U.S. Department of Energy
[redacted]
P.O. Box 450, MSIN H6-60
Richland, Washington 99352

JUN 2 6 2007

07-WTP-170

Mr. C. M. Albert, Project Manager
Bechtel National, Inc.
2435 Stevens Center Place
Richland, Washington 99354

Dear Mr. Albert:

CONTRACT NO. DE-AC27-01RV14136 – TRANSMITTAL OF THE U.S. DEPARTMENT OF ENERGY, OFFICE OF RIVER PROTECTION (ORP) DESIGN OVERSIGHT REPORT, NUMBER D-07-DESIGN-044: REVIEW OF BECHTEL NATIONAL, INC.'S (BNI) LOW-ACTIVITY WASTE (LAW) FACILITY ELECTRICAL DISTRIBUTION DESIGN

This letter transmits the subject design oversight report. The report provides the conclusions reached in the assessment of the LAW Facility Electrical Distribution design, conducted by ORP staff in the April/May 2007 time period. The overall conclusion is that the design, satisfies the applicable requirements in the Basis of Design, the Operations Requirements Document, and the Safety Requirements Document. In addition, the design implements the required industry standards.

There were no findings identified in this assessment. However, there were nine follow-up items. These are listed in Attachment B of the attached report and have been discussed with members of the BNI electrical engineering staff.

If you have any questions, please contact me, or your staff may contact Robert W. Griffith, Acting Director, WTP Project Engineering Division, (509) 372-2821.

Sincerely,

John R. Eschenberg, Project Manager
Waste Treatment and Immobilization Plant Project

WTP:MLR

Attachment

cc w/attach:
BNI Correspondence

U.S. Department of Energy, Office of River Protection

DESIGN OVERSIGHT REPORT
REVIEW BECHTEL NATIONAL, INC. (BNI)
LAW FACILITY ELECTRICAL DISTRIBUTION SYSTEM
ELECTRICAL DESIGN

MAY 2007

DESIGN OVERSIGHT: D-07-DESIGN-044

Team Lead:

Mark L. Ramsay, SSO Engineer
Waste Treatment and Immobilization Plant Project (WTP)
Engineering Division

EXECUTIVE SUMMARY

In the April/May 2007 time period, an assessment was performed on the Electrical Distribution System for the Low Activity Waste (LAW) Facility. The LAW Facility is one of the main processing plants within the Waste Treatment and Immobilization Plant. Specific areas evaluated included the following:

- 13.8kV electrical distribution system and equipment including medium voltage switchgear, the 125V DC system, transformers, and the melter power supply systems
- Selected 480V distribution systems and equipment including switchboards, motor control centers, standby power loads, and uninterruptible power supply (UPS) systems
- Important-to-safety electrical equipment which only includes the safety significant UPS system
- Interface between the LAW electrical distribution equipment and the Integrated Control Network (controller and remote input/output enclosure planning)

Through document reviews, contractor personnel interviews, presentations, and observations of installed equipment*, the following conclusions concerning the LAW Facility Electrical Distribution System design were reached:

- Design media reflects an electrical design that meets upper-level contract requirements extending from sources such as the *Basis of Design*, the *Operations Requirements Document*, and the *Safety Requirements Document.*
- The electrical design is driven by, and implements, industry standards such as Institute of Electrical and Electronics Engineers, Inc. standards, National Electrical Manufacturers' Association standards, and the National Electric Code.
- Electrical calculations are comprehensive and well documented and provide a sound basis for equipment and cable specifications even though changes to some of the calculations are in progress and updates to documentation will necessarily follow.
- Reliability has been adequately planned into the electrical design in terms of redundant and independent power trains and equipment, back-up power, and provisions for uninterrupted power to sensitive electrical loads.
- Equipment specifications appear to be thorough and are clear in conveying detailed requirements for vendors involved in the equipment procurements.
- Procedures dealing with such areas as quality assurance and design configuration management appear to have been followed.

No Findings were cited in this assessment, but nine Assessment Follow-up Items were identified. These are listed in Attachment B and discussed in the body of the report.

* Electrical equipment has not yet been installed in the LAW Facility, but similar equipment complying with the same specifications has been installed in other facilities.

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LIST OF TERMS

AFI	Assessment Follow-up Item
AIC	amps interrupt capacity
ASD	adjustable speed drives
AWG	American wire gauge
BOD	*Basis of Design*
BOF	Balance of Facilities
C&I	control and instrumentation
DCE	125V DC System
GA	general arrangement
HEPA	high-efficiency particulate air
HVAC	heating, ventilation and air conditioning
I/O	input/output
ICEA	Insulated Cable Engineers Association
ICN	Integrated Control Network
IEEE	Institute of Electrical and Electronics Engineers, Inc.
IGBT	Insulated Gate Bipolar Transistor
ISM	Integrated Safety Management
ITS	important-to-safety
LAW	Low-Activity Waste
LAW-EDS	LAW Electrical Distribution System
LVE	Low Voltage Electrical
MCC	motor control center
MEPS	melter electrode power supply
MVE	Medium Voltage Electrical
NEC	National Electrical Code
NEMA	National Electrical Manufacturer Association
ORD	*Operations Requirements Document*
ORP	Office of River Protection
PEBB	Power Electronic Building Block
PSAR	*Preliminary Safety Assessment Report*
SC	safety class
SC	Seismic Criteria
SDG	standby diesel generator
SLD	single-line diagram
SPS	static power supply
SRD	*Safety Requirements Document*
SS	safety significant
UL	Underwriters Laboratory
UPS	Uninterruptible Power Supply
WTP	Waste Treatment and Immobilization Plant Project

1.0 INTRODUCTION AND BACKGROUND

1.1 Introduction

The Low-Activity Waste (LAW) Facility is one of three waste treatment facilities within the Waste Treatment and Immobilization Plant (WTP). The LAW Facility treats the low radioactivity feed streams that will be provided directly by the underground double-shell storage tank system within the Hanford Site 200 East Area or by the Pretreatment Facility within the WTP. The LAW Facility combines the received waste feed with glass former chemicals and then processes the mix in joule-heated melters. The molten glass from the melters is then poured into stainless steel containers and allowed to cool and solidify. The containers will be stored at a designated location on the Hanford Site.

In order to safely perform the waste treat functions described above, the LAW Facility must be provided with reliable electrical power for melters, offgas systems, ventilation, and a host of process and support equipment.

1.2 Background

Electrical conduit and cable trays are now being installed in the LAW Facility. This equipment is the first of the facility electrical items to be installed and indicates that the electrical design for the LAW Facility has progressed to a detailed level. Since an evaluation of the LAW electrical design had not been performed by the U.S. Department of Energy, Office of River Protection (ORP) up to this time, it was appropriate, prior to the installation of major electrical equipment, that a formal assessment be conducted. This assessment provides ORP with a documented evaluation as to the adequacy of the Contractor's (Bechtel National, Inc. [BNI]) design product deliverable in meeting requirements stemming from contract documents such as the *Basis of Design* (BOD), the *Safety Requirements Document* (SRD), the *Operations Requirements Document* (ORD), the *Preliminary Safety Assessment Report* (PSAR), and others.

2.0 OBJECTIVES, SCOPE AND APPROACH

2.1 Objectives

The purpose of this review was to verify that selected elements in the LAW Facility electrical distribution design are consistent with functional and design requirements specified in contract documents and implementing codes and standards; and to confirm that the Contractor's design documentation and configuration management process for the LAW Facility electrical distribution design is consistent with procedures and meets requirements.

General Lines of Inquiry:

- Is the LAW Electrical Distribution System (LAW-EDS) design consistent with the BOD?
- Does the LAW-EDS meet the applicable requirements in the SRD and the ORD?
- Does the LAW-EDS implement applicable industry codes and standards?
- Is the design media adequate for equipment procurement and installation?
- Does the design media (drawings, specifications, etc.) reflect a consistent flow of information that adequately conveys the configuration of the plant irrespective of detail?

2.2 Scope

The scope of this review was limited to the requirements, processes, procedures, and design documentation associated with the following systems and equipment:

- 13.8kV Medium Voltage Electrical (MVE) distribution system and equipment for the LAW Facility (MVE switchgear, 125V DC system, transformers, and melter power supply systems)
- Selected 480V distribution systems (Low Voltage Electrical [LVE]) and equipment for LAW (switchboards, Motor Control Centers [MCC]), standby power loads, and Uninterruptible Power Supply (UPS) systems
- Important-to-safety (ITS) electrical equipment (safety significant UPS system)
- Interface between the LAW electrical distribution equipment and the Integrated Control Network (ICN) (controller and remote input/output [I/O] enclosure planning)

2.3 Approach

- Identify and understand the technical requirements imposed on, and selected by, the Contractor for performing the LAW Facility electrical distribution design.
- Identify and understand the applicable processes, procedures, guides, etc., used by the Contractor for performing the LAW Facility electrical distribution design.
- Evaluate design documentation (drawings, load lists, specifications, system descriptions, calculations, etc.) to confirm that technical requirements are being implemented.

3.0 SYSTEM OVERVIEW AND DESIGN STATUS

3.1 System Overview

A basic block diagram of the LAW-EDS is shown in Figure 1 (Section 6.0) and is based on the electrical single-line diagrams (SLD) listed in Section 5.1.

As depicted in Figure 1, the LAW Facility is provided with 13.8kV, 3-phase power from four feeders originating from 13.8kV MVE switchgear located in the Non-ITS Switchgear Building (Bldg. 87). Two of the MVE feeders provide A and B trains of normal power to the LAW Switchgear Building (Bldg. 24) located immediately north of the LAW Facility. The LAW MVE switchgear provides power to the melter electrode power supplies and to step-down power transformers for the 480V LVE system. The other two feeders from Bldg. 87 provide normal and standby power directly to step-down transformers for normal and standby LVE system loads. The MVE switchgear is provided with 125V DC power for protective relay instrumentation and actuation of the main 13.8kV vacuum circuit breakers.

The MVE system provides distribution to the LVE distribution equipment for system utilization at 480V, 3-phase. Transformers feed LVE switchboards that distribute power to MCCs and to main system loads such as ventilation system fans and melter system heaters. The MCCs provide power to most of the plant electrical loads comprised of motors, actuators, mechanical handling equipment, instrumentation, heating, ventilation, and air conditioning (HVAC), lighting, etc. Some of the MCCs are also associated with UPS equipment.

Based on the two melter loads, large motor and heater loads, and connected loads for MCCs, the total connected electrical load for the LAW Facility is about 17.5MVA. However, based on demand factors, the actual metered utilization will be somewhat less. The LAW Facility electrical demand accounts for about 28% of the available power to the WTP.

3.2 LAW-EDS Design Status

The LAW electrical design is more than 90% complete. The remaining design work includes control and instrumentation (C&I) raceway design and associated cable routing for elevations at 28 feet, 48 feet, and 68 feet; oversight of the ongoing electrical design of the LAW Annex Building and the LAW Switchgear Building (both under subcontract); raceway design of the LAW Switchgear Building (Bldg. 24); and relay setting calculations and terminations for power and C&I cable.

All equipment procurements have been awarded. The status of major equipment is indicated below:

- 13.8kV Switchgear units (2) have been delivered.
- Melter Electrode Power supplies (designed but not yet built).
- 13.8kV/480V Transformers (4) have been delivered.
- Main 480V Switchboards (4) have been delivered.
- Motor control centers (MCC):
  - (2) MCCs have been delivered.
  - (6) MCCs are forecasted for delivery in June 2007
  - (4) MCCs are forecasted for delivery in September 2007.
- 125V DC Chargers have been delivered.
- Non-ITS UPS systems (2) (each system includes UPS and bypass transformer) are scheduled for delivery in August 2007. Battery units for these systems are scheduled for delivery in July 2009.
- ITS UPS systems (3) are scheduled for delivery in March 2008. Battery units for these systems are scheduled for delivery in October 2010.
- Melter Startup Heater power supplies are forecasted for delivery in January 2008.
- Discharge Heater power supplies are forecasted for delivery in February 2009.

There are no significant design issues or trends in process that would have a substantial impact on the current LAW electrical design.

Substantial LAW electrical construction and equipment installation is not scheduled to commence until the first quarter of fiscal year (FY) 2008 according to the baseline (Level 4) schedule.

Separate trains of power also facilitate maintenance and power availability. Standby power is provided to the LAW Facility by the standby diesel generator (SDG), which starts automatically upon the loss of normal site power. Power from the SDG is distributed to the LAW Facility through the 13.8kV switchgear building (Bldg. 87). The aforementioned complies with requirements 2a, 2b, 12b, 12d, and 15 in Attachment A.

