, performing preventive and predictive maintenance as appropriate, performing plumbing and electrical maintenance of the Facility, maintaining instrumentation and updating software as may be necessary, activities required or recommended by the equipment or facility manufacturer or Contractor to maximize the service life of the equipment, sewer, vehicles and facility. Maintenance does not include the services of the Contractor's specialized maintenance team which are further described under the Repairs Limit definition.

2. Article 1.20, "Repair Limit", under Article 1 - DEFINITIONS, is hereby deleted in its entirety and replaced with the following:

   1.20 "Repair Limit" means the total repair expenditures for the Project for any one Contract Year. Except as otherwise excluded here, Repair Limit expenditures include, but are not limited to all repair parts, oil and grease, packing, outside maintenance services, all maintenance supplies and equipment rental. The Repair Limit does not include labor costs for Repairs performed by Contractor local staff assigned to the Project. However, Contractor's specialized maintenance personnel not assigned to the Project, who provide specialized services, will be charged to the Repair Limit, with the prior approval from the Owner.

3. Article 1.23.9 under Article 1.23, "Unforeseen Circumstances", under Article 1 - DEFINITIONS, is hereby deleted in its entirety and replaced with the following:

   1.23.9 a design or construction defect

4. Article 5.11, is hereby added under Article 5 - OWNER RESPONSIBILITIES, as follows:

   5.11 Owner shall provide and pay for all chemicals used in the treatment process.

5. Article 5.12, is hereby added under Article 5 - OWNER RESPONSIBILITIES, as follows:

5.12 Owner shall provide and pay for all solids handling costs other than labor to transport the solids to the landfill which includes:

5.12.1 the purchase of a tandem dump truck and all fuel and maintenance;

5.12.2 all landfill tip fees; and

5.12.3 all contracted hauling costs needed prior to acquisition of the dump truck and during any period the truck is unavailable for use.

6. Contractor's address under Article 20 - NOTICES, is hereby deleted in its entirety and replaced with the following:

CH2M Hill Engineers, Inc
Attn: OMFS Commercial Director
6312 S. Fiddler's Green, Suite 300N
Greenwood Village, CO 80111

7. Article A.3.2.01 under APPENDIX A - SCOPE OF SERVICE, A.3 - PHASE 3 - OPERATIONS, MAINTENANCE AND MANAGEMENT SERVICES, A.3.2, "Alterations, Repairs and Maintenance", is hereby deleted in its entirety and replaced with the following:

A.3.2.01 Alter, as needed the process and/or facilities to achieve the objectives of this Agreement. No alteration will be executed without Owner's written approval if alteration will cost in excess of One Thousand Dollars ($1,000.00).

Any significant delays in approval from Owner that causes material performance disruptions, additional equipment downtimes, a need for Contractor labor support in an overtime status, and/or other circumstances by which Contractor could be entitled to additional compensation and/or relief from performance timelines due to the inaction of Owner.

8. Article A.3.2.07 under APPENDIX A - SCOPE OF SERVICE, A.3 - PHASE 3 - OPERATIONS, MAINTENANCE AND MANAGEMENT SERVICES, A.3.2, "Alterations, Repairs and Maintenance", is hereby deleted in its entirety and replaced with the following:

A.3.2.07 Within the fence line of the facility, keep trees and shrubs trimmed and keep other grounds free of noxious weeds.

9. Article A.3.2.10 under APPENDIX A - SCOPE OF SERVICE, A.3 - PHASE 3 - OPERATIONS, MAINTENANCE AND MANAGEMENT SERVICES, A.3.2, "Alterations, Repairs and Maintenance", is hereby deleted in its entirety and replaced with the following:

A.3.2.10 Furnish fuel required for normal operation of the facility and lift stations. Any chemicals or fuel required in emergency situations will be provided and billed as an additional cost to Owner.

10. Article A.4.6 under APPENDIX A - SCOPE OF SERVICE, A.4 - WASTEWATER TREATMENT PLANT, is hereby deleted in its entirety and replaced with the following:

A.4.6 Provide for the disposal of screenings, grit, scum, and sludges, except biosolids (collectively, "Residuals") to existing disposal sites. Owner and Contractor agree that Owner is the owner and generator of the residuals.

11. Article A.4.7 under APPENDIX A - SCOPE OF SERVICE, A.4 - WASTEWATER TREATMENT PLANT, is hereby deleted in its entirety.

12. Article A.4.9 under APPENDIX A - SCOPE OF SERVICE, A.4 - WASTEWATER TREATMENT PLANT, is hereby deleted in its entirety and replaced with the following:

    A.4.9 Provide and document all Preventative Maintenance for the WW Plant in accordance with the "Maintenance" definition included in Article 1.14. Owner will have the right to inspect these records during normal business hours.

13. Article A.5.1 under APPENDIX A - SCOPE OF SERVICE, A.5 - SANITARY SEWER COLLECTION SYSTEM, is hereby deleted in its entirety and replaced with the following:

    A.5.1 Within the design capacity and capability of the Project, manage, operate, and maintain the sanitary sewer collection system lift stations, included in Article C.1.2 of APPENDIX C - LOCATION OF PROJECT, to maintain free flowing conditions and minimize overflows.

14. Article A.5.2 under APPENDIX A - SCOPE OF SERVICE, A.5 - SANITARY SEWER COLLECTION SYSTEM, is hereby deleted in its entirety and replaced with the following:

    A.5.2 Inspect and clean lift stations included in Article C.1.2 of APPENDIX C – LOCATION OF PROJECT. Inventory and verify all instrumentation, pumps, and control for each lift station within one hundred eighty (180) days of the start of Phase 3 and at each subsequent renewal period. Any changes or replacements of equipment will be noted and provided to the City in a summary report.

15. Article A.5.3 under APPENDIX A - SCOPE OF SERVICE, A.5 - SANITARY SEWER COLLECTION SYSTEM, is hereby deleted in its entirety and replaced with the following:

    A.5.3 Inspect and clean wet wells in accordance with a schedule to be mutually developed between Owner and Contractor.

16. Article A.5.4 under APPENDIX A - SCOPE OF SERVICE, A.5 - SANITARY SEWER COLLECTION SYSTEM, is hereby deleted in its entirety and replaced with the following:

    A.5.4 Perform inspections of lift stations a minimum of three (3) times a week.

17. Article B.1.2 under APPENDIX B - CAPACITY AND CHARACTERISTICS, B.1 - CAPACITY AND CHARACTERISTICS OF WASTEWATER TREATMENT PLANT, is hereby deleted in its entirety and replaced with the following:

    B.1.2 The Base Fee for services under this Agreement is based on the following Project influent characteristics.

| Parameter | Average Value Per Day |
|---|---|
| Flow, million gallons/day | 2.2 |
| BOD5, pounds per day | 4,180 |
| TSS, pounds per day | 3,636 |

18. The fifth paragraph under Article D.1.1 under APPENDIX D – COMPENSATION, PAYMENT AND BASE FEE ADJUSTMENT FORMULA, D.1 – COMPENSATION, is hereby deleted in its entirety and replaced with the following:

    D.1.1. Para. 5 Upon commencement of Phase 3, Owner shall pay Contractor as compensation for service performed under this Agreement a Base Fee of One Million Two Hundred Forty-Nine Thousand Nine Hundred Seventy-Eight Dollars and Fifty

Cents ($1,249,978.50) paid in eighteen (18) monthly installments of Sixty-Nine Thousand Four Hundred Forty-Three Dollars and Twenty-Five Cents ($69,443.25) for the first Contract Year of this Agreement and as further set forth in Sections D.1. through D.4, below. **Owner shall pay Contractor as compensation for services performed under this Agreement a Base Fee of Eight Hundred Forty-Six Thousand Nine Hundred Eleven Dollars and Zero Cents ($846,911.00) paid in twelve (12) monthly installments of Seventy Thousand Five Hundred Seventy-Five Dollars and Ninety-Two Cents ($70,575.92) for Contract Year 2 (CY2) of this Agreement.** Subsequent years' base fees shall be determined as specified in Appendix D.4

19. Article D.1.1.01 under APPENDIX D – COMPENSATION, PAYMENT AND BASE FEE ADJUSTMENT FORMULA, D.1 – COMPENSATION, is hereby deleted in its entirety and replaced with the following:

    D.1.1.01 The Base Fee includes the following cost incurred for the direct or indirect benefit of the Project: personnel services, equipment, materials/supplies, defined outside services, other insurance and amortized costs, and administration overhead and profit.

20. Article D.1.1.02 under APPENDIX D – COMPENSATION, PAYMENT AND BASE FEE ADJUSTMENT FORMULA, D.1 – COMPENSATION, is hereby deleted in its entirety and replaced with the following:

    D.1.1.02 The services provided under this Agreement assume expected overtime for normal breakdowns or services required after hours in accordance with the facility's design as listed in B.1.1 Any additional expenses including straight, or overtime wages caused by Unforeseen Circumstances will be billed to the Owner for reimbursement, unless these services are due to an operational failure by the CONTRACTOR.

21. Article D.1.1.03 under APPENDIX D – COMPENSATION, PAYMENT AND BASE FEE ADJUSTMENT FORMULA, D.1 – COMPENSATION, is hereby deleted in its entirety and replaced with the following:

    D.1.1.03 If, at any time, prior to Owner's Final Acceptance of the plant's condition, (i) Contractor discovers new information about the condition of the Project or facilities that materially differs from the information reasonably available to Contractor prior to execution of this Agreement; and (ii) such information substantially impacts the ability of Contractor to meet the performance objectives described herein or causes a material increase in the operating and maintenance costs incurred by Contractor to meet such performance objective, Contractor will be entitled to an equitable adjustment mutually agreed upon by both Parties.

22. Article D.2.1 under APPENDIX D – COMPENSATION, PAYMENT AND BASE FEE ADJUSTMENT FORMULA, D.2 – CHANGES IN COMPENSATION, is hereby deleted in its entirety and replaced with the following:

    D.2.1 Changes in the Base Fee will be negotiated annually, three (3) months prior to anniversary of the Commencement Date hereof. In the event that Owner and Contractor fail to agree by the anniversary of the Commencement Date, and that there have been no changes in scope that impact the cost of providing the scope of services, the Base Fee will be adjusted using the Base Fee Adjustment Formula shown in

Appendix D.4. In the event that the Parties reach subsequent agreement on the Base Fee adjustment, Contractor shall issue an invoice retroactively adjusting the Base Fee amount.

23. APPENDIX E – PROJECT VEHICLES AND EQUIPMENT is hereby deleted in its entirety and replaced with the attached APPENDIX E – PROJECT VEHICLES AND EQUIPMENT.
24. APPENDIX F – PERMITS is hereby deleted in its entirety and replaced with the attached APPENDIX F – PERMITS.

This Amendment No. 1 together with the Agreement and all prior amendments constitute the entire agreement between the Parties and supersedes all prior oral and written understandings with respect to the subject matter set forth herein. Unless specifically stated all other terms and conditions of the Agreement shall remain in full force and effect. Neither this Amendment No. 1 nor the Agreement may be modified except in writing signed by an authorized representative of the Parties. The Parties agree that all changes contained in this Amendment shall be considered to be in effect as of 1 July 2023 and all fees including costs for chemicals and solids shall be paid retroactively to 1 July 2023.

The Parties, intending to be legally bound, indicate their approval of this Amendment No. 1 by their signatures below.

| **CH2M HILL ENGINEERS, INC.** | **BIXBY PUBLIC WORKS AUTHORITY** |
|---|---|
| Authorized Signature: | Authorized Signature: |
| _____ | _____ |
| Name: _____ | Name: _____ |
| Title: _____ | Title: _____ |
| Date:_____ | Date:_____ |

## APPENDIX E – PROJECT VEHICLES AND EQUIPMENT

The Project includes all vehicles, rolling stock, and other equipment as follows:

**Contractor's Vehicles**

2010 Ford F-150 IPP Truck/Pool Vehicle
VIN-1FTMF1CW3AKE74410

2021 Ford F-150 Operations Truck
VIN-1FTMF1EPXMKF07347

2021 Ford F-150
VIN-1FTMF1EP1MKF07348

2021 Ford F-250 Maintenance Service Truck
VIN-1FT7X2B61MED57221

**Owner's Vehicles**

Vac Truck
2020 International MV607 SBA
VIN-3HAEUTAL3ML589781

Crane Truck
2019 Peter-Built PB337
VIN-2NP2HM6X4LM660930

## APPENDIX F – PERMITS

NPDES Permit # OK0026913

# AGREEMENT
# for
# OPERATIONS, MAINTENANCE and MANAGEMENT SERVICES for the BIXBY PUBLIC WORKS AUTHORITY

## AGREEMENT FOR OPERATIONS, MAINTENANCE AND MANAGEMENT SERVICES

**THIS AGREEMENT** is made and entered into this 14th day of June 2021, ("Contract Date") by and between the Bixby Public Works Authority, whose address for any formal notice is 116 West Needles Avenue, PO Box 70, Bixby, OK 74008 ("Owner") and CH2M HILL Engineers, Inc., a wholly owned subsidiary of Jacobs Engineering Company, Inc., whose address for any formal notice is 9191 South Jamaica Street, Englewood, CO 80112 ("Contractor"), collectively referred to as the "Parties".

### STATEMENT OF PURPOSE

**WHEREAS**, the Owner owns certain facilities and systems which are further described in **Appendix C**; and

**WHEREAS**, Owner issued a Request for Qualifications and Proposals for the Operation, Maintenance and Management of its Wastewater Facilities (the "RFQP"); and

**WHEREAS**, Contractor submitted its qualifications and proposal in response to the RFQP and was ultimately selected by Owner as most qualified to render the services sought by Owner; and

**WHEREAS**, Owner desires to employ Contractor to perform certain operations, management and maintenance services as further described in **Appendix A** under the terms and conditions set forth in this Agreement.

**NOW THEREFORE**, Owner and Contractor agree as follows:

### 1. DEFINITIONS

1.1 "Adequate Nutrients" means plant influent nitrogen, phosphorous, and iron contents proportional to $BOD_5$ in the ratio of five (5) parts nitrogen, one (1) part phosphorous, and one-half (0.5) part iron for each one hundred (100) parts $BOD_5$.

1.2 "Applicable Law" means as of the Contract Date (1) any federal, state or local law, code, regulation, consent order or agreement; (2) any formally adopted and generally applicable rule, requirement, determination, standard, policy, implementation schedule or order of any Governmental Body having appropriate jurisdiction; (3) any established interpretation of law or regulation utilized by an appropriate governmental body if such interpretation is documented by such regulatory body and generally applicable; and (4) any Permit.

1.3 "Base Fee" means the compensation paid by Owner to Contractor for the base services defined in **Appendix A** of this Agreement for any Contract Year of the Agreement.

1.4 "Biologically Toxic Substances" means any substance or combination of substances contained in the plant influent in sufficiently high concentrations so as to interfere with the biological processes necessary to meet Applicable Law. Biologically Toxic

Substances include but are not limited to heavy metals, phenols, cyanides, pesticides, and herbicides.

1.5 "$BOD_5$" means Biochemical Oxygen Demand over a five (5) day period.

1.6 "Capital Expenditures" means any expenditures for (i) the purchase of new equipment or facility items that cost more than Ten Thousand Dollars ($10,000.00); (ii) Major Repairs that cost more than Ten Thousand Dollars ($10,000.00); or (iii) expenditures that are planned, non-routine, and budgeted by Owner. Capital Expenditures are not Repairs. Owner is responsible for payment of Capital Expenditures, unless otherwise agreed to by the Parties.

1.7 "Categorical Industrial User" ("CIU") means CIUs as defined in 40 CFR §403 (U.S.).

1.8 "Change in Scope" means events or services beyond the Scope of Services set forth in **Appendix A**.

1.9 "Commencement Date" means the date the Phase 3 O&M services will begin for the Owner under this Agreement as defined in Section 2.1.

1.10 "Contract Year" means any period during the Term of this Agreement commencing on the Commencement Date or any anniversary thereof and concluding twelve (12) months thereafter.

1.11 Fats, Oils and Grease Program (FOG) means a pretreatment program regulating the commercial facilities discharging wastewater to Owner's facilities.

1.12 "Industrial Pretreatment Program" ("IPP") means a pretreatment program regulating the industrial facilities discharging wastewater to the Owner's facilities.

1.13 "Initial Term" means the first term of the Agreement as defined in Section 2.1.

1.14 "Maintenance" means routine and/or repetitive activities that may include but not be limited to maintaining warranties, ensuring inspections of equipment, cleaning and lubricating equipment as necessary, performing preventive and predictive maintenance as appropriate, performing plumbing and electrical maintenance of the Facility, maintaining instrumentation and updating software as may be necessary, activities required or recommended by the equipment or facility manufacturer or Contractor to maximize the service life of the equipment, sewer, vehicles and facility.

1.15 "Notice of Violation" (NOV) means an informal noncompliance notification provided to an individual or entity as defined in 40 CFR §403 (U.S.), the IPP, the requirements of the State and Federal Clean Water Act or any Local, State or Federal regulations that apply to other aspects of the business of the Owner.

1.16 "Permit" means the permits issued to the Owner for the operation of the Project. This includes the OPDES Permit Nos. OK0026913. A copy of this Permit is included in **Appendix F**.

1.17 "Project" means all equipment, vehicles, grounds, and facilities described in **Appendix C** and **Appendix E**.

1.18 "Renewal Term" means any additional term of this Agreement beyond the Initial Term of the Agreement as defined in Section 2.1.

1.19 "Repairs" means non-routine/non-repetitive activities required for operational continuity, safety, and performance generally resulting from failure or necessary to avert a failure of the equipment, sewer, vehicle, or facility or some component thereof.

1.20 "Repair Limit" means the total repair expenditures for the Project for any one Contract Year. Repair expenditures may include, but are not limited to repair parts, oil and grease, packing, outside maintenance services, maintenance supplies and equipment rental. The Repair Limit does not include labor costs for Repairs performed by Contractor staff assigned to the Project. However, Contractor's specialized maintenance personnel not assigned to the Project, who provide specialized services, including, but not limited to, vibration, thermographic and electrical analyses, instrumentation Repairs will be charged to the Repair Limit.

1.21 "Significant Industrial User" ("SIU") means SIUs as defined in 40 CFR §403 (U.S.).

1.22 "Term" means the Initial Term and any Renewal Term.

1.23 "Unforeseen Circumstances" means any event or condition that has an effect on the rights or obligations of the Parties under this Agreement or the Project beyond the reasonable control of the party, which constitutes a justification for a delay in or non-performance of action required by this Agreement. Unforeseen Circumstances include, but are not limited to:

1.23.1 an act of God, landslide, lightening, earthquake, tornado, fire or explosion not caused by the acts or omissions of Contractor, flood, failure to possess sufficient property rights, acts of the public enemy, war blockade, sabotage, insurrection, riot or civil disturbance or a pandemic event;

1.23.2 any change in Applicable Law after the Contract Date;

1.23.3 labor disputes, strikes, work slowdowns or work stoppages, but excluding labor disputes, strike or work slowdowns or stoppages by employees of Contractor;

1.23.4 influent does not contain Adequate Nutrients to support operation of the WW Plant's biological processes or contains Biologically Toxic Substances or other substances that may cause pass-through or interference that cannot be removed by the existing processes and facilities;

1.23.5 loss of or inability to obtain service from a utility necessary to furnish power for the operation and maintenance of the Project;

1.23.6 the flow, influent biochemical demand ($BOD_5$,) and/or total suspended solids (TSS) exceeds the WW Plant's design parameters and other parameters that exceed the plant's maximum allowable loadings;

1.23.7 discharge into Owner's sewer system that violate any or all regulations as stated in applicable law;

1.23.8 insufficient volume of raw water to satisfy production demands;

1.23.9 a design or construction defector

1.23.10 for Contractor, Owner's breach of this Agreement.

## 2. TERM

2.1 The Initial Term of this Agreement shall commence upon Owner providing Contractor notice to proceed for the Phase 1 service described in Section A.1 and will continue until Owner provides notice to Contractor to terminate Phase 1 services and commence Phase 2 services described in Section A.2. Phase 2 services shall continue until Owner provides Contractor notice to terminate Phase 2 services and commence the Phase 3 services described in Section A.3 through A.6. Phase 3 services will begin upon receipt of Owner notice to proceed, scheduled for January 1, 2022 and be denoted as Contract Year 1, which will conclude on June 30, 2023. The duration of the Phase 3 services shall be for ten (10) years, beginning on July 1, 2022. (the "Commencement Date"). Thereafter, this Agreement shall be subject to annual review in compliance with Title 62 of the Oklahoma Statutes and renewed for successive terms of five (5) years each ("Renewal Term"), unless cancelled by either party not less than one hundred twenty (120) calendar days prior to expiration.

2.2 Either party may terminate this Agreement for a material breach by the other party if the other party fails to correct the breach within thirty (30) calendar days after receiving written notice of the breach. In the event of a breach by Owner for non-payment of Contractor's invoices, Contractor may terminate this Agreement if Owner fails to make outstanding payments on non-contested amounts within ten (10) calendar days after receiving written notice of the breach.

2.3 Upon notice of termination by Owner, Contractor shall assist Owner in assuming operation of the Project. If Contractor incurs additional cost at the request of Owner, Owner shall pay Contractor for the total cost incurred within fifteen (15) calendar days of invoice receipt.

2.4 Upon termination of this Agreement and all renewals and extensions of it, Contractor shall return the Project to Owner in the same condition as it was upon the Commencement Date of this Agreement, excluding ordinary wear and tear. Equipment and other personal property purchased by Contractor for use in the routine operation or maintenance practices of the Project and billed to the Project will become the property of the Owner upon termination of this Agreement. However, any equipment or personal property purchased by Contractor and not billed to the Project will be the property of

Contractor and removed from the Project by Contractor at the termination of this Agreement.

## 3. SERVICES AND STANDARD OF PERFORMANCE

3.1 Contractor shall perform the services set forth in **Appendix A** for the facilities described in **Appendix C**, within the design capacity and capability of these facilities as further described in **Appendix B**.

3.2 Contractor shall perform the services with the degree of skill and diligence normally employed by operations and maintenance personnel performing the same or similar services.

## 4. INSPECTION ADMINISTRATION SERVICES

4.1 The Inspection Administration Services described in Section A.1 shall be performed in accordance with the Terms of **Appendix H**.

## 5. OWNER RESPONSIBILITIES

5.1 The Owner shall pay for all Capital Expenditures necessary to maintain operational continuity and compliance with Applicable Law. Any loss, damage or injury resulting from Owner's failure to provide Capital Expenditures shall be the sole responsibility of Owner.

5.2 Owner shall pay for repairs in excess of the Repair Limit necessary to maintain operational continuity or compliance with Applicable Law.

5.3 Owner shall provide and pay for utility costs (including electric, gas, water, and sewer), network and WIFI connectivity.

5.4 Owner shall pay for SCADA software and communications fees.

5.5 Owner shall maintain and renew, with respect to all existing portions of the Project, warranties, guarantees, easements, permits, authorizations and licenses granted to the Owner, to the extent the maintenance is not a responsibility of Contractor under this Agreement. All land, buildings, facilities, easements, licenses, structures, rights-of-way, equipment, and vehicles presently or subsequently acquired by Owner will remain the exclusive property of Owner unless specifically agreed upon in writing by the Parties.

5.6 The Owner shall pay all amounts associated with the occupancy or operation of the Project and the performance of the obligations as listed in **Appendix A** including, but not limited to, all excise, ad valorem, property, franchise, occupational and disposal taxes, or other taxes associated with the Project. Taxes imposed upon Contractor's net income and/or payroll taxes for Contractor employees are not included.

5.7 The Owner agrees to not solicit, offer employment or other compensation to all Project personnel of Contractor currently working on this Project, for a period of two (2) years after the end date of this Agreement or re-assignment of Project personnel from this Project. If Owner hires Project personnel in violation of this Section, Owner shall pay Contractor a finder's fee equal to the employee's annual salary when last employed by Contractor.

5.8 Owner shall provide to Contractor all data in Owner's possession relating to the Project, including, but not limited to, operations and maintenance manuals, warranties, or any other data necessary to operate, manage and maintain the Project. Contractor may rely upon the accuracy and completeness of the information provided by the Owner.

5.9 Owner warrants that during the interim period between the initial Project inspection by Contractor during the bidding process and the commencement of Contractor's services identified in **Appendix A**, the Project, facilities and equipment have been operated only in the normal course of business, all scheduled and proper maintenance has been performed, and there are no issues known to Owner regarding the condition of the facilities or the Project and/or any equipment used by the Project or facilities. Owner warrants and agrees that it will turn over the Project, facilities, and equipment to Contractor in good working order and in compliance with the NPDES permit(s) and all other applicable laws, rules, and regulations. In the event Owner fails to comply with the provisions of this clause, Owner will be liable for all costs incurred by Contractor resulting from such failure.

5.10 Owner agrees to provide a minimum sixty (60) day notice to proceed with the Phase 2 start date in order to provide Contractor with sufficient time to hire staff and perform the Phase 3 scope of service.

## 6. COMPENSATION AND PAYMENT

Compensation and Payment is set forth in **Appendix D.**

## 7. INDEMNITY AND LIABILITY

7.1 Contractor hereby agrees to indemnify and hold Owner harmless from any claim, liability or damages for property damage or bodily injury, including death, which may arise from Contractor's negligent operations under this Agreement, to the proportionate extent such negligence contributed to the damages, injury, or loss, whether such negligent operation be by Contractor or by Contractor's employees.

7.2 Owner, to the fullest extent allowable by law, agrees to indemnify and hold Contractor harmless from any claim, liability or damages which may arise from Owner's negligence, gross negligence, or willful misconduct or that of its employees or its subcontractors.

7.3 In no event will Contractor, its subcontractors or their officers or employees be liable for Owner's incidental, special, indirect, or consequential damages, whether such

liability arises in breach of contract or warranty, tort including negligence, strict or statutory liability, or any other cause of action.

7.4 Contractor's aggregate liability under this Agreement with respect to damages to Owner for any cause or combination of causes, whether based upon contract, tort, strict liability, negligence or otherwise, and arising out of the performance or unexcused nonperformance of the Scope of Services as a consequence of a claim or suit initiated by the Owner shall not exceed One Million Dollars ($1,000,000).

## 8. HAZARDOUS SUBSTANCES

8.1 If Contractor suspects hazardous substances other than asbestos on the facilities where Contractor performs services, the Parties may agree for Contractor to conduct tests to determine the extent of the hazardous condition and recommend necessary remedial measures. Contractor will perform these services under a separate agreement negotiated by the Parties and for an additional fee.

8.2 Contractor assumes no risk and/or liability for any hazardous waste or conditions present at the facilities prior to the commencement of this Agreement or for any hazardous waste or conditions attributable to any party other than Contractor.

8.3 In the event that Owner requests Contractor, in the performance of the services set forth herein, to execute Hazardous Waste Manifests on its behalf, Owner must execute a Letter of Authorization, the form of which will be agreed upon by both Parties, delegating such authority to Contractor prior to Contractor undertaking this duty.

8.4 The Parties agree that in the performance of services by Contractor under this Agreement, Owner is requesting Contractor to undertake inherently unsafe obligations for Owner's benefit involving the presence or potential presence of hazardous substances. Therefore, Owner agrees to hold harmless, indemnify, and defend Contractor from and against any and all claims, losses, damages, liability, and costs including, but not limited to, costs of defense arising out of or in any way connected with the presence, discharge, release, or escape of contaminants of any kind, unless such liability arises out of the negligence or willful misconduct of Contractor, its employees, or its subcontractors in the performance of services under this Agreement. Owner is the owner and generator of any waste, residuals, or byproduct generated at the Project.

## 9. FINES AND CIVIL PENALTIES

9.1 Contractor will be liable for fines or civil penalties which may be imposed by a regulatory or enforcement agency for violations occurring on or after the Commencement Date, as a result of the failure to comply with the terms and conditions of any duly authorized permit, court order, administrative order, law, statute, or ordinance for reasons resulting from Contractor's breach, negligence, or willful misconduct during the term of this Agreement. Owner will assist Contractor to contest any such fines in administrative proceedings and/or in court prior to any payment by Contractor. Contractor shall pay the costs of contesting any such fines.

9.2 Contractor will not be liable for fines or civil penalties that result from violations (i) that occurred prior to the Commencement Date of this Agreement; (ii) for the effects of prior violations that have contributed to the assessment of any fine or civil penalty caused by Contractor's negligent operations; (iii) penalties that result from inadequate infrastructure or investment in the technology necessary to comply with permit requirements and/or changes in applicable regulations or (iv) are otherwise directly related to the ownership of the Project.

## 10. INSURANCE AND BONDS

10.1 Contractor shall provide the following insurance policies throughout the term of the Agreement, and shall provide to Owner an ACORD-form Certificate of Insurance (COI) demonstrating compliance with this provision:

10.1.1 Worker's Compensation providing statutory coverage and Employer's Liability Insurance providing limits of One Million Dollars ($1,000,000) each accident, One Million Dollars ($1,000,000) disease-each employee, and One Million Dollars ($1,000,000) disease-policy limit.

10.1.2 Business Automobile Insurance providing Two Million Dollars ($2,000,000) combined single limits covering claims for injuries to members of the public and/or damages to property of others arising from the use of Contractor owned or leased motor vehicles, including onsite and offsite operations. Limits may be satisfied using primary and excess/umbrella policies.

10.1.3 Commercial General Liability Insurance providing limits of Five Million Dollars ($5,000,000) per occurrence and aggregate, covering claims for injuries to members of the public or damages to property of others arising out of any covered act or omission of Contractor or any of its employees or subcontractors for whom Contractor is legally liable. Limits may be satisfied through the use of primary and excess/umbrella policies.

10.1.4 Contractor's Pollution Liability (CPL) Insurance providing limits of Two Million Dollars ($2,000,000) per claim and aggregate. CPL coverage will provide for liability due to pollution conditions caused by or exacerbated by Contractor and will include coverage related to the remediation of pollutants and for third-party claims alleging bodily injury and/or damage to third-party property due to pollutants. Claims made coverage will include a retroactive date that predates all Work executed per this Agreement.

10.2 Contractor shall add Owner and Owner's directors, officers, employees, and representatives as additional insured in Contractor's commercial general liability, automobile liability, excess/umbrella, and Contractor's pollution liability policies.

10.3 Contractor's commercial general liability, automobile liability, employer's liability, excess/umbrella, and Contractor's pollution liability policies will be primary and non-contributory to any other coverage available to Owner.

10.4 Contractor's policy will provide at least thirty (30) days written notice to Owner prior to any cancellation, non-renewal or material change in coverage contemplated in Section 10 (except ten (10) days' notice for non-payment of premium).

10.5 Owner shall maintain the following insurance policies throughout the term of the Agreement, and shall provide Contractor with a COI to demonstrate compliance with this provision:

10.5.1 "All Risk" Property Insurance covering all property on a replacement cost basis and including Owner-supplied vehicles and equipment for the full fair market value of such property.

10.5.2 Liability Insurance covering all motor vehicles and equipment provided by Owner and operated by Contractor under this Agreement.

10.6 Certificates of Insurance ("COI").

10.6.1 The Parties shall provide a COI evidencing the required insurance policies, limits, term of insurance, insured parties, and other information sufficient to demonstrate conformance with this Section and its subsections. Certificates of insurance will reference the project name as identified on the first page of this Agreement.

10.6.2 In the event the COI provided indicates that any required insurance will expire during the period of this Agreement, the party shall furnish, on or before the expiration date, a renewed COI as proof that equal and like coverage for the balance of the period of the Agreement and any extension thereafter has been procured and in effect.

10.6.3 In the event a COI evidencing the renewed coverage is not available prior to the policy renewal date, that party shall provide to the other party, within fifteen (15) days of the policy's(ies') renewal date(s). The party shall furnish the insurance certificates to the other party immediately upon the first party's receipt.

10.7 On or before the Commencement Date, Contractor shall provide to Owner an annual Performance Bond, equal to the Base for the applicable Contract Year. The Performance Bond shall secure the faithful performance of the services contemplated under the Agreement and the payment of labor, outside services, and supplies required for the Contract Services. The Performance Bond may be provided on an annual basis and the liability to the surety for each period shall not be cumulative. The Performance Bond shall: (1) be provided by a surety company having a minimum rating of "A" in the latest revision of the A.M. Best Company's Insurance Report; (2) be listed in the United States Treasury Department's Circular 570, "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsurance Companies"; and (3) be properly registered and licensed to conduct business in the State of Oklahoma. The Performance Bond shall be provided to Owner prior to the Commencement Date.

## 11. LABOR DISPUTES

In the event activities by Owner's employee groups or unions causes disruption in Contractor's ability to perform its obligations under this Agreement, Owner, with Contractor's assistance, or Contractor at its own option, may seek appropriate injunctive court orders during any such disruption. Contractor shall operate the facilities on a best-efforts basis until any such disruptions cease, but Contractor will not be obligated to assure compliance with all contract conditions.

In the event activities by Contractor's employee groups or unions causes disruption in Contractor's ability to perform its obligations under this Agreement, Contractor at its own option, may seek appropriate injunctive court orders during any such disruption. Contractor shall continue operate the facilities on a best-efforts basis until any such disruptions cease.

## 12. UNFORESEEN CIRCUMSTANCE

12.1 Neither party will be liable for damages, delays, or failure to perform its obligations under this Agreement if such failure is due an Unforeseen Circumstance. The party invoking this clause shall notify the other party immediately by verbal communication and in writing of the nature and extent of the contingency within ten (10) business days after its occurrence and shall take reasonable measures to mitigate any impact of an Unforeseen Circumstance.

12.2 In the case of Unforeseen Circumstances, Owner agrees to pay any costs (including without limitation all overtime charges and additional equipment charges) incurred by Contractor in connection with the Unforeseen Circumstance. Owner is not responsible for Contractor equipment or Contractor property damages in the event of Unforeseen Circumstance through which Owner has not acted or failed to act in a negligent manner.

## 13. ACCESS TO FACILITIES AND PROPERTIES

13.1 Owner will make its facilities accessible to Contractor as required for Contractor's performance of its services and will secure access to any other Owner property necessary for performance of Contractor's services.

13.2 Contractor will provide 24-hour per day access to Project for Owner's personnel. Owner's employees, designated by Owner's Representative, may visit the Project at any time. Contractor will provide Owner keys for the Project. All visitors to the Project shall comply with Contractor's operating and safety procedures.

## 14. CHANGES

14.1 Owner and Contractor, from time to time, may make changes to this Agreement or to any of the services performed under this Agreement. The Parties must mutually agree upon all changes. Changes must be in writing in the form of a change order, modification or amendment to the Agreement executed by both Parties.

14.2 Owner and Contractor may agree to out of scope services performed under the terms of this Agreement. The Parties must mutually agree upon out-of-scope services Out of scope services must be in writing. Compensation for the out-of-scope services will be invoiced to Owner in an amount equal to Contractor's cost-plus fifteen percent (15%), unless otherwise agreed to by the Parties, and will be due and payable by Owner commencing the month following the out-of-scope services. Owner may use a properly licensed affiliate to deliver out of scope services.

14.3 In the event scope of services change Contractor will be entitled to additional compensation if the Change in Scope results in additional costs to Contractor for providing such services. The Parties agree that the occurrence of one or more of the following events will constitute a Change in Scope:

14.3.1 Any long-term change in Project operations, personnel qualifications, required certification, staffing or other cost that is a result of an Unforeseen Circumstance. Contractor's will invoice Owner the amount equal to Contractor's cost-plus fifteen percent (15%).

14.3.2 Any change in Project operations, personnel qualifications, required certification, staffing or other cost that is a result of a Change in Applicable Law.

14.3.3 Increases of ten percent (10%) or more in the Wastewater Treatment Plant influent flow or loadings, as set forth in **Appendix B**, as demonstrated by a twelve (12) month rolling average. The Parties must mutually agree upon compensation for the Changes in Scope.

14.3.4 Increases in Contractor's health care costs above the applicable CPI or ECI for the twelve (12) month period for which the annual increase is calculated. In the event health care costs increase, Contractor is entitled to increase its Base Fee in excess of the formula set forth in Appendix D.4, in an amount equal to the increase in costs.

14.3.5 A change in Project operations, personnel qualifications, required certification, staffing or other cost that is the result of a Capital Expenditure.

14.3.6 A material increase in Owner's service area.

14.3.7 Support services provided by Contractor for Owner's capital projects. Parties must mutually agree upon compensation for the Changes in Scope.

## 15. WARRANTIES

15.1 To the best of its knowledge, Contractor warrants that all materials and equipment furnished under this Agreement will be of good quality and free from defective workmanship and materials.

15.2 Contractor shall pass through to Owner the warranty extended by the manufacturer for all products, equipment, systems or materials.

15.3 All other warranties, express or implied, including any warranty of merchantability and any warranty of fitness for a particular purpose are expressly disclaimed.

## 16. NO THIRD-PARTY BENEFICIARIES

This Agreement gives no rights or benefits to anyone other than Owner and Contractor and has no third-party beneficiaries.

## 17. JURISDICTION

This Agreement will be governed by and interpreted in accordance with the laws of the State of Oklahoma.

## 18. SEVERABILITY AND SURVIVAL

If any of the provisions contained in this Agreement are held for any reason to be invalid, illegal, or unenforceable, the enforceability of the remaining provisions will not be impaired thereby.

## 19. AUTHORITY

Both Parties represent and warrant to the other party that the execution, delivery and performance of this Agreement have been duly authorized by the responsible parties thereof. Both Parties warrant that all required approvals have been obtained and the executing party has authority to bind the party.

## 20. NOTICE

Whenever either party desires to give notice to the other, notices must be in writing, sent by certified United States mail with return receipt requested, hand delivered, by national commercial express delivery service or via electronic transmission with proof of successful transmission, to the addresses listed below. Notice will be deemed given upon receipt by any method of delivery authorized in this provision.

Owner: Bixby Public Works Authority
116 West Needles Avenue, PO Box 70
Bixby, OK 74008
Attn: Public Works Director
Email: BAamodt@BixbyOK.gov

Contractor: CH2M HILL Engineers, Inc.
9191 S. Jamaica St
Englewood, CO 80112
Attn: Hope Anastasakis, Risk Manager
Email: hope.anastasakis@jacobs.com

## 21. NO WAIVER

The failure of any party at any time to require performance of any provision or to resort to any remedy provided under this Agreement will in no way affect the right of that party to require performance or to resort to a remedy at any time thereafter, nor will the waiver by any party of a breach be deemed to be a waiver of any subsequent breach. A waiver will not be effective unless it is in writing and signed by the party against whom the waiver is being enforced.

## 22. SURVIVAL OF PROVISIONS

Any terms or conditions of this Agreement that require acts beyond the date of its termination will survive the termination of this Agreement, will remain in full force and effect unless and until the terms of conditions are completed, and will be fully enforceable by either party.

## 23. ASSIGNMENT

Neither party will have the power to or will assign any of the duties or rights or any claim arising out of or related to this Agreement, whether arising in tort, contract or otherwise, without the prior written consent of the other party. Any unauthorized assignment is void and unenforceable. These conditions and the entire Agreement is binding on and inures to the benefit of the parties and their respective permitted successors, and assigns.

## 24. NO CONFLICT OF INTEREST FOR FUTURE WORK

The services performed by Contractor under this Agreement do not preclude Contractor from proposing on or for providing services to Owner in the future. Information and knowledge gained by Contractor in providing the Services under this Agreement will not constitute a conflict of interest in proposing on or providing any additional services for Owner.

## 25. DISPUTE RESOLUTION

. Prior to the initiation of any litigation, the parties agree to first attempt to resolve all disputes through and as provided by Oklahoma's Dispute Resolution Act. To the extent such disputes are not resolved by the Dispute Resolution Act, an aggrieved party may bring an action in a court of competent jurisdiction. The right to a jury trial is hereby waived.

## 26. CAPTIONS AND HEADINGS

The captions and headings of the paragraphs and sections are set forth only for the convenience and reference of the Parties and are not intended in any way to define, limit or describe the scope or intent of this Agreement.

## 27. ENTIRE AGREEMENT

This Agreement, together with all Appendices attached hereto, contains all representations and the entire understanding between the Parties with respect to the subject matter of this Agreement. This Agreement and its Appendices replace any prior correspondence, memoranda, or agreements, whether or not such correspondence, memoranda or agreements are in conflict with this Agreement. The Parties mutually declare there are no oral understandings or promises not contained in the Agreement, which contains the complete, integrated, and final agreement between the Parties.

The following Appendices are hereby made a part of this Agreement:

**Appendix A Scope of Services**

**Appendix B Capacity and Characteristics**

**Appendix C Location of Project**

**Appendix D Compensation and Payment**

**Appendix E Project Vehicles and Equipment**

**Appendix F Permits**

**Appendix G IPP/FOG Program Outline**

**Appendix H Supplemental Terms and Conditions for Engineering and Consulting Services**

////----------**Remainder of Page Intentionally Left Blank**----------////

IN WITNESS WHEREOF, the parties hereto have caused this Contract to be executed by their duly authorized officers or representatives on the dates set forth below.

CH2M HILL Engineers, Inc.

SWORN/SUBSCRIBED:

Asst Corporate Secretary

Date 6/21/2021

Lars B Ostervold, Client Account Manager

ATTEST:

Secretary

Date 6/22/2021

Bixby Public Works Authority, a Public Trust

Chairman

APPROVED AS TO FORM:

City Attorney

## APPENDIX A - SCOPE OF SERVICE

Contractor shall perform the following services for the benefit of the Owner:

### A.1 PHASE 1 - COORDINATION OF INSPECTION SERVICES

A.1.1 Provide oversight of ICAN inspection service to average twelve (12) hours per month through 30 April 2022.

A.1.2 Provide ICAN inspection service to average no more than six (6) hours per day Monday through Friday through 30 April 2022.

A.1.3 Initiate IPP and FOG Programs including public education and community outreach as outlined in Appendix A Section A.6 and A.7.

### A.2 PHASE 2 - TRAINING AND ASSOCIATED SERVICES

A.2.1 Provide Owner with a minimum of 3 members of Contractor's staff to obtain training directly from Owner's design builder regarding the operation of the Project.

A.2.2 Install telemetry monitoring and alarming on seven (7) of Owner's lift stations.

A.2.3 Conduct other activities at Owner's discretion in preparation of the commencement of the work set forth in Phase 3.

A.2.4 Document via a video record of manufacturer training provided on new equipment associated with new BWRF construction.

### A.3 PHASE 3 - OPERATIONS MAINTENANCE AND MANAGEMENT SERVICES

A.3.1 Staff

A.3.1.01 Staff the Project with enough qualified employees who possess the managerial, administrative, and technical skills to perform the services specified in this Agreement. Staff to complete Contractor's training on Code of Conduct and instructed to interact with the public in a respectful and professional manner. Should the need arise to replace the Project Manager, Contractor agrees to allow a representative from the Owner to participate in the hiring process.

A.3.1.02 Operate, maintain and/or monitor and staff the Project seven (7) days per week, eight (8) hours per day. Contractor shall be responsive to alarms and emergency calls 24 hours per day, 7 days per week, within one half (1/2) hour of being notified. Contractor shall designate a minimum of one (1) staff member as standby to respond to alarms and emergency calls. Emergency services calls will be addressed within thirty (30) minutes of being received by Contractor.

A.3.1.03 Place at each permanently staffed Project facility, a copy of Contractor's corporate safety program and provide all employees training specific to this Program, within forty-five (45) days from the effective date of this Agreement.

Owner will pay the cost of any capital improvement required at the Project to bring the facilities within OSHA compliance.

A.3.1.04 Provide and document job related training for personnel in the areas including but not limited to operation, quality, maintenance, safety, supervisory skills, regulatory compliance, laboratory, and energy management. Where the law or regulation requires employees to hold current licenses, certificates or authority to perform the work required of their respective positions, Contractor shall provide the training and agree with the employee to a reasonable time frame for the employee to qualify for such certificate, license or authority.

A.3.1.05 Comply with all State and Federal requirements regarding affirmative action and provisions for minority hiring.

A.3.1.06 Provide up to 120 hours per Contract Year of engineering services at a 2.0 multiplier. Such services shall be documented through an out-of-scope letter agreement and performed in accordance with the terms set forth in Appendix H.

A.3.1.07 Standard Operating Procedures (SOPs) for Operations and Maintenance of the Wastewater Treatment Plant and Lift Stations will be provided before the commencement of Phase 3 and updated annually thereafter.

A.3.1.08 Facility records will be maintained by Operator in a like manner and according to industry standards; records shall remain the property of Owner and shall not be destroyed without prior written consent for authorized Owner representative.

A.3.1.09 Operator will support local non-profit organizations and sponsor community events as well as participate in community outreach and education activities including cooperative efforts with the Owner as appropriate and deemed mutually beneficial.

A.3.1.10 For Owner budgeting purposes, Operator will provide an estimate of annual contract fee adjustments and capital expenditures by April 1 of each contract year.

A.3.1.11 Project Manager or designee shall attend City Council meetings, as required, to address items related to BWRF operations and related expenditures.

A.3.2 Alterations, Repairs and Maintenance

A.3.2.01 Alter, as needed, the process and/or facilities to achieve the objectives of this Agreement. No alteration will be executed without Owner's written approval if alteration will cost in excess of Ten Thousand Dollars ($10,000.00).

A.3.2.02 Perform Repairs for the Project, subject to the Repairs Limit.

A.3.2.03 Furnish and pay all cost incurred in normal Project operations except as otherwise included in Article 5 - Owner's Responsibilities.

A.3.2.04 Maintain aesthetics of the facilities, including maintaining all facilities in a clean, neat and orderly fashion. Site maintenance standards will be similar in overall cleanliness and orderly appearance as the adjoining sports parks.

A.3.2.05 Keep administrative and other occupied spaces clean, dry, and habitable. Other spaces and floors will be free of sewage, screenings, sludge and debris.

A.3.2.06 Equipment, tools, and material will be properly stored.

A.3.2.07 Keep trees and shrubs trimmed and keep other grounds free of noxious weeds.

A.3.2.08 In any emergency affecting the safety of persons or property, or regulatory compliance, Contractor shall act without written amendment or change order, at Contractor's discretion, to prevent threatened damage, injury or loss; In the event emergency expenditures exceed Ten Thousand Dollars ($10,000.00) in aggregate, Contractor shall obtain prior approval from Owner. Contractor will notify Owner of the emergency as soon as reasonably possible, and Owner will compensate Contractor for any emergency work notwithstanding the lack of written amendment or change order. Such compensation will include Contractor's direct costs for the emergency work plus fifteen percent (15%).

A.3.2.09 Utilize Owner provided security devices during Contractor's hours of operation to protect against any losses resulting from theft, damage or unauthorized use of the Project. Existing security devices include fencing, lockable structures, and limited intrusion alarm. Upon exiting the Project, Contractor shall lock all Project gates and structures and activate any security alarms.

A.3.2.10 Furnish chemicals and fuel required for normal operation of the facility and lift stations. Any chemicals or fuel required in emergency situations will be provided and billed as an additional cost to Owner.

## A.4 WASTEWATER TREATMENT PLANT

A.4.1 Within the design capacity and capability of the Wastewater Treatment Plant (the "WW Plant"), manage, operate, and maintain the WW Plant so that effluent discharged from the WW Plant meets Applicable Law.

A.4.2 Within the design capacity and capability of the WW Plant, operate the WW Plant in a manner that minimizes odor and noise.

A.4.3 Prepare and submit to Owner for transmittal to appropriate agencies, all regulatory reports pertaining to routine operation and maintenance of the facilities specified in this Agreement.

A.4.4 Comply with all current local, State and Federal notice and reporting requirements, regarding violations, upsets, excursions, or emergencies related to the Plant.

A.4.5 Assist the Owner with the OPDES permit renewal process by providing Project information within Contractor's possession and control. Any additional assistance requested by the Owner will constitute a Change in Scope.

A.4.6 Provide for the disposal of screenings, grit, scum, sludges, and biosolids (collectively, "Residuals) to existing disposal sites. Owner and Contractor agree that Owner is the owner and generator of the residuals.

A.4.7 If Contractor uses land application as the method for disposal of biosolids, Contractor shall comply with the State and Federal regulations, including 40 CFR 503 applicable to the land application method. Specifically, Contractor shall assist Owner in securing all permits and land use agreements, perform soils and biosolids testing, and report the volume and quantity of biosolids land applied. Contractor may use the existing Owner secured permits and land application sites.

A.4.8 Perform all laboratory testing and sampling currently required by the State and Federal Clean Water Act, OPDES Permit, OPDES referenced documents and all Federal or State issued permits. Contractor will provide additional laboratory testing and sampling requested by the Owner on a fee per test basis to be determined at the time of the request. This additional testing will constitute a Change in Scope.

A.4.9 Provide and document all Preventive Maintenance for the WW Plant. Owner will have the right to inspect these records during normal business hours.

A.4.10 Provide and document Repairs for the WW Plant, subject to the Repair Limit. Contractor will provide Owner with a monthly report on the expenditures of Repairs.

A.4.11 Provide Owner representative access to O&M software for monitoring and data collection and communicate process control and operating plans with Owner's representative at least weekly or as otherwise required.

## A.5 SANITARY SEWER COLLECTION SYSTEM

A.5.1 Within the design capacity and capability of the Project, manage, operate, and maintain the sanitary sewer collection system lift stations to maintain free flowing conditions and minimize overflows.

A.5.2 Inspect and clean lift stations. Inventory and verify all instrumentation, pumps, and control for each lift station within one hundred eighty (180) days of the start of Phase 3 and at each subsequent renewal period. Any changes or replacements of equipment will be noted and provided to the City in a summary report.

A.5.3 Inspect and clean wet wells in accordance with Owner's Wastewater Collection System Master Plan schedule to be mutually developed between Owner and Contractor.

A.5.4 Perform daily inspections of non-telemetered pump stations and telemetered lift stations shall be inspected at least 3 times a week.

A.5.5 Track illegal discharges in the collection system as reasonably identifiable and report to Owner.

A.5.6 Perform work associated with Customer service work orders relating to lift station maintenance or failures.

## A.6 INDUSTRIAL PRETREATMENT PROGRAM

A.6.1 Develop and implement an Industrial Pretreatment Program ("IPP"), including an annual evaluation of the IPP and notification to Owner of changes in Federal and State pretreatment standards that may affect the IPP.

A.6.2 Update, as required, the list of CIUs and SIUs as described in Appendix C.2 according to the definition of CIU and SIU in 40 CFR 403 or the definition in the IPP, whichever is more stringent.

A.6.3 Determine if SIUs are complying by carrying out inspection, surveillance, and monitoring procedures in accordance with the Pretreatment Standards and the IPP. Sample and inspect each CIU and SIU at the frequency established in 40 CFR 403 or the Owner's approved implementation manual, whichever is more stringent. Where analysis is more complex (e.g., organics or other priority pollutants that are not within the capabilities of the Project), Contractor shall be responsible for submitting samples to another laboratory.

A.6.4 Contractor shall maintain records of sampling and inspection.

A.6.5 Maintain the laboratory analysis program for each SIU as described in Appendix C.2. Report results of all industrial sampling and testing to Owner in a timely manner.

A.6.6 Implement Owner's industrial permitting system. Contractor shall review applications and prepare permits. The Owner is the issuing authority.

A.6.7 Prepare NOVs for noncompliance with 40 CFR 403 or the IPP, whichever is more stringent, and recommend other enforcement actions by notifying Owner of the appropriate enforcement action according to the approved enforcement response plan. Notify Owner of all incidents of noncompliance in a timely manner. Owner will be the issuing authority for enforcement actions.

A.6.8 Advise Owner of changes in Federal and State pretreatment standards and regulations and the impacts to the IPP resulting from the changes. Significant changes to the IPP will be approved by the Owner and the appropriate approval authority prior to implementation in accordance with 40 CFR 403.18(c).

A.6.9 Notify Owner as soon as is practical, verbally and followed by written confirmation, whenever Contractor suspects an industry is violating or has violated Owner's industrial waste and/or sewer ordinance(s).

A.6.10 Responsibility for program elements is determined in **Appendix G.** Changes or additions to the IPP elements described in **Appendix G** will constitute a Change in Scope.

## A.7 FATS, OILS AND GREASE PROGRAM

A.7.1 Develop and submit for Owner adoption a Grease Control Ordinance including grease trap permitting system and trap cleaning manifests.

A.7.2 Initiate outreach program to increase public awareness of the grease trap program requirements, the need for the program and the importance of maintaining the system. The program will include designing and printing flyers, providing online Q&A site and ongoing telephone support.

A.7.3 Perform survey of City to identify potential dischargers of fats, oils and grease. Permit users and provide requirements for grease trap size and maintenance.

A.7.4 Perform inspections; consisting of two forms:

- A.7.4.01 Routine inspections of permitted users as needed to review manifest and trap conditions.
- A.7.4.02 Inspections conducted in response to grease interference in the collection system.

A.7.5 Monthly reporting to Owner including recommendations for enforcement actions.

## APPENDIX B - CAPACITY AND CHARACTERISTICS

### B.1 CAPACITY AND CHARACTERISTICS OF WASTEWATER TREATMENT PLANT

B.1.1 Wastewater Treatment Plant Design Capacity is described as follows:

| Parameter | Plant |
|---|---|
| Flow, million gallons/day | 2.8 |
| BOD5, pounds per day | 5,301 |
| TSS, pounds per day | 5,091 |
| Daily Peaking Factor | 1.6 |

All parameters will be based on the design average dry weather flow with the Daily Peaking Factor being the multiplier applied to the design average dry weather flow.

B.1.2 The Base Fee for services under this Agreement is based on the following Project influent characteristics per current information provided by Owner:

| Parameter | Plant |
|---|---|
| Flow, million gallons/day | 2 |
| BOD5, pounds per day | 3,786 |
| TSS, pounds per day | 3,636 |

## APPENDIX C - LOCATION OF PROJECT

**C.1** Contractor agrees to provide the services necessary for the operation, maintenance, and management of the facilities described in **Appendix C**.

C.1.1 All equipment, grounds, and facilities now existing within the current property boundaries of or being used to operate Owner's WW Plant located at:

9499 E 151st Street, Bixby Oklahoma

C.1.2 The following grounds and equipment for Owner's Sanitary Collection system:

| **Lift Station** | **Address** |
|---|---|
| 126 Center | 8798 E. 124 St. S |
| 131 Street | 7043 E 131st Street S |
| 555 | 14902 S Mingo Road |
| Adkinson Acres | 164th Street S and Kingston Avenue |
| Eagle Rock 1 | 13812 S Hudson Avenue |
| Eagle Rock 2 | 6075 E 141st Street S |
| Ellard | 15727 S Memorial Drive |
| Heritage Park | 124th Street S and Mingo Road |
| Johns Park | 9736 E 166th Street S |
| Lantern Hill | 146th Street S and Sheridan Road |
| North Lagoon Transfer | 13700 S Memorial Drive |
| Saker | 16801 S 88th East Aveune |
| Shannondale | 106th East Avenue and 111th Street S |
| South Main | 149 S Riverview Drive |
| Southbridge | 13940 S 90th East Avenue |
| Southtown | 17249 S 92nd East Avenue |
| Springtree | 13299 Kimberly Clark Place |
| White Hawk | 5250 E 141st Street S |

### C.2 INDUSTRIAL WASTE DISCHARGERS

A list of industrial waste dischargers will be developed together with Owner's IPP program. If there is a material increase in the number of dischargers greater than the anticipated total of three (3) SIU/CIUs at the commencement date of the program, such change will be considered a change in scope.

### C.3 FATS, OILS AND GREASE (FOG) DISCHARGERS

A list of FOG dischargers will be developed together with Owner's FOG program. If there is a material increase in the number of dischargers greater than the anticipated total of sixty-five (65) entities at the commencement date of the program, such change will be considered a change in scope.

## APPENDIX D - COMPENSATION, PAYMENT AND BASE FEE ADJUSTMENT FORMULA

### D.1 COMPENSATION

D.1.1 The Owner shall pay to Contractor for Phase 1 on a time and material basis over an eleven (11) month period in accordance with the rates below. The estimated Phase 1 cost is One Hundred Thirteen Thousand One Hundred Sixty-One ($113,161) Dollars. Should the ICAN hourly rate change for any reason, Owner agrees to compensate accordingly as a pass-through expense.

- ICAN - $75/hour
- Jacobs Engineer - $104.92/hour

IPP program initial set-up fee of Eighty-Five Thousand Seven Hundred Twenty Dollars ($85,720) to be billed in twelve (12) monthly installments of Seven Thousand One Hundred Forty-Three Dollars and Thirty-Three Cents ($7,143.33); billing to begin in Phase 1 of the contract term.

FOG program initial set-up fee of Eighteen Thousand Five Hundred Six Dollars ($18,506) to be billed in twelve (12) monthly installments of One Thousand Five Hundred Forty-Two Dollars and Sixteen Cents ($1,542.16); billing to begin in Phase 1 of the contract term.

Upon commencement of Phase 2, Owner shall pay to Contractor a monthly fee of Twenty-Nine Thousand One Hundred Twenty-Six Dollars and Sixty Cents ($29,126.60) for the projected five-month period. If Phase 2 extends beyond the five-month interval, Owner agrees to continue paying a monthly fee to be negotiated between the parties for services through the completion of Phase 2 activities.

