License Agreement

THIS LICENSE AGREEMENT ("Agreement") is made as of ___________________________ by and between the City of Fullerton, a California municipal corporation (the "City") and Raytheon Company, a Delaware corporation ("Raytheon") (collectively "Parties").

WHEREAS, the City owns certain real property and improvements (Well 9) thereon located at 4000 Artesia Avenue in Fullerton Municipal Airport, Fullerton, California (the "Property"); and

WHEREAS, Raytheon is a voluntary and willing party in implementing corrective measures for remediating the level of the solvent specifically referred to as 1,1-DCE, and the intent of the proposed work by Raytheon is to improve the water quality in the City's Production Well 9 by blocking the infiltration of 1,1-DCE into drinking water supply; and

WHEREAS, Raytheon conducted a packer testing program at the City production Well 9 in coordination with the City to evaluate the water quality associated with selected well screen intervals; and

WHEREAS, the City has opted to isolate the lower two screens of Well 9 allowing Raytheon to replace the existing equipment with a new packer, pump and motor; and

WHEREAS, Raytheon desires access to the Property to have its consultant, Hargis + Associates, Inc., perform the Scope of Work, as described on Exhibit A; and

WHEREAS, the Parties entered into a License Agreement for the same scope of work on December 15, 2017; and

WHEREAS, for the mutual benefit of both Parties, the Parties wish to further define Raytheon's responsibilities with the regard to continuing water and electrical costs and expenses that will be incurred after the performance of the scope of work.

NOW, THEREFORE, in consideration of the mutual benefits to be derived from the City allowing Raytheon to perform the Scope of Work on the Property, the City and Raytheon hereby covenant and agree as follows:

1. Grant of Temporary License. The City hereby grants and conveys to Raytheon, its contractors, subcontractors, consultants, employees and agents (herein "Representatives") temporary and revocable permission to enter upon and access the Property to perform the Scope of Work.

2. Rights and Responsibilities of both Parties and Conditions of Entry. The foregoing rights and restrictions shall be expressly subject to the following terms and conditions:

   a. Raytheon and its Representatives shall have access only at reasonable times pre-arranged with the City's Contact set forth below.

   b. The Scope of Work performed by Raytheon on or at the Property shall be carried out in a manner so as to reasonably minimize any damage to the Property. Raytheon shall request the City for any storage of equipment or materials on the Property during the performance of the Scope of Work. Approval to store any equipment or materials must be obtained from both the Airport Manager and Water System Manager so as not to hinder Airport operations and Water Division operations. After performing the Scope of Work, Raytheon shall repair and restore the Property to substantially the same condition or better as it was in immediately preceding performance of the Scope of Work.

c. The Scope of Work shall be performed in compliance with all applicable laws, rules, regulations, ordinances, permits (including without limitation a business license and no-fee encroachment permit) and guidelines and in a reasonably prompt manner. The Scope of Work shall also be conducted in accordance with good and safe business practices. Raytheon shall not suffer or permit to be enforced against the Property any mechanic's, materialman's, contractor's or subcontractor's liens or any claim for damage arising from the Scope of Work and shall pay any and all such liens before any action is brought to enforce such liens.

d. All costs and expenses incurred or to be incurred in the performance of the Scope of Work by Raytheon shall be the sole responsibility of Raytheon at no cost to the City of Fullerton, including the cost of import water to replace Well No. 9 water supplies and any incremental Metropolitan Water District of Southern California (MWD) capacity charges if the Scope of Work extends beyond the original schedule reasonably agreed to by the Parties. Import water cost calculation will be based on current Well No. 9 production capacity of up to 2,200 gallons per minute (gpm) by the then current MWD import water rate and reduced by the cost of Orange County Water District Replenishment Assessment fees (per acre foot) and electrical costs that would have been incurred during operation of Well 9. Payment for incremental MWD capacity charges shall be determined at the sole discretion of the City. MWD capacity charge is imposed for a three-year period and is based on peak day demand. Raytheon's responsibility for the increase to the capacity charge based on incremental peak day demand shall not exceed 2,200 gpm or 4.90 cfs with Raytheon's responsibility to pay the City lasting as long as the increased charge applies. The City will provide an invoice to Raytheon with payment due no later than the 25th of the following month. If payment is not received by the 25th, interest in the amount of 10% per annum will be applied.

e. All costs and expenses incurred or to be incurred by the packer system installation onto Well No. 9 and its associated appurtenances, including but not limited to mechanical, structural, and electrical repairs, shall be the sole responsibility of Raytheon.

f. Any cost incurred necessary or needed to upgrade the pump/motor/electrical panel to meet the initial design pumping production rate of 2,500 gpm at a total dynamic head of 425 feet shall be the sole responsibility of Raytheon.

g. All costs and expenses incurred or to be incurred after the performance of the Scope of Work by Raytheon shall be the sole responsibility of the City, with the exception of the following costs which shall be Raytheon's sole responsibility: (a) payment for water pumped from Well 9 during disinfection, calculated by the volume of water pumped to the sewer during disinfection, at the rate that Orange County Water District charges the City for water pumped from Well 9, plus an administrative fee of ten percent (10%) of said costs of water pumped to the sewer to cover City costs for tracking and (b) starting in 2028, to the extent the isolation packer is still operating at that time, any incremental electrical charges associated with the greater pumping lifts when the packer is inflated, plus an administrative fee of ten percent (10%) of said incremental electrical charges to cover City costs for tracking.

h. Warranty. Raytheon shall warrant the initial installation of the well packer as described in the Scope of Work against defective materials and workmanship for a period of one (1) year from the date of completion of said work as confirmed by the City in writing ("Warranty Period"). All warranties, express or implied, from subcontractors, manufacturers, or suppliers of any tier for materials furnished or work performed shall be assigned to the City and such warranties shall be delivered to the City prior to acceptance of Raytheon's completion of said installation. Raytheon shall replace or repair defective materials and workmanship in a manner satisfactory to the City, after notice to do so from the City, and within a timeframe reasonably agreed on by the parties. If Raytheon fails to make such replacement or repairs within said timeframe, the City may perform the replacement or repairs at Raytheon's expense.

3. Indemnification. Raytheon shall indemnify, protect, hold harmless and defend the City and its officials, officers, employees, agents, volunteers, attorneys and affiliates, and their successors and assigns (collectively, the "Indemnitees") from and against any and all claims, damages, losses, liens, costs, liabilities, fines and penalties, damage to or destruction of property, and death or injury to any person (collectively, "Losses"), caused by the performance of the Scope of Work on the Property pursuant to the provisions of this Agreement, or failure to comply with this Agreement, except where such Losses are caused by the sole or active negligence or willful misconduct of any of the Indemnitees.

4. Insurance. Raytheon shall provide insurance coverage pursuant to the terms set forth in Exhibit B attached hereto.

5. No Admission. No provision of this Agreement constitutes an admission of Raytheon or the City that any condition at or arising from the Property constitutes a release of Hazardous Substances defined as (a) any agent, pollutant, contaminant, waste, chemical or other substance, material (whether solid, liquid or gas) that is currently regulated by any government entity, including any that is defined or clarified as a "pollutant," "contaminant," "toxic waste," "hazardous substance" "toxic substance," "hazardous constituent," "extremely hazardous waste," "restricted hazard waste," or a work, term, or phrase of similar meaning or regulatory effect under any environmental law, and (b) petroleum or an derivative or by-product thereof, radon, radioactive material, or asbestos, or asbestos containing material, urea formaldehyde foam insulation, off specification commercial chemical product, solid waste, infectious medical waste, leased

based paint, lead, mold, mold spores and mycotoxins or polychlorinated biphenyls. No provision of this Agreement constitutes an admission by Raytheon or the City that it is liable for the clean-up of, or otherwise responsible for, any Hazardous Substances, if any, at the Property.

6. Notices. Any notice, communication, report or demand required or desired to be given under this Agreement shall be in writing and shall be deemed to have been received for all purposes if it is delivered (I) personally, (II) by overnight courier prepaid by the sender or (iii) by registered or certified mail, return receipt requested, postage prepaid, to the parties at the addresses shown below or at such other address as the respective parties may from time to time designate by like notice. Each such notice shall be effective upon being so delivered. Such addresses shall be the following:

To the City: City of Fullerton
Attn: Meg McWade
City of Fullerton Public Works Director
303 West Commonwealth Avenue
Fullerton, California 92832

To Raytheon: Raytheon Company
870 Winter Street
Waltham, MA 02451
Attn: EHSS Counsel

or to such other addresses as the parties may designate from time to time by written notice to the other.

7. Termination of Agreement. If either Party fails to observe the conditions of this Agreement after notice from the other Party and a reasonable opportunity to cure, this Agreement may be terminated by the non-defaulting Party without further notice; provided, however, that in the event of a material violation of this Agreement by Raytheon, this Agreement may be terminated on three (3) days' notice without providing Raytheon an opportunity to cure the default. If the City terminates this Agreement due to Raytheon default and prior to Raytheon's completion of the installation of the well packer as described in the Scope of Work, the City may contract with a third party to complete said work and Raytheon shall reimburse the reasonable costs thereof within sixty (60) days. The City may terminate this Agreement for any or no reason with thirty (30) days' prior notice to Raytheon, in which case the rights and obligations of each party shall terminate.

8. Termination of Previous Agreement. On the effective date of this Agreement, the previous License agreement between the Parties, regarding the same subject matter, dated December 15, 2017 shall be terminated and superseded by the herein Agreement.

9. Miscellaneous.

a. Captions. The captions of the sections of this Agreement are for convenience only and shall not be considered or referred to in resolving questions of interpretation and construction.

b. Governing Law. This Agreement shall be construed, interpreted and applied in accordance with the internal laws of the State of California, without regard to principles of conflicts of law.

c. Integration; Amendment. This Agreement may not be altered, modified, or amended unless by an instrument in writing duly executed by each of the parties then bound by this Agreement. This Agreement constitutes all of the agreements and understanding of the parties concerning the subject matter contained herein and supersedes all prior oral or written agreements, applications, waivers or understandings.

d. No Partnership or Agency Created. This Agreement is not intended, nor shall it be construed, as constituting a partnership or joint venture among the parties hereto, or as constituting any party the agent of any other party, or to render any party liable for the debts or obligations of any other party.

e. Severability. If any one or more of the provisions of this Agreement shall for any reason be held invalid, illegal or unenforceable in any respect, that invalidity, illegality or unenforceability shall not affect any other provision herein and this Agreement shall be construed as if the invalid, illegal or unenforceable provision had never been included, provided, however, in no event shall either party be deprived of a material consideration by operation of this provision.

f. Assignment. Raytheon shall have the right to assign all or any portion of this Agreement or any of its interests herein to any affiliate of Raytheon or successor corporation, with notice to the City, but any other assignment shall require the City's consent and in no event shall Raytheon be released from its obligations under this Agreement.

g. Binding Effect. Subject to the limitations set forth in Section 9(f) above, this Agreement shall be binding upon and inure to the benefit of the parties hereto and their respective heirs, legal representatives, tenants, lenders, and successors and assigns.

h. Warranty of Authorized Signatories. Each of the signatories hereto warrants and represents that he or she is competent and authorized to enter into this Agreement on behalf of the party for whom he or she purports to sign.

i. Reservation of Rights. Each of the rights of the parties set forth in the individual sections of this Agreement are in addition to, and not exclusive of, the rights of such party, at law, in equity or otherwise. No damages or remedies available to a party at law, in equity or otherwise, shall be deemed or construed to be limited by or under the terms of this Agreement.

j. Electronic Signatures. This Agreement may be executed by electronic signature (including without limitation DocuSign, Adobe Sign, and scanned signature pages) and delivered by email or other electronic method pursuant to the U.S. Electronic Signatures in Global and National Commerce Act or applicable state law.