The 13.8kV distribution system does not include any safety class (SC) or safety significant (SS) equipment.

The 13.8kV system is adequately depicted on the referenced SLDs and equipment enclosures are clearly identified on GA drawings listed in Section 5.6. Specific locations are as follows:

- Switchgear assemblies, MVE-SWGR-20603 and MVE-SWGR-20603, are located in Bldg. 24 at 0'- 0" elevation to the north of LAW main facility.
- The 13.8 kV to 480 V transformers, MVE-XFMR-20605 and MVE-XFMR-20606, are located at the south perimeter of 3'-0" elevation, and MVE-XFMR-20603 and MVE-XFMR-20604 are located at the west perimeter of 3'-0" elevation.
- Melter power supplies, MVE-PSUP-20001 and MVE-PSUP-20002, are located on -21'-0" elevation at the north center of the LAW Facility.

The 13.8kV distribution equipment is adequately separated to prevent common mode failure.

4.2.2 MVE Switchgear

The switchgear is metal clad and rated for 13.8kV, 3-phase, 60Hz. Additional bus ratings are for 1,200 amps (A) current, and 28kA for short circuit current, amps interrupt capacity. Based on the 13.8 kV equipment in the main 13.8 kV switchgear building (Bldg. 87) which feeds the LAW MVE equipment, this short circuit rating is adequate for withstanding available fault current from the system. The switchgear is designed for indoor use, employing vacuum-break, stored energy, draw-out type circuit breakers for both incoming and outgoing distribution breakers. The aforementioned complies with requirements 26, 27, and 51a in Attachment A.

According to the switchgear specification (5.8[8]) and the SLDs, the incoming switchgear breakers (one for each train), employ solid state microprocessor based multifunction units for overcurrent and undervoltage protection. In addition, these units provide meter outputs such as kilowatts, watthours, power factor, etc. Solid state microprocessor-based multifunction units are also used with the distribution breakers for overcurrent protection. These programmable units also provide for remote indication of breaker position and trip status. Identical units are used in the MVE switchgear installed in buildings 87 and 91. The aforementioned complies with requirements 28a, 28b, 51b, 52, and 57 in Attachment A.

The switchgear specification (5.8[8]) used for LAW is also applicable to all the WTP 13.8kV switchgear. The specification provides a detailed and thorough listing of requirements.
In addition, it implements the following key industry standards listed in the BOD:

- IEEE C57.13, *Requirements for Instrument Transformers*
- IEEE C37.06, *AC High Voltage Circuit Breakers Rated on Symmetrical Current Basis, Preferred Ratings and Related Required Capabilities*
- IEEE C37.20.2, *Metal-Clad Switchgear*

3.3 Upper Level Requirements

High-level electrical design requirements for the LAW Facility are defined in the following WTP Contract required documents:

- 24590-WTP-DB-ENG-01-001, *Basis of Design* (BOD)
- 24590-WTP-RPT-OP-01-001, *Operations Requirements Document* (ORD)
- 24590-WTP-SRD-ESH-01-001-02, *Safety Requirements Document Volume II* (SRD)

Section 8 of the BOD describes the basis for the WTP electrical design. Section 16 of the ORD describes electrical requirements for the WTP that are mainly associated with operational requirements. Section 4.4 of the SRD describes electrical requirements for the WTP relative to safety systems. The requirements from these source documents applicable to this evaluation are compiled in table form and presented in Attachment A. Each requirement was assigned a number for easy reference within this report. Although the listed requirements are high-level, more specific requirements extend from the industry codes and standards referenced within the listed documents.

The LAW-EDS design was evaluated mainly against the upper level requirements contained in the documents listed above, as well as to a few selected industry standards, which are referenced in the documents. Compliance to selected requirements listed in Attachment A are noted throughout this report.

4.0 RESULTS

4.1 General Observations

Referenced SLDs, load lists, MCC schedules, and panel schedules for the LAW-EDS reflect electrical loads that are consistent with the types of equipment and processes that will be necessary for plant operations. Based on interviews, meeting minutes, and the Integrated Safety Management (ISM) process, the loads have been determined by collaboration among the various engineering disciplines within the contractor's design groups. The electrical loads are clearly divided into load groups A and B for plant electrical availability and maintenance purposes. The aforementioned complies with requirements 11a, 11b, 12a, 23, and 50 in Attachment A.

Based on referenced plant-wide equipment specifications, general arrangement (GA) drawings, and field observation of similar distribution equipment installed in switchgear building 87 and the BOF Switchgear Building (Bldg. 91), the design for the LAW-EDS accommodates replacement, removal, calibration, maintenance, troubleshooting, repairs, periodic functional testing, and inspections of the electrical equipment items such as power sources, relays, and switches while the plant is in normal operation. This is made possible through redundant trains of power and lockable isolation devices such as load disconnects and circuit breakers.
The aforementioned complies with requirements 1, 43, 44, and 45 in Attachment A.

Based on review of the referenced SLDs, equipment procurement specifications, and observation of installed electrical equipment in switchgear buildings 87 and 91, each piece of major electrical equipment for the LAW Facility has been appropriately specified for the area in which it will be installed. The equipment will be enclosed in suitable National Electrical Manufacturer Association (NEMA) class enclosures and labeled with unique alpha-numeric identification in accordance with referenced guides (5.13[1]) and procedures (5.12[1]). The aforementioned complies with requirements 21, 22, 46, and 48 in Attachment A.

Exception: Instrument tag numbers are the same (#2306) for programmable trip units in compartments B4 and C5 of LVE-SWBD-20101 as shown on SLD, 24590-LAW-E1-LVE-00003 (5.1[4]). This is a minor discrepancy and will be tracked as an Assessment Follow-up Item (AFI) as stated below.

AFI: D-07-DESIGN-044-1: At the next drawing update, correct the duplicate instrument tag numbers (#2306) for the programmable trip units in compartments B4 and C5 of LVE-SWBD-20101 as shown on single-line drawing, 24590-LAW-E1-LVE-00003 (5.1[4]).

In all the specifications for electrical equipment, acceptance of the equipment is based on provisions in the National Electrical Code (NEC) regarding certification by a nationally recognized testing laboratory such as Underwriters Laboratory (UL). Acceptance inspection of the equipment is assured if a UL label or other nationally recognized testing laboratory label is affixed to the equipment.

Regarding Cable Sizing: Connected load values between the MCC schedules and various load and sizing calculations are not currently consistent. Consequently, cable sizing is not consistent and sizes shown on the SLDs are different from those shown in the calculations. Also, in some instances, branch circuit protection (breaker trip settings) for the cables as shown on the SLDs are not in compliance with rated cable ampacities listed in the NEC, Table 310.16. When this issue was brought to the attention of the design engineers, it was explained to this evaluator that some of the calculations were being superseded by other calculations, and that the new calculations were complete but not yet formally issued. Moreover, when the new calculations are finally issued, the SLDs will be updated to reflect new cable sizes that will also be consistent with the NEC Table 310.16 with respect to branch circuit protection. Consequently, the evaluation of this aspect of the design cannot be adequately performed until the new calculations are issued and the SLDs are appropriately updated. Issuance of the feeder sizing calculations and update of the SLDs will be tracked as an AFI as stated below.

AFI: D-07-DESIGN-044-2: Ensure that when the new electrical calculations for cable sizing are issued, that MCC schedules, electrical SLDs, specifications, etc. are updated and revised to be consist with the calculations and with NEC Table 310.16 (as applicable).

Programs were demonstrated as effective for circuit breaker coordination and for cable tray, conduit, and cable routing (SETROUTE).

4.2 13.8kV (MVE) Electrical Distribution System and Equipment

This section covers MVE switchgear, the 125V DC system, transformers, and melter electrode power supply systems.

4.2.1 13.8kV System

The LAW electrical distribution (13.8kV) system is comprised of two sets of 13.8kV switchgear for A and B trains of power, four 13.8kV-to-480V transformers, and two melter electrode power supplies as shown in Figure 1 (Section 6.0). In addition, 13.8kV power is provided directly to two of the transformers for additional A and B trains of normal power and standby power to backup selected non-ITS LAW loads, thus minimizing potential for common mode failure.

- IEEE C37.90, *Relays and Relay Systems Associated With Electric Power Apparatus*

A brief review of these standards shows them to be exhaustive in their coverage of detailed requirements for switchgear equipment and components; particularly Institute of Electrical and Electronics Engineers, Inc.(IEEE) C37.20.2, which covers such items as ratings for voltage, current, power frequency, insulation and temperature, and testing and equipment construction. The 13.8kV switchgear as observed in Bldg. 87 is covered under the same equipment specification as the LAW MVE equipment and from observation appears to have met the requirements discussed above. Thus, the Bldg. 87 switchgear represents what may be expected in the LAW switchgear procurement.

The MVE switchgear meets upper-level requirements and is driven by accepted industry standards. A consistent and detailed design is communicated via the SLDs and specifications.

4.2.3 125V DC System

The SLD for the 125V DC System (5.2[1]) and the associated panel schedule (5.2[2]) presents a design that employs nominal 125V DC control power to the 13.8kV switchgear units (MVE-SWGR-20603 and MVE-SWGR-20604). This type of power is required for breaker operation and protective relay controls. The aforementioned complies with requirements 9b, 36a, and 36b in Attachment A.

The 125V DC System (DCE) is non-ITS and includes a battery bank (DCE-BATT-20601) rated for 100 amp-hours (50 Ah for each set of switchgear based on the DCE battery calculation) and composed of (60) valve-regulated lead acid cells. The DCE also includes redundant battery chargers (DCE-CHGR-20601 and DCE-CHGR-20602) and a distribution panelboard (DCE-PNL-20601) that provides service to the MVE switchgear. The aforementioned complies with requirement 9a in Attachment A.

The DCE SLD shows a battery charger that includes a transformer, rectifier and filter that provides continuous service to the panelboard bus in parallel to the battery bank, which is also connected to the distribution bus. Thus, the battery bank floats while normal power to the DC loads is provided by the chargers and a float charge is provided by the chargers to the battery bank. The aforementioned complies with requirements 9c, 10a, and 36c in Attachment A.

Normal power to the battery chargers is 480V, 3-phase from distribution panel, LVE-PNL-20602, which is fed from MCC-20104. When normal power is lost, the charger is not provided with standby power. Hence, the battery is sized to operate for three hours under conservative load assumptions, according to the calculation referenced in Section 5.10(5). The battery is also rated for a 20-year service life and is sized to include spare capacity for future load growth of 15%. The 20-year service life is achieved by maintaining battery room temperatures to 72° to 77°F and conducting annual performance battery testing to IEEE standards. In addition, the battery charger is rated to carry all the DC loads including charging the battery. The aforementioned complies with requirements 9d, 10b, and 36c in Attachment A.

The battery sizing calculation (5.10[5]) employs IEEE 485-1997, *Recommended Practice for Sizing Large Lead Storage Batteries for Generating Stations and Substations*, for calculation of the number of positive plates for amp-hour rating. Also used is IEEE 946-1992, *Design of Safety-Related DC Auxiliary Power Systems for Nuclear Power Generating Stations*, for sizing the battery chargers. These standards are listed as implementing standards in the SRD under

Safety Criterion 4.4-4. Thus, even though the DCE is designated as non-ITS, more stringent safety standards have been applied in the calculations.

Sections 2.8 and 7.5 of the calculation describe the process methodology to ensure battery system capacity and the end-of-discharge voltage is selected in accordance with the load profile and the allowable voltage drop. The aforementioned complies with requirement 36d in Attachment A.

Overall, the 125V DC system (DCE) meets upper-level requirements and is driven by accepted industry standards. A consistent and detailed design is communicated via the SLDs, specification, and calculations. The design is consistent with other 125V DC systems in the WTP.

Exception: Inputs to the calculation need to be updated to reflect current 13.8kV design configuration. MVE-SWGR-20601 and MVE-SWGR-20602 no longer exist, yet these units are figured into the calculation and the fact that they are no longer part of the design may impact sizing (possible reduction) of the battery and the chargers. This will be tracked as an AFI as stated below.

AFI: D-07-DESIGN-044-3: Calculation, 24590-LAW-E1C-DCE-00001 (5.10[5]) needs to be updated to be consistent with current LAW electrical design.