Upon commencement of Phase 3, Owner shall pay Contractor as compensation for services performed under this Agreement a Base Fee of One Million Two Hundred Forty-Nine Thousand Nine Hundred Seventy-Eight Dollars and Fifty Cents ($1,249,978.50) paid in eighteen (18) monthly installments of Sixty-Nine Thousand Four Hundred Forty-Three Dollars and Twenty-Five Cents ($69,443.25) for the first Contract Year of this Agreement and as further set forth in Sections D.1. through D.4, below. Subsequent years' base fees shall be determined as specified in Appendix D.4.

Beginning with Contract Year 2, Owner Fiscal Year 2024, (CY2), Operator will add Ten Thousand One Hundred Eighty-Five ($10,185) Dollars to the fee for the management and completion of the ongoing annual IPP scope as dictated by the approved IPP program.

Beginning with Contract Year 2 (CY2), Operator will add Four Thousand Nine Hundred Five ($4,905) Dollars to the fee for the management and completion of the ongoing annual FOG scope as dictated by the approved IPP program. This price does not include laboratory analysis of FOG samples from commercial discharges.

D.1.1.01 The Base Fee includes the following cost incurred for the direct or indirect benefit of the Project: personnel services, equipment, materials/supplies, outside services, dewatered biosolids hauling and disposal other insurance and amortized costs, and administration overhead and profit.

D.1.1.02 The services provided under this Agreement assume expected overtime for normal breakdowns or services required after hours. Any additional expenses including straight, or overtime wages caused by Unforeseen Circumstances will be billed to the Owner for reimbursement.

D.1.1.03 If, at any time, during the first twelve months following the Commencement Date, (i) Contractor discovers new information about the condition of the Project or facilities that materially differs from the information reasonably available to Contractor prior to execution of this Agreement; and (ii) such information substantially impacts the ability of Contractor to meet the performance objectives described herein or causes a material increase in the operating and maintenance costs incurred by Contractor to meet such performance objective, Contractor will be entitled to an equitable adjustment mutually agreed upon by both Parties.

D.1.2 Limitations

D.1.2.01 The total amount Contractor will be required to pay for Repairs will not exceed a Repairs Limit of Sixty-Seven Thousand Five Hundred Dollars ($67,500) for the first Contract Year. Beginning with Contract Year 2, the annual Repairs Limit is no less than Forty-Five Thousand Dollars ($45,000) for each subsequent Contract Year Contractor shall provide Owner with a detailed invoice of Repairs over the annual Repairs Limit, and Owner shall pay Contractor for all Repairs in excess of such limit. Contractor shall rebate to Owner the entire amount that the cost of Repairs is less than the annual Repairs Limit. At the end of each Contract Year, Contractor shall rebate to Owner any unspent balance of the annual Repairs Limit.

## D.2 CHANGES IN COMPENSATION

D.2.1 Changes in the Base Fee will be negotiated annually, three (3) months prior to anniversary of the Commencement Date hereof. In the event that Owner and Contractor fail to agree by the anniversary of the Commencement Date, the Base Fee will be adjusted using the Base Fee Adjustment Formula shown in Appendix D.4. In the event that the Parties reach subsequent agreement on the Base Fee adjustment, Contractor shall issue an invoice retroactively adjusting the Base Fee amount.

D.2.2 The Parties will negotiate the Repairs Limit each year, three (3) months prior to anniversary of the Commencement Date hereof. Should Owner and Contractor fail to agree, the Repairs Limit will be determined by the prior year's actual Repairs Cost plus application of the Consumer Price Index (CPI) component of the Base Fee Adjustment Formula shown in Appendix D.4.

D.2.3 The Parties will negotiate compensation for Changes in Scope, except as otherwise set forth in this Agreement.

## D.3 PAYMENT OF COMPENSATION

D.3.1 For Contract Year 1, one-eighteenth (1/18) of the Base Fee together with one eighteenth (1/18) of the Repairs Limit shall be due on the first of the month for which services commence. Beginning with Contract Year 2, one-twelfth (1/12) of the Base Fee together with one twelfth ($1/12^{th}$) of the Repairs Limit for the current Contract Year shall be due on the first of the month for which services commence.

D.3.2 All compensation to Contractor is due on receipt of Contractor's invoice and payable within thirty (30) calendar days.

D.3.3 Owner shall pay interest at a rate of one percent (1%) compounded monthly, subject to limitation provided by law, on payments not paid and received within thirty (30) calendar days. Interest will be calculated from the due date of the invoice.

D.3.4 In the event of a contested billing, Owner may only withhold the contested portion from payment. The Owner will pay Contractor the undisputed portion in accordance with Appendix D.3.2. Interest will accrue on any contested portion of the billing and shall be immediately payable if the contested billing is resolved in favor of Contractor. No interest will be due on any contested portion of the billing if the contested portion is mutually resolved.

## D.4 BASE FEE ADJUSTMENT FORMULA

$$ABF = BF \times AF$$

Where:

BF = Base Fee specified in Appendix D.1.1

ABF = Adjusted Base Fee

AF = Adjustment Factor as determined by the formula:

AF = [((ECI) .50 + (CPI) .50))] +1.0

ECI = The twelve-month percent change (from the fourth quarter of the prior year to the fourth quarter in the current year) in the Employment Cost Index for Total Compensation for Civilian Workers, Not Seasonally Adjusted as published by U. S. Department of Labor, Bureau of Labor Statistics in the Detailed Report Series ID: CIU1010000000000A.

CPI = The twelve-month percent change (from December of the prior year to December of the current year) in the Consumer Price Index U.S. city average; Water and Sewerage Maintenance, Not Seasonally Adjusted as published by U.S. Department of Labor, Bureau of Labor Statistics in the CPI Detailed Report Series Id: CUSR0000SEHG01.

## APPENDIX E - PROJECT VEHICLES AND EQUIPMENT

The Project includes all vehicles, rolling stock, and other equipment as follows:

NONE

# APPENDIX F - PERMITS

## APPENDIX G – IPP/FOG PROGRAM OUTLINE

**[To be incorporated upon program development]**

## APPENDIX H

The below referenced supplemental terms and conditions shall apply to all engineering and consulting services provided by Contractor during the Term of the Agreement. In the event of a conflict between the terms and conditions of the Agreement and the supplemental terms set forth below, the supplemental terms shall prevail, but only with respect to the engineering or consulting services.

1. Warranty

A. Contractor warrants that Services provided will be performed in accordance with accepted standards in the industry. Following completion of its Services and for a period of twelve (12) months thereafter, if the Services provided hereunder do not conform to the warranty above stated and the same is reported to Contractor by Owner in writing promptly after recognition thereof, Contractor shall, at no cost to Owner, furnish all remedial Services required in connection therewith as soon as reasonably possible after receipt of such report from Owner; and Owner shall have no liability for costs related to the repair, replacement, addition or deletion of materials, equipment or facilities as a result of such failure to conform to the above-referenced warranties, which costs shall be deemed costs of the project, whether incurred during performance of the Services or after completion of the Services.

B. Contractor's warranties shall not apply to any defect which results from: ordinary wear and tear, mis operation, corrosion or erosion, noise levels, operating conditions more severe than those contemplated in the original design, or a defect in a process or mechanical design or equipment furnished or specified by Owner or others.

C. All representations, warranties and guarantees made by Contractor in connection with its Services are limited to those set forth above. IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE SPECIFICALLY EXCLUDED. For any deficiencies in the services, Owner shall be restricted to the remedies expressly set forth in these supplemental terms; such remedies are Owner's sole and exclusive remedies for deficiencies in the Services and Owner hereby waives any and all other remedies, whether at law or in equity, and regardless of whether the claim is asserted under contract, tort (including the concurrent or sole and exclusive negligence of Contractor), strict liability or otherwise.

2. INDEMNIFICATION

A. Contractor will defend, indemnify, and hold Owner harmless from all claims, liabilities, demands, costs, expenses (including attorneys' fees) and causes of action arising out of third-party claims for bodily injury (including death) and damage to tangible property to the extent caused by a negligent act or omission of Contractor, its employee or

subcontractor. Owner hereby agrees to release, waive all rights of subrogation against, defend, indemnify and hold Contractor harmless from all claims, liabilities, demands, costs, expenses (including attorneys' fees) and causes of action arising out of bodily injury (including death) to any person or damage or loss to any property ("Harms"), irrespective of Contractor's fault (including, without limitation, breach of contract, tort including concurrent or sole and exclusive negligence, strict liability or otherwise of Contractor), when the Harms result from (i) the discharge, dispersal, release or escape of smoke, vapors, soot, fumes, acids, alkalis, toxic chemicals, liquids or gases, waste materials or other irritants, contaminants or pollutants into or upon land, the atmosphere or any water course or body of water; (ii) errors or omissions in Contractor's Services due to Contractor being required, directly or indirectly, by Owner to take certain actions contrary to the recommendations of Contractor; and (iii) the acts, errors, omissions or negligence of Owner, its employee or other contractor.

3. LIMITATION OF LIABILITY

The total aggregate liability of Contractor arising out of the performance of consulting or engineering services under this Agreement or breach of this Agreement in performance thereof shall not exceed twenty-five percent (25%) of the compensation paid to Contractor for such services. Notwithstanding any other provision of this Agreement, Contractor shall have no liability to the Owner for contingent, consequential, or other indirect damages including, without limitation, damages for loss of use, revenue, or profit (direct or indirect); operating costs and facility downtime; or other similar business interruption losses, however the same may be caused. The limitations and exclusions of liability set forth in this Article shall apply regardless of the fault, breach of contract, tort (including negligence), strict liability or otherwise of Contractor, its employees, or subcontractors. The Parties agree that the limitations of liability and waiver of damages as set forth herein shall not be interpreted as a form of indemnification.

4. OWNERSHIP OF INSTRUMENTS OF SERVICE AND DATA

A. Owner agrees to defend, indemnify, and hold harmless Contractor and its employees from and against claims resulting from re-use of the design data, drawings, estimates, calculations, and specifications prepared by Contractor ("instruments of service") on extensions of the project or at a location other than that contemplated by this Agreement. Owner is advised that should Owner re-use the instruments of service at another location, the instruments of service should be reviewed and sealed by Owner or a Contractor licensed in the jurisdiction where the instruments of service are sought to be re-used.

B. All materials and information that are the property of Owner and all copies or duplications thereof shall be delivered to Owner by Contractor, if requested by Owner, upon completion of Services. Contractor may retain one complete set of reproducible copies of all its instruments of service.

C. All specifications, drawings, and other engineering documents that are prepared by Contractor shall be certified or sealed by a registered professional Contractor. Such certifications or seals shall be valid for the state in which the specifications, drawings, or other Engineering documents are to be used or applied.

5. CONSTRUCTION PHASE SERVICES

If this Agreement includes the furnishing of any Services during the construction, the following terms will apply:

A. If Contractor is called upon to observe the work of Owner's construction contractor(s) for the detection of defects or deficiencies in such work, Contractor will not bear any responsibility or liability for such defects or deficiencies or for the failure to so detect. Contractor shall not make inspections or reviews of the safety programs or procedures of the construction contractor(s) and shall not review their work for the purpose of ensuring their compliance with safety standards.

B. If Contractor is called upon to review submittals from construction contractors, Contractor shall review and approve or take other appropriate action upon construction contractor(s)' submittals such as shop drawings, product data and samples, but only for the limited purpose of checking for conformance with information given and the design concept expressed in the contract documents. The Contractor's action shall be taken with such reasonable promptness as to cause no delay in the work while allowing sufficient time in the Contractor's professional judgment to permit adequate review. Review of such submittals will not be conducted for the purpose of determining the accuracy and completeness of other details such as dimensions and quantities or for substantiating instructions for installation or performance of equipment or systems designed by the construction contractor, all of which remain the responsibility of the construction contractor. The Contractor's review shall not constitute approval of safety precautions or of construction means, methods, techniques, sequences, or procedures. The Contractor's approval of a specific item shall not indicate approval of an assembly of which the item is a component.

C. Contractor shall not assume any responsibility or liability for performance of the construction services, or for the safety of persons and property during construction, or for compliance with federal, state, and local statutes, rules, regulations, and codes applicable to the conduct of the construction services.

D. All services performed by others, including construction contractors and their subcontractors, shall be warranted only by such others and not by the Contractor.

E. All contracts between Owner and its construction contractor(s) shall contain broad form indemnity and insurance clauses in favor of Owner and Contractor, in a form satisfactory to Contractor.

# REGULAR AGENDA ITEM COMMENTARY

ITEM TITLE: Discuss and/or approve Change Order #9 for the Bixby Water Reclamation Facility Project for $254,265

INITIATOR: Bea Aamodt

STAFF INFORMATION SOURCE: Bea Aamodt

BACKGROUND: This Change Order is necessary to install a large filter bank for the overall electrical system to reduce the harmonic voltage distortion on the electrical system. Electrical fluctuations appear to be affecting the UV Unit, resulting in "burned out" ballast. A study conducted by Eaton Electrical Services has shown that the harmonic distortion do not meet recommended industry limits and a filter bank must be installed.

EXHIBITS: Change Order Backup information, Eaton Study

KEY ISSUE: WTTP O&M

COUNCIL ACTION: Approve or deny

RECOMMENDATION: Approve.

ITEM NO: _____

MEETING DATE: 07-24-23

MEETING: Council

15-May-23

Bixby Water Reclamation Facility — Change Proposal for Capacitor Filter
Bixby Oklahoma — Outlet Structure Erosion Improvements
$254,265.00
Olsson

| DESCRIPTION | QUANITY | UNIT | cost | MATERIAL | cost | LABOR | cost | EQUIPMENT | cost | SUB-CONTR. |
|---|---|---|---|---|---|---|---|---|---|---|
| Add Capacitor to Main WWTP | | | | | | | | | | PAGE 1 |
| Equipment | 1 | LS | | 0.00 | | 0.00 | | 0.00 | | 57,000.00 |
| Start-up | 1 | LS | | 0.00 | | 0.00 | | 0.00 | | 28,600.00 |
| 5-Year Warranty | 1 | LS | | 0.00 | | 0.00 | | 0.00 | | 31,500.00 |
| Material | 1 | LS | | 0.00 | | 0.00 | | 0.00 | | 10,350.00 |
| Labor | 1 | LS | | 0.00 | | 0.00 | | 0.00 | | 27,675.00 |
| | 1 | LS | | 0.00 | | 0.00 | | 0.00 | | 0.00 |
| | | | | 0.00 | | 0.00 | | 0.00 | | 0.00 |
| TOTALS: | | | | 0.00 | | 0.00 | | 0.00 | | 155,125.00 |

| SUMMARY | MATERIAL | LABOR | EQUIPMENT | SUB-CONT. |
|---|---|---|---|---|
| GENERAL CONDITIONS | 0.00 | 0.00 | 0.00 | 155,125.00 |
| ("On-Job Cost") | 0.00 | 0.00 | 0.00 | 155,125.00 |

ESTIMATE SUMMARY

| | | | |
|---|---|---|---|
| TOTAL MATERIAL | | | 0.00 |
| TOTAL LABOR (PAYROLLS) | | | 0.00 |
| TOTAL EQUIPMENT & MISC | | | 0.00 |
| TOTAL SUB-CONTRACT | | | 155,125.00 |
| SUB-TOTAL (ON-JOB COST) | | | 155,125.00 |
| SALES TAX ON MATERIALS | FACTOR: | 0 | 0.00 |
| TAX ON PAYROLLS | FACTOR: | 35% | 0.00 |
| ALL INSURANCE EXCEPT BUILDER RISK | FACTOR: | 7.727 | 2,218.00 |
| BUILDER'S RISK ON INCREASE TO TIME | FACTOR: | 0.015 | 59,650.00 |
| BUILDERS RISK ON CHANGE ORDER AMOUNT | | 0.015 | 1,264.00 |
| SUB-TOTAL (ACTUAL COST) | | | 218,257.00 |
| BOND PREMIUM - GENERAL CONTRACT | | | 2,843.00 |
| SUB-TOTAL (ADJUSTED JOB COST) | | | 221,100.00 |
| OVERHEAD/PROFIT | 15 % | | 33,165.00 |
| TOTAL | | | 254,265.00 |

Price valid for 30 days ( Expires August 7, 2023)
Bixby must release project retainage for this price to be valid.

Electrical Mechanical Co.

2211 East 6th Street
Tulsa, OK 74104
Phone: 918-585-3640
Fax: 918-585-3683

# Change Order for New Capacitor/Filter in Plant Electrical Room

**DATE:** 5/12/2023

**TO:** Kevin Lang

**FROM:** Tony Watson

**PROJECT:** 2034 Bixby Water Reclamation Facility

---

Complete cost for Removal of existing Capacitor bank and installation of new Capacitor/Filter Bank at the main WWTP electrical room.

Equipment - $112,570.00
Start-up – $28,600.00
5-year Warranty - $31,500.00
Material - $ 10,350.00
Labor - $27,675.00

Total Cost = $210,695.00

**Items provided by EMC:**

- All labor for mobilization, Removal, Installation, and Demobilization.
- Conduit system to match existing installation, wireways system, wire, fittings, and supports. Terminations of power conductors and control conductors.
- Demo of 1 existing Capacitor Bank and Removal.
- Installation of 1 Capacitor/Filter Bank.

**Items not provided by EMC:**

- Any modification to the PLC/SCADA Network.
- Any other items other than the Capacitor/Filter Bank installation for this project are not included in this bid.

If you have any questions or need any further clarification, please call.

Thanks,

Tony Watson
Project Manager
918-688-6979

# Detail Bill of Material



**Project Name:** Bixby Filtered Cap Bank

| Item No. | Qty | Product | Description |
|---|---|---|---|
| | 1 | EESS SAT | |

***See Approval Drawings for Comments and Clarifications***
Start-up Contact: Contractor
DAVID TYLER
Estimated Start-up Date:
A Coordination Study does not exist.

**Designation** Start-up and Warranty

| Qty | List of Materials |
|---|---|
| 1 | EESS Office: Tulsa, OK, quote as of 4/24/2023 8:48:40 PM |
| 1 | Jobsite: , Bixby, Oklahoma 74133 |
| 1 | Drive Time: 0.35 Hours |
| 1 | 1 Test Equipment Setup Locations |
| 1 | Service Agreement, 5 Year Warranty Gold |
| 1 | Switched Anti-Resonant Capacitor Bank (Low Volt.) |

| Item No. | Qty | Product | Description |
|---|---|---|---|
| | 1 | Power Factor Correction | Switched Anti-Resonant Capacitor Bank (Low Volt.) |

**Catalog No** 200THFSR431
**Designation** 200kvar Cap

| Qty | List of Materials |
|---|---|
| 1 | FLR MTD SWT HTMNC FLTR 480V 200KVAR |
| 1 | C Option, Communicating Power Factor Controller, Modbus RTU RS-485 (Order Entry on VISTA Suffix PFC) |
| 1 | T2 Option, Integrated SPD Series Surge Protection, 160 kA per phase, with EMI/RFI Filtering (Order Entry on VISTA Suffix PFC) |
| 1 | M1 Option, Molded Case Breaker, 400 A, High Interrupting Rating (Order Entry on VISTA Suffix PFC) |
| 1 | N1 Option, 100 kA busbar bracing (Order Entry on VISTA Suffix PFC) |
| 1 | Optional Compartment Heater (Order Entry on VISTA Suffix PFC) |

Instruction Manual **IM02607001E**
Effective May 2022
Supersedes July 2019

# AutoVAR 600 and AutoVAR detuned filter automatically switched capacitor and filter bank installation operations and maintenance manual

## Contents


| Description | Page |
|---|---|
| Installation overview | 2 |
| Handling and installation instructions for low-voltage switched capacitor banks | 2 |
| Storage and handling instructions for low-voltage PFC | 3 |
| Positioning | 4 |
| Installation and interconnect instructions | 5 |
| Electrical system connections | 7 |
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Powering Business Worldwide

**⚠ WARNING**

**FAILURE TO INSTALL THE AUTOVAR 600 IN ACCORDANCE WITH THESE INSTRUCTIONS MAY CAUSE DAMAGE TO THE EQUIPMENT AND/OR PERSONAL INJURY.**

**⚠ WARNING**

**INCOMING POWER SHOULD BE DISCONNECTED BEFORE MAKING ANY WIRING CONNECTIONS.**

**⚠ WARNING**

**AFTER ALL RIGGING, SETTING, AND WIRING HAS BEEN COMPLETED AND BEFORE THE POWER TO THE AUTOVAR IS ENERGIZED, THE INTERIOR OF THE UNIT SHOULD BE CLEARED OF ANY METAL EQUIPMENT, METAL SHAVINGS, TOOLS, AND OTHER DEBRIS.**

**⚠ WARNING**

**WHEN THE FRONT DOOR IS OPENED WITH THE MAIN DISCONNECTS CLOSED, THE MAIN POWER BUSBARS, CAPACITOR FUSES, CAPACITOR CONTACTOR LINE SIDE, AND CONTROL TRANSFORMER FUSES ARE ENERGIZED AT LINE VOLTAGE. ONLY QUALIFIED PERSONNEL SHOULD HAVE ACCESS TO THE CABINET INTERIOR.**

**⚠ WARNING**

**AFTER DE-ENERGIZING THE UNIT, WAIT FIVE MINUTES BEFORE OPENING THE FRONT DOOR.**

## Installation overview

The installation of the AutoVAR consists of the following steps:

1. Setting the cabinet(s) in place.
2. Connecting the assembly to the electrical system.
3. Installing the current transformer (CT) on the system (checking CT polarity) and terminating secondary in the unit.
4. Programming the controller.
5. Starting and ensuring proper operation.

## Handling and installation instructions for low-voltage switched capacitor banks

### General

The following handling and installation instructions are intended to help customers install the low-voltage switched capacitor banks properly and efficiently. Handling and installation instructions are only recommendations. They do not relieve the purchaser, customer, installer, or contractor from full responsibility for proper inspection, handling, and installation. Failure by the customer to comply with handling or installation instructions will void the capacitor bank warranty.

### Inspection

At the time of delivery, the customer shall be responsible for inspecting all sections of the equipment for damage during transit. Both the inside and outside of the equipment must be inspected. If any damage has occurred, it should be noted on the delivery receipt prior to signing acceptance. If damage has occurred, a claim should be immediately filed by the customer with the delivering carrier. Minor paint scratch or minor dent can be touched up or repaired at the site.

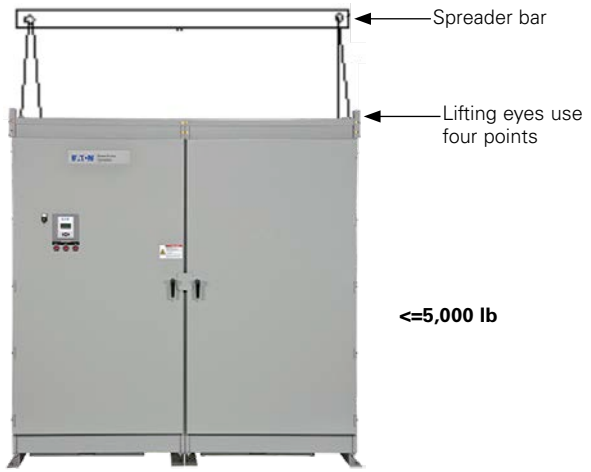
### Moving

1. Shipping pallets can be moved using fork lifts on both ends of the wood pallet. Do not use fork lift if the equipment has been un-mounted from the wood pallet.

2. Do not drop the equipment.
3. Do not allow hard impact from tools and handling equipment.
4. Never use cables or chains around the equipment.
5. Never fork lift equipment without the wood pallet.
6. Keep equipment upright. Do not tilt or invert the equipment.
7. Use of rollers to allow equipment to roll on base channel is permitted.
8. Weights shown on drawings are estimated weights. Refer to shipping papers for actual weights of shipping sections.

### Lifting

1. For 78-inch-wide shipping sections (KK or double door enclosures) weighing up to 5,000 lb (2,270 kg), use all four lifting eyes to lift the shipping section as shown below. The use of a spreader bar is required to avoid equipment damage.




2. For 39-inch-wide shipping section (L or single door enclosures) weighing up to 3,000 lb (1,360 kg), use lines attached to all four lifting eyes to move equipment.

### Installation

1. The equipment requires a concrete slab for continuous bottom support.
2. Locate and line-up all sections as shown on the equipment drawing. For units shipped in split sections, locate and install the provided conduit interconnecting section.
3. Once the conduit and interconnection is completed, anchor the base channel to the concrete slab with anchor bolts and hold-down hardware. Anchor bolts and hold-down hardware are to be supplied by the customer.
4. The customer can use either external anchor clips or use the holes provided in base channel to anchor this equipment.

## Storage and handling instructions for low-voltage PFC

AutoVAR units are shipped on pallets and are provided with lifting eyes.

All PFC units must be stored upright.

### Short-term storage

If a capacitor unit is not energized for up to three months, store it in a climate-controlled environment with adequate air circulation so that it is protected from dirt, air born contaminants, moisture/humidity, water, and chemicals. The storage temperatures should be from –40 °C (–40 °F) to +55 °C (+131 °F). The environment humidity should be less than 70%.

If the storage area is cool and/or damp, space heaters should be provided to prevent condensation inside the automatic capacitor bank.

Evaluate and if necessary replace the dust/air filter.

### Long-term storage

Store the equipment in a dry, ventilated location protected from dirt, air born contaminants, moisture/humidity, water, and chemicals. The storage temperatures should be from 0 °C (32 °F) to 40 °C (104 °F). The environment humidity should be less than 70%.

Stored equipment could be protected by a water-resistant cover such as a tarp or plastic, providing effective protection against dust, dirt, and water, etc., taking care as to not impede the natural ventilation.

Putting a capacitor bank into service after a prolonged storage requires that the unit be subjected to INSULATION RESISTANCE AND CAPACITANCE measurements. Note: INSULATION RESISTANCE SHOULD ONLY BE PERFORMED BETWEEN TERMINAL AND GROUND. Ensure the control power fuses are disconnected/isolated during and from the test. The test readings should be at least 200 Mohm or greater. If the value is found to be lesser, take steps to trace and eliminate moisture from the unit.

Evaluate and, if necessary, clean or replace the dust/air filter.

### After short-term and long-term storage

Follow instructions of individual components such as circuit breakers.

### For circuit breakers

Remove dust, dirt, soil, grease, or moisture from the surface of the circuit breaker using a lint-free dry cloth, brush, or vacuum cleaner. Do not blow debris into the circuit breaker. If contamination is found, look for the source and eliminate the problem.

Switch circuit breaker to ON and OFF several times to be sure that the mechanical linkages are free and do not bind. If mechanical linkages are not free, replace the circuit breaker.

With the circuit breaker in the ON position, press the PUSH-TO-TRIP button to mechanically trip the circuit breaker. Trip, reset, and switch the circuit breaker ON several times. If the mechanism does not reset each time the circuit breaker is tripped, replace the circuit breaker.

Check base, cover, and operating handle for cracks, chipping, and discoloration. Circuit breakers should be replaced if cracks or severe discoloration is found.

Check circuit breaker mounting hardware and tighten if necessary.

Check area where the circuit breaker is installed for any safety hazards, including personal safety and fire hazards.

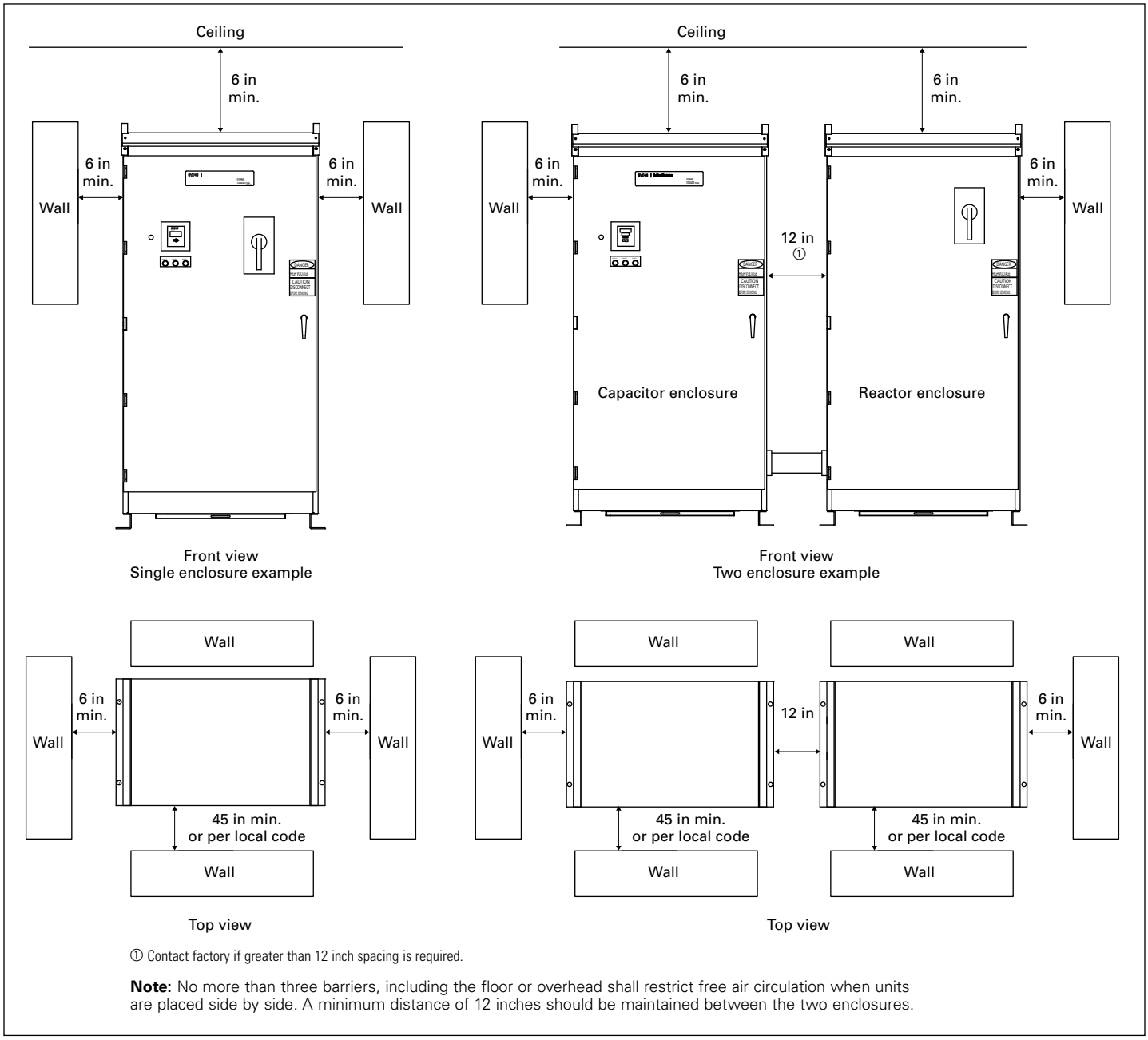
Exposure to certain types of chemicals can cause deterioration of electrical connections.

The operation of circuit breakers with electronic trip units can be field tested using the appropriate test kit.

## Positioning

Position the unit so that:

1. Natural ventilation is not impeded.
2. Ambient temperature does not exceed 104 °F (40 °C).
3. Spacing complies with the National Electrical Code®.
4. Follow the clearance requirements as shown in **Figure 1**. Failure to follow the clearance can degrade the capacitance value of the unit, which is not covered under the manufacturer's warranty.




① Contact factory if greater than 12 inch spacing is required.

**Note:** No more than three barriers, including the floor or overhead shall restrict free air circulation when units are placed side by side. A minimum distance of 12 inches should be maintained between the two enclosures.

**Figure 1. Position of the unit**

## Installation and interconnect instructions for AutoVAR filter in two separate enclosures

When the AutoVAR filter bank is built in two enclosures, with capacitors in one enclosure and reactors in the other, the following instructions will guide in completing the installation and interconnection of the two cabinets.

Capacitor cabinet

Reactor cabinet

**Note:** NEMA® 3R rated conduit hubs and a loose conduit nipple along with all needed conductor terminating hardware is included with the equipment. The two enclosures must be positioned next to each other and the short length of conduit placed between the two and tighten the conduit fittings to secure the conduit in place and proceed with the electrical wiring as outlined on **page 6**.

**Figure 2. Capacitor cabinet and reactor cabinet**

The main three-phase 480 V incoming power conductors are terminated in the reactor cabinet at the power conductor mechanical lugs (see **Figure 3**). The lugs are sized to accommodate the maximum sized power conductors sized to the rating of the unit and calculated based on the latest edition of NEC®.

A ground lug is provided for the grounding conductors in both the capacitor and reactor cabinet.

**Figure 3. CT and power wiring termination points**

The service entrance CT wiring gets connected to terminal block TB1 to terminals 1 and 2 in the capacitor cabinet. The TB1 terminals 1 and 2 also have a temporary (to be removed and stored safely) shorting pin installed that will facilitate reversal of CT lead polarities if required during commissioning and shall be removed after successful commissioning and once the CT polarities are verified.

Both power and control wiring interconnection is required between the two cabinets.

There are three 4 AWG wires per stage that need to be interconnected between the capacitor and reactor cabinet. These wires are labeled, retracted, and coiled inside the capacitor cabinet and are of sufficient length to complete the interconnection (see **Figure 6**). These wires are to be routed through the conduit from the capacitor enclosure to the reactor enclosure. Correctly match and terminate the labeled conductors to the appropriate reactor leads to ensure that the phase sequence is maintained. Use the included hardware to connect each power wire to the proper reactor phase lug, as determined by the labels on the wire (see **Figure 4**) and on the reactors. The recommended torque value is shown in **Table 4**.

**Figure 4. Wire labels**

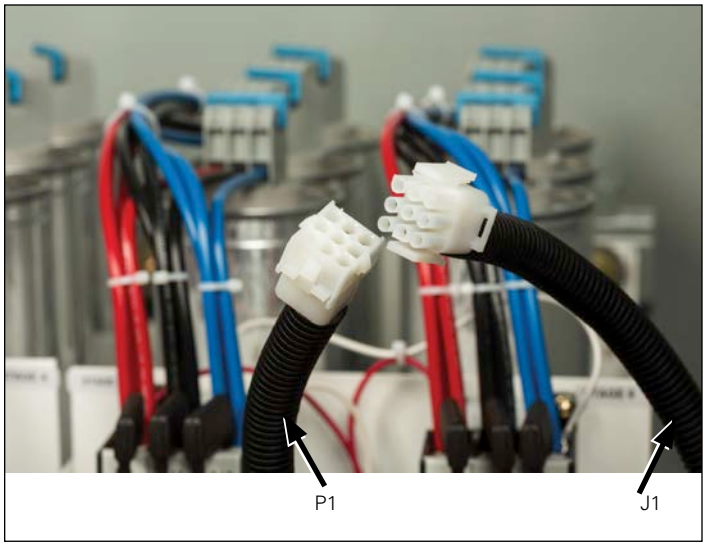



**Figure 5. Control wiring interconnection**

A control wiring harness is terminated into a male female termination plug. Complete the routing of control wiring harness through the conduit and form the connection between the P1 and J1 end of the control wiring harness (see **Figure 5**).

**Figure 6. CT wiring for PXM**

The internal CT wiring for the Power Xpert® Meter (PXM) 1300 (option if ordered) is also retracted and coiled inside the capacitor cabinet. Route the CT wires through the conduit and connect it to the shorting terminal block SCTB1 on the control panel inside the capacitor cabinet.

**Figure 7. CT shorting block for PXM**

This completes the electrical interconnection of the two cabinets.

## Electrical system connections

When connecting the unit to the power system, the ground lug must be grounded and all applicable NEC codes must be followed.

The AutoVAR must be connected as shown in **Figure 8**. All three phases and a ground connection must be provided to the AutoVAR unit. No neutral connection is provided, because neutral wiring is not required. The lugs that accommodate the incoming conductors are located on the busbars on the right side of the cabinet. Refer to equipment drawings for lug specifications. If the unit is supplied with a disconnect, the incoming conductors are connected directly to the disconnect's line lugs. The lugs shall be torqued as indicated on these devices.

### Fused disconnects

Fused disconnects should be sized no less than 165% of the rated capacitor current.

### Circuit breaker

The circuit breaker should be sized no less than 135% of the rated capacitor current.

**Note:** Rated capacitor current = (1000 x kvar) / (√ 3 x voltage) (amps)

Where: Voltage = line-to-line voltage

kvar = Three-phase kvar rating of capacitor (nameplate rating)

Example: 500 kvar capacitor, 480 V system:

Rated capacitor current = (500 x 1000) / (√ 3 x 480) = 601 A

The breaker shall be rated to carry the 601 A x 135% or 811 A continuously in its operating environment. In this case, therefore, a 1000 A 100% rated breaker will be required as a minimum.

### Conductor ampacity

NEC Article 460 specifies that the ampacity of capacitor conductors be rated at 135% of rated capacitor current. Our UL® listed units require that only 90 °C copper conductors be used at their 75 °C ampacity rating to supply the units. The ampacity should be derated as necessary for ambient temperature (see NEC).

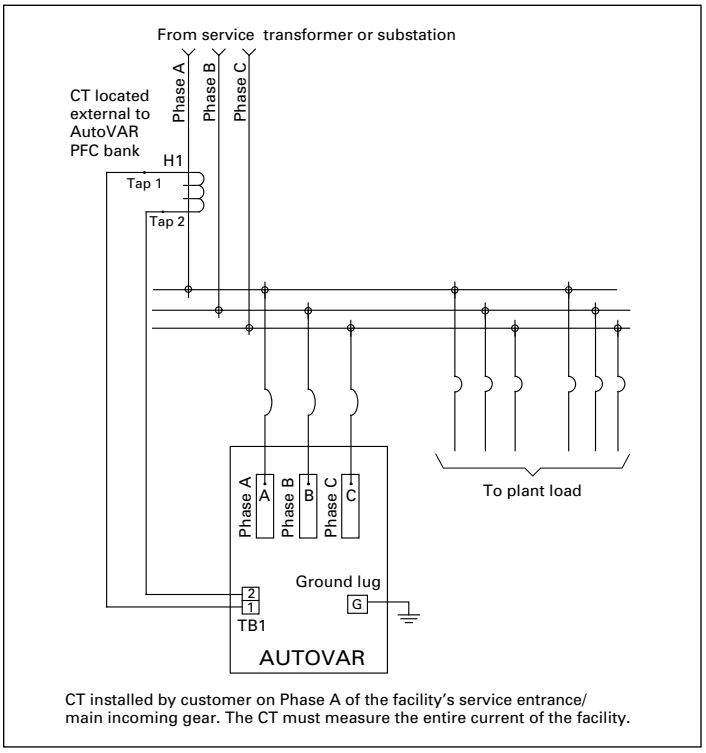



**Figure 8. Connection schematic**

### CT placement

**⚠ WARNING**

**FOLLOW ALL SAFETY PRECAUTIONS AND REGULATIONS FOR WORKING ON ELECTRICAL SYSTEMS RATED UP TO 600 V. ALWAYS WEAR APPROPRIATE PERSONAL PROTECTIVE EQUIPMENT (PPE). FOLLOW ALL LOCK OUT/TAG OUT PROCEDURES.**

**⚠ WARNING**

**FAILURE TO FOLLOW THESE INSTRUCTIONS CAN RESULT IN MALFUNCTION OF THE EQUIPMENT.**

- A CT is required for operation of an automatically switched capacitor bank. If an order for the CT was placed on Eaton to supply a CT with the order, it is included within your unit. Please reference AutoVAR Current Transformer Installation Manual IL157001EN for Eaton supplied CTs
- The CT is to be installed on "A-phase" of the main service entrance and wired to the terminal block TB1, terminals 1 and 2 of the capacitor bank (see **Figure 9**)
- The CT should always be installed upstream of the loads and capacitor bank
- CT shall not be installed on the feeder feeding the capacitor bank
- CT polarity must be observed accurately for proper functioning of the capacitor bank. H1 should always face the source (utility) side
- CT rating determined by the mains service entrance rating. If exact rating is not available, select the next higher appropriate rating
- If only transformer rating is known, use the following formula to calculate the maximum current

$$\text{Current for CT rating} = \frac{\text{transformer kVA} \times 1000}{1.732 \times \text{line voltage}}$$

- The CT shall be metering class, primary rating as required, 5 A secondary rating. The minimum Burden designation is B-0.5, as defined in IEEE® Standard C57.13-2008
- The CT secondary current shall not exceed 5 A nominal. CT secondary currents of greater than 6 A can cause damage to the controller

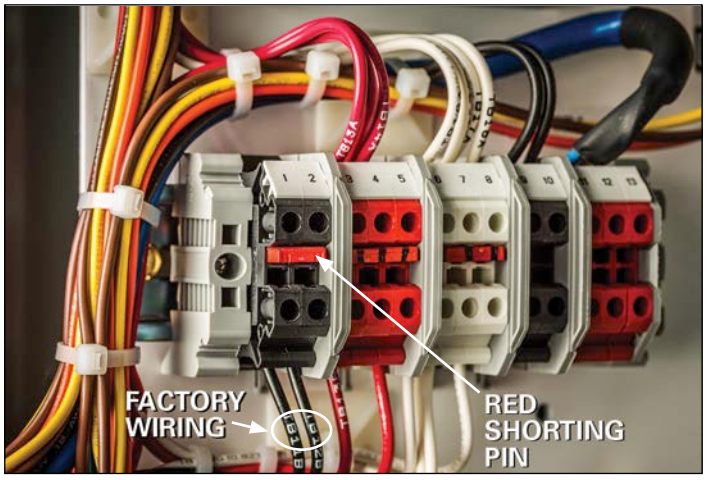



**Figure 9. Terminal block TB1**

The placement of the CT is critical to the proper operation of the AutoVAR. **Improper location and phasing of the CT causes more startup problems than any other error.**

As shown in **Figure 8**, the CT must be placed upstream of the AutoVAR power connections preferably on phase A of the main incoming bus. In other words, place the CT so that it 'sees' the entire plant load, including the AutoVAR and any other capacitors. The high side of the CT (marked "H1") must face the utility source.

After the CT has been placed on the main incoming bus, the interconnects from the CT secondary should be terminated on the terminal strip (TB) pins #1 and #2 (located on the inside left panel of the capacitor cabinet) (see **Figure 9**). The Terminals TB1 and 2 are factory fitted with a shorting pin (that should be safeguarded until after successful commissioning) to allow for changing any mis-wired CT wiring.

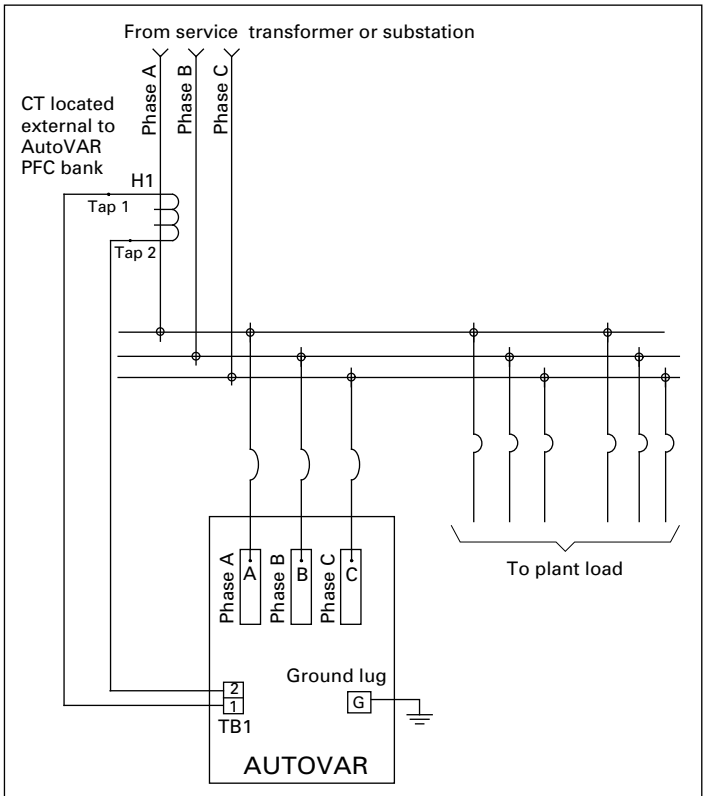
Precaution should be taken to disconnect the factory side wiring when attempting to correct the field wiring in order to avoid an open circuit on the CT secondary. Once the CT polarity and phasing has been verified, the CT shorting pin may then be removed.

### CT cabling and connections

CT wires should be minimum #12 AWG up to 100 ft of wire length and #10 AWG up to 150 ft. CT wires will need to be routed separately from the power conductors in a separate conduit. Shielded type cable will be required if the CT conductors are not routed in a metal conduit.

The length and gauge of wire is applicable for up to ANSI C57 B-0.5 burden. CT lead resistance will be kept to a minimum and calculated at expected overload capacity of up to 120%.

**The AutoVAR electrical connections are now complete.**




CT installed by customer on Phase A of the facility's service entrance/ main incoming gear. The CT must measure the entire current of the facility.

**Figure 10. Connection schematic**

## Startup and commissioning

### ON/OFF switch

Ensure the ON/OFF switch located on the door is in the OFF position. Before energizing the unit, please verify that all connections within the unit are secure. Tighten any loose connections to the specified values (see **Table 4**) using a calibrated tool. The upstream or (optional integral) disconnect or circuit breaker can now be closed to energize the unit. Once energized, turn the ON/OFF switch to the ON position and the unit is ready to begin operation as indicated by the illuminated light within the ON/OFF switch.

### Cleared fuse indicator lights

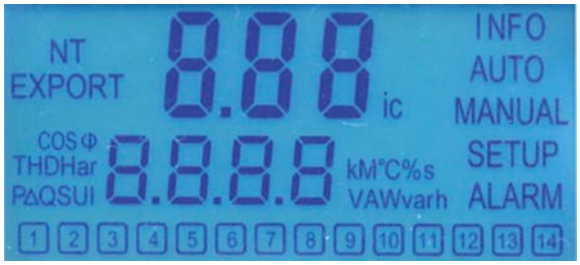
The three lights on the door are cleared fuse indicator lights. These lights come on when a power fuse inside the unit is cleared. If the door of the unit is opened (with unit still energized), the cleared fuse can be identified by the red light(s) that are illuminated (a light is located next to each fuse).

Ensure that the internal and external cleared fuse indicator lights are not brightly lit before beginning the commissioning.

## Controller setup procedure

Instructions henceforth are only applicable for the factory standard (default) controller. For Option C controller, please refer to the separately included instructions on Modbus enabled controller.

## Eaton BLR-CX Plus quick commissioning guide




**Screen legends**

| | |
|---|---|
| INFO | Capacitor database |
| AUTO | Automatic mode |
| MANUAL | Manual mode |
| SETUP | Setup mode |
| ALARM | Blinking during alarm |
| NT | Second target-pf is active |
| EXPORT | Export of active energy |
| 1-12 | Capacitor stage number indication |

**Figure 11. Digital display**

### Operation

Operation of BLR-CX Plus is done by 4 keys.

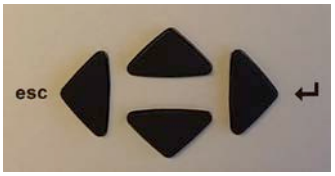



**Figure 12. Operational keys**

Submenus are scrolled through by pushing the ▲ (up) key or ▼ (down) key.

Pressing ▶ (↵ right / Enter) key allows selection, entering the edit mode or accepts the edited values.

In edit mode, the ◀ (left / esc) key or ▶ (↵ right / Enter) key scroll left and right to allow setting of the appropriate digit.

Outside of edit mode, the ◀ (left / esc) key exits to the next higher level.

Press and hold the ◀ (left / esc) key for approximately 3 seconds to silence any alarms.

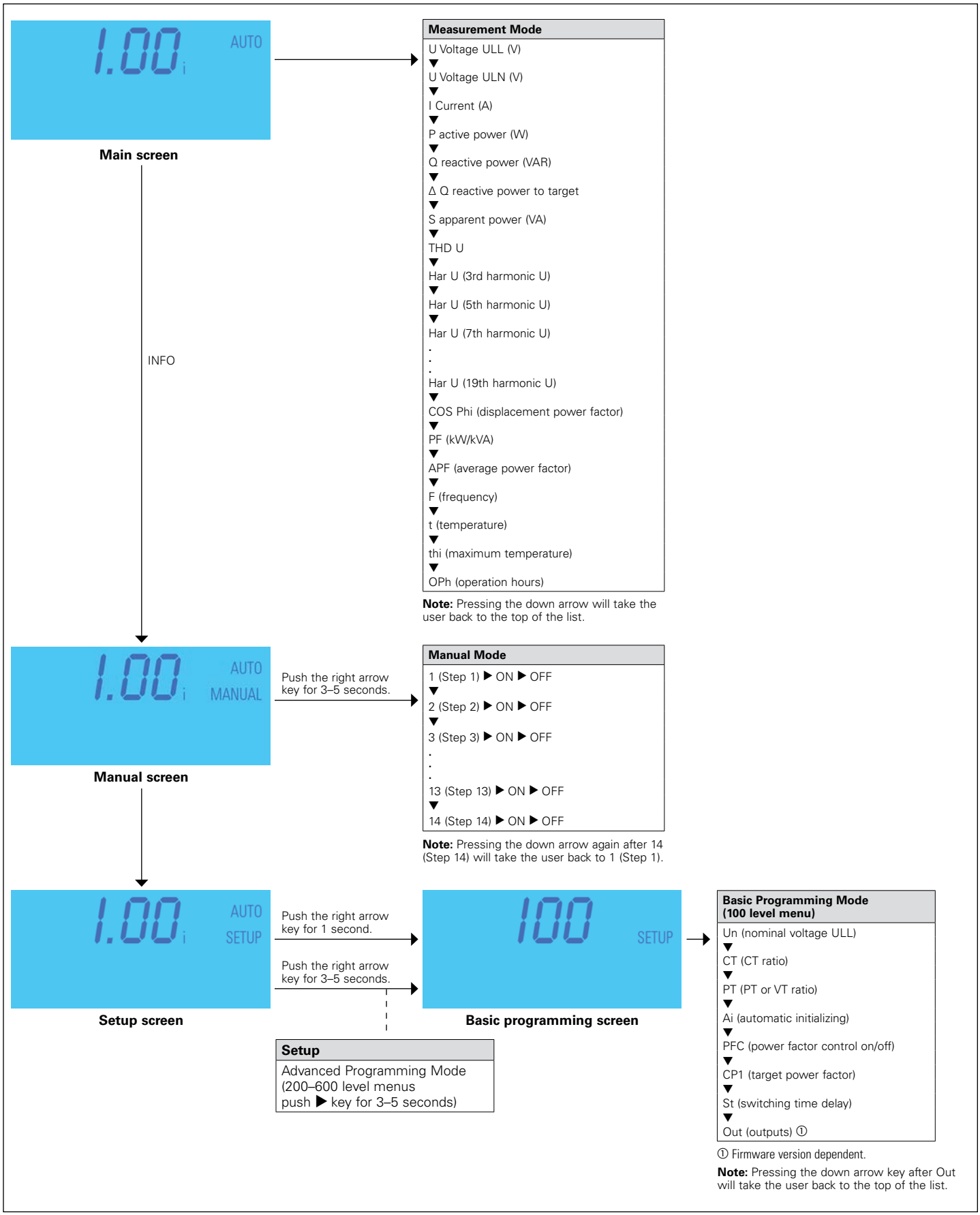



**Figure 13. Menu map**

**Programming the controller**

Step 1

**Upon power on the controller displays the existing power factor value "X.XX i" and enters the Automatic Control mode.**

The 'i" at the end indicates an inductive power factor and would be appropriate for most installations. A "c" at the end indicates capacitive power factor and suggests reactive power export and may not be appropriate. Refer to the troubleshooting section for resolution steps.

Step 2

Next step is to set up the basic parameters in the controller.

From the main screen, press the ▼ (down) key to step through the "INFO", "MANUAL" and to "SETUP" mode. When "SETUP" is shown, press the ▶ (↵ right /Enter) key to enter the Menu 100. Press the ▶ (↵ right /Enter) key and program and or verify the following values.

Un Nominal voltage (factory programmed, customer may verify)

**Ct CT-ratio (factory set to 600, which corresponds to 3000:5 CT ratio. Changing the CT ratio will change the capacitor step sizes in 402 and those values will have to be re-programmed.**

Pt PT-ratio (factory programmed)

Ai Start of automatic initialization (factory programmed)

PFC PF-control ON/OFF/ HOLD (factory programmed)

**CP1 Target-PF (customer to program)**

St Switching time delay (factory programmed, customer may verify)

Out Output type of each stage (Auto/Alarm/Fixed Off/Fixed On) (factory programmed, customer may verify)

Once the Menu 100 is programmed, press the ◀ (left / esc) key three times to return to the main screen that displays the existing PF.

**Overview**

BLR-CX Plus is factory preset to the default values shown in the **Table 1**. Customer to program and verify the values set to meet the specific conditions of each installation.

Step 3

The next step is to verify the measured values.

From the main screen, press the ▶ (↵ right / Enter) key to enter the Measurement mode. See menu map for a list of designated parameters.

Press the ◀ (left / esc) key to return to the main screen that displays the existing PF.

Step 4

The final programming step is to verify the working of the capacitor bank. This is done by activating the controller in manual control mode and cycling through all the available steps.

**Note:** The steps will switch on only after the factory set capacitor stage discharge time has elapsed.

After each manual operation of the stage, the PF should change in the right direction (for example, 0.70 i >> 0.78 i >> 0.85 i…).

If the PF changes in the right direction, the capacitor bank has been correctly commissioned. If not, please refer to the troubleshooting section.

To switch the controller in manual control mode, press the ▼ (down) key to step through the "INFO" mode to "MANUAL" mode. Press and hold the ▶ (↵ right /Enter) key for approximately 3 seconds until "1" displays, indicating the stage number 1 is available for control.

**Note:** In manual mode, the controller freezes the stages in their existing state (ON, OFF, or HOLD). Therefore, it is important to ensure that at the end of this Step 4, the controller is returned back to the automatic control mode by pressing the ◀ (left / esc) key to return to the main screen that displays the existing PF.

After activating all available steps, one should make note of the displayed PF value as that reading should be greater than or equal to the target PF desired. If the displayed PF with the electrical system fully loaded and all steps energized is less than the target PF, then the selected capacitor bank is not sized adequately to raise the PF to the desired value. The customer should either upgrade the capacity of the capacitor bank or the target PF value should be decreased to prevent "PF alarms".

### Menu structure

The following table provides an overview about the basic and advanced programming parameters of BLR-CX Plus.

Menu 100 is the Basic Menu. Menu 200 through 800 is for advanced users only and requires a PIN access (242). The settings in these submenus should only be accessed and changed after consulting with Eaton. Menu 700 is Modbus setting menu. It is only available on capacitor banks with the "C" suffix.