Executed as of the date first written above.

CITY OF FULLERTON, a municipal corporation

By: ______________________________
Name: Ken Domer
Title: City of Fullerton, City Manager

RAYTHEON COMPANY, a Delaware corporation

By: ______________________________
Name: David Platt
Title: Vice President & Associate General Counsel
EH&S/Real Estate

Approved as to Form:

____
Name: Richard D. Jones
Title: City Attorney

Exhibit A

Scope of Work

1. Install semi-permanent packer system along with a new pump system to isolate the lower two screens of City Well 9. The semi-permanent packer system consists of: an inflatable packer and associated appurtenances; pump shroud; and drop pipe between the inflatable packer and pump shroud. The new pump system consists of: an appropriately sized turbine pump and motor; pump column pipe, line shaft, and associated appurtenances; and well discharge head.

2. Any modifications required for the new pump system to tie into the electrical service will be coordinated with Southern California Edison (SCE) and the City. Raytheon, through its consultant Hargis and Associates, Inc. shall provide all engineering designs/specifications for the semi-permanent packer system, new pump system, and electrical equipment to meet the production rate as specified in Section 2-f and coordinate the design parameters with the City Water Division prior to Raytheon's procurement of equipment. The installation of the semi-permanent packer and new pump systems will include removal of the existing pump motor, discharge head, and downhole equipment from Well 9 along with disinfection of the well following installation of the semi- permanent packer, new pump systems, and electrical equipment . The Parties acknowledge that the City has approved the basis of design pursuant to a Technical Memorandum from Hargis and Associates, Inc. dated November 15, 2017 attached hereto as Exhibit C and a Technical Memorandum from Hargis and Associates, Inc. dated November 28, 2018 attached hereto as Exhibit D and acknowledge that the equipment has been procured.

3. Provide maintenance of the inflatable packer system during the City's operation of Well 9. Maintenance will include providing nitrogen gas to inflate packer and repairing/replacing the inflatable packer system components to the extent required with the understanding that the repair/replacement would be implemented during low water demand periods to avoid temporary loss of water supply during the repair/replacement. The repairing/replacement of inflatable packer system would likely require removing the motor, discharge head, and downhole equipment from Well 9 along with disinfection of the well following installation of the repaired/replaced inflatable packer system.

4. At a time when the semi-permanent packer system is not required or when the City decides to discontinue the inflated packer system at Well 9, the components of the semi-permanent pump system will be removed from Well 9. The removal of the semi-permanent packer system will require: removing motor, discharge head and downhole equipment from Well 9; reinstallation of the pump system without the semi-permanent packer system; and disinfection of the well following installation of the pump system. The pump system shall be capable of delivering 2,500 gpm.

5. The schedule of work shall be reasonably agreed on by the parties.

Exhibit B

Standard Insurance Requirements

Raytheon shall procure and maintain throughout the duration of this Agreement, insurance against claims for injuries to persons or damages to property which may arise from or in connection with the performance of the work hereunder by Raytheon, his agents, representatives, employees, consultants or subcontractors. Raytheon shall provide current evidence of the required insurance in a form acceptable to the City and shall provide replacement evidence for any required insurance which expires prior to the completion, expiration or termination of this Agreement.

Nothing in this section shall be construed as limiting in any way, the Indemnification and Hold Harmless clause contained in the License Agreement or the extent to which Raytheon may be held responsible for payments of damages to persons or property.

I. Minimum Scope and Limits of Insurance

A. Commercial General Liability Insurance. Raytheon shall maintain commercial general liability insurance coverage in a form at least as broad as ISO Form #CG 00 01, with a limit of not less than $5,000,000 each occurrence. If such insurance contains a general aggregate limit, it shall apply separately to the Agreement or shall be twice the required occurrence limit.

B. Business Automobile Liability Insurance. Raytheon shall maintain business automobile liability insurance coverage in a form at least as broad as ISO Form # CA 00 01, with a limit of not less than $1,000,000 each accident. Such insurance shall include coverage for owned, hired and non-owned automobiles.

C. Workers' Compensation and Employers' Liability Insurance. Raytheon shall maintain workers' compensation insurance as required by the State of California and employers' liability insurance with limits of not less than $1,000,000 each accident.

D. Professional Liability Insurance. Raytheon shall maintain professional liability insurance appropriate to Raytheon's profession with a limit of not less than $5,000,000. If policy is written as a "claims made" policy, the retro date of the policy shall be prior to the start of the contract work.

E. Non-limiting. Nothing in this Section shall be construed as limiting in any way, the indemnification provision contained in this Agreement, or the extent to which Raytheon may be held responsible for payments of damages to persons or property.

II. Captive Insurance

Raytheon may insure any of the coverages described herein through one or more insurance companies wholly-owned by Raytheon Company or any parent companies, subsidiaries, or affiliates ("Captive Insurer"), provided that this right shall be personal to Raytheon Company and any parent companies, subsidiaries, or affiliates, and shall not apply to any unaffiliated assignees or successors-in-interest.

III. Other Insurance Provisions

The required insurance policies shall contain or be endorsed to contain the following provisions:

A. Commercial General Liability

1. The City, its elected or appointed officials, officers, and employees are to be covered as additional insureds with respect to liability arising out of work or operations performed by or on behalf of Raytheon, including materials, parts or equipment furnished in connection with such work or operations. Such coverage as an additional insured shall not be limited to the period of time during which the Raytheon is conducting ongoing operations for the City but rather, shall continue after the completion of such operations. The coverage shall contain no special limitations on the scope of its protection afforded to the City, its officers, or employees.

This insurance shall be primary insurance as respects the City, its officers, employees and volunteers and shall apply separately to each insured against whom a suit is brought or a claim is made. Any insurance or self-insurance maintained by the City, its officers, and employees shall be excess of this insurance and shall not contribute with it.

B. Professional Liability.

If the Professional Liability policy is written on a "claims made" basis:

1. The Retroactive Date must be shown and must be before the date of the agreement or the beginning of contract work.
2. Insurance must be maintained and evidence of insurance must be provided for at least five (5) years after completion of the contract work.
3. If coverage is canceled or non-renewed, and not replaced with another claims made policy form with a Retroactive Date prior to the agreement effective date, Raytheon must purchase "extended reporting" coverage for a minimum of five (5) years after the completion of the contract work.

C. Waiver of Subrogation.

Raytheon hereby grants to City a waiver of any right to subrogation which any insurer may require against the City by virtue of the payment of any loss under such insurance. Raytheon agrees to obtain any endorsement that may be necessary to affect this waiver of subrogation but this provision applies regardless of whether or not the City has received a waiver of subrogation endorsement from the insurer(s).

D. All Coverages.

Raytheon shall not cancel any of the insurance policies described above except with notice to the City.

If Raytheon maintains higher insurance liability limits or has broader coverage than the minimum insurance liability limits shown above, the City requires and shall be entitled to all coverage, and to the higher insurance liability limits maintained by Raytheon. Any available insurance proceeds in excess of the specified minimum insurance liability limits and coverage shall be available to the City.

E. Subcontractors/sub-consultants.

Raytheon shall require and verify that all its subcontractors/sub-consultants maintain insurance meeting all the requirements stated herein and Raytheon shall ensure that City is an additional insured on insurance required from subcontractors. Notwithstanding the foregoing, the City shall reasonably waive or reduce certain requirements based on the scope of work of any subcontractor/sub-consultant and associated risk.

F. Special Risks or Circumstances

City reserves the right to reasonably modify these requirements, including limits, based on the nature of the risk, prior experience, insurer, coverage or other special circumstances.

IV. Acceptability of Insurers

All required insurance other than insurance placed with a Captive Insurer shall be placed with insurers with current A.M. Best's ratings of no less than A, Class VII. Workers' compensation insurance may be placed with the California State Compensation Insurance Fund. All insurers shall be authorized to write business in the State of California.

V. Verification of Coverage

Raytheon shall furnish the City with certificates of insurance which bear original or electronic signatures of authorized agents and which reflect insurer's names and addresses, policy numbers, coverage, and limits. All certificates must be received and approved by City before work commences.

Exhibit C

Technical Memorandum dated November 15, 2017

[see attached]

HARGIS + ASSOCIATES, INC.
HYDROGEOLOGY • ENGINEERING

La Jolla Gateway
9171 Towne Centre Drive, Suite 375
San Diego, CA 92122
Phone: 858.455.6500
Fax: 858.455.6533

Technical Memorandum

Via: EMAIL Project No: 532.81

Date: November 15, 2017

To: Ms. Tiffany Foo
CITY OF FULLERTON - PUBLIC WORKS DEPARTMENT
Water Engineering Division
303 W. Commonwealth Avenue
Fullerton, CA 92832-2728

cc: Mr. Paul E. Brewer, Raytheon Company

From:

Roger Niemeyer, PG 3616 Jim Schwall, PE CH5044

Re: Basis of Design for Well Equipment, City of Fullerton Production Well No. 9, Former Raytheon Company (Formerly Hughes Aircraft Company) Site, 1901 West Malvern Avenue, Fullerton, California – Revision 1.0

This memorandum has been prepared by Hargis + Associates, Inc. (H+A) on behalf of the Raytheon Company to provide the basis of design for proposed new well equipment at the City of Fullerton's Production Well No. 9 (Well 9). The well equipment outlined in this memo is a voluntary effort and includes installation of well packer and associated controls, new turbine pump, motor, column pipe and accessories.

Well 9 is located on the north boundary of the Fullerton Airport (Figure 1) and is routinely used for municipal water supply. Well 9 is approximately 1,080 feet deep and was constructed with 7 separate screen intervals (Figure 2). Well 9 is currently fitted with a nominal 16 inch shaft driven turbine pump with 15 inch diameter bowls with intake set at approximately 231 feet.

The design basis is outlined for each well component and the design and vendor data have been attached.

DESIGN BASIS: The basis of design for Well 9 is based on requirements provided by the City of Fullerton, and hydraulic properties of the groundwater system (H+A, Feb 21, 2017).

Design Parameter	Well 9	Source	Comments
Design Flowrate	2,500 gallon per minute (gpm)	City of Fullerton	
Design Pressure (System) Measured at Wellhead	90 pounds per square inch gauge	City of Fullerton	Water delivery pressure measured at gauge on wellhead
Pump Motor Voltage	480 volt, 3 phase	City of Fullerton Design	
Pump Speed	1200 revolutions per minute (RPM)	City of Fullerton	
Median Static Depth to Water (Design)	96 feet below measuring point (bmp)	H+A (Attachment 1)	Median calculated using Well 9 water level data 8/2001 to 6/2017
High Static Depth to Water	55 feet bmp	H+A (Attachment 1)	Based on water level observed in Well 9 May 2006
Low Static Depth to Water	127 feet bmp	H+A (Attachment 1)	Based on water level observed in Well 9 December 2008
Well Specific Capacity	23 gpm/foot	H+A (Attachment 2)	Data developed during packer testing
Nominal Column Pipe Diameter	12-inches	City of Fullerton	
Design Pressure (friction) Loss Allowance (Column pipe, wellhead)	12 feet of H2O Column	H+A and Layne Christensen	
Centerline Packer Installation Location	900 feet/40 feet above second screen from the bottom of the well	H+A (Attachment 2)	Data developed during packer testing
Water Temperature	68 degrees Fahrenheit	H+A	
Atmospheric Pressure	14.7 pounds per square inch absolute	Atmospheric pressure at sea level, Perry's Chemical Engineering Handbook, 6th Ed.	City of Fullerton Municipal Airport is 96 feet above mean sea level

PROPOSED EQUIPMENT: The proposed well equipment selected based on the basis of deign includes the following:

<u>1. Well Pump:</u> Simflo SK16C Line Shaft Turbine Pump (11 Stage) – Design Point 2,500 gpm at 425 feet of total dynamic head. Nominal speed 1,200 RPM. Manufacturer's Standard Material, with the following material changes: Impeller material A582-316 Grade 316SS; coupling, bowl shaft material A582-304 Grade 304SS; collet, impeller material A582-416 Grade 416SS; and bolting material A582-316 Grade 316. Data sheets and engineering data have been summarized (Attachment 3).