4.2.4 Transformers

According to the transformer specification (5.8[9]), the LAW main distribution transformers are 13.8kV to 480V, 3-phase, 60Hz, liquid filled and are designed for outdoor installation. The liquid is an insulating type approved by Factory Mutual as a "less flammable" dielectric coolant and certified as polychlorinated biphenyl (PCB) free. The transformers will include berms similar to the 13.8kV to 4.16kV outdoor transformers located at the BOF Switchgear Building (Bldg. 91). The aforementioned complies with requirements 24a, 24b, and 25a in Attachment A.

The specification and transformer calculations require the units to be delta connected on the primary side and wye connected on the secondary side with the neutral being solidly connected to ground. The SLDs indicate this configuration. The aforementioned complies with requirements 25b and 25d in Attachment A.

The transformer specification incorporates key industry standards that are also listed in the BOD. The standards cover requirements for the primary side load interrupter switch, the transformer itself, the low voltage switchgear, secondary power circuit breaker, and shop testing.

Transformer instruments for temperature, pressure, and liquid level monitoring are shown on the SLDs.

Each transformer is sized for 3,000kVA and this size is adequately supported in the transformer sizing calculation (5.10[4]). The methodology in the calculation is clear and logical and incorporates industry guidance provided in IEEE 141, *Recommended Practice for Electrical Power Distribution for Industrial Plants*. Load requirements for the transformers are based on the MCC connected loads. The load values, diversity, and demand factors are part of the sizing calculation. For normal transformer operations, calculated load margins allow at least 25% spare capacity.

The transformer design meets upper-level requirements and is driven by accepted industry standards. A consistent and detailed design is communicated via the SLDs, specification, and calculations.

4.2.5 Melter Power Supply Systems

As shown on the SLDs, (5.1[1] and 5.1[3]), and as depicted in Figure 1 (Section 6.0), two trains of 13.8kV power (A and B trains) are provided to each of the two melter electrode power supply (MEPS) systems from the LAW MVE switchgear. The aforementioned complies with requirement 17a in Attachment A.

The MEPS system converts 13.8 kV three-phase power to low voltage (460 V nominal), single-phase power in order to provide the high electrode currents required for the joule-heated melters.

As depicted on the SLD (5.1[3]), each MEPS system is composed of two units, each comprised of transformers, a power electronic control unit, and power converter, required for supplying at least half the required electrode power. Full power is provided by both units working together to provide 1430kW to the melter electrodes. Thus, if one unit fails, the other unit is adequate to maintain the melter in an idle mode until full power can be restored. The aforementioned complies with requirement 17b in Attachment A.

BNI has contracted with ABB, Inc. to provide the MEPS system design. As shown on ABB drawings (Section 5.14), in addition to the two power units within each MEPS, there is provision for a third power unit in case three units of power are required in the future. The aforementioned complies with requirement 17c in Attachment A.

In the course of ABB's work, they have submitted to BNI a final report (5.14[8]) on the melter power system design. The report provides a very detailed and thorough explanation of the melter power system design, and asserts that the following design considerations and objectives were incorporated into the design:

- Melter will operate continuously 24 hours, 7 days a week, and will be replaced every 5 years
- 45-year life on power supplies
- Standard production assemblies with easily replaceable modular components wherever possible
- Minimal or no maintenance required
- No prototype designs for major components
- Minimization of space requirements for each power supply to fit in the spaces allocated by the Contractor (BNI)
- Ambient air-cooled bus design (no forced cooling)
- Modification required to the melter assembly shall be kept at a minimum and approved by BNI

In addition, the design work performed by ABB also required the MEPS system design to be in accordance with applicable portions of key industry standards. A few of the standards were specifically referenced in the report. One in particular, IEEE 519, *IEEE Recommended Practices* *and Requirements for Harmonic Control in Electrical Power Systems*, presents the harmonics requirements for electronic power conversion equipment. According to ABB's report, the harmonic distortion requirements in the standard were greatly exceeded in the MEPS design. The aforementioned complies with requirement 18 in Attachment A.

The current design is based on Power Electronic Building Block (PEBB) technology originally developed in cooperation with the U.S. Office of Naval Research. The PEBB unit is a water-cooled Insulated Gate Bipolar Transistor (IGBT)-based technology. (IGBTs are power electronic switching devices.) ABB recommended the use of water-cooled transformers to complement the power electronics and accommodate limited space requirements. To control the power electronics, the system employs the AC800PEC electronic controller. This unit, manufactured by ABB, will also interface with AC 800M controllers used with the ICN. These equipment components are modular, non-prototypical, and have been tried and tested.

According to BNI, the MEPS system design contract was awarded separately from the build contract. As of April 2007, the design contract was complete and the build contract was still being negotiated. The design is as depicted in the referenced design drawings (Section 5.14) and uses the AC800PEC control power module. However, ABB will no longer use this power controller in favor of a new model, the AC800LC. The new model is liquid-cooled and is smaller compared to the previous drive unit. This change will result in the design drawings being updated in the near future to show the new control module. ABB indicated to BNI that the change, in terms of overall functionality, would not impact the current PEBB system design or the interface with the process control system via the ICN. This change and verification that test requirements are in the build contract specifications will be an AFI as stated below.

AFI: D-07-DESIGN-044-4: Ensure system drawings for the MEPS system reflect the change to the power control module (from AC800PEC to AC800LC) before initiation of the build contract. Verify that test requirements are included in the build contract specification for the MEPS.

The design report for the MEPS indicates an efficiency of 92.7% and a power factor of .997, which is commendable. However, the SLD (5.1[1]) indicates a load to the melter power supplies of 1950kVA each, and other documents indicate power to the melter electrode is 1430kW. This represents a power factor of .733. BNI Engineering staff could not account for this disparity and indicated that when the MEPS system design changes are made, the disparity will be reconciled. This item will be tracked as an AFI as stated below.

AFI: D-07-DESIGN-044-5: Reconcile the 1,950kVA power value to the MEPS system as shown on SLD 24590-LAW-E1-MVE-00001 (5.1[1]) with the 1,430kW power provided to the melter electrode.

According to SLD 24590-LAW-E1-MVE-00004 (5.1[3]), independent trains of UPS power are required to be provided to the melter power system controllers (AC800PEC units). This power is supposed to be provided from UPS panels. However, the UPS panel, UPE-PNL-20046 (according to 24590-LAW-E8-UPE-00006 [5.4(7)]) does not show a service to PSUP-20001 (Lineup A) as the referenced SLD (5.1[3]) indicates. Likewise for UPS service from UPE-PNL-20045 to PSUP-20002 for Lineup B, according to 24590-LAW-E8-UPE-00005 (5.4[6]). This correction will be tracked as an AFI as stated below.

AFI: D-07-DESIGN-044-6: Update or revise drawings, 24590-LAW-E8-UPE-00006 (for UPE-PNL-20046) and 24590-LAW-E8-UPE-00005 (for UPE-PNL-20045) to show UPS service to PSUP-20001 and PSUP-2002 respectively, as indicated on SLD 24590-LAW-E1-MVE-00004 (5.1[3]).

4.3 Selected 480V Distribution Systems and Equipment

This section covers 480V switchboards, MCCs, standby power loads, and UPS systems.

4.3.1 Switchboards

The LAW electrical design does not employ unit substations (integral dry transformers with unit switchgear) as are provided in some of the other WTP facilities. The BOD indicates that in some cases an outdoor secondary distribution transformer may be used to supply power to switchboards located indoors, rather than using unit substations. According to the SLDs, power is distributed from the four main (oil filled) distribution transformers to four 480V switchboard units; see Figure 1 (Section 6.0). The switchboards provide power to MCCs and large motors via adjustable speed drives (ASD). The aforementioned complies with requirements 16, 19, and 29a in Attachment A.

Two of the motor loads shown on the SLDs are for C5 ventilation exhaust fans. Since these exhaust units affect environmental air quality, they must meet rigorous quality assurance requirements and are appropriately labeled as “Q” on the SLDs, and are procured as quality equipment according to contractor QA procedures listed in 5.12.

According to the 480V switchboard specification (5.8[4]), the switchboard main breakers are power air type and the feeder breakers are molded case type. Switchboard internal wiring requirements are stipulated that are consistent with the BOD. The aforementioned complies with requirements 30a and 42a in Attachment A.

The specification appears to be complete particularly with regard to construction requirements covering the main breaker, metering and control, bus requirements, feeder breakers, wire and terminations, busway connection, and nameplates. The specification incorporates a comprehensive listing of industry standards applicable to low power (480V) metal-enclosed switchgear and power circuit breaker construction and testing. For performance, the specification stipulates that the switchboards shall be designed for reliable service during the 40-year design life of the plant, consistent with the BOD.

The SLDs indicate that incoming power to the switchboards from the 13.8kV-to- 480V distribution transformers will be via bus duct. According to GA drawings (5.6[2] and 5.6[3]), switchboards, LVE-SWBD-20201 and LVE-SWBD-20202, are located at the south perimeter of 28’-0” elevation, and will be fed vertically from two of the transformers (MVE-XFMR-20605 and MVE-XFMR-20602) located directly below the switchboards on 3’-0” elevation. The other two switchboards, LVE-SWBD-20101 and LVE-SWBD-20102, are located at the west perimeter of 3’-0” elevation adjacent to their respective distribution transformers, and will be fed horizontally. The LAW Feeder Breaker and Cable Sizing calculation (5.10[3]) factors in the bus feeder lengths and the equipment manufacturers’ impedance values for voltage drop calculation and bus ratings, as is typical practice. The rated loading of each switchboard bus duct is 4,000 amps and the listed connected loads are well below this value. The bus bracing for each switchboard is rated for 65,000 amps interrupt capacity (AIC), which is adequate to handle the available fault current from the 3,000 kVA distribution transformer and motor loads. The aforementioned complies with requirement 29b in Attachment A.

The switchboard design meets upper-level requirements and is driven by accepted industry standards. A consistent and detailed design is communicated via the SLDs, specifications, and calculations.

4.3.2 Motor Control Centers

As depicted in Figure 1 (Section 6.0) and the main SLD (5.1[1]), the LAW-EDS incorporates 12 MCCs for distribution of 480V power to the LAW Facility loads. All the low-voltage power required for the LAW Facility is distributed through the MCCs. The MCCs are easily located on GA drawings (Section 5.6), and are listed in Table 1 with elevations and connected loads. This information is based on the MCC schedules (Section 5.5).

Table 1. LAW Motor Control Centers

Identification	Elevation	Load (KVA)
LVE-MCC-20302	+48	965.8
LVE-MCC-20301	+48	989.8
LVE-MCC-20204	+28	861.2
LVE-MCC-20203	+28	869.5
LVE-MCC-20202	+28	917.5
LVE-MCC-20201	+28	953.9
LVE-MCC-20104	+3	869.5
LVE-MCC-20103	+3	892.1
LVE-MCC-20102	+3	892.7
LVE-MCC-20101	+3	875.5
LVE-MCC-20002	-21	916.1
LVE-MCC-20001	-21	952.4

According to the 480V MCC specification (5.8[3]), the MCCs will be designed for indoor use, freestanding, and anchored to the building. According to the MCC schedule, no motor starters are smaller than size NEMA 1. Also, the specification indicates that all the feeder breakers in the MCCs shall be molded case, thermal magnetic type. According to the *Electrical Design Criteria and Guide* (5.13[1]), the MCCs also have a short circuit rating of 65kA (AIC), which is equal to the upstream switchboard rating and therefore adequate. The aforementioned complies with requirements 32a and 32b in Attachment A.

Based on review of the MCC schedules, there are no motor loads larger than 200 hp and no static resistive loads greater than 400kW. The largest motor loads service by an LAW MCC is 150hp and resistive loads are typically much smaller than 400kW. The aforementioned complies with requirements 31a and 31b in Attachment A.

Seven of the MCCs listed in Table 1 utilize ASDs for at least 13 motors in the LAW-EDS. The ASDs are listed as interposing equipment and based on the procurement specification (5.8[3]) are not mounted in the MCCs. Use of ASDs is expected in the design as long as harmonic distortion requirements are satisfied. The aforementioned complies with requirement 35 in Attachment A.

The specification also stipulates that starters are to be microprocessor-based in order to accommodate digital communications with control and instrumentation devices via the ICN. This requirement is met by the use of SIMOCODE-DP 3UF5 motor protection and control units. These devices are connected within the MCCs via Profibus-DP networks. The aforementioned complies with requirement 33 in Attachment A.