**Table 1. Programming mode detailed menu map**

| Menu | Function | Default | Customer settings |
|---|---|---|---|
| **100** | **Quick start setup** | | |
| Un | Nominal voltage (phase-phase) | 208 V / 240 V / 480 V / 600 V | |
| Ct | CT-Ratio | 600 (corresponds to 3000:5 CT ratio) | |
| Pt | VT-ratio | 1.7 (240 V unit)<br>3.7 (480 V unit)<br>4.7 (600 V unit) | |
| Ai | Start automatic initializing | N | |
| PFC | Start/Stop/Hold PF-control | On | |
| CP1 | Target-PF 1 | 0.95i | |
| St | Switching time delay | 60 s | |
| Out | Type of each step (1, 2, 3…12) | Auto (for each step installed in unit), Fixed Off (for unused controller outputs) | |
| **200** | **Setup measuring system** | | |
| 201 | Nominal voltage (phase-phase) | 208 V / 240 V / 480 V / 600 V | |
| 202 | CT-ratio | 600 (corresponds to 3000:5 CT ratio) | |
| 203 | VT-ratio | 1.7 (240 V unit)<br>3.7 (480 V unit)<br>4.7 (600 V unit) | |
| 204 | Tolerance nominal voltage | 20% | |
| 205 | Voltage measuring | Y = L–L | |
| 206 | Phase-offset | 90 | |
| 207 | Start automatic initializing | N | |
| 208 | Synchronization to frequency | 60 (60 Hz unit) | |
| 209 | Temperature offset | 0 °C | |
| **300** | **Setup control system** | | |
| 301 | Switching threshold | 55% | |
| 302 | Target-PF 1 | 0.95i | |
| 303 | Target-PF 2 | 0.95i | |
| 304 | Target-PF 2 at kW-export | N | |
| 305 | Switching time delay | 60 s | |
| 306 | Switching time delay for fine control | 10 s | |
| 307 | Fine control active | N (for units with equal stage sizes), Y (for units with multiple stage sizes) | |
| 308 | Automatic Stage detection | N | |
| 309 | Block defective capacitors | N | |
| 310 | Start/Stop/Hold PF-control | On | |
| 311 | Control algorithm | 1 | |
| 312 | Reactive-power offset | 0 | |
| 313 | Asymmetrical switching time delay | 1 | |
| 314 | Switch-off capacitors in leading condition | N | |
| 315 | Distribute switching operations | N | |
| 316 | Detect faulty stages | Y | |
| **400** | **Setup capacitor database** | | |
| 401 | Discharge time | 60 s | |
| 402 | Capacitor size: step 1…max. 12 | Varies (see equipment drawings for step size, typically 25, 50, or 100 kvar capacitive) | |

| Menu | Function | Default | Customer settings |
|---|---|---|---|
| **400** | **Setup capacitor database, continued** | | |
| 403 | Type of exit: step 1…max. 12 | Auto (for each step installed in unit), Fixed Off (for unused controller outputs) | |
| 404 | Switching operations: step 1…max. 12 | 0 | |
| 405 | Operations hours counter: step 1…max. 12 | 0 h | |
| 406 | Fan relay as stage output | N | |
| **500** | **Setup alarm system** | | |
| 501 | Reset alarms manually | N | |
| 502 | THD-U threshold | 6% | |
| 503 | Disconnect capacitors when THD > | N | |
| 504 | THD alarm delay | 120 s | |
| 505 | Stop control if I=0 | N | |
| 506 | Service alarm | N | |
| 507 | Max. operations per step | 262 k | |
| 508 | Max. operation hours of BLR-ACX-V | 65.5 k | |
| 509 | Max. operation hours per step | 65.5 k | |
| 510 | THD-I threshold | 20% | |
| 511 | Digital input logic | Y | |
| 512 | Temp. threshold level 1 (fan control, type of exit: AL) | 40 °C | |
| 513 | Temp. threshold level 2, disconnect capacitors | 55 °C | |
| 514 | Control alarm (target cannot be reached) | Y | |
| 515 | Faulty stages alarm | Y | |
| 516 | Stage power loss alarm | Y | |
| 517 | Flashing display | N | |
| 518 | Digital input function | CP2 | |
| 519 | I-Low alarm suppr. | Y | |
| 520 | Switch off active stages if digital input alarm | N | |
| 521 | I-Low alarm | Y | |
| 522 | I-High alarm delay | 10 s | |
| 523 | Switch-off interval | 60 s | |
| **600** | **Reset** | | |
| 601 | Reset to default values | N | |
| 602 | Reset capacitor database to default | N | |
| 603 | Reset operation hours | N | |
| 604 | Reset average PF | N | |
| 605 | Reset max. temperature | N | |
| 606 | Reset alarm | N | |
| 607 | Info firmware | — | |
| 608 | Change password | 242 | |
| 609 | Restart first setup | N | |
| **700** | **Modbus** | | |
| — | Baud rate | 19.2 k | |
| — | Parity and stop bits | EVEN | |
| — | Slave address | 1 | |
| **800** | **System** | | |
| 801 | Backlight during commissioning mode | N | |
| 802 | Backlight delay time | 0.25 h | |

## Troubleshooting

**⚠ CAUTION**

**WHILE ATTEMPTING ANY TROUBLESHOOTING STEPS THAT REQUIRE ACCESS INTO THE CAPACITOR BANK, ALWAYS FOLLOW ALL SAFETY PRECAUTIONS AND REGULATIONS FOR WORKING ON ELECTRICAL SYSTEMS. ALWAYS WEAR PROPER PPE AND FOLLOW APPROPRIATE LOCK OUT AND TAG OUT PROCEDURES.**

### Automatic control mode

The controller should display status "Auto," which indicates that the controller is working in automatic mode. This is the desired mode of operation. If "Auto" is not displayed, then the power factor control is not working. Reasons for this are:

- Manual mode is active
- Control mode has been switched off
- Temperature is too high (if temperature input is provided)
- Current from the CT is less than 15 mA
- Voltage is out of range
- Harmonic level of voltage is too high

### Alarms and description

The controller has an extended alarm system. When an alarm is active, the sign ALARM in the display blinks and an error code is shown on the screen. Possible error codes are shown in the table below.

| Alarm | | | | Description |
|---|---|---|---|---|
| U | ALARM | | | The measured voltage is out of the set tolerance. |
| I LO | ALARM | | | Measuring current is less than 15 mA (please check CT signal and verify that CT shorting pin has been removed). |
| I HI | ALARM | | | Measuring current is too high. |
| PFC | ALARM | | | Target cannot be reached. |
| HARU | ALARM | | | The set THD voltage threshold has been exceeded. |
| HARL | ALARM | | | The set THD current threshold has been exceeded. |
| STEP | ALARM | FLTY | ALARM | One or more steps are defective. The defective steps are blinking together with the ALARM sign. |
| SPL | ALARM | /11 | ALARM | One or more steps have less than 70% of original size. Number of step and alarm text are blinking alternately. |
| THI | ALARM | | | Over temperature alarm. Threshold level 2 exceeded. The steps will be switched-off step-by-step. |
| OPH | ALARM | | | The set operating hours of the controller have been exceeded. |
| OPC | ALARM | /11 | ALARM | The maximum switching cycles threshold of at least one stage has been exceeded. |
| OPH | ALARM | /11 | ALARM | The set operating hours of at least one stage have been exceeded. |
| AI/ABRT | ALARM | | | The Automatic initialization has been aborted due to an error. The control is switched off. |

### Current and voltage monitoring

The controller is equipped with current and voltage monitoring to ensure it is within its operating parameters. The controller will show "I LO" alarm if there is no measured current or the magnitude sensed is less than 15 mA. If the current is greater than 6 A, the controller will show "I Hi alarm".

If either of these alarms are displayed, check the CT current path, verifying that the correct CT ratio is selected, the CT is in the correct position, and the current input and shorting jumpers at the terminal block are removed.

The allowed range of voltage depends on nominal voltage. When nominal voltage is out of range, "U Alarm" is shown. If this alarm is seen, then the setting of nominal voltage has to be adjusted. Nominal Voltage is measured and entered phase to phase.

### Capacitor stage database

A step fault ("STEP / FLTY") or step low ("SPL") alarm indicates problems with the sensed capacitor size. To check the capacitor stages, switch the controller into the INFO mode by pressing the ▼ (down) key. In the INFO submenu, by pressing the ▲ (up) or ▼ (down) key, the steps can be chosen and once the steps are indicated in the display, pressing the ▶ (↵) (right/enter) key displays the information for the selected steps.

| CC C INFO 50 kvar ① | ▼ | INFO 99.9% ① | ▼ | OC INFO 10.12 k ① | ▼ | i INFO AUTO ① |
|---|---|---|---|---|---|---|
| actual power of step | | percentage actual to nominal power | | number of operations | | step type |

It's possible to have capacitive steps as well as inductive steps. Ensure the steps show capacitive ("C") kvar.

### High temperature alarm

1. Replace dust filters (Catalog Number AUTOVAR6FX8).
2. Verify proper operation of fans.
3. Verify that measured ambient temperature does not exceed 40 °C (104 °F).
4. Check for external sources of heat such as direct sunlight.

### PFC alarm

Possible reasons could be:

1. Insufficient capacitance available or target PF set too high.
2. Capacitor stages deteriorated.
3. Capacitor stages sensed or set incorrectly, both in terms of type (inductive or capacitive) and value (100 kvar instead of 50 kvar).

### PF value incorrect, decreases as steps are added or shows X.XX"c"

1. CT polarity is incorrect.
2. CT leads are swapped.
3. CT is not mounted on A phase.

Adjust the Phase-Offset menu parameter according to the following chart.

| CT installed phase (with respect to incoming AutoVAR bus) | CT polarity | Controller phase-offset |
|---|---|---|
| A | Straight | 90 |
| A | Reverse | 270 |
| B | Straight | 330 |
| B | Reverse | 150 |
| C | Straight | 210 |
| C | Reverse | 30 |

### PF value shows unity or does not change even after steps are engaged

1. Location of CT is incorrect. Ensure that the CT is connected electrically ahead of the capacitor bank (at the service entrance panel or switchgear) and is not connected on the feeder that supplies power to the capacitor bank.
2. Steps have failed.

### Incorrect measurement values

1. Check that CT and PT ratios are programmed correctly in Menu 100.
2. Check that Nominal voltage is programmed correctly in Menu 100.

### Controller not switching on additional steps and does not reach target PF

This usually happens when the amount of capacitance available does not match the amount of kvar required. This can happen especially in low load situations when the amount of kvar required is very low compared to the smallest available step size (for example, total kvar required is 12 kvar and the smallest step size available is 60 kvar). The controller will not bring on any step to prevent overcompensation.

1. Check that the sensed and programmed capacitor step sizes are set and match the actual value.
2. Check that the setting in 314 is set to N.
3. Check the amount of shortfall kvar (▲Q) in the measurement menu and program this value in menu 312.
4. If all above fails, one may need to install smaller kvar size steps to allow the controller to switch them during low demand.

### BLR-CX Plus controller technical data

| Description | Specification |
|---|---|
| Measuring and supply voltage | Connection: Single-phase<br>Range: 90–550 Vac, 45–65 Hz<br>Protection: Max. 6 A<br>Power consumption: 6 VA<br>Transformer factor: Adjustable 1.0 to 350.0 |
| Current measurement | Connection: Single-phase<br>Range: 5 mA to 5 A<br>Transformer factor: Adjustable 1 to 9600 |
| Stage outputs:<br>Option -xxR | 6 or 12 Stage outputs<br>Type: Relay, normally-open, potential-free<br>Supply: Common, max. 10 A<br>Switch capacity per relay: 250 Vac / 5 A 400 Vac/<br>1 A 48 Vdc / 1 A 110 Vdc / 0.2 A<br>Type: Transistor, normally-open, open collector output<br>Supply: Common, max. 1.2 A<br>Switching capacity per transistor: 100 mA/8–48 Vdc |
| Temperature measurement | NTC: Under the housing cover<br>Accuracy: ± 5 °C |
| Alarm output:<br>Default Option -nc | Type: Relay, normally-open, potential-free<br>Switching capacity: 5 A / 250 Vac<br>Type: Relay, normally-closed, potential-free<br>Switching capacity: 5 A / 250 Vac |
| Digital input | Logic: Adjustable, high- or low-active<br>Input signal: 90–250 Vac |
| Service Interface | For service purpose only |
| Modbus:<br>Default Option -MB | Unassembled protocol: Modbus-RTU<br>Interface: RS-485<br>Common-mode range: –7 to 12 V<br>Differential-mode range: –12 to 12 V<br>Output current: –60 to 60 mA |
| Ambient temperature | Operating: –20 °C to +70 °C<br>Storing: –40 °C to +85 °C |
| Humidity | Range: 0–95%<br>Condensation: Not allowed |
| Overvoltage category | 300 VLN / 519 VLL CAT III 519–550 V CAT II<br>Degree of contamination = 2 |
| Standards | IEC 61010-1, IEC 61000 6-2, IEC 61000 6-4: Level B,<br>IEC 61326-1, UL 61010 |
| Compliance and listing | CE, c NRTL us (c UL us), EAC |
| Connections | Type: Screw terminals, pluggable<br>Cross section: Max. 4 mm² |
| Housing | Front: Plastic housing (UL 94 V-0)<br>Back: Metal cover |
| Protection class | Front: IP41 Back: IP20 |
| Weight | Approx. 0.6 kg |
| Dimensions | Device: H x B x T: 144 x 144 x 58 mm<br>Cut-out: H x B: 138 (+0.5) x 138 (+0.5) mm |

### Retrofit installations with BLR-CX Plus controller

Please retain and follow all instructions and safety precautions during and after installation.

1. Compare voltage and current ratings of BLR-CX Plus with data of mains and installation.
2. Mount the relay in the control panel with the two mounting clips.
3. Connect protection GROUND to PE connection of metal case.
4. BLR-CX Plus is to be connected according to the wiring diagram.
5. Ensure that the short-link for CT input signal is removed.
6. Typical wiring diagram of the controller is shown below. This may not match the existing installation. Please consult Eaton for retrofitting this into existing Eaton capacitor banks.

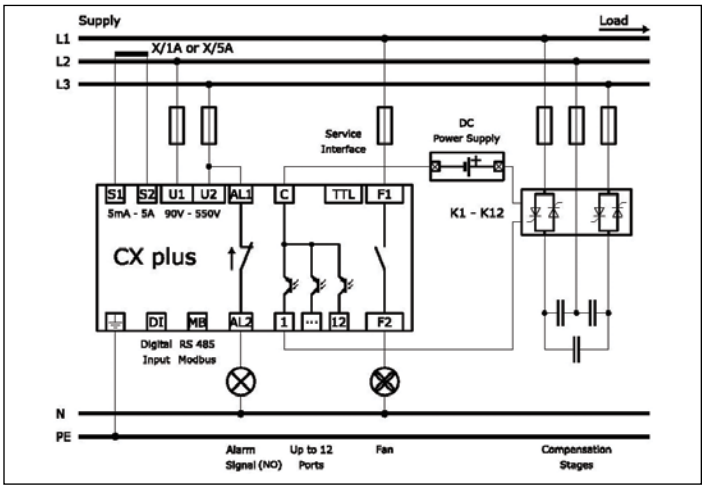



**Figure 14. Connection diagram: CX plus —12T**

### Troubleshooting

| Symptom | Correction |
|---|---|
| No control power | Check primary control fuses (three fuses located in fuse holder) and secondary fuse located on control transformer. |
| | Check disconnect or circuit breaker is ON. |
| | Check GFCI located on control panel inside cabinet. |
| | Check the reactor thermal switches status (open if operated, closed if healthy). |
| Displayed power factor is obviously wrong or decreases as stages engage | CT secondary current is too low (check CT tap setting and plant load). |
| | CT polarity is incorrect or leads are reversed. |
| Stages do not engage and target power factor has not been reached | Confirm that an inductive power factor is being displayed (i.e., 'i.73', not 'c.73'). |
| | Confirm that the required reactive power is at least 60% of the smallest step size available for switching. |
| | Confirm availability of capacitor stages and there is no stage alarm. |
| | Confirm "AUTO" is being displayed on the controller. |
| Blown fuse lights on front cabinet are lit (w/no blown fuses) | Check 3 primary control fuses (on control panel) if check system voltage matches the nameplate voltage. |
| Displayed power factor does not change as stages engage | Review 'Current transformer placement and connection' |
| Controller troubleshooting | Refer to "Controller setup procedure" section. |

### Fuse (clearing)

Capacitor fuses may clear for many reasons. An occasional cleared fuse may be the result of a switching 'spike', lightning strike, or other electrical disturbance. However, frequent fuse clearing may be a sign of a more serious problem. Please contact your Eaton representative or Eaton's Technical Resource Center at 1-800-809-2772 option 5, sub-option 2 for assistance if frequent fuse clearing occurs.

### Temperature control

The controller is fitted factory default with an ambient temperature alarm and trip option. The controller is also fitted with a non-reversing temperature sticker that helps monitor the highest reached temperature inside the cabinet.

The alarm and trip options are field adjustable and are set at the values shown in the controller set point table (see **Table 1**).

When the cabinet temperature exceeds the trip set point, the controller will shut down all the stages until the cabinet temperature falls below the trip set point, at point which the controller will resume the control of the stages.

If the PFC unit appears not to bring on any stages or is otherwise inoperable, check the temperature indicator on the back of the controller and verify that the temperature is within the specified limits of the unit.

### Reactor humming

If excessive humming is heard from the reactors in the unit, this could be due to the reactors being under too much stress. To reduce this stress, if the AutoVAR unit is bolted to the floor, try to loosen the bolts. The unistrut on the top of the reactor stack can be removed if the unit is in its final location. Please refer to **Figure 15**. Loosening or tightening the bolts on the unistrut can affect the stress on the reactors. Ensure the stack of reactors is aligned vertically and straight to the cabinet left to right.

**Figure 15. Reactor with unistruts**

## Options

### Remote alarm relay (option code A)

Remote alarm relay provides a single Normally Open volt-free 250 V / 5 A contact wired to a terminal block for customers' use.

### Communications controller (option code C)

Selecting option code C provides the user with our advanced controller that is equipped with Modbus® RTU RS-485 communications capability and additional advanced features. See IB157002EN.

### HOA switches (option code H)

The HOA switches provide external control of the capacitor stages. The following switch positions are available:

- Hand—turns stage on
- Off—turns stage off
- Auto—controller activated stages

### Circuit breaker (option code M or M1)

The trip settings on the circuit breakers shall be set in accordance with the NEC and coordination requirements within the facility.

### PXM (option code Q)

The PXM 1300 provides an electronic panel meter to those who wish to monitor various electrical parameters of the capacitor bank. The PXM cannot display the system parameters and thus should not be used for displaying the system parameters such as power factor, power, voltage, current, etc. For operation of the PXM 1300, please refer to the PXM 1000 series manual.

### Detuned (applies to AutoVAR filters only, code Y)

Detuned code Y supplies a 4.2 (5.67% reactors) tuned unit instead of 4.7 (4.53% reactors).

### Custom options (option code S)

Non-standard options including remote shutdown command, external interlock, etc. Consult with factory.

### Weather-resistant (option code W)

Allows the enclosure ingress protection rating to be NEMA 3R.

## Maintenance

The AutoVAR requires very little maintenance to operate reliably. However, please follow the Startup and Maintenance Schedule included.

**De-energize unit before withdrawing tray to access dust filter.**

**NOTICE**

**IF ANY LARGE NONLINEAR LOADS (ADJUSTABLE SPEED DRIVES, VFDS, DC DRIVES, BATTERY CHARGERS, ETC.) ARE INSTALLED IN THE PLANT AFTER INSTALLATION, PLEASE CONTACT YOUR EATON SALES REPRESENTATIVE TO ENSURE THAT THE CAPACITOR WILL NOT BE ADVERSELY AFFECTED.**

Dust filters—Strata density panel air filters UL Class 2—1-inch H x 25 inches W x 18-1/2 inches D.

The dust filter is located at the bottom of the equipment enclosure and does not require opening the cabinet door.

Dust filters should be replaced at least quarterly as suggested in our preventive maintenance guidelines and more often if the unit is located in a polluted environment. Eaton stocks and sells replacement air filter part number AUTOVAR6FX8. Contact your Eaton distributor or sales team to order.

**Figure 16. Dust filter location**

**Table 2. Low-voltage capacitor bank startup inspection and maintenance schedule**

| **CUSTOMER:** | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **UNIT SERIAL NUMBER:** | | | | | | | | | | | | | | | | | | | | | | | |
| Qtr: Every 3 months<br>Semi: Every 6 months<br>Ann: Every 12 months | C | Clean | | P | Touch-up Paint | | | | | | | | | | | | | | | | | | |
| | F | Check for Open/Damage Fuse | | R | Replace parts or component | | | | | | | | | | | | | | | | | | |
| | I | Inspection of Component/Equipment | | S | Apply Silicone Caulk (Outdoor Unit) | | | | | | | | | | | | | | | | | | |
| | L | Lubricate | | T | Test component | | | | | | | | | | | | | | | | | | |
| | O | Torque Connections | | V | Verify Operation | | | | | | | | | | | | | | | | | | |
| | **Routine** | | | | | | **Service Schedule Years From Installation Date** | | | | | | | | | | | | | | | | |
| **Component** | **Startup** | **Quarterly** | **Semi-Annually** | **Annually** | **2.5** | **5** | **7.5** | **10** | **12.5** | **15** | **17.5** | **20** | | | | | | | | | | | |
| Date of Service: | | | | | | | | | | | | | | | | | | | | | | | |
| Service Performed By: | | | | | | | | | | | | | | | | | | | | | | | |
| Air Filters | I | R | | | | | | | | | | | | | | | | | | | | | |
| Alarm Indication | V | | | V | | | | | | | | | | | | | | | | | | | |
| Bus Connections | O | | | | O | O | O | O | O | O | O | O | | | | | | | | | | | |
| Bushings | I | | | I, C | | | | | | | | | | | | | | | | | | | |
| Cable Terminations | O | | | I | O | O | O | O | O | O | O | O | | | | | | | | | | | |
| Capacitor | I | | | I | | T | | T | | T | | T, R | | | | | | | | | | | |
| Control & Timing Relays | V | | | | | T | | T | | T | | T, R | | | | | | | | | | | |
| Controller | V | | | V | | T | | T | | T | | T, R | | | | | | | | | | | |
| Corrosion / Condensation | I | | | I, P | | | | | | | | | | | | | | | | | | | |
| CT Circuit | V | | | V | | | | T | | | | | | | | | | | | | | | |
| Enclosure | I, S, P | | | I, P | | | | S | | | | S | | | | | | | | | | | |
| Fans | V | | I | I, V | | | | T | | | | R | | | | | | | | | | | |
| Fuses | T | | | F | | | | | | | | R | | | | | | | | | | | |
| Insect Screens | I, C | | | | C | C | C | C | C | C | C | C | | | | | | | | | | | |
| Insulators and Supports | I, C | | | I, C | | | | | | | | | | | | | | | | | | | |
| Power & Control Cables | I | | | I | | | | T | | | | T | | | | | | | | | | | |
| Reactor | I | | | I, C | | | | T | | | | T | | | | | | | | | | | |
| Contactors | V | | | V | | | | T | | | | T, R | | | | | | | | | | | |
| Test CT Polarity (optional) | T | | | | | | | | | | | | | | | | | | | | | | |

(Perform inspection and maintenance service per above schedule and record service dates)

**Table 3. Low-voltage AutoVAR commissioning checklist**

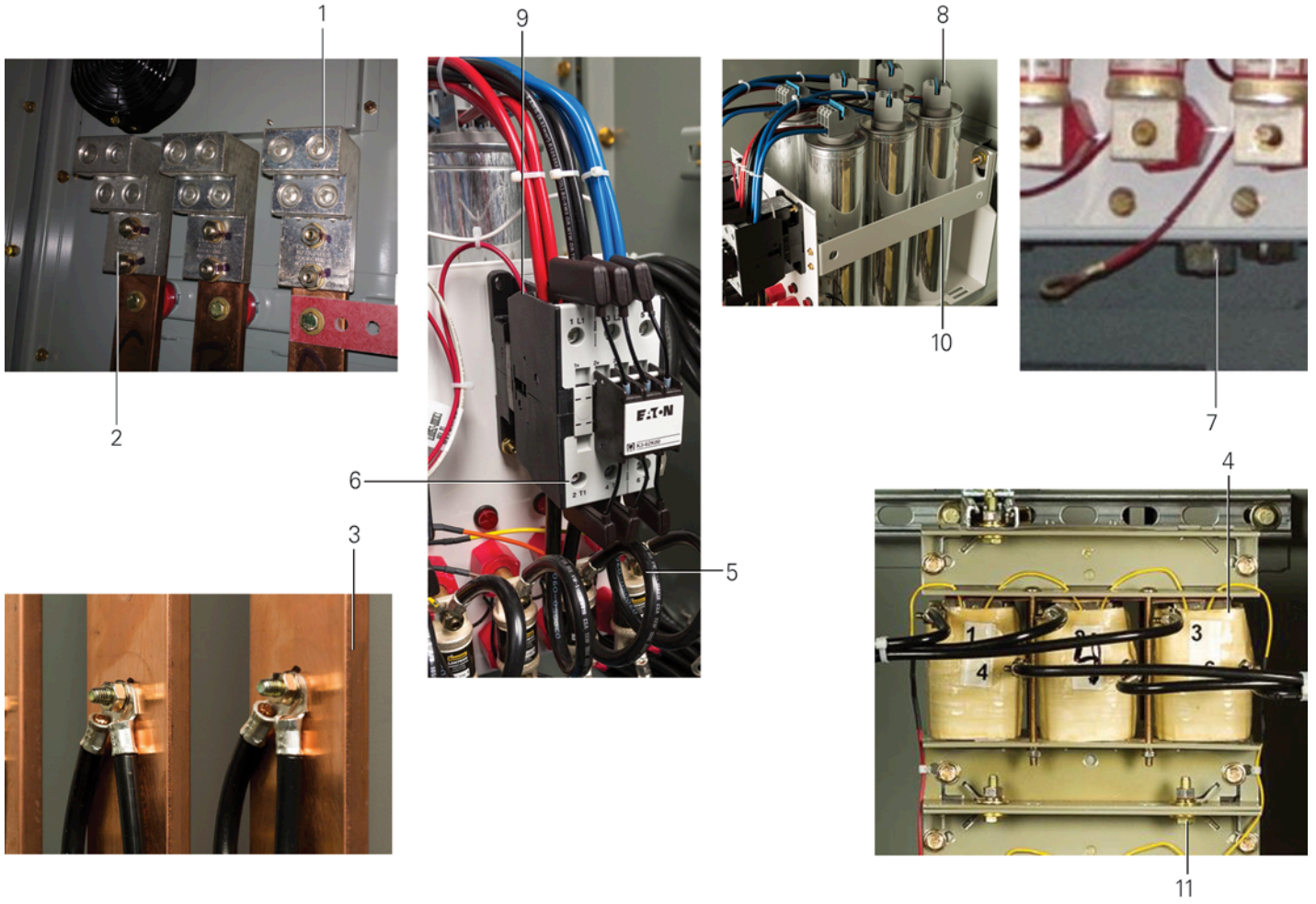
**Note:** Form and photograph of installation must be completed and returned to Eaton Power Factor Correction Product Line (pfcwarranty@eaton.com) for activation of extended warranties, if purchased.

| **Project information** | |
|---|---|
| Name of qualified individual | |
| Company name for qualified individual | |
| Customer name | |
| Customer location (city and state or province) | |
| Unit catalog number | |
| Unit general order number | |
| Unit serial number | |
| **Current transformer information** | |
| CT installation location (example switchboard main breaker) | |
| CT primary tap selected | A |
| CT secondary rating | A |
| CT ratio for controller (example 600 = 3000/5) | |
| **Physical clearances for ventilation** | **Measured values** |
| Top clearance (please specify units) | |
| Left side clearance (please specify units) | |
| Right side clearance (please specify units) | |
| Clearance between cabinets, if applicable (please specify units) | |
| **Environmental considerations** | |
| Installation type (indoor our outdoor) | |
| Measured ambient temperature, please specify C or F with measured value | |
| Sources of particulate buildup | |
| Sources of heat (e.g., direct sunlight) | |

**Attach a photograph of the installation here.**

| **Inspection (for each item, please note 'Acceptable' or list any deficiencies)** | |
|---|---|
| Air filter(s) | |
| Bushings | |
| Capacitor cells | |
| Corrosion/condensation | |
| Enclosure | |
| Vents/screens | |
| Insulators and supports | |
| Power and control cables | |
| Reactor(s), applicable only to filtered units | |
| **Fastener torque** | |
| Bus connections | |
| Cable terminations | |
| **Testing** | |
| Control power fuses | |
| Contactor fuses | |
| CT ratio and polarity (test is optional) | |
| **Controller settings** | |
| System nominal voltage | V |
| CT ratio | |
| VT/PT ratio | |
| Automatic initialization (verify that this is set to No or Off) | |
| CP1 (Cos Phi 1)—target power factor, please specify number and I or C | |
| Switching time delay | |
| If CT ratio has been changed from factory default, have the capacitor step sizes in the 402 menu been re-set accordingly? | |
| If any modifications have been made to parameters in the advanced menus (with the exception of 402), please note the modifications | |
| **Verification** | |
| Does each contactor function properly during operation in the controller's manual mode? | |
| Does the power factor measured by the controller go in the correct direction when the contactors are closed in the manual mode? | |
| Does the voltage measured by the controller match the system voltage, within 10%? | |
| Does the current measured by the controller match the system current, within 10%? | |
| Does the controller show ALARM or EXPORT condition? | |
| Do the fans run? | |
| Do the push-to-test cleared fuse indicator lamps on the capacitor enclosure door glow brightly when pushed? | |

**Table 4. Torque chart**




| Location identifier | Torque table | Torque value | Remarks |
|---|---|---|---|
| 1 | Customer incoming conductor to mechanical lug (customer wiring) | 275 in-lb | For lug size suitable to accommodate conductors maximum up to 350 kcmil |
| | | 375 in-lb | For lug suitable to accept conductors greater than 350 kcmil up to 750 kcmil |
| 2 | Mechanical lug to bus bar (factory wiring) | 20 ft-lb | |
| 3 | 4 AWG wire terminated onto bus (factory wiring) | 60 in-lb | |
| 4 | 4 AWG wire terminated onto reactor (if applicable) (factory wiring) | 60 in-lb | |
| 5 | 4 AWG wire terminated onto fuse (factory wiring) | 60 in-lb | Bottom terminals |
| 6 | 4 AWG (pigtail) wire terminated onto contactor (factory wiring) | 45 in-lb | Bottom terminals |
| 7 | Capacitor mounting M8/M10 stud (factory wiring) ① | 14.8 ft-lb | Stud on bottom of capacitor |
| 8 | 8 AWG wires to capacitor contactors (factory wiring) ① | 22 in-lb | Top terminals |
| 9 | 8 AWG wires to contactors (factory wiring) ① | 45 in-lb | Top terminals |
| 10 | Nest assembly mounting bolt (not a factory torqued live part) | 20 ft-lb | Rear of nest |
| 11 | Reactor mounting bolt (not a factory torqued live part) | 20 ft-lb | |

① Customer wiring if expanding unit in field.

## Warranty

Standard warranty is 1 year, parts only, against manufacturing defects for entire unit. For units with standard-duty capacitor cells, the capacitor cells provided with the unit have a standard 2-year warranty against manufacturing defects, parts only. For units with heavy-duty capacitor cells, the capacitor cells have a standard 5-year warranty against manufacturing defects, parts only.

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For technical support and application engineering assistance, please contact Eaton's TRC at
**1-800-809-2772** option 5, option 2
or email **pfc@eaton.com**

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GENERAL ORDER NUMBER: STLB010623.001

REPORT NUMBER: TQSITLB010623

SUBMITTED BY: SHREERANG GANU,PE

# HARMONIC STUDY

**FOR**

**BIXBY WATER RECLAMATION FACILITY**
**BIXBY,OK**

**FEBRUARY 2023**

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## REVISION HISTORY

| Rev # | TQS Number | Issued | Revision / Modification Description |
|---|---|---|---|
| - | TQSITLB010623 | 02/2023 | Initial Study Report Issue |

# 1.0 HARMONIC ANALYSIS STUDY

## 1.1 Introduction

The objective of this study is to perform harmonic analysis to evaluate harmonic distortion at the point of common coupling (PCC) and check it against recommended limits given in IEEE standard 519-2022. The scope of work included:

- Model harmonic source for new VFDs.
- Run the harmonic load flow and impedance scan to check for resonances
- Evaluate harmonic voltage and current distortion at PCC and other locations of interest to verify they are within IEEE-519 recommended limits.

Eaton used HIWAVE module of the SKM Power Tools for Windows (PTW) software to simulate harmonic analysis.

The following assumptions were used in modeling the power system:

- VFD is assumed to be operating at full speed and full load. This is the worst-case condition as harmonics in amperes are highest at full load.
- All existing VFDs are assumed to be running simultaneously.

## 1.2 Harmonic Data

The information provided by Eaton who is VFD manufacturer was entered in the program. The harmonic model can be seen below. VFD for motors below 200HP is DG1. It is 6 pulse drive and is shown in Figure 1.2.1. VFD for 200HP motors is CPX9000. It is 18 pulse drive and is shown in Figure 1.2.2.

**Figure 1.2.1** – Eaton DG1 Characteristic Harmonic Currents

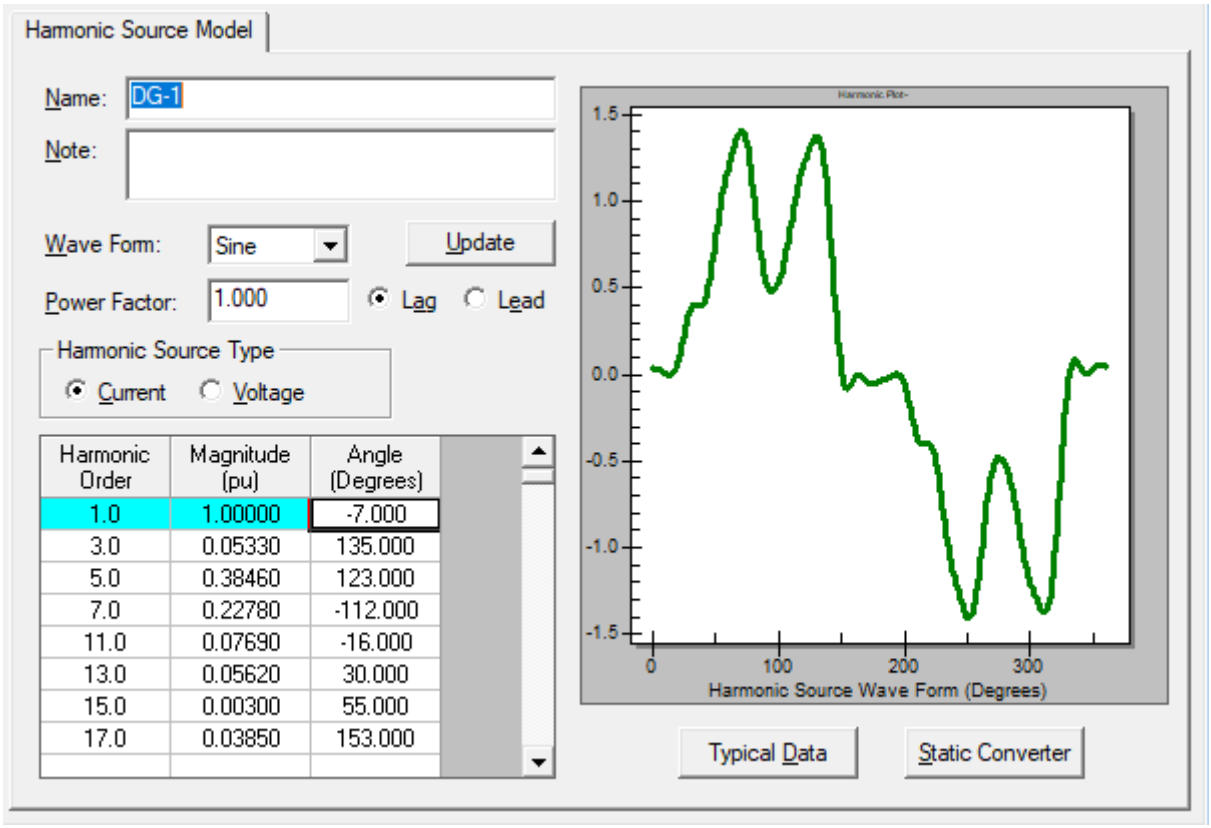
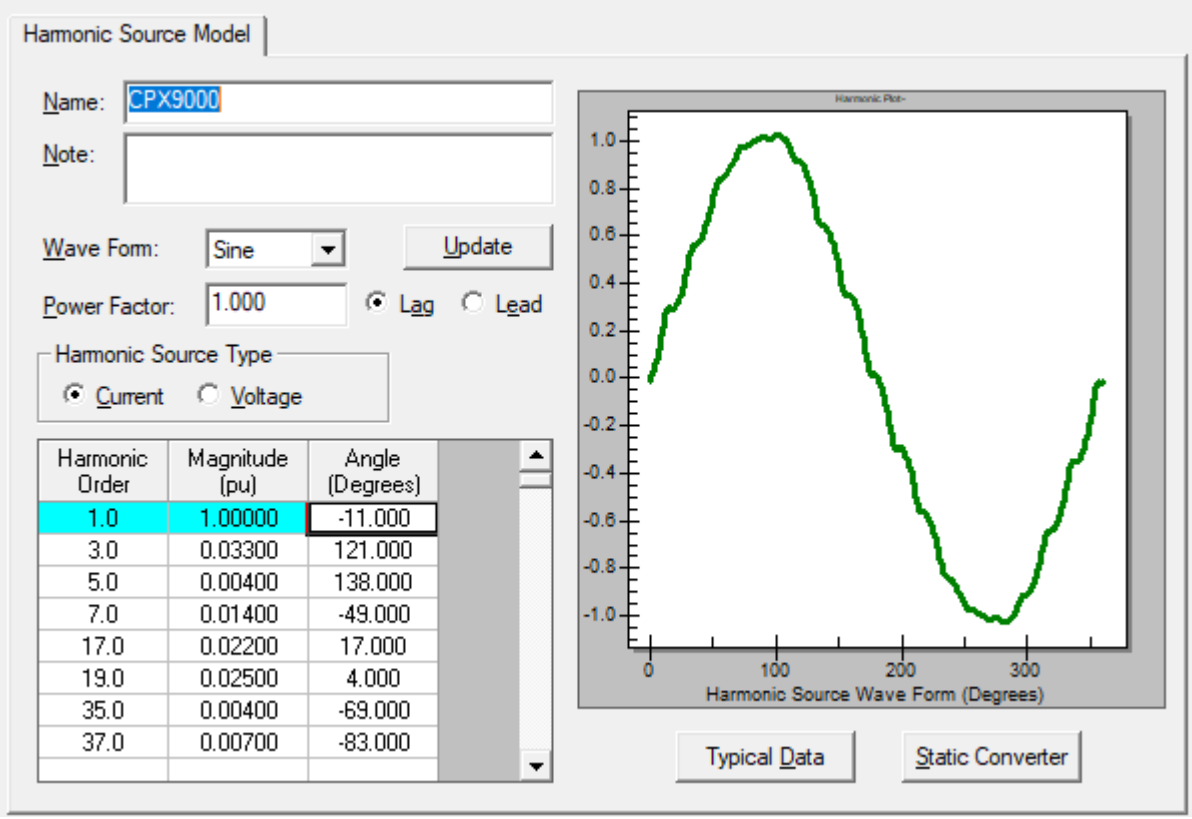


**Figure 1.2.2** – Eaton CPX9000 Characteristic Harmonic Currents




## 1.3 Point of common coupling (PCC) and point of analysis (POA)

12470V incoming location to the facility is considered as PCC for evaluating harmonic voltage distortion. The incoming cable to the facility is considered as PCC for evaluating harmonic current distortion.

| PCC | PCC cable |
|---|---|
| BUS-UTILITY | CBL-UTILITY |

Below are harmonic sources at 480V and also point of analysis (POA) buses and cables.

| Harmonic source | POA bus | POA cable |
|---|---|---|
| VFD-B-1-4 | MHE1<br>MHE2<br>MHE3<br>PFC-SBHE1<br>SBH01<br>SBHE1 | CBL-MHE1<br>CBL-MHE2<br>CBL-MHE3<br>CBL-PFC-SBHE1<br>CBL-SBH01<br>CBL-SBHE1 |
| VFD-P-2-3 | | |
| VFD-P-14-9 | | |
| VFD-CF-1-9 | | |
| VFD-1-9 | | |
| VFD-POLYMER SYSTEM | | |
| VFD-P-12-8 | | |
| VFD-B-5-8 | | |
| VFD-P-3-3 | | |
| VFD-B-2-4 | | |
| VFD-P-15-9 | | |
| VFD-P-13-8 | | |
| VFD-B-6-8 | | |
| VFD-P-4-3 | | |
| VFD-B-3-4 | | |
| VFD-B-4-4 | | |

## 1.4 Scenario description for harmonic analysis

Following scenarios are considered to evaluate PCC and POA locations.

1. Scenario S1:First stage of capacitor bank online
2. Scenario S2:First 2 stages of capacitor bank online
3. Scenario S3:First 3 stages of capacitor bank online
4. Scenario S4:All 4 stages of capacitor bank online

## 1.5 Results

Results of total voltage harmonic distortion at PCC and POA are given in Table 1.5.1. Highlighted values are not within the limits given in IEEE-519-2022 standard Table 1 which is given in section 3. All values given are in percentages.

**Table 1.5.1 Results of Total Harmonic Voltage Distortion**

| Component | VTHD S1 | Limit | VTHD S2 | Limit | VTHD S3 | Limit | VTHD S4 | Limit |
|---|---|---|---|---|---|---|---|---|
| BUS-UTILITY | 5.53 | 5 | 5.19 | 5 | 4.72 | 5 | 2.48 | 5 |
| MHE1 | 16.54 | 8 | 15.47 | 8 | 13.9 | 8 | 7.39 | 8 |
| MHE2 | 16.53 | 8 | 15.46 | 8 | 13.8 | 8 | 7.38 | 8 |
| MHE3 | 16.54 | 8 | 15.46 | 8 | 14 | 8 | 7.36 | 8 |
| PFC-SBHE1 | 17.03 | 8 | 15.93 | 8 | 14.4 | 8 | 7.52 | 8 |
| SBH01 | 16.29 | 8 | 15.23 | 8 | 13.7 | 8 | 7.24 | 8 |
| SBHE1 | 16.58 | 8 | 15.5 | 8 | 14 | 8 | 7.37 | 8 |

Results for total current demand distortion at PCC and POA are given in Table 1.5.2. Highlighted values are not within the limits given in IEEE-519-2022 standard Table 2 given in section 3. All values given are in percentages.

**Table 1.5.2 Results of Total Current Demand Distortion**

| Component | ITDD S1 | Limit | ITDD S2 | Limit | ITDD S3 | Limit | ITDD S4 | Limit |
|---|---|---|---|---|---|---|---|---|
| CBL-UTILITY | 6.7 | 5 | 8.75 | 5 | 8.21 | 5 | 6.65 | 5 |
| CBL-MHE1 | 6.9 | 8 | 8 | 8 | 7.22 | 8 | 5.95 | 8 |
| CBL-MHE2 | 5.3 | 8 | 6.52 | 8 | 5.75 | 8 | 4.25 | 8 |
| CBL-MHE3 | 3.8 | 8 | 4.75 | 8 | 4.56 | 8 | 3.31 | 8 |
| CBL-SBH01 | 7.2 | 5 | 9.12 | 5 | 8.61 | 5 | 7.14 | 5 |
| CBL-SBHE1 | 7.2 | 5 | 9.12 | 5 | 8.61 | 5 | 7.14 | 5 |

Results of individual harmonic voltage distortion which exceeds the limits given in IEEE-519-2022 standard Table 1 at PCC and POA are given in Table 1.5.3. All values given are in percentages.

**Table 1.5.3 Results of Harmonic Voltage Distortion for individual harmonic order**

| | S4 | | S3 | | S2 | | S1 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Component | $7^{th}$ | Limit | $11^{th}$ | Limit | $13^{th}$ | Limit | $17^{th}$ | Limit | $19^{th}$ | Limit |
| BUS-UTILITY | | | 4.2 | 3 | 4.6 | 3 | 3.0 | 3 | 4.3 | 3 |
| MHE1 | 5.448 | 5 | 12.6 | 5 | 13.8 | 5 | 9 | 5 | 12.8 | 5 |
| MHE2 | 5.441 | 5 | 12.6 | 5 | 13.8 | 5 | 9 | 5 | 12.8 | 5 |
| MHE3 | 5.422 | 5 | 12.6 | 5 | 13.8 | 5 | 9 | 5 | 12.8 | 5 |
| PFC-SBHE1 | 5.515 | 5 | 13.1 | 5 | 14.3 | 5 | 9 | 5 | 13.2 | 5 |
| SBH01 | 5.332 | 5 | 12.48 | 5 | 13.6 | 5 | 8.9 | 5 | 12.6 | 5 |
| SBHE1 | 5.425 | 5 | 12.7 | 5 | 13.9 | 5 | 9.1 | 5 | 12.8 | 5 |

Results of individual harmonic current distortion which exceeds the limits given in IEEE-519-2022 standard Table 2 at PCC and POA are given in Table 1.5.4. All values given are in percentages.

**Table 1.5.4 Results of Current Harmonic Distortion for individual harmonic order**

| | S4, S3 | | | | S2, S3 | | | | S1 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Component | 5th | Limit | 7th | Limit | 11th | Limit | 13th | Limit | 17th | Limit | 19th | Limit |
| UTILITY | 4.508, 4.03 | 4 | 4.719, - | 4 | 2.29, 6.9 | 2 | 6.27 | 2 | 3 | 1.5 | 3.9 | 1.5 |
| MHE1 | - | | - | | -, 5.88 | 3.5 | 4.24 | 3.5 | - | - | 3.1 | 2.5 |
| MHE2 | - | | - | | -, 5.5 | 3.5 | 4.21 | 3.5 | - | - | 3.1 | 2.5 |
| MHE3 | - | | - | | -, 4.05 | 3.5 | 3.63 | 3.5 | - | - | 3 | 2.5 |
| SBH01 | 4.508, 4.03 | 4 | 4.719, - | 4 | 2.29, 6.9 | 2 | 6.27 | 2 | 3 | 1.5 | 3.9 | 1.5 |
| SBHE1 | 4.508, 4.03 | 4 | 4.719, - | 4 | 2.29, 6.9 | 2 | 6.27 | 2 | 3 | 1.5 | 3.8 | 1.5 |

Detailed results of individual voltage and current distortion are given in section 2 of this report.

## 1.6 Capacitor evaluation

IEEE-18 evaluation of the capacitor bank show the duty imposed on each stage is not within the limits of IEEE-18. Detailed IEEE-18 capacitor bank evaluation results are given in section 2. Table 1.6.1 show evaluation summary of all 4 scenarios. The IRMS parameter values are shown in red. In scenario 4, although they are within the IEEE-18 limits they are not within Eaton recommended practice. Eaton recommends these values to be within 100% of its rating.

**Table 1.6.1- IEEE-18 Evaluation of 4 stage capacitor bank in different scenarios**

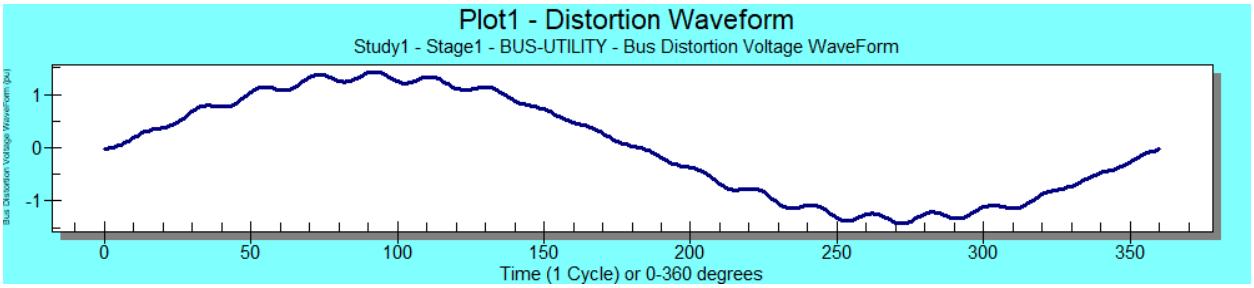
| Scenario | Capacitor Duty Parameter | Stage 1 | Stage 2 | Stage 3 | Stage 4 | IEEE-18 Limit |
|---|---|---|---|---|---|---|
| 1 | VRMS | 90 | | | | 110 |
| | IRMS | 293 | | | | 135 |
| | KVA | 122 | | | | 135 |
| 2 | VRMS | 90 | 90 | | | 110 |
| | IRMS | 203 | 203 | | | 135 |
| | KVA | 106 | 106 | | | 135 |
| 3 | VRMS | 91 | 91 | 91 | | 110 |
| | IRMS | 166 | 166 | 166 | | 135 |
| | KVA | 99 | 99 | 99 | | 135 |
| 4 | VRMS | 90.82 | 90.82 | 90.82 | 90.82 | 110 |
| | IRMS | 105.17 | 105.17 | 105.17 | 105.17 | 135 |
| | KVA | 85.48 | 85.48 | 85.48 | 85.48 | 135 |

All values given are in percentages

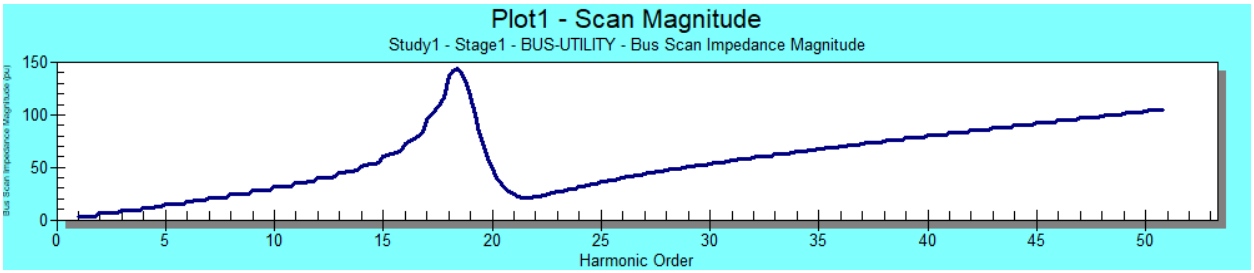
## 1.7 Resonance plots

Figure 1 through 8 below show voltage distortion and resonance plots for capacitor bank in different scenarios. Resonance value changes from 18 in scenario 1 to 9 in scenario 4.

BUS-UTILITY Scenario 1, Figure 1: Voltage distortion plot

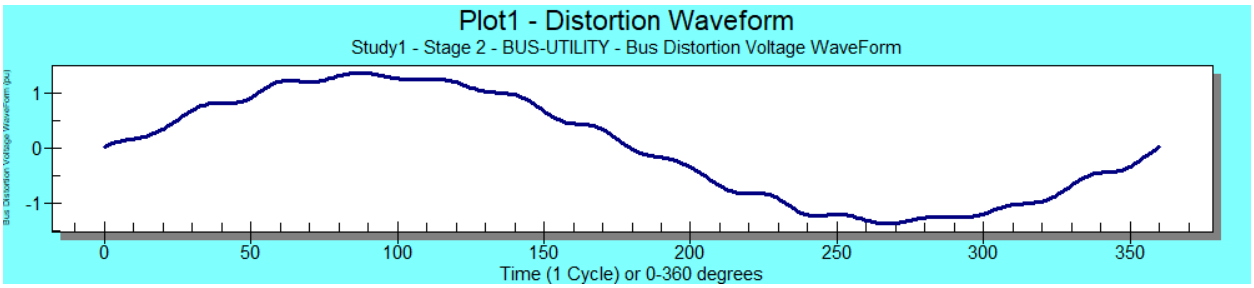



BUS-UTILITY Scenario 1, Figure 2: Impedance scan plot

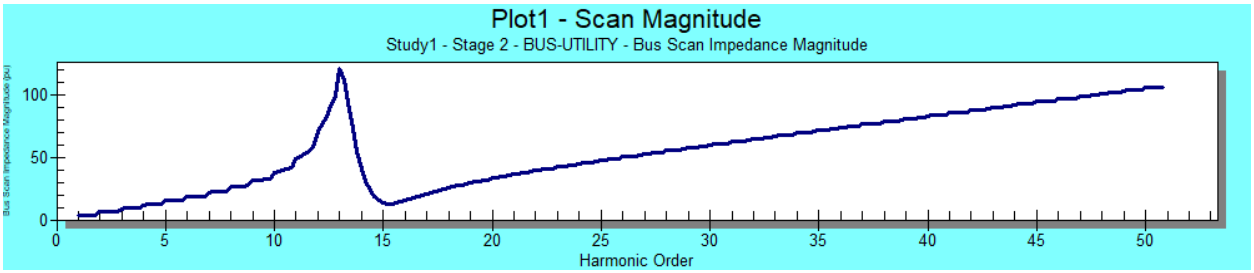



Resonance at 18.40

BUS-UTILITY Scenario 2, Figure 3: Voltage distortion plot

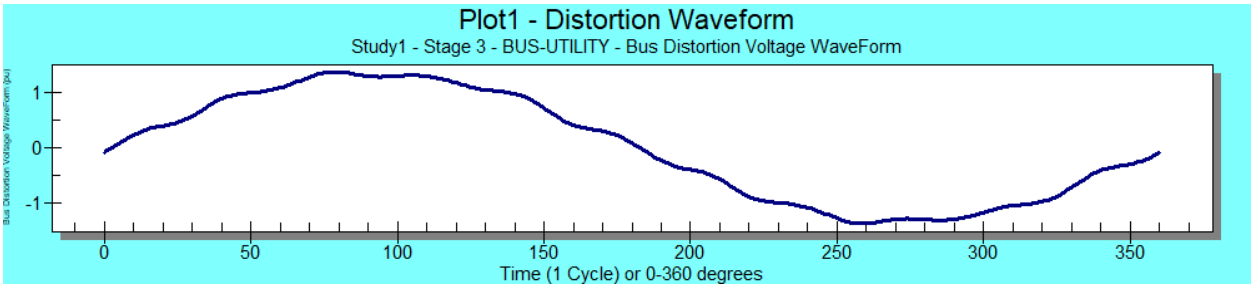



BUS-UTILITY Scenario 2, Figure 4: Impedance scan plot

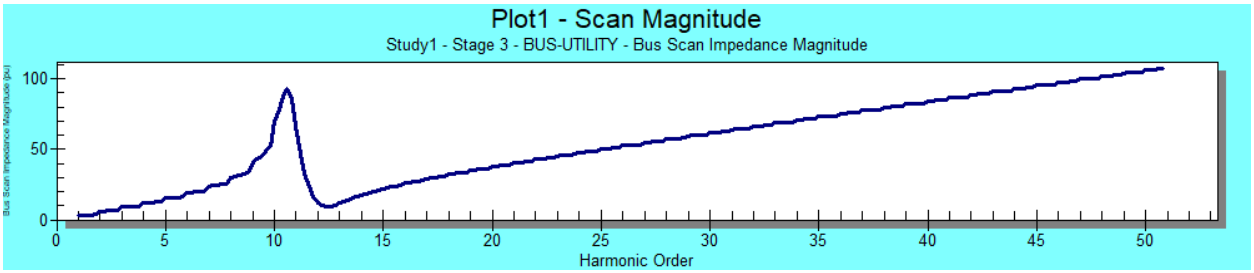



Resonance at 13

BUS-UTILITY Scenario 3, Figure 5: Voltage distortion plot

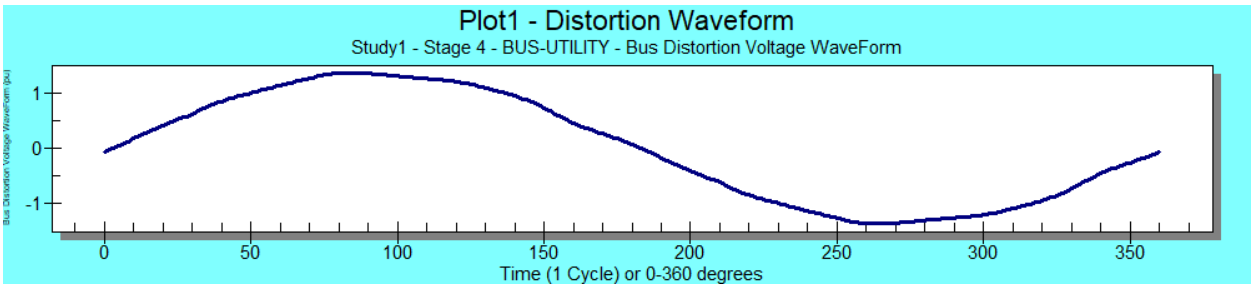



BUS-UTILITY Scenario 3 Figure 6: Impedance scan plot

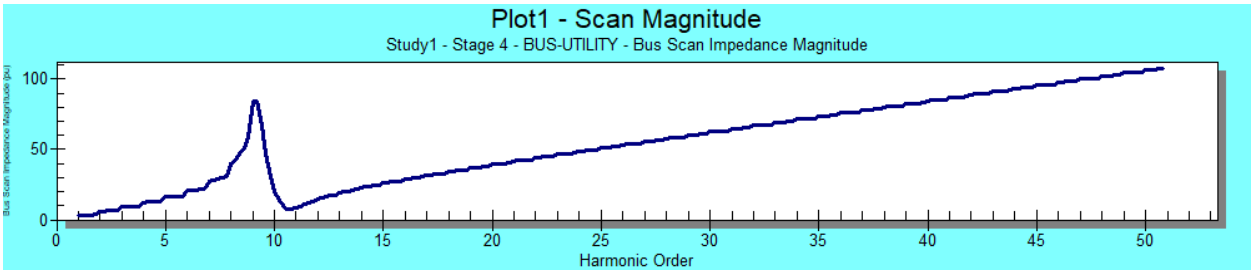



Resonance at 10.60

BUS-UTILITY Scenario 4, Figure 7: Voltage distortion plot




BUS-UTILITY Scenario 4, Figure 8: Impedance scan plot




Resonance at 9

## 1.8 Conclusions

1. As per table 1.5.1, total harmonic voltage distortion at PCC and POA shows many violations in IEEE-519-2022 compliance in scenarios 1 through 3.
2. As per table 1.5.2, total harmonic current distortion at PCC and POA shows many violations in IEEE-519-2022 compliance in all scenarios.
3. As per table 1.5.3, individual harmonic voltage distortion at PCC and POA shows many violations in IEEE-519-2022 compliance in all scenarios.
4. As per table 1.5.4, individual harmonic current distortion at PCC and POA shows many violations in IEEE-519-2022 compliance in all scenarios.
5. Resonance plots in section 1.7 show that resonance values are near 18, 13,11 and 9 in different scenarios. These resonances are near the dominant harmonic orders produced by 6 pulse VFDs. This causes amplification of harmonics at resonance frequencies. This results in increased voltage distortion at various locations.
6. Capacitor evaluation also shows violations in IRMS parameter of evaluation in scenarios 1 through 3. In scenario 4, they are within IEEE-18 limits but are not within Eaton's safe practice recommended limits.
7. It can be concluded that existing capacitor bank can not be safely applied in the system. It should be converted to filter bank tuned to $4.7^{th}$ harmonic.