2. Pump Motor: US Motors, Nidec Motor Corporation, 350 Horsepower, Premium Efficiency, 1200 RPM, Weather Protected Type 1, Frame 5000PH. Data sheets and engineering data have been summarized (Attachment 4).

3. Column Pipe and Couplings: Epoxy coated/lined column pipe, 12-inch nominal diameter, material American Society for Testing and Materials (ASTM) A53 Grade B, 12-3/4-inch outer diameter, schedule 40, 0.375-inch wall thickness, straight thread for coupling. Column pipe consists of twenty-four 10-foot sections and two 5-foot sections. Pump set at 250 feet below reference elevation. Column pipe coupling, Straight coupling, 12-inch nominal size, material A108 Grade 1020. Data sheet and engineering data have been summarized (Attachment 5).

4. Pump Shaft, Shaft Couplings, Retainers and Inserts: Pump shaft, 1-15/16-inch size, material ASTM A582-416 Grade 416SS, 10THD Threaded. Pump shaft consists of twenty-four 10-foot sections and two 5-foot sections. Pump set at 250 feet below reference elevation. Pump shaft coupling, Shaft coupling, 1-15/16-inch, Material A582-304 Grade 304SS, 10THD Threaded. Coupling count 27. Retainers with Rubber Bearings, 12-inch by 1-15/16-inch size, retainer material A582-304 Grade 304SS, drop-in type, Neoprene Rubber. Retainers count 26. Data sheet and engineering data have been summarized (Attachment 5).

5. Well Pump Head: (Existing). Pump head to be sand blasted and epoxy coated.

6. Pump Shroud: Pump shroud custom fabrication by Baski, Inc., similar to current shroud, 18-inch nominal diameter by 23-feet long, material ASTM A53 Grade B, 18-inch outer diameter, 0.375-inch wall thickness. Fabricated flanged, beveled for field weld for assembly. Fins and integral guides based on pump drawings. Data sheet and engineering data to be provided with packer information under separate cover.

7. Packer Drop Pipe and Couplings: Epoxy coated/lined drop pipe, 4-inch nominal diameter, material ASTM A53 Grade B, 4.5-inch outer diameter, 0.237-inch wall thickness, straight thread for coupling. Drop pipe consists of sixty-two 10-foot sections and two 5-foot sections. Packer set at 900 feet below reference elevation. Column pipe coupling, Straight coupling, 4-inch nominal size, material A108 Grade 1020. Data sheet and engineering data have been summarized (Attachment 5).

8. Well Packer and Controls: Well Packer, Baski Model FCP13.5SS custom design for well. Packer air supply lines will consist of ¼-inch nominal, 316 stainless steel and tube fittings. Product and engineering data to be provided below and have been summarized (Attachment 6).

Design Parameter	Well Packer	Source	Comments
Dimensions	13.5 inches OD (uninflated) by 11 to 12 feet long	Baski	
Inflated Diameter	Equal to blank casing ID = 15.5 inch	Hargis	

Design Parameter	Well Packer	Source	Comments
Set Depth	900 feet	Hargis	
Materials of Construction	Metal components: 304L and 316L Stainless steel Bladder: natural rubber with polyester reinforcing	Baski	
Through Pipe	4.5” API 8rnd Short casing threads on both ends	Baski	
Liquid Inflation Chamber Capacity	26 gallons	Baski	
Inflation Liquid	Distilled water	Baski	
Inflation Gas	Nitrogen	Baski	
Minimum Inflation Pressure	50 psi above highest head zone (above or below packer)	Baski	
Inflation Tubing	Twin ¼” 316L stainless steel tubing	Baski	
Packer Control Panel	Manufacturer’s Standard	Baski	Attachment 6

9. Pump Motor Controls: Pump motor controls and electrical distribution are pending field inspection by electrical contractor and utility representatives.

Figures

Figure 1. Well and Piezometer Locations
Figure 2. Proposed Pump and Packer Diagram Fullerton Well #9

Attachments

Attachment 1: City of Fullerton Well 9 Water Level Data (Email from T. Foo City of Fullerton to C. Ross H+A, August 29, 2017)
Attachment 2: Hargis + Associates, Inc. Technical Memorandum dated February 21, 2017
Attachment 3: Simflo Pump Vendor Literature
Attachment 4: US Motor Vendor Literature
Attachment 5: Column Pipe Vendor Literature (Layne Proposal Sheet)
Attachment 6: Packer Vendor Literature

References

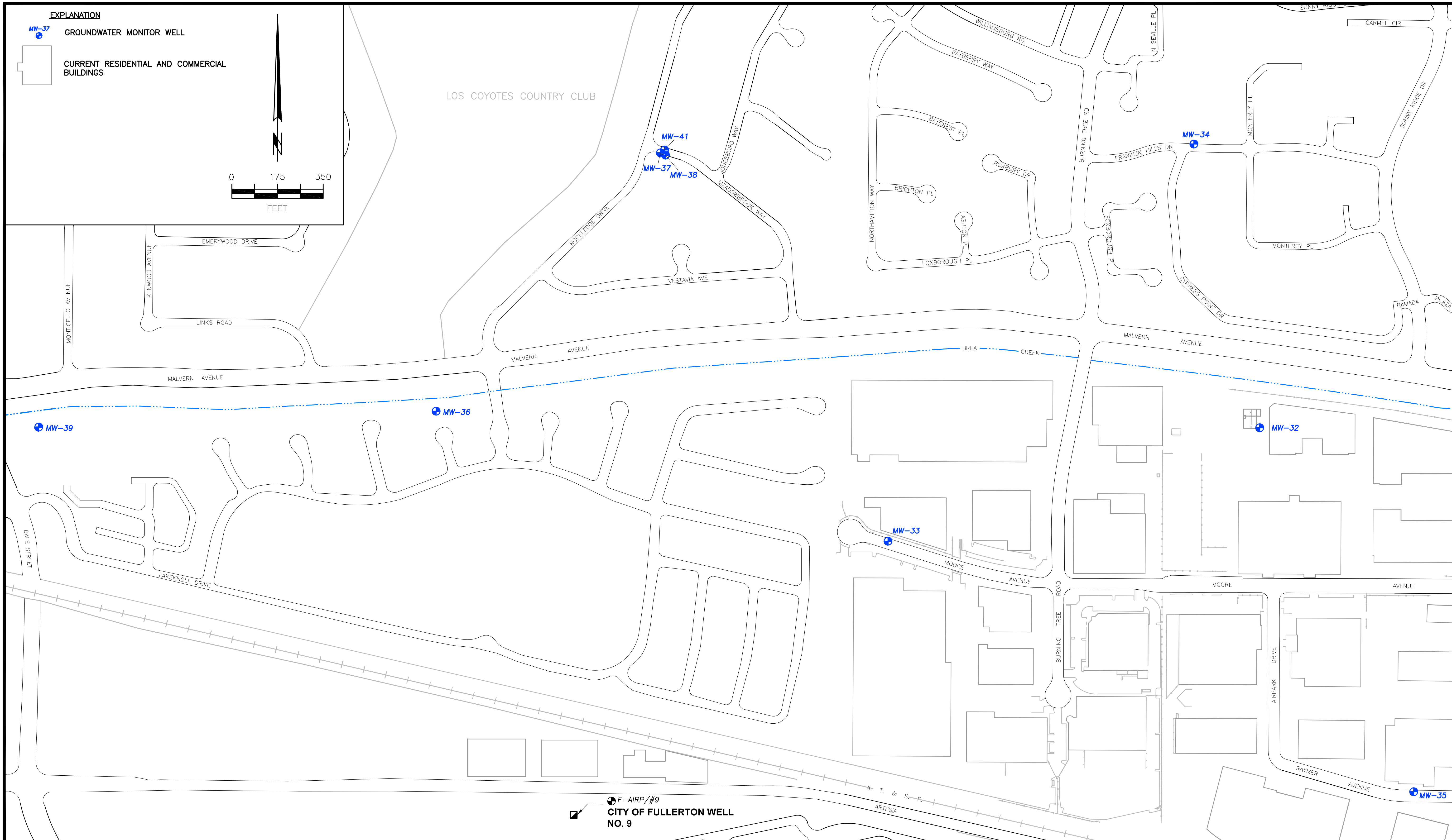
Hargis + Associates, Inc., 2017. Technical Memorandum to P. Nguyen, City of Fullerton, Re: Summary of Second Packer Test Results, October through December 2016, City of Fullerton Production Well No. 9, Former Raytheon Company (Formerly Hughes Aircraft Company) Site, 1901 West Malvern Avenue, Fullerton, California, dated February 21, 2017.

Perry, R. H, and Green, D. W., Editors, 1984. Perry’s Chemical Engineers’ Handbook. 6th Edition. McGraw-Hill, 1984.

City of Fullerton accepts this Basis of Design.

Signature

11/15/17
Date



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HARGIS + ASSOCIATES, INC
Hydrogeology/Engineering

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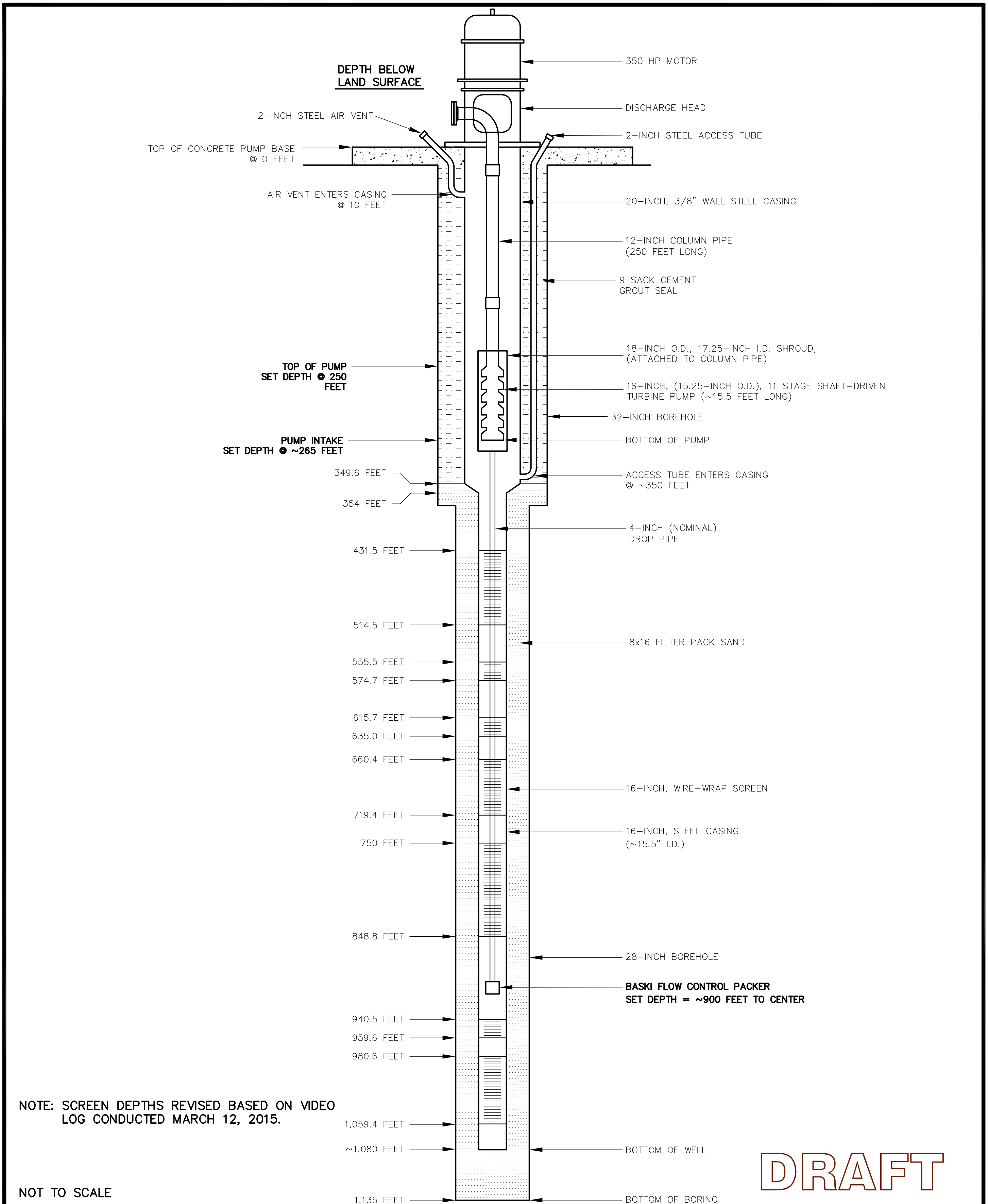
FIGURE 1.
WELL AND PIEZOMETER LOCATIONS



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HARGIS + ASSOCIATES, INC.
Hydrogeology/Engineering

FIGURE 2.
PROPOSED PUMP AND PACKER DIAGRAM
FULLERTON WELL #9

HARGIS + ASSOCIATES, INC.