The MCC schedules provide cable sizes for the various feeds. None of the feeder cables are smaller than #12 (American wire gauge [AWG]). In addition, the MCC specification stipulates wire sizes for power, control, and current transformer secondary leads; these sizes are consistent with BOD requirements. The aforementioned complies with requirement 42a in Attachment A).

In addition to cable sizes, the MCC schedules also provide breaker sizes for protection of the feeder cables. Several of the breaker sizes were compared against the 75-degree column ampacities listed in the 2005 NEC, Table 310.16. The comparison indicated conservative breaker protection and compliance to the NEC ampacities.

The MCC design appears to meet upper-level requirements and is driven by a well-defined set of more detailed technical requirements in the MCC specification.

Exception: Regarding spare capacity, the BOD states: "MCCs shall be provided with a minimum number of equipped spaces for starters/breakers intended for future operational growth" (see requirement 34 in Attachment A). The ORD states: "MCCs shall be provided with a minimum of spare starter/breakers intended for future operational growth, and not design growth" (see requirement 54 in Attachment A). These two requirements are unclear as to what is meant by "minimum." In addition, the BOD is concerned with spare "equipped spaces," while the ORD deals with spare "starter/breakers." Moreover, the MCC specification does not indicate how this requirement is met. Discussion with BNI Engineering staff indicated that the construction of the MCCs is such that spare capacity can be provided easily enough if needed, and generally some spare capacity results simply because not all of the compartments in a typical MCC are utilized. However, it has been BNI's design philosophy not to require spare capacity in the MCCs. While this issue has minimal impact on the design, the requirements in both the BOD and the ORD need to be reconciled, clarified, or otherwise deleted at the next document update. This item will be tracked as an AFI as stated below.

AFI: D-07-DESIGN-044-7: At the next update or revision of the BOD and ORD documents, reconcile the differences in spare equipment requirements associated with starter/breakers in the MCCs. See Section 8.4.7 in the BOD and Section 16.2 in the ORD. Clarify what is meant by "minimum" as stated in the requirements.

4.3.3 Standby Power Loads

Two independent trains of power are provided to the LAW Facility from the standby 13.8kV switchgear units (87003A and 87003B) in Bldg. 87. From this switchgear, LAW standby electrical loads are serviced through two 13.8kV- 480V transformers and two 480V distribution switchboards; see Figure 1 (Section 6.0).

As indicated on the LAW main SLD (5.1[1]), the LAW standby loads include C5 ventilation exhaust fans, their associated ASDs, and various loads distributed from MCCs LVE-MCC-20203 (train A) and LVE-MCC-20204 (train B). The MCC standby loads include the UPS bypass transformer, UPS battery room ventilation equipment, melter feed agitators, and cooling water pumps. Train B loads are redundant to the train A loads as required and the UPS units are provided with standby power and are not SC or SS.

The standby loads are required to maintain ventilation systems and control system software associated with monitoring instrumentation. This was verified from the UPS drawings. The aforementioned complies with requirement 56 in Attachment A. In addition, standby power is also required for melter feed agitators based on the following:

> "Loss of an agitator (identified by a low current draw from the agitator motor) would impact fluid mixing in the vessel. If the vessel contents are not properly agitated, the solids in solution may settle out and could result in transfer problems" (24590-LAW-3YD-LFP-00001, *System Description for LAW Melter Feed Process (LFP) System*)

Plugged transfer lines could result in costly impacts to the operation mission of the LAW Facility.

When normal power is lost to the WTP, the LAW non-standby loads are immediately dropped from service by means of undervoltage release devices as indicated on the SLDs and the SDG starts. As the SDG comes on line, the LAW standby loads are gradually added to the SDG service in steps. This is indicated from a calculation sheet included in the SDG sizing calculation 24590-BOF-E1C-MVE-00004 (5.10[6]). The aforementioned complies with requirement 55 in Attachment A.

4.3.4 UPS Systems

The LAW electrical design employs five UPS systems. Three of these systems are designated as SS ITS. Thus, the design employs both ITS and non-ITS classified UPS systems. The aforementioned complies with requirement 4 in Attachment A.

The ITS UPS systems are discussed in Section 4.4.

The SLDs for the UPS systems are listed in Section 5.3. The SLDs for the two non-ITS UPS systems indicate that these systems include a system battery bank, a battery charger (rectifier), a DC-to-AC inverter, static transfer, a manual bypass switch, and a bypass transformer. The units also include microprocessor based instrumentation for monitoring equipment performance and status as well as for synchronizing with the normal supply frequency to accommodate high-speed changeover to the bypass supply without interruption of the load. In addition, the system specification (5.8[10]) indicates the manual bypass switch will be a hardwired "make before break" device in order to electrically isolate the unit for maintenance. The aforementioned complies with requirements 37a, 37c, 38d, and 60 in Attachment A.

The units draw normal power (480V, 3-phase) from two designated MCCs (see Figure 1 [Section 6.0]). The MCCs are also provided with SDG backup power and therefore are able to provide power to the battery room HVAC equipment necessary for maintaining an environment optimum for battery performance. The UPS units rectify and then invert the incoming power in order to supply power to several 208/120 V, 3-phase distribution panels providing service to 120V loads. All the UPS loads are listed in the non-ITS UPS sizing calculation (5.10[2]). The loads appear to be mainly for process monitoring instrumentation and control and thus are loads that cannot tolerate an interruption of power. The aforementioned complies with requirements 3, 5, 37b, 38a, 58, and 59 in Attachment A.

The sizing calculation for the UPS presents a clear and reasonable methodology for sizing the UPS units. All essential loads appear to be listed and tabulated in the calculation as well as appropriate factors for design margin, future allowance, and load diversity. Given that the UPS units are provided with backup power from SDGs upon loss of normal power, the main requirement for battery sizing is that the battery must provide the required system power for 15 minutes. This requirement originates from the *Electrical Design Criteria and Guide* (5.13[1]). The design criteria and guide also stipulates the battery type to be valve regulated lead acid, and the UPS output must include a 25% design margin. These requirements are also in the UPS procurement specification (5.8[10]]. Based on the calculation, each UPS unit must provide about 180kVA. The aforementioned complies with requirements 7, 8b, and 37c in Attachment A.

The vendor performs the battery sizing according to the requirements in the UPS procurement specification. The specification references several industry standards for selecting and sizing the battery and for testing the UPS. The expectation, according to the specification, is that the battery charger be sized to provide the DC load and a battery charge up rate sufficient to restore discharged batteries. The aforementioned complies with requirement 37c in Attachment A.

4.4 ITS Electrical Equipment (Safety Significant UPS System)

The only ITS electrical distribution equipment employed in the LAW Facility are uninterruptible power supply (UPS) units. The ITS UPS units are required to maintain power, when normal power is interrupted, to the LAW Melter Offgas System exhausters in order to adequately vent nitrogen oxide gases. Venting is required to prevent exposure of the gas to the facility worker and co-located workers. As such, the ITS UPS provides critical power to designated safety systems in accordance with the ISM process and as described in the PSAR. The aforementioned complies with requirement 3 in Attachment A.

The Melter Offgas System evaluation and the basis for requiring the ITS UPS is adequately described in 24590-WTP-SED-ENS-03-002-03, *Safety Envelope Document; LAW Facility Specific Information* (SED).

The ITS UPS units within the LAW Facility are classified as SS because of the types of electrical loads to which they must provide service. Those electrical loads are consistent with the criteria provided in the SRD. The aforementioned complies with requirement 13 in Attachment A.

As a SS system, the ITS UPS must meet Seismic Criteria (SC)-III requirements and Nuclear Quality Assurance (NQA) requirements. The SLDs for the ITS UPS systems are listed in Section 5.3 and are clearly designated for quality (Q) procurement as is required for safety systems. The LAW Offgas UPS system specification (5.8[1]] lists several implementing standards from the SRD, thereby communicating stringent safety requirements to the UPS equipment vendors. Applicable safety standards are also listed in Section 4.4.3.4 of the SED. Specifically, in accordance with IEEE 384, *IEEE Standard Criteria for Independence of Class 1E Equipment and Circuits*, the main breakers to the UPS units are designated as qualified isolation devices with respect to the non-ITS normal supply.

As indicated from the ITS UPS panel schedules in Section 5.4, the units provide power to exhauster motors via adjustable speed drives and support equipment such as high-efficiency particulate air (HEPA) filter preheaters, auxiliary cooling units, condensers, and Programmable Protection System loads. Three ITS UPS units are utilized, one for each exhauster motor. These loads are also listed in the ITS UPS sizing calculation (5.10[1]) and are consistent with the types of loads listed in the BOD. Much of the equipment listed above is required to ensure the UPS battery room is environmentally controlled to prolong battery cell life. In addition, instrumentation loads such as for the Programmable Protection System cannot tolerate a power interruption and therefore require a UPS source of power. The aforementioned complies with requirements 3, 58, and 59 in Attachment A.

According to the calculation, each unit is sized to provide two hours of continuous operation of the exhausters upon loss of normal power. The basis for this requirement is well documented in the calculation and is also a requirement according to the system evaluation described in the SED. The calculation appears to be complete and addresses the expected loads. The estimated size for the UPS to meet the 2-hour requirements is at least 186kVA with a battery bank of 150kW. The aforementioned complies with requirements 7, 8a, and 8b in Attachment A.

The ITS UPS units draw normal power 480V, 3-phase, 60Hz power from two designated MCCs (see Figure 1 [Section 6.0]). The units rectify and then invert the incoming power in order to provide UPS output power to 480V distribution panels. Those panels provide 480V, 3-phase power to the equipment discussed previously. The aforementioned complies with requirements 5, 6, 37b, and 38a in Attachment A.

Several of the breaker sizes in the ITS UPS circuits were checked with respect to service conductor ampacities listed in the 75-degree (F) column of NEC Table 310-16. The breaker sizes were consistent with the wire ampacities, and therefore compliant with the NEC.

The ITS UPS units and battery banks are located in separate fire rated rooms on the south side of LAW at 48'-0" elevation as depicted on the LAW GA drawing (5.6[4]). Based on the ITS UPS SLDs (Section 5.3), the SS loads are redundant and independent, and therefore satisfy single-failure criteria. Since the equipment is also class 1E qualified under required quality assurance provisions as indicated by the specification, the units are designed to function under normal and accident conditions. The aforementioned complies with requirement 63a in Attachment A.

The ITS UPS specification requires shop tests, many of which are to comply with IEEE 944, *Recommended Practice for the Application and Testing of Uninterruptible Power Supplies for Power Generating Stations*. The specification also calls for compliance to the applicable portions of IEEE 338, *IEEE Standard Criteria for the Periodic Surveillance Testing of Nuclear Power Generating Station Safety Systems*. This standard is intended to implement the surveillance, inspection, and testing criteria described in SRD Safety Criteria 4.4-2 and 4.4-5. The aforementioned complies with requirements 62 and 63b in Attachment A.

The SLDs indicate that the UPS units include a system battery bank, a battery charger (rectifier), a DC-to-AC inverter, static transfer, a manual bypass switch, and a dedicated distribution panel. According to the system specification, the manual bypass switch will be a hardwired "make before break" device in order to electrically isolate the unit for maintenance. The ITS UPS also includes monitoring instrumentation and controls for synchronizing with the normal supply frequency to accommodate high-speed changeover to the bypass supply without interruption of the load. The aforementioned complies with requirements 37a, 38c, 38d, and 60 in Attachment A.

Exception: The UPS equipment as required in the BOD includes bypass transformers (see requirement 37a in Attachment A). However, bypass transformers are not shown on the ITS UPE SLDs even though MCC schedules (5.5[11] and 5.5[12]) indicate service to the bypass transformers and SLDs for other WTP UPS units show bypass transformers. BNI engineers indicated that in this application, bypass transformers would not be necessary as they would not have any useful function such as voltage conversion or isolation. This suggests that updates to the BOD and MCC schedules need to be made. This will be tracked as an AFI as stated below.

AFI: D-07-DESIGN-044-8: At the next update or revision of the BOD, modify Section 8.4.11 to indicate that in some cases bypass transformers may not be necessary in the design. Also, correct and revise MCC schedules (and any other related documentation) that show service to bypass transformers where bypass transformers are actually not being used.

For most of the UPS drawings that were reviewed, information was consistent with the overall design. However, the ITS UPS panel schedules (Rev. 0) had the following discrepancies: (1) Phase loads on the panel schedules for the melter offgas exhausters are not consistent with the horsepower rating of the exhauster motor; (2) Loads for the two LVP heaters are inconsistent; and (3) Phase loads as listed and calculated are inconsistent. These items will be tracked as an AFI as stated below.