# 2.0 HIWAVE RESULTS

BIXBY WRF

TQSITL0010020
MTL0010020
U0130

Scenario 1

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OUTPUT DATA REPORT
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# STUDY CRITERIA

| | |
|---|---|
| **Studies Selected To Run:** | |
| Load Flow: | Yes |
| Frequency Scan: | Yes |
| Harmonic Distortion: | Yes |
| **Load Flow Study Setup Options** | |
| Utility Impedance: | Yes |
| Transformer Phase Shift: | Yes |
| Solution Method: | Exact |
| Load Specification: | Connected Load |
| Generation Acceleration Factor: | 1.00 |
| Load Acceleration Factor: | 1.00 |
| Bus Voltage Drop: | 5.00 |
| Branch Voltage Drop: | 3.00 |
| **HI_WAVE Study Setup Options** | |
| Fundamental Frequency: | 60 Hz |
| Max. Harmonic Order: | 50 |
| Include Triplet Harmonics Path (Static Load): | No |
| Include Triplet Harmonics Path (Ind. Motor): | No |
| Modify Motor Z by Load Factor (Ind. Motor): | No |
| Modify Load Z by Load Factor (Static Load): | No |
| **HI_WAVE Study Setup Options for Frequency Scan** | |
| Scan Impedance Option: | Scan Self Impedance |
| Use Positive Sequence Network: | Yes |
| Use Negative Sequence Network: | Yes |
| Use Zero Sequence Network: | No |
| Model Transformer Tap: | Yes |
| Model Transformer Phase Shift: | Yes |
| Report Bus Equivalent Impedance: | No |
| Number of Scan Steps Per Order: | 5 |
| **HI_WAVE Study Setup Options for Distortion** | |
| Use Positive Sequence Network: | Yes |
| Use Negative Sequence Network: | Yes |
| Use Zero Sequence Network: | Yes |
| Model Transformer Tap: | Yes |
| Model Transformer Phase Shift: | Yes |
| Fundamental Solution: | Use Load Flow Result |
| Report Option: | All Distortions and Violations |
| Current Limits: | IEEE 519-2022 Std, Current Distortion Limit Tables 2, 3, & 4, All buses as PCC |

LOADS AND MOTORS WITH HARMONIC SOURCE MODELS

| Bus Name | Voltage | Component Name | LF Current | Harmonic Library |
|---|---|---|---|---|
| BUS-0062 | 480 | VFD-B-1-4 | 234.4 | CPX9000 |
| BUS-0064 | 480 | VFD-P-2-3 | 34.4 | DG-1 |
| BUS-0066 | 480 | VFD-P-14-9 | 11.4 | DG-1 |
| BUS-0068 | 480 | VFD-CF-1-9 | 57.6 | DG-1 |
| BUS-0070 | 480 | VFD-C-1-9 | 3.4 | DG-1 |
| BUS-0072 | 480 | VFD-POLYMER SYSTEM | 1.1 | DG-1 |
| BUS-0074 | 480 | VFD-P-12-8 | 11.4 | DG-1 |
| BUS-0076 | 480 | VFD-B-5-8 | 85.8 | DG-1 |
| BUS-0078 | 480 | VFD-P-3-3 | 34.4 | DG-1 |
| BUS-0080 | 480 | VFD-B-2-4 | 234.5 | CPX9000 |
| BUS-0082 | 480 | VFD-P-15-9 | 11.4 | DG-1 |
| BUS-0084 | 480 | VFD-P-13-8 | 11.4 | DG-1 |
| BUS-0086 | 480 | VFD-B-6-8 | 85.8 | DG-1 |
| BUS-0088 | 480 | VFD-P-4-3 | 34.3 | DG-1 |
| BUS-0090 | 480 | VFD-B-3-4 | 234.3 | CPX9000 |
| BUS-0092 | 480 | VFD-B-4-4 | 234.3 | CPX9000 |

| HARMONIC SOURCE | | |
|---|---|---|
| CPX9000 | | |
| Order | Magnitude (%) | Angle (Degrees) |
| 1 | 100.000 | -11.00 |
| 3 | 3.300 | 121.00 |
| 5 | 0.400 | 138.00 |
| 7 | 1.400 | -49.00 |
| 17 | 2.200 | 17.00 |
| 19 | 2.500 | 4.00 |
| 35 | 0.400 | -69.00 |
| 37 | 0.700 | -83.00 |

| HARMONIC SOURCE | | |
|---|---|---|
| DG-1 | | |
| Order | Magnitude (%) | Angle (Degrees) |
| 1 | 100.000 | -7.00 |
| 3 | 5.330 | 135.00 |
| 5 | 38.460 | 123.00 |
| 7 | 22.780 | -112.00 |
| 11 | 7.690 | -16.00 |
| 13 | 5.620 | 30.00 |
| 15 | 0.300 | 55.00 |
| 17 | 3.850 | 153.00 |

| H A R M O N I C  S O U R C E  I N D E X  T A B L E |
|---|
| HARMONIC SOURCES HAVE BEEN FOUND AND INJECTED FOR EACH OF THE FOLLOWING HARMONIC ORDERS |
| 3 5 7 11 13 15 17 19 35 37 |

P A S S I V E F I L T E R D A T A

| Filter Name | Bus Name | Bus Volts | Rated Volts | Connect | Filter Type | Capacitor KVAR | Tuned Order | Q | M | R (Ω) | L (H) | C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CAP1-SBHE1 | BUS-0100 | 480 | 480 | WYE_G | Capacitor | 50.0 | | | | 0.0000<br>0.0000 | 0.0000<br>0.0000 | 575.6472uF<br>575.6472uF |

| U T I L I T Y , G E N E R A T O R A N D M O T O R D A T A | | | | | | | |
|---|---|---|---|---|---|---|---|
| Component Name | Component Type | Bus Name | Bus Voltage | Base Voltage | Base KVA | R1(pu)<br>R2<br>R0 | X1(pu)<br>X2<br>X0 |
| UTIL-1 MAX | UTILITY | BUS-0104 | 12470 | 12470 | 100000 | 1.9106<br>1.9106<br>3.0389 | 3.2862<br>3.2862<br>8.4512 |

| TOTAL VOLTAGE DISTORTION | | | | | |
|---|---|---|---|---|---|
| Bus Name | Voltage | V_RMS(V) | V_TIF | V_THD(%) | LIMIT |
| ADMIN SEC | 480 | 454.97 | 289.0378 | 5.5331 | 8.0 |
| ATS1 | 480 | 432.97 | 851.6311 | 16.5450> | 8.0 |
| BUS-0007 | 480 | 430.76 | 847.9850 | 16.4726> | 8.0 |
| BUS-0008 | 480 | 430.98 | 853.9879 | 16.5920> | 8.0 |
| BUS-0009 | 480 | 429.53 | 845.5643 | 16.4237> | 8.0 |
| BUS-0010 | 480 | 431.62 | 848.9125 | 16.4901> | 8.0 |
| BUS-0011 | 480 | 429.38 | 846.2291 | 16.4229> | 8.0 |
| BUS-0012 | 480 | 431.16 | 847.3981 | 16.4609> | 8.0 |
| BUS-0013 | 480 | 430.80 | 853.2192 | 16.5758> | 8.0 |
| BUS-0014 | 480 | 430.80 | 853.2192 | 16.5758> | 8.0 |
| BUS-0015 | 480 | 432.97 | 851.6311 | 16.5450> | 8.0 |
| BUS-0016 | 480 | 432.79 | 850.8616 | 16.5288> | 8.0 |
| BUS-0017 | 480 | 432.31 | 850.9377 | 16.5162> | 8.0 |
| BUS-0022 | 480 | 432.97 | 851.6311 | 16.5450> | 8.0 |
| BUS-0023 | 208 | 187.61 | 851.6566 | 16.5172> | 8.0 |
| BUS-0024 | 480 | 454.97 | 289.0378 | 5.5331 | 8.0 |
| BUS-0025 | 208 | 197.15 | 289.0378 | 5.5331 | 8.0 |
| BUS-0026 | 480 | 454.97 | 289.0378 | 5.5331 | 8.0 |
| BUS-0027 | 208 | 187.61 | 851.6566 | 16.5172> | 8.0 |
| BUS-0028 | 208 | 187.61 | 851.6566 | 16.5172> | 8.0 |
| BUS-0029 | 208 | 197.15 | 289.0378 | 5.5331 | 8.0 |
| BUS-0036 | 208 | 197.15 | 289.0378 | 5.5331 | 8.0 |
| BUS-0060 | 12470 | 11819.69 | 289.0378 | 5.5331> | 5.0 |
| BUS-0061 | 480 | 474.94 | 534.6039 | 12.5915> | 8.0 |
| BUS-0062 | 480 | 483.70 | 529.9384 | 12.4387> | 8.0 |
| BUS-0063 | 480 | 487.03 | 714.6746 | 18.7236> | 8.0 |
| BUS-0064 | 480 | 488.32 | 713.7994 | 18.7005> | 8.0 |
| BUS-0065 | 480 | 485.33 | 743.5285 | 15.8125> | 8.0 |
| BUS-0066 | 480 | 485.96 | 743.0569 | 15.8023> | 8.0 |
| BUS-0067 | 480 | 487.88 | 692.7158 | 21.6221> | 8.0 |
| BUS-0068 | 480 | 491.02 | 690.5264 | 21.5526> | 8.0 |
| BUS-0069 | 480 | 485.07 | 755.0490 | 14.9917> | 8.0 |
| BUS-0070 | 480 | 485.36 | 754.7568 | 14.9858> | 8.0 |
| BUS-0071 | 480 | 485.13 | 758.3336 | 14.8054> | 8.0 |
| BUS-0072 | 480 | 485.23 | 758.2358 | 14.8034> | 8.0 |
| BUS-0073 | 480 | 485.33 | 743.5285 | 15.8125> | 8.0 |
| BUS-0074 | 480 | 485.96 | 743.0569 | 15.8023> | 8.0 |
| BUS-0075 | 480 | 493.13 | 666.5001 | 24.3709> | 8.0 |
| BUS-0076 | 480 | 494.07 | 667.0594 | 24.3913> | 8.0 |
| BUS-0077 | 480 | 487.02 | 713.8491 | 18.7109> | 8.0 |

| TOTAL VOLTAGE DISTORTION | | | | | |
|---|---|---|---|---|---|
| Bus Name | Voltage | V_RMS(V) | V_TIF | V_THD(%) | LIMIT |
| BUS-0078 | 480 | 488.31 | 712.9749 | 18.6878> | 8.0 |
| BUS-0079 | 480 | 474.94 | 534.4777 | 12.5914> | 8.0 |
| BUS-0080 | 480 | 483.70 | 529.8134 | 12.4385> | 8.0 |
| BUS-0081 | 480 | 485.32 | 742.6021 | 15.7943> | 8.0 |
| BUS-0082 | 480 | 485.94 | 742.1309 | 15.7841> | 8.0 |
| BUS-0083 | 480 | 485.32 | 742.6021 | 15.7943> | 8.0 |
| BUS-0084 | 480 | 485.94 | 742.1309 | 15.7841> | 8.0 |
| BUS-0085 | 480 | 493.13 | 665.8727 | 24.3672> | 8.0 |
| BUS-0086 | 480 | 494.07 | 666.4316 | 24.3877> | 8.0 |
| BUS-0087 | 480 | 487.01 | 715.1346 | 18.7059> | 8.0 |
| BUS-0088 | 480 | 488.31 | 714.2587 | 18.6827> | 8.0 |
| BUS-0089 | 480 | 474.95 | 535.1873 | 12.5955> | 8.0 |
| BUS-0090 | 480 | 483.70 | 530.5168 | 12.4427> | 8.0 |
| BUS-0091 | 480 | 474.95 | 535.1873 | 12.5955> | 8.0 |
| BUS-0092 | 480 | 483.70 | 530.5168 | 12.4427> | 8.0 |
| BUS-0100 | 480 | 434.50 | 911.7465 | 17.6309> | 8.0 |
| BUS-0104 | 12470 | 11820.11 | 288.9932 | 5.5322> | 5.0 |
| BUS-UTILITY | 12470 | 11819.69 | 289.0378 | 5.5331> | 5.0 |
| DS-CU-1 | 480 | 432.97 | 851.6311 | 16.5450> | 8.0 |
| DS-CU-2 | 480 | 432.97 | 851.6311 | 16.5450> | 8.0 |
| DS-CU-3 | 208 | 197.15 | 289.0378 | 5.5331 | 8.0 |
| DS-CU-4 | 208 | 197.15 | 289.0378 | 5.5331 | 8.0 |
| DS-CU-5 | 208 | 197.15 | 289.0378 | 5.5331 | 8.0 |
| DS-CU-6 | 208 | 197.15 | 289.0378 | 5.5331 | 8.0 |
| DS-EF-1 | 208 | 187.61 | 851.6566 | 16.5172> | 8.0 |
| DS-EF-2 | 208 | 187.61 | 851.6566 | 16.5172> | 8.0 |
| DS-EF-3 | 208 | 187.61 | 851.6566 | 16.5172> | 8.0 |
| DS-EF-4 | 208 | 187.61 | 851.6566 | 16.5172> | 8.0 |
| DS-EF-5 | 208 | 187.61 | 851.6566 | 16.5172> | 8.0 |
| DS-EF-6 | 208 | 197.15 | 289.0378 | 5.5331 | 8.0 |
| DS-EF-7 | 208 | 197.15 | 289.0378 | 5.5331 | 8.0 |
| DS-EF-8 | 208 | 197.15 | 289.0378 | 5.5331 | 8.0 |
| DS-SS-1 | 208 | 187.61 | 851.6566 | 16.5172> | 8.0 |
| DS-SS-2 | 208 | 187.61 | 851.6566 | 16.5172> | 8.0 |
| DS-SS-3 | 208 | 197.15 | 289.0378 | 5.5331 | 8.0 |
| DS-SS-4 | 208 | 197.15 | 289.0378 | 5.5331 | 8.0 |
| DS-SS-6 | 208 | 197.15 | 289.0378 | 5.5331 | 8.0 |
| MHE1 | 480 | 432.97 | 851.6311 | 16.5450> | 8.0 |
| MHE2 | 480 | 432.79 | 850.8616 | 16.5288> | 8.0 |
| MHE3 | 480 | 433.04 | 852.1557 | 16.5404> | 8.0 |

| TOTAL VOLTAGE DISTORTION | | | | | |
|---|---|---|---|---|---|
| Bus Name | Voltage | V_RMS(V) | V_TIF | V_THD(%) | LIMIT |
| PFC-SBHE1 | 480 | 434.01 | 879.2248 | 17.0320> | 8.0 |
| PHA1 | 480 | 454.97 | 289.0378 | 5.5331 | 8.0 |
| PHC1 | 480 | 432.97 | 851.6311 | 16.5450> | 8.0 |
| PHC2 | 480 | 432.97 | 851.6311 | 16.5450> | 8.0 |
| PHC3 | 480 | 432.97 | 851.6311 | 16.5450> | 8.0 |
| PHE1 | 480 | 432.97 | 851.6311 | 16.5450> | 8.0 |
| PLA1 | 208 | 197.15 | 289.0378 | 5.5331 | 8.0 |
| PLAU | 208 | 197.15 | 289.0378 | 5.5331 | 8.0 |
| PLC1 | 208 | 187.61 | 851.6566 | 16.5172> | 8.0 |
| PLC2 | 208 | 187.61 | 851.6566 | 16.5172> | 8.0 |
| PLCU | 208 | 187.61 | 851.6566 | 16.5172> | 8.0 |
| SBH01 | 480 | 434.60 | 840.0516 | 16.2882> | 8.0 |
| SBHE1 | 480 | 433.65 | 854.4245 | 16.5768> | 8.0 |
| UTIL-1 SEC | 480 | 435.56 | 825.7347 | 16.0012> | 8.0 |

| VOLTAGE DISTORTION SUMMARY | | | | | |
|---|---|---|---|---|---|
| Bus Name | Voltage | V_RMS(V) | V_TIF | V_THD(%) | LIMIT |
| ATS1 | 480 | 432.97 | 851.6311 | 16.5450> | 8.0 |
| BUS-0007 | 480 | 430.76 | 847.9850 | 16.4726> | 8.0 |
| BUS-0008 | 480 | 430.98 | 853.9879 | 16.5920> | 8.0 |
| BUS-0009 | 480 | 429.53 | 845.5643 | 16.4237> | 8.0 |
| BUS-0010 | 480 | 431.62 | 848.9125 | 16.4901> | 8.0 |
| BUS-0011 | 480 | 429.38 | 846.2291 | 16.4229> | 8.0 |
| BUS-0012 | 480 | 431.16 | 847.3981 | 16.4609> | 8.0 |
| BUS-0013 | 480 | 430.80 | 853.2192 | 16.5758> | 8.0 |
| BUS-0014 | 480 | 430.80 | 853.2192 | 16.5758> | 8.0 |
| BUS-0015 | 480 | 432.97 | 851.6311 | 16.5450> | 8.0 |
| BUS-0016 | 480 | 432.79 | 850.8616 | 16.5288> | 8.0 |
| BUS-0017 | 480 | 432.31 | 850.9377 | 16.5162> | 8.0 |
| BUS-0022 | 480 | 432.97 | 851.6311 | 16.5450> | 8.0 |
| BUS-0023 | 208 | 187.61 | 851.6566 | 16.5172> | 8.0 |
| BUS-0027 | 208 | 187.61 | 851.6566 | 16.5172> | 8.0 |
| BUS-0028 | 208 | 187.61 | 851.6566 | 16.5172> | 8.0 |
| BUS-0060 | 12470 | 11819.69 | 289.0378 | 5.5331> | 5.0 |
| BUS-0061 | 480 | 474.94 | 534.6039 | 12.5915> | 8.0 |
| BUS-0062 | 480 | 483.70 | 529.9384 | 12.4387> | 8.0 |
| BUS-0063 | 480 | 487.03 | 714.6746 | 18.7236> | 8.0 |
| BUS-0064 | 480 | 488.32 | 713.7994 | 18.7005> | 8.0 |
| BUS-0065 | 480 | 485.33 | 743.5285 | 15.8125> | 8.0 |
| BUS-0066 | 480 | 485.96 | 743.0569 | 15.8023> | 8.0 |
| BUS-0067 | 480 | 487.88 | 692.7158 | 21.6221> | 8.0 |
| BUS-0068 | 480 | 491.02 | 690.5264 | 21.5526> | 8.0 |
| BUS-0069 | 480 | 485.07 | 755.0490 | 14.9917> | 8.0 |
| BUS-0070 | 480 | 485.36 | 754.7568 | 14.9858> | 8.0 |
| BUS-0071 | 480 | 485.13 | 758.3336 | 14.8054> | 8.0 |
| BUS-0072 | 480 | 485.23 | 758.2358 | 14.8034> | 8.0 |
| BUS-0073 | 480 | 485.33 | 743.5285 | 15.8125> | 8.0 |
| BUS-0074 | 480 | 485.96 | 743.0569 | 15.8023> | 8.0 |
| BUS-0075 | 480 | 493.13 | 666.5001 | 24.3709> | 8.0 |
| BUS-0076 | 480 | 494.07 | 667.0594 | 24.3913> | 8.0 |
| BUS-0077 | 480 | 487.02 | 713.8491 | 18.7109> | 8.0 |
| BUS-0078 | 480 | 488.31 | 712.9749 | 18.6878> | 8.0 |
| BUS-0079 | 480 | 474.94 | 534.4777 | 12.5914> | 8.0 |
| BUS-0080 | 480 | 483.70 | 529.8134 | 12.4385> | 8.0 |
| BUS-0081 | 480 | 485.32 | 742.6021 | 15.7943> | 8.0 |
| BUS-0082 | 480 | 485.94 | 742.1309 | 15.7841> | 8.0 |
| BUS-0083 | 480 | 485.32 | 742.6021 | 15.7943> | 8.0 |

| VOLTAGE DISTORTION SUMMARY | | | | | |
|---|---|---|---|---|---|
| Bus Name | Voltage | V_RMS(V) | V_TIF | V_THD(%) | LIMIT |
| BUS-0084 | 480 | 485.94 | 742.1309 | 15.7841> | 8.0 |
| BUS-0085 | 480 | 493.13 | 665.8727 | 24.3672> | 8.0 |
| BUS-0086 | 480 | 494.07 | 666.4316 | 24.3877> | 8.0 |
| BUS-0087 | 480 | 487.01 | 715.1346 | 18.7059> | 8.0 |
| BUS-0088 | 480 | 488.31 | 714.2587 | 18.6827> | 8.0 |
| BUS-0089 | 480 | 474.95 | 535.1873 | 12.5955> | 8.0 |
| BUS-0090 | 480 | 483.70 | 530.5168 | 12.4427> | 8.0 |
| BUS-0091 | 480 | 474.95 | 535.1873 | 12.5955> | 8.0 |
| BUS-0092 | 480 | 483.70 | 530.5168 | 12.4427> | 8.0 |
| BUS-0100 | 480 | 434.50 | 911.7465 | 17.6309> | 8.0 |
| BUS-0104 | 12470 | 11820.11 | 288.9932 | 5.5322> | 5.0 |
| BUS-UTILITY | 12470 | 11819.69 | 289.0378 | 5.5331> | 5.0 |
| DS-CU-1 | 480 | 432.97 | 851.6311 | 16.5450> | 8.0 |
| DS-CU-2 | 480 | 432.97 | 851.6311 | 16.5450> | 8.0 |
| DS-EF-1 | 208 | 187.61 | 851.6566 | 16.5172> | 8.0 |
| DS-EF-2 | 208 | 187.61 | 851.6566 | 16.5172> | 8.0 |
| DS-EF-3 | 208 | 187.61 | 851.6566 | 16.5172> | 8.0 |
| DS-EF-4 | 208 | 187.61 | 851.6566 | 16.5172> | 8.0 |
| DS-EF-5 | 208 | 187.61 | 851.6566 | 16.5172> | 8.0 |
| DS-SS-1 | 208 | 187.61 | 851.6566 | 16.5172> | 8.0 |
| DS-SS-2 | 208 | 187.61 | 851.6566 | 16.5172> | 8.0 |
| MHE1 | 480 | 432.97 | 851.6311 | 16.5450> | 8.0 |
| MHE2 | 480 | 432.79 | 850.8616 | 16.5288> | 8.0 |
| MHE3 | 480 | 433.04 | 852.1557 | 16.5404> | 8.0 |
| PFC-SBHE1 | 480 | 434.01 | 879.2248 | 17.0320> | 8.0 |
| PHC1 | 480 | 432.97 | 851.6311 | 16.5450> | 8.0 |
| PHC2 | 480 | 432.97 | 851.6311 | 16.5450> | 8.0 |
| PHC3 | 480 | 432.97 | 851.6311 | 16.5450> | 8.0 |
| PHE1 | 480 | 432.97 | 851.6311 | 16.5450> | 8.0 |
| PLC1 | 208 | 187.61 | 851.6566 | 16.5172> | 8.0 |
| PLC2 | 208 | 187.61 | 851.6566 | 16.5172> | 8.0 |
| PLCU | 208 | 187.61 | 851.6566 | 16.5172> | 8.0 |
| SBH01 | 480 | 434.60 | 840.0516 | 16.2882> | 8.0 |
| SBHE1 | 480 | 433.65 | 854.4245 | 16.5768> | 8.0 |
| UTIL-1 SEC | 480 | 435.56 | 825.7347 | 16.0012> | 8.0 |

| TOTAL CURRENT DISTORTION | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Device Name | Bus Name<br>From/To | Voltage<br>From/To | I_RMS(A) | kWLo ss<br>Tot/Harm | kVARLoss<br>Tot/Harm | IT | HLF | KF | I_TDD(%)/<br>I_IHD(%) | LIMIT |
| CAP1-SBHE1 | BUS-0100 | 480<br>480 | 176.21 | 0.000<br>0.000 | -61.305<br>-21.570 | 915040.81 | | | 279.11<br>313.10 | |
| CBL-0008 | MHE1<br>BUS-0007 | 480<br>480 | 136.40 | 0.480<br>0.002 | 0.209<br>0.008 | 30188.58 | | | 4.83<br>5.34 | 15.0 |
| CBL-0009 | MHE1<br>BUS-0015 | 480<br>480 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0010 | BUS-0062<br>BUS-0061 | 480<br>480 | 245.87 | 4.413<br>0.007 | 0.334<br>0.007 | 42303.86 | | | 2.97<br>3.64 | 12.0 |
| CBL-0011 | MHE1<br>PHE1 | 480<br>480 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0012 | MHE2<br>BUS-0009 | 480<br>480 | 136.77 | 0.709<br>0.002 | 0.309<br>0.011 | 30016.78 | | | 4.80<br>5.30 | 15.0 |
| CBL-0013 | MHE2<br>BUS-0016 | 480<br>480 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0014 | MHE2<br>BUS-0010 | 480<br>480 | 136.13 | 0.253<br>0.001 | 0.110<br>0.004 | 30282.43 | | | 4.84<br>5.37 | 15.0 |
| CBL-0015 | MHE3<br>BUS-0011 | 480<br>480 | 136.82 | 0.794<br>0.003 | 0.346<br>0.012 | 30026.09 | | | 4.78<br>5.27 | 15.0 |
| CBL-0016 | ATS1<br>PHC1 | 480<br>480 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0017 | PHC1<br>PHC2 | 480<br>480 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0018 | PHC2<br>PHC3 | 480<br>480 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0019 | BUS-0023<br>PLC1 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |

| TOTAL CURRENT DISTORTION | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Device Name | Bus Name<br>From/To | Voltage<br>From/To | I_RMS(A) | kWLo ss<br>Tot/Harm | kVARLoss<br>Tot/Harm | IT | HLF | KF | I_TDD(%)/<br>I_IHD(%) | LIMIT |
| CBL-0020 | PLC1<br>PLC2 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0021 | PHC1<br>BUS-0022 | 480<br>480 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0022 | PLC1<br>BUS-0027 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0023 | BUS-0028<br>PLCU | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0024 | PHA1<br>BUS-0024 | 480<br>480 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0025 | BUS-0025<br>PLA1 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0026 | PHA1<br>BUS-0026 | 480<br>480 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0027 | BUS-0036<br>PLAU | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0028 | ADMIN SEC<br>PHA1 | 480<br>480 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0030 | BUS-0064<br>BUS-0063 | 480<br>480 | 36.65 | 0.098<br>0.002 | 0.008<br>0.001 | 8913.75 | | | 11.42<br>14.24 | 15.0 |
| CBL-0031 | PHC3<br>DS-CU-1 | 480<br>480 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0032 | PHC3<br>DS-CU-2 | 480<br>480 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0033 | PLC1<br>DS-EF-1 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |

| TOTAL CURRENT DISTORTION | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Device Name | Bus Name<br>From/To | Voltage<br>From/To | I_RMS(A) | kWLo ss<br>Tot/Harm | kVARLoss<br>Tot/Harm | IT | HLF | KF | I_TDD(%)/<br>I_IHD(%) | LIMIT |
| CBL-0034 | PLC1<br>DS-EF-2 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0035 | PLC1<br>DS-EF-3 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0036 | PLC1<br>DS-EF-4 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0037 | PLC1<br>DS-EF-5 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0038 | PLC1<br>DS-SS-1 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0039 | PLC1<br>DS-SS-2 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0040 | PLA1<br>DS-CU-3 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0041 | PLA1<br>DS-CU-4 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0042 | PLA1<br>DS-CU-5 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0043 | PLA1<br>DS-CU-6 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0044 | PLA1<br>DS-EF-6 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0045 | PLA1<br>DS-EF-7 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0046 | PLA1<br>DS-EF-8 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |

| TOTAL CURRENT DISTORTION | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Device Name | Bus Name<br>From/To | Voltage<br>From/To | I_RMS(A) | kWLo ss<br>Tot/Harm | kVARLoss<br>Tot/Harm | IT | HLF | KF | I_TDD(%)/<br>I_IHD(%) | LIMIT |
| CBL-0047 | PLA1<br>DS-SS-3 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0048 | PLA1<br>DS-SS-4 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0049 | PLA1<br>DS-SS-6 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0050 | BUS-0066<br>BUS-0065 | 480<br>480 | 12.12 | 0.016<br>0.000 | 0.001<br>0.000 | 3009.34 | | | 7.20<br>8.99 | 20.0 |
| CBL-0051 | BUS-0068<br>BUS-0067 | 480<br>480 | 61.70 | 0.404<br>0.013 | 0.033<br>0.006 | 14811.17 | | | 14.65<br>18.20 | 15.0 |
| CBL-0052 | BUS-UTILITY<br>BUS-0060 | 12470<br>12470 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0053 | BUS-0070<br>BUS-0069 | 480<br>480 | 3.63 | 0.002<br>0.000 | 0.000<br>0.000 | 910.28 | | | 5.54<br>6.92 | 20.0 |
| CBL-0054 | BUS-0072<br>BUS-0071 | 480<br>480 | 1.21 | 0.000<br>0.000 | 0.000<br>0.000 | 304.28 | | | 5.09<br>6.36 | 20.0 |
| CBL-0055 | BUS-0074<br>BUS-0073 | 480<br>480 | 12.12 | 0.016<br>0.000 | 0.001<br>0.000 | 3009.34 | | | 7.20<br>8.99 | 20.0 |
| CBL-0056 | BUS-0076<br>BUS-0075 | 480<br>480 | 92.76 | 0.158<br>0.009 | 0.044<br>0.010 | 22295.32 | | | 17.51><br>21.85 | 15.0 |
| CBL-0057 | MHE1<br>BUS-0008 | 480<br>480 | 13.64 | 0.056<br>0.000 | 0.004<br>0.000 | 3041.83 | | | 4.86<br>5.39 | 20.0 |
| CBL-0058 | MHE1<br>BUS-0012 | 480<br>480 | 136.27 | 0.363<br>0.002 | 0.203<br>0.007 | 30195.99 | | | 4.83<br>5.35 | 15.0 |
| CBL-0059 | BUS-0078<br>BUS-0077 | 480<br>480 | 36.64 | 0.098<br>0.002 | 0.008<br>0.001 | 8903.95 | | | 11.42<br>14.24 | 15.0 |

| TOTAL CURRENT DISTORTION | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Device Name | Bus Name<br>From/To | Voltage<br>From/To | I_RMS(A) | kWLo ss<br>Tot/Harm | kVARLoss<br>Tot/Harm | IT | HLF | KF | I_TDD(%)/<br>I_IHD(%) | LIMIT |
| CBL-0060 | BUS-0080<br>BUS-0079 | 480<br>480 | 245.86 | 4.413<br>0.006 | 0.334<br>0.007 | 42288.51 | | | 2.96<br>3.64 | 12.0 |
| CBL-0061 | BUS-0082<br>BUS-0081 | 480<br>480 | 12.12 | 0.016<br>0.000 | 0.001<br>0.000 | 3005.58 | | | 7.19<br>8.98 | 20.0 |
| CBL-0062 | BUS-0084<br>BUS-0083 | 480<br>480 | 12.12 | 0.016<br>0.000 | 0.001<br>0.000 | 3005.58 | | | 7.19<br>8.98 | 20.0 |
| CBL-0063 | BUS-0086<br>BUS-0085 | 480<br>480 | 92.76 | 0.158<br>0.009 | 0.044<br>0.010 | 22278.31 | | | 17.51><br>21.85 | 15.0 |
| CBL-0064 | MHE2<br>BUS-0013 | 480<br>480 | 13.64 | 0.056<br>0.000 | 0.004<br>0.000 | 3037.84 | | | 4.86<br>5.37 | 20.0 |
| CBL-0065 | MHE2<br>BUS-0014 | 480<br>480 | 13.64 | 0.056<br>0.000 | 0.004<br>0.000 | 3037.84 | | | 4.86<br>5.37 | 20.0 |
| CBL-0066 | BUS-0088<br>BUS-0087 | 480<br>480 | 36.64 | 0.098<br>0.002 | 0.008<br>0.001 | 8916.72 | | | 11.40<br>14.21 | 15.0 |
| CBL-0067 | BUS-0090<br>BUS-0089 | 480<br>480 | 245.86 | 4.413<br>0.006 | 0.334<br>0.007 | 42340.86 | | | 2.96<br>3.64 | 12.0 |
| CBL-0068 | BUS-0092<br>BUS-0091 | 480<br>480 | 245.86 | 4.413<br>0.006 | 0.334<br>0.007 | 42340.86 | | | 2.96<br>3.64 | 12.0 |
| CBL-0069 | MHE3<br>BUS-0017 | 480<br>480 | 27.18 | 0.031<br>0.000 | 0.014<br>0.001 | 6079.83 | | | 4.84<br>5.37 | 15.0 |
| CBL-CAP1-SBHE1 | PFC-SBHE1<br>BUS-0100 | 480<br>480 | 176.21 | 0.713<br>0.685 | 0.787<br>0.783 | 915040.81 | | | 279.11><br>313.10 | 15.0 |
| CBL-MHE1 | SBHE1<br>MHE1 | 480<br>480 | 713.80 | 0.593<br>0.008 | 0.704<br>0.034 | 141743.66 | | | 6.98<br>7.55 | 8.0 |
| CBL-MHE2 | SBHE1<br>MHE2 | 480<br>480 | 665.23 | 0.684<br>0.005 | 0.806<br>0.028 | 129860.78 | | | 5.30<br>5.73 | 8.0 |

| TOTAL CURRENT DISTORTION | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Device Name | Bus Name<br>From/To | Voltage<br>From/To | I_RMS(A) | kWLo ss<br>Tot/Harm | kVARLoss<br>Tot/Harm | IT | HLF | KF | I_TDD(%)/<br>I_IHD(%) | LIMIT |
| CBL-MHE3 | SBHE1<br>MHE3 | 480<br>480 | 657.74 | 0.501<br>0.003 | 0.586<br>0.015 | 123318.93 | | | 3.87<br>4.26 | 8.0 |
| CBL-PFC-SBHE1 | SBHE1<br>PFC-SBHE1 | 480<br>480 | 176.21 | 0.444<br>0.440 | 0.612<br>0.608 | 915040.81 | | | 69.78><br>313.10 | 15.0 |
| CBL-SBH01 | UTIL-1 SEC<br>SBH01 | 480<br>480 | 2017.21 | 2.836<br>0.042 | 4.009<br>0.233 | 550364.69 | | | 7.20><br>7.03 | 5.0 |
| CBL-SBHE1 | SBH01<br>SBHE1 | 480<br>480 | 2017.21 | 2.836<br>0.042 | 4.009<br>0.233 | 550364.69 | | | 7.20><br>7.03 | 5.0 |
| CBL-UTILITY | BUS-0104<br>BUS-UTILITY | 12470<br>12470 | 77.62 | 0.058<br>0.001 | 0.011<br>0.001 | 21183.89 | | | 6.71><br>6.55 | 5.0 |
| SW-ATS1 | BUS-0015<br>ATS1 | 480<br>480 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| T-LA1 | BUS-0024<br>BUS-0025 | 480<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | 0.00 | 0.00 | 0.00<br>0.00 | 20.0 |
| T-PLC1 | BUS-0022<br>BUS-0023 | 480<br>208 | 0.00 | 0.005<br>0.005 | 0.029<br>0.029 | 0.00 | 0.00 | 0.00 | 0.00<br>0.00 | 20.0 |
| T-UPS-PLAU | BUS-0026<br>BUS-0029 | 480<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | 0.00 | 0.00 | 0.00<br>0.00 | 20.0 |
| TX-ADMIN | BUS-0060<br>ADMIN SEC | 12470<br>480 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | 0.00 | 0.00 | 0.00<br>0.00 | 20.0 |
| TX-UTIL-1 | BUS-UTILITY<br>UTIL-1 SEC | 12470<br>480 | 77.62 | 22.724<br>0.555 | 168.727<br>9.332 | 21183.89 | 1.90 | 5.33 | 6.71<br>6.55 | 20.0 |
| UPS-PLAU | BUS-0029<br>BUS-0036 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| UPS-PLCU | BUS-0027<br>BUS-0028 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |

| TOTAL CURRENT DISTORTION | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Device Name | Bus Name<br>From/To | Voltage<br>From/To | I_RMS(A) | kWLo ss<br>Tot/Harm | kVARLoss<br>Tot/Harm | IT | HLF | KF | I_TDD(%)/<br>I_IHD(%) | LIMIT |
| UTIL-1 MAX | BUS-0104 | 12470<br>12470 | 77.62 | 0.229<br>0.229 | 5.205<br>5.205 | 21183.89 | | | 0.42<br>6.55 | |
| VFD-B-1-4 | MHE1<br>BUS-0062 | 480<br>480 | 234.64 | 3.364<br>0.000 | -78.495<br>0.000 | 44166.60 | | | 3.76<br>4.84 | 12.0 |
| VFD-B-2-4 | MHE2<br>BUS-0080 | 480<br>480 | 234.73 | 3.364<br>0.000 | -78.495<br>0.000 | 44097.48 | | | 3.76<br>4.83 | 12.0 |
| VFD-B-3-4 | MHE3<br>BUS-0090 | 480<br>480 | 234.61 | 3.364<br>0.000 | -78.495<br>0.000 | 44159.12 | | | 3.76<br>4.83 | 12.0 |
| VFD-B-4-4 | MHE3<br>BUS-0092 | 480<br>480 | 234.61 | 3.364<br>0.000 | -78.495<br>0.000 | 44159.12 | | | 3.76<br>4.83 | 12.0 |
| VFD-B-5-8 | MHE1<br>BUS-0076 | 480<br>480 | 88.20 | 1.231<br>0.000 | -29.732<br>0.000 | 24433.89 | | | 18.26><br>24.08 | 15.0 |
| VFD-B-6-8 | MHE2<br>BUS-0086 | 480<br>480 | 88.24 | 1.231<br>0.000 | -29.732<br>0.000 | 24418.97 | | | 18.28><br>24.09 | 15.0 |
| VFD-C-1-9 | MHE1<br>BUS-0070 | 480<br>480 | 3.70 | 0.049<br>0.000 | -1.189<br>0.000 | 1289.71 | | | 30.96><br>40.88 | 20.0 |
| VFD-CF-1-9 | MHE1<br>BUS-0068 | 480<br>480 | 59.79 | 0.827<br>0.000 | -19.751<br>0.000 | 17813.13 | | | 21.37><br>27.97 | 15.0 |
| VFD-P-12-8 | MHE1<br>BUS-0074 | 480<br>480 | 12.23 | 0.164<br>0.000 | -3.962<br>0.000 | 4163.83 | | | 28.93><br>38.17 | 20.0 |
| VFD-P-13-8 | MHE2<br>BUS-0084 | 480<br>480 | 12.24 | 0.164<br>0.000 | -3.962<br>0.000 | 4161.86 | | | 28.95><br>38.18 | 20.0 |
| VFD-P-14-9 | MHE1<br>BUS-0066 | 480<br>480 | 12.23 | 0.164<br>0.000 | -3.962<br>0.000 | 4163.83 | | | 28.93><br>38.17 | 20.0 |
| VFD-P-15-9 | MHE2<br>BUS-0082 | 480<br>480 | 12.24 | 0.164<br>0.000 | -3.962<br>0.000 | 4161.86 | | | 28.95><br>38.18 | 20.0 |

## TOTAL CURRENT DISTORTION

| Device Name | Bus Name<br>From/To | Voltage<br>From/To | I_RMS(A) | kWLo ss<br>Tot/Harm | kVARLoss<br>Tot/Harm | IT | HLF | KF | I_TDD(%)/<br>I_IHD(%) | LIMIT |
|---|---|---|---|---|---|---|---|---|---|---|
| VFD-P-2-3 | MHE1<br>BUS-0064 | 480<br>480 | 36.09 | 0.493<br>0.000 | -11.877<br>0.000 | 11489.98 | | | 24.45><br>32.20 | 15.0 |
| VFD-P-3-3 | MHE2<br>BUS-0078 | 480<br>480 | 36.10 | 0.493<br>0.000 | -11.877<br>0.000 | 11483.97 | | | 24.47><br>32.20 | 15.0 |
| VFD-P-4-3 | MHE3<br>BUS-0088 | 480<br>480 | 36.09 | 0.493<br>0.000 | -11.877<br>0.000 | 11502.51 | | | 24.48><br>32.23 | 15.0 |
| VFD-POLYMER SYSTEM | MHE1<br>BUS-0072 | 480<br>480 | 1.24 | 0.016<br>0.000 | -0.396<br>0.000 | 433.99 | | | 31.60><br>41.73 | 20.0 |

## TOTAL SYSTEM POWER LOSSES

| Harmonic Losses | | Total RMS Losses | |
|---|---|---|---|
| P(kW) | Q{kVAR) | P(kW) | Q(kVAR) |
| 14.26 | 17.56 | 84.27 | -296.85 |

## CURRENT DISTORTION SUMMARY

| Device Name | Bus Name<br>From/To | Voltage<br>From/To | I_RMS(A) | kWLo ss<br>Tot/Harm | kVARLoss<br>Tot/Harm | IT | HLF | KF | I_TDD(%)/<br>I_IHD(%) | LIMIT |
|---|---|---|---|---|---|---|---|---|---|---|
| CBL-0056 | BUS-0076<br>BUS-0075 | 480<br>480 | 92.76 | 0.158<br>0.009 | 0.044<br>0.010 | 22295.32 | | | 17.51><br>21.85 | 15.0 |
| CBL-0063 | BUS-0086<br>BUS-0085 | 480<br>480 | 92.76 | 0.158<br>0.009 | 0.044<br>0.010 | 22278.31 | | | 17.51><br>21.85 | 15.0 |
| CBL-CAP1-SBHE1 | PFC-SBHE1<br>BUS-0100 | 480<br>480 | 176.21 | 0.713<br>0.685 | 0.787<br>0.783 | 915040.81 | | | 279.11><br>313.10 | 15.0 |
| CBL-PFC-SBHE1 | SBHE1<br>PFC-SBHE1 | 480<br>480 | 176.21 | 0.444<br>0.440 | 0.612<br>0.608 | 915040.81 | | | 69.78><br>313.10 | 15.0 |
| CBL-SBH01 | UTIL-1 SEC<br>SBH01 | 480<br>480 | 2017.21 | 2.836<br>0.042 | 4.009<br>0.233 | 550364.69 | | | 7.20><br>7.03 | 5.0 |
| CBL-SBHE1 | SBH01<br>SBHE1 | 480<br>480 | 2017.21 | 2.836<br>0.042 | 4.009<br>0.233 | 550364.69 | | | 7.20><br>7.03 | 5.0 |
| CBL-UTILITY | BUS-0104<br>BUS-UTILITY | 12470<br>12470 | 77.62 | 0.058<br>0.001 | 0.011<br>0.001 | 21183.89 | | | 6.71><br>6.55 | 5.0 |
| VFD-B-5-8 | MHE1<br>BUS-0076 | 480<br>480 | 88.20 | 1.231<br>0.000 | -29.732<br>0.000 | 24433.89 | | | 18.26><br>24.08 | 15.0 |
| VFD-B-6-8 | MHE2<br>BUS-0086 | 480<br>480 | 88.24 | 1.231<br>0.000 | -29.732<br>0.000 | 24418.97 | | | 18.28><br>24.09 | 15.0 |
| VFD-C-1-9 | MHE1<br>BUS-0070 | 480<br>480 | 3.70 | 0.049<br>0.000 | -1.189<br>0.000 | 1289.71 | | | 30.96><br>40.88 | 20.0 |
| VFD-CF-1-9 | MHE1<br>BUS-0068 | 480<br>480 | 59.79 | 0.827<br>0.000 | -19.751<br>0.000 | 17813.13 | | | 21.37><br>27.97 | 15.0 |
| VFD-P-12-8 | MHE1<br>BUS-0074 | 480<br>480 | 12.23 | 0.164<br>0.000 | -3.962<br>0.000 | 4163.83 | | | 28.93><br>38.17 | 20.0 |
| VFD-P-13-8 | MHE2<br>BUS-0084 | 480<br>480 | 12.24 | 0.164<br>0.000 | -3.962<br>0.000 | 4161.86 | | | 28.95><br>38.18 | 20.0 |

## CURRENT DISTORTION SUMMARY

| Device Name | Bus Name<br>From/To | Voltage<br>From/To | I_RMS(A) | kWLo ss<br>Tot/Harm | kVARLoss<br>Tot/Harm | IT | HLF | KF | I_TDD(%)/<br>I_IHD(%) | LIMIT |
|---|---|---|---|---|---|---|---|---|---|---|
| VFD-P-14-9 | MHE1<br>BUS-0066 | 480<br>480 | 12.23 | 0.164<br>0.000 | -3.962<br>0.000 | 4163.83 | | | 28.93><br>38.17 | 20.0 |
| VFD-P-15-9 | MHE2<br>BUS-0082 | 480<br>480 | 12.24 | 0.164<br>0.000 | -3.962<br>0.000 | 4161.86 | | | 28.95><br>38.18 | 20.0 |
| VFD-P-2-3 | MHE1<br>BUS-0064 | 480<br>480 | 36.09 | 0.493<br>0.000 | -11.877<br>0.000 | 11489.98 | | | 24.45><br>32.20 | 15.0 |
| VFD-P-3-3 | MHE2<br>BUS-0078 | 480<br>480 | 36.10 | 0.493<br>0.000 | -11.877<br>0.000 | 11483.97 | | | 24.47><br>32.20 | 15.0 |
| VFD-P-4-3 | MHE3<br>BUS-0088 | 480<br>480 | 36.09 | 0.493<br>0.000 | -11.877<br>0.000 | 11502.51 | | | 24.48><br>32.23 | 15.0 |
| VFD-POLYMER SYSTEM | MHE1<br>BUS-0072 | 480<br>480 | 1.24 | 0.016<br>0.000 | -0.396<br>0.000 | 433.99 | | | 31.60><br>41.73 | 20.0 |

## TOTAL SYSTEM POWER LOSSES

| Harmonic Losses | | Total RMS Losses | |
|---|---|---|---|
| P(kW) | Q{kVAR) | P(kW) | Q(kVAR) |
| 14.26 | 17.56 | 84.27 | -296.85 |

HARMONIC VOLTAGE SPECTRUM REPORT

Bus: BUS-UTILITY (12470V)

| Harmonic Order | Harmonic Voltages | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 11801.639 | -2.02 | | | |
| 3 | 0.000 | 0.00 | 0.000 | | 3.000 |
| 5 | 114.390 | 134.41 | 0.969 | | 3.000 |
| 7 | 108.879 | -123.44 | 0.923 | | 3.000 |
| 11 | 80.236 | 91.01 | 0.680 | | 3.000 |
| 13 | 88.616 | 106.97 | 0.751 | | 3.000 |
| 15 | 0.000 | 0.00 | 0.000 | | 3.000 |
| 17 | 359.382 | -58.62 | 3.045 | > | 3.000 |
| 19 | 507.835 | 146.59 | 4.303 | > | 3.000 |
| 35 | 5.952 | 34.34 | 0.050 | | 3.000 |
| 37 | 9.289 | 1.10 | 0.079 | | 3.000 |

Voltage: 12470.0 V_RMS: 11819.69 V_THD(%): 5.53 >
LIMIT (THD%): 5.0

HARMONIC VOLTAGE SPECTRUM REPORT

Bus: MHE1 (480V)

| Harmonic Order | Harmonic Voltages | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 427.164 | -37.35 | | | |
| 3 | 4.065 | -94.20 | 0.952 | | 5.000 |
| 5 | 12.496 | 166.17 | 2.925 | | 5.000 |
| 7 | 11.907 | -152.75 | 2.787 | | 5.000 |
| 11 | 8.757 | 120.76 | 2.050 | | 5.000 |
| 13 | 9.650 | 76.40 | 2.259 | | 5.000 |
| 15 | 0.460 | 15.06 | 0.108 | | 5.000 |
| 17 | 38.858 | -29.60 | 9.097 | > | 5.000 |
| 19 | 54.764 | 115.38 | 12.820 | > | 5.000 |
| 35 | 0.625 | 62.73 | 0.146 | | 5.000 |
| 37 | 0.971 | -30.41 | 0.227 | | 5.000 |

Voltage: 480.0 V_RMS: 432.97 V_THD(%): 16.54 >
LIMIT (THD%): 8.0

HARMONIC VOLTAGE SPECTRUM REPORT

Bus: MHE2 (480V)

| Harmonic Order | Harmonic Voltages | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 426.998 | -37.36 | | | |
| 3 | 4.076 | -94.20 | 0.955 | | 5.000 |
| 5 | 12.467 | 166.22 | 2.920 | | 5.000 |
| 7 | 11.880 | -152.69 | 2.782 | | 5.000 |
| 11 | 8.738 | 120.79 | 2.046 | | 5.000 |
| 13 | 9.632 | 76.42 | 2.256 | | 5.000 |
| 15 | 0.458 | 15.10 | 0.107 | | 5.000 |
| 17 | 38.814 | -29.61 | 9.090 | > | 5.000 |
| 19 | 54.689 | 115.40 | 12.808 | > | 5.000 |
| 35 | 0.618 | 62.90 | 0.145 | | 5.000 |
| 37 | 0.958 | -30.17 | 0.224 | | 5.000 |

Voltage: 480.0 V_RMS: 432.79 V_THD(%): 16.53 >
LIMIT (THD%): 8.0

HARMONIC VOLTAGE SPECTRUM REPORT

Bus: MHE3 (480V)

| Harmonic Order | Harmonic Voltages | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 427.232 | -37.36 | | | |
| 3 | 4.057 | -94.21 | 0.950 | | 5.000 |
| 5 | 12.357 | 166.33 | 2.892 | | 5.000 |
| 7 | 11.782 | -152.54 | 2.758 | | 5.000 |
| 11 | 8.682 | 120.83 | 2.032 | | 5.000 |
| 13 | 9.585 | 76.43 | 2.244 | | 5.000 |
| 15 | 0.445 | 15.13 | 0.104 | | 5.000 |
| 17 | 38.889 | -29.71 | 9.103 | > | 5.000 |
| 19 | 54.814 | 115.43 | 12.830 | > | 5.000 |
| 35 | 0.609 | 63.50 | 0.142 | | 5.000 |
| 37 | 0.940 | -29.41 | 0.220 | | 5.000 |

Voltage: 480.0 V_RMS: 433.04 V_THD(%): 16.54 >
LIMIT (THD%): 8.0

HARMONIC VOLTAGE SPECTRUM REPORT

Bus: PFC-SBHE1 (480V)

| Harmonic Order | Harmonic Voltages | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 427.850 | -37.32 | | | |
| 3 | 3.955 | -93.98 | 0.924 | | 5.000 |
| 5 | 12.380 | 166.23 | 2.894 | | 5.000 |
| 7 | 11.834 | -152.79 | 2.766 | | 5.000 |
| 11 | 8.786 | 120.35 | 2.054 | | 5.000 |
| 13 | 9.747 | 75.76 | 2.278 | | 5.000 |
| 15 | 0.442 | 15.14 | 0.103 | | 5.000 |
| 17 | 39.961 | -30.85 | 9.340 | > | 5.000 |
| 19 | 56.835 | 113.84 | 13.284 | > | 5.000 |
| 35 | 0.723 | 55.70 | 0.169 | | 5.000 |
| 37 | 1.144 | -38.69 | 0.267 | | 5.000 |

Voltage: 480.0 V_RMS: 434.01 V_THD(%): 17.03 >
LIMIT (THD%): 8.0

HARMONIC VOLTAGE SPECTRUM REPORT

Bus: SBH01 (480V)

| Harmonic Order | Harmonic Voltages | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 428.949 | -37.21 | | | |
| 3 | 3.730 | -93.59 | 0.870 | | 5.000 |
| 5 | 12.170 | 166.49 | 2.837 | | 5.000 |
| 7 | 11.611 | -152.45 | 2.707 | | 5.000 |
| 11 | 8.568 | 120.90 | 1.997 | | 5.000 |
| 13 | 9.466 | 76.49 | 2.207 | | 5.000 |
| 15 | 0.417 | 15.22 | 0.097 | | 5.000 |
| 17 | 38.402 | -29.63 | 8.953 | > | 5.000 |
| 19 | 54.272 | 115.37 | 12.652 | > | 5.000 |
| 35 | 0.636 | 62.02 | 0.148 | | 5.000 |
| 37 | 0.993 | -31.32 | 0.232 | | 5.000 |

Voltage: 480.0 V_RMS: 434.60 V_THD(%): 16.29 >
LIMIT (THD%): 8.0

HARMONIC VOLTAGE SPECTRUM REPORT

Bus: SBHE1 (480V)

| Harmonic Order | Harmonic Voltages | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 427.813 | -37.31 | | | |
| 3 | 3.955 | -93.98 | 0.924 | | 5.000 |
| 5 | 12.354 | 166.32 | 2.888 | | 5.000 |
| 7 | 11.784 | -152.60 | 2.755 | | 5.000 |
| 11 | 8.696 | 120.80 | 2.033 | | 5.000 |
| 13 | 9.607 | 76.40 | 2.246 | | 5.000 |
| 15 | 0.442 | 15.14 | 0.103 | | 5.000 |
| 17 | 38.974 | -29.73 | 9.110 | > | 5.000 |
| 19 | 55.079 | 115.28 | 12.875 | > | 5.000 |
| 35 | 0.646 | 61.94 | 0.151 | | 5.000 |
| 37 | 1.008 | -31.40 | 0.236 | | 5.000 |

Voltage: 480.0 V_RMS: 433.65 V_THD(%): 16.58 >
LIMIT (THD%): 8.0

## HARMONIC CURRENT SPECTRUM REPORT

Device Name: CBL-UTILITY
From: BUS-0104 (12470V)
To: BUS-UTILITY (12470V)
Point of Common Coupling (PCC): (Isc/Ilf = 17.250)

| Harmonic Order | Harmonic Amperes | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 77.456 | -28.20 | | | |
| 3 | 0.000 | -180.00 | 0.000 | | 4.000 |
| 5 | 2.567 | -128.95 | 3.314 | | 4.000 |
| 7 | 1.751 | -28.69 | 2.261 | | 4.000 |
| 11 | 0.823 | -175.96 | 1.062 | | 2.000 |
| 13 | 0.769 | -160.47 | 0.993 | | 2.000 |
| 15 | 0.000 | -180.00 | 0.000 | | 2.000 |
| 17 | 2.387 | 33.34 | 3.081 | > | 1.500 |
| 19 | 3.018 | -121.65 | 3.896 | > | 1.500 |
| 35 | 0.019 | 125.30 | 0.025 | | 0.300 |
| 37 | 0.028 | 92.01 | 0.037 | | 0.300 |

Voltage: 12470.0 I_RMS: 77.62 I_TDD(%): 6.71 >
I_THD(%): 6.55
kWLoss: 0.058 kVARLoss: 0.011
I_K: LIMIT (TDD%): 5.0

HARMONIC CURRENT SPECTRUM REPORT

Device Name: CBL-SBHE1
From: SBH01 (480V)
To: SBHE1 (480V)
Point of Common Coupling (PCC): (Isc/Ilf = 8.155)

| Harmonic Order | Harmonic Amperes | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 2012.243 | -58.20 | | | |
| 3 | 51.316 | 0.51 | 2.550 | | 4.000 |
| 5 | 66.693 | -98.95 | 3.314 | | 4.000 |
| 7 | 45.492 | -58.69 | 2.261 | | 4.000 |
| 11 | 21.377 | -145.96 | 1.062 | | 2.000 |
| 13 | 19.986 | 169.53 | 0.993 | | 2.000 |
| 15 | 1.147 | 108.59 | 0.057 | | 2.000 |
| 17 | 62.007 | 63.34 | 3.081 | > | 1.500 |
| 19 | 78.406 | -151.65 | 3.896 | > | 1.500 |
| 35 | 0.499 | 155.30 | 0.025 | | 0.300 |
| 37 | 0.737 | 62.01 | 0.037 | | 0.300 |

Voltage: 480.0 I_RMS: 2017.21 I_TDD(%): 7.20 >
I_THD(%): 7.03
kWLoss: 2.836 kVARLoss: 4.009
I_K: LIMIT (TDD%): 5.0

## HARMONIC CURRENT SPECTRUM REPORT

Device Name: CBL-MHE1
From: SBHE1 (480V)
To: MHE1 (480V)
Point of Common Coupling (PCC): (Isc/Ilf = 22.788)

| Harmonic Order | Harmonic Amperes | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 711.776 | -60.36 | | | |
| 3 | 18.664 | 0.90 | 2.622 | | 7.000 |
| 5 | 36.452 | -99.06 | 5.121 | | 7.000 |
| 7 | 22.722 | -61.45 | 3.192 | | 7.000 |
| 11 | 7.143 | -142.45 | 1.004 | | 3.500 |
| 13 | 4.329 | 178.21 | 0.608 | | 3.500 |
| 15 | 0.615 | 108.64 | 0.086 | | 3.500 |
| 17 | 10.922 | -146.03 | 1.534 | | 2.500 |
| 19 | 22.460 | 17.34 | 3.155 | > | 2.500 |
| 35 | 0.834 | -41.16 | 0.117 | | 0.500 |
| 37 | 1.438 | -136.17 | 0.202 | | 0.500 |