ATTACHMENT 1

CITY OF FULLERTON WELL 9 WATER LEVEL DATA

Attachment 1
Water Level Data, City of Fullerton Well 9

Date (MM/DD/YYYY)	Hours Since Pump On/Off	Reference Point to Water Level (feet)	Comments
8/28/2001	.5OFF	117	
3/25/2003	24 OFF	82.0	
4/21/2003	.5OFF	103.0	
5/29/2003	.5OFF	105.0	
6/26/2003	.5OFF	108.0	
7/30/2003	.5OFF	107	
8/25/2003	.5OFF	105.0	
9/25/2003	.5OFF	115.0	
12/22/2003	24	93.0	
1/29/2004	24	80.0	
3/23/2004	24	76.0	
4/21/2004	24	77.0	
5/19/2004	24	80.0	
6/28/2004	24	85.5	
7/23/2004	24	87.5	
8/26/2004	24	90.0	
9/27/2004	24	92.0	
10/25/2004	24	89.0	
11/30/2004	24	85.5	
12/28/2004	24	86.0	
1/27/2005	24 OFF	86.0	
2/24/2005	24 OFF	75.0	
3/29/2005	24 OFF	72.0	
4/26/2005	24 OFF	86.0	
5/26/2005	24 OFF	82.0	
6/30/2005	24 OFF	78.0	
7/28/2005	0.5 OFF	93.0	
8/31/2005	0.5 OFF	97.5	
9/29/2005	0.5 OFF	83.0	
10/27/2005	24 OFF	81.0	
11/28/2005	24 OFF	67.0	
12/20/2005	24 OFF	64.0	
1/26/2006	24 OFF	58.0	
2/28/2006	24 OFF	56.0	
3/31/2006	24 OFF	59.0	
4/27/2006	24 OFF	56.0	

Attachment 1
Water Level Data, City of Fullerton Well 9

Date (MM/DD/YYYY)	Hours Since Pump On/Off	Reference Point to Water Level (feet)	Comments
5/16/2006	24 OFF	55.0	
6/30/2006	24 OFF	87.0	
7/25/2006	24 OFF	64.0	
8/29/2006	24 OFF	65.0	
9/27/2006	24	63.0	
10/23/2006	24	64.0	
11/28/2006	24 OFF	72.0	
12/20/2006	24 OFF	68.0	
1/31/2007	0.5 ON	77.0	
2/26/2007	0.5 ON	81.0	
3/29/2007	0.5 OFF	83.0	
4/24/2007	24 OFF	67.0	
5/28/2007	0.5 OFF	88.0	
6/25/2007	24 OFF	91.0	
7/25/2007	0.5 OFF	109.0	
8/29/2007	0.5 OFF	104.0	
9/19/2007	0.5 OFF	105.0	
10/25/2007	24 OFF	111.0	
11/27/2007	0.5 OFF	111.0	
12/19/2007	0.5 OFF	111.0	
1/30/2008	0.5 OFF	107.0	
2/26/2008	0.5 ON	100.0	
3/27/2008	0.5 OFF	106.0	
4/20/2008	0.5 OFF	108.0	
5/27/2008	0.5 OFF	112.0	
6/24/2008	0.5 OFF	114.0	
7/29/2008	0.5 OFF	116.0	
8/27/2008	0.5 OFF	120.0	
9/25/2008	0.5 OFF	122.0	
10/29/2008	0.5 OFF	122.0	
11/24/2008	0.5 OFF	127.0	
12/19/2008	0.5 OFF	127.0	
1/19/2009	0.5 OFF	115.0	
2/23/2009	24 OFF	101.5	
3/30/2009	24 OFF	101.0	
4/29/2009	24 OFF	98.0	

Attachment 1
Water Level Data, City of Fullerton Well 9

Date (MM/DD/YYYY)	Hours Since Pump On/Off	Reference Point to Water Level (feet)	Comments
5/18/2009	0.5 OFF	97.0	
7/6/2009	4 Hrs	109.0	
7/21/2009	0.5 OFF	116.0	
9/21/2009	24 HR	110.0	
10/23/2009	24 HRS	105.0	
11/19/2009	24 HRS	99.0	
1/25/2010	0.5 HRS	104.0	
3/18/2010	24 Hrs	105.0	
4/19/2010	24 Hrs	88.0	
5/20/2010	24 Hrs	102.0	
6/24/2010	24 Hrs	88.0	
8/19/2010	0.5 Hrs	103.0	
9/27/2010	24 Hrs Off	96.0	
10/24/2010	3 Hrs Off	97.0	
11/29/2010	1 Hrs Off	97.0	
12/29/2010	24 Hrs Off	95.0	
1/31/2011	24 Hrs Off	100.0	
2/28/2011	24 Hrs Off	100.0	
3/21/2011	24 Hrs Off	81.0	
4/25/2011	0.5 Hrs Off	86.0	
5/12/2011	24 Hrs Off	114.0	
6/28/2011	24 Hrs Off	111.0	
8/29/2011	24HR OFF	110.0	
9/26/2011	0.5 HR OFF	80.0	
10/26/2011	5HR OFF	95.0	
1/9/2012	0.5 Hr Off	101.0	
1/27/2012	24 Hr Off	109.0	
2/23/2012	0.5 Hr Off	75.5	
3/19/2012	24 Hr Off	85.0	
4/23/2012	24 Hr Off	68.0	
6/21/2012	24 Hr Off	90.0	
7/28/2012	0.5 Hr Off	91.0	
8/27/2012	0.5 Hr Off	92.0	
9/27/2012	0.5 Hr Off	96.0	
10/29/2012	12.0 Hr Off	93.0	
11/30/2012	12Hrs off	88.0	

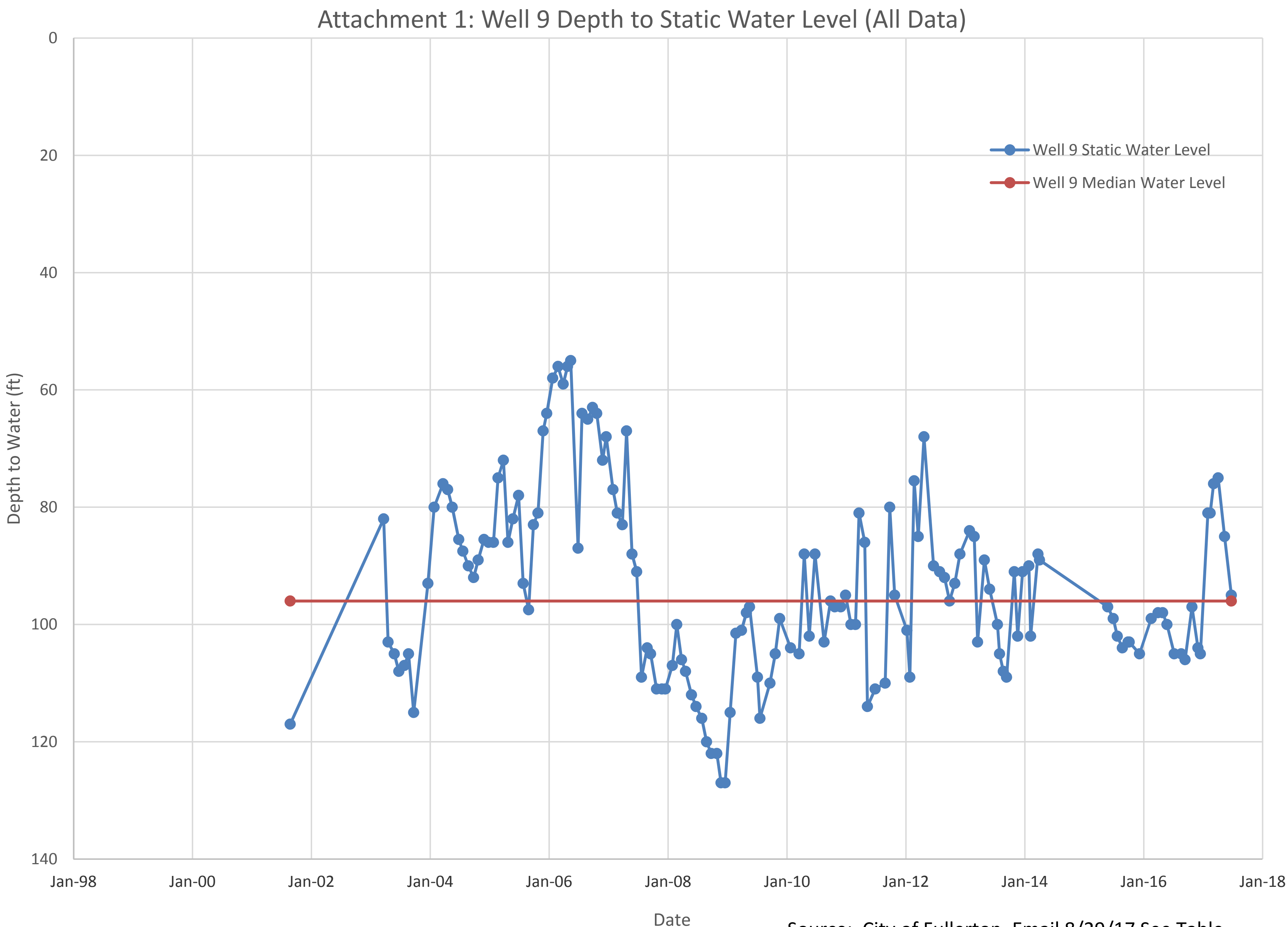
Attachment 1
Water Level Data, City of Fullerton Well 9