AFI: D-07-DESIGN-044-9: Update and revise ITS UPS panel schedules to correct load information discrepancies.

4.5 Interface with Integrated Control Network (ICN)

This section discusses the interface between the LAW electrical distribution equipment and the ICN with respect to system design and equipment layout.

Sections 9.5.1 and 9.6.1 of the BOD indicate that electrical system I/O interfaces (with the ICN) are integrated into the electrical equipment or MCCs, and that the Process Control System (PCJ) as part of the ICN provides monitoring and some control of electrical services and electrical switchgear. These statements necessarily require the LAW electrical distribution system to have equipment in place for interfacing with the ICN.

This portion of the assessment considered the interface provisions between the LAW electrical equipment and the ICN in terms of equipment and system planning.

The SLDs indicate that 13.8kV and 480V distribution equipment contain microprocessor-based protective relay devices and circuit breaker trip units. These devices communicate multivariable information to the facility control room via the ICN for monitoring purposes.

Specific devices are:

- GE750 multi-function microprocessor-based relay units – for main breakers to MVE switchgear
- GEMIF multi-function microprocessor-based relay units – for feeder breakers from MVE switchgear
- Cutler Hammer Digitrip 1150 units for main breakers at 480V switchboards
- Cutler Hammer Optim550 units for feeder breakers at 480V switchboards
- SIMOCODE-DP 3UF5 devices for specific motor control

Remote actuation of circuit breakers via the ICN is not programmed for the electrical distribution system although the equipment listed above does not preclude this feature being added. Breaker reset, closure, or opening operations will be made locally by qualified personnel. This control approach is consistent with the plant control philosophy described in the BOD and the ORD.

According to specifications, the distribution equipment must include the means to connect up to the ICN via Profibus network segment. Evidence for these types of connections is provided in the system block diagrams listed in Section 5.7. Connections are shown as either by twisted shielded pair or by fiber optic cable. The aforementioned complies with requirements 41a and 41d in Attachment A.

One example: 24590-LAW-J1-MVE-00002 (5.7[2]) conveys the interface between the 13.8kV switchgear equipment (including the 13.8kV-480V transformers) and the ICN process controller equipment. The drawing presents fiber optic and copper signal lines connecting ICN controller and remote I/O equipment to switchgear system components (microprocessor relay units, breakers, transformers, etc.) and UPS equipment. Device numbers and system/component labeling are listed consistent with electrical SLDs. Equipment location information is provided consistent with GA drawings. The same kind of information is provided on the system block diagrams covering the remaining distribution equipment.

Based on the system block diagrams and SLDs, Figure 2 (Section 6.0) was developed depicting controller assignments and enclosures associated with the ICN and the LAW electrical distribution equipment. The diagram summarizes what this assessment verified regarding the mapping of the LAW electrical equipment to the ICN.

Communication network interface equipment requirements are particularly detailed in the specifications listed below. Other specifications may only require the equipment to have contacts for common trouble alarms as in the case of UPS equipment.

> 13.8kV Switchgear specification, Section 3.8

> 125V DC System specification, Section 3.9

> MCCs specification, Section 3.4

> 480V Switchboard specification Section 3.4

In most instances, communication from the electrical distribution equipment to the ICN will be by network buses (Profibus DP or a Modbus remote terminal unit). The specifications are clear regarding cable type and conversion equipment in order to interface with the ICN.

ICN interface equipment is contained within designated cabinets near the electrical equipment that include controllers, communication modules, I/O devices, and power supplies. This equipment provides the communication interface capability between the electrical distribution equipment and the LAW control room server equipment and control consoles.

The drawings listed in Section 5.9 provide the enclosure layout details of the controller and I/O equipment used to interface with the LAW electrical distribution system. The drawings indicate a systematic design approach and philosophy consistent with other WTP facility designs (e.g., Balance of Facilities [BOF]) that utilize the ABB platform equipment for the ICN.

The ICN interface with the LAW-EDS appears to be adequately designed and planned for as indicted by the equipment specifications and drawings.

5.0 REFERENCES

5.1 Main Single-Line Diagrams

(1) 24590-LAW-E1-MVE-00001, *LAW Vitrification Building Power Distribution Main Single Line Diagram*

(2) 24590-LAW-E1-MVE-00003, *LAW Vitrification Building 13.8KV switchgear MVE-SWGR-20603 and 20604 Single Line Diagram*

(3) 24590-LAW-E1-MVE-00004, *LAW Vitrification Building Melter LMP-System Electrode Power Supply Single Line Diagram*

(4) 24590-LAW-E1-LVE-00003, *LAW Vitrification Building 480V Switchboard LVE-SWBD-20101 Single Line Diagram*

(5) 24590-LAW-E1-LVE-00004, *LAW Vitrification Building 480V Switchboard LVE-SWBD-20102 Single Line Diagram*

(6) 24590-LAW-E1-LVE-00005, *LAW Vitrification Building 480V Switchboard LVE-SWBD-20201 Single Line Diagram*

(7) 24590-LAW-E1-LVE-00006, *LAW Vitrification Building 480V Switchboard LVE-SWBD-20202 Single Line Diagram*

5.2 125V DC System Drawings

(1) 24590-LAW-E1-DCE-00001, *LAW Vitrification Building 125VDC System Single Line Diagram*

(2) 24590-LAW-E8-DCE-20601, *LAW Vitrification Building DC Power 125VDC Panel Schedule*

5.3 UPS Single-Line Diagrams

(1) 24590-LAW-E1-UPE-00001, *Uninterruptible Power Supply, UPE- UPS-20201, Single-Line Diagram*

(2) 24590-LAW-E1-UPE-00002, *Uninterruptible Power Supply, UPE- UPS-20202, Single-Line Diagram*

(3) 24590-LAW-E1-UPE-00003, *LAW Vitrification Building, ITS UPS, UPE-UPS-20301, Single-Line Diagram*

(4) 24590-LAW-E1-UPE-00004, *LAW Vitrification Building, ITS UPS, UPE-UPS-20302, Single-Line Diagram*

(5) 24590-LAW-E1-UPE-00005, *LAW Vitrification Building, ITS UPS, UPE-UPS-20303, Single-Line Diagram*

5.4 UPS Panel Schedules

(1) 24590-LAW-E8-UPE-00301, *ITS UPS, 480V Panel Schedule, UPE-PNL-20301*

(2) 24590-LAW-E8-UPE-00302, *ITS UPS, 480V Panel Schedule, UPE-PNL-20302*

(3) 24590-LAW-E8-UPE-00303, *ITS UPS, 480V Panel Schedule, UPE-PNL-20303*

(4) 24590-LAW-E8-UPE-00308, *ITS UPS, 480V Panel Schedule, UPE-PNL-20350*

(5) 24590-LAW-E8-UPE-00309, *ITS UPS, 480V Panel Schedule, UPE-PNL-20351*

(6) 24590-LAW-E8-UPE-00005, *LAW Vitrification Building Non-ITS UPS 208/120V Panel Schedule UPE-PNL-20045*

(7) 24590-LAW-E8-UPE-00006, *LAW Vitrification Building Non-ITS UPS 208/120V Panel Schedule UPE-PNL-20046*

5.5 MCC Schedules

(1) 24590-LAW-EC-LVE-00001, *Motor Control Center Schedule, LVE-MCC-20001 (EL -21')*

(2) 24590-LAW-EC-LVE-00002, *Motor Control Center Schedule, LVE-MCC-20002 (EL -21')*

(3) 24590-LAW-EC-LVE-00003, *Motor Control Center Schedule, LVE-MCC-20101 (EL 3')*

(4) 24590-LAW-EC-LVE-00004, *Motor Control Center Schedule, LVE-MCC-20102 (EL 3')*

(5) 24590-LAW-EC-LVE-00005, *Motor Control Center Schedule, LVE-MCC-20103 (EL 3')*

(6) 24590-LAW-EC-LVE-00006, *Motor Control Center Schedule, LVE-MCC-20104 (EL 3')*

(7) 24590-LAW-EC-LVE-00007, *Motor Control Center Schedule, LVE-MCC-20201 (EL 28')*

(8) 24590-LAW-EC-LVE-00008, *Motor Control Center Schedule, LVE-MCC-20202 (EL 28')*

(9) 24590-LAW-EC-LVE-00009, *Motor Control Center Schedule, LVE-MCC-20203 (EL 28')*

(10) 24590-LAW-EC-LVE-00010, *Motor Control Center Schedule, LVE-MCC-20204 (EL 28')*

(11) 24590-LAW-EC-LVE-00011, *Motor Control Center Schedule, LVE-MCC-20301 (EL 48')*

(12) 24590-LAW-EC-LVE-00012, *Motor Control Center Schedule, LVE-MCC-20302 (EL 48')*

5.6 General Arrangement Drawings

(1) 24590-LAW-P1-P01T-00001, *LAW Vitrification Building, General Arrangement, Plan at El. (-)21'-0"*

(2) 24590-LAW-P1-P01T-00002, *LAW Vitrification Building, General Arrangement, Plan at El. 3'-0"*

(3) 24590-LAW-P1-P01T-00004, *LAW Vitrification Building, General Arrangement, Plan at El. 28'-0"*

(4) 24590-LAW-P1-P01T-00005, *LAW Vitrification Building, General Arrangement, Plan at El. 48'-0"*

(5) 24590-LAW-P1-P01T-00012, *LAW Vitrification Building, General Arrangement, Plan at El. 0'-0"*

5.7 Block Diagrams -Process Control System Interface

(1) 24590-LAW-JJ-PCJ-00003, *LAW Vitrification System ICN, Control System Architecture Diagram*

(2) 24590-LAW-J1-MVE-00002, *LAW Vitrification System MVE, System Block Diagram, Medium Voltage Switchgear*

(3) 24590-LAW-J1-PCJ-00001, *LAW Vitrification System PCJ, System Block Diagram, Process Control System Network*

(4) 24590-LAW-J1-PCJ-00002, *LAW Vitrification System PCJ, System Block Diagram, Process Control System Network*

(5) 24590-LAW-J1-LVE-00001, *LAW Vitrification System LVE, System Block Diagram, Low Voltage MCC, EL -21'-0"*

(6) 24590-LAW-J1-LVE-00002, *LAW Vitrification System LVE, System Block Diagram, Low Voltage MCC, EL 3'-0"*

(7) 24590-LAW-J1-LVE-00004, *LAW Vitrification System LVE, System Block Diagram, Low Voltage MCC, EL 28'-0"*

(8) 24590-LAW-J1-LVE-00005, *LAW Vitrification System LVE, System Block Diagram, Low Voltage MCC, EL 28'-0"*

(9) 24590-LAW-J1-LVE-00006, *LAW Vitrification System LVE, System Block Diagram, Low Voltage MCC, EL 48'-0"*

5.8 Procurement Specifications

(1) 24590-LAW-3PS-EU00-T0001, *Engineering Specification for LAW Offgas UPS*

(2) 24590-WTP-3PS-ECD0-T0002, *Engineering Specification for Panelboards and Dry Type Transformers – Non ITS*

(3) 24590-WTP-3PS-ECM1-T0001, *Engineering Specification for Motor Control Centers*

(4) 24590-WTP-3PS-ECM1-T0002, *Engineering Specification for 480 V Switchboards*

(5) 24590-WTP-3PS-EVV1-T0001, *Engineering Specification for Low Voltage Adjustable Speed Drives*

(6) 24590-WTP-3PS-ED00-T0003, *Engineering Specification for 125V DC System*

(7) 24590-WTP-3PS-EKP0-T0001, *Engineering Specification for Electrical Requirements for Packaged Equipment*

(8) 24590-WTP-3PS-ESM1-T0001, *Engineering Specification for 13.8kV Switchgear*

(9) 24590-WTP-3PS-ETP2-T0004, *Engineering Specification for 13.8kV-480V Liquid Filled Transformers & Secondary Unit Substations*

(10) 24590-WTP-3PS-EU00-T0002, *Engineering Specification for Uninterruptible Power Supply (UPS) Systems*

5.9 Controller Cabinet Layout Drawings

(1) 24590-CM-POA-JD01-00001-05-00283, *Controller Cabinet Layout, LVE-ENCL-00017*

(2) 24590-CM-POA-JD01-00001-05-00203, *Controller Cabinet Layout, LVE-ENCL-00025*