Voltage: 480.0 I_RMS: 713.80 I_TDD(%): 6.98
I_THD(%): 7.55
kWLoss: 0.593 kVARLoss: 0.704
I_K: LIMIT (TDD%): 8.0

## HARMONIC CURRENT SPECTRUM REPORT

Device Name: CBL-MHE2
From: SBHE1 (480V)
To: MHE2 (480V)
Point of Common Coupling (PCC): (Isc/Ilf = 24.423)

| Harmonic Order | Harmonic Amperes | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 664.142 | -61.47 | | | |
| 3 | 15.358 | 0.70 | 2.312 | | 7.000 |
| 5 | 21.870 | -98.59 | 3.293 | | 7.000 |
| 7 | 13.292 | -60.01 | 2.001 | | 7.000 |
| 11 | 3.729 | -140.80 | 0.561 | | 3.500 |
| 13 | 1.860 | -175.35 | 0.280 | | 3.500 |
| 15 | 0.429 | 108.52 | 0.065 | | 3.500 |
| 17 | 10.113 | -137.66 | 1.523 | | 2.500 |
| 19 | 20.837 | 16.66 | 3.137 | > | 2.500 |
| 35 | 0.823 | -41.59 | 0.124 | | 0.500 |
| 37 | 1.421 | -136.61 | 0.214 | | 0.500 |

Voltage: 480.0 I_RMS: 665.23 I_TDD(%): 5.30
I_THD(%): 5.73
kWLoss: 0.684 kVARLoss: 0.806
I_K: LIMIT (TDD%): 8.0

## HARMONIC CURRENT SPECTRUM REPORT

Device Name: CBL-MHE3
From: SBHE1 (480V)
To: MHE3 (480V)
Point of Common Coupling (PCC): (Isc/Ilf = 24.683)

| Harmonic Order | Harmonic Amperes | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 657.146 | -56.94 | | | |
| 3 | 17.296 | -0.06 | 2.632 | | 7.000 |
| 5 | 0.883 | -54.03 | 0.134 | | 7.000 |
| 7 | 2.401 | 53.15 | 0.365 | | 7.000 |
| 11 | 1.710 | 27.39 | 0.260 | | 3.500 |
| 13 | 2.216 | -16.56 | 0.337 | | 3.500 |
| 15 | 0.103 | 108.62 | 0.016 | | 3.500 |
| 17 | 6.438 | -116.91 | 0.980 | | 2.500 |
| 19 | 20.461 | 6.70 | 3.114 | > | 2.500 |
| 35 | 1.510 | -42.68 | 0.230 | | 0.500 |
| 37 | 2.644 | -137.62 | 0.402 | | 0.500 |

Voltage: 480.0 I_RMS: 657.74 I_TDD(%): 3.87
I_THD(%): 4.26
kWLoss: 0.501 kVARLoss: 0.586
I_K: LIMIT (TDD%): 8.0

## HARMONIC CURRENT SPECTRUM REPORT

Device Name: CBL-PFC-SBHE1
From: SBHE1 (480V)
To: PFC-SBHE1 (480V)
Point of Common Coupling (PCC): (Isc/Ilf = 302.547)

| Harmonic Order | Harmonic Amperes | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 53.612 | 52.64 | | | |
| 3 | 0.000 | -139.01 | 0.000 | | 12.000 |
| 5 | 7.777 | -104.05 | 14.506 | > | 12.000 |
| 7 | 10.435 | -63.22 | 19.463 | > | 12.000 |
| 11 | 12.271 | -150.50 | 22.889 | > | 5.500 |
| 13 | 16.174 | 164.66 | 30.168 | > | 5.500 |
| 15 | 0.000 | -29.86 | 0.000 | | 5.500 |
| 17 | 87.867 | 57.46 | 163.893 | > | 5.000 |
| 19 | 140.794 | -158.20 | 262.615 | > | 5.000 |
| 35 | 3.646 | 140.33 | 6.800 | > | 1.000 |
| 37 | 6.204 | 45.23 | 11.572 | > | 1.000 |

Voltage: 480.0 I_RMS: 176.21 I_TDD(%): 69.78 >
I_THD(%): 313.10
kWLoss: 0.444 kVARLoss: 0.612
I_K: LIMIT (TDD%): 15.0

## HARMONIC CURRENT SPECTRUM REPORT

Device Name: CBL-SBH01
From: UTIL-1 SEC (480V)
To: SBH01 (480V)
Point of Common Coupling (PCC): (Isc/Ilf = 8.252)

| Harmonic Order | Harmonic Amperes | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 2012.243 | -58.20 | | | |
| 3 | 51.316 | 0.51 | 2.550 | | 4.000 |
| 5 | 66.693 | -98.95 | 3.314 | | 4.000 |
| 7 | 45.492 | -58.69 | 2.261 | | 4.000 |
| 11 | 21.377 | -145.96 | 1.062 | | 2.000 |
| 13 | 19.986 | 169.53 | 0.993 | | 2.000 |
| 15 | 1.147 | 108.59 | 0.057 | | 2.000 |
| 17 | 62.007 | 63.34 | 3.081 | > | 1.500 |
| 19 | 78.406 | -151.65 | 3.896 | > | 1.500 |
| 35 | 0.499 | 155.30 | 0.025 | | 0.300 |
| 37 | 0.737 | 62.01 | 0.037 | | 0.300 |

Voltage: 480.0 I_RMS: 2017.21 I_TDD(%): 7.20 >
I_THD(%): 7.03
kWLoss: 2.836 kVARLoss: 4.009
I_K: LIMIT (TDD%): 5.0

## F I L T E R S P E C T R U M R E P O R T

Filter Name: CAP1-SBHE1 (Capacitor)
Bus Name: BUS-0100 (480V)

| Harmonic Order | IR (Amp) | IL (Amp) | IC (Amp) | R (kW) | L (kVAR) | C (kVAR) | R (V) | L (V) | C (V) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | | 53.61245 | | | 39.73424 | | | 427.89648 |
| 3 | | | | | | | | | |
| 5 | | | 7.77683 | | | 0.16721 | | | 12.41382 |
| 7 | | | 10.43472 | | | 0.21503 | | | 11.89751 |
| 11 | | | 12.27123 | | | 0.18924 | | | 8.90366 |
| 13 | | | 16.17370 | | | 0.27817 | | | 9.92977 |
| 15 | | | | | | | | | |
| 17 | | | 87.86691 | | | 6.27821 | | | 41.25243 |
| 19 | | | 140.79429 | | | 14.42282 | | | 59.14316 |
| 35 | | | 3.64588 | | | 0.00525 | | | 0.83139 |
| 37 | | | 6.20419 | | | 0.01438 | | | 1.33831 |

Capacitor Rated Voltage: 480.00 Rated 3 Phase KVA: 50.00

| | | | |
|---|---|---|---|
| V_RMS: 434.478 | V_CREST: 573.607 | I_RMS: 176.214 | KVA: 61.305 |
| V_RMS: 90.5162% | V_CREST: 119.5014% | I_RMS: 293.0025% > | KVA: 122.6091% |
| Limit: 110.0% | Limit: 169.7% | Limit: 135.0% | Limit: 135.0% |

BIXBY WRF

TQSITL0010020
MTL0010020
U0130

Scenario 2

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ALL INFORMATION PRESENTED IS FOR REVIEW, APPROVAL
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# STUDY CRITERIA

| | |
|---|---|
| **Studies Selected To Run:** | |
| Load Flow: | Yes |
| Frequency Scan: | Yes |
| Harmonic Distortion: | Yes |
| **Load Flow Study Setup Options** | |
| Utility Impedance: | Yes |
| Transformer Phase Shift: | Yes |
| Solution Method: | Exact |
| Load Specification: | Connected Load |
| Generation Acceleration Factor: | 1.00 |
| Load Acceleration Factor: | 1.00 |
| Bus Voltage Drop: | 5.00 |
| Branch Voltage Drop: | 3.00 |
| **HI_WAVE Study Setup Options** | |
| Fundamental Frequency: | 60 Hz |
| Max. Harmonic Order: | 50 |
| Include Triplet Harmonics Path (Static Load): | No |
| Include Triplet Harmonics Path (Ind. Motor): | No |
| Modify Motor Z by Load Factor (Ind. Motor): | No |
| Modify Load Z by Load Factor (Static Load): | No |
| **HI_WAVE Study Setup Options for Frequency Scan** | |
| Scan Impedance Option: | Scan Self Impedance |
| Use Positive Sequence Network: | Yes |
| Use Negative Sequence Network: | Yes |
| Use Zero Sequence Network: | No |
| Model Transformer Tap: | Yes |
| Model Transformer Phase Shift: | Yes |
| Report Bus Equivalent Impedance: | No |
| Number of Scan Steps Per Order: | 5 |
| **HI_WAVE Study Setup Options for Distortion** | |
| Use Positive Sequence Network: | Yes |
| Use Negative Sequence Network: | Yes |
| Use Zero Sequence Network: | Yes |
| Model Transformer Tap: | Yes |
| Model Transformer Phase Shift: | Yes |
| Fundamental Solution: | Use Load Flow Result |
| Report Option: | All Distortions and Violations |
| Current Limits: | IEEE 519-2022 Std, Current Distortion Limit Tables 2, 3, & 4, All buses as PCC |

| LOADS AND MOTORS WITH HARMONIC SOURCE MODELS | | | | |
|---|---|---|---|---|
| Bus Name | Voltage | Component Name | LF Current | Harmonic Library |
| BUS-0062 | 480 | VFD-B-1-4 | 233.2 | CPX9000 |
| BUS-0064 | 480 | VFD-P-2-3 | 34.2 | DG-1 |
| BUS-0066 | 480 | VFD-P-14-9 | 11.4 | DG-1 |
| BUS-0068 | 480 | VFD-CF-1-9 | 57.3 | DG-1 |
| BUS-0070 | 480 | VFD-C-1-9 | 3.4 | DG-1 |
| BUS-0072 | 480 | VFD-POLYMER SYSTEM | 1.1 | DG-1 |
| BUS-0074 | 480 | VFD-P-12-8 | 11.4 | DG-1 |
| BUS-0076 | 480 | VFD-B-5-8 | 85.3 | DG-1 |
| BUS-0078 | 480 | VFD-P-3-3 | 34.2 | DG-1 |
| BUS-0080 | 480 | VFD-B-2-4 | 233.2 | CPX9000 |
| BUS-0082 | 480 | VFD-P-15-9 | 11.4 | DG-1 |
| BUS-0084 | 480 | VFD-P-13-8 | 11.4 | DG-1 |
| BUS-0086 | 480 | VFD-B-6-8 | 85.3 | DG-1 |
| BUS-0088 | 480 | VFD-P-4-3 | 34.2 | DG-1 |
| BUS-0090 | 480 | VFD-B-3-4 | 233.1 | CPX9000 |
| BUS-0092 | 480 | VFD-B-4-4 | 233.1 | CPX9000 |

| HARMONIC SOURCE | | |
|---|---|---|
| CPX9000 | | |
| Order | Magnitude (%) | Angle (Degrees) |
| 1 | 100.000 | -11.00 |
| 3 | 3.300 | 121.00 |
| 5 | 0.400 | 138.00 |
| 7 | 1.400 | -49.00 |
| 17 | 2.200 | 17.00 |
| 19 | 2.500 | 4.00 |
| 35 | 0.400 | -69.00 |
| 37 | 0.700 | -83.00 |

| HARMONIC SOURCE | | |
|---|---|---|
| DG-1 | | |
| Order | Magnitude (%) | Angle (Degrees) |
| 1 | 100.000 | -7.00 |
| 3 | 5.330 | 135.00 |
| 5 | 38.460 | 123.00 |
| 7 | 22.780 | -112.00 |
| 11 | 7.690 | -16.00 |
| 13 | 5.620 | 30.00 |
| 15 | 0.300 | 55.00 |
| 17 | 3.850 | 153.00 |

| H A R M O N I C  S O U R C E  I N D E X  T A B L E |
|---|
| HARMONIC SOURCES HAVE BEEN FOUND AND INJECTED FOR EACH OF THE FOLLOWING HARMONIC ORDERS |
| 3 5 7 11 13 15 17 19 35 37 |

P A S S I V E F I L T E R D A T A

| Filter Name | Bus Name | Bus Volts | Rated Volts | Connect | Filter Type | Capacitor KVAR | Tuned Order | Q | M | R (Ω) | L (H) | C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CAP1-SBHE1 | BUS-0100 | 480 | 480 | WYE_G | Capacitor | 50.0 | | | | 0.0000<br>0.0000 | 0.0000<br>0.0000 | 575.6472uF<br>575.6472uF |
| CAP2-SBHE1 | BUS-0101 | 480 | 480 | WYE_G | Capacitor | 50.0 | | | | 0.0000<br>0.0000 | 0.0000<br>0.0000 | 575.6472uF<br>575.6472uF |

| U T I L I T Y , G E N E R A T O R A N D M O T O R D A T A | | | | | | | |
|---|---|---|---|---|---|---|---|
| Component Name | Component Type | Bus Name | Bus Voltage | Base Voltage | Base KVA | R1(pu)<br>R2<br>R0 | X1(pu)<br>X2<br>X0 |
| UTIL-1 MAX | UTILITY | BUS-0104 | 12470 | 12470 | 100000 | 1.9106<br>1.9106<br>3.0389 | 3.2862<br>3.2862<br>8.4512 |

| TOTAL VOLTAGE DISTORTION | | | | | |
|---|---|---|---|---|---|
| Bus Name | Voltage | V_RMS(V) | V_TIF | V_THD(%) | LIMIT |
| ADMIN SEC | 480 | 455.68 | 166.8261 | 5.1929 | 8.0 |
| ATS1 | 480 | 434.50 | 490.1989 | 15.4736> | 8.0 |
| BUS-0007 | 480 | 432.31 | 488.0617 | 15.4049> | 8.0 |
| BUS-0008 | 480 | 432.52 | 491.5294 | 15.5165> | 8.0 |
| BUS-0009 | 480 | 431.09 | 486.6298 | 15.3585> | 8.0 |
| BUS-0010 | 480 | 433.16 | 488.5921 | 15.4215> | 8.0 |
| BUS-0011 | 480 | 430.94 | 486.9488 | 15.3523> | 8.0 |
| BUS-0012 | 480 | 432.71 | 487.7290 | 15.3942> | 8.0 |
| BUS-0013 | 480 | 432.34 | 491.0660 | 15.5012> | 8.0 |
| BUS-0014 | 480 | 432.34 | 491.0660 | 15.5012> | 8.0 |
| BUS-0015 | 480 | 434.50 | 490.1989 | 15.4736> | 8.0 |
| BUS-0016 | 480 | 434.32 | 489.7350 | 15.4582> | 8.0 |
| BUS-0017 | 480 | 433.84 | 489.7092 | 15.4409> | 8.0 |
| BUS-0022 | 480 | 434.50 | 490.1989 | 15.4736> | 8.0 |
| BUS-0023 | 208 | 188.27 | 490.1989 | 15.4446> | 8.0 |
| BUS-0024 | 480 | 455.68 | 166.8261 | 5.1929 | 8.0 |
| BUS-0025 | 208 | 197.46 | 166.8261 | 5.1929 | 8.0 |
| BUS-0026 | 480 | 455.68 | 166.8261 | 5.1929 | 8.0 |
| BUS-0027 | 208 | 188.27 | 490.1989 | 15.4446> | 8.0 |
| BUS-0028 | 208 | 188.27 | 490.1989 | 15.4446> | 8.0 |
| BUS-0029 | 208 | 197.46 | 166.8261 | 5.1929 | 8.0 |
| BUS-0036 | 208 | 197.46 | 166.8261 | 5.1929 | 8.0 |
| BUS-0060 | 12470 | 11838.18 | 166.8261 | 5.1929> | 5.0 |
| BUS-0061 | 480 | 473.91 | 295.6941 | 10.6950> | 8.0 |
| BUS-0062 | 480 | 482.67 | 293.1152 | 10.5529> | 8.0 |
| BUS-0063 | 480 | 486.37 | 404.0252 | 17.9591> | 8.0 |
| BUS-0064 | 480 | 487.66 | 403.5340 | 17.9371> | 8.0 |
| BUS-0065 | 480 | 484.72 | 425.0112 | 14.9742> | 8.0 |
| BUS-0066 | 480 | 485.34 | 424.7432 | 14.9646> | 8.0 |
| BUS-0067 | 480 | 487.17 | 392.7867 | 20.9035> | 8.0 |
| BUS-0068 | 480 | 490.31 | 391.5538 | 20.8367> | 8.0 |
| BUS-0069 | 480 | 484.47 | 434.9442 | 14.1221> | 8.0 |
| BUS-0070 | 480 | 484.76 | 434.7767 | 14.1166> | 8.0 |
| BUS-0071 | 480 | 484.54 | 437.9766 | 13.9276> | 8.0 |
| BUS-0072 | 480 | 484.63 | 437.9203 | 13.9258> | 8.0 |
| BUS-0073 | 480 | 484.72 | 425.0112 | 14.9742> | 8.0 |
| BUS-0074 | 480 | 485.34 | 424.7432 | 14.9646> | 8.0 |
| BUS-0075 | 480 | 492.36 | 384.1118 | 23.6873> | 8.0 |
| BUS-0076 | 480 | 493.30 | 384.4382 | 23.7071> | 8.0 |
| BUS-0077 | 480 | 486.36 | 403.5978 | 17.9489> | 8.0 |

| TOTAL VOLTAGE DISTORTION | | | | | |
|---|---|---|---|---|---|
| Bus Name | Voltage | V_RMS(V) | V_TIF | V_THD(%) | LIMIT |
| BUS-0078 | 480 | 487.65 | 403.1070 | 17.9269> | 8.0 |
| BUS-0079 | 480 | 473.91 | 295.7714 | 10.6948> | 8.0 |
| BUS-0080 | 480 | 482.67 | 293.1918 | 10.5526> | 8.0 |
| BUS-0081 | 480 | 484.71 | 424.4809 | 14.9578> | 8.0 |
| BUS-0082 | 480 | 485.33 | 424.2131 | 14.9482> | 8.0 |
| BUS-0083 | 480 | 484.71 | 424.4809 | 14.9578> | 8.0 |
| BUS-0084 | 480 | 485.33 | 424.2131 | 14.9482> | 8.0 |
| BUS-0085 | 480 | 492.36 | 383.8805 | 23.6862> | 8.0 |
| BUS-0086 | 480 | 493.30 | 384.2068 | 23.7061> | 8.0 |
| BUS-0087 | 480 | 486.35 | 404.1000 | 17.9379> | 8.0 |
| BUS-0088 | 480 | 487.64 | 403.6086 | 17.9159> | 8.0 |
| BUS-0089 | 480 | 473.91 | 296.1750 | 10.6957> | 8.0 |
| BUS-0090 | 480 | 482.67 | 293.5918 | 10.5535> | 8.0 |
| BUS-0091 | 480 | 473.91 | 296.1750 | 10.6957> | 8.0 |
| BUS-0092 | 480 | 482.67 | 293.5918 | 10.5535> | 8.0 |
| BUS-0100 | 480 | 435.76 | 516.7896 | 16.2035> | 8.0 |
| BUS-0101 | 480 | 435.76 | 516.7896 | 16.2035> | 8.0 |
| BUS-0104 | 12470 | 11838.60 | 166.8002 | 5.1921> | 5.0 |
| BUS-UTILITY | 12470 | 11838.18 | 166.8261 | 5.1929> | 5.0 |
| DS-CU-1 | 480 | 434.50 | 490.1989 | 15.4736> | 8.0 |
| DS-CU-2 | 480 | 434.50 | 490.1989 | 15.4736> | 8.0 |
| DS-CU-3 | 208 | 197.46 | 166.8261 | 5.1929 | 8.0 |
| DS-CU-4 | 208 | 197.46 | 166.8261 | 5.1929 | 8.0 |
| DS-CU-5 | 208 | 197.46 | 166.8261 | 5.1929 | 8.0 |
| DS-CU-6 | 208 | 197.46 | 166.8261 | 5.1929 | 8.0 |
| DS-EF-1 | 208 | 188.27 | 490.1989 | 15.4446> | 8.0 |
| DS-EF-2 | 208 | 188.27 | 490.1989 | 15.4446> | 8.0 |
| DS-EF-3 | 208 | 188.27 | 490.1989 | 15.4446> | 8.0 |
| DS-EF-4 | 208 | 188.27 | 490.1989 | 15.4446> | 8.0 |
| DS-EF-5 | 208 | 188.27 | 490.1989 | 15.4446> | 8.0 |
| DS-EF-6 | 208 | 197.46 | 166.8261 | 5.1929 | 8.0 |
| DS-EF-7 | 208 | 197.46 | 166.8261 | 5.1929 | 8.0 |
| DS-EF-8 | 208 | 197.46 | 166.8261 | 5.1929 | 8.0 |
| DS-SS-1 | 208 | 188.27 | 490.1989 | 15.4446> | 8.0 |
| DS-SS-2 | 208 | 188.27 | 490.1989 | 15.4446> | 8.0 |
| DS-SS-3 | 208 | 197.46 | 166.8261 | 5.1929 | 8.0 |
| DS-SS-4 | 208 | 197.46 | 166.8261 | 5.1929 | 8.0 |
| DS-SS-6 | 208 | 197.46 | 166.8261 | 5.1929 | 8.0 |
| MHE1 | 480 | 434.50 | 490.1989 | 15.4736> | 8.0 |
| MHE2 | 480 | 434.32 | 489.7350 | 15.4582> | 8.0 |

| TOTAL VOLTAGE DISTORTION | | | | | |
|---|---|---|---|---|---|
| Bus Name | Voltage | V_RMS(V) | V_TIF | V_THD(%) | LIMIT |
| MHE3 | 480 | 434.56 | 490.4225 | 15.4638> | 8.0 |
| PFC-SBHE1 | 480 | 435.53 | 506.9912 | 15.9254> | 8.0 |
| PHA1 | 480 | 455.68 | 166.8261 | 5.1929 | 8.0 |
| PHC1 | 480 | 434.50 | 490.1989 | 15.4736> | 8.0 |
| PHC2 | 480 | 434.50 | 490.1989 | 15.4736> | 8.0 |
| PHC3 | 480 | 434.50 | 490.1989 | 15.4736> | 8.0 |
| PHE1 | 480 | 434.50 | 490.1989 | 15.4736> | 8.0 |
| PLA1 | 208 | 197.46 | 166.8261 | 5.1929 | 8.0 |
| PLAU | 208 | 197.46 | 166.8261 | 5.1929 | 8.0 |
| PLC1 | 208 | 188.27 | 490.1989 | 15.4446> | 8.0 |
| PLC2 | 208 | 188.27 | 490.1989 | 15.4446> | 8.0 |
| PLCU | 208 | 188.27 | 490.1989 | 15.4446> | 8.0 |
| SBH01 | 480 | 436.11 | 483.7503 | 15.2313> | 8.0 |
| SBHE1 | 480 | 435.17 | 492.0122 | 15.5001> | 8.0 |
| UTIL-1 SEC | 480 | 437.05 | 475.5204 | 14.9640> | 8.0 |

| VOLTAGE DISTORTION SUMMARY | | | | | |
|---|---|---|---|---|---|
| Bus Name | Voltage | V_RMS(V) | V_TIF | V_THD(%) | LIMIT |
| ATS1 | 480 | 434.50 | 490.1989 | 15.4736> | 8.0 |
| BUS-0007 | 480 | 432.31 | 488.0617 | 15.4049> | 8.0 |
| BUS-0008 | 480 | 432.52 | 491.5294 | 15.5165> | 8.0 |
| BUS-0009 | 480 | 431.09 | 486.6298 | 15.3585> | 8.0 |
| BUS-0010 | 480 | 433.16 | 488.5921 | 15.4215> | 8.0 |
| BUS-0011 | 480 | 430.94 | 486.9488 | 15.3523> | 8.0 |
| BUS-0012 | 480 | 432.71 | 487.7290 | 15.3942> | 8.0 |
| BUS-0013 | 480 | 432.34 | 491.0660 | 15.5012> | 8.0 |
| BUS-0014 | 480 | 432.34 | 491.0660 | 15.5012> | 8.0 |
| BUS-0015 | 480 | 434.50 | 490.1989 | 15.4736> | 8.0 |
| BUS-0016 | 480 | 434.32 | 489.7350 | 15.4582> | 8.0 |
| BUS-0017 | 480 | 433.84 | 489.7092 | 15.4409> | 8.0 |
| BUS-0022 | 480 | 434.50 | 490.1989 | 15.4736> | 8.0 |
| BUS-0023 | 208 | 188.27 | 490.1989 | 15.4446> | 8.0 |
| BUS-0027 | 208 | 188.27 | 490.1989 | 15.4446> | 8.0 |
| BUS-0028 | 208 | 188.27 | 490.1989 | 15.4446> | 8.0 |
| BUS-0060 | 12470 | 11838.18 | 166.8261 | 5.1929> | 5.0 |
| BUS-0061 | 480 | 473.91 | 295.6941 | 10.6950> | 8.0 |
| BUS-0062 | 480 | 482.67 | 293.1152 | 10.5529> | 8.0 |
| BUS-0063 | 480 | 486.37 | 404.0252 | 17.9591> | 8.0 |
| BUS-0064 | 480 | 487.66 | 403.5340 | 17.9371> | 8.0 |
| BUS-0065 | 480 | 484.72 | 425.0112 | 14.9742> | 8.0 |
| BUS-0066 | 480 | 485.34 | 424.7432 | 14.9646> | 8.0 |
| BUS-0067 | 480 | 487.17 | 392.7867 | 20.9035> | 8.0 |
| BUS-0068 | 480 | 490.31 | 391.5538 | 20.8367> | 8.0 |
| BUS-0069 | 480 | 484.47 | 434.9442 | 14.1221> | 8.0 |
| BUS-0070 | 480 | 484.76 | 434.7767 | 14.1166> | 8.0 |
| BUS-0071 | 480 | 484.54 | 437.9766 | 13.9276> | 8.0 |
| BUS-0072 | 480 | 484.63 | 437.9203 | 13.9258> | 8.0 |
| BUS-0073 | 480 | 484.72 | 425.0112 | 14.9742> | 8.0 |
| BUS-0074 | 480 | 485.34 | 424.7432 | 14.9646> | 8.0 |
| BUS-0075 | 480 | 492.36 | 384.1118 | 23.6873> | 8.0 |
| BUS-0076 | 480 | 493.30 | 384.4382 | 23.7071> | 8.0 |
| BUS-0077 | 480 | 486.36 | 403.5978 | 17.9489> | 8.0 |
| BUS-0078 | 480 | 487.65 | 403.1070 | 17.9269> | 8.0 |
| BUS-0079 | 480 | 473.91 | 295.7714 | 10.6948> | 8.0 |
| BUS-0080 | 480 | 482.67 | 293.1918 | 10.5526> | 8.0 |
| BUS-0081 | 480 | 484.71 | 424.4809 | 14.9578> | 8.0 |
| BUS-0082 | 480 | 485.33 | 424.2131 | 14.9482> | 8.0 |
| BUS-0083 | 480 | 484.71 | 424.4809 | 14.9578> | 8.0 |

| VOLTAGE DISTORTION SUMMARY | | | | | |
|---|---|---|---|---|---|
| Bus Name | Voltage | V_RMS(V) | V_TIF | V_THD(%) | LIMIT |
| BUS-0084 | 480 | 485.33 | 424.2131 | 14.9482> | 8.0 |
| BUS-0085 | 480 | 492.36 | 383.8805 | 23.6862> | 8.0 |
| BUS-0086 | 480 | 493.30 | 384.2068 | 23.7061> | 8.0 |
| BUS-0087 | 480 | 486.35 | 404.1000 | 17.9379> | 8.0 |
| BUS-0088 | 480 | 487.64 | 403.6086 | 17.9159> | 8.0 |
| BUS-0089 | 480 | 473.91 | 296.1750 | 10.6957> | 8.0 |
| BUS-0090 | 480 | 482.67 | 293.5918 | 10.5535> | 8.0 |
| BUS-0091 | 480 | 473.91 | 296.1750 | 10.6957> | 8.0 |
| BUS-0092 | 480 | 482.67 | 293.5918 | 10.5535> | 8.0 |
| BUS-0100 | 480 | 435.76 | 516.7896 | 16.2035> | 8.0 |
| BUS-0101 | 480 | 435.76 | 516.7896 | 16.2035> | 8.0 |
| BUS-0104 | 12470 | 11838.60 | 166.8002 | 5.1921> | 5.0 |
| BUS-UTILITY | 12470 | 11838.18 | 166.8261 | 5.1929> | 5.0 |
| DS-CU-1 | 480 | 434.50 | 490.1989 | 15.4736> | 8.0 |
| DS-CU-2 | 480 | 434.50 | 490.1989 | 15.4736> | 8.0 |
| DS-EF-1 | 208 | 188.27 | 490.1989 | 15.4446> | 8.0 |
| DS-EF-2 | 208 | 188.27 | 490.1989 | 15.4446> | 8.0 |
| DS-EF-3 | 208 | 188.27 | 490.1989 | 15.4446> | 8.0 |
| DS-EF-4 | 208 | 188.27 | 490.1989 | 15.4446> | 8.0 |
| DS-EF-5 | 208 | 188.27 | 490.1989 | 15.4446> | 8.0 |
| DS-SS-1 | 208 | 188.27 | 490.1989 | 15.4446> | 8.0 |
| DS-SS-2 | 208 | 188.27 | 490.1989 | 15.4446> | 8.0 |
| MHE1 | 480 | 434.50 | 490.1989 | 15.4736> | 8.0 |
| MHE2 | 480 | 434.32 | 489.7350 | 15.4582> | 8.0 |
| MHE3 | 480 | 434.56 | 490.4225 | 15.4638> | 8.0 |
| PFC-SBHE1 | 480 | 435.53 | 506.9912 | 15.9254> | 8.0 |
| PHC1 | 480 | 434.50 | 490.1989 | 15.4736> | 8.0 |
| PHC2 | 480 | 434.50 | 490.1989 | 15.4736> | 8.0 |
| PHC3 | 480 | 434.50 | 490.1989 | 15.4736> | 8.0 |
| PHE1 | 480 | 434.50 | 490.1989 | 15.4736> | 8.0 |
| PLC1 | 208 | 188.27 | 490.1989 | 15.4446> | 8.0 |
| PLC2 | 208 | 188.27 | 490.1989 | 15.4446> | 8.0 |
| PLCU | 208 | 188.27 | 490.1989 | 15.4446> | 8.0 |
| SBH01 | 480 | 436.11 | 483.7503 | 15.2313> | 8.0 |
| SBHE1 | 480 | 435.17 | 492.0122 | 15.5001> | 8.0 |
| UTIL-1 SEC | 480 | 437.05 | 475.5204 | 14.9640> | 8.0 |

| TOTAL CURRENT DISTORTION | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Device Name | Bus Name<br>From/To | Voltage<br>From/To | I_RMS(A) | kWLo ss<br>Tot/Harm | kVARLoss<br>Tot/Harm | IT | HLF | KF | I_TDD(%)/<br>I_IHD(%) | LIMIT |
| CAP1-SBHE1 | BUS-0100 | 480 | 122.58 | 0.000 | -53.231 | 378056.34 | | | 183.06 | |
| | | 480 | | 0.000 | -13.076 | | | | 204.27 | |
| CAP2-SBHE1 | BUS-0101 | 480 | 122.58 | 0.000 | -53.231 | 378056.34 | | | 183.06 | |
| | | 480 | | 0.000 | -13.076 | | | | 204.27 | |
| CBL-0008 | MHE1 | 480 | 135.78 | 0.475 | 0.208 | 24248.98 | | | 5.90 | 15.0 |
| | BUS-0007 | 480 | | 0.003 | 0.009 | | | | 6.56 | |
| CBL-0009 | MHE1 | 480 | 0.00 | 0.000 | 0.000 | 0.00 | | | 0.00 | 20.0 |
| | BUS-0015 | 480 | | 0.000 | 0.000 | | | | 0.00 | |
| CBL-0010 | BUS-0062 | 480 | 245.87 | 4.413 | 0.333 | 28098.57 | | | 2.97 | 12.0 |
| | BUS-0061 | 480 | | 0.006 | 0.005 | | | | 3.64 | |
| CBL-0011 | MHE1 | 480 | 0.00 | 0.000 | 0.000 | 0.00 | | | 0.00 | 20.0 |
| | PHE1 | 480 | | 0.000 | 0.000 | | | | 0.00 | |
| CBL-0012 | MHE2 | 480 | 136.15 | 0.703 | 0.308 | 24110.50 | | | 5.86 | 15.0 |
| | BUS-0009 | 480 | | 0.003 | 0.013 | | | | 6.51 | |
| CBL-0013 | MHE2 | 480 | 0.00 | 0.000 | 0.000 | 0.00 | | | 0.00 | 20.0 |
| | BUS-0016 | 480 | | 0.000 | 0.000 | | | | 0.00 | |
| CBL-0014 | MHE2 | 480 | 135.52 | 0.251 | 0.110 | 24324.16 | | | 5.92 | 15.0 |
| | BUS-0010 | 480 | | 0.002 | 0.005 | | | | 6.60 | |
| CBL-0015 | MHE3 | 480 | 136.19 | 0.787 | 0.345 | 24113.72 | | | 5.85 | 15.0 |
| | BUS-0011 | 480 | | 0.004 | 0.015 | | | | 6.49 | |
| CBL-0016 | ATS1 | 480 | 0.00 | 0.000 | 0.000 | 0.00 | | | 0.00 | 20.0 |
| | PHC1 | 480 | | 0.000 | 0.000 | | | | 0.00 | |
| CBL-0017 | PHC1 | 480 | 0.00 | 0.000 | 0.000 | 0.00 | | | 0.00 | 20.0 |
| | PHC2 | 480 | | 0.000 | 0.000 | | | | 0.00 | |
| CBL-0018 | PHC2 | 480 | 0.00 | 0.000 | 0.000 | 0.00 | | | 0.00 | 20.0 |
| | PHC3 | 480 | | 0.000 | 0.000 | | | | 0.00 | |

| TOTAL CURRENT DISTORTION | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Device Name | Bus Name<br>From/To | Voltage<br>From/To | I_RMS(A) | kWLo ss<br>Tot/Harm | kVARLoss<br>Tot/Harm | IT | HLF | KF | I_TDD(%)/<br>I_IHD(%) | LIMIT |
| CBL-0019 | BUS-0023<br>PLC1 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0020 | PLC1<br>PLC2 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0021 | PHC1<br>BUS-0022 | 480<br>480 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0022 | PLC1<br>BUS-0027 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0023 | BUS-0028<br>PLCU | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0024 | PHA1<br>BUS-0024 | 480<br>480 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0025 | BUS-0025<br>PLA1 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0026 | PHA1<br>BUS-0026 | 480<br>480 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0027 | BUS-0036<br>PLAU | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0028 | ADMIN SEC<br>PHA1 | 480<br>480 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0030 | BUS-0064<br>BUS-0063 | 480<br>480 | 36.68 | 0.098<br>0.002 | 0.008<br>0.001 | 7048.41 | | | 11.93<br>14.87 | 15.0 |
| CBL-0031 | PHC3<br>DS-CU-1 | 480<br>480 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0032 | PHC3<br>DS-CU-2 | 480<br>480 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |

| TOTAL CURRENT DISTORTION | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Device Name | Bus Name<br>From/To | Voltage<br>From/To | I_RMS(A) | kWLo ss<br>Tot/Harm | kVARLoss<br>Tot/Harm | IT | HLF | KF | I_TDD(%)/<br>I_IHD(%) | LIMIT |
| CBL-0033 | PLC1<br>DS-EF-1 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0034 | PLC1<br>DS-EF-2 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0035 | PLC1<br>DS-EF-3 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0036 | PLC1<br>DS-EF-4 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0037 | PLC1<br>DS-EF-5 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0038 | PLC1<br>DS-SS-1 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0039 | PLC1<br>DS-SS-2 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0040 | PLA1<br>DS-CU-3 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0041 | PLA1<br>DS-CU-4 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0042 | PLA1<br>DS-CU-5 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0043 | PLA1<br>DS-CU-6 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0044 | PLA1<br>DS-EF-6 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0045 | PLA1<br>DS-EF-7 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |

| TOTAL CURRENT DISTORTION | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Device Name | Bus Name<br>From/To | Voltage<br>From/To | I_RMS(A) | kWLo ss<br>Tot/Harm | kVARLoss<br>Tot/Harm | IT | HLF | KF | I_TDD(%)/<br>I_IHD(%) | LIMIT |
| CBL-0046 | PLA1<br>DS-EF-8 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0047 | PLA1<br>DS-SS-3 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0048 | PLA1<br>DS-SS-4 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0049 | PLA1<br>DS-SS-6 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0050 | BUS-0066<br>BUS-0065 | 480<br>480 | 12.14 | 0.016<br>0.000 | 0.001<br>0.000 | 2396.85 | | | 8.00<br>9.99 | 20.0 |
| CBL-0051 | BUS-0068<br>BUS-0067 | 480<br>480 | 61.74 | 0.405<br>0.013 | 0.033<br>0.006 | 11736.92 | | | 15.01><br>18.63 | 15.0 |
| CBL-0052 | BUS-UTILITY<br>BUS-0060 | 12470<br>12470 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0053 | BUS-0070<br>BUS-0069 | 480<br>480 | 3.63 | 0.002<br>0.000 | 0.000<br>0.000 | 729.04 | | | 6.53<br>8.16 | 20.0 |
| CBL-0054 | BUS-0072<br>BUS-0071 | 480<br>480 | 1.21 | 0.000<br>0.000 | 0.000<br>0.000 | 244.17 | | | 6.14<br>7.67 | 20.0 |
| CBL-0055 | BUS-0074<br>BUS-0073 | 480<br>480 | 12.14 | 0.016<br>0.000 | 0.001<br>0.000 | 2396.85 | | | 8.00<br>9.99 | 20.0 |
| CBL-0056 | BUS-0076<br>BUS-0075 | 480<br>480 | 92.82 | 0.158<br>0.009 | 0.045<br>0.010 | 17823.87 | | | 17.76><br>22.15 | 15.0 |
| CBL-0057 | MHE1<br>BUS-0008 | 480<br>480 | 13.57 | 0.055<br>0.000 | 0.004<br>0.000 | 2443.35 | | | 5.94<br>6.62 | 20.0 |
| CBL-0058 | MHE1<br>BUS-0012 | 480<br>480 | 135.65 | 0.360<br>0.002 | 0.203<br>0.009 | 24255.00 | | | 5.90<br>6.57 | 15.0 |

| TOTAL CURRENT DISTORTION | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Device Name | Bus Name<br>From/To | Voltage<br>From/To | I_RMS(A) | kWLo ss<br>Tot/Harm | kVARLoss<br>Tot/Harm | IT | HLF | KF | I_TDD(%)/<br>I_IHD(%) | LIMIT |
| CBL-0059 | BUS-0078<br>BUS-0077 | 480<br>480 | 36.68 | 0.098<br>0.002 | 0.008<br>0.001 | 7041.58 | | | 11.92<br>14.86 | 15.0 |
| CBL-0060 | BUS-0080<br>BUS-0079 | 480<br>480 | 245.86 | 4.413<br>0.006 | 0.333<br>0.005 | 28085.68 | | | 2.96<br>3.64 | 12.0 |
| CBL-0061 | BUS-0082<br>BUS-0081 | 480<br>480 | 12.14 | 0.016<br>0.000 | 0.001<br>0.000 | 2393.93 | | | 8.00<br>9.98 | 20.0 |
| CBL-0062 | BUS-0084<br>BUS-0083 | 480<br>480 | 12.14 | 0.016<br>0.000 | 0.001<br>0.000 | 2393.93 | | | 8.00<br>9.98 | 20.0 |
| CBL-0063 | BUS-0086<br>BUS-0085 | 480<br>480 | 92.82 | 0.158<br>0.009 | 0.045<br>0.010 | 17815.50 | | | 17.76><br>22.15 | 15.0 |
| CBL-0064 | MHE2<br>BUS-0013 | 480<br>480 | 13.58 | 0.055<br>0.000 | 0.004<br>0.000 | 2440.11 | | | 5.94<br>6.60 | 20.0 |
| CBL-0065 | MHE2<br>BUS-0014 | 480<br>480 | 13.58 | 0.055<br>0.000 | 0.004<br>0.000 | 2440.11 | | | 5.94<br>6.60 | 20.0 |
| CBL-0066 | BUS-0088<br>BUS-0087 | 480<br>480 | 36.68 | 0.098<br>0.002 | 0.008<br>0.001 | 7048.36 | | | 11.90<br>14.84 | 15.0 |
| CBL-0067 | BUS-0090<br>BUS-0089 | 480<br>480 | 245.86 | 4.413<br>0.006 | 0.333<br>0.005 | 28123.78 | | | 2.96<br>3.64 | 12.0 |
| CBL-0068 | BUS-0092<br>BUS-0091 | 480<br>480 | 245.86 | 4.413<br>0.006 | 0.333<br>0.005 | 28123.78 | | | 2.96<br>3.64 | 12.0 |
| CBL-0069 | MHE3<br>BUS-0017 | 480<br>480 | 27.06 | 0.031<br>0.000 | 0.014<br>0.001 | 4882.76 | | | 5.92<br>6.61 | 15.0 |
| CBL-CAP1-SBHE1 | PFC-SBHE1<br>BUS-0100 | 480<br>480 | 122.58 | 0.270<br>0.242 | 0.245<br>0.240 | 378056.34 | | | 183.06><br>204.27 | 15.0 |
| CBL-CAP2-SBHE1 | PFC-SBHE1<br>BUS-0101 | 480<br>480 | 122.58 | 0.270<br>0.242 | 0.245<br>0.240 | 378056.34 | | | 0.00<br>204.27 | 15.0 |

| TOTAL CURRENT DISTORTION | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Device Name | Bus Name<br>From/To | Voltage<br>From/To | I_RMS(A) | kWLo ss<br>Tot/Harm | kVARLoss<br>Tot/Harm | IT | HLF | KF | I_TDD(%)/<br>I_IHD(%) | LIMIT |
| CBL-MHE1 | SBHE1<br>MHE1 | 480<br>480 | 710.26 | 0.587<br>0.008 | 0.699<br>0.036 | 125591.61 | | | 7.22<br>7.86 | 8.0 |
| CBL-MHE2 | SBHE1<br>MHE2 | 480<br>480 | 661.97 | 0.678<br>0.006 | 0.801<br>0.031 | 112896.80 | | | 5.75<br>6.25 | 8.0 |
| CBL-MHE3 | SBHE1<br>MHE3 | 480<br>480 | 654.56 | 0.497<br>0.003 | 0.583<br>0.018 | 109696.19 | | | 4.56<br>5.04 | 8.0 |
| CBL-PFC-SBHE1 | SBHE1<br>PFC-SBHE1 | 480<br>480 | 245.16 | 0.558<br>0.545 | 0.760<br>0.746 | 756112.69 | | | 91.53><br>204.27 | 15.0 |
| CBL-SBH01 | UTIL-1 SEC<br>SBH01 | 480<br>480 | 1990.27 | 2.765<br>0.051 | 3.944<br>0.277 | 442163.41 | | | 8.61><br>8.53 | 5.0 |
| CBL-SBHE1 | SBH01<br>SBHE1 | 480<br>480 | 1990.27 | 2.765<br>0.051 | 3.944<br>0.277 | 442163.41 | | | 8.61><br>8.53 | 5.0 |
| CBL-UTILITY | BUS-0104<br>BUS-UTILITY | 12470<br>12470 | 76.58 | 0.057<br>0.001 | 0.011<br>0.001 | 17018.75 | | | 8.21><br>8.14 | 5.0 |
| SW-ATS1 | BUS-0015<br>ATS1 | 480<br>480 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| T-LA1 | BUS-0024<br>BUS-0025 | 480<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | 0.00 | 0.00 | 0.00<br>0.00 | 20.0 |
| T-PLC1 | BUS-0022<br>BUS-0023 | 480<br>208 | 0.00 | 0.005<br>0.005 | 0.029<br>0.029 | 0.00 | 0.00 | 0.00 | 0.00<br>0.00 | 20.0 |
| T-UPS-PLAU | BUS-0026<br>BUS-0029 | 480<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | 0.00 | 0.00 | 0.00<br>0.00 | 20.0 |
| TX-ADMIN | BUS-0060<br>ADMIN SEC | 12470<br>480 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | 0.00 | 0.00 | 0.00<br>0.00 | 20.0 |
| TX-UTIL-1 | BUS-UTILITY<br>UTIL-1 SEC | 12470<br>480 | 76.58 | 22.146<br>0.616 | 165.987<br>11.183 | 17018.75 | 1.81 | 4.96 | 8.21<br>8.14 | 20.0 |

| TOTAL CURRENT DISTORTION | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Device Name | Bus Name<br>From/To | Voltage<br>From/To | I_RMS(A) | kWLo ss<br>Tot/Harm | kVARLoss<br>Tot/Harm | IT | HLF | KF | I_TDD(%)/<br>I_IHD(%) | LIMIT |
| UPS-PLAU | BUS-0029<br>BUS-0036 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| UPS-PLCU | BUS-0027<br>BUS-0028 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| UTIL-1 MAX | BUS-0104 | 12470<br>12470 | 76.58 | 0.344<br>0.344 | 6.275<br>6.275 | 17018.75 | | | 0.51<br>8.14 | |
| VFD-B-1-4 | MHE1<br>BUS-0062 | 480<br>480 | 233.50 | 3.364<br>0.000 | -78.495<br>0.000 | 40978.18 | | | 4.19<br>5.42 | 12.0 |
| VFD-B-2-4 | MHE2<br>BUS-0080 | 480<br>480 | 233.59 | 3.364<br>0.000 | -78.495<br>0.000 | 40949.74 | | | 4.19<br>5.42 | 12.0 |
| VFD-B-3-4 | MHE3<br>BUS-0090 | 480<br>480 | 233.46 | 3.364<br>0.000 | -78.495<br>0.000 | 40964.14 | | | 4.19<br>5.42 | 12.0 |
| VFD-B-4-4 | MHE3<br>BUS-0092 | 480<br>480 | 233.46 | 3.364<br>0.000 | -78.495<br>0.000 | 40964.14 | | | 4.19<br>5.42 | 12.0 |
| VFD-B-5-8 | MHE1<br>BUS-0076 | 480<br>480 | 87.72 | 1.231<br>0.000 | -29.732<br>0.000 | 24274.09 | | | 18.05><br>23.93 | 15.0 |
| VFD-B-6-8 | MHE2<br>BUS-0086 | 480<br>480 | 87.75 | 1.231<br>0.000 | -29.732<br>0.000 | 24263.89 | | | 18.06><br>23.93 | 15.0 |
| VFD-C-1-9 | MHE1<br>BUS-0070 | 480<br>480 | 3.68 | 0.049<br>0.000 | -1.189<br>0.000 | 1297.30 | | | 30.55><br>40.55 | 20.0 |
| VFD-CF-1-9 | MHE1<br>BUS-0068 | 480<br>480 | 59.45 | 0.827<br>0.000 | -19.751<br>0.000 | 17781.96 | | | 21.11><br>27.78 | 15.0 |
| VFD-P-12-8 | MHE1<br>BUS-0074 | 480<br>480 | 12.16 | 0.164<br>0.000 | -3.962<br>0.000 | 4183.24 | | | 28.55><br>37.86 | 20.0 |
| VFD-P-13-8 | MHE2<br>BUS-0084 | 480<br>480 | 12.16 | 0.164<br>0.000 | -3.962<br>0.000 | 4181.61 | | | 28.57><br>37.87 | 20.0 |

## TOTAL CURRENT DISTORTION

| Device Name | Bus Name<br>From/To | Voltage<br>From/To | I_RMS(A) | kWLo ss<br>Tot/Harm | kVARLoss<br>Tot/Harm | IT | HLF | KF | I_TDD(%)/<br>I_IHD(%) | LIMIT |
|---|---|---|---|---|---|---|---|---|---|---|
| VFD-P-14-9 | MHE1<br>BUS-0066 | 480<br>480 | 12.16 | 0.164<br>0.000 | -3.962<br>0.000 | 4183.24 | | | 28.55><br>37.86 | 20.0 |
| VFD-P-15-9 | MHE2<br>BUS-0082 | 480<br>480 | 12.16 | 0.164<br>0.000 | -3.962<br>0.000 | 4181.61 | | | 28.57><br>37.87 | 20.0 |
| VFD-P-2-3 | MHE1<br>BUS-0064 | 480<br>480 | 35.88 | 0.493<br>0.000 | -11.877<br>0.000 | 11503.32 | | | 24.15><br>31.95 | 15.0 |
| VFD-P-3-3 | MHE2<br>BUS-0078 | 480<br>480 | 35.89 | 0.493<br>0.000 | -11.877<br>0.000 | 11498.68 | | | 24.16><br>31.96 | 15.0 |
| VFD-P-4-3 | MHE3<br>BUS-0088 | 480<br>480 | 35.87 | 0.493<br>0.000 | -11.877<br>0.000 | 11514.80 | | | 24.17><br>31.99 | 15.0 |
| VFD-POLYMER SYSTEM | MHE1<br>BUS-0072 | 480<br>480 | 1.23 | 0.016<br>0.000 | -0.396<br>0.000 | 436.70 | | | 31.18><br>41.39 | 20.0 |

## TOTAL SYSTEM POWER LOSSES

| Harmonic Losses | | Total RMS Losses | |
|---|---|---|---|
| P(kW) | Q{kVAR) | P(kW) | Q(kVAR) |
| 11.54 | 18.96 | 80.73 | -340.86 |

## CURRENT DISTORTION SUMMARY

| Device Name | Bus Name<br>From/To | Voltage<br>From/To | I_RMS(A) | kWLo ss<br>Tot/Harm | kVARLoss<br>Tot/Harm | IT | HLF | KF | I_TDD(%)/<br>I_IHD(%) | LIMIT |
|---|---|---|---|---|---|---|---|---|---|---|
| CBL-0051 | BUS-0068<br>BUS-0067 | 480<br>480 | 61.74 | 0.405<br>0.013 | 0.033<br>0.006 | 11736.92 | | | 15.01><br>18.63 | 15.0 |
| CBL-0056 | BUS-0076<br>BUS-0075 | 480<br>480 | 92.82 | 0.158<br>0.009 | 0.045<br>0.010 | 17823.87 | | | 17.76><br>22.15 | 15.0 |
| CBL-0063 | BUS-0086<br>BUS-0085 | 480<br>480 | 92.82 | 0.158<br>0.009 | 0.045<br>0.010 | 17815.50 | | | 17.76><br>22.15 | 15.0 |
| CBL-CAP1-SBHE1 | PFC-SBHE1<br>BUS-0100 | 480<br>480 | 122.58 | 0.270<br>0.242 | 0.245<br>0.240 | 378056.34 | | | 183.06><br>204.27 | 15.0 |
| CBL-PFC-SBHE1 | SBHE1<br>PFC-SBHE1 | 480<br>480 | 245.16 | 0.558<br>0.545 | 0.760<br>0.746 | 756112.69 | | | 91.53><br>204.27 | 15.0 |
| CBL-SBH01 | UTIL-1 SEC<br>SBH01 | 480<br>480 | 1990.27 | 2.765<br>0.051 | 3.944<br>0.277 | 442163.41 | | | 8.61><br>8.53 | 5.0 |
| CBL-SBHE1 | SBH01<br>SBHE1 | 480<br>480 | 1990.27 | 2.765<br>0.051 | 3.944<br>0.277 | 442163.41 | | | 8.61><br>8.53 | 5.0 |
| CBL-UTILITY | BUS-0104<br>BUS-UTILITY | 12470<br>12470 | 76.58 | 0.057<br>0.001 | 0.011<br>0.001 | 17018.75 | | | 8.21><br>8.14 | 5.0 |
| VFD-B-5-8 | MHE1<br>BUS-0076 | 480<br>480 | 87.72 | 1.231<br>0.000 | -29.732<br>0.000 | 24274.09 | | | 18.05><br>23.93 | 15.0 |
| VFD-B-6-8 | MHE2<br>BUS-0086 | 480<br>480 | 87.75 | 1.231<br>0.000 | -29.732<br>0.000 | 24263.89 | | | 18.06><br>23.93 | 15.0 |
| VFD-C-1-9 | MHE1<br>BUS-0070 | 480<br>480 | 3.68 | 0.049<br>0.000 | -1.189<br>0.000 | 1297.30 | | | 30.55><br>40.55 | 20.0 |
| VFD-CF-1-9 | MHE1<br>BUS-0068 | 480<br>480 | 59.45 | 0.827<br>0.000 | -19.751<br>0.000 | 17781.96 | | | 21.11><br>27.78 | 15.0 |
| VFD-P-12-8 | MHE1<br>BUS-0074 | 480<br>480 | 12.16 | 0.164<br>0.000 | -3.962<br>0.000 | 4183.24 | | | 28.55><br>37.86 | 20.0 |

## CURRENT DISTORTION SUMMARY

| Device Name | Bus Name<br>From/To | Voltage<br>From/To | I_RMS(A) | kWLo ss<br>Tot/Harm | kVARLoss<br>Tot/Harm | IT | HLF | KF | I_TDD(%)/<br>I_IHD(%) | LIMIT |
|---|---|---|---|---|---|---|---|---|---|---|
| VFD-P-13-8 | MHE2<br>BUS-0084 | 480<br>480 | 12.16 | 0.164<br>0.000 | -3.962<br>0.000 | 4181.61 | | | 28.57><br>37.87 | 20.0 |
| VFD-P-14-9 | MHE1<br>BUS-0066 | 480<br>480 | 12.16 | 0.164<br>0.000 | -3.962<br>0.000 | 4183.24 | | | 28.55><br>37.86 | 20.0 |
| VFD-P-15-9 | MHE2<br>BUS-0082 | 480<br>480 | 12.16 | 0.164<br>0.000 | -3.962<br>0.000 | 4181.61 | | | 28.57><br>37.87 | 20.0 |
| VFD-P-2-3 | MHE1<br>BUS-0064 | 480<br>480 | 35.88 | 0.493<br>0.000 | -11.877<br>0.000 | 11503.32 | | | 24.15><br>31.95 | 15.0 |
| VFD-P-3-3 | MHE2<br>BUS-0078 | 480<br>480 | 35.89 | 0.493<br>0.000 | -11.877<br>0.000 | 11498.68 | | | 24.16><br>31.96 | 15.0 |
| VFD-P-4-3 | MHE3<br>BUS-0088 | 480<br>480 | 35.87 | 0.493<br>0.000 | -11.877<br>0.000 | 11514.80 | | | 24.17><br>31.99 | 15.0 |
| VFD-POLYMER SYSTEM | MHE1<br>BUS-0072 | 480<br>480 | 1.23 | 0.016<br>0.000 | -0.396<br>0.000 | 436.70 | | | 31.18><br>41.39 | 20.0 |

## TOTAL SYSTEM POWER LOSSES

| Harmonic Losses | | Total RMS Losses | |
|---|---|---|---|
| P(kW) | Q{kVAR) | P(kW) | Q(kVAR) |
| 11.54 | 18.96 | 80.73 | -340.86 |

HARMONIC VOLTAGE SPECTRUM REPORT

Bus: BUS-UTILITY (12470V)

| Harmonic Order | Harmonic Voltages | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 11822.254 | -2.07 | | | |
| 3 | 0.000 | 0.00 | 0.000 | | 3.000 |
| 5 | 123.869 | 133.80 | 1.048 | | 3.000 |
| 7 | 130.267 | -124.65 | 1.102 | | 3.000 |
| 11 | 170.590 | 83.05 | 1.443 | | 3.000 |
| 13 | 551.371 | 38.49 | 4.664 | > | 3.000 |
| 15 | 0.000 | 0.00 | 0.000 | | 3.000 |
| 17 | 96.556 | 157.30 | 0.817 | | 3.000 |
| 19 | 46.159 | 87.26 | 0.390 | | 3.000 |
| 35 | 2.253 | 39.02 | 0.019 | | 3.000 |
| 37 | 3.564 | 7.43 | 0.030 | | 3.000 |

Voltage: 12470.0 V_RMS: 11838.18 V_THD(%): 5.19 >
LIMIT (THD%): 5.0

HARMONIC VOLTAGE SPECTRUM REPORT

Bus: MHE1 (480V)

| Harmonic Order | Harmonic Voltages | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 429.388 | -37.39 | | | |
| 3 | 4.044 | -94.31 | 0.942 | | 5.000 |
| 5 | 13.514 | 165.59 | 3.147 | | 5.000 |
| 7 | 14.210 | -153.91 | 3.309 | | 5.000 |
| 11 | 18.500 | 112.89 | 4.308 | | 5.000 |
| 13 | 59.502 | 8.05 | 13.857 | > | 5.000 |
| 15 | 0.457 | 14.50 | 0.106 | | 5.000 |
| 17 | 10.307 | -173.66 | 2.400 | | 5.000 |
| 19 | 4.930 | 56.22 | 1.148 | | 5.000 |
| 35 | 0.227 | 69.13 | 0.053 | | 5.000 |
| 37 | 0.356 | -21.81 | 0.083 | | 5.000 |