Date (MM/DD/YYYY)	Hours Since Pump On/Off	Reference Point to Water Level (feet)	Comments
1/28/2013	0.5 Hrs Off	84.0	
2/25/2013	0.5 Hrs Off	85.0	
3/18/2013	24 Hrs Off	103.0	
4/29/2013	24 Hrs On	89.0	
5/31/2013	0.5 Hrs Off	94.0	
7/18/2013	4 Hrs Off	100.0	
7/31/2013	0.5 Hrs Off	105.0	
8/23/2013	0.5 Hrs Off	108.0	
9/12/2013	0.5 Hrs Off	109.0	
10/29/2013	24 Hrs Off	91.0	
11/19/2013	24 Hrs Off	102.0	
12/19/2013	24 Hrs Off	91.0	
1/27/2014	24 Hrs Off	90.0	
2/7/2014	24 Hrs Off	102.0	
3/24/2014	24 Hrs Off	88.0	
4/2/2014	H+A SWL	89.0	H+A measured value
5/26/2015	0.5 Hrs Off	97.0	
6/29/2015	2 Hrs Off	99.0	
7/24/2015	0.5 Hrs Off	102.0	
8/24/2015	0.5 Hrs Off	104.0	
9/28/2015	0.5 Hrs Off	103.0	
10/5/2015	0.5 Hrs Off	103.0	
12/7/2015	24 Hrs Off	105.0	
2/17/2016	0.5 Hrs Off	99.0	
3/30/2016	0.5 Hrs Off	98.0	
4/27/2016	0.5 Hrs Off	98.0	
5/24/2016	0.5 Hrs Off	100.0	
7/7/2016	3.0 Hrs Off	105.0	
8/19/2016	0.5 Hrs Off	105.0	
9/12/2016	0.5 Hrs Off	106.0	
10/24/2016	0.5 Hrs Off	97.0	
11/30/2016	0.5 Hrs Off	104.0	
12/15/2016	0.5 Hrs Off	105.0	
1/30/2017	24 Hrs Off	81.0	
2/13/2017	24 Hrs Off	81	
3/6/2017	24 Hrs Off	76.0	

Attachment 1
Water Level Data, City of Fullerton Well 9

Date (MM/DD/YYYY)	Hours Since Pump On/Off	Reference Point to Water Level (feet)	Comments
4/3/2017	0.5 Hrs Off	75.0	
5/12/2017	24 Hrs Off	85.0	
6/23/2017	6 Hrs Off	95.0	
Calculated Median		96.0	
Deleted Row:			
4/28/2014	0.5 Hrs Off	135.0	Extreme Low Value Deleted

HARGIS+ASSOCIATES, INC.



Source: City of Fullerton, Email 8/29/17 See Table

HARGIS + ASSOCIATES, INC.

ATTACHMENT 2

HARGIS + ASSOCIATES, INC. TECHNICAL MEMORANDUM

FEBRUARY 21, 2017

(Text, Tables, and Figures Only)

HARGIS + ASSOCIATES, INC.
HYDROGEOLOGY • ENGINEERING

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Technical Memorandum

Via: EMAIL & FEDERAL EXPRESS Project No: 532.80

Date: February 21, 2017

To: Ms. Phuong Nguyen
CITY OF FULLERTON – PUBLIC WORKS DEPARTMENT
Water Engineering Division
303 W. Commonwealth Avenue
Fullerton, CA 92832-2728

cc: Ms. Hye Jin Lee, City of Fullerton (2 copies) (via Email & Federal Express)
Mr. Paul E. Brewer, Raytheon Company (Via Email & Federal Express)
Mr. Alex E. Brown, Esq., Raytheon Company (via Email)
Mr. Gregory S Taylor, Raytheon Company (via Email)
Mr. Dave Mark, Orange County Water District (via Email)
Mr. Kevin Coe, City of Fullerton (via Email)
Mr. Steve Rounds, Department of Toxic Substances Control (via Email)
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From:

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Re: Summary of Second Packer Test Results, October through December 2016, City of Fullerton Production Well No. 9, Former Raytheon Company (Formerly Hughes Aircraft Company) Site, 1901 West Malvern Avenue, Fullerton, California

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This Technical Memorandum has been prepared by Hargis + Associates, Inc. (H+A) on behalf of Raytheon Company (Raytheon) to summarize the results of a second Packer Test conducted at the City of Fullerton's (City's) production Well No. 9 (Well 9) from October through December, 2016 .

Activities associated with the first Packer Test were conducted from October 2015 through May 2016. Results from the first packer test were provided in previous Technical Memoranda (H+A, 2015e, 2016a, and 2016b,) The Packer Testing Program is being conducted and funded by Raytheon and coordinated with the City, in accordance with the scope of work outlined in our letters dated January 9, 2015 (H+A, 2015a), Addendum 1 dated February 12, 2015 (H+A, 2015b), Addendum 2 (Revision 1) dated March 20, 2015 (H+A, 2015c), and Addendum 3 dated September 30, 2015 (H+A, 2015d). The activities specific to the second packer test presented in this Technical Memorandum were conducted in general accordance with Addendum 6 of the Packer Testing Program (H+A, 2016c).

Well 9 is located on the north boundary of the Fullerton Airport (Figure 1) and is routinely used for municipal water supply. Well 9 is approximately 1,080 feet deep and was constructed with 7 separate screen intervals (Figure 2). During the previous packer test the packer was set at a depth of 969 feet, within a 20-foot section of blank casing just above the bottom screen. For the second test, described herein, the pump and packer were raised 40 feet so that the packer was set just above the second screen from the bottom as depicted in Figure 2.

1.0 Introduction

As indicated above, the first Packer Test was conducted with the packer located above the lower screen. Results from the first Packer Test indicated that isolating the lowermost screen of Well 9 did not significantly reduce 1,1-dicloroethene (1,1-DCE) concentrations. Additional evaluation of water level responses in nearby Unit B monitor wells indicates that the inflation of the packer reduced inflow from Unit B, but it appears that approximately 25 to 40 percent of the flow from Unit B continued following packer inflation. This suggested that the second screen from the bottom may also be in hydraulic communication with Unit B and may have continued contributing 1,1-DCE to Well 9 with the packer inflated.

The principal objective of the second Packer Test was to evaluate whether sealing off both of the lower two screens in Well 9 would reduce the concentration of 1,1-DCE in the well discharge without significantly reducing the well capacity or causing a significant degradation of the inorganic water quality. The sequence of events conducted during the second Packer Test is detailed in Attachment 4 and are briefly described below.

The initial task (Task 1) included raising the packer and pump assembly 40 feet so that the packer is located just above the second screen from the bottom (Figure 2). Following the resetting of the pump and packer and prior to packer testing activities Well 9 was disinfected and purged to remove residual chlorine in accordance with procedures outlined in Addendum 6, Task 2. Following confirmation that Well 9 met regulatory bacterial requirements Well 9 was pumped for approximately 6 weeks on a nearly continuous basis until 1,1-DCE concentrations stabilized at the target concentration of 1 microgram per liter (ug/l) (Task 3). Prior to pumping to the City main with the packer inflated, water samples were collected while discharging to a Baker tank with the packer temporarily inflated to verify that water quality requirements would be met (Task 4). Once water quality was verified the second Packer Test was conducted by operating Well 9 with the packer inflated for two weeks while monitoring well performance and water quality (Task 5).

The following sections present water quality, water level, flow, and aquifer response data collected during the second Packer Test. These sections are followed by a discussion of the potential path forward.

2.0 Water Quality

Groundwater samples were collected from the wellhead sampling port and analyzed for inorganic constituents, volatile organic compounds (VOCs) and/or 1,4-dioxane (Table 1) as described in the following section.

Samples were collected on October 21, 2016 during a brief packer inflation check conducted at the conclusion of Well 9 disinfection and purging (Task 2). Following sample collection, the pump was turned off and the packer was deflated.

Well 9 was returned to operation on October 24, 2016 and pumped on a nearly continuous basis with the packer uninflated (Task 3). Water samples were collected periodically between November 8th through November 28th to confirm 1,1-DCE concentrations returned to the target concentration and remained relatively stable, similar to concentrations observed in May 2016 (Table 2).

Water samples were collected on November 29, 2016 in conjunction with Task 4 packer verification sampling. For this sampling event the packer was temporarily inflated while the well was discharging to a Baker tank. These water samples were analyzed for VOCs using U.S. Environmental Protection Agency Method 524.2 (Table 2; Attachment 1).

Water samples were collected immediately before the initiation of the Packer Test on December 5, 2016 (Task 5). Approximately one hour after achieving full packer inflation on December 5th, water samples were again collected. Well 9 was pumped on a nearly continuous basis for a two week period with the packer inflated (Task 5). Water samples were collected on a daily basis for the first five days, three times in the following week, and on the final testing day of December 19, 2016 just prior to packer deflation. Analytical results are summarized in Tables 2 through 4 and laboratory results are provided in Attachment 1.

<u>Sample Results</u>

The results of groundwater samples indicated that none of the compounds or constituents exceeded respective primary drinking water maximum contaminant levels (MCLs) (Tables 2 through 4).

The results for groundwater samples collected prior to packer inflation on December 5, 2016 and after packer inflation are summarized as follows:

- The results of the samples collected with packer uninflated and inflated indicate no exceedances of primary drinking MCLs for the tested compounds and constituents (Table 2 through 4).
- During the 26 day period preceding the packer test, the 1,1-DCE concentrations ranged from 0.90 to 1.0 ug/l (Table 2; Figure 3).
- With the packer inflated, the 1,1-DCE concentrations were all non-detect at less than 0.5 ug/L (Table 2; Figure 3).
- The inorganic constituents were below the secondary drinking water MCLs with the exception of total dissolved solids (TDS). TDS ranged from 625 to 680 milligrams per liter (mg/l) in water samples collected with the packer inflated which exceeds the Federal secondary drinking water MCL of 500 mg/l. The TDS in water samples collected during the first Packer Test while the packer was not inflated ranged from 545 to 610 mg/l which also exceeds the Federal secondary drinking water MCL; however, none of the samples exceeded the California secondary drinking water MCL of 1,000 mg/l for TDS (Table 3).
- No other VOCs or 1,4-dioxane were detected in any of the samples collected (Table 4).

<u>Quality Assurance/Quality Control</u>

Original and field duplicate groundwater samples for VOCs were analyzed by Test America, Inc., Irvine, California (TAA). Original and field duplicate groundwater samples for all other constituents outlined in Table 1 were analyzed by Eurofins Calscience, Inc. Chain-of-custody (COC) documentation was enclosed with each sample shipment. COC documents and laboratory results have been compiled (Attachment 1).

Quality assurance/quality control (QA/QC) samples collected during these sampling events consisted of trip blanks, field blanks, and/or field duplicates. Trip blanks were provided by TAA. Field duplicate samples were collected for analysis of all analytes listed in Table 1 for samples COF9-WH-102116, COF9-WH-112916, COF9-WH-120516, COF9-WH-120716, and COF9-WH-121916 (Tables 2 through 4). The relative percent difference was calculated between the results of each field duplicate sample with its corresponding original sample. The data quality assessment indicated that the groundwater sample results are within acceptable QA/QC criteria.

There were no detections of VOCs in the trip and/or field blanks analyzed with the groundwater samples collected (Table 2; Attachment 1).

The data quality assessment also included review of laboratory QA/QC results. Laboratory QA/QC results are within acceptable criteria.

3.0 Water Levels in Well 9

The water levels in Well 9 were monitored manually using electric sounders and with pressure transducers which continuously record the water level using an integrated data logger. Well 9 was constructed with a 2-inch access tube which allows a transducer to be set and manual measurement of the water level above the packer. A second sounding tube was installed with the packer which allows measurement of the water level below the packer.

All water level measurements in Well 9 are from the top of the respective sounding tubes which extend less than a foot above the pump base. During times when the well is off and the packer was uninflated the depth to the static water level in the zone above and below the packer were generally within a foot of each other (Figure 4).