(3) 24590-CM-POA-JD01-00001-05-00175, *Controller Cabinet Layout, LVE-ENCL-00016*

(4) 24590-WTP-J1-50-00001, *Controls & Instrumentation, RIO Enclosure General Arrangement, Typical Single Cabinet Layout*

5.10 Calculations

(1) 24590-LAW-E1C-UPE-00002, *ITS Safety System - Uninterruptible Power Supply Sizing*

(2) 24590-LAW-E1C-UPE-00001, *Non-ITS Uninterruptible Power Supply Sizing Calculation*

(3) 24590-LAW-E1C-MVE-00006, *LAW Feeder Breaker and Cable Sizing*

(4) 24590-LAW-E1C-MVE-00003, *LAW Building Transformer Sizing*

(5) 24590-LAW-E1C-DCE-00001, *125V DC System Battery Sizing*

(6) 24590-BOF-E1C-MVE-00004, *Standby Diesel Generator Sizing*

5.11 Construction Specifications

(1) 24590-WTP-3PS-E00X-T0005, *Engineering Specification for Electrical Raceway and Cable Identification*

5.12 Procedures

(1) 24590-WTP-3DP-G03B-00044, *Standard Component Numbering*

(2) 24590-WTP-3DP-G04T-00905, *Determination of Quality Levels*

(3) 24590-WTP-3DP-G04B-00028, *Identification of Items/Services Subject to Quality Assurance Programs*

(4) 24590-WTP-3DP-G06B-00028, *Specifying Supplier Quality Assurance Program Requirements*

5.13 Guides

(1) 24590-WTP-GPG-E-001, *Guide to SETROUTE Work Process*

(2) 24590-WTP-DC-E-01-001, *Electrical Design Criteria and Guide*

5.14 Melter Electrode Power Supply Documents

(1) 24590-CM-HC4-EBB0-00001-03-00034, *LAW – Single Line Diagram – Melter Power Supply System*

(2) 24590-CM-HC4-EBB0-00001-03-00035, *LAW – Single Line Diagram – Melter Power Supply System- Control Diagram*

(3) 24590-CM-HC4-EBB0-00001-03-00036, LAW – *Single Line Diagram – Melter Power Supply System - Protection Diagram*

(4) 24590-CM-HC4-EBB0-00001-03-00037, LAW – *Single Line Diagram – Melter Power Supply System- Metering Diagram*

(5) 24590-CM-HC4-EBB0-00001-03-00042, *LAW – Block Diagram – Control Hardware*

(6) 24590-CM-HC4-EBB0-00001-03-00111, *LAW – Block Diagram – Control Software*

(7) 24590-CM-HC4-EBB0-00001-03-00113, *LAW – Block Diagram – Control Hardware*

(8) 24590-CM-HC4-EBB0-00001, *WTP-E-ABB-1030, LAW-Final Report, LAW Melter Power Supply*

5.15 Miscellaneous Documents

(1) 24590-LAW-3YD-LFP-00001, *System Description for LAW Melter Feed Process (LFP) System*

(2) 24590-WTP-DB-ENG-01-001, *Basis of Design*

(3) 24590-WTP-RPT-OP-01-001, *Operations Requirements Document*

(4) 24590-WTP-SRD-ESH-01-001-02, *Safety Requirements Document, Volume II*

(5) 24590-WTP-SED-ENS-03-002-03, *Safety Envelope Document; LAW Facility Specific Information*

6.0 HARDWARE

Figure 1. LAW Electrical Distribution System

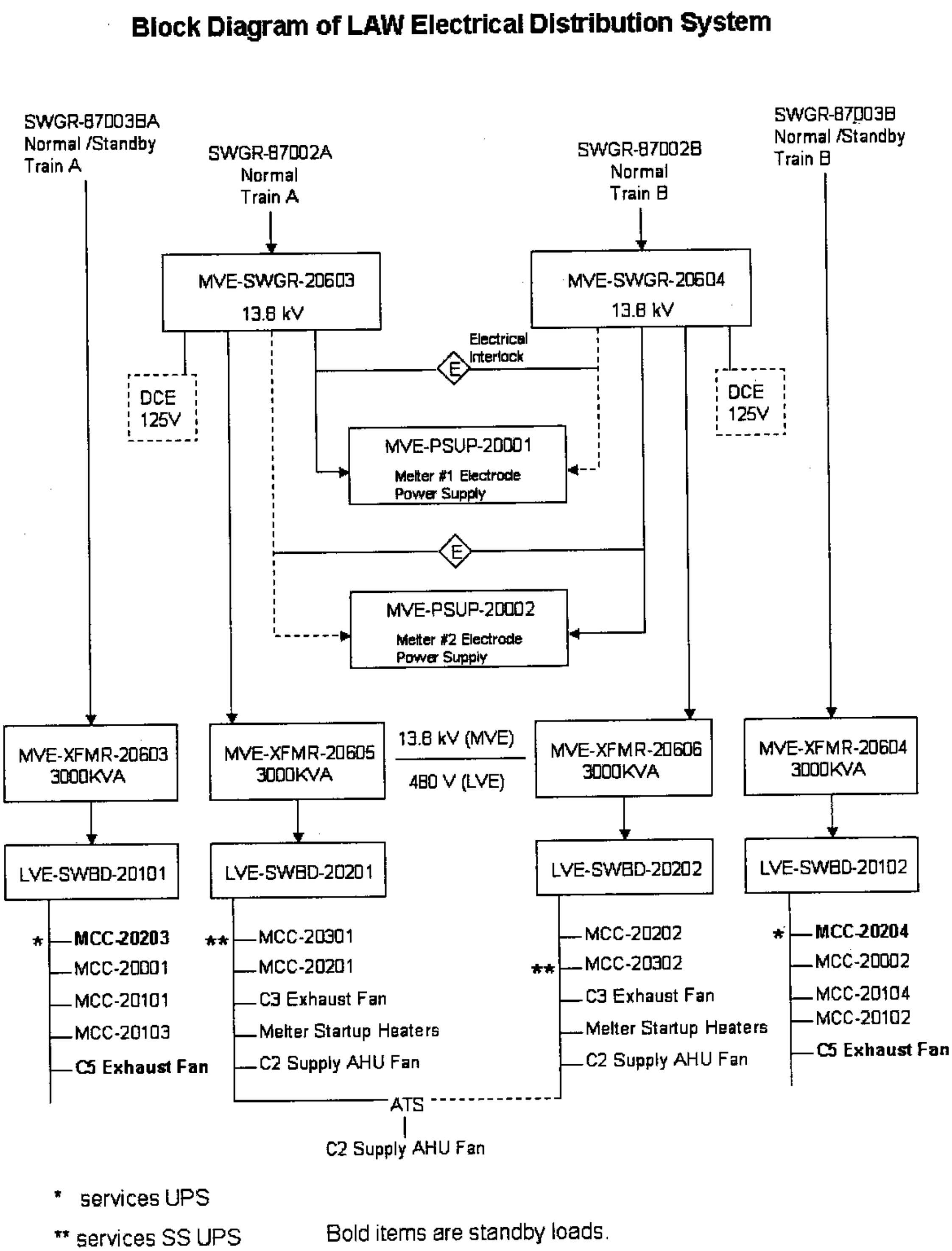
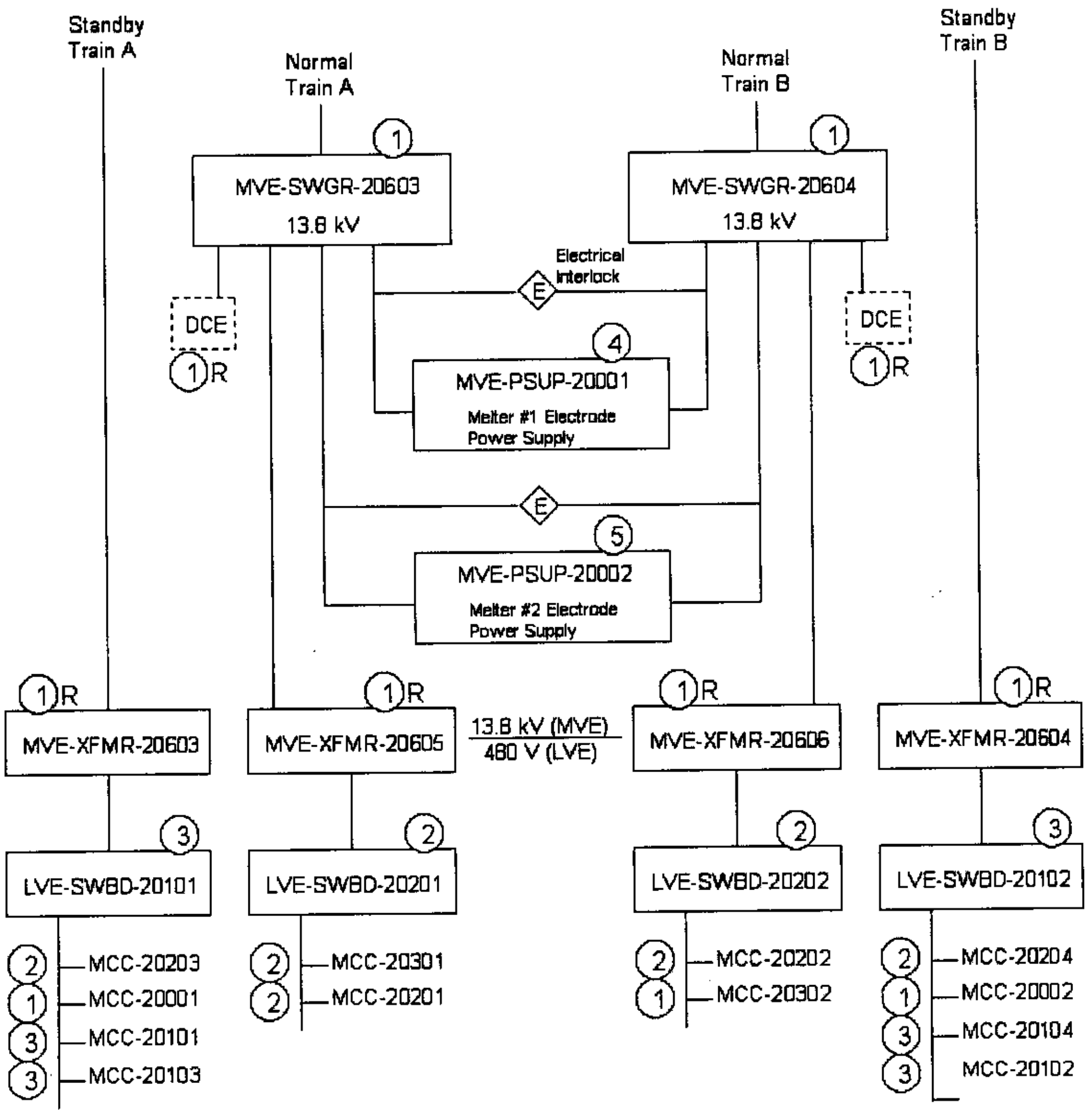


Figure 2. LAW Electrical Distribution and ICN Controller Assignments

Block Diagram of LAW Electrical Distribution and ICN Controller Assignments



R — Remote I/O 2001, Enclosure (MVE-ENCL-00002), Elev. +3'-0", interfaces with controllers in 1 and 2. Status of UPS equipment is conveyed through this I/O cabinet and to the ICN via controllers listed in 1 and 2.