Voltage: 480.0 V_RMS: 434.50 V_THD(%): 15.47 >
LIMIT (THD%): 8.0

HARMONIC VOLTAGE SPECTRUM REPORT

Bus: MHE2 (480V)

| Harmonic Order | Harmonic Voltages | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 429.223 | -37.40 | | | |
| 3 | 4.055 | -94.32 | 0.945 | | 5.000 |
| 5 | 13.485 | 165.64 | 3.142 | | 5.000 |
| 7 | 14.181 | -153.86 | 3.304 | | 5.000 |
| 11 | 18.469 | 112.90 | 4.303 | | 5.000 |
| 13 | 59.426 | 8.05 | 13.845 | > | 5.000 |
| 15 | 0.456 | 14.53 | 0.106 | | 5.000 |
| 17 | 10.293 | -173.62 | 2.398 | | 5.000 |
| 19 | 4.906 | 56.26 | 1.143 | | 5.000 |
| 35 | 0.221 | 69.82 | 0.052 | | 5.000 |
| 37 | 0.346 | -20.86 | 0.081 | | 5.000 |

Voltage: 480.0 V_RMS: 434.32 V_THD(%): 15.46 >
LIMIT (THD%): 8.0

HARMONIC VOLTAGE SPECTRUM REPORT

Bus: MHE3 (480V)

| Harmonic Order | Harmonic Voltages | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 429.456 | -37.39 | | | |
| 3 | 4.036 | -94.32 | 0.940 | | 5.000 |
| 5 | 13.377 | 165.73 | 3.115 | | 5.000 |
| 7 | 14.089 | -153.75 | 3.281 | | 5.000 |
| 11 | 18.436 | 112.88 | 4.293 | | 5.000 |
| 13 | 59.540 | 7.97 | 13.864 | > | 5.000 |
| 15 | 0.442 | 14.57 | 0.103 | | 5.000 |
| 17 | 10.368 | -173.41 | 2.414 | | 5.000 |
| 19 | 4.886 | 56.43 | 1.138 | | 5.000 |
| 35 | 0.212 | 71.95 | 0.049 | | 5.000 |
| 37 | 0.329 | -18.06 | 0.077 | | 5.000 |

Voltage: 480.0 V_RMS: 434.56 V_THD(%): 15.46 >
LIMIT (THD%): 8.0

HARMONIC VOLTAGE SPECTRUM REPORT

Bus: PFC-SBHE1 (480V)

| Harmonic Order | Harmonic Voltages | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 430.107 | -37.36 | | | |
| 3 | 3.934 | -94.09 | 0.915 | | 5.000 |
| 5 | 13.434 | 165.53 | 3.123 | | 5.000 |
| 7 | 14.218 | -154.18 | 3.306 | | 5.000 |
| 11 | 18.876 | 111.92 | 4.389 | | 5.000 |
| 13 | 61.540 | 6.62 | 14.308 | > | 5.000 |
| 15 | 0.439 | 14.58 | 0.102 | | 5.000 |
| 17 | 11.011 | -176.12 | 2.560 | | 5.000 |
| 19 | 5.332 | 52.98 | 1.240 | | 5.000 |
| 35 | 0.305 | 52.59 | 0.071 | | 5.000 |
| 37 | 0.495 | -41.69 | 0.115 | | 5.000 |

Voltage: 480.0 V_RMS: 435.53 V_THD(%): 15.93 >
LIMIT (THD%): 8.0

HARMONIC VOLTAGE SPECTRUM REPORT

Bus: SBH01 (480V)

| Harmonic Order | Harmonic Voltages | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 431.135 | -37.25 | | | |
| 3 | 3.711 | -93.70 | 0.861 | | 5.000 |
| 5 | 13.179 | 165.89 | 3.057 | | 5.000 |
| 7 | 13.891 | -153.66 | 3.222 | | 5.000 |
| 11 | 18.217 | 112.93 | 4.225 | | 5.000 |
| 13 | 58.896 | 8.01 | 13.661 | > | 5.000 |
| 15 | 0.415 | 14.66 | 0.096 | | 5.000 |
| 17 | 10.318 | -173.71 | 2.393 | | 5.000 |
| 19 | 4.933 | 56.04 | 1.144 | | 5.000 |
| 35 | 0.241 | 66.70 | 0.056 | | 5.000 |
| 37 | 0.381 | -24.99 | 0.088 | | 5.000 |

Voltage: 480.0 V_RMS: 436.11 V_THD(%): 15.23 >
LIMIT (THD%): 8.0

HARMONIC VOLTAGE SPECTRUM REPORT

Bus: SBHE1 (480V)

| Harmonic Order | Harmonic Voltages | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 430.034 | -37.35 | | | |
| 3 | 3.934 | -94.09 | 0.915 | | 5.000 |
| 5 | 13.377 | 165.72 | 3.111 | | 5.000 |
| 7 | 14.099 | -153.81 | 3.279 | | 5.000 |
| 11 | 18.488 | 112.83 | 4.299 | | 5.000 |
| 13 | 59.773 | 7.92 | 13.900 | > | 5.000 |
| 15 | 0.439 | 14.58 | 0.102 | | 5.000 |
| 17 | 10.471 | -173.80 | 2.435 | | 5.000 |
| 19 | 5.006 | 55.95 | 1.164 | | 5.000 |
| 35 | 0.245 | 66.62 | 0.057 | | 5.000 |
| 37 | 0.387 | -25.07 | 0.090 | | 5.000 |

Voltage: 480.0 V_RMS: 435.17 V_THD(%): 15.50 >
LIMIT (THD%): 8.0

## HARMONIC CURRENT SPECTRUM REPORT

Device Name: CBL-UTILITY
From: BUS-0104 (12470V)
To: BUS-UTILITY (12470V)
Point of Common Coupling (PCC): (Isc/Ilf = 17.503)

| Harmonic Order | Harmonic Amperes | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 76.333 | -26.77 | | | |
| 3 | 0.000 | -180.00 | 0.000 | | 4.000 |
| 5 | 2.780 | -129.55 | 3.642 | | 4.000 |
| 7 | 2.095 | -29.89 | 2.745 | | 4.000 |
| 11 | 1.750 | 176.08 | 2.292 | > | 2.000 |
| 13 | 4.787 | 131.05 | 6.271 | > | 2.000 |
| 15 | 0.000 | -180.00 | 0.000 | | 2.000 |
| 17 | 0.641 | -110.73 | 0.840 | | 1.500 |
| 19 | 0.274 | 179.02 | 0.359 | | 1.500 |
| 35 | 0.007 | 129.98 | 0.010 | | 0.300 |
| 37 | 0.011 | 98.34 | 0.014 | | 0.300 |

Voltage: 12470.0 I_RMS: 76.58 I_TDD(%): 8.21 >
I_THD(%): 8.14
kWLoss: 0.057 kVARLoss: 0.011
I_K: LIMIT (TDD%): 5.0

## HARMONIC CURRENT SPECTRUM REPORT

Device Name: CBL-SBHE1
From: SBH01 (480V)
To: SBHE1 (480V)
Point of Common Coupling (PCC): (Isc/Ilf = 8.275)

| Harmonic Order | Harmonic Amperes | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 1983.056 | -56.77 | | | |
| 3 | 51.050 | 0.40 | 2.574 | | 4.000 |
| 5 | 72.219 | -99.56 | 3.642 | | 4.000 |
| 7 | 54.428 | -59.89 | 2.745 | | 4.000 |
| 11 | 45.451 | -153.92 | 2.292 | > | 2.000 |
| 13 | 124.352 | 101.05 | 6.271 | > | 2.000 |
| 15 | 1.141 | 108.03 | 0.058 | | 2.000 |
| 17 | 16.660 | -80.74 | 0.840 | | 1.500 |
| 19 | 7.127 | 149.02 | 0.359 | | 1.500 |
| 35 | 0.189 | 159.98 | 0.010 | | 0.300 |
| 37 | 0.283 | 68.34 | 0.014 | | 0.300 |

Voltage: 480.0 I_RMS: 1990.27 I_TDD(%): 8.61 >
I_THD(%): 8.53
kWLoss: 2.765 kVARLoss: 3.944
I_K: LIMIT (TDD%): 5.0

## HARMONIC CURRENT SPECTRUM REPORT

Device Name: CBL-MHE1
From: SBHE1 (480V)
To: MHE1 (480V)
Point of Common Coupling (PCC): (Isc/Ilf = 22.908)

| Harmonic Order | Harmonic Amperes | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 708.075 | -60.39 | | | |
| 3 | 18.567 | 0.79 | 2.622 | | 7.000 |
| 5 | 35.029 | -98.98 | 4.947 | | 7.000 |
| 7 | 20.531 | -61.19 | 2.900 | | 7.000 |
| 11 | 2.490 | -87.92 | 0.352 | | 3.500 |
| 13 | 30.076 | -98.32 | 4.248 | > | 3.500 |
| 15 | 0.612 | 108.08 | 0.086 | | 3.500 |
| 17 | 12.632 | 97.18 | 1.784 | | 2.500 |
| 19 | 5.448 | -41.02 | 0.769 | | 2.500 |
| 35 | 0.743 | -43.66 | 0.105 | | 0.500 |
| 37 | 1.302 | -138.61 | 0.184 | | 0.500 |

Voltage: 480.0 I_RMS: 710.26 I_TDD(%): 7.22
I_THD(%): 7.86
kWLoss: 0.587 kVARLoss: 0.699
I_K: LIMIT (TDD%): 8.0

## HARMONIC CURRENT SPECTRUM REPORT

Device Name: CBL-MHE2
From: SBHE1 (480V)
To: MHE2 (480V)
Point of Common Coupling (PCC): (Isc/Ilf = 24.551)

| Harmonic Order | Harmonic Amperes | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 660.683 | -61.51 | | | |
| 3 | 15.278 | 0.58 | 2.312 | | 7.000 |
| 5 | 20.607 | -98.33 | 3.119 | | 7.000 |
| 7 | 11.305 | -59.16 | 1.711 | | 7.000 |
| 11 | 2.515 | -15.14 | 0.381 | | 3.500 |
| 13 | 27.836 | -93.88 | 4.213 | > | 3.500 |
| 15 | 0.427 | 107.96 | 0.065 | | 3.500 |
| 17 | 10.392 | 93.28 | 1.573 | | 2.500 |
| 19 | 5.297 | -41.34 | 0.802 | | 2.500 |
| 35 | 0.738 | -44.04 | 0.112 | | 0.500 |
| 37 | 1.295 | -139.01 | 0.196 | | 0.500 |

Voltage: 480.0 I_RMS: 661.97 I_TDD(%): 5.75
I_THD(%): 6.25
kWLoss: 0.678 kVARLoss: 0.801
I_K: LIMIT (TDD%): 8.0

HARMONIC CURRENT SPECTRUM REPORT

Device Name: CBL-MHE3
From: SBHE1 (480V)
To: MHE3 (480V)
Point of Common Coupling (PCC): (Isc/Ilf = 24.812)

| Harmonic Order | Harmonic Amperes | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 653.730 | -56.98 | | | |
| 3 | 17.206 | -0.18 | 2.632 | | 7.000 |
| 5 | 0.767 | 7.01 | 0.117 | | 7.000 |
| 7 | 3.376 | 75.17 | 0.516 | | 7.000 |
| 11 | 6.231 | 19.95 | 0.953 | | 3.500 |
| 13 | 23.790 | -85.04 | 3.639 | > | 3.500 |
| 15 | 0.103 | 108.06 | 0.016 | | 3.500 |
| 17 | 9.522 | 71.61 | 1.457 | | 2.500 |
| 19 | 8.647 | -43.07 | 1.323 | | 2.500 |
| 35 | 1.428 | -44.60 | 0.218 | | 0.500 |
| 37 | 2.520 | -139.53 | 0.386 | | 0.500 |

Voltage: 480.0 I_RMS: 654.56 I_TDD(%): 4.56
I_THD(%): 5.04
kWLoss: 0.497 kVARLoss: 0.583
I_K: LIMIT (TDD%): 8.0

## HARMONIC CURRENT SPECTRUM REPORT

Device Name: CBL-PFC-SBHE1
From: SBHE1 (480V)
To: PFC-SBHE1 (480V)
Point of Common Coupling (PCC): (Isc/Ilf = 150.479)

| Harmonic Order | Harmonic Amperes | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 107.791 | 52.60 | | | |
| 3 | 0.000 | -139.09 | 0.000 | | 12.000 |
| 5 | 16.878 | -104.75 | 15.659 | > | 12.000 |
| 7 | 25.074 | -64.61 | 23.262 | > | 12.000 |
| 11 | 52.726 | -158.92 | 48.915 | > | 5.500 |
| 13 | 204.226 | 95.53 | 189.465 | > | 5.500 |
| 15 | 0.000 | -30.42 | 0.000 | | 5.500 |
| 17 | 48.421 | -87.81 | 44.922 | > | 5.000 |
| 19 | 26.419 | 140.94 | 24.509 | > | 5.000 |
| 35 | 3.081 | 137.22 | 2.859 | > | 1.000 |
| 37 | 5.369 | 42.23 | 4.981 | > | 1.000 |

Voltage: 480.0 I_RMS: 245.16 I_TDD(%): 91.53 >
I_THD(%): 204.27
kWLoss: 0.558 kVARLoss: 0.760
I_K: LIMIT (TDD%): 15.0

HARMONIC CURRENT SPECTRUM REPORT

Device Name: CBL-SBH01
From: UTIL-1 SEC (480V)
To: SBH01 (480V)
Point of Common Coupling (PCC): (Isc/Ilf = 8.374)

| Harmonic Order | Harmonic Amperes | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 1983.056 | -56.77 | | | |
| 3 | 51.050 | 0.40 | 2.574 | | 4.000 |
| 5 | 72.219 | -99.56 | 3.642 | | 4.000 |
| 7 | 54.428 | -59.89 | 2.745 | | 4.000 |
| 11 | 45.451 | -153.92 | 2.292 | > | 2.000 |
| 13 | 124.352 | 101.05 | 6.271 | > | 2.000 |
| 15 | 1.141 | 108.03 | 0.058 | | 2.000 |
| 17 | 16.660 | -80.74 | 0.840 | | 1.500 |
| 19 | 7.127 | 149.02 | 0.359 | | 1.500 |
| 35 | 0.189 | 159.98 | 0.010 | | 0.300 |
| 37 | 0.283 | 68.34 | 0.014 | | 0.300 |

Voltage: 480.0 I_RMS: 1990.27 I_TDD(%): 8.61 >
I_THD(%): 8.53
kWLoss: 2.765 kVARLoss: 3.944
I_K: LIMIT (TDD%): 5.0

## F I L T E R  S P E C T R U M  R E P O R T

Filter Name: CAP1-SBHE1 (Capacitor)
Bus Name: BUS-0100 (480V)

| Harmonic Order | IR (Amp) | IL (Amp) | IC (Amp) | R (kW) | L (kVAR) | C (kVAR) | R (V) | L (V) | C (V) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | | 53.89537 | | | 40.15473 | | | 430.15462 |
| 3 | | | | | | | | | |
| 5 | | | 8.43923 | | | 0.19691 | | | 13.47119 |
| 7 | | | 12.53689 | | | 0.31040 | | | 14.29437 |
| 11 | | | 26.36285 | | | 0.87343 | | | 19.12814 |
| 13 | | | 102.11312 | | | 11.08801 | | | 62.69188 |
| 15 | | | | | | | | | |
| 17 | | | 24.21070 | | | 0.47665 | | | 11.36662 |
| 19 | | | 13.20943 | | | 0.12695 | | | 5.54886 |
| 35 | | | 1.54062 | | | 0.00094 | | | 0.35132 |
| 37 | | | 2.68454 | | | 0.00269 | | | 0.57908 |

Capacitor Rated Voltage: 480.00 Rated 3 Phase KVA: 50.00

| | | | |
|---|---|---|---|
| V_RMS: 435.747 | V_CREST: 557.586 | I_RMS: 122.578 | KVA: 53.231 |
| V_RMS: 90.7806% | V_CREST: 116.1638% | I_RMS: 203.8193% > | KVA: 106.4614% |
| Limit: 110.0% | Limit: 169.7% | Limit: 135.0% | Limit: 135.0% |

## F I L T E R  S P E C T R U M  R E P O R T

Filter Name: CAP2-SBHE1 (Capacitor)
Bus Name: BUS-0101 (480V)

| Harmonic Order | IR (Amp) | IL (Amp) | IC (Amp) | R (kW) | L (kVAR) | C (kVAR) | R (V) | L (V) | C (V) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | | 53.89537 | | | 40.15473 | | | 430.15462 |
| 3 | | | | | | | | | |
| 5 | | | 8.43923 | | | 0.19691 | | | 13.47119 |
| 7 | | | 12.53689 | | | 0.31040 | | | 14.29437 |
| 11 | | | 26.36285 | | | 0.87343 | | | 19.12814 |
| 13 | | | 102.11312 | | | 11.08801 | | | 62.69188 |
| 15 | | | | | | | | | |
| 17 | | | 24.21070 | | | 0.47665 | | | 11.36662 |
| 19 | | | 13.20943 | | | 0.12695 | | | 5.54886 |
| 35 | | | 1.54062 | | | 0.00094 | | | 0.35132 |
| 37 | | | 2.68454 | | | 0.00269 | | | 0.57908 |

Capacitor Rated Voltage: 480.00 Rated 3 Phase KVA: 50.00

| | | | |
|---|---|---|---|
| V_RMS: 435.747 | V_CREST: 557.586 | I_RMS: 122.578 | KVA: 53.231 |
| V_RMS: 90.7806% | V_CREST: 116.1638% | I_RMS: 203.8193% > | KVA: 106.4614% |
| Limit: 110.0% | Limit: 169.7% | Limit: 135.0% | Limit: 135.0% |

BIXBY WRF

TQSITL0010020
MTL0010020
U0130

Scenario 3

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ALL INFORMATION PRESENTED IS FOR REVIEW, APPROVAL
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# STUDY CRITERIA

| | |
|---|---|
| **Studies Selected To Run:** | |
| Load Flow: | Yes |
| Frequency Scan: | Yes |
| Harmonic Distortion: | Yes |
| **Load Flow Study Setup Options** | |
| Utility Impedance: | Yes |
| Transformer Phase Shift: | Yes |
| Solution Method: | Exact |
| Load Specification: | Connected Load |
| Generation Acceleration Factor: | 1.00 |
| Load Acceleration Factor: | 1.00 |
| Bus Voltage Drop: | 5.00 |
| Branch Voltage Drop: | 3.00 |
| **HI_WAVE Study Setup Options** | |
| Fundamental Frequency: | 60 Hz |
| Max. Harmonic Order: | 50 |
| Include Triplet Harmonics Path (Static Load): | No |
| Include Triplet Harmonics Path (Ind. Motor): | No |
| Modify Motor Z by Load Factor (Ind. Motor): | No |
| Modify Load Z by Load Factor (Static Load): | No |
| **HI_WAVE Study Setup Options for Frequency Scan** | |
| Scan Impedance Option: | Scan Self Impedance |
| Use Positive Sequence Network: | Yes |
| Use Negative Sequence Network: | Yes |
| Use Zero Sequence Network: | No |
| Model Transformer Tap: | Yes |
| Model Transformer Phase Shift: | Yes |
| Report Bus Equivalent Impedance: | No |
| Number of Scan Steps Per Order: | 5 |
| **HI_WAVE Study Setup Options for Distortion** | |
| Use Positive Sequence Network: | Yes |
| Use Negative Sequence Network: | Yes |
| Use Zero Sequence Network: | Yes |
| Model Transformer Tap: | Yes |
| Model Transformer Phase Shift: | Yes |
| Fundamental Solution: | Use Load Flow Result |
| Report Option: | All Distortions and Violations |
| Current Limits: | IEEE 519-2022 Std, Current Distortion Limit Tables 2, 3, & 4, All buses as PCC |

LOADS AND MOTORS WITH HARMONIC SOURCE MODELS

| Bus Name | Voltage | Component Name | LF Current | Harmonic Library |
|---|---|---|---|---|
| BUS-0062 | 480 | VFD-B-1-4 | 231.9 | CPX9000 |
| BUS-0064 | 480 | VFD-P-2-3 | 34.0 | DG-1 |
| BUS-0066 | 480 | VFD-P-14-9 | 11.3 | DG-1 |
| BUS-0068 | 480 | VFD-CF-1-9 | 57.0 | DG-1 |
| BUS-0070 | 480 | VFD-C-1-9 | 3.4 | DG-1 |
| BUS-0072 | 480 | VFD-POLYMER SYSTEM | 1.1 | DG-1 |
| BUS-0074 | 480 | VFD-P-12-8 | 11.3 | DG-1 |
| BUS-0076 | 480 | VFD-B-5-8 | 84.9 | DG-1 |
| BUS-0078 | 480 | VFD-P-3-3 | 34.0 | DG-1 |
| BUS-0080 | 480 | VFD-B-2-4 | 232.0 | CPX9000 |
| BUS-0082 | 480 | VFD-P-15-9 | 11.3 | DG-1 |
| BUS-0084 | 480 | VFD-P-13-8 | 11.3 | DG-1 |
| BUS-0086 | 480 | VFD-B-6-8 | 84.9 | DG-1 |
| BUS-0088 | 480 | VFD-P-4-3 | 34.0 | DG-1 |
| BUS-0090 | 480 | VFD-B-3-4 | 231.9 | CPX9000 |
| BUS-0092 | 480 | VFD-B-4-4 | 231.9 | CPX9000 |

| HARMONIC SOURCE | | |
|---|---|---|
| CPX9000 | | |
| Order | Magnitude (%) | Angle (Degrees) |
| 1 | 100.000 | -11.00 |
| 3 | 3.300 | 121.00 |
| 5 | 0.400 | 138.00 |
| 7 | 1.400 | -49.00 |
| 17 | 2.200 | 17.00 |
| 19 | 2.500 | 4.00 |
| 35 | 0.400 | -69.00 |
| 37 | 0.700 | -83.00 |

| HARMONIC SOURCE | | |
|---|---|---|
| DG-1 | | |
| Order | Magnitude (%) | Angle (Degrees) |
| 1 | 100.000 | -7.00 |
| 3 | 5.330 | 135.00 |
| 5 | 38.460 | 123.00 |
| 7 | 22.780 | -112.00 |
| 11 | 7.690 | -16.00 |
| 13 | 5.620 | 30.00 |
| 15 | 0.300 | 55.00 |
| 17 | 3.850 | 153.00 |

| H A R M O N I C  S O U R C E  I N D E X  T A B L E |
|---|
| HARMONIC SOURCES HAVE BEEN FOUND AND INJECTED FOR EACH OF THE FOLLOWING HARMONIC ORDERS |
| 3 5 7 11 13 15 17 19 35 37 |

P A S S I V E F I L T E R D A T A

| Filter Name | Bus Name | Bus Volts | Rated Volts | Connect | Filter Type | Capacitor KVAR | Tuned Order | Q | M | R (Ω) | L (H) | C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CAP1-SBHE1 | BUS-0100 | 480 | 480 | WYE_G | Capacitor | 50.0 | | | | 0.0000<br>0.0000 | 0.0000<br>0.0000 | 575.6472uF<br>575.6472uF |
| CAP2-SBHE1 | BUS-0101 | 480 | 480 | WYE_G | Capacitor | 50.0 | | | | 0.0000<br>0.0000 | 0.0000<br>0.0000 | 575.6472uF<br>575.6472uF |
| CAP3-SBHE1 | BUS-0102 | 480 | 480 | WYE_G | Capacitor | 50.0 | | | | 0.0000<br>0.0000 | 0.0000<br>0.0000 | 575.6472uF<br>575.6472uF |

| U T I L I T Y , G E N E R A T O R A N D M O T O R D A T A | | | | | | | |
|---|---|---|---|---|---|---|---|
| Component Name | Component Type | Bus Name | Bus Voltage | Base Voltage | Base KVA | R1(pu)<br>R2<br>R0 | X1(pu)<br>X2<br>X0 |
| UTIL-1 MAX | UTILITY | BUS-0104 | 12470 | 12470 | 100000 | 1.9106<br>1.9106<br>3.0389 | 3.2862<br>3.2862<br>8.4512 |

| TOTAL VOLTAGE DISTORTION | | | | | |
|---|---|---|---|---|---|
| Bus Name | Voltage | V_RMS(V) | V_TIF | V_THD(%) | LIMIT |
| ADMIN SEC | 480 | 456.37 | 102.6213 | 4.7176 | 8.0 |
| ATS1 | 480 | 435.84 | 300.4041 | 13.9936> | 8.0 |
| BUS-0007 | 480 | 433.67 | 299.0708 | 13.9307> | 8.0 |
| BUS-0008 | 480 | 433.87 | 301.2054 | 14.0316> | 8.0 |
| BUS-0009 | 480 | 432.47 | 298.2117 | 13.8896> | 8.0 |
| BUS-0010 | 480 | 434.52 | 299.4360 | 13.9474> | 8.0 |
| BUS-0011 | 480 | 432.33 | 298.8606 | 13.8985> | 8.0 |
| BUS-0012 | 480 | 434.07 | 298.8697 | 13.9212> | 8.0 |
| BUS-0013 | 480 | 433.69 | 300.9508 | 14.0190> | 8.0 |
| BUS-0014 | 480 | 433.69 | 300.9508 | 14.0190> | 8.0 |
| BUS-0015 | 480 | 435.84 | 300.4041 | 13.9936> | 8.0 |
| BUS-0016 | 480 | 435.66 | 300.1491 | 13.9811> | 8.0 |
| BUS-0017 | 480 | 435.20 | 300.5858 | 13.9798> | 8.0 |
| BUS-0022 | 480 | 435.84 | 300.4041 | 13.9936> | 8.0 |
| BUS-0023 | 208 | 188.85 | 300.3826 | 13.9622> | 8.0 |
| BUS-0024 | 480 | 456.37 | 102.6213 | 4.7176 | 8.0 |
| BUS-0025 | 208 | 197.76 | 102.6213 | 4.7176 | 8.0 |
| BUS-0026 | 480 | 456.37 | 102.6213 | 4.7176 | 8.0 |
| BUS-0027 | 208 | 188.85 | 300.3826 | 13.9622> | 8.0 |
| BUS-0028 | 208 | 188.85 | 300.3826 | 13.9622> | 8.0 |
| BUS-0029 | 208 | 197.76 | 102.6213 | 4.7176 | 8.0 |
| BUS-0036 | 208 | 197.76 | 102.6213 | 4.7176 | 8.0 |
| BUS-0060 | 12470 | 11856.20 | 102.6213 | 4.7176 | 5.0 |
| BUS-0061 | 480 | 473.63 | 250.4004 | 10.1275> | 8.0 |
| BUS-0062 | 480 | 482.39 | 248.2096 | 9.9884> | 8.0 |
| BUS-0063 | 480 | 484.76 | 208.2577 | 15.9463> | 8.0 |
| BUS-0064 | 480 | 486.05 | 208.0048 | 15.9269> | 8.0 |
| BUS-0065 | 480 | 483.61 | 244.3549 | 13.3125> | 8.0 |
| BUS-0066 | 480 | 484.23 | 244.2010 | 13.3041> | 8.0 |
| BUS-0067 | 480 | 485.22 | 192.6152 | 18.7997> | 8.0 |
| BUS-0068 | 480 | 488.36 | 192.0108 | 18.7401> | 8.0 |
| BUS-0069 | 480 | 483.57 | 262.2022 | 12.7200> | 8.0 |
| BUS-0070 | 480 | 483.86 | 262.1013 | 12.7151> | 8.0 |
| BUS-0071 | 480 | 483.71 | 267.7648 | 12.6189> | 8.0 |
| BUS-0072 | 480 | 483.81 | 267.7304 | 12.6173> | 8.0 |
| BUS-0073 | 480 | 483.61 | 244.3549 | 13.3125> | 8.0 |
| BUS-0074 | 480 | 484.23 | 244.2010 | 13.3041> | 8.0 |
| BUS-0075 | 480 | 490.16 | 192.4397 | 21.6081> | 8.0 |
| BUS-0076 | 480 | 491.10 | 192.6045 | 21.6261> | 8.0 |
| BUS-0077 | 480 | 484.75 | 208.0143 | 15.9386> | 8.0 |

| TOTAL VOLTAGE DISTORTION | | | | | |
|---|---|---|---|---|---|
| Bus Name | Voltage | V_RMS(V) | V_TIF | V_THD(%) | LIMIT |
| BUS-0078 | 480 | 486.04 | 207.7618 | 15.9193> | 8.0 |
| BUS-0079 | 480 | 473.63 | 250.6333 | 10.1291> | 8.0 |
| BUS-0080 | 480 | 482.39 | 248.4404 | 9.9899> | 8.0 |
| BUS-0081 | 480 | 483.60 | 244.0464 | 13.2987> | 8.0 |
| BUS-0082 | 480 | 484.22 | 243.8928 | 13.2903> | 8.0 |
| BUS-0083 | 480 | 483.60 | 244.0464 | 13.2987> | 8.0 |
| BUS-0084 | 480 | 484.22 | 243.8928 | 13.2903> | 8.0 |
| BUS-0085 | 480 | 490.17 | 192.3844 | 21.6095> | 8.0 |
| BUS-0086 | 480 | 491.10 | 192.5492 | 21.6274> | 8.0 |
| BUS-0087 | 480 | 484.74 | 208.4599 | 15.9305> | 8.0 |
| BUS-0088 | 480 | 486.04 | 208.2068 | 15.9111> | 8.0 |
| BUS-0089 | 480 | 473.64 | 251.0082 | 10.1328> | 8.0 |
| BUS-0090 | 480 | 482.39 | 248.8122 | 9.9937> | 8.0 |
| BUS-0091 | 480 | 473.64 | 251.0082 | 10.1328> | 8.0 |
| BUS-0092 | 480 | 482.39 | 248.8122 | 9.9937> | 8.0 |
| BUS-0100 | 480 | 437.03 | 316.8626 | 14.6173> | 8.0 |
| BUS-0101 | 480 | 437.03 | 316.8626 | 14.6173> | 8.0 |
| BUS-0102 | 480 | 437.03 | 316.8626 | 14.6173> | 8.0 |
| BUS-0104 | 12470 | 11856.61 | 102.6053 | 4.7168 | 5.0 |
| BUS-UTILITY | 12470 | 11856.20 | 102.6213 | 4.7176 | 5.0 |
| DS-CU-1 | 480 | 435.84 | 300.4041 | 13.9936> | 8.0 |
| DS-CU-2 | 480 | 435.84 | 300.4041 | 13.9936> | 8.0 |
| DS-CU-3 | 208 | 197.76 | 102.6213 | 4.7176 | 8.0 |
| DS-CU-4 | 208 | 197.76 | 102.6213 | 4.7176 | 8.0 |
| DS-CU-5 | 208 | 197.76 | 102.6213 | 4.7176 | 8.0 |
| DS-CU-6 | 208 | 197.76 | 102.6213 | 4.7176 | 8.0 |
| DS-EF-1 | 208 | 188.85 | 300.3826 | 13.9622> | 8.0 |
| DS-EF-2 | 208 | 188.85 | 300.3826 | 13.9622> | 8.0 |
| DS-EF-3 | 208 | 188.85 | 300.3826 | 13.9622> | 8.0 |
| DS-EF-4 | 208 | 188.85 | 300.3826 | 13.9622> | 8.0 |
| DS-EF-5 | 208 | 188.85 | 300.3826 | 13.9622> | 8.0 |
| DS-EF-6 | 208 | 197.76 | 102.6213 | 4.7176 | 8.0 |
| DS-EF-7 | 208 | 197.76 | 102.6213 | 4.7176 | 8.0 |
| DS-EF-8 | 208 | 197.76 | 102.6213 | 4.7176 | 8.0 |
| DS-SS-1 | 208 | 188.85 | 300.3826 | 13.9622> | 8.0 |
| DS-SS-2 | 208 | 188.85 | 300.3826 | 13.9622> | 8.0 |
| DS-SS-3 | 208 | 197.76 | 102.6213 | 4.7176 | 8.0 |
| DS-SS-4 | 208 | 197.76 | 102.6213 | 4.7176 | 8.0 |
| DS-SS-6 | 208 | 197.76 | 102.6213 | 4.7176 | 8.0 |
| MHE1 | 480 | 435.84 | 300.4041 | 13.9936> | 8.0 |

| TOTAL VOLTAGE DISTORTION | | | | | |
|---|---|---|---|---|---|
| Bus Name | Voltage | V_RMS(V) | V_TIF | V_THD(%) | LIMIT |
| MHE2 | 480 | 435.66 | 300.1491 | 13.9811> | 8.0 |
| MHE3 | 480 | 435.91 | 301.0313 | 14.0008> | 8.0 |
| PFC-SBHE1 | 480 | 436.87 | 312.3761 | 14.4400> | 8.0 |
| PHA1 | 480 | 456.37 | 102.6213 | 4.7176 | 8.0 |
| PHC1 | 480 | 435.84 | 300.4041 | 13.9936> | 8.0 |
| PHC2 | 480 | 435.84 | 300.4041 | 13.9936> | 8.0 |
| PHC3 | 480 | 435.84 | 300.4041 | 13.9936> | 8.0 |
| PHE1 | 480 | 435.84 | 300.4041 | 13.9936> | 8.0 |
| PLA1 | 208 | 197.76 | 102.6213 | 4.7176 | 8.0 |
| PLAU | 208 | 197.76 | 102.6213 | 4.7176 | 8.0 |
| PLC1 | 208 | 188.85 | 300.3826 | 13.9622> | 8.0 |
| PLC2 | 208 | 188.85 | 300.3826 | 13.9622> | 8.0 |
| PLCU | 208 | 188.85 | 300.3826 | 13.9622> | 8.0 |
| SBH01 | 480 | 437.44 | 297.0508 | 13.7901> | 8.0 |
| SBHE1 | 480 | 436.51 | 302.1201 | 14.0327> | 8.0 |
| UTIL-1 SEC | 480 | 438.38 | 292.0014 | 13.5489> | 8.0 |

| VOLTAGE DISTORTION SUMMARY | | | | | |
|---|---|---|---|---|---|
| Bus Name | Voltage | V_RMS(V) | V_TIF | V_THD(%) | LIMIT |
| ATS1 | 480 | 435.84 | 300.4041 | 13.9936> | 8.0 |
| BUS-0007 | 480 | 433.67 | 299.0708 | 13.9307> | 8.0 |
| BUS-0008 | 480 | 433.87 | 301.2054 | 14.0316> | 8.0 |
| BUS-0009 | 480 | 432.47 | 298.2117 | 13.8896> | 8.0 |
| BUS-0010 | 480 | 434.52 | 299.4360 | 13.9474> | 8.0 |
| BUS-0011 | 480 | 432.33 | 298.8606 | 13.8985> | 8.0 |
| BUS-0012 | 480 | 434.07 | 298.8697 | 13.9212> | 8.0 |
| BUS-0013 | 480 | 433.69 | 300.9508 | 14.0190> | 8.0 |
| BUS-0014 | 480 | 433.69 | 300.9508 | 14.0190> | 8.0 |
| BUS-0015 | 480 | 435.84 | 300.4041 | 13.9936> | 8.0 |
| BUS-0016 | 480 | 435.66 | 300.1491 | 13.9811> | 8.0 |
| BUS-0017 | 480 | 435.20 | 300.5858 | 13.9798> | 8.0 |
| BUS-0022 | 480 | 435.84 | 300.4041 | 13.9936> | 8.0 |
| BUS-0023 | 208 | 188.85 | 300.3826 | 13.9622> | 8.0 |
| BUS-0027 | 208 | 188.85 | 300.3826 | 13.9622> | 8.0 |
| BUS-0028 | 208 | 188.85 | 300.3826 | 13.9622> | 8.0 |
| BUS-0061 | 480 | 473.63 | 250.4004 | 10.1275> | 8.0 |
| BUS-0062 | 480 | 482.39 | 248.2096 | 9.9884> | 8.0 |
| BUS-0063 | 480 | 484.76 | 208.2577 | 15.9463> | 8.0 |
| BUS-0064 | 480 | 486.05 | 208.0048 | 15.9269> | 8.0 |
| BUS-0065 | 480 | 483.61 | 244.3549 | 13.3125> | 8.0 |
| BUS-0066 | 480 | 484.23 | 244.2010 | 13.3041> | 8.0 |
| BUS-0067 | 480 | 485.22 | 192.6152 | 18.7997> | 8.0 |
| BUS-0068 | 480 | 488.36 | 192.0108 | 18.7401> | 8.0 |
| BUS-0069 | 480 | 483.57 | 262.2022 | 12.7200> | 8.0 |
| BUS-0070 | 480 | 483.86 | 262.1013 | 12.7151> | 8.0 |
| BUS-0071 | 480 | 483.71 | 267.7648 | 12.6189> | 8.0 |
| BUS-0072 | 480 | 483.81 | 267.7304 | 12.6173> | 8.0 |
| BUS-0073 | 480 | 483.61 | 244.3549 | 13.3125> | 8.0 |
| BUS-0074 | 480 | 484.23 | 244.2010 | 13.3041> | 8.0 |
| BUS-0075 | 480 | 490.16 | 192.4397 | 21.6081> | 8.0 |
| BUS-0076 | 480 | 491.10 | 192.6045 | 21.6261> | 8.0 |
| BUS-0077 | 480 | 484.75 | 208.0143 | 15.9386> | 8.0 |
| BUS-0078 | 480 | 486.04 | 207.7618 | 15.9193> | 8.0 |
| BUS-0079 | 480 | 473.63 | 250.6333 | 10.1291> | 8.0 |
| BUS-0080 | 480 | 482.39 | 248.4404 | 9.9899> | 8.0 |
| BUS-0081 | 480 | 483.60 | 244.0464 | 13.2987> | 8.0 |
| BUS-0082 | 480 | 484.22 | 243.8928 | 13.2903> | 8.0 |
| BUS-0083 | 480 | 483.60 | 244.0464 | 13.2987> | 8.0 |
| BUS-0084 | 480 | 484.22 | 243.8928 | 13.2903> | 8.0 |

| VOLTAGE DISTORTION SUMMARY | | | | | |
|---|---|---|---|---|---|
| Bus Name | Voltage | V_RMS(V) | V_TIF | V_THD(%) | LIMIT |
| BUS-0085 | 480 | 490.17 | 192.3844 | 21.6095> | 8.0 |
| BUS-0086 | 480 | 491.10 | 192.5492 | 21.6274> | 8.0 |
| BUS-0087 | 480 | 484.74 | 208.4599 | 15.9305> | 8.0 |
| BUS-0088 | 480 | 486.04 | 208.2068 | 15.9111> | 8.0 |
| BUS-0089 | 480 | 473.64 | 251.0082 | 10.1328> | 8.0 |
| BUS-0090 | 480 | 482.39 | 248.8122 | 9.9937> | 8.0 |
| BUS-0091 | 480 | 473.64 | 251.0082 | 10.1328> | 8.0 |
| BUS-0092 | 480 | 482.39 | 248.8122 | 9.9937> | 8.0 |
| BUS-0100 | 480 | 437.03 | 316.8626 | 14.6173> | 8.0 |
| BUS-0101 | 480 | 437.03 | 316.8626 | 14.6173> | 8.0 |
| BUS-0102 | 480 | 437.03 | 316.8626 | 14.6173> | 8.0 |
| DS-CU-1 | 480 | 435.84 | 300.4041 | 13.9936> | 8.0 |
| DS-CU-2 | 480 | 435.84 | 300.4041 | 13.9936> | 8.0 |
| DS-EF-1 | 208 | 188.85 | 300.3826 | 13.9622> | 8.0 |
| DS-EF-2 | 208 | 188.85 | 300.3826 | 13.9622> | 8.0 |
| DS-EF-3 | 208 | 188.85 | 300.3826 | 13.9622> | 8.0 |
| DS-EF-4 | 208 | 188.85 | 300.3826 | 13.9622> | 8.0 |
| DS-EF-5 | 208 | 188.85 | 300.3826 | 13.9622> | 8.0 |
| DS-SS-1 | 208 | 188.85 | 300.3826 | 13.9622> | 8.0 |
| DS-SS-2 | 208 | 188.85 | 300.3826 | 13.9622> | 8.0 |
| MHE1 | 480 | 435.84 | 300.4041 | 13.9936> | 8.0 |
| MHE2 | 480 | 435.66 | 300.1491 | 13.9811> | 8.0 |
| MHE3 | 480 | 435.91 | 301.0313 | 14.0008> | 8.0 |
| PFC-SBHE1 | 480 | 436.87 | 312.3761 | 14.4400> | 8.0 |
| PHC1 | 480 | 435.84 | 300.4041 | 13.9936> | 8.0 |
| PHC2 | 480 | 435.84 | 300.4041 | 13.9936> | 8.0 |
| PHC3 | 480 | 435.84 | 300.4041 | 13.9936> | 8.0 |
| PHE1 | 480 | 435.84 | 300.4041 | 13.9936> | 8.0 |
| PLC1 | 208 | 188.85 | 300.3826 | 13.9622> | 8.0 |
| PLC2 | 208 | 188.85 | 300.3826 | 13.9622> | 8.0 |
| PLCU | 208 | 188.85 | 300.3826 | 13.9622> | 8.0 |
| SBH01 | 480 | 437.44 | 297.0508 | 13.7901> | 8.0 |
| SBHE1 | 480 | 436.51 | 302.1201 | 14.0327> | 8.0 |
| UTIL-1 SEC | 480 | 438.38 | 292.0014 | 13.5489> | 8.0 |

| TOTAL CURRENT DISTORTION | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Device Name | Bus Name<br>From/To | Voltage<br>From/To | I_RMS(A) | kWLo ss<br>Tot/Harm | kVARLoss<br>Tot/Harm | IT | HLF | KF | I_TDD(%)/<br>I_IHD(%) | LIMIT |
| CAP1-SBHE1 | BUS-0100 | 480 | 99.95 | 0.000 | -49.616 | 200507.41 | | | 139.65 | |
| | | 480 | | 0.000 | -9.035 | | | | 155.01 | |
| CAP2-SBHE1 | BUS-0101 | 480 | 99.95 | 0.000 | -49.616 | 200507.41 | | | 139.65 | |
| | | 480 | | 0.000 | -9.035 | | | | 155.01 | |
| CAP3-SBHE1 | BUS-0102 | 480 | 99.95 | 0.000 | -49.616 | 200507.41 | | | 139.65 | |
| | | 480 | | 0.000 | -9.035 | | | | 155.01 | |
| CBL-0008 | MHE1 | 480 | 135.11 | 0.471 | 0.206 | 17479.20 | | | 6.28 | 15.0 |
| | BUS-0007 | 480 | | 0.003 | 0.009 | | | | 7.02 | |
| CBL-0009 | MHE1 | 480 | 0.00 | 0.000 | 0.000 | 0.00 | | | 0.00 | 20.0 |
| | BUS-0015 | 480 | | 0.000 | 0.000 | | | | 0.00 | |
| CBL-0010 | BUS-0062 | 480 | 245.87 | 4.413 | 0.332 | 22533.35 | | | 2.98 | 12.0 |
| | BUS-0061 | 480 | | 0.006 | 0.005 | | | | 3.65 | |
| CBL-0011 | MHE1 | 480 | 0.00 | 0.000 | 0.000 | 0.00 | | | 0.00 | 20.0 |
| | PHE1 | 480 | | 0.000 | 0.000 | | | | 0.00 | |
| CBL-0012 | MHE2 | 480 | 135.47 | 0.696 | 0.305 | 17381.44 | | | 6.24 | 15.0 |
| | BUS-0009 | 480 | | 0.004 | 0.013 | | | | 6.96 | |
| CBL-0013 | MHE2 | 480 | 0.00 | 0.000 | 0.000 | 0.00 | | | 0.00 | 20.0 |
| | BUS-0016 | 480 | | 0.000 | 0.000 | | | | 0.00 | |
| CBL-0014 | MHE2 | 480 | 134.85 | 0.249 | 0.109 | 17535.63 | | | 6.30 | 15.0 |
| | BUS-0010 | 480 | | 0.002 | 0.005 | | | | 7.06 | |
| CBL-0015 | MHE3 | 480 | 135.52 | 0.779 | 0.341 | 17408.92 | | | 6.23 | 15.0 |
| | BUS-0011 | 480 | | 0.004 | 0.014 | | | | 6.95 | |
| CBL-0016 | ATS1 | 480 | 0.00 | 0.000 | 0.000 | 0.00 | | | 0.00 | 20.0 |
| | PHC1 | 480 | | 0.000 | 0.000 | | | | 0.00 | |
| CBL-0017 | PHC1 | 480 | 0.00 | 0.000 | 0.000 | 0.00 | | | 0.00 | 20.0 |
| | PHC2 | 480 | | 0.000 | 0.000 | | | | 0.00 | |

| TOTAL CURRENT DISTORTION | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Device Name | Bus Name<br>From/To | Voltage<br>From/To | I_RMS(A) | kWLo ss<br>Tot/Harm | kVARLoss<br>Tot/Harm | IT | HLF | KF | I_TDD(%)/<br>I_IHD(%) | LIMIT |
| CBL-0018 | PHC2<br>PHC3 | 480<br>480 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0019 | BUS-0023<br>PLC1 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0020 | PLC1<br>PLC2 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0021 | PHC1<br>BUS-0022 | 480<br>480 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0022 | PLC1<br>BUS-0027 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0023 | BUS-0028<br>PLCU | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0024 | PHA1<br>BUS-0024 | 480<br>480 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0025 | BUS-0025<br>PLA1 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0026 | PHA1<br>BUS-0026 | 480<br>480 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0027 | BUS-0036<br>PLAU | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0028 | ADMIN SEC<br>PHA1 | 480<br>480 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0030 | BUS-0064<br>BUS-0063 | 480<br>480 | 36.67 | 0.098<br>0.002 | 0.008<br>0.001 | 4378.11 | | | 11.87<br>14.80 | 15.0 |
| CBL-0031 | PHC3<br>DS-CU-1 | 480<br>480 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |

| TOTAL CURRENT DISTORTION | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Device Name | Bus Name<br>From/To | Voltage<br>From/To | I_RMS(A) | kWLo ss<br>Tot/Harm | kVARLoss<br>Tot/Harm | IT | HLF | KF | I_TDD(%)/<br>I_IHD(%) | LIMIT |
| CBL-0032 | PHC3<br>DS-CU-2 | 480<br>480 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0033 | PLC1<br>DS-EF-1 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0034 | PLC1<br>DS-EF-2 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0035 | PLC1<br>DS-EF-3 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0036 | PLC1<br>DS-EF-4 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0037 | PLC1<br>DS-EF-5 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0038 | PLC1<br>DS-SS-1 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0039 | PLC1<br>DS-SS-2 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0040 | PLA1<br>DS-CU-3 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0041 | PLA1<br>DS-CU-4 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0042 | PLA1<br>DS-CU-5 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0043 | PLA1<br>DS-CU-6 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0044 | PLA1<br>DS-EF-6 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |

| TOTAL CURRENT DISTORTION | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Device Name | Bus Name<br>From/To | Voltage<br>From/To | I_RMS(A) | kWLo ss<br>Tot/Harm | kVARLoss<br>Tot/Harm | IT | HLF | KF | I_TDD(%)/<br>I_IHD(%) | LIMIT |
| CBL-0045 | PLA1<br>DS-EF-7 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0046 | PLA1<br>DS-EF-8 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0047 | PLA1<br>DS-SS-3 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0048 | PLA1<br>DS-SS-4 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0049 | PLA1<br>DS-SS-6 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0050 | BUS-0066<br>BUS-0065 | 480<br>480 | 12.14 | 0.016<br>0.000 | 0.001<br>0.000 | 1625.80 | | | 8.17<br>10.20 | 20.0 |
| CBL-0051 | BUS-0068<br>BUS-0067 | 480<br>480 | 61.72 | 0.404<br>0.013 | 0.033<br>0.005 | 7025.32 | | | 14.84<br>18.43 | 15.0 |
| CBL-0052 | BUS-UTILITY<br>BUS-0060 | 12470<br>12470 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0053 | BUS-0070<br>BUS-0069 | 480<br>480 | 3.63 | 0.002<br>0.000 | 0.000<br>0.000 | 515.54 | | | 6.84<br>8.54 | 20.0 |
| CBL-0054 | BUS-0072<br>BUS-0071 | 480<br>480 | 1.21 | 0.000<br>0.000 | 0.000<br>0.000 | 174.87 | | | 6.50<br>8.12 | 20.0 |
| CBL-0055 | BUS-0074<br>BUS-0073 | 480<br>480 | 12.14 | 0.016<br>0.000 | 0.001<br>0.000 | 1625.80 | | | 8.17<br>10.20 | 20.0 |
| CBL-0056 | BUS-0076<br>BUS-0075 | 480<br>480 | 92.76 | 0.158<br>0.009 | 0.044<br>0.009 | 10757.22 | | | 17.52><br>21.86 | 15.0 |
| CBL-0057 | MHE1<br>BUS-0008 | 480<br>480 | 13.51 | 0.055<br>0.000 | 0.004<br>0.000 | 1761.22 | | | 6.33<br>7.08 | 20.0 |

| TOTAL CURRENT DISTORTION | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Device Name | Bus Name<br>From/To | Voltage<br>From/To | I_RMS(A) | kWLo ss<br>Tot/Harm | kVARLoss<br>Tot/Harm | IT | HLF | KF | I_TDD(%)/<br>I_IHD(%) | LIMIT |
| CBL-0058 | MHE1<br>BUS-0012 | 480<br>480 | 134.98 | 0.356<br>0.002 | 0.201<br>0.009 | 17483.59 | | | 6.28<br>7.03 | 15.0 |
| CBL-0059 | BUS-0078<br>BUS-0077 | 480<br>480 | 36.67 | 0.098<br>0.002 | 0.008<br>0.001 | 4373.84 | | | 11.87<br>14.80 | 15.0 |
| CBL-0060 | BUS-0080<br>BUS-0079 | 480<br>480 | 245.87 | 4.413<br>0.006 | 0.332<br>0.005 | 22535.07 | | | 2.97<br>3.65 | 12.0 |
| CBL-0061 | BUS-0082<br>BUS-0081 | 480<br>480 | 12.14 | 0.016<br>0.000 | 0.001<br>0.000 | 1623.88 | | | 8.17<br>10.20 | 20.0 |
| CBL-0062 | BUS-0084<br>BUS-0083 | 480<br>480 | 12.14 | 0.016<br>0.000 | 0.001<br>0.000 | 1623.88 | | | 8.17<br>10.20 | 20.0 |
| CBL-0063 | BUS-0086<br>BUS-0085 | 480<br>480 | 92.76 | 0.158<br>0.009 | 0.044<br>0.009 | 10755.28 | | | 17.52><br>21.86 | 15.0 |
| CBL-0064 | MHE2<br>BUS-0013 | 480<br>480 | 13.51 | 0.055<br>0.000 | 0.004<br>0.000 | 1759.10 | | | 6.32<br>7.07 | 20.0 |
| CBL-0065 | MHE2<br>BUS-0014 | 480<br>480 | 13.51 | 0.055<br>0.000 | 0.004<br>0.000 | 1759.10 | | | 6.32<br>7.07 | 20.0 |
| CBL-0066 | BUS-0088<br>BUS-0087 | 480<br>480 | 36.67 | 0.098<br>0.002 | 0.008<br>0.001 | 4381.97 | | | 11.85<br>14.77 | 15.0 |
| CBL-0067 | BUS-0090<br>BUS-0089 | 480<br>480 | 245.87 | 4.413<br>0.006 | 0.332<br>0.005 | 22577.81 | | | 2.98<br>3.65 | 12.0 |
| CBL-0068 | BUS-0092<br>BUS-0091 | 480<br>480 | 245.87 | 4.413<br>0.006 | 0.332<br>0.005 | 22577.81 | | | 2.98<br>3.65 | 12.0 |
| CBL-0069 | MHE3<br>BUS-0017 | 480<br>480 | 26.93 | 0.031<br>0.000 | 0.014<br>0.001 | 3525.16 | | | 6.31<br>7.08 | 15.0 |
| CBL-CAP1-SBHE1 | PFC-SBHE1<br>BUS-0100 | 480<br>480 | 99.95 | 0.157<br>0.129 | 0.123<br>0.118 | 200507.41 | | | 139.65><br>155.01 | 15.0 |

| TOTAL CURRENT DISTORTION | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Device Name | Bus Name<br>From/To | Voltage<br>From/To | I_RMS(A) | kWLo ss<br>Tot/Harm | kVARLoss<br>Tot/Harm | IT | HLF | KF | I_TDD(%)/<br>I_IHD(%) | LIMIT |
| CBL-CAP2-SBHE1 | PFC-SBHE1<br>BUS-0101 | 480<br>480 | 99.95 | 0.157<br>0.129 | 0.123<br>0.118 | 200507.41 | | | 0.00<br>155.01 | 15.0 |
| CBL-CAP3-SBHE1 | PFC-SBHE1<br>BUS-0102 | 480<br>480 | 99.95 | 0.157<br>0.129 | 0.123<br>0.118 | 200507.41 | | | 0.00<br>155.01 | 15.0 |
| CBL-MHE1 | SBHE1<br>MHE1 | 480<br>480 | 707.08 | 0.584<br>0.011 | 0.701<br>0.045 | 121492.80 | | | 8.00><br>8.76 | 8.0 |
| CBL-MHE2 | SBHE1<br>MHE2 | 480<br>480 | 658.89 | 0.672<br>0.008 | 0.800<br>0.038 | 103109.42 | | | 6.52<br>7.12 | 8.0 |
| CBL-MHE3 | SBHE1<br>MHE3 | 480<br>480 | 651.23 | 0.492<br>0.004 | 0.577<br>0.017 | 90228.79 | | | 4.75<br>5.29 | 8.0 |
| CBL-PFC-SBHE1 | SBHE1<br>PFC-SBHE1 | 480<br>480 | 299.84 | 0.636<br>0.606 | 0.857<br>0.826 | 601522.19 | | | 104.74><br>155.01 | 12.0 |
| CBL-SBH01 | UTIL-1 SEC<br>SBH01 | 480<br>480 | 1963.27 | 2.690<br>0.052 | 3.836<br>0.272 | 319265.66 | | | 9.12><br>9.17 | 5.0 |
| CBL-SBHE1 | SBH01<br>SBHE1 | 480<br>480 | 1963.27 | 2.690<br>0.052 | 3.836<br>0.272 | 319265.66 | | | 9.12><br>9.17 | 5.0 |
| CBL-UTILITY | BUS-0104<br>BUS-UTILITY | 12470<br>12470 | 75.55 | 0.055<br>0.001 | 0.011<br>0.001 | 12287.68 | | | 8.75><br>8.79 | 5.0 |
| SW-ATS1 | BUS-0015<br>ATS1 | 480<br>480 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| T-LA1 | BUS-0024<br>BUS-0025 | 480<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | 0.00 | 0.00 | 0.00<br>0.00 | 20.0 |
| T-PLC1 | BUS-0022<br>BUS-0023 | 480<br>208 | 0.00 | 0.005<br>0.005 | 0.029<br>0.029 | 0.00 | 0.00 | 0.00 | 0.00<br>0.00 | 20.0 |
| T-UPS-PLAU | BUS-0026<br>BUS-0029 | 480<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | 0.00 | 0.00 | 0.00<br>0.00 | 20.0 |

| TOTAL CURRENT DISTORTION | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Device Name | Bus Name<br>From/To | Voltage<br>From/To | I_RMS(A) | kWLo ss<br>Tot/Harm | kVARLoss<br>Tot/Harm | IT | HLF | KF | I_TDD(%)/<br>I_IHD(%) | LIMIT |
| TX-ADMIN | BUS-0060<br>ADMIN SEC | 12470<br>480 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | 0.00 | 0.00 | 0.00<br>0.00 | 20.0 |
| TX-UTIL-1 | BUS-UTILITY<br>UTIL-1 SEC | 12470<br>480 | 75.55 | 21.514<br>0.587 | 161.422<br>10.957 | 12287.68 | 1.69 | 4.49 | 8.75<br>8.79 | 20.0 |
| UPS-PLAU | BUS-0029<br>BUS-0036 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| UPS-PLCU | BUS-0027<br>BUS-0028 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| UTIL-1 MAX | BUS-0104 | 12470<br>12470 | 75.55 | 0.390<br>0.390 | 6.146<br>6.146 | 12287.68 | | | 0.54<br>8.79 | |
| VFD-B-1-4 | MHE1<br>BUS-0062 | 480<br>480 | 232.27 | 3.364<br>0.000 | -78.495<br>0.000 | 34569.44 | | | 4.10<br>5.33 | 12.0 |
| VFD-B-2-4 | MHE2<br>BUS-0080 | 480<br>480 | 232.36 | 3.364<br>0.000 | -78.495<br>0.000 | 34554.93 | | | 4.10<br>5.33 | 12.0 |
| VFD-B-3-4 | MHE3<br>BUS-0090 | 480<br>480 | 232.24 | 3.364<br>0.000 | -78.495<br>0.000 | 34559.64 | | | 4.10<br>5.33 | 12.0 |
| VFD-B-4-4 | MHE3<br>BUS-0092 | 480<br>480 | 232.24 | 3.364<br>0.000 | -78.495<br>0.000 | 34559.64 | | | 4.10<br>5.33 | 12.0 |
| VFD-B-5-8 | MHE1<br>BUS-0076 | 480<br>480 | 87.44 | 1.231<br>0.000 | -29.732<br>0.000 | 27437.95 | | | 18.64><br>24.83 | 15.0 |
| VFD-B-6-8 | MHE2<br>BUS-0086 | 480<br>480 | 87.47 | 1.231<br>0.000 | -29.732<br>0.000 | 27435.91 | | | 18.64><br>24.83 | 15.0 |
| VFD-C-1-9 | MHE1<br>BUS-0070 | 480<br>480 | 3.67 | 0.049<br>0.000 | -1.189<br>0.000 | 1488.12 | | | 31.03><br>41.40 | 20.0 |
| VFD-CF-1-9 | MHE1<br>BUS-0068 | 480<br>480 | 59.29 | 0.827<br>0.000 | -19.751<br>0.000 | 20201.27 | | | 21.69><br>28.69 | 15.0 |