Figure 4 provides a plot of transducer water level data for the Upper Zone (above packer) and Lower Zone (below packer) in Well 9 during the period prior to the restart of Well 9 production on October 25, 2016 to several days after the end of the packer testing program on December 19, 2016. Prior to startup of Well 9 on October 25, the static water level in Well 9 was approximately 96 feet below the reference point (brp). Following startup of pumping, the pumping water level above the packer (Upper Zone) stabilized at approximately 166 feet brp indicating a drawdown of about 70 feet. The pumping water level below the packer (Lower Zone) stabilized at about 162 feet brp.

From October 25, 2016 to the day the packer was inflated on December 5, 2016, the well was pumped on a nearly continuous basis except for several brief periods due to temporary outages or when the well was shut off briefly for sampling or equipment checks (Figure 4). Immediately prior to inflating the packer, the pumping water level in the Upper Zone and Lower Zone were about 166 and 162 feet brp, respectively. Following packer inflation, the water levels in the Upper Zone and Lower Zone separated. Following packer inflation, the water level in the Upper Zone declined to 188 feet brp or by an additional 22 feet. The water level in the Lower Zone recovered to a depth of about 98 feet brp (near the static water level) due to a near complete reduction in the amount of groundwater being produced from the two lower screen intervals. The 90-foot difference in the water level above and below the packer indicated that the packer was successful in hydraulically isolating the lower two screens in Well 9.

4.0 Water Production and Electrical Use

The Well 9 flow meter (both instantaneous and totalizer) was monitored periodically during the period leading up to packer inflation and while the packer was inflated to evaluate the normal pumping rate (packer uninflated) and the pumping rate with the lower two screens sealed off (packer inflated).

Typically the instantaneous flowrate indicated by the flow meter varied up and down by about 200 gallons per minute (gpm) over short periods, therefore, the instantaneous flowrate data was considered qualitative. A more precise estimate of the flowrate was therefore based on the average flowrate calculated using the change in the totalizer readings over time (Table 5). The average flowrate prior to and during packer inflation was approximately 2,235 gpm and 2,113 gpm, respectively (Table 5). The reduction in pumping rate following packer inflation was approximately 120 gpm and is attributable to incremental drawdown observed in Well 9 after packer inflation and existing pump characteristics. As discussed later, the production rate could be increased with a different pump/motor installed in the well, which could be considered to off-set the loss in production if the lower screen(s) were to be isolated in the future.

Specific Capacity

A well's specific capacity (SC) is defined as the amount of water that is produced for each foot of drawdown that is caused by pumping the well. At any given pumping rate, the drawdown is not constant, but tends to approach a stable pumping level over time. For the purpose of this evaluation, the change in water level (drawdown or recovery) that occurred during the two week period following packer inflation was used to compare and assess changes in well performance.

In the days leading up to packer inflation, Well 9 was pumping at an average rate of 2,235 gpm (Table 6). In the period following packer inflation, the pumping rate decreased to an average rate of about 2,113 gpm. The drawdown in Well 9 was estimated at about 70 feet based on transducer water level data obtained in early December 2016, prior to inflating the packer (Figure 4). Following packer inflation on December 5, 2016, the pumping water level declined by an additional 22 feet indicating that the drawdown with the packer inflated was about 92 feet. Based on these data, the SC with the packer uninflated was about 31.9 gallons per minute/foot (gpm/ft) and about 23.0 gpm/ft with the packer inflated indicating a decrease in SC of approximately 28 percent due to packer inflation (Table 6).

Electrical Use

Since inflation of the packer results in a decrease in the SC of Well 9 there is also change in the electrical use per volume of water pumped. Electrical use was monitored during the period preceding packer inflation and during the two week period the packer was inflated. Electric meter readings are summarized in Table 7 along with flow meter totalizer readings. These data indicate that prior to packer inflation electrical use was 0.21 kilowatt-hours per 1,000 gallons pumped whereas following packer inflation the electrical use increased to 0.22 kilowatt-hours per 1,000 gallons pumped. This represents about a 5.6 percent increase in the electrical use per volume of water pumped. The electrical use per volume of water pumped may change somewhat in the future depending on the future target pumping rate or in the event the existing pump and motor are replaced.

5.0 Aquifer Response

Inflating the packer in Well 9 was effective in reducing the vast majority of flow from the lower two screens based on the observed differences in water levels measured above and below the packer during packer inflation (Figure 4; Attachment 3). This resulted in the concentrations of 1,1-DCE declining to below the detection limit due to the packer inflation (Figure 3). This indicates 1,1-DCE is likely entering Well 9 from one or both of the lower well screens which are likely communicating with the B-Zone aquifer when the packer is not inflated.

Transducers were also installed in 13 monitor wells located in the vicinity of Well 9 prior to packer inflation to monitor the water level response in the Shallow Unit (equivalent to the upper screen interval of Well 9), Unit A (near the middle section of screen intervals of Well 9), and Unit B (near the bottom of Well 9) (Figure 1). The transducer data obtained indicate the water level response in these three zones due to inflating and deflating the packer while pumping Well 9 (Attachment 2). The evaluation of water level response during the packer test indicates that the flow from Unit B was significantly reduced (between 94 and 100 percent) (Attachment 3). The water level responses and water quality data indicate that isolating the lower two screens in Well 9 is effective at cutting off the vast majority of flow of groundwater from Unit B to Well 9.

6.0 Potential Path Forward

Based on the results of the Packer Testing Program conducted to date, it is apparent that isolating the lower two screens effectively decreases the concentration of 1,1-DCE in Well 9 to less than the detection limit. It is also apparent that the SC of Well 9 is reduced by about 28 percent when the lower two screens are isolated which reduces the amount of water the well can produce with the existing pump and motor combination. However, it appears that it would be possible to maintain the current pumping rate with a packer installed and inflated if a new higher head pump and greater horsepower (HP) motor were installed. This would result in additional drawdown which would require setting the new pump deeper in the well than the current pump. Potential alternatives for modification of Well 9 equipment will be developed in consultation with the City. Once the plan for modification is complete and approved by the City it can be implemented in late 2017 after the coming high demand water production season when Well 9 is needed for municipal supply. The following describes a conceptual path forward for both operating Well 9 during the 2017 high demand season and modifying the well equipment near the end of 2017.

<u>Options for Well 9 Operation during 2017 High Demand Season:</u>

There are at least two alternatives for the upcoming water production season, as follows:

- Operating Well 9 with the packer in place but uninflated while operating the existing pump at the normal pumping rate (approximately 2,235 gpm) as was done in 2016.

- Operating Well 9 with the packer inflated during the upcoming season, resulting in a somewhat decreased pumping rate (approximately 2,113 gpm).

The first alternative will likely result in a return of 1,1-DCE to the low concentration observed prior to packer testing while the second alternative may eliminate the 1,1-DCE in the well discharge. In addition, there will be a slight increase in TDS if the well is operated with the packer inflated. There will also be a small increase in electricity use with the packer inflated. In either case H+A would be available to sample Well 9 for analysis of 1,1-DCE on a monthly basis, to the extent this is not currently being performed. Under either of the above two alternatives the packer inflation status could be altered (e.g. inflated or deflated) based on data collected or City operating constraints, if necessary.

Potential Modifications:

At the onset of the Packer Testing Program, it was contemplated that the lower portion of Well 9 might be sealed off using a semi-permanent method such as infilling the lower portion of the well with inert/low permeability materials. This option is still available; however, use of an inflatable packer to isolate the lower screens of the well would allow a more flexible operation without modifying the well itself. Either method would also require some modification to existing equipment to attain current water production rates to extent that is a requirement. The following outlines conceptual modifications to equipment, which would be discussed and evaluated in consultation with the City.

- New packer assembly designed for long-term service (similar to those used for aquifer storage and recovery projects);
- New motor to provide sufficient operational efficiently with new pump;
- New pump designed for efficient operations with higher drawdown during packer inflation (may also need new column pipe and line shaft);
- Variable Frequency Drive motor control to allow more effective/continuous purging following well disinfection without the need for using a Baker tank
- Modify wellhead piping to facilitate chlorine injection and local injection water supply with flow control

Once the approach for isolation and equipment modifications are complete and agreed upon, specifications for new equipment would be provided to and approved by the City. The equipment would be ordered so that the equipment could be installed soon after Well 9 is taken out of service during the fall/winter of 2017/18.

7.0 References

Hargis + Associates, Inc., 2015a. Letter to V. Xayarath, City of Fullerton, Re: Planned Packer Testing Program, City of Fullerton Production Well No. 9, Former Raytheon Company (Formerly Hughes Aircraft Company) Site, 1901 West Malvern Avenue, Fullerton, California, dated January 9, 2015.

_____, 2015b. Letter to V. Xayarath, City of Fullerton, Re: Addendum 1 to Planned Packer Testing Program, City of Fullerton Production Well No. 9, Former Raytheon Company (Formerly Hughes Aircraft Company) Site ("Addendum 1"), 1901 West Malvern Avenue, Fullerton, California, dated February 12, 2015.

_____, 2015c. Letter to V. Xayarath, City of Fullerton, Re: Addendum 2 (Revision 1) to Planned Packer Testing Program, City of Fullerton Production Well No. 9, Former Raytheon Company (Formerly Hughes Aircraft Company) Site, 1901 West Malvern Avenue, Fullerton, California, dated March 20, 2015.

_____, 2015d. Letter to V. Xayarath, City of Fullerton, Re: Updated Packer Testing Program (Addendum 3, Revision 1A), City of Fullerton Production Well No. 9, Former Raytheon Company (Formerly Hughes Aircraft Company) Site, 1901 West Malvern Avenue, Fullerton, California, dated September 30, 2015.

_____, 2015e. Technical Memorandum to V. Xayarath, City of Fullerton, Re: Summary of Packer Testing Program Activities, City of Fullerton Production Well No. 9, Former Raytheon Company (Formerly Hughes Aircraft Company) Site, 1901 West Malvern Avenue, Fullerton, California. October 13, 2015.

_____, 2016a. Letter Report to V. Xayarath, City of Fullerton, Re: Data Submittal for Analytical Results for the Packer Test Program, City of Fullerton Production Well No. 9, Former Raytheon Company (Formerly Hughes Aircraft Company) Site, 1901 West Malvern Avenue, Fullerton, California, dated April 7, 2016.