(1) Controller 2012, LVE Enclosure 00016, FNJ Enclosure 00001, Elev. -21'-0"

(2) Controller 2071, LVE Enclosure 00025, FNJ Enclosure 00008, Elev. +28'-0"

(3) Controller 2022, LVE Enclosure 00017, FNJ Enclosure 00007, Elev. +3'-0"

(4) Controller 2086, LMP Enclosure 00030, FNJ Enclosure 00001, Elev. -21'-0"

(5) Controller 2087, LMP Enclosure 00032, FNJ Enclosure 00002, Elev. -21'-0"

ATTACHMENT A – HIGH LEVEL REQUIREMENTS

ID#	High-Level Requirement	Source
1	To achieve efficient operability, provisions shall be made in the design that allow for replacement, removal, calibration, maintenance, troubleshooting, repairs, periodic functional testing, and inspections of plant items while the plant is in normal operation.	BOD 8.1.2
2a	The standby power system provides backup (non-ITS) power to support selected HLW, LAW, and BOF loads.	BOD 8.2.2.3
2b	The source of the backup power source for the standby power is from a 13.8kV standby generator (SDG). The SDG will start automatically on loss of offsite power and provide power until the offsite power source is restored.	BOD 8.2.2.3
3	The uninterruptible power supply (UPS) system shall be designed to provide critical power of acceptable quality without delay or transients, when the normal power supply is not available. The UPS shall be utilized for systems and components that require a reliable source of power and shall include, but not necessarily be limited to, the following systems and components: – Network servers – Process monitoring instrumentation and control systems – Emergency lighting fixtures for the main control room (MCR) and the facility control room (FCR) – Certain loads identified during the ISM process	BOD 8.2.2.4
4	The UPS system shall consist of both ITS and non-ITS classified UPS units.	BOD 8.2.2.4
5	The input power to the non-ITS UPS system shall be from the non-ITS low voltage power system (LVE).	BOD 8.2.2.4
6	The input power to the SS UPS units for the LAW Off-gas system exhaust fans shall be from the non-ITS low voltage power system (LVE).	BOD 8.2.2.4
7	In general, the UPS system (UPE) output power shall meet the power requirements of the respective essential loads.	BOD 8.2.2.4
8a	Upon loss of normal plant power, the UPS batteries shall be sized to provide power long enough to safely shut down the associated system and components.	BOD 8.2.2.4
8b	The battery operation time shall be based on the criticality of the load, the type of power source provided for the 480-V input to the UPS battery charger, and the type of bypass power source.	BOD 8.2.2.4
9a	The 125V DC power system (DCE) shall consist of SC and non-ITS batteries, battery chargers, and distribution panelboards.	BOD 8.2.2.5
9b	DC power system shall provide 125-V DC (nominal) control power to the medium-voltage switchgear and certain low-voltage switchgear as needed.	BOD 8.2.2.5
9c	The DC power shall be available from DC battery banks being kept on a continuous float charge by dedicated battery chargers.	BOD 8.2.2.5
9d	The battery size shall be based on a three-hour load profile and include an additional 15 % capacity for future loads.	BOD 8.2.2.5

ATTACHMENT A – HIGH LEVEL REQUIREMENTS

ID#	High-Level Requirement	Source
10a	Under normal plant operating conditions, the DC loads are supplied from battery chargers.	BOD 8.2.2.5
10b	The battery chargers shall have adequate capacity to recharge batteries while supplying power to the normal continuous DC system loads.	BOD 8.2.2.5
11a	The supply category of all plant items shall be determined in accordance with process requirements and ISM process considerations.	BOD 8.2.3
11b	These supply categories are detailed in electrical load lists, equipment lists, single line diagrams, and panelboard schedules.	BOD 8.2.3
12a	In general, non-ITS electrical loads are designated as either load group A or B.	BOD 8.2.3
12b	Where standby equipment exists, one shall be designated for connection to load group A, while the other is designated for connection to load group B.	BOD 8.2.3
12d	Division of the loads is intended to facilitate maintenance and increase availability of plant loads. This division reflects a general concept of providing power for plant electrical loads from two utility-furnished transformers. To the extent practical, the effects of a common mode failure on the non-ITS power trains A and B is minimized.	BOD 8.2.3
13	While common mode failures are to generally be avoided in the design of non-ITS systems, electrical supply, and distribution systems supporting SC and SS, electrical loads shall be designed in accordance with the safety criteria listed in the SRD.	BOD 8.2.3
15	Power is distributed from the primary 13.8kV power distribution system switchgear to various WTP facilities including BOF, PT, LAW, HLW, and other buildings throughout the site through underground duct banks. Each breaker in the primary 13.8kV power distribution system switchgear feeds a specific building or facility.	BOD 8.3.1
16	Each facility has its own 13.8kV load group A and B power distribution equipment, which is powered from the respective load group A or B primary switchgear. Power is then distributed to the facility unit substations and switchboards, as well as to the HLW and LAW melters from the facility 13.8kVdistribution equipment.	BOD 8.3.3
17a	Power to the LAW melter electrodes originates at the respective facility 13.8kV switchgear. One 13.8kV power feed is provided from each load group A and B switchgear to a static power supply (SPS) that is dedicated to each melter.	BOD 8.3.3
17b	Each SPS is composed of two 50 % units. If one unit is lost, the remaining unit will be capable of supplying enough power to maintain the melter in an idle mode until full power is restored.	BOD 8.3.3
17c	The LAW SPS is equipped with provisions for the addition of a third unit in the event that three zone melter power control is required in the future.	BOD 8.3.3

ATTACHMENT A – HIGH LEVEL REQUIREMENTS

ID#	High-Level Requirement	Source
18	Power variations from melter operations are mitigated so they do not cause problems (such as harmonics, power factor) with other equipment of the power distribution system supplying the melter power supplies.	BOD 8.3.3
19	The 480V power distribution system is supplied from 13.8kV … power distribution systems. … an outdoor, stand-alone secondary distribution transformer may be used to supply 480V power to a separate low-voltage distribution section or switchboard located indoors.	BOD 8.3.6.1
20	Power to the LAW … melter discharge and startup heaters originate at 480V MCCs. One 480V feeder is routed from each A and B source to a discharge heater power supply. Each heater power supply converts the 3-phase 480V input to a single-phase variable voltage (based on heater type) output at the power level required by the heater.	BOD 8.3.6.1
21	Procurement specifications shall be developed for all major electrical equipment … Appropriate NEMA class enclosures shall be used, with a minimum requirement of Type 1 for indoor use and Type 3R for outdoor use.	BOD 8.4
22	All electrical equipment, of the WTP shall be given unique identification numbers.	BOD 8.4.1
23	An electrical load assessment shall be performed as an interactive, inter-discipline process and shall be documented in the electrical load lists.	BOD 8.4.2
24a	Generally, unit substation transformers shall be liquid-filled for outdoors service and dry-type for indoor service.	BOD 8.4.3
24b	Liquid-filled transformers, if used, may have less flammable, insulating liquids and shall be provided with a catch basin or berm, as required, to contain the liquid in case of tank rupture.	BOD 8.4.3
25a	The unit substation transformers shall be 13.8kV to 480V, 13.8 kV to 4.16 kV, or 4.16 kV to 480V; 3- phase, 6O-Hz, with no-load, manually operated taps.	BOD 8.4.3
25b	The primary side [of the transformers] shall be delta-connected, and the secondary side shall be wye-connected.	BOD 8.4.3
25c	For medium-voltage [transformers] wye-connected windings, the neutral shall be low-resistance grounded.	BOD 8.4.3
25d	For low-voltage [transformers] wye-connected windings, the neutral shall be solidly grounded.	BOD 8.4.3
26	The main medium-voltage switchgear shall be rated at 13.8kV, 3-phase, 60Hz. The metal-clad switchgear shall be rated to withstand the maximum short circuit current available in the system.	BOD 8.4.4.1
27	The [13.8kV] switchgear shall be designed for indoor service, with an incoming vacuum-break, stored-energy, draw-out type breaker. Where necessary, switchgears may be located outdoors in outdoor type walk-in enclosures.	BOD 8.4.4.1
28a	Switchgear circuit breakers are provided with multi-function protection relays whenever practical.	BOD 8.4.4.1

ATTACHMENT A – HIGH LEVEL REQUIREMENTS

ID#	High-Level Requirement	Source
28b	Remote indication of the breaker position and trip status shall be provided for each switchgear circuit breaker.	BOD 8.4.4.1
29a	The 480V switchboards receive power from distribution transformers and provide power to motors, MCCs, and various other loads.	BOD 8.4.6
29b	Each switchboard shall be rated for the load it serves and the available short circuit current encountered by its components.	BOD 8.4.6
30a	The main and feeder circuit breakers [in the switchboard] shall be either power circuit breakers, or molded-case circuit breakers.	BOD 8.4.7
30b	For feeding motors requiring a starter at the switchboard, the switchboard bus shall be extended into MCC sections with branch circuit devices (circuit breakers and starters, for example).	BOD 8.4.7
31a	The 480V[ed.] MCCs shall be used to provide AC power to induction motors up to and including 200 hp, and to other miscellaneous branch circuit loads. Reduced voltage starting for motors larger than 100 hp may be considered, if necessary.	BOD 8.4.7
31b	Static (resistive) loads up to 400kW can be served from MCCs. Deviations from the motor or static load limits are permissible if technically justified on a case-by-case basis.	BOD 8.4.7
32a	The 480V MCCs shall be freestanding, indoor type, and have a minimum starter size of NEMA 1.	BOD 8.4.7
32b	The [MCC] feeder breakers shall be the molded-case thermal-magnetic type.	BOD 8.4.7
33	MCC starters shall be microprocessor based to facilitate digital communication with the control and instrumentation systems.	BOD 8.4.7
34	MCCs shall be provided with a minimum number of equipped spaces for starters/breakers intended for future operational growth.	BOD 8.4.7
35	Adjustable speed drives (ASD) shall be provided to control the speed of the selected motors. ASDs of small size (where manufacturer's size permits) may be mounted in standard MCCs; however, integral motor drive units may be appropriate for selected applications.	BOD 8.4.9
36a	The DC battery system shall be 125-V DC nominal voltage.	BOD 8.4.10
36b	The battery design shall be selected to ensure a long design life and low maintenance requirements. Loads served include switchgear breakers and protective controls.	BOD 8.4.10
36c	The battery charger shall be rated to carry all normal operating DC loads while floating and recharging the battery.	BOD 8.4.10
36d	The battery system capacity and the end-of-discharge voltage shall be selected in accordance with the load profile and acceptable voltage drop.	BOD 8.4.10

ATTACHMENT A – HIGH LEVEL REQUIREMENTS

ID#	High-Level Requirement	Source
37a	Each UPS system consists of a dedicated battery bank, battery charger, DC-to-AC inverter, static transfer switch with bypass transformer, a manual maintenance bypass switch, and monitoring instrumentation and synchronizing controls. The static transfer switch automatically switches to the bypass source upon inverter trouble or failure without an interruption of output power.	BOD 8.4.11
37b	UPS loads normally draw power from the inverter that converts direct current (DC) to 60Hz AC. The inverter output may be either 3-phase or single phase.	BOD 8.4.11
37c	The battery charger shall be sized to provide full-load DC power to the inverter input while also charging the backup batteries at a rate sufficient to restore discharged batteries.	BOD 8.4.11
38a	The input power to battery charger for UPS system batteries shall be 480V AC, 3-phase, 60Hz. For small UPS units rated 5kVA and less, the input power may be 208V[ed.] 3-phase, or 120V AC single phase, 60Hz.	BOD 8.4.11
38b	UPS battery banks shall be sized to provide full UPS rated load the time necessary to safely shut down the associated components and systems and to supply the load profile developed for each UPS during the design process.	BOD 8.4.11
38c	The UPS shall be internally synchronized with the bypass supply to permit a high-speed changeover without interruption to the load.	BOD 8.4.11
38d	As a further safeguard and aid to maintenance, there shall be a hardwired maintenance bypass device on each UPS system.	BOD 8.4.11
39a	The 15kV and 5kV power cable shall be Class B stranded copper conductor with an extruded semiconducting layer, ethylene-propylene rubber (EPR) insulation, and shielding.	BOD 8.5.1
39b	The cable insulation shall be rated 133% and rated for continuous operation at 90°C (194°F), 130°C (266°F) for emergency overload operation and 250°C (482°F) for short circuit conditions, in accordance with applicable Insulated Cable Engineers Association (ICEA) standards.	BOD 8.5.1
40a	Power, lighting, motor feeder, and control cable shall be single conductor or multi-conductor, stranded copper conductors, rated 600V, 75°C or 90°F.	BOD 8.5.2
40b	All power and control wiring shall be standard copper flame-retardant insulated 75°C or 90°F type XHHW or FREP.	BOD 8.5.2
41a	Instrument cables shall be twisted single-pair shielded, triad-twisted shielded, or twisted multi-pair with individual shields or unshielded pairs with an overall shield and drain wire.	
41b	All instrument cable shall be fire-resistant and of a type listed and marked on the surface for use in cable trays.	BOD 8.5.3
41c	All instrument wiring shall be stranded.	BOD 8.5.3
41d	Fiber optic cable and field-bus can be used for most data network, voice, and video communication.	BOD 8.5.3
41e	For special applications, instrument cable may be supplied by the vendor and meet the vendor's design standard.	BOD 8.5.3