## TOTAL CURRENT DISTORTION

| Device Name | Bus Name<br>From/To | Voltage<br>From/To | I_RMS(A) | kWLo ss<br>Tot/Harm | kVARLoss<br>Tot/Harm | IT | HLF | KF | I_TDD(%)/<br>I_IHD(%) | LIMIT |
|---|---|---|---|---|---|---|---|---|---|---|
| VFD-P-12-8 | MHE1<br>BUS-0074 | 480<br>480 | 12.13 | 0.164<br>0.000 | -3.962<br>0.000 | 4791.55 | | | 29.07><br>38.74 | 20.0 |
| VFD-P-13-8 | MHE2<br>BUS-0084 | 480<br>480 | 12.13 | 0.164<br>0.000 | -3.962<br>0.000 | 4791.18 | | | 29.08><br>38.75 | 20.0 |
| VFD-P-14-9 | MHE1<br>BUS-0066 | 480<br>480 | 12.13 | 0.164<br>0.000 | -3.962<br>0.000 | 4791.55 | | | 29.07><br>38.74 | 20.0 |
| VFD-P-15-9 | MHE2<br>BUS-0082 | 480<br>480 | 12.13 | 0.164<br>0.000 | -3.962<br>0.000 | 4791.18 | | | 29.08><br>38.75 | 20.0 |
| VFD-P-2-3 | MHE1<br>BUS-0064 | 480<br>480 | 35.79 | 0.493<br>0.000 | -11.877<br>0.000 | 13120.06 | | | 24.71><br>32.87 | 15.0 |
| VFD-P-3-3 | MHE2<br>BUS-0078 | 480<br>480 | 35.80 | 0.493<br>0.000 | -11.877<br>0.000 | 13119.03 | | | 24.72><br>32.87 | 15.0 |
| VFD-P-4-3 | MHE3<br>BUS-0088 | 480<br>480 | 35.78 | 0.493<br>0.000 | -11.877<br>0.000 | 13134.65 | | | 24.73><br>32.90 | 15.0 |
| VFD-POLYMER SYSTEM | MHE1<br>BUS-0072 | 480<br>480 | 1.23 | 0.016<br>0.000 | -0.396<br>0.000 | 501.13 | | | 31.65><br>42.24 | 20.0 |

## TOTAL SYSTEM POWER LOSSES

| Harmonic Losses | | Total RMS Losses | |
|---|---|---|---|
| P(kW) | Q{kVAR) | P(kW) | Q(kVAR) |
| 9.20 | 16.81 | 77.64 | -388.99 |

| CURRENT DISTORTION SUMMARY | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Device Name | Bus Name<br>From/To | Voltage<br>From/To | I_RMS(A) | kWLo ss<br>Tot/Harm | kVARLoss<br>Tot/Harm | IT | HLF | KF | I_TDD(%)/<br>I_IHD(%) | LIMIT |
| CBL-0056 | BUS-0076<br>BUS-0075 | 480<br>480 | 92.76 | 0.158<br>0.009 | 0.044<br>0.009 | 10757.22 | | | 17.52><br>21.86 | 15.0 |
| CBL-0063 | BUS-0086<br>BUS-0085 | 480<br>480 | 92.76 | 0.158<br>0.009 | 0.044<br>0.009 | 10755.28 | | | 17.52><br>21.86 | 15.0 |
| CBL-CAP1-SBHE1 | PFC-SBHE1<br>BUS-0100 | 480<br>480 | 99.95 | 0.157<br>0.129 | 0.123<br>0.118 | 200507.41 | | | 139.65><br>155.01 | 15.0 |
| CBL-MHE1 | SBHE1<br>MHE1 | 480<br>480 | 707.08 | 0.584<br>0.011 | 0.701<br>0.045 | 121492.80 | | | 8.00><br>8.76 | 8.0 |
| CBL-PFC-SBHE1 | SBHE1<br>PFC-SBHE1 | 480<br>480 | 299.84 | 0.636<br>0.606 | 0.857<br>0.826 | 601522.19 | | | 104.74><br>155.01 | 12.0 |
| CBL-SBH01 | UTIL-1 SEC<br>SBH01 | 480<br>480 | 1963.27 | 2.690<br>0.052 | 3.836<br>0.272 | 319265.66 | | | 9.12><br>9.17 | 5.0 |
| CBL-SBHE1 | SBH01<br>SBHE1 | 480<br>480 | 1963.27 | 2.690<br>0.052 | 3.836<br>0.272 | 319265.66 | | | 9.12><br>9.17 | 5.0 |
| CBL-UTILITY | BUS-0104<br>BUS-UTILITY | 12470<br>12470 | 75.55 | 0.055<br>0.001 | 0.011<br>0.001 | 12287.68 | | | 8.75><br>8.79 | 5.0 |
| VFD-B-5-8 | MHE1<br>BUS-0076 | 480<br>480 | 87.44 | 1.231<br>0.000 | -29.732<br>0.000 | 27437.95 | | | 18.64><br>24.83 | 15.0 |
| VFD-B-6-8 | MHE2<br>BUS-0086 | 480<br>480 | 87.47 | 1.231<br>0.000 | -29.732<br>0.000 | 27435.91 | | | 18.64><br>24.83 | 15.0 |
| VFD-C-1-9 | MHE1<br>BUS-0070 | 480<br>480 | 3.67 | 0.049<br>0.000 | -1.189<br>0.000 | 1488.12 | | | 31.03><br>41.40 | 20.0 |
| VFD-CF-1-9 | MHE1<br>BUS-0068 | 480<br>480 | 59.29 | 0.827<br>0.000 | -19.751<br>0.000 | 20201.27 | | | 21.69><br>28.69 | 15.0 |
| VFD-P-12-8 | MHE1<br>BUS-0074 | 480<br>480 | 12.13 | 0.164<br>0.000 | -3.962<br>0.000 | 4791.55 | | | 29.07><br>38.74 | 20.0 |

## CURRENT DISTORTION SUMMARY

| Device Name | Bus Name<br>From/To | Voltage<br>From/To | I_RMS(A) | kWLo ss<br>Tot/Harm | kVARLoss<br>Tot/Harm | IT | HLF | KF | I_TDD(%)/<br>I_IHD(%) | LIMIT |
|---|---|---|---|---|---|---|---|---|---|---|
| VFD-P-13-8 | MHE2<br>BUS-0084 | 480<br>480 | 12.13 | 0.164<br>0.000 | -3.962<br>0.000 | 4791.18 | | | 29.08><br>38.75 | 20.0 |
| VFD-P-14-9 | MHE1<br>BUS-0066 | 480<br>480 | 12.13 | 0.164<br>0.000 | -3.962<br>0.000 | 4791.55 | | | 29.07><br>38.74 | 20.0 |
| VFD-P-15-9 | MHE2<br>BUS-0082 | 480<br>480 | 12.13 | 0.164<br>0.000 | -3.962<br>0.000 | 4791.18 | | | 29.08><br>38.75 | 20.0 |
| VFD-P-2-3 | MHE1<br>BUS-0064 | 480<br>480 | 35.79 | 0.493<br>0.000 | -11.877<br>0.000 | 13120.06 | | | 24.71><br>32.87 | 15.0 |
| VFD-P-3-3 | MHE2<br>BUS-0078 | 480<br>480 | 35.80 | 0.493<br>0.000 | -11.877<br>0.000 | 13119.03 | | | 24.72><br>32.87 | 15.0 |
| VFD-P-4-3 | MHE3<br>BUS-0088 | 480<br>480 | 35.78 | 0.493<br>0.000 | -11.877<br>0.000 | 13134.65 | | | 24.73><br>32.90 | 15.0 |
| VFD-POLYMER SYSTEM | MHE1<br>BUS-0072 | 480<br>480 | 1.23 | 0.016<br>0.000 | -0.396<br>0.000 | 501.13 | | | 31.65><br>42.24 | 20.0 |

## TOTAL SYSTEM POWER LOSSES

| Harmonic Losses | | Total RMS Losses | |
|---|---|---|---|
| P(kW) | Q{kVAR) | P(kW) | Q(kVAR) |
| 9.20 | 16.81 | 77.64 | -388.99 |

HARMONIC VOLTAGE SPECTRUM REPORT

Bus: BUS-UTILITY (12470V)

| Harmonic Order | Harmonic Voltages | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 11843.031 | -2.11 | | | |
| 3 | 0.000 | 0.00 | 0.000 | | 3.000 |
| 5 | 135.232 | 133.09 | 1.142 | | 3.000 |
| 7 | 162.758 | -126.45 | 1.374 | | 3.000 |
| 11 | 506.702 | -31.59 | 4.278 | > | 3.000 |
| 13 | 91.317 | -54.34 | 0.771 | | 3.000 |
| 15 | 0.000 | 0.00 | 0.000 | | 3.000 |
| 17 | 41.962 | 153.78 | 0.354 | | 3.000 |
| 19 | 22.752 | 85.77 | 0.192 | | 3.000 |
| 35 | 1.290 | 46.80 | 0.011 | | 3.000 |
| 37 | 2.051 | 17.22 | 0.017 | | 3.000 |

Voltage: 12470.0 V_RMS: 11856.20 V_THD(%): 4.72
LIMIT (THD%): 5.0

HARMONIC VOLTAGE SPECTRUM REPORT

Bus: MHE1 (480V)

| Harmonic Order | Harmonic Voltages | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 431.632 | -37.43 | | | |
| 3 | 4.023 | -94.43 | 0.932 | | 5.000 |
| 5 | 14.736 | 164.90 | 3.414 | | 5.000 |
| 7 | 17.711 | -155.66 | 4.103 | | 5.000 |
| 11 | 54.593 | -1.64 | 12.648 | > | 5.000 |
| 13 | 9.762 | -84.64 | 2.262 | | 5.000 |
| 15 | 0.455 | 13.93 | 0.105 | | 5.000 |
| 17 | 4.418 | -177.13 | 1.024 | | 5.000 |
| 19 | 2.405 | 54.93 | 0.557 | | 5.000 |
| 35 | 0.126 | 79.98 | 0.029 | | 5.000 |
| 37 | 0.198 | -7.98 | 0.046 | | 5.000 |

Voltage: 480.0 V_RMS: 435.84 V_THD(%): 13.99 >
LIMIT (THD%): 8.0

HARMONIC VOLTAGE SPECTRUM REPORT

Bus: MHE2 (480V)

| Harmonic Order | Harmonic Voltages | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 431.468 | -37.44 | | | |
| 3 | 4.034 | -94.43 | 0.935 | | 5.000 |
| 5 | 14.704 | 164.94 | 3.408 | | 5.000 |
| 7 | 17.677 | -155.62 | 4.097 | | 5.000 |
| 11 | 54.529 | -1.65 | 12.638 | > | 5.000 |
| 13 | 9.757 | -84.64 | 2.261 | | 5.000 |
| 15 | 0.454 | 13.96 | 0.105 | | 5.000 |
| 17 | 4.411 | -177.03 | 1.022 | | 5.000 |
| 19 | 2.385 | 55.02 | 0.553 | | 5.000 |
| 35 | 0.121 | 81.77 | 0.028 | | 5.000 |
| 37 | 0.190 | -5.53 | 0.044 | | 5.000 |

Voltage: 480.0 V_RMS: 435.66 V_THD(%): 13.98 >
LIMIT (THD%): 8.0

HARMONIC VOLTAGE SPECTRUM REPORT

Bus: MHE3 (480V)

| Harmonic Order | Harmonic Voltages | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 431.700 | -37.43 | | | |
| 3 | 4.015 | -94.44 | 0.930 | | 5.000 |
| 5 | 14.600 | 165.02 | 3.382 | | 5.000 |
| 7 | 17.594 | -155.55 | 4.075 | | 5.000 |
| 11 | 54.696 | -1.74 | 12.670 | > | 5.000 |
| 13 | 9.844 | -84.84 | 2.280 | | 5.000 |
| 15 | 0.440 | 13.99 | 0.102 | | 5.000 |
| 17 | 4.470 | -176.51 | 1.036 | | 5.000 |
| 19 | 2.359 | 55.37 | 0.546 | | 5.000 |
| 35 | 0.114 | 86.77 | 0.026 | | 5.000 |
| 37 | 0.180 | 0.96 | 0.042 | | 5.000 |

Voltage: 480.0 V_RMS: 435.91 V_THD(%): 14.00 >
LIMIT (THD%): 8.0

HARMONIC VOLTAGE SPECTRUM REPORT

Bus: PFC-SBHE1 (480V)

| Harmonic Order | Harmonic Voltages | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 432.385 | -37.40 | | | |
| 3 | 3.914 | -94.21 | 0.905 | | 5.000 |
| 5 | 14.698 | 164.72 | 3.399 | | 5.000 |
| 7 | 17.839 | -156.17 | 4.126 | | 5.000 |
| 11 | 56.656 | -3.19 | 13.103 | > | 5.000 |
| 13 | 10.343 | -86.89 | 2.392 | | 5.000 |
| 15 | 0.437 | 14.00 | 0.101 | | 5.000 |
| 17 | 4.908 | 179.11 | 1.135 | | 5.000 |
| 19 | 2.714 | 49.85 | 0.628 | | 5.000 |
| 35 | 0.193 | 50.76 | 0.045 | | 5.000 |
| 37 | 0.314 | -43.57 | 0.073 | | 5.000 |

Voltage: 480.0 V_RMS: 436.87 V_THD(%): 14.44 >
LIMIT (THD%): 8.0

HARMONIC VOLTAGE SPECTRUM REPORT

Bus: SBH01 (480V)

| Harmonic Order | Harmonic Voltages | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 433.340 | -37.29 | | | |
| 3 | 3.692 | -93.82 | 0.852 | | 5.000 |
| 5 | 14.388 | 165.18 | 3.320 | | 5.000 |
| 7 | 17.356 | -155.46 | 4.005 | | 5.000 |
| 11 | 54.109 | -1.71 | 12.486 | > | 5.000 |
| 13 | 9.754 | -84.82 | 2.251 | | 5.000 |
| 15 | 0.412 | 14.08 | 0.095 | | 5.000 |
| 17 | 4.484 | -177.24 | 1.035 | | 5.000 |
| 19 | 2.431 | 54.54 | 0.561 | | 5.000 |
| 35 | 0.138 | 74.48 | 0.032 | | 5.000 |
| 37 | 0.219 | -15.21 | 0.051 | | 5.000 |

Voltage: 480.0 V_RMS: 437.44 V_THD(%): 13.79 >
LIMIT (THD%): 8.0

HARMONIC VOLTAGE SPECTRUM REPORT

Bus: SBHE1 (480V)

| Harmonic Order | Harmonic Voltages | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 432.275 | -37.39 | | | |
| 3 | 3.914 | -94.21 | 0.905 | | 5.000 |
| 5 | 14.604 | 165.00 | 3.378 | | 5.000 |
| 7 | 17.616 | -155.61 | 4.075 | | 5.000 |
| 11 | 54.914 | -1.80 | 12.704 | > | 5.000 |
| 13 | 9.900 | -84.91 | 2.290 | | 5.000 |
| 15 | 0.437 | 14.00 | 0.101 | | 5.000 |
| 17 | 4.551 | -177.33 | 1.053 | | 5.000 |
| 19 | 2.468 | 54.45 | 0.571 | | 5.000 |
| 35 | 0.140 | 74.39 | 0.032 | | 5.000 |
| 37 | 0.223 | -15.29 | 0.052 | | 5.000 |

Voltage: 480.0 V_RMS: 436.51 V_THD(%): 14.03 >
LIMIT (THD%): 8.0

## HARMONIC CURRENT SPECTRUM REPORT

Device Name: CBL-UTILITY
From: BUS-0104 (12470V)
To: BUS-UTILITY (12470V)
Point of Common Coupling (PCC): (Isc/Ilf = 17.754)

| Harmonic Order | Harmonic Amperes | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 75.255 | -25.28 | | | |
| 3 | 0.000 | -180.00 | 0.000 | | 4.000 |
| 5 | 3.035 | -130.27 | 4.033 | > | 4.000 |
| 7 | 2.618 | -31.69 | 3.478 | | 4.000 |
| 11 | 5.197 | 61.44 | 6.905 | > | 2.000 |
| 13 | 0.793 | 38.23 | 1.053 | | 2.000 |
| 15 | 0.000 | -180.00 | 0.000 | | 2.000 |
| 17 | 0.279 | -114.26 | 0.370 | | 1.500 |
| 19 | 0.135 | 177.52 | 0.180 | | 1.500 |
| 35 | 0.004 | 137.76 | 0.006 | | 0.300 |
| 37 | 0.006 | 108.12 | 0.008 | | 0.300 |

Voltage: 12470.0 I_RMS: 75.55 I_TDD(%): 8.75 >
I_THD(%): 8.79
kWLoss: 0.055 kVARLoss: 0.011
I_K: LIMIT (TDD%): 5.0

## HARMONIC CURRENT SPECTRUM REPORT

Device Name: CBL-SBHE1
From: SBH01 (480V)
To: SBHE1 (480V)
Point of Common Coupling (PCC): (Isc/Ilf = 8.393)

| Harmonic Order | Harmonic Amperes | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 1955.067 | -55.28 | | | |
| 3 | 50.784 | 0.29 | 2.598 | | 4.000 |
| 5 | 78.845 | -100.27 | 4.033 | > | 4.000 |
| 7 | 68.004 | -61.69 | 3.478 | | 4.000 |
| 11 | 135.002 | 91.44 | 6.905 | > | 2.000 |
| 13 | 20.595 | 8.23 | 1.053 | | 2.000 |
| 15 | 1.136 | 107.45 | 0.058 | | 2.000 |
| 17 | 7.240 | -84.26 | 0.370 | | 1.500 |
| 19 | 3.513 | 147.52 | 0.180 | | 1.500 |
| 35 | 0.108 | 167.75 | 0.006 | | 0.300 |
| 37 | 0.163 | 78.12 | 0.008 | | 0.300 |

Voltage: 480.0 I_RMS: 1963.27 I_TDD(%): 9.12 >
I_THD(%): 9.17
kWLoss: 2.690 kVARLoss: 3.836
I_K: LIMIT (TDD%): 5.0

## HARMONIC CURRENT SPECTRUM REPORT

Device Name: CBL-MHE1
From: SBHE1 (480V)
To: MHE1 (480V)
Point of Common Coupling (PCC): (Isc/Ilf = 23.028)

| Harmonic Order | Harmonic Amperes | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 704.380 | -60.43 | | | |
| 3 | 18.471 | 0.67 | 2.622 | | 7.000 |
| 5 | 33.379 | -98.77 | 4.739 | | 7.000 |
| 7 | 17.310 | -59.92 | 2.458 | | 7.000 |
| 11 | 41.461 | -104.71 | 5.886 | > | 3.500 |
| 13 | 14.344 | 176.64 | 2.036 | | 3.500 |
| 15 | 0.609 | 107.50 | 0.086 | | 3.500 |
| 17 | 10.103 | 96.04 | 1.434 | | 2.500 |
| 19 | 4.474 | -43.55 | 0.635 | | 2.500 |
| 35 | 0.715 | -45.30 | 0.102 | | 0.500 |
| 37 | 1.259 | -140.30 | 0.179 | | 0.500 |

Voltage: 480.0 I_RMS: 707.08 I_TDD(%): 8.00
I_THD(%): 8.76
kWLoss: 0.584 kVARLoss: 0.701
I_K: LIMIT (TDD%): 8.0

HARMONIC CURRENT SPECTRUM REPORT

Device Name: CBL-MHE2
From: SBHE1 (480V)
To: MHE2 (480V)
Point of Common Coupling (PCC): (Isc/Ilf = 24.680)

| Harmonic Order | Harmonic Amperes | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 657.230 | -61.55 | | | |
| 3 | 15.199 | 0.47 | 2.313 | | 7.000 |
| 5 | 19.133 | -97.83 | 2.911 | | 7.000 |
| 7 | 8.384 | -55.77 | 1.276 | | 7.000 |
| 11 | 36.209 | -101.76 | 5.509 | > | 3.500 |
| 13 | 11.118 | 177.62 | 1.692 | | 3.500 |
| 15 | 0.425 | 107.38 | 0.065 | | 3.500 |
| 17 | 8.080 | 90.97 | 1.229 | | 2.500 |
| 19 | 4.398 | -43.82 | 0.669 | | 2.500 |
| 35 | 0.712 | -45.67 | 0.108 | | 0.500 |
| 37 | 1.255 | -140.69 | 0.191 | | 0.500 |

Voltage: 480.0 I_RMS: 658.89 I_TDD(%): 6.52
I_THD(%): 7.12
kWLoss: 0.672 kVARLoss: 0.800
I_K: LIMIT (TDD%): 8.0

## HARMONIC CURRENT SPECTRUM REPORT

Device Name: CBL-MHE3
From: SBHE1 (480V)
To: MHE3 (480V)
Point of Common Coupling (PCC): (Isc/Ilf = 24.942)

| Harmonic Order | Harmonic Amperes | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 650.320 | -57.02 | | | |
| 3 | 17.117 | -0.29 | 2.632 | | 7.000 |
| 5 | 1.499 | 44.23 | 0.231 | | 7.000 |
| 7 | 5.348 | 88.78 | 0.822 | | 7.000 |
| 11 | 26.378 | -94.74 | 4.056 | > | 3.500 |
| 13 | 5.645 | -178.28 | 0.868 | | 3.500 |
| 15 | 0.102 | 107.48 | 0.016 | | 3.500 |
| 17 | 7.788 | 64.27 | 1.198 | | 2.500 |
| 19 | 7.845 | -44.83 | 1.206 | | 2.500 |
| 35 | 1.400 | -46.09 | 0.215 | | 0.500 |
| 37 | 2.477 | -141.09 | 0.381 | | 0.500 |

Voltage: 480.0 I_RMS: 651.23 I_TDD(%): 4.75
I_THD(%): 5.29
kWLoss: 0.492 kVARLoss: 0.577
I_K: LIMIT (TDD%): 8.0

## HARMONIC CURRENT SPECTRUM REPORT

Device Name: CBL-PFC-SBHE1
From: SBHE1 (480V)
To: PFC-SBHE1 (480V)
Point of Common Coupling (PCC): (Isc/Ilf = 99.791)

| Harmonic Order | Harmonic Amperes | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 162.542 | 52.56 | | | |
| 3 | 0.000 | -139.21 | 0.000 | | 10.000 |
| 5 | 27.699 | -105.56 | 17.041 | > | 10.000 |
| 7 | 47.189 | -66.60 | 29.032 | > | 10.000 |
| 11 | 237.384 | 85.96 | 146.045 | > | 4.500 |
| 13 | 51.486 | 2.02 | 31.675 | > | 4.500 |
| 15 | 0.000 | -30.99 | 0.000 | | 4.500 |
| 17 | 32.378 | -92.58 | 19.920 | > | 4.000 |
| 19 | 20.167 | 137.81 | 12.407 | > | 4.000 |
| 35 | 2.918 | 135.39 | 1.795 | > | 0.700 |
| 37 | 5.118 | 40.35 | 3.149 | > | 0.700 |

Voltage: 480.0 I_RMS: 299.84 I_TDD(%): 104.74>
I_THD(%): 155.01
kWLoss: 0.636 kVARLoss: 0.857
I_K: LIMIT (TDD%): 12.0

## HARMONIC CURRENT SPECTRUM REPORT

Device Name: CBL-SBH01
From: UTIL-1 SEC (480V)
To: SBH01 (480V)
Point of Common Coupling (PCC): (Isc/Ilf = 8.493)

| Harmonic Order | Harmonic Amperes | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 1955.067 | -55.28 | | | |
| 3 | 50.784 | 0.29 | 2.598 | | 4.000 |
| 5 | 78.845 | -100.27 | 4.033 | > | 4.000 |
| 7 | 68.004 | -61.69 | 3.478 | | 4.000 |
| 11 | 135.002 | 91.44 | 6.905 | > | 2.000 |
| 13 | 20.595 | 8.23 | 1.053 | | 2.000 |
| 15 | 1.136 | 107.45 | 0.058 | | 2.000 |
| 17 | 7.240 | -84.26 | 0.370 | | 1.500 |
| 19 | 3.513 | 147.52 | 0.180 | | 1.500 |
| 35 | 0.108 | 167.75 | 0.006 | | 0.300 |
| 37 | 0.163 | 78.12 | 0.008 | | 0.300 |

Voltage: 480.0 I_RMS: 1963.27 I_TDD(%): 9.12 >
I_THD(%): 9.17
kWLoss: 2.690 kVARLoss: 3.836
I_K: LIMIT (TDD%): 5.0

## F I L T E R  S P E C T R U M  R E P O R T

Filter Name: CAP1-SBHE1 (Capacitor)
Bus Name: BUS-0100 (480V)

| Harmonic Order | IR (Amp) | IL (Amp) | IC (Amp) | R (kW) | L (kVAR) | C (kVAR) | R (V) | L (V) | C (V) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | | 54.18078 | | | 40.58114 | | | 432.43251 |
| 3 | | | | | | | | | |
| 5 | | | 9.23310 | | | 0.23570 | | | 14.73841 |
| 7 | | | 15.72975 | | | 0.48863 | | | 17.93481 |
| 11 | | | 79.12811 | | | 7.86869 | | | 57.41313 |
| 13 | | | 17.16189 | | | 0.31320 | | | 10.53646 |
| 15 | | | | | | | | | |
| 17 | | | 10.79259 | | | 0.09472 | | | 5.06699 |
| 19 | | | 6.72242 | | | 0.03288 | | | 2.82387 |
| 35 | | | 0.97278 | | | 0.00037 | | | 0.22183 |
| 37 | | | 1.70615 | | | 0.00109 | | | 0.36803 |

Capacitor Rated Voltage: 480.00 Rated 3 Phase KVA: 50.00
V_RMS: 437.010 V_CREST: 541.536 I_RMS: 99.948 KVA: 49.616
V_RMS: 91.0438% V_CREST: 112.8200% I_RMS: 166.1900% > KVA: 99.2328%
Limit: 110.0% Limit: 169.7% Limit: 135.0% Limit: 135.0%

## F I L T E R  S P E C T R U M  R E P O R T

Filter Name: CAP2-SBHE1 (Capacitor)
Bus Name: BUS-0101 (480V)

| Harmonic Order | IR (Amp) | IL (Amp) | IC (Amp) | R (kW) | L (kVAR) | C (kVAR) | R (V) | L (V) | C (V) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | | 54.18078 | | | 40.58114 | | | 432.43251 |
| 3 | | | | | | | | | |
| 5 | | | 9.23310 | | | 0.23570 | | | 14.73841 |
| 7 | | | 15.72975 | | | 0.48863 | | | 17.93481 |
| 11 | | | 79.12811 | | | 7.86869 | | | 57.41313 |
| 13 | | | 17.16189 | | | 0.31320 | | | 10.53646 |
| 15 | | | | | | | | | |
| 17 | | | 10.79259 | | | 0.09472 | | | 5.06699 |
| 19 | | | 6.72242 | | | 0.03288 | | | 2.82387 |
| 35 | | | 0.97278 | | | 0.00037 | | | 0.22183 |
| 37 | | | 1.70615 | | | 0.00109 | | | 0.36803 |

Capacitor Rated Voltage: 480.00 Rated 3 Phase KVA: 50.00
V_RMS: 437.010 V_CREST: 541.536 I_RMS: 99.948 KVA: 49.616
V_RMS: 91.0438% V_CREST: 112.8200% I_RMS: 166.1900% > KVA: 99.2328%
Limit: 110.0% Limit: 169.7% Limit: 135.0% Limit: 135.0%

## F I L T E R  S P E C T R U M  R E P O R T

Filter Name: CAP3-SBHE1 (Capacitor)
Bus Name: BUS-0102 (480V)

| Harmonic Order | IR (Amp) | IL (Amp) | IC (Amp) | R (kW) | L (kVAR) | C (kVAR) | R (V) | L (V) | C (V) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | | 54.18078 | | | 40.58114 | | | 432.43251 |
| 3 | | | | | | | | | |
| 5 | | | 9.23310 | | | 0.23570 | | | 14.73841 |
| 7 | | | 15.72975 | | | 0.48863 | | | 17.93481 |
| 11 | | | 79.12811 | | | 7.86869 | | | 57.41313 |
| 13 | | | 17.16189 | | | 0.31320 | | | 10.53646 |
| 15 | | | | | | | | | |
| 17 | | | 10.79259 | | | 0.09472 | | | 5.06699 |
| 19 | | | 6.72242 | | | 0.03288 | | | 2.82387 |
| 35 | | | 0.97278 | | | 0.00037 | | | 0.22183 |
| 37 | | | 1.70615 | | | 0.00109 | | | 0.36803 |

Capacitor Rated Voltage: 480.00 Rated 3 Phase KVA: 50.00
V_RMS: 437.010 V_CREST: 541.536 I_RMS: 99.948 KVA: 49.616
V_RMS: 91.0438% V_CREST: 112.8200% I_RMS: 166.1900% > KVA: 99.2328%
Limit: 110.0% Limit: 169.7% Limit: 135.0% Limit: 135.0%

BIXBY WRF

TQSITL0010020
MTL0010020
U0130

Scenario 4

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ALL INFORMATION PRESENTED IS FOR REVIEW, APPROVAL
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# STUDY CRITERIA

| | |
|---|---|
| **Studies Selected To Run:** | |
| Load Flow: | Yes |
| Frequency Scan: | Yes |
| Harmonic Distortion: | Yes |
| **Load Flow Study Setup Options** | |
| Utility Impedance: | Yes |
| Transformer Phase Shift: | Yes |
| Solution Method: | Exact |
| Load Specification: | Connected Load |
| Generation Acceleration Factor: | 1.00 |
| Load Acceleration Factor: | 1.00 |
| Bus Voltage Drop: | 5.00 |
| Branch Voltage Drop: | 3.00 |
| **HI_WAVE Study Setup Options** | |
| Fundamental Frequency: | 60 Hz |
| Max. Harmonic Order: | 50 |
| Include Triplet Harmonics Path (Static Load): | No |
| Include Triplet Harmonics Path (Ind. Motor): | No |
| Modify Motor Z by Load Factor (Ind. Motor): | No |
| Modify Load Z by Load Factor (Static Load): | No |
| **HI_WAVE Study Setup Options for Frequency Scan** | |
| Scan Impedance Option: | Scan Self Impedance |
| Use Positive Sequence Network: | Yes |
| Use Negative Sequence Network: | Yes |
| Use Zero Sequence Network: | No |
| Model Transformer Tap: | Yes |
| Model Transformer Phase Shift: | Yes |
| Report Bus Equivalent Impedance: | No |
| Number of Scan Steps Per Order: | 5 |
| **HI_WAVE Study Setup Options for Distortion** | |
| Use Positive Sequence Network: | Yes |
| Use Negative Sequence Network: | Yes |
| Use Zero Sequence Network: | Yes |
| Model Transformer Tap: | Yes |
| Model Transformer Phase Shift: | Yes |
| Fundamental Solution: | Use Load Flow Result |
| Report Option: | All Distortions and Violations |
| Current Limits: | IEEE 519-2022 Std, Current Distortion Limit Tables 2, 3, & 4, All buses as PCC |

LOADS AND MOTORS WITH HARMONIC SOURCE MODELS

| Bus Name | Voltage | Component Name | LF Current | Harmonic Library |
|---|---|---|---|---|
| BUS-0062 | 480 | VFD-B-1-4 | 230.7 | CPX9000 |
| BUS-0064 | 480 | VFD-P-2-3 | 33.8 | DG-1 |
| BUS-0066 | 480 | VFD-P-14-9 | 11.3 | DG-1 |
| BUS-0068 | 480 | VFD-CF-1-9 | 56.7 | DG-1 |
| BUS-0070 | 480 | VFD-C-1-9 | 3.4 | DG-1 |
| BUS-0072 | 480 | VFD-POLYMER SYSTEM | 1.1 | DG-1 |
| BUS-0074 | 480 | VFD-P-12-8 | 11.3 | DG-1 |
| BUS-0076 | 480 | VFD-B-5-8 | 84.4 | DG-1 |
| BUS-0078 | 480 | VFD-P-3-3 | 33.8 | DG-1 |
| BUS-0080 | 480 | VFD-B-2-4 | 230.8 | CPX9000 |
| BUS-0082 | 480 | VFD-P-15-9 | 11.3 | DG-1 |
| BUS-0084 | 480 | VFD-P-13-8 | 11.3 | DG-1 |
| BUS-0086 | 480 | VFD-B-6-8 | 84.5 | DG-1 |
| BUS-0088 | 480 | VFD-P-4-3 | 33.8 | DG-1 |
| BUS-0090 | 480 | VFD-B-3-4 | 230.7 | CPX9000 |
| BUS-0092 | 480 | VFD-B-4-4 | 230.7 | CPX9000 |

| HARMONIC SOURCE | | |
|---|---|---|
| CPX9000 | | |
| Order | Magnitude (%) | Angle (Degrees) |
| 1 | 100.000 | -11.00 |
| 3 | 3.300 | 121.00 |
| 5 | 0.400 | 138.00 |
| 7 | 1.400 | -49.00 |
| 17 | 2.200 | 17.00 |
| 19 | 2.500 | 4.00 |
| 35 | 0.400 | -69.00 |
| 37 | 0.700 | -83.00 |

| HARMONIC SOURCE | | |
|---|---|---|
| DG-1 | | |
| Order | Magnitude (%) | Angle (Degrees) |
| 1 | 100.000 | -7.00 |
| 3 | 5.330 | 135.00 |
| 5 | 38.460 | 123.00 |
| 7 | 22.780 | -112.00 |
| 11 | 7.690 | -16.00 |
| 13 | 5.620 | 30.00 |
| 15 | 0.300 | 55.00 |
| 17 | 3.850 | 153.00 |

| H A R M O N I C  S O U R C E  I N D E X  T A B L E |
|---|
| HARMONIC SOURCES HAVE BEEN FOUND AND INJECTED FOR EACH OF THE FOLLOWING HARMONIC ORDERS |
| 3 5 7 11 13 15 17 19 35 37 |

P A S S I V E F I L T E R D A T A

| Filter Name | Bus Name | Bus Volts | Rated Volts | Connect | Filter Type | Capacitor KVAR | Tuned Order | Q | M | R (Ω) | L (H) | C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CAP1-SBHE1 | BUS-0100 | 480 | 480 | WYE_G | Capacitor | 50.0 | | | | 0.0000<br>0.0000 | 0.0000<br>0.0000 | 575.6472uF<br>575.6472uF |
| CAP2-SBHE1 | BUS-0101 | 480 | 480 | WYE_G | Capacitor | 50.0 | | | | 0.0000<br>0.0000 | 0.0000<br>0.0000 | 575.6472uF<br>575.6472uF |
| CAP3-SBHE1 | BUS-0102 | 480 | 480 | WYE_G | Capacitor | 50.0 | | | | 0.0000<br>0.0000 | 0.0000<br>0.0000 | 575.6472uF<br>575.6472uF |
| CAP4-SBHE1 | BUS-0103 | 480 | 480 | WYE_G | Capacitor | 50.0 | | | | 0.0000<br>0.0000 | 0.0000<br>0.0000 | 575.6472uF<br>575.6472uF |

| UTILITY, GENERATOR AND MOTOR DATA | | | | | | | |
|---|---|---|---|---|---|---|---|
| Component Name | Component Type | Bus Name | Bus Voltage | Base Voltage | Base KVA | R1(pu)<br>R2<br>R0 | X1(pu)<br>X2<br>X0 |
| UTIL-1 MAX | UTILITY | BUS-0104 | 12470 | 12470 | 100000 | 1.9106<br>1.9106<br>3.0389 | 3.2862<br>3.2862<br>8.4512 |

| TOTAL VOLTAGE DISTORTION | | | | | |
|---|---|---|---|---|---|
| Bus Name | Voltage | V_RMS(V) | V_TIF | V_THD(%) | LIMIT |
| ADMIN SEC | 480 | 456.81 | 31.3524 | 2.4754 | 8.0 |
| ATS1 | 480 | 435.08 | 91.2058 | 7.3869 | 8.0 |
| BUS-0007 | 480 | 432.96 | 90.7922 | 7.3537 | 8.0 |
| BUS-0008 | 480 | 433.12 | 91.4480 | 7.4062 | 8.0 |
| BUS-0009 | 480 | 431.79 | 90.5088 | 7.3300 | 8.0 |
| BUS-0010 | 480 | 433.79 | 90.8886 | 7.3604 | 8.0 |
| BUS-0011 | 480 | 431.64 | 91.0916 | 7.3091 | 8.0 |
| BUS-0012 | 480 | 433.36 | 90.7313 | 7.3488 | 8.0 |
| BUS-0013 | 480 | 432.95 | 91.3520 | 7.3976 | 8.0 |
| BUS-0014 | 480 | 432.95 | 91.3520 | 7.3976 | 8.0 |
| BUS-0015 | 480 | 435.08 | 91.2058 | 7.3869 | 8.0 |
| BUS-0016 | 480 | 434.91 | 91.1097 | 7.3782 | 8.0 |
| BUS-0017 | 480 | 434.44 | 91.6293 | 7.3518 | 8.0 |
| BUS-0022 | 480 | 435.08 | 91.2058 | 7.3869 | 8.0 |
| BUS-0023 | 208 | 188.53 | 91.0970 | 7.3283 | 8.0 |
| BUS-0024 | 480 | 456.81 | 31.3524 | 2.4754 | 8.0 |
| BUS-0025 | 208 | 197.95 | 31.3524 | 2.4754 | 8.0 |
| BUS-0026 | 480 | 456.81 | 31.3524 | 2.4754 | 8.0 |
| BUS-0027 | 208 | 188.53 | 91.0970 | 7.3283 | 8.0 |
| BUS-0028 | 208 | 188.53 | 91.0970 | 7.3283 | 8.0 |
| BUS-0029 | 208 | 197.95 | 31.3524 | 2.4754 | 8.0 |
| BUS-0036 | 208 | 197.95 | 31.3524 | 2.4754 | 8.0 |
| BUS-0060 | 12470 | 11867.61 | 31.3524 | 2.4754 | 5.0 |
| BUS-0061 | 480 | 472.98 | 224.6503 | 8.6506> | 8.0 |
| BUS-0062 | 480 | 481.74 | 222.6693 | 8.5164> | 8.0 |
| BUS-0063 | 480 | 483.40 | 74.6409 | 14.0363> | 8.0 |
| BUS-0064 | 480 | 484.69 | 74.5512 | 14.0195> | 8.0 |
| BUS-0065 | 480 | 481.44 | 66.3365 | 9.2992> | 8.0 |
| BUS-0066 | 480 | 482.07 | 66.2947 | 9.2935> | 8.0 |
| BUS-0067 | 480 | 484.40 | 109.3223 | 17.8529> | 8.0 |
| BUS-0068 | 480 | 487.54 | 108.9801 | 17.7967> | 8.0 |
| BUS-0069 | 480 | 481.04 | 76.2880 | 7.4478 | 8.0 |
| BUS-0070 | 480 | 481.33 | 76.2584 | 7.4449 | 8.0 |
| BUS-0071 | 480 | 481.05 | 80.3034 | 6.9292 | 8.0 |
| BUS-0072 | 480 | 481.15 | 80.2930 | 6.9283 | 8.0 |
| BUS-0073 | 480 | 481.44 | 66.3365 | 9.2992> | 8.0 |
| BUS-0074 | 480 | 482.07 | 66.2947 | 9.2935> | 8.0 |
| BUS-0075 | 480 | 489.79 | 151.9341 | 21.2347> | 8.0 |
| BUS-0076 | 480 | 490.72 | 152.0636 | 21.2524> | 8.0 |
| BUS-0077 | 480 | 483.40 | 74.5602 | 14.0325> | 8.0 |

| TOTAL VOLTAGE DISTORTION | | | | | |
|---|---|---|---|---|---|
| Bus Name | Voltage | V_RMS(V) | V_TIF | V_THD(%) | LIMIT |
| BUS-0078 | 480 | 484.69 | 74.4706 | 14.0157> | 8.0 |
| BUS-0079 | 480 | 472.98 | 224.9749 | 8.6562> | 8.0 |
| BUS-0080 | 480 | 481.74 | 222.9911 | 8.5218> | 8.0 |
| BUS-0081 | 480 | 481.44 | 66.1993 | 9.2911> | 8.0 |
| BUS-0082 | 480 | 482.06 | 66.1577 | 9.2854> | 8.0 |
| BUS-0083 | 480 | 481.44 | 66.1993 | 9.2911> | 8.0 |
| BUS-0084 | 480 | 482.06 | 66.1577 | 9.2854> | 8.0 |
| BUS-0085 | 480 | 489.79 | 151.9633 | 21.2368> | 8.0 |
| BUS-0086 | 480 | 490.72 | 152.0928 | 21.2544> | 8.0 |
| BUS-0087 | 480 | 483.38 | 74.0643 | 14.0072> | 8.0 |
| BUS-0088 | 480 | 484.67 | 73.9754 | 13.9904> | 8.0 |
| BUS-0089 | 480 | 472.98 | 225.2010 | 8.6505> | 8.0 |
| BUS-0090 | 480 | 481.74 | 223.2152 | 8.5163> | 8.0 |
| BUS-0091 | 480 | 472.98 | 225.2010 | 8.6505> | 8.0 |
| BUS-0092 | 480 | 481.74 | 223.2152 | 8.5163> | 8.0 |
| BUS-0100 | 480 | 435.97 | 99.4768 | 7.5676 | 8.0 |
| BUS-0101 | 480 | 435.97 | 99.4768 | 7.5676 | 8.0 |
| BUS-0102 | 480 | 435.97 | 99.4768 | 7.5676 | 8.0 |
| BUS-0103 | 480 | 435.97 | 99.4768 | 7.5676 | 8.0 |
| BUS-0104 | 12470 | 11868.02 | 31.3475 | 2.4750 | 5.0 |
| BUS-UTILITY | 12470 | 11867.61 | 31.3524 | 2.4754 | 5.0 |
| DS-CU-1 | 480 | 435.08 | 91.2058 | 7.3869 | 8.0 |
| DS-CU-2 | 480 | 435.08 | 91.2058 | 7.3869 | 8.0 |
| DS-CU-3 | 208 | 197.95 | 31.3524 | 2.4754 | 8.0 |
| DS-CU-4 | 208 | 197.95 | 31.3524 | 2.4754 | 8.0 |
| DS-CU-5 | 208 | 197.95 | 31.3524 | 2.4754 | 8.0 |
| DS-CU-6 | 208 | 197.95 | 31.3524 | 2.4754 | 8.0 |
| DS-EF-1 | 208 | 188.53 | 91.0970 | 7.3283 | 8.0 |
| DS-EF-2 | 208 | 188.53 | 91.0970 | 7.3283 | 8.0 |
| DS-EF-3 | 208 | 188.53 | 91.0970 | 7.3283 | 8.0 |
| DS-EF-4 | 208 | 188.53 | 91.0970 | 7.3283 | 8.0 |
| DS-EF-5 | 208 | 188.53 | 91.0970 | 7.3283 | 8.0 |
| DS-EF-6 | 208 | 197.95 | 31.3524 | 2.4754 | 8.0 |
| DS-EF-7 | 208 | 197.95 | 31.3524 | 2.4754 | 8.0 |
| DS-EF-8 | 208 | 197.95 | 31.3524 | 2.4754 | 8.0 |
| DS-SS-1 | 208 | 188.53 | 91.0970 | 7.3283 | 8.0 |
| DS-SS-2 | 208 | 188.53 | 91.0970 | 7.3283 | 8.0 |
| DS-SS-3 | 208 | 197.95 | 31.3524 | 2.4754 | 8.0 |
| DS-SS-4 | 208 | 197.95 | 31.3524 | 2.4754 | 8.0 |
| DS-SS-6 | 208 | 197.95 | 31.3524 | 2.4754 | 8.0 |

| TOTAL VOLTAGE DISTORTION | | | | | |
|---|---|---|---|---|---|
| Bus Name | Voltage | V_RMS(V) | V_TIF | V_THD(%) | LIMIT |
| MHE1 | 480 | 435.08 | 91.2058 | 7.3869 | 8.0 |
| MHE2 | 480 | 434.91 | 91.1097 | 7.3782 | 8.0 |
| MHE3 | 480 | 435.14 | 91.7680 | 7.3628 | 8.0 |
| PFC-SBHE1 | 480 | 435.91 | 97.7418 | 7.5183 | 8.0 |
| PHA1 | 480 | 456.81 | 31.3524 | 2.4754 | 8.0 |
| PHC1 | 480 | 435.08 | 91.2058 | 7.3869 | 8.0 |
| PHC2 | 480 | 435.08 | 91.2058 | 7.3869 | 8.0 |
| PHC3 | 480 | 435.08 | 91.2058 | 7.3869 | 8.0 |
| PHE1 | 480 | 435.08 | 91.2058 | 7.3869 | 8.0 |
| PLA1 | 208 | 197.95 | 31.3524 | 2.4754 | 8.0 |
| PLAU | 208 | 197.95 | 31.3524 | 2.4754 | 8.0 |
| PLC1 | 208 | 188.53 | 91.0970 | 7.3283 | 8.0 |
| PLC2 | 208 | 188.53 | 91.0970 | 7.3283 | 8.0 |
| PLCU | 208 | 188.53 | 91.0970 | 7.3283 | 8.0 |
| SBH01 | 480 | 436.70 | 91.0600 | 7.2379 | 8.0 |
| SBHE1 | 480 | 435.71 | 92.6357 | 7.3683 | 8.0 |
| UTIL-1 SEC | 480 | 437.70 | 89.4916 | 7.1083 | 8.0 |

| VOLTAGE DISTORTION SUMMARY | | | | | |
|---|---|---|---|---|---|
| Bus Name | Voltage | V_RMS(V) | V_TIF | V_THD(%) | LIMIT |
| BUS-0061 | 480 | 472.98 | 224.6503 | 8.6506> | 8.0 |
| BUS-0062 | 480 | 481.74 | 222.6693 | 8.5164> | 8.0 |
| BUS-0063 | 480 | 483.40 | 74.6409 | 14.0363> | 8.0 |
| BUS-0064 | 480 | 484.69 | 74.5512 | 14.0195> | 8.0 |
| BUS-0065 | 480 | 481.44 | 66.3365 | 9.2992> | 8.0 |
| BUS-0066 | 480 | 482.07 | 66.2947 | 9.2935> | 8.0 |
| BUS-0067 | 480 | 484.40 | 109.3223 | 17.8529> | 8.0 |
| BUS-0068 | 480 | 487.54 | 108.9801 | 17.7967> | 8.0 |
| BUS-0073 | 480 | 481.44 | 66.3365 | 9.2992> | 8.0 |
| BUS-0074 | 480 | 482.07 | 66.2947 | 9.2935> | 8.0 |
| BUS-0075 | 480 | 489.79 | 151.9341 | 21.2347> | 8.0 |
| BUS-0076 | 480 | 490.72 | 152.0636 | 21.2524> | 8.0 |
| BUS-0077 | 480 | 483.40 | 74.5602 | 14.0325> | 8.0 |
| BUS-0078 | 480 | 484.69 | 74.4706 | 14.0157> | 8.0 |
| BUS-0079 | 480 | 472.98 | 224.9749 | 8.6562> | 8.0 |
| BUS-0080 | 480 | 481.74 | 222.9911 | 8.5218> | 8.0 |
| BUS-0081 | 480 | 481.44 | 66.1993 | 9.2911> | 8.0 |
| BUS-0082 | 480 | 482.06 | 66.1577 | 9.2854> | 8.0 |
| BUS-0083 | 480 | 481.44 | 66.1993 | 9.2911> | 8.0 |
| BUS-0084 | 480 | 482.06 | 66.1577 | 9.2854> | 8.0 |
| BUS-0085 | 480 | 489.79 | 151.9633 | 21.2368> | 8.0 |
| BUS-0086 | 480 | 490.72 | 152.0928 | 21.2544> | 8.0 |
| BUS-0087 | 480 | 483.38 | 74.0643 | 14.0072> | 8.0 |
| BUS-0088 | 480 | 484.67 | 73.9754 | 13.9904> | 8.0 |
| BUS-0089 | 480 | 472.98 | 225.2010 | 8.6505> | 8.0 |
| BUS-0090 | 480 | 481.74 | 223.2152 | 8.5163> | 8.0 |
| BUS-0091 | 480 | 472.98 | 225.2010 | 8.6505> | 8.0 |
| BUS-0092 | 480 | 481.74 | 223.2152 | 8.5163> | 8.0 |

| TOTAL CURRENT DISTORTION | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Device Name | Bus Name<br>From/To | Voltage<br>From/To | I_RMS(A) | kWLo ss<br>Tot/Harm | kVARLoss<br>Tot/Harm | IT | HLF | KF | I_TDD(%)/<br>I_IHD(%) | LIMIT |
| CAP1-SBHE1 | BUS-0100 | 480 | 63.25 | 0.000 | -42.743 | 69312.35 | | | 53.47 | |
| | | 480 | | 0.000 | -1.730 | | | | 59.04 | |
| CAP2-SBHE1 | BUS-0101 | 480 | 63.25 | 0.000 | -42.743 | 69312.35 | | | 53.47 | |
| | | 480 | | 0.000 | -1.730 | | | | 59.04 | |
| CAP3-SBHE1 | BUS-0102 | 480 | 63.25 | 0.000 | -42.743 | 69312.35 | | | 53.47 | |
| | | 480 | | 0.000 | -1.730 | | | | 59.04 | |
| CAP4-SBHE1 | BUS-0103 | 480 | 63.25 | 0.000 | -42.743 | 69312.35 | | | 53.47 | |
| | | 480 | | 0.000 | -1.730 | | | | 59.04 | |
| CBL-0008 | MHE1 | 480 | 134.26 | 0.464 | 0.199 | 5641.26 | | | 4.78 | 15.0 |
| | BUS-0007 | 480 | | 0.002 | 0.004 | | | | 5.37 | |
| CBL-0009 | MHE1 | 480 | 0.00 | 0.000 | 0.000 | 0.00 | | | 0.00 | 20.0 |
| | BUS-0015 | 480 | | 0.000 | 0.000 | | | | 0.00 | |
| CBL-0010 | BUS-0062 | 480 | 245.78 | 4.409 | 0.330 | 16508.52 | | | 2.07 | 12.0 |
| | BUS-0061 | 480 | | 0.003 | 0.002 | | | | 2.54 | |
| CBL-0011 | MHE1 | 480 | 0.00 | 0.000 | 0.000 | 0.00 | | | 0.00 | 20.0 |
| | PHE1 | 480 | | 0.000 | 0.000 | | | | 0.00 | |
| CBL-0012 | MHE2 | 480 | 134.62 | 0.687 | 0.294 | 5609.63 | | | 4.75 | 15.0 |
| | BUS-0009 | 480 | | 0.002 | 0.005 | | | | 5.33 | |
| CBL-0013 | MHE2 | 480 | 0.00 | 0.000 | 0.000 | 0.00 | | | 0.00 | 20.0 |
| | BUS-0016 | 480 | | 0.000 | 0.000 | | | | 0.00 | |
| CBL-0014 | MHE2 | 480 | 134.01 | 0.245 | 0.105 | 5659.49 | | | 4.79 | 15.0 |
| | BUS-0010 | 480 | | 0.001 | 0.002 | | | | 5.40 | |
| CBL-0015 | MHE3 | 480 | 134.66 | 0.769 | 0.329 | 5627.78 | | | 4.72 | 15.0 |
| | BUS-0011 | 480 | | 0.002 | 0.006 | | | | 5.30 | |
| CBL-0016 | ATS1 | 480 | 0.00 | 0.000 | 0.000 | 0.00 | | | 0.00 | 20.0 |
| | PHC1 | 480 | | 0.000 | 0.000 | | | | 0.00 | |

| TOTAL CURRENT DISTORTION | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Device Name | Bus Name<br>From/To | Voltage<br>From/To | I_RMS(A) | kWLo ss<br>Tot/Harm | kVARLoss<br>Tot/Harm | IT | HLF | KF | I_TDD(%)/<br>I_IHD(%) | LIMIT |
| CBL-0017 | PHC1<br>PHC2 | 480<br>480 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0018 | PHC2<br>PHC3 | 480<br>480 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0019 | BUS-0023<br>PLC1 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0020 | PLC1<br>PLC2 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0021 | PHC1<br>BUS-0022 | 480<br>480 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0022 | PLC1<br>BUS-0027 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0023 | BUS-0028<br>PLCU | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0024 | PHA1<br>BUS-0024 | 480<br>480 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0025 | BUS-0025<br>PLA1 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0026 | PHA1<br>BUS-0026 | 480<br>480 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0027 | BUS-0036<br>PLAU | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0028 | ADMIN SEC<br>PHA1 | 480<br>480 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0030 | BUS-0064<br>BUS-0063 | 480<br>480 | 36.66 | 0.098<br>0.002 | 0.008<br>0.001 | 2154.69 | | | 11.72<br>14.61 | 15.0 |

| TOTAL CURRENT DISTORTION | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Device Name | Bus Name<br>From/To | Voltage<br>From/To | I_RMS(A) | kWLo ss<br>Tot/Harm | kVARLoss<br>Tot/Harm | IT | HLF | KF | I_TDD(%)/<br>I_IHD(%) | LIMIT |
| CBL-0031 | PHC3<br>DS-CU-1 | 480<br>480 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0032 | PHC3<br>DS-CU-2 | 480<br>480 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0033 | PLC1<br>DS-EF-1 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0034 | PLC1<br>DS-EF-2 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0035 | PLC1<br>DS-EF-3 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0036 | PLC1<br>DS-EF-4 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0037 | PLC1<br>DS-EF-5 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0038 | PLC1<br>DS-SS-1 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0039 | PLC1<br>DS-SS-2 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0040 | PLA1<br>DS-CU-3 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0041 | PLA1<br>DS-CU-4 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0042 | PLA1<br>DS-CU-5 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0043 | PLA1<br>DS-CU-6 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |

| TOTAL CURRENT DISTORTION | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Device Name | Bus Name<br>From/To | Voltage<br>From/To | I_RMS(A) | kWLo ss<br>Tot/Harm | kVARLoss<br>Tot/Harm | IT | HLF | KF | I_TDD(%)/<br>I_IHD(%) | LIMIT |
| CBL-0044 | PLA1<br>DS-EF-6 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0045 | PLA1<br>DS-EF-7 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0046 | PLA1<br>DS-EF-8 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0047 | PLA1<br>DS-SS-3 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0048 | PLA1<br>DS-SS-4 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0049 | PLA1<br>DS-SS-6 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0050 | BUS-0066<br>BUS-0065 | 480<br>480 | 12.13 | 0.016<br>0.000 | 0.001<br>0.000 | 563.84 | | | 7.47<br>9.33 | 20.0 |
| CBL-0051 | BUS-0068<br>BUS-0067 | 480<br>480 | 61.73 | 0.404<br>0.013 | 0.032<br>0.005 | 4678.05 | | | 14.87<br>18.47 | 15.0 |
| CBL-0052 | BUS-UTILITY<br>BUS-0060 | 12470<br>12470 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| CBL-0053 | BUS-0070<br>BUS-0069 | 480<br>480 | 3.63 | 0.002<br>0.000 | 0.000<br>0.000 | 167.65 | | | 5.64<br>7.05 | 20.0 |
| CBL-0054 | BUS-0072<br>BUS-0071 | 480<br>480 | 1.21 | 0.000<br>0.000 | 0.000<br>0.000 | 56.50 | | | 5.10<br>6.37 | 20.0 |
| CBL-0055 | BUS-0074<br>BUS-0073 | 480<br>480 | 12.13 | 0.016<br>0.000 | 0.001<br>0.000 | 563.84 | | | 7.47<br>9.33 | 20.0 |
| CBL-0056 | BUS-0076<br>BUS-0075 | 480<br>480 | 92.79 | 0.158<br>0.009 | 0.044<br>0.009 | 8883.39 | | | 17.62><br>21.99 | 15.0 |