_____, 2016b. Technical Memorandum to V. Xayarath, City of Fullerton, Re: Summary of Packer Testing Program Activities, October 2015 through March 2016,City of Fullerton Production Well No. 9, Former Raytheon Company (Formerly Hughes Aircraft Company) Site, 1901 West Malvern Avenue, Fullerton, California, dated May 3, 2016

_____, 2016c. Letter to V. Xayarath, City of Fullerton, Re: Updated Packer Testing Program (Addendum 6), City of Fullerton Production Well No. 9, Former Raytheon Company (Formerly Hughes Aircraft Company) Site, 1901 West Malvern Avenue, Fullerton, California, dated September 16, 2016

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Attachments

Attachment 1	Laboratory Analytical Data *(Provided on CD Only in Hard Copy)*
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TABLE 1
ANALYTICAL SCHEDULE

SAMPLE CONTAINER REQUIREMENTS

	METHOD	CONTAINER	PRESERVATION
VOCs	EPA 524.2[(1)]	3 x 40 ml VOA	HCl
Total Dissolved Solids	SM 2540C	1 L Poly	none
1,4-Dioxane	EPA 8270C(M) ID	500-ml Amber glass	none
Metals (ICP/MS)	EPA 6020	250 ml Poly	none - lab to filter and acidify
Mercury	EPA 7470A		
Cations	EPA 6020		
Bicarbonate/Carbonate	SM 2320B	250 ml Poly	none
Anions	EPA 300.0		

ANALYTICAL DETAILS

		Reporting Limit	Method Detection Level	Unit	Method
VOCs	Various	1,1-DCE - 0.50 Other various	1,1-DCE - 0.048 Other various	ug/L	EPA 524.2
1,4-Dioxane	1,4-Dioxane	1.0	0.42	ug/L	EPA 8270C(M) ID
Metals	Antimony	0.001	0.0000995	mg/L	EPA 6020
	Arsenic	0.001	0.000386	mg/L	EPA 6020
	Barium	0.001	0.0000986	mg/L	EPA 6020
	Beryllium	0.001	0.00029	mg/L	EPA 6020
	Boron	0.05	0.00676	mg/L	EPA 6020
	Cadmium	0.001	0.000128	mg/L	EPA 6020
	Chromium	0.001	0.000402	mg/L	EPA 6020
	Cobalt	0.001	0.0000919	mg/L	EPA 6020
	Copper	0.001	0.00014	mg/L	EPA 6020
	Lead	0.001	0.0000898	mg/L	EPA 6020
	Mercury	0.0005	0.0000453	mg/L	EPA 7470A
	Molybdenum	0.001	0.000127	mg/L	EPA 6020
	Nickel	0.001	0.000132	mg/L	EPA 6020
	Selenium	0.001	0.000168	mg/L	EPA 6020
	Silver	0.001	0.000111	mg/L	EPA 6020
	Thallium	0.001	0.000101	mg/L	EPA 6020
	Vanadium	0.001	0.000149	mg/L	EPA 6020
	Zinc	0.005	0.000479	mg/L	EPA 6020
Anion	Bicarbonate (as CaCO3)	1.0	0.85	mg/L	SM 2320B
	Bromide	0.1	0.037	mg/L	EPA 300.0
	Carbonate (as CaCO3)	1.0	0.85	mg/L	SM 2320B
	Chloride	1.0	0.12	mg/L	EPA 300.0
	Fluoride	0.10	0.025	mg/L	EPA 300.0
	Sulfate	1.0	0.19	mg/L	EPA 300.0
	Nitrate (as N)	0.10	0.025	mg/L	EPA 300.0
Cation	Calcium	0.1	0.00665	mg/L	EPA 6020
	Iron	0.05	0.00926	mg/L	EPA 6020
	Magnesium	0.1	0.00278	mg/L	EPA 6020
	Potassium	0.1	0.00744	mg/L	EPA 6020
	Sodium	0.1	0.00303	mg/L	EPA 6020
	Manganese	0.001	0.000139	mg/L	EPA 6020

FOOTNOTES

EPA = U.S. Environmental Protection Agency
mg/L = Milligrams per liter
ml = Milliliters
ug/L = Micrograms per liter
1,1-DCE = 1,1-Dichloroethene
ICP/MS = Inductively coupled plasma mass spectometry
Poly = Polyethylene bottle
N = Nitrogen
SM = Standard Method
VOCs = Volatile organic compounds
CaCO3 = Calcium carbonate
HCl = Hydrochloric Acid
VOA = Volatile Organics Analysis
L = Liter

(1) EPA Method 8260B with low level detection was used in several instances, the 1,1-dichloroethene was the same as EPA Method 524.2

TABLE 2

WELLHEAD 1,1-DICHLOROETHENE IN GROUNDWATER
CITY OF FULLERTON WELL NO. 9 (October through December 2016)

Sample Identifier	Sample Date Time	Sample Depth (Feet)	Packer Status	Sample Type	Laboratory	Analytical Method	1,1-DCE (ug/l)	Detection Limit (ug/l)	Reporting Limit (ug/l)
					FEDERAL MCL		**7**	----	----
					CALIFORNIA MCL		**6**	----	----
COF9-WH-TASK2-102116	10/21/2016	Wellhead	Inflated	ORG	TAA	EPA 524.2	<0.5	0.2	0.5
COF9-WH-TASK2-102116X	10/21/2016	Wellhead	Inflated	DUP	TAA	EPA 524.2	<0.5	0.2	0.5
COF9-WH-110916	11/9/2016	Wellhead	Uninflated	ORG	TAA	EPA 524.2	**1.0**	0.2	0.5
COF9-WH-111716	11/17/2016	Wellhead	Uninflated	ORG	TAA	EPA 524.2	**0.9**	0.2	0.5
COF9-WH-111716X	11/17/2016	Wellhead	Uninflated	DUP	TAA	EPA 524.2	**1.0**	0.2	0.5
COF9-WH-112816	11/28/2016	Wellhead	Uninflated	ORG	TAA	EPA 524.2	**1.0**	0.2	0.5
COF9-WH-112916	11/29/2016	Wellhead	Inflated	ORG	TAA	EPA 524.2	<0.5	0.2	0.5
COF9-WH-112916X	11/29/2016	Wellhead	Inflated	DUP	TAA	EPA 524.2	**0.31J**	0.2	0.5
COF9-WH-113016	11/30/2016	Wellhead	Uninflated	ORG	TAA	EPA 524.2	**0.98**	0.2	0.5
COF9-WH-120516-PRE	12/5/2016	Wellhead	Uninflated	ORG	TAA	EPA 524.2	**0.97**	0.2	0.5
COF9-WH-120516	12/5/2016	Wellhead	Inflated	ORG	TAA	EPA 524.2	<0.5	0.2	0.5
COF9-WH-120516X	12/5/2016	Wellhead	Inflated	DUP	TAA	EPA 524.2	<0.5	0.2	0.5
COF9-WH-120616	12/6/2016	Wellhead	Inflated	ORG	TAA	EPA 524.2	<0.5	0.2	0.5
COF9-WH-120716	12/7/2016	Wellhead	Inflated	ORG	TAA	EPA 524.2	<0.5	0.2	0.5
COF9-WH-120716X	12/7/2016	Wellhead	Inflated	DUP	TAA	EPA 524.2	<0.5	0.2	0.5
COF9-WH-120816	12/8/2016	Wellhead	Inflated	ORG	TAA	EPA 524.2	<0.5	0.2	0.5
COF9-WH-120916	12/9/2016	Wellhead	Inflated	ORG	TAA	EPA 524.2	<0.5	0.2	0.5
COF9-WH-121216	12/12/2016	Wellhead	Inflated	ORG	TAA	EPA 524.2	<0.5	0.2	0.5
COF9-WH-121416	12/14/2016	Wellhead	Inflated	ORG	TAA	EPA 524.2	<0.5	0.2	0.5
COF9-WH-121616	12/16/2016	Wellhead	Inflated	ORG	TAA	EPA 524.2	<0.5	0.2	0.5
COF9-WH-121916	12/19/2016	Wellhead	Inflated	ORG	TAA	EPA 524.2	<0.5	0.2	0.5
COF9-WH-121916X	12/19/2016	Wellhead	Inflated	DUP	TAA	EPA 524.2	<0.5	0.2	0.5
	Quality Assurance/Quality Control								
TB-102116	10/21/2016	----	----	TB	TAA	EPA 524.2	<0.5	0.2	0.5
FB-102116	10/21/2016	----	----	FB	TAA	EPA 524.2	<0.5	0.2	0.5
TB-110916	11/9/2016	----	----	TB	TAA	EPA 524.2	<0.5	0.2	0.5
FB-110916	11/9/2016	----	----	FB	TAA	EPA 524.2	<0.5	0.2	0.5
TB-111716	11/17/2016	----	----	TB	TAA	EPA 524.2	<0.5	0.2	0.5
FB-111716	11/17/2016	----	----	FB	TAA	EPA 524.2	<0.5	0.2	0.5
TB-112816	11/28/2016	----	----	TB	TAA	EPA 524.2	<0.5	0.2	0.5
FB-112816	11/28/2016	----	----	FB	TAA	EPA 524.2	<0.5	0.2	0.5
TB-112916	11/29/2016	----	----	TB	TAA	EPA 524.2	<0.5	0.2	0.5
FB-112916	11/29/2016	----	----	FB	TAA	EPA 524.2	<0.5	0.2	0.5
TB-113016	11/30/2016	----	----	TB	TAA	EPA 524.2	<0.5	0.2	0.5
FB-113016	11/30/2016	----	----	FB	TAA	EPA 524.2	<0.5	0.2	0.5
FB-120516-PRE	12/5/2016	----	----	FB	TAA	EPA 524.2	<0.5	0.2	0.5
TB-120516	12/5/2016	----	----	TB	TAA	EPA 524.2	<0.5	0.2	0.5
FB-120516	12/5/2016	----	----	FB	TAA	EPA 524.2	<0.5	0.2	0.5
TB-120616	12/6/2016	----	----	TB	TAA	EPA 524.2	<0.5	0.2	0.5
FB-120616	12/6/2016	----	----	FB	TAA	EPA 524.2	<0.5	0.2	0.5
TB-120716	12/7/2016	----	----	TB	TAA	EPA 524.2	<0.5	0.2	0.5
FB-120716	12/7/2016	----	----	FB	TAA	EPA 524.2	<0.5	0.2	0.5
TB-120816	12/8/2016	----	----	TB	TAA	EPA 524.2	<0.5	0.2	0.5
FB-120816	12/8/2016	----	----	FB	TAA	EPA 524.2	<0.5	0.2	0.5
TB-120916	12/9/2016	----	----	TB	TAA	EPA 524.2	<0.5	0.2	0.5
FB-120916	12/9/2016	----	----	FB	TAA	EPA 524.2	<0.5	0.2	0.5
TB-121216	12/12/2016	----	----	TB	TAA	EPA 524.2	<0.5	0.2	0.5
FB-121216	12/12/2016	----	----	FB	TAA	EPA 524.2	<0.5	0.2	0.5
TB-121416	12/14/2016	----	----	TB	TAA	EPA 524.2	<0.5	0.2	0.5
FB-121416	12/14/2016	----	----	FB	TAA	EPA 524.2	<0.5	0.2	0.5

TABLE 2

WELLHEAD 1,1-DICHLOROETHENE IN GROUNDWATER
CITY OF FULLERTON WELL NO. 9 (October through December 2016)

Sample Identifier	Sample Date Time	Sample Depth (Feet)	Packer Status	Sample Type	Laboratory	Analytical Method	1,1-DCE (ug/l)	Detection Limit (ug/l)	Reporting Limit (ug/l)
					FEDERAL MCL		**7**	----	----
					CALIFORNIA MCL		**6**	----	----
TB-121616	12/16/2016	----	----	TB	TAA	EPA 524.2	<0.5	0.2	0.5
FB-121616[2]	12/16/2016	----	----	FB	TAA	EPA 524.2	<0.5	0.2	0.5
TB-121916	12/19/2016	----	----	TB	TAA	EPA 524.2	<0.5	0.2	0.5
FB-121916	12/19/2016	----	----	FB	TAA	EPA 524.2	<0.5	0.2	0.5

NOTES

Detections are shown in **BOLD** type.

There were no detections above Federal/California MCLs.

Federal and California MCL found at http://www.cdph.ca.gov/certlic/drinkingwater/Documents/DWdocuments/EPAandCDPH-2-13-2014.pdf.

FOOTNOTES

1,1-DCE = 1,1-Dichloroethene
TB = Trip blank sample
ug/L = Micrograms per liter
(<) = Less than; the value is the Limit of Detection for that compound
EPA = US Environmental Protection Agency
ORG = Original sample
DUP = Field Duplicate Sample
MCL = Maximum Contaminant Level
FB = Field Blank
TAA = TestAmerica, Inc.
(----) = Not applicable

TABLE 3

WELLHEAD GENERAL MINERALS AND METALS IN GROUNDWATER
CITY OF FULLERTON WELL NO. 9

			CALIFORNIA MCL	FEDERAL MCL	COF9-WH-TASK2-102116 10/21/2016 WELLHEAD (ORG) Packer Inflated	COF9-WH-TASK2-102116X 10/21/2016 WELLHEAD (DUP) Packer Inflated	COF9-WH-112916 11/29/2016 WELLHEAD (ORG) Packer Inflated	COF9-WH-112916X 11/29/2016 WELLHEAD (DUP) Packer Inflated	COF9-WH-120516 12/5/2016 WELLHEAD (ORG) Packer Inflated	COF9-WH-120516X 12/5/2016 WELLHEAD (DUP) Packer Inflated	COF9-WH-120816 12/8/2016 WELLHEAD (ORG) Packer Inflated	COF9-WH-120916 12/9/2016 WELLHEAD (ORG) Packer Inflated	COF9-WH-121616 12/16/2016 WELLHEAD (ORG) Packer Inflated	COF9-WH-121916 12/19/2016 WELLHEAD (ORG) Packer Inflated	COF9-WH-121916X 12/19/2016 WELLHEAD (DUP) Packer Inflated
CATIONS	Boron	mg/L	--	--	**0.132**	**0.119**	**0.127 (0.15)**	**0.128 (0.14)**	**0.108**	**0.107**	**0.109**	**0.107**	**0.134**	**0.144**	**0.144**
	Calcium	mg/L	--	--	**103**	**93.5**	**93.6**	**96**	**94.7**	**92.1**	**92.9**	**82.7**	**94**	**92**	**92.4**
	Iron	mg/L	0.3[a]	0.3[a]	**0.0384J**	**0.0543**	**0.0405J**	**0.249**	**0.0392J**	**0.0416J**	**0.0672**	<0.05	**0.0368J**	<0.05	<0.05
	Magnesium	mg/L	--	--	**36**	**34.9**	**29.3**	**30.6**	**29.1**	**28.5**	**28.4**	**28.7**	**29.8**	**31.2**	**31.3**
	Manganese	mg/L	0.05[a]	0.05[a]	**0.00181**	**0.00266**	**0.00701**	**0.00919**	**0.00799**	**0.0079**	**0.00893**	**0.00791**	**0.00884**	**0.00857**	**0.00883**
	Potassium	mg/L	--	--	**3.49**	**3.24**	**2.88**	**2.97**	**2.91**	**2.91**	**3.08**	**2.88**	**2.92**	**3.22**	**3.17**
	Sodium	mg/L	--	--	**91.1**	**92.2**	**79.7**	**81.6**	**72.5**	**73.4**	**70.3**	**78.0**	**78.1**	**89.9**	**88.3**
ANIONS	Bromide	mg/L	--	--	<0.10	<0.10	**0.13**	**0.13**	**0.21**	**0.20**	**0.21**	**0.23**	**0.17**	**0.16**	**0.15**
	Chloride	mg/L	250-500[a]	250[a]	**73**	**75**	**73**	**73**	**67**	**66**	**66**	**66**	**64**	**68**	**68**
	Nitrate as Nitrogen	mg/L	10	10	**4.3**	**4.4**	**4.4**	**4.5**	**3.7**	**3.8**	**3.7**	**3.7**	**3.6**	**3.9**	**3.9**
	Fluoride	mg/L	2	4	**0.32**	**0.36**	**0.53**	**0.50**	**0.45**	**0.46**	**0.44**	**0.44**	**0.48**	**0.43**	**0.44**
	Sulfate	mg/L	250-500[a]	250[a]	**220**	**220**	**210**	**210**	**180**	**190**	**190**	**190**	**190B**	**190**	**190**
	Bicarbonate (as CaCO3)	mg/L	--	--	**206**	**215**	**212**	**209**	**210**	**207**	**215**	**215**	**211**	**208**	**207**
	Carbonate (as CaCO3)	mg/L	--	--	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	Total Dissolved Solids	mg/L	500-1,000[a]	500[a]	**680**	**670**	**635**	**650**	**670**	**675**	**635**	**680**	**635**	**635**	**625**
METALS	Antimony	mg/L	0.006	0.006	**0.000149J**	**0.000126J**	<0.0005	<0.00083	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100
	Arsenic	mg/L	0.01	0.01	**0.000909J**	**0.00104**	**0.0014**	**0.0015**	**0.00117**	**0.00151**	**0.00156**	**0.00139**	**0.00138**	**0.00135**	**0.00155**
	Barium	mg/L	1	2	**0.0563**	**0.0573**	**0.056**	**0.057**	**0.0539**	**0.0554**	**0.0551**	**0.0529**	**0.0548**	**0.0556**	**0.0538**
	Beryllium	mg/L	0.004	0.004	<0.00100	<0.00100	<0.0002	<0.00033	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100
	Cadmium	mg/L	0.005	0.005	<0.00100	<0.00100	**0.000059J**	**0.00012J**	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100
	Chromium	mg/L	0.05	0.1	**0.00401**	**0.00397**	**0.0018**	**0.0027**	**0.00125**	**0.00123**	**0.00134**	**0.00115**	**0.00135**	**0.00134**	**0.00147**
	Cobalt	mg/L	--	--	**0.000166J**	**0.000213J**	**0.00012J**	**0.00021J**	**0.000179J**	**0.000177J**	**0.000191J**	**0.000191J**	**0.000194J**	**0.000242J**	**0.000244J**
	Copper	mg/L	1.0[a]	1.3	**0.00736**	**0.00408**	**0.029**	**0.038**	**0.00499**	**0.0059**	**0.00627**	**0.00698**	**0.0162**	**0.00625**	**0.0067**
	Lead	mg/L	0.015	0.015	**0.000109J**	<0.00100	**0.0032**	**0.0060**	**0.000356J**	**0.000533J**	**0.000508J**	**0.000359J**	**0.00169**	**0.000192J**	**0.000236J**
	Molybdenum	mg/L	--	--	**0.0194**	**0.0201**	**0.015**	**0.016**	**0.0204**	**0.0210**	**0.0199**	**0.0176**	**0.0220**	**0.0216**	**0.0209**
	Nickel	mg/L	Remanded	0.1	**0.00216**	**0.00290**	**0.0029**	**0.0087**	**0.00215**	**0.00230**	**0.00168**	**0.00186**	**0.00238**	**0.002**	**0.00216**
	Selenium	mg/L	0.05	0.05	**0.0100B**	**0.00965B**	**0.0071**	**0.0074**	**0.00826B**	**0.00772B**	**0.00834**	**0.00977**	**0.00883**	**0.0104**	**0.0101**
	Silver	mg/L	0.1[a]	0.1[a]	<0.00100	<0.00100	<0.0002	<0.00033	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100
	Thallium	mg/L	0.002	0.002	<0.00100	<0.00100	<0.0001	**0.00016J**	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100
	Vanadium	mg/L	--	--	**0.00668**	**0.00679**	**0.0080**	**0.0085**	**0.00728**	**0.00732**	**0.00844**	**0.00745**	**0.00789**	**0.00795**	**0.00785**
	Zinc	mg/L	5[a]	5[a]	**0.0125**	**0.0135**	**0.0091**	**0.012**	**0.0110**	**0.0320**	**0.0254**	**0.0278**	**0.0309**	**0.0142**	**0.0302**
	Mercury	mg/L	0.002	0.002	<0.000500	<0.000500	<0.000500	<0.000500	<0.000500	<0.000500	<0.000500	<0.000500	<0.000500	**0.0000574J**	**0.0000515J**

NOTES
Detections are shown in **BOLD** type.
There were no detections above Federal/California MCLs.
Federal and California MCLs found at http://www.cdph.ca.gov/certlic/drinkingwater/Documents/DWdocuments/EPAandCDPH-2-13-2014.pdf.
California Secondary MCLs found at http://www.cdph.ca.gov/certlic/drinkingwater/Documents/Recentlyadoptedregulations/R-21-03-finalregtext.pdf.
(a) Secondary MCL. For constituents with range: the lower number is recommended and the higher number is upper portion of range (not including short-term upper, which is higher).
Samples analyzed by Eurofins Calscience, Inc. with exception of shaded cells or results in () which were analyzed by TestAmerica, Inc.

FOOTNOTES
mg/L = Milligrams per liter
MCL = Maximum Contaminant Level
ORG = Original Sample
DUP = Field Duplicate Sample
J = Estimated Concentration
B = Analyte was present in the associated Method Blank
(<) = Less than; the value is the Limit of Detection for that compound
-- = Not promulgated
CaCO3 = Calcium carbonate

TABLE 4

WELLHEAD 1,4-DIOXANE IN GROUNDWATER
CITY OF FULLERTON WELL NO. 9 (October through December 2016)

Sample Identifier	Sample Date Time	Sample Depth (Feet)	Packer Status	Sample Type	Laboratory	Analytical Method	1,4-DIOXANE (ug/l)	Method Detection Limit (ug/l)	Reporting Limit (ug/l)
COF9-WH-TASK2-102116	10/21/2016	Wellhead	Inflated	ORG	ECI	EPA 8270C MOD	<1.0	0.28	1.0
COF9-WH-TASK2-102116X	10/21/2016	Wellhead	Inflated	DUP	ECI	EPA 8270C MOD	<1.0	0.28	1.0
COF9-WH-112916	11/29/2016	Wellhead	Inflated	ORG	ECI	EPA 8270C MOD	<1.0	0.28	1.0
COF9-WH-112916X	11/29/2016	Wellhead	Inflated	DUP	ECI	EPA 8270C MOD	<1.0	0.28	1.0
COF9-WH-120516	12/5/2016	Wellhead	Inflated	ORG	ECI	EPA 8270C MOD	<1.0	0.28	1.0
COF9-WH-120516X	12/5/2016	Wellhead	Inflated	DUP	ECI	EPA 8270C MOD	<1.0	0.28	1.0
COF9-WH-120816	12/8/2016	Wellhead	Inflated	ORG	ECI	EPA 8270C MOD	<1.0	0.28	1.0
COF9-WH-120916	12/9/2016	Wellhead	Inflated	ORG	ECI	EPA 8270C MOD	<1.0	0.28	1.0
COF9-WH-121616	12/16/2016	Wellhead	Inflated	ORG	ECI	EPA 8270C MOD	<1.0	0.28	1.0
COF9-WH-121916	12/19/2016	Wellhead	Inflated	ORG	ECI	EPA 8270C MOD	<1.0	0.28	1.0
COF9-WH-121916X	12/19/2016	Wellhead	Inflated	DUP	ECI	EPA 8270C MOD	<1.0	0.28	1.0

FOOTNOTES

ECI = Eurofins Calscience, Inc.
(<) = Less than; the value is the Limit of Detection for that compoud
ug/L = Micrograms per liter
EPA = U.S. Environmental Protection Agency

ORG = Original sample
DUP = Field Duplicate Sample

TABLE 5
CITY OF FULLERTON WELL NO. 9 FLOWRATE

Date	Time	Packer Status	WellHead Pressure (psi)	Totalizer Reading (gallons x 1,000)	Calculated Average FlowRate (gpm)	Period Average (gpm)
11/29/16	12:00	Uninflated	--	4,097,182	--	2,235
11/30/16	7:37	Uninflated	90	4,099,826	2,246	
12/5/16	9:00	Uninflated	90	4,116,094	2,234	
12/9/16	14:45	Inflated	91	4,129,108	--	2,113
12/19/16	11:30	Inflated	87	4,159,129	2,113	

FOOTNOTES:

(--) = Parameter not calculated

psi = Pounds per square inch

gpm = Gallons per minute

TABLE 6
PACKER TEST SPECIFIC CAPACITY ESTIMATES
CITY OF FULLERTON WELL NO. 9

	Pre-Packer Inflation	Post-Packer Inflation
Average Pumping Rate (gpm)	2,235	2,113
Drawdown (feet)	70	92
Estimated Specific Capacity (gpm/foot)	31.9	23.0
Reduction in Specific Capacity		28.0%

FOOTNOTE:
gpm = gallon(s) per minute