ATTACHMENT A – HIGH LEVEL REQUIREMENTS

ID#	High-Level Requirement	Source
42a	The minimum conductor size for scheduled power, control, and instrument circuits will be as listed below. Conductor sizes for vendor supplied cables, specialty cables, and wiring integral to components may vary from these requirements. Minimum Conductor Size (AWG): Power and lighting 480V and below — 12 Current transformer wiring — 10 120V AC/ 125V DC control and instrument power circuits — 14 Instrumentation - single pair or triad & dual pair cable (note 1) — 16 Instrumentation - multi-pair or triad cable (note 1) — 18 Communication cable (Fieldbus, Profibus) — 18-22 Note 1: Instrumentation conductors include low-level voltage, discrete and analog circuits.	BOD 8.5.5
42b	Control cables shall be multiconductor, and color-coded in accordance with the ICEA standard method.	BOD 8.5.5
42c	Approximately 10 % spare pairs will be provided in multi-pair control and instrumentation cables.	BOD 8.5.5
43	The design shall permit appropriate periodic inspection and testing of electrical equipment such as wiring, insulation, connections, and switchboards, to assess the continuity of the systems and the condition of their components.	ORD 16.1
44	Means shall be provided for the complete and safe isolation of electrically powered equipment. Isolation points shall be readily accessible, lockable in the de-energized position, and prevent unintentional or inadvertent re-energization.	ORD 16.1
45	The system design shall be consistent with industrial practices for highly reliable power supply systems. For example, the system should have the capability to periodically test: – The operability and functional performance of system components, such as onsite power sources, relays, switches, and buses. – The operability of the systems as a whole under conditions as close to design as practical, including operation of protective systems, and the transfer of power between normal and backup systems.	ORD 16.1
46	Equipment enclosures shall be suitable for the area classification in which they are installed.	ORD 16.1
47	Dry-type (rather than liquid filled) transformers shall be used where practical to minimize maintenance and reduce the risk of fire and/or explosion.	ORD 16.1
48	All electrical equipment, containment systems, and cabling shall be provided and labeled with unique identification numbers.	ORD 16.1

ATTACHMENT A – HIGH LEVEL REQUIREMENTS

ID#	High-Level Requirement	Source
49	To minimize utilities, the following measures will be considered: – Use of premium efficiency motors for pumps, fans, and other uses – Use of double- or triple-sized neutral conductors – Use of high efficiency dry-type transformers	ORD 16.1
50	Plant loads shall be divided into load groups A and B to facilitate maintenance and increase availability of plant loads.	ORD .16.2
51a	Switchgear shall be designed for its intended environment.	ORD 16.2
51b	Breakers shall be provided with multifunction protection relays with local indication.	ORD 16.2
52	Switchgear feeder and tie breakers shall be provided with remote position indication and strip status.	ORD 16.2
53	Low voltage switchgear featuring bus-tie breakers between alternate switchgear shall be provided with remote control, phase protective relays, and to the extent practical shall allow transfer of loads without interruption of power to supplied circuits. [Note: The LAW-EDS does not use bus-tie breakers.]	ORD 16.2
54	MCCs shall be provided with a minimum of spare starters/breakers intended for future operational growth, and not design growth.	ORD 16.2
55	Sequencing schemes shall be developed for the restoration of selected loads following a power failure. Consideration shall be given to restoration from emergency power, and returning to normal power without further power interruption when it again becomes available.	ORD 16.2
56	Monitoring instrumentation shall be capable of returning to normal operation following switching transients (for example, without requiring manual recalibration).	ORD 16.2
57	Power factor monitoring and automatic power factor correcting equipment shall be considered, to increase system current carrying capacity, improve voltage to equipment, and reduce power loss.	ORD 16.2
58	Uninterruptible power supplies (UPS) power sources shall be provided to support those monitoring and control loads that cannot tolerate a power interruption.	ORD 16.3
59	Battery rooms shall be environmentally controlled to optimize cell service life.	ORD 16.3
60	Hard-wired "bypass" devices shall be provided for all UPS system to facilitate maintenance.	ORD 16.3
61	Structures, systems, and components Important to Safety shall be designed and qualified to function as intended in the environments associated with the events for which they are intended to respond. The effects of aging on normal and abnormal functioning shall be considered in design and qualification.	SRD 4.4-1

ATTACHMENT A – HIGH LEVEL REQUIREMENTS

ID#	High-Level Requirement	Source
62	Structures, systems, and components Important to Safety shall be designated, designed and constructed to permit appropriate inspection, testing, and maintenance throughout their operating lives to verify their continued acceptability for service with an adequate safety margin.	SRD 4.4-2
63a	Electric power systems designated as Safety Significant shall be designed to ensure their operability under normal and accident conditions and the single failure criteria shall be considered for active components in the system.	SRD 4.4-5
63b	The design shall permit appropriate periodic inspection and testing of important areas and features, such as wiring, insulation, connections, and switchboards to assess the continuity of the systems and the condition of their components. The systems shall be designed with capability to periodically test: (1) the operability and functional performance of the components of the systems, such as onsite power sources, relays, switches, and buses (2) the operability of the systems as a whole and, under conditions as close to design as practical, the full operation sequence that brings the systems into operation, including operation of applicable portions of the protection system.	SRD 4.4-5

ATTACHMENT B – ADDITIONAL FOLLOW-UP ITEMS (AFI)

AFI: D-07-DESIGN-044-1: At the next drawing update, correct the duplicate instrument tag numbers (#2306) for the programmable trip units in compartments B4 and C5 of LVE-SWBD-20101 as shown on single-line drawing, 24590-LAW-E1-LVE-00003.

AFI: D-07-DESIGN-044-2; Ensure that when the new electrical calculations for cable sizing are issued, that MCC schedules, electrical single-line drawings (SLD), specifications, etc. are updated and revised to be consist with the calculations and with NEC Table 310.16 (as applicable).

AFI: D-07-DESIGN-044-3: Calculation, 24590-LAW-E1C-DCE-00001, LAW 125V DC System Battery Sizing needs to be updated to be consistent with current LAW electrical design.

AFI: D-07-DESIGN-044-4: Ensure system drawings for the Melter Electrode Power Supply (MEPS) system reflect the change to the power control module (from AC800PEC to AC800LC) before initiation of the build contract. Verify that test requirements are included in the build contract specification for the MEPS.

AFI: D-07-DESIGN-044-5: Reconcile the 1950kVA power value to the MEPS system as shown on single-line diagram (SLD), 24590-LAW-E1-MVE-00001, with the 1430kW power provided to the melter electrode.

AFI: D-07-DESIGN-044-6: Update or revise drawings, 24590-LAW-E8-UPE-00006 (for UPE-PNL-20046) and 24590-LAW-E8-UPE-00005 (for UPE-PNL-20045) to show UPS service to PSUP-20001 and PSUP-2002, respectively, as indicated on single-line diagram (SLD), 24590-LAW-E1-MVE-00004.

AFI: D-07-DESIGN-044-7: At the next update or revision of the BOD and ORD documents reconcile the differences in spare equipment requirements associated with starter/breakers in the MCCs. See Section 8.4.7 in the BOD and Section 16.2 in the ORD. Clarify what is meant by "minimum" as stated in the requirements.

AFI: D-07-DESIGN-044-8: At the next update or revision of the BOD, modify Section 8.4.11 to indicate that in some cases bypass transformers may not be necessary in the design. Also, correct and revise MCC schedules (and any other related documentation) that show service to bypass transformers where bypass transformers are actually not being used.

AFI: D-07-DESIGN-044-9: Update and revise ITS UPS panel schedules to correct load information discrepancies.

Task# ORP-WTP-2007-0183

E-STARS[R] Report
Task Detail Report
06/26/2007 0748

TASK INFORMATION			
Task#	ORP-WTP-2007-0183		
Subject	(Concur 07-WTP-170) TRANSMITTAL OF THE U.S. DEPARTMENT OF ENERGY, OFFICE OF RIVER PROTECTION (ORP) DESIGN OVERSIGHT REPORT, NUMBER D-07-DESIGN-044: REVIEW OF BECHTEL NATIONAL, INC.'S (BNI) LOW-ACTIVITY WASTE (LAW) FACILITY ELECTRICAL DISTRIBUTION DESIGN		
Parent Task#		**Status**	CLOSED 06/26/2007
Reference		**Due**	
Originator	Licht, Sarah (Licht, Sarah)	**Priority**	High
Originator Phone	(509) 373-0068	**Category**	None
Origination Date	06/11/2007 1313	**Generic1**	
Remote Task#		**Generic2**	
Deliverable	None	**Generic3**	
Class	None	**View Permissions**	Normal
Instructions	Hard copy of the correspondence is being routed for concurrence. Once you have reviewed the correspondence, please approve or disapprove via E-STARS and route to the next person on the list. Thank you. bcc: MGR RDG file WTP OFF file WTP RGD file M. K. Barrett, AMD T. M. Williams, AMD J. R. Eschenberg, WTP R. W. Griffith, WTP M. L. Ramsay, WTP		

ROUTING LISTS

1	Route List	Inactive
	• Ramsay, Mark L - Review - Cancelled - 06/26/2007 0748 *Instructions:*	
	• Griffith, Robert W - Review - Concur - 06/20/2007 0859 *Instructions:*	
	• Eschenberg, John R - Review - Concur - 06/25/2007 1025 *Instructions:*	
	• Olinger, Shirley J - Review - Concur with comments - 06/25/2007 1454 *Instructions:*	
	• Eschenberg, John R - Approve - Approved - 06/26/2007 0747 *Instructions:*	

ATTACHMENTS

Attachments	1. 07-WTP-170.MLR.Albert.doc

Task# ORP-WTP-2007-0183	
	2. 07-WTP-170.MLR.Attach.LAW-ElectricalAssessment.doc
COLLABORATION	
COMMENTS	
Poster	Olinger, Shirley J (Poynor, Cathy D) - 06/25/2007 0206
	Concur
	signed by Zack for SJO
TASK DUE DATE HISTORY	
No Due Date History	
SUB TASK HISTORY	
No Subtasks	

-- end of report --

Task# ORP-WTP-2007-0183

E-STARS™ Report
Task Detail Report
06/19/2007 0737

TASK INFORMATION			
Task#	ORP-WTP-2007-0183		
Subject	(Concur 07-WTP-170) TRANSMITTAL OF THE U.S. DEPARTMENT OF ENERGY, OFFICE OF RIVER PROTECTION (ORP) DESIGN OVERSIGHT REPORT, NUMBER D-07-DESIGN-044: REVIEW OF BECHTEL NATIONAL, INC.'S (BNI) LOW-ACTIVITY WASTE (LAW) FACILITY ELECTRICAL DISTRIBUTION DESIGN		
Parent Task#		**Status**	Open
Reference		**Due**	
Originator	Licht, Sarah	**Priority**	High
Originator Phone	(509) 373-0068	**Category**	None
Origination Date	06/11/2007 1313	**Generic1**	
Remote Task#		**Generic2**	
Deliverable	None	**Generic3**	
Class	None	**View Permissions**	Normal
Instructions	Hard copy of the correspondence is being routed for concurrence. Once you have reviewed the correspondence, please approve or disapprove via E-STARS and route to the next person on the list. Thank you. bcc: MGR RDG file WTP OFF file WTP RGD file M. K. Barrett, AMD T. M. Williams, AMD J. R. Eschenberg, WTP R. W. Griffith, WTP M. L. Ramsay, WTP		

ROUTING LISTS

1	Route List	Active
	• Ramsay, Mark L - Review - Awaiting Response *Instructions:* MLR 6/19/07	
	• Griffith, Robert W - Review - ~~Awaiting Response~~ *Instructions:* RWG 6/19/07	
recvd 6/20/07	• Eschenberg, John R - Review - Awaiting Response *Instructions:* OK w/ change JRE 6/22/07	
[illegible]	• Olinger, Shirley J - Review - Awaiting Response *Instructions:* SJO for 6/25/07	
recvd 6/25/07	• Eschenberg, John R - Approve - Awaiting Response *Instructions:*	

ATTACHMENTS

Attachments	1. 07-WTP-170.MLR.Albert.doc 2. 07-WTP-170.MLR.Attach.LAW-ElectricalAssessment.doc

Task# ORP-WTP-2007-0183
COLLABORATION
COMMENTS
No Comments
TASK DUE DATE HISTORY
No Due Date History
SUB TASK HISTORY
No Subtasks

-- end of report --