| TOTAL CURRENT DISTORTION | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Device Name | Bus Name<br>From/To | Voltage<br>From/To | I_RMS(A) | kWLo ss<br>Tot/Harm | kVARLoss<br>Tot/Harm | IT | HLF | KF | I_TDD(%)/<br>I_IHD(%) | LIMIT |
| CBL-0057 | MHE1<br>BUS-0008 | 480<br>480 | 13.42 | 0.054<br>0.000 | 0.004<br>0.000 | 568.41 | | | 4.82<br>5.42 | 20.0 |
| CBL-0058 | MHE1<br>BUS-0012 | 480<br>480 | 134.14 | 0.352<br>0.001 | 0.193<br>0.004 | 5642.70 | | | 4.78<br>5.38 | 15.0 |
| CBL-0059 | BUS-0078<br>BUS-0077 | 480<br>480 | 36.66 | 0.098<br>0.002 | 0.008<br>0.001 | 2153.64 | | | 11.72<br>14.61 | 15.0 |
| CBL-0060 | BUS-0080<br>BUS-0079 | 480<br>480 | 245.78 | 4.409<br>0.003 | 0.330<br>0.002 | 16527.72 | | | 2.07<br>2.54 | 12.0 |
| CBL-0061 | BUS-0082<br>BUS-0081 | 480<br>480 | 12.13 | 0.016<br>0.000 | 0.001<br>0.000 | 563.17 | | | 7.46<br>9.32 | 20.0 |
| CBL-0062 | BUS-0084<br>BUS-0083 | 480<br>480 | 12.13 | 0.016<br>0.000 | 0.001<br>0.000 | 563.17 | | | 7.46<br>9.32 | 20.0 |
| CBL-0063 | BUS-0086<br>BUS-0085 | 480<br>480 | 92.79 | 0.158<br>0.009 | 0.044<br>0.009 | 8884.68 | | | 17.62><br>21.99 | 15.0 |
| CBL-0064 | MHE2<br>BUS-0013 | 480<br>480 | 13.43 | 0.054<br>0.000 | 0.004<br>0.000 | 567.73 | | | 4.81<br>5.40 | 20.0 |
| CBL-0065 | MHE2<br>BUS-0014 | 480<br>480 | 13.43 | 0.054<br>0.000 | 0.004<br>0.000 | 567.73 | | | 4.81<br>5.40 | 20.0 |
| CBL-0066 | BUS-0088<br>BUS-0087 | 480<br>480 | 36.66 | 0.098<br>0.002 | 0.008<br>0.001 | 2147.84 | | | 11.70<br>14.58 | 15.0 |
| CBL-0067 | BUS-0090<br>BUS-0089 | 480<br>480 | 245.78 | 4.409<br>0.003 | 0.330<br>0.002 | 16540.89 | | | 2.07<br>2.54 | 12.0 |
| CBL-0068 | BUS-0092<br>BUS-0091 | 480<br>480 | 245.78 | 4.409<br>0.003 | 0.330<br>0.002 | 16540.89 | | | 2.07<br>2.54 | 12.0 |
| CBL-0069 | MHE3<br>BUS-0017 | 480<br>480 | 26.76 | 0.030<br>0.000 | 0.013<br>0.000 | 1139.61 | | | 4.78<br>5.40 | 15.0 |

| TOTAL CURRENT DISTORTION | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Device Name | Bus Name<br>From/To | Voltage<br>From/To | I_RMS(A) | kWLo ss<br>Tot/Harm | kVARLoss<br>Tot/Harm | IT | HLF | KF | I_TDD(%)/<br>I_IHD(%) | LIMIT |
| CBL-CAP1-SBHE1 | PFC-SBHE1<br>BUS-0100 | 480<br>480 | 63.25 | 0.046<br>0.017 | 0.019<br>0.015 | 69312.35 | | | 53.47><br>59.04 | 15.0 |
| CBL-CAP2-SBHE1 | PFC-SBHE1<br>BUS-0101 | 480<br>480 | 63.25 | 0.046<br>0.017 | 0.019<br>0.015 | 69312.35 | | | 0.00<br>59.04 | 15.0 |
| CBL-CAP3-SBHE1 | PFC-SBHE1<br>BUS-0102 | 480<br>480 | 63.25 | 0.046<br>0.017 | 0.019<br>0.015 | 69312.35 | | | 0.00<br>59.04 | 15.0 |
| CBL-CAP4-SBHE1 | PFC-SBHE1<br>BUS-0103 | 480<br>480 | 63.25 | 0.046<br>0.017 | 0.019<br>0.015 | 69312.35 | | | 0.00<br>59.04 | 15.0 |
| CBL-MHE1 | SBHE1<br>MHE1 | 480<br>480 | 702.19 | 0.572<br>0.005 | 0.671<br>0.022 | 81401.62 | | | 5.95<br>6.55 | 8.0 |
| CBL-MHE2 | SBHE1<br>MHE2 | 480<br>480 | 654.50 | 0.661<br>0.003 | 0.769<br>0.015 | 64807.61 | | | 4.25<br>4.67 | 8.0 |
| CBL-MHE3 | SBHE1<br>MHE3 | 480<br>480 | 647.36 | 0.485<br>0.002 | 0.562<br>0.008 | 65957.66 | | | 3.31<br>3.70 | 8.0 |
| CBL-PFC-SBHE1 | SBHE1<br>PFC-SBHE1 | 480<br>480 | 253.01 | 0.186<br>0.134 | 0.237<br>0.181 | 277249.41 | | | 53.47><br>59.04 | 12.0 |
| CBL-SBH01 | UTIL-1 SEC<br>SBH01 | 480<br>480 | 1933.42 | 2.595<br>0.029 | 3.588<br>0.120 | 103482.48 | | | 7.10><br>7.24 | 5.0 |
| CBL-SBHE1 | SBH01<br>SBHE1 | 480<br>480 | 1933.42 | 2.595<br>0.029 | 3.588<br>0.120 | 103482.48 | | | 7.10><br>7.24 | 5.0 |
| CBL-UTILITY | BUS-0104<br>BUS-UTILITY | 12470<br>12470 | 74.40 | 0.053<br>0.000 | 0.010<br>0.000 | 3978.37 | | | 6.62><br>6.75 | 5.0 |
| SW-ATS1 | BUS-0015<br>ATS1 | 480<br>480 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| T-LA1 | BUS-0024<br>BUS-0025 | 480<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | 0.00 | 0.00 | 0.00<br>0.00 | 20.0 |

| TOTAL CURRENT DISTORTION | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Device Name | Bus Name<br>From/To | Voltage<br>From/To | I_RMS(A) | kWLo ss<br>Tot/Harm | kVARLoss<br>Tot/Harm | IT | HLF | KF | I_TDD(%)/<br>I_IHD(%) | LIMIT |
| T-PLC1 | BUS-0022<br>BUS-0023 | 480<br>208 | 0.00 | 0.005<br>0.005 | 0.028<br>0.028 | 0.00 | 0.00 | 0.00 | 0.00<br>0.00 | 20.0 |
| T-UPS-PLAU | BUS-0026<br>BUS-0029 | 480<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | 0.00 | 0.00 | 0.00<br>0.00 | 20.0 |
| TX-ADMIN | BUS-0060<br>ADMIN SEC | 12470<br>480 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | 0.00 | 0.00 | 0.00<br>0.00 | 20.0 |
| TX-UTIL-1 | BUS-UTILITY<br>UTIL-1 SEC | 12470<br>480 | 74.40 | 20.602<br>0.243 | 150.946<br>4.562 | 3978.37 | 1.19 | 3.08 | 6.62<br>6.75 | 20.0 |
| UPS-PLAU | BUS-0029<br>BUS-0036 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| UPS-PLCU | BUS-0027<br>BUS-0028 | 208<br>208 | 0.00 | 0.000<br>0.000 | 0.000<br>0.000 | 0.00 | | | 0.00<br>0.00 | 20.0 |
| UTIL-1 MAX | BUS-0104 | 12470<br>12470 | 74.40 | 0.224<br>0.224 | 2.458<br>2.458 | 3978.37 | | | 0.41<br>6.75 | |
| VFD-B-1-4 | MHE1<br>BUS-0062 | 480<br>480 | 230.97 | 3.364<br>0.000 | -78.495<br>0.000 | 29819.39 | | | 3.47<br>4.54 | 12.0 |
| VFD-B-2-4 | MHE2<br>BUS-0080 | 480<br>480 | 231.06 | 3.364<br>0.000 | -78.495<br>0.000 | 29814.45 | | | 3.47<br>4.53 | 12.0 |
| VFD-B-3-4 | MHE3<br>BUS-0090 | 480<br>480 | 230.93 | 3.364<br>0.000 | -78.495<br>0.000 | 29792.00 | | | 3.47<br>4.53 | 12.0 |
| VFD-B-4-4 | MHE3<br>BUS-0092 | 480<br>480 | 230.93 | 3.364<br>0.000 | -78.495<br>0.000 | 29792.00 | | | 3.47<br>4.53 | 12.0 |
| VFD-B-5-8 | MHE1<br>BUS-0076 | 480<br>480 | 86.71 | 1.231<br>0.000 | -29.732<br>0.000 | 23658.60 | | | 17.51><br>23.45 | 15.0 |
| VFD-B-6-8 | MHE2<br>BUS-0086 | 480<br>480 | 86.75 | 1.231<br>0.000 | -29.732<br>0.000 | 23666.70 | | | 17.52><br>23.46 | 15.0 |

## TOTAL CURRENT DISTORTION

| Device Name | Bus Name<br>From/To | Voltage<br>From/To | I_RMS(A) | kWLo ss<br>Tot/Harm | kVARLoss<br>Tot/Harm | IT | HLF | KF | I_TDD(%)/<br>I_IHD(%) | LIMIT |
|---|---|---|---|---|---|---|---|---|---|---|
| VFD-C-1-9 | MHE1<br>BUS-0070 | 480<br>480 | 3.63 | 0.049<br>0.000 | -1.189<br>0.000 | 1276.18 | | | 29.50><br>39.56 | 20.0 |
| VFD-CF-1-9 | MHE1<br>BUS-0068 | 480<br>480 | 58.75 | 0.827<br>0.000 | -19.751<br>0.000 | 17415.41 | | | 20.45><br>27.19 | 15.0 |
| VFD-P-12-8 | MHE1<br>BUS-0074 | 480<br>480 | 11.99 | 0.164<br>0.000 | -3.962<br>0.000 | 4111.68 | | | 27.58><br>36.96 | 20.0 |
| VFD-P-13-8 | MHE2<br>BUS-0084 | 480<br>480 | 12.00 | 0.164<br>0.000 | -3.962<br>0.000 | 4113.14 | | | 27.60><br>36.97 | 20.0 |
| VFD-P-14-9 | MHE1<br>BUS-0066 | 480<br>480 | 11.99 | 0.164<br>0.000 | -3.962<br>0.000 | 4111.68 | | | 27.58><br>36.96 | 20.0 |
| VFD-P-15-9 | MHE2<br>BUS-0082 | 480<br>480 | 12.00 | 0.164<br>0.000 | -3.962<br>0.000 | 4113.14 | | | 27.60><br>36.97 | 20.0 |
| VFD-P-2-3 | MHE1<br>BUS-0064 | 480<br>480 | 35.43 | 0.493<br>0.000 | -11.877<br>0.000 | 11278.79 | | | 23.36><br>31.24 | 15.0 |
| VFD-P-3-3 | MHE2<br>BUS-0078 | 480<br>480 | 35.45 | 0.493<br>0.000 | -11.877<br>0.000 | 11282.75 | | | 23.37><br>31.24 | 15.0 |
| VFD-P-4-3 | MHE3<br>BUS-0088 | 480<br>480 | 35.43 | 0.493<br>0.000 | -11.877<br>0.000 | 11291.45 | | | 23.38><br>31.27 | 15.0 |
| VFD-POLYMER SYSTEM | MHE1<br>BUS-0072 | 480<br>480 | 1.21 | 0.016<br>0.000 | -0.396<br>0.000 | 429.68 | | | 30.10><br>40.38 | 20.0 |

## TOTAL SYSTEM POWER LOSSES

| Harmonic Losses | | Total RMS Losses | |
|---|---|---|---|
| P(kW) | Q{kVAR) | P(kW) | Q(kVAR) |
| 8.30 | 20.36 | 76.03 | -432.04 |

| CURRENT DISTORTION SUMMARY | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Device Name | Bus Name<br>From/To | Voltage<br>From/To | I_RMS(A) | kWLo ss<br>Tot/Harm | kVARLoss<br>Tot/Harm | IT | HLF | KF | I_TDD(%)/<br>I_IHD(%) | LIMIT |
| CBL-0056 | BUS-0076<br>BUS-0075 | 480<br>480 | 92.79 | 0.158<br>0.009 | 0.044<br>0.009 | 8883.39 | | | 17.62><br>21.99 | 15.0 |
| CBL-0063 | BUS-0086<br>BUS-0085 | 480<br>480 | 92.79 | 0.158<br>0.009 | 0.044<br>0.009 | 8884.68 | | | 17.62><br>21.99 | 15.0 |
| CBL-CAP1-SBHE1 | PFC-SBHE1<br>BUS-0100 | 480<br>480 | 63.25 | 0.046<br>0.017 | 0.019<br>0.015 | 69312.35 | | | 53.47><br>59.04 | 15.0 |
| CBL-PFC-SBHE1 | SBHE1<br>PFC-SBHE1 | 480<br>480 | 253.01 | 0.186<br>0.134 | 0.237<br>0.181 | 277249.41 | | | 53.47><br>59.04 | 12.0 |
| CBL-SBH01 | UTIL-1 SEC<br>SBH01 | 480<br>480 | 1933.42 | 2.595<br>0.029 | 3.588<br>0.120 | 103482.48 | | | 7.10><br>7.24 | 5.0 |
| CBL-SBHE1 | SBH01<br>SBHE1 | 480<br>480 | 1933.42 | 2.595<br>0.029 | 3.588<br>0.120 | 103482.48 | | | 7.10><br>7.24 | 5.0 |
| CBL-UTILITY | BUS-0104<br>BUS-UTILITY | 12470<br>12470 | 74.40 | 0.053<br>0.000 | 0.010<br>0.000 | 3978.37 | | | 6.62><br>6.75 | 5.0 |
| VFD-B-5-8 | MHE1<br>BUS-0076 | 480<br>480 | 86.71 | 1.231<br>0.000 | -29.732<br>0.000 | 23658.60 | | | 17.51><br>23.45 | 15.0 |
| VFD-B-6-8 | MHE2<br>BUS-0086 | 480<br>480 | 86.75 | 1.231<br>0.000 | -29.732<br>0.000 | 23666.70 | | | 17.52><br>23.46 | 15.0 |
| VFD-C-1-9 | MHE1<br>BUS-0070 | 480<br>480 | 3.63 | 0.049<br>0.000 | -1.189<br>0.000 | 1276.18 | | | 29.50><br>39.56 | 20.0 |
| VFD-CF-1-9 | MHE1<br>BUS-0068 | 480<br>480 | 58.75 | 0.827<br>0.000 | -19.751<br>0.000 | 17415.41 | | | 20.45><br>27.19 | 15.0 |
| VFD-P-12-8 | MHE1<br>BUS-0074 | 480<br>480 | 11.99 | 0.164<br>0.000 | -3.962<br>0.000 | 4111.68 | | | 27.58><br>36.96 | 20.0 |
| VFD-P-13-8 | MHE2<br>BUS-0084 | 480<br>480 | 12.00 | 0.164<br>0.000 | -3.962<br>0.000 | 4113.14 | | | 27.60><br>36.97 | 20.0 |

## CURRENT DISTORTION SUMMARY

| Device Name | Bus Name<br>From/To | Voltage<br>From/To | I_RMS(A) | kWLo ss<br>Tot/Harm | kVARLoss<br>Tot/Harm | IT | HLF | KF | I_TDD(%)/<br>I_IHD(%) | LIMIT |
|---|---|---|---|---|---|---|---|---|---|---|
| VFD-P-14-9 | MHE1<br>BUS-0066 | 480<br>480 | 11.99 | 0.164<br>0.000 | -3.962<br>0.000 | 4111.68 | | | 27.58><br>36.96 | 20.0 |
| VFD-P-15-9 | MHE2<br>BUS-0082 | 480<br>480 | 12.00 | 0.164<br>0.000 | -3.962<br>0.000 | 4113.14 | | | 27.60><br>36.97 | 20.0 |
| VFD-P-2-3 | MHE1<br>BUS-0064 | 480<br>480 | 35.43 | 0.493<br>0.000 | -11.877<br>0.000 | 11278.79 | | | 23.36><br>31.24 | 15.0 |
| VFD-P-3-3 | MHE2<br>BUS-0078 | 480<br>480 | 35.45 | 0.493<br>0.000 | -11.877<br>0.000 | 11282.75 | | | 23.37><br>31.24 | 15.0 |
| VFD-P-4-3 | MHE3<br>BUS-0088 | 480<br>480 | 35.43 | 0.493<br>0.000 | -11.877<br>0.000 | 11291.45 | | | 23.38><br>31.27 | 15.0 |
| VFD-POLYMER SYSTEM | MHE1<br>BUS-0072 | 480<br>480 | 1.21 | 0.016<br>0.000 | -0.396<br>0.000 | 429.68 | | | 30.10><br>40.38 | 20.0 |

## TOTAL SYSTEM POWER LOSSES

| Harmonic Losses | | Total RMS Losses | |
|---|---|---|---|
| P(kW) | Q{kVAR) | P(kW) | Q(kVAR) |
| 8.30 | 20.36 | 76.03 | -432.04 |

HARMONIC VOLTAGE SPECTRUM REPORT

Bus: BUS-UTILITY (12470V)

| Harmonic Order | Harmonic Voltages | Phase Angle | Distortion Percent | Limit |
|---|---|---|---|---|
| 1 | 11863.974 | -2.16 | | |
| 3 | 0.000 | 0.00 | 0.000 | 3.000 |
| 5 | 149.096 | 132.24 | 1.257 | 3.000 |
| 7 | 217.790 | -129.47 | 1.836 | 3.000 |
| 11 | 117.099 | -71.60 | 0.987 | 3.000 |
| 13 | 44.401 | -58.96 | 0.374 | 3.000 |
| 15 | 0.000 | 0.00 | 0.000 | 3.000 |
| 17 | 26.194 | 153.23 | 0.221 | 3.000 |
| 19 | 14.720 | 85.93 | 0.124 | 3.000 |
| 35 | 0.875 | 56.60 | 0.007 | 3.000 |
| 37 | 1.417 | 29.20 | 0.012 | 3.000 |

Voltage: 12470.0 V_RMS: 11867.61 V_THD(%): 2.48
LIMIT (THD%): 5.0

HARMONIC VOLTAGE SPECTRUM REPORT

Bus: MHE1 (480V)

| Harmonic Order | Harmonic Voltages | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 433.896 | -37.47 | | | |
| 3 | 4.002 | -94.55 | 0.922 | | 5.000 |
| 5 | 16.226 | 164.07 | 3.740 | | 5.000 |
| 7 | 23.640 | -158.63 | 5.448 | > | 5.000 |
| 11 | 12.533 | -41.53 | 2.888 | | 5.000 |
| 13 | 4.701 | -89.10 | 1.083 | | 5.000 |
| 15 | 0.452 | 13.33 | 0.104 | | 5.000 |
| 17 | 2.718 | -177.58 | 0.626 | | 5.000 |
| 19 | 1.539 | 55.37 | 0.355 | | 5.000 |
| 35 | 0.084 | 94.19 | 0.019 | | 5.000 |
| 37 | 0.138 | 9.22 | 0.032 | | 5.000 |

Voltage: 480.0 V_RMS: 435.08 V_THD(%): 7.39
LIMIT (THD%): 8.0

HARMONIC VOLTAGE SPECTRUM REPORT

Bus: MHE2 (480V)

| Harmonic Order | Harmonic Voltages | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 433.732 | -37.48 | | | |
| 3 | 4.013 | -94.55 | 0.925 | | 5.000 |
| 5 | 16.193 | 164.11 | 3.733 | | 5.000 |
| 7 | 23.599 | -158.60 | 5.441 | > | 5.000 |
| 11 | 12.524 | -41.56 | 2.888 | | 5.000 |
| 13 | 4.702 | -89.11 | 1.084 | | 5.000 |
| 15 | 0.451 | 13.37 | 0.104 | | 5.000 |
| 17 | 2.714 | -177.42 | 0.626 | | 5.000 |
| 19 | 1.521 | 55.51 | 0.351 | | 5.000 |
| 35 | 0.081 | 97.68 | 0.019 | | 5.000 |
| 37 | 0.134 | 13.62 | 0.031 | | 5.000 |

Voltage: 480.0 V_RMS: 434.91 V_THD(%): 7.38
LIMIT (THD%): 8.0

HARMONIC VOLTAGE SPECTRUM REPORT

Bus: MHE3 (480V)

| Harmonic Order | Harmonic Voltages | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 433.963 | -37.47 | | | |
| 3 | 3.994 | -94.56 | 0.920 | | 5.000 |
| 5 | 16.093 | 164.17 | 3.708 | | 5.000 |
| 7 | 23.530 | -158.57 | 5.422 | > | 5.000 |
| 11 | 12.625 | -41.73 | 2.909 | | 5.000 |
| 13 | 4.778 | -89.42 | 1.101 | | 5.000 |
| 15 | 0.438 | 13.40 | 0.101 | | 5.000 |
| 17 | 2.769 | -176.59 | 0.638 | | 5.000 |
| 19 | 1.493 | 56.10 | 0.344 | | 5.000 |
| 35 | 0.077 | 106.41 | 0.018 | | 5.000 |
| 37 | 0.132 | 23.75 | 0.030 | | 5.000 |

Voltage: 480.0 V_RMS: 435.14 V_THD(%): 7.36
LIMIT (THD%): 8.0

HARMONIC VOLTAGE SPECTRUM REPORT

Bus: PFC-SBHE1 (480V)

| Harmonic Order | Harmonic Voltages | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 434.683 | -37.45 | | | |
| 3 | 3.894 | -94.32 | 0.896 | | 5.000 |
| 5 | 16.240 | 163.77 | 3.736 | | 5.000 |
| 7 | 23.971 | -159.37 | 5.515 | > | 5.000 |
| 11 | 13.231 | -43.69 | 3.044 | | 5.000 |
| 13 | 5.104 | -92.20 | 1.174 | | 5.000 |
| 15 | 0.435 | 13.41 | 0.100 | | 5.000 |
| 17 | 3.143 | 177.25 | 0.723 | | 5.000 |
| 19 | 1.813 | 48.28 | 0.417 | | 5.000 |
| 35 | 0.141 | 49.16 | 0.032 | | 5.000 |
| 37 | 0.230 | -45.23 | 0.053 | | 5.000 |

Voltage: 480.0 V_RMS: 435.91 V_THD(%): 7.52
LIMIT (THD%): 8.0

HARMONIC VOLTAGE SPECTRUM REPORT

Bus: SBH01 (480V)

| Harmonic Order | Harmonic Voltages | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 435.564 | -37.33 | | | |
| 3 | 3.672 | -93.93 | 0.843 | | 5.000 |
| 5 | 15.863 | 164.33 | 3.642 | | 5.000 |
| 7 | 23.225 | -158.48 | 5.332 | > | 5.000 |
| 11 | 12.505 | -41.72 | 2.871 | | 5.000 |
| 13 | 4.743 | -89.43 | 1.089 | | 5.000 |
| 15 | 0.410 | 13.49 | 0.094 | | 5.000 |
| 17 | 2.799 | -177.78 | 0.643 | | 5.000 |
| 19 | 1.573 | 54.71 | 0.361 | | 5.000 |
| 35 | 0.094 | 84.27 | 0.021 | | 5.000 |
| 37 | 0.152 | -3.23 | 0.035 | | 5.000 |

Voltage: 480.0 V_RMS: 436.70 V_THD(%): 7.24
LIMIT (THD%): 8.0

HARMONIC VOLTAGE SPECTRUM REPORT

Bus: SBHE1 (480V)

| Harmonic Order | Harmonic Voltages | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 434.535 | -37.43 | | | |
| 3 | 3.894 | -94.32 | 0.896 | | 5.000 |
| 5 | 16.102 | 164.15 | 3.705 | | 5.000 |
| 7 | 23.572 | -158.63 | 5.425 | > | 5.000 |
| 11 | 12.691 | -41.81 | 2.921 | | 5.000 |
| 13 | 4.813 | -89.53 | 1.108 | | 5.000 |
| 15 | 0.435 | 13.41 | 0.100 | | 5.000 |
| 17 | 2.841 | -177.87 | 0.654 | | 5.000 |
| 19 | 1.596 | 54.62 | 0.367 | | 5.000 |
| 35 | 0.095 | 84.19 | 0.022 | | 5.000 |
| 37 | 0.154 | -3.31 | 0.035 | | 5.000 |

Voltage: 480.0 V_RMS: 435.71 V_THD(%): 7.37
LIMIT (THD%): 8.0

## HARMONIC CURRENT SPECTRUM REPORT

Device Name: CBL-UTILITY
From: BUS-0104 (12470V)
To: BUS-UTILITY (12470V)
Point of Common Coupling (PCC): (Isc/Ilf = 18.000)

| Harmonic Order | Harmonic Amperes | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 74.228 | -23.73 | | | |
| 3 | 0.000 | -180.00 | 0.000 | | 4.000 |
| 5 | 3.346 | -131.12 | 4.508 | > | 4.000 |
| 7 | 3.503 | -34.71 | 4.719 | > | 4.000 |
| 11 | 1.201 | 21.43 | 1.618 | | 2.000 |
| 13 | 0.385 | 33.61 | 0.519 | | 2.000 |
| 15 | 0.000 | -180.00 | 0.000 | | 2.000 |
| 17 | 0.174 | -114.81 | 0.234 | | 1.500 |
| 19 | 0.087 | 177.69 | 0.118 | | 1.500 |
| 35 | 0.003 | 147.55 | 0.004 | | 0.300 |
| 37 | 0.004 | 120.10 | 0.006 | | 0.300 |

Voltage: 12470.0 I_RMS: 74.40 I_TDD(%): 6.62 >
I_THD(%): 6.75
kWLoss: 0.053 kVARLoss: 0.010
I_K: LIMIT (TDD%): 5.0

## HARMONIC CURRENT SPECTRUM REPORT

Device Name: CBL-SBHE1
From: SBH01 (480V)
To: SBHE1 (480V)
Point of Common Coupling (PCC): (Isc/Ilf = 8.510)

| Harmonic Order | Harmonic Amperes | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 1928.376 | -53.73 | | | |
| 3 | 50.519 | 0.17 | 2.620 | | 4.000 |
| 5 | 86.928 | -101.12 | 4.508 | > | 4.000 |
| 7 | 90.998 | -64.71 | 4.719 | > | 4.000 |
| 11 | 31.199 | 51.43 | 1.618 | | 2.000 |
| 13 | 10.014 | 3.61 | 0.519 | | 2.000 |
| 15 | 1.130 | 106.86 | 0.059 | | 2.000 |
| 17 | 4.519 | -84.81 | 0.234 | | 1.500 |
| 19 | 2.273 | 147.69 | 0.118 | | 1.500 |
| 35 | 0.073 | 177.55 | 0.004 | | 0.300 |
| 37 | 0.112 | 90.10 | 0.006 | | 0.300 |

Voltage: 480.0 I_RMS: 1933.42 I_TDD(%): 7.10 >
I_THD(%): 7.24
kWLoss: 2.595 kVARLoss: 3.588
I_K: LIMIT (TDD%): 5.0

## HARMONIC CURRENT SPECTRUM REPORT

Device Name: CBL-MHE1
From: SBHE1 (480V)
To: MHE1 (480V)
Point of Common Coupling (PCC): (Isc/Ilf = 23.149)

| Harmonic Order | Harmonic Amperes | Phase Angle | Distortion Percent | Limit |
|---|---|---|---|---|
| 1 | 700.693 | -60.47 | | |
| 3 | 18.374 | 0.55 | 2.622 | 7.000 |
| 5 | 31.432 | -98.36 | 4.486 | 7.000 |
| 7 | 12.124 | -53.77 | 1.730 | 7.000 |
| 11 | 19.694 | -140.18 | 2.811 | 3.500 |
| 13 | 11.695 | 173.13 | 1.669 | 3.500 |
| 15 | 0.606 | 106.91 | 0.086 | 3.500 |
| 17 | 9.344 | 95.58 | 1.334 | 2.500 |
| 19 | 4.126 | -44.85 | 0.589 | 2.500 |
| 35 | 0.700 | -46.81 | 0.100 | 0.500 |
| 37 | 1.236 | -141.88 | 0.176 | 0.500 |

Voltage: 480.0 I_RMS: 702.19 I_TDD(%): 5.95
I_THD(%): 6.55
kWLoss: 0.572 kVARLoss: 0.671
I_K: LIMIT (TDD%): 8.0

HARMONIC CURRENT SPECTRUM REPORT

Device Name: CBL-MHE2
From: SBHE1 (480V)
To: MHE2 (480V)
Point of Common Coupling (PCC): (Isc/Ilf = 24.810)

| Harmonic Order | Harmonic Amperes | Phase Angle | Distortion Percent | Limit |
|---|---|---|---|---|
| 1 | 653.783 | -61.59 | | |
| 3 | 15.119 | 0.35 | 2.313 | 7.000 |
| 5 | 17.386 | -96.91 | 2.659 | 7.000 |
| 7 | 3.978 | -32.32 | 0.608 | 7.000 |
| 11 | 15.386 | -139.12 | 2.353 | 3.500 |
| 13 | 8.675 | 173.63 | 1.327 | 3.500 |
| 15 | 0.422 | 106.79 | 0.065 | 3.500 |
| 17 | 7.386 | 90.10 | 1.130 | 2.500 |
| 19 | 4.076 | -45.10 | 0.623 | 2.500 |
| 35 | 0.698 | -47.17 | 0.107 | 0.500 |
| 37 | 1.233 | -142.26 | 0.189 | 0.500 |

Voltage: 480.0 I_RMS: 654.50 I_TDD(%): 4.25
I_THD(%): 4.67
kWLoss: 0.661 kVARLoss: 0.769
I_K: LIMIT (TDD%): 8.0

## HARMONIC CURRENT SPECTRUM REPORT

Device Name: CBL-MHE3
From: SBHE1 (480V)
To: MHE3 (480V)
Point of Common Coupling (PCC): (Isc/Ilf = 25.073)

| Harmonic Order | Harmonic Amperes | Phase Angle | Distortion Percent | Limit |
|---|---|---|---|---|
| 1 | 646.917 | -57.06 | | |
| 3 | 17.027 | -0.41 | 2.632 | 7.000 |
| 5 | 2.645 | 55.75 | 0.409 | 7.000 |
| 7 | 9.020 | 95.35 | 1.394 | 7.000 |
| 11 | 7.953 | -135.01 | 1.229 | 3.500 |
| 13 | 3.598 | 176.56 | 0.556 | 3.500 |
| 15 | 0.101 | 106.89 | 0.016 | 3.500 |
| 17 | 7.260 | 61.45 | 1.122 | 2.500 |
| 19 | 7.543 | -45.86 | 1.166 | 2.500 |
| 35 | 1.384 | -47.53 | 0.214 | 0.500 |
| 37 | 2.449 | -142.60 | 0.379 | 0.500 |

Voltage: 480.0 I_RMS: 647.36 I_TDD(%): 3.31
I_THD(%): 3.70
kWLoss: 0.485 kVARLoss: 0.562
I_K: LIMIT (TDD%): 8.0

HARMONIC CURRENT SPECTRUM REPORT

Device Name: CBL-PFC-SBHE1
From: SBHE1 (480V)
To: PFC-SBHE1 (480V)
Point of Common Coupling (PCC): (Isc/Ilf = 74.448)

| Harmonic Order | Harmonic Amperes | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 217.875 | 52.51 | | | |
| 3 | 0.000 | -139.32 | 0.000 | | 10.000 |
| 5 | 40.806 | -106.50 | 18.729 | > | 10.000 |
| 7 | 84.548 | -69.80 | 38.806 | > | 10.000 |
| 11 | 73.918 | 45.47 | 33.927 | > | 4.500 |
| 13 | 33.875 | -3.29 | 15.548 | > | 4.500 |
| 15 | 0.000 | -31.59 | 0.000 | | 4.500 |
| 17 | 27.646 | -94.44 | 12.689 | > | 4.000 |
| 19 | 17.964 | 136.24 | 8.245 | > | 4.000 |
| 35 | 2.835 | 133.79 | 1.301 | > | 0.700 |
| 37 | 4.988 | 38.69 | 2.289 | > | 0.700 |

Voltage: 480.0 I_RMS: 253.01 I_TDD(%): 53.47 >
I_THD(%): 59.04
kWLoss: 0.186 kVARLoss: 0.237
I_K: LIMIT (TDD%): 12.0

## HARMONIC CURRENT SPECTRUM REPORT

Device Name: CBL-SBH01
From: UTIL-1 SEC (480V)
To: SBH01 (480V)
Point of Common Coupling (PCC): (Isc/Ilf = 8.611)

| Harmonic Order | Harmonic Amperes | Phase Angle | Distortion Percent | | Limit |
|---|---|---|---|---|---|
| 1 | 1928.376 | -53.73 | | | |
| 3 | 50.519 | 0.17 | 2.620 | | 4.000 |
| 5 | 86.928 | -101.12 | 4.508 | > | 4.000 |
| 7 | 90.998 | -64.71 | 4.719 | > | 4.000 |
| 11 | 31.199 | 51.43 | 1.618 | | 2.000 |
| 13 | 10.014 | 3.61 | 0.519 | | 2.000 |
| 15 | 1.130 | 106.86 | 0.059 | | 2.000 |
| 17 | 4.519 | -84.81 | 0.234 | | 1.500 |
| 19 | 2.273 | 147.69 | 0.118 | | 1.500 |
| 35 | 0.073 | 177.55 | 0.004 | | 0.300 |
| 37 | 0.112 | 90.10 | 0.006 | | 0.300 |

Voltage: 480.0 I_RMS: 1933.42 I_TDD(%): 7.10 >
I_THD(%): 7.24
kWLoss: 2.595 kVARLoss: 3.588
I_K: LIMIT (TDD%): 5.0

## F I L T E R S P E C T R U M R E P O R T

Filter Name: CAP1-SBHE1 (Capacitor)
Bus Name: BUS-0100 (480V)

| Harmonic Order | IR (Amp) | IL (Amp) | IC (Amp) | R (kW) | L (kVAR) | C (kVAR) | R (V) | L (V) | C (V) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | | 54.46869 | | | 41.01357 | | | 434.73044 |
| 3 | | | | | | | | | |
| 5 | | | 10.20146 | | | 0.28773 | | | 16.28417 |
| 7 | | | 21.13696 | | | 0.88231 | | | 24.10003 |
| 11 | | | 18.47938 | | | 0.42916 | | | 13.40812 |
| 13 | | | 8.46871 | | | 0.07626 | | | 5.19932 |
| 15 | | | | | | | | | |
| 17 | | | 6.91154 | | | 0.03884 | | | 3.24488 |
| 19 | | | 4.49108 | | | 0.01468 | | | 1.88656 |
| 35 | | | 0.70878 | | | 0.00020 | | | 0.16163 |
| 37 | | | 1.24691 | | | 0.00058 | | | 0.26897 |

Capacitor Rated Voltage: 480.00 Rated 3 Phase KVA: 50.00

V_RMS: 435.956 V_CREST: 499.284 I_RMS: 63.253 KVA: 42.743

V_RMS: 90.8241% V_CREST: 104.0175% I_RMS: 105.1743% KVA: 85.4867%

Limit: 110.0% Limit: 169.7% Limit: 135.0% Limit: 135.0%

## F I L T E R  S P E C T R U M  R E P O R T

Filter Name: CAP2-SBHE1 (Capacitor)
Bus Name: BUS-0101 (480V)

| Harmonic Order | IR (Amp) | IL (Amp) | IC (Amp) | R (kW) | L (kVAR) | C (kVAR) | R (V) | L (V) | C (V) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | | 54.46869 | | | 41.01357 | | | 434.73044 |
| 3 | | | | | | | | | |
| 5 | | | 10.20146 | | | 0.28773 | | | 16.28417 |
| 7 | | | 21.13696 | | | 0.88231 | | | 24.10003 |
| 11 | | | 18.47938 | | | 0.42916 | | | 13.40812 |
| 13 | | | 8.46871 | | | 0.07626 | | | 5.19932 |
| 15 | | | | | | | | | |
| 17 | | | 6.91154 | | | 0.03884 | | | 3.24488 |
| 19 | | | 4.49108 | | | 0.01468 | | | 1.88656 |
| 35 | | | 0.70878 | | | 0.00020 | | | 0.16163 |
| 37 | | | 1.24691 | | | 0.00058 | | | 0.26897 |

Capacitor Rated Voltage: 480.00 Rated 3 Phase KVA: 50.00
V_RMS: 435.956 V_CREST: 499.284 I_RMS: 63.253 KVA: 42.743
V_RMS: 90.8241% V_CREST: 104.0175% I_RMS: 105.1743% KVA: 85.4867%
Limit: 110.0% Limit: 169.7% Limit: 135.0% Limit: 135.0%

## F I L T E R S P E C T R U M R E P O R T

Filter Name: CAP3-SBHE1 (Capacitor)
Bus Name: BUS-0102 (480V)

| Harmonic Order | IR (Amp) | IL (Amp) | IC (Amp) | R (kW) | L (kVAR) | C (kVAR) | R (V) | L (V) | C (V) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | | 54.46869 | | | 41.01357 | | | 434.73044 |
| 3 | | | | | | | | | |
| 5 | | | 10.20146 | | | 0.28773 | | | 16.28417 |
| 7 | | | 21.13696 | | | 0.88231 | | | 24.10003 |
| 11 | | | 18.47938 | | | 0.42916 | | | 13.40812 |
| 13 | | | 8.46871 | | | 0.07626 | | | 5.19932 |
| 15 | | | | | | | | | |
| 17 | | | 6.91154 | | | 0.03884 | | | 3.24488 |
| 19 | | | 4.49108 | | | 0.01468 | | | 1.88656 |
| 35 | | | 0.70878 | | | 0.00020 | | | 0.16163 |
| 37 | | | 1.24691 | | | 0.00058 | | | 0.26897 |

Capacitor Rated Voltage: 480.00 Rated 3 Phase KVA: 50.00
V_RMS: 435.956 V_CREST: 499.284 I_RMS: 63.253 KVA: 42.743
V_RMS: 90.8241% V_CREST: 104.0175% I_RMS: 105.1743% KVA: 85.4867%
Limit: 110.0% Limit: 169.7% Limit: 135.0% Limit: 135.0%

## F I L T E R S P E C T R U M R E P O R T

Filter Name: CAP4-SBHE1 (Capacitor)
Bus Name: BUS-0103 (480V)

| Harmonic Order | IR (Amp) | IL (Amp) | IC (Amp) | R (kW) | L (kVAR) | C (kVAR) | R (V) | L (V) | C (V) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | | 54.46869 | | | 41.01357 | | | 434.73044 |
| 3 | | | | | | | | | |
| 5 | | | 10.20146 | | | 0.28773 | | | 16.28417 |
| 7 | | | 21.13696 | | | 0.88231 | | | 24.10003 |
| 11 | | | 18.47938 | | | 0.42916 | | | 13.40812 |
| 13 | | | 8.46871 | | | 0.07626 | | | 5.19932 |
| 15 | | | | | | | | | |
| 17 | | | 6.91154 | | | 0.03884 | | | 3.24488 |
| 19 | | | 4.49108 | | | 0.01468 | | | 1.88656 |
| 35 | | | 0.70878 | | | 0.00020 | | | 0.16163 |
| 37 | | | 1.24691 | | | 0.00058 | | | 0.26897 |

Capacitor Rated Voltage: 480.00 Rated 3 Phase KVA: 50.00
V_RMS: 435.956 V_CREST: 499.284 I_RMS: 63.253 KVA: 42.743
V_RMS: 90.8241% V_CREST: 104.0175% I_RMS: 105.1743% KVA: 85.4867%
Limit: 110.0% Limit: 169.7% Limit: 135.0% Limit: 135.0%

## 3.0 IEEE-519-2022 DISTORTION LIMITS

The Harmonic Distortion Requirements are based on IEEE Std. 519-2022 “IEEE Recommended Practices and Requirements for Harmonic Control in Electric Power Systems.” This section contains excerpts from IEEE Std. 519-2022.

Voltage and Current Distortion

IEEE Std. 519-2022 defines the maximum distortion limits recommended for industrial, commercial, institutional, and utility electrical distribution systems.

Voltage Distortion Limits

The voltage distortion gives a clear representation of the impact of harmonics on the electrical distribution system. The harmonic voltage distortion from an individual customer is evaluated at the point-of-common-coupling (PCC) where the utility can supply other customers.

Harmonic voltage distortion is defined as:

$$\%THD_V = \frac{\sqrt{V_2^{\,2} + V_3^{\,2} + V_4^{\,2} + \ldots}}{V_1} \times 100\%$$

*Where $V_n$ is the magnitude (rms Volts) of the $n^{th}$ harmonic*

Table 1 IEEE Std. 519-2022 Harmonic Voltage Distortion Limits

| Bus voltage V at PCC | Individual harmonic percentage | Total harmonic distortion THD (%) |
|---|---|---|
| V≤ 1kV | 5.0 | 8.0 |
| 1kV<V≤69kV | 3.0 | 5.0 |
| 69kV<V≤161kV | 1.5 | 2.5 |
| 161kV<V | 1.0 | 1.5* |

*High voltage systems can have up to 2% THD where the cause is an HVDC terminal whose effects will have attenuated at points in the network where future users may be connected.

Current Distortion Limits

The harmonic currents from an individual customer are evaluated at the point-of-common-coupling (PCC) where the utility can supply other customers. The limits depend upon the customer's load with respect to available fault current at the PCC.

Harmonic current distortion is defined as:

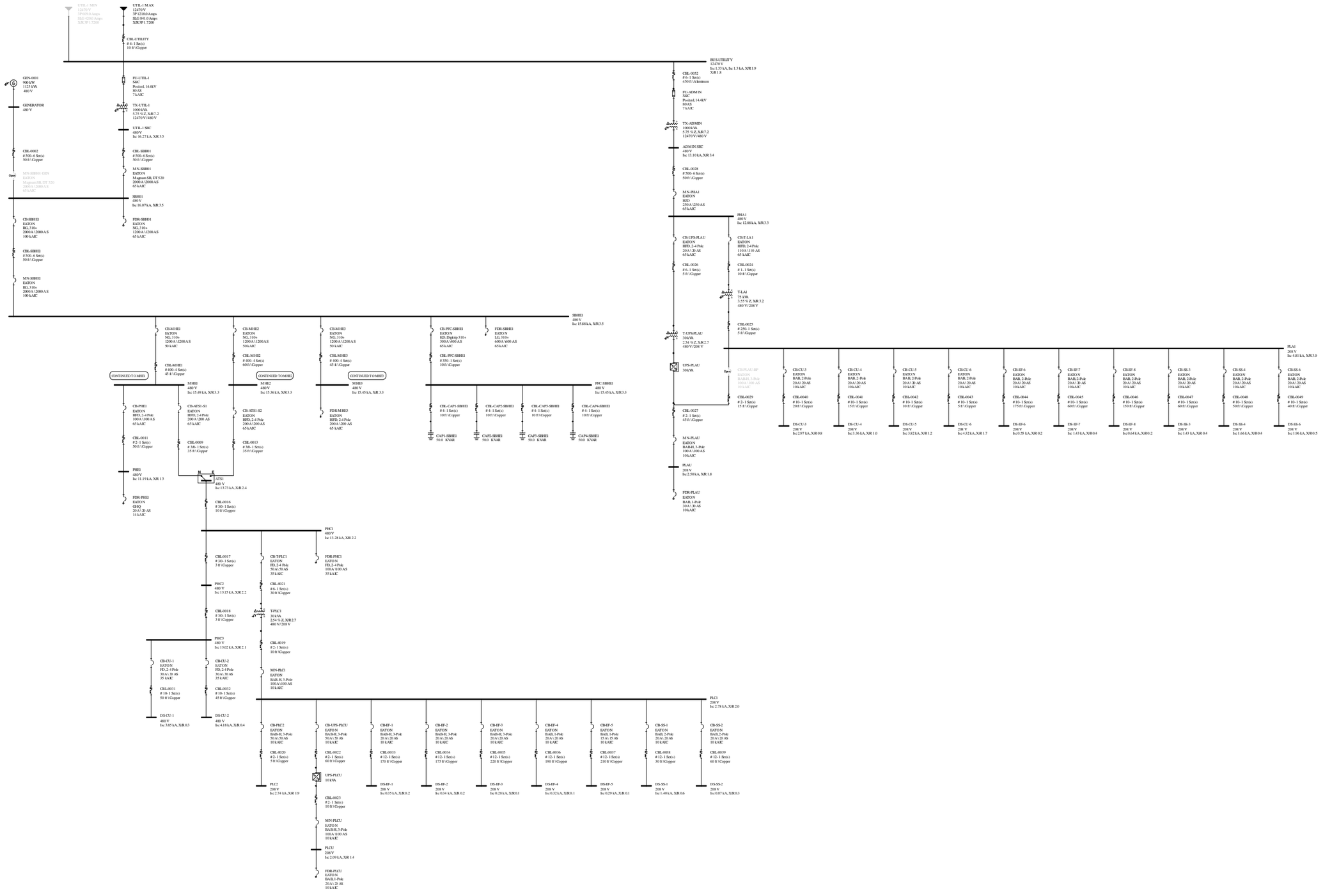
$$\%THD_I = \frac{\sqrt{I_2^{\,2} + I_3^{\,2} + I_4^{\,2} + \ldots}}{I_1} \times 100\%$$

*Where $I_n$ is the magnitude (rms Amps) of the $n^{th}$ harmonic*

Table 2- IEEE Std. 519-2022 Harmonic Current Distortion Limits

| MAXIMUM HARMONIC CURRENT DISTORTION IN PERCENT OF FUNDAMENTAL | | | | | | |
|---|---|---|---|---|---|---|
| $I_{SC}/I_L$ | HARMONIC ORDER (ODD HARMONICS)* | | | | | % TDD |
| | <11 | 11≤*h*<17 | 17≤*h*<23 | 23≤*h*<35 | 35≤*h* | |
| < 20 * | 4.0 | 2.0 | 1.5 | 0.6 | 0.3 | 5.0 |
| 20-50 | 7.0 | 3.5 | 2.5 | 1.0 | 0.5 | 8.0 |
| 50-100 | 10.0 | 4.5 | 4.0 | 1.5 | 0.7 | 12.0 |
| 100-1000 | 12.0 | 5.5 | 5.0 | 2.0 | 1.0 | 15.0 |
| > 1000 | 15.0 | 7.0 | 6.0 | 2.5 | 1.4 | 20.0 |
| | For h</=6, Even harmonics are limited to 50% of the odd harmonic limits above. | | | | | |
| * | All power generation facilities are limited to these values of current distortion, regardless of actual $I_{SC}$ / $I_L$ unless covered by other standards with applicable scope. | | | | | |
| | Where $I_{SC}$ = Maximum Short Circuit at PCC.<br>And $I_L$ = Maximum demand Load Current (Fundamental Frequency) at PCC under normal load operating conditions | | | | | |
| | For PCC's from 69kV to 138kV, the limits are 50 percent of the limits above. A case-by-case evaluation is required for PCC's of 161kV and above. | | | | | |

## 4.0 ONE LINE SHOWING INPUT DATA




_Mainoneline
2/15/2023

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| | | SCALE: NONE | HARMONIC STUDY | _Mainoneline | |
| CAD FILENAME | PRODUCT CODE U0130 | REVISION 0 / DATE 2/15/2023 | G.O.# MTL0010020 | DWG TQSITL0010020 | SHEET 1 OF 4 |

CONTINUED FROM SBHE1

MHE1
480 V
15.5 kA, X/R 3.3

HMCP-P-2-3
EATON/CUTLER-HAMMER
HMCP
100 A \ 100 AS \

VFD-P-2-3
30 hp

CBL-0030
# 8- 1 Set(s)
30 ft \ Copper
50.0 A

MTR-P-2-3
30 hp
480 V / 36.2 A
NumMotors 1

HFD-P-5-4
EATON
HMCP
150 A \ 150 AS \

CBL-0008
# 2/0- 1 Set(s)
85 ft \ Copper
175.0A

MTR-P-5-4
100 hp
480 V / 120.6 A
NumMotors 1

HMCP-B-1-4
EATON/CUTLER-HAMMER
HMCP
400 A \ 400 AS \

VFD-B-1-4
200 hp

CBL-0010
# 8- 1 Set(s)
30 ft \ Copper
50.0 A

MTR-B-1-4
200 hp
480 V / 241.2 A
NumMotors 1

HMCP-P-14-9
EATON/CUTLER-HAMMER
HMCP
30 A \ 30 AS \

VFD-P-14-9
10 hp

CBL-0050
# 10- 1 Set(s)
30 ft \ Copper
30.0 A

MTR-P-14-9
10 hp
480 V / 12.1 A
NumMotors 1

HMCP-CF-1-9
EATON/CUTLER-HAMMER
HMCP
100 A \ 100 AS \

VFD-CF-1-9
50 hp

CBL-0051
# 10- 1 Set(s)
30 ft \ Copper
30.0 A

MTR-CF-1-9
50 hp
480 V / 60.3 A
NumMotors 1

HMCP-C-1-9
EATON/CUTLER-HAMMER
HMCP
15 A \ 15 AS \

VFD-C-1-9
3 hp

CBL-0053
# 12- 1 Set(s)
30 ft \ Copper
20.0 A

MTR-C-1-9
3 hp
480 V / 3.6A
NumMotors 1

HMCP-POLYMER SYSTEM
EATON/CUTLER-HAMMER
HMCP
3 A \ 3 AS \

VFD-POLYMER SYSTEM
1 hp

CBL-0054
# 12- 1 Set(s)
30 ft \ Copper
20.0 A

MTR-POLYMER SYSTEM
1 hp
480 V / 1.2A
NumMotors 1

HMCP-P-12-8
EATON/CUTLER-HAMMER
HMCP
30 A \ 30 AS \

VFD-P-12-8
10 hp

CBL-0055
# 10- 1 Set(s)
30 ft \ Copper
30.0 A

MTR-P-12-8
10 hp
480 V / 12.1 A
NumMotors 1

HFD-P-10-6
EATON
HFD, 2-4 Pole
20 A \ 20 AS \

CBL-0057
# 10- 1 Set(s)
85 ft \ Copper
30.0 A

MTR-P-10-6
10 hp
480 V / 12.1 A
NumMotors 1

HMCP-B-5-8
EATON/CUTLER-HAMMER
HMCP
150 A \ 150 AS \

VFD-B-5-8
75 hp

CBL-0056
# 2- 1 Set(s)
30 ft \ Copper
115.0A

MTR-B-5-8
75 hp
480 V / 90.5 A
NumMotors 1

CB-ATS1-S1
EATON
HFD, 2-4 Pole
200 A \ 200 AS \

CBL-0009
# 3/0- 1 Set(s)
35 ft \ Copper
200.0A

N E
ATS1
480 V
13.7 kA, X/R 2.4

CONTINUED TO PHC1

HFD-P-8-8
EATON
HFD, 2-4 Pole
200 A \ 200 AS \

CBL-0058
# 3/0- 1 Set(s)
85 ft \ Copper
200.0A

MTR-P-8-8
100 hp
480 V / 120.6 A
NumMotors 1

CB-PHE1
EATON
HFD, 2-4 Pole
100 A \ 100 AS \

CBL-0011
# 2- 1 Set(s)
50 ft \ Copper
115.0A

PHE1
480 V
11.2 kA, X/R 1.3

FDR-PHE1
EATON
GHQ
20 A \ 20 AS \

_MHE1
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| | | SCALE: NONE | HARMONIC STUDY | _MHE1 | |
| CAD FILENAME | PRODUCT CODE U0130 | REVISION 0 / DATE 2/15/2023 | G.O.# MTL0010020 | DWG TQSITL0010020 | SHEET 2 OF 4 |

CONTINUED FROM SBHE1

MHE2
480 V
15.4 kA, X/R 3.3

HMCP-P-3-3
EATON/CUTLER-HAMMER
HMCP
100 A \ 100 AS \

VFD-P-3-3
30 hp

CBL-0059
# 8- 1 Set(s)
30 ft \ Copper
50.0 A

MTR-P-3-3
30 hp
480 V / 36.2 A
NumMotors 1

HMCP-P-6-4
EATON
HMCP
150 A \ 150 AS \

CBL-0012
# 2/0- 1 Set(s)
125 ft \ Copper
175.0 A

MTR-P-6-4
100 hp
480 V / 120.6 A
NumMotors 1

HMCP-B-2-4
EATON/CUTLER-HAMMER
HMCP
400 A \ 400 AS \

VFD-B-2-4
200 hp

CBL-0060
# 8- 1 Set(s)
30 ft \ Copper
50.0 A

MTR-B-2-4
200 hp
480 V / 241.2 A
NumMotors 1

HMCP-P-15-9
EATON/CUTLER-HAMMER
HMCP
30 A \ 30 AS \

VFD-P-15-9
10 hp

CBL-0061
# 10- 1 Set(s)
30 ft \ Copper
30.0 A

MTR-P-15-9
10 hp
480 V / 12.1 A
NumMotors 1

HMCP-P-13-8
EATON/CUTLER-HAMMER
HMCP
30 A \ 30 AS \

VFD-P-13-8
10 hp

CBL-0062
# 10- 1 Set(s)
30 ft \ Copper
30.0 A

MTR-P-13-8
10 hp
480 V / 12.1 A
NumMotors 1

HMCP-P-9-8
EATON
HMCP
150 A \ 150 AS \

CBL-0014
# 2/0- 1 Set(s)
45 ft \ Copper
175.0 A

MTR-P-9-8
100 hp
480 V / 120.6 A
NumMotors 1

HMCP-B-6-8
EATON/CUTLER-HAMMER
HMCP
150 A \ 150 AS \

VFD-B-6-8
75 hp

CBL-0063
# 2- 1 Set(s)
30 ft \ Copper
115.0 A

MTR-B-6-8
75 hp
480 V / 90.5 A
NumMotors 1

HFD-MAU-1
EATON
HFD, 2-4 Pole
20 A \ 20 AS \

CBL-0064
# 10- 1 Set(s)
85 ft \ Copper
30.0 A

MTR-MAU-1
10 hp
480 V / 12.1 A
NumMotors 1

HFD-P-11-6
EATON
HFD, 2-4 Pole
20 A \ 20 AS \

CBL-0065
# 10- 1 Set(s)
85 ft \ Copper
30.0 A

MTR-P-11-6
10 hp
480 V / 12.1 A
NumMotors 1



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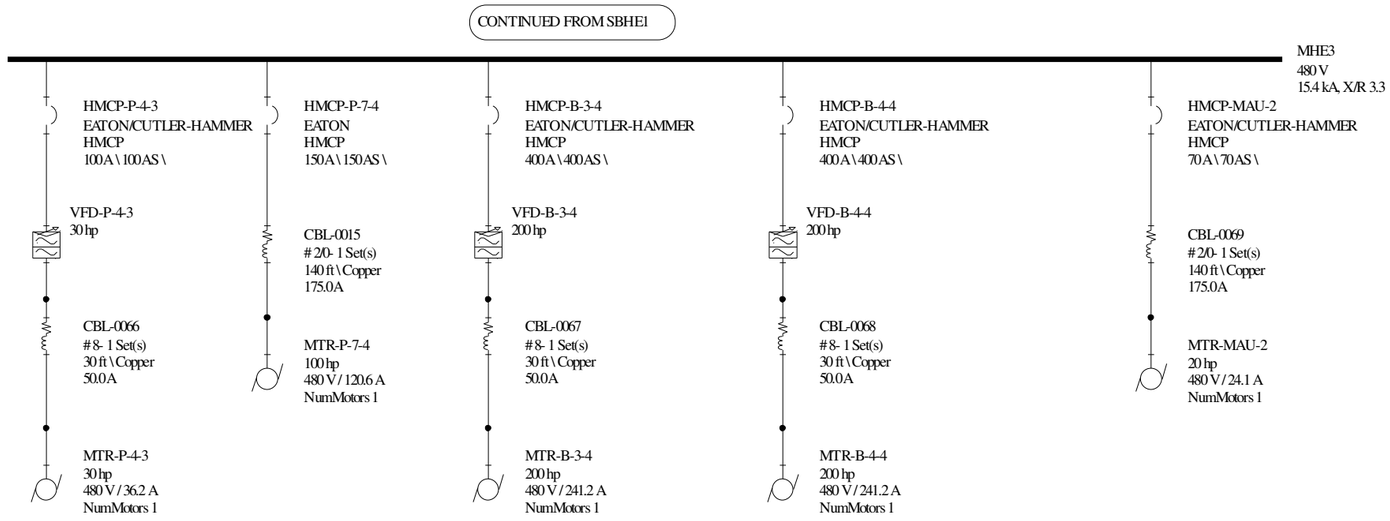


_MHE3
2/15/2023

| | | | | | | |
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| | | SCALE: NONE | HARMONIC STUDY | | _MHE3 | |
| CAD FILENAME | PRODUCT CODE U0130 | REVISION 0 | DATE 2/15/2023 | G.O.# MTL0010020 | DWG TQSITL0010020 | SHEET 4 OF 4 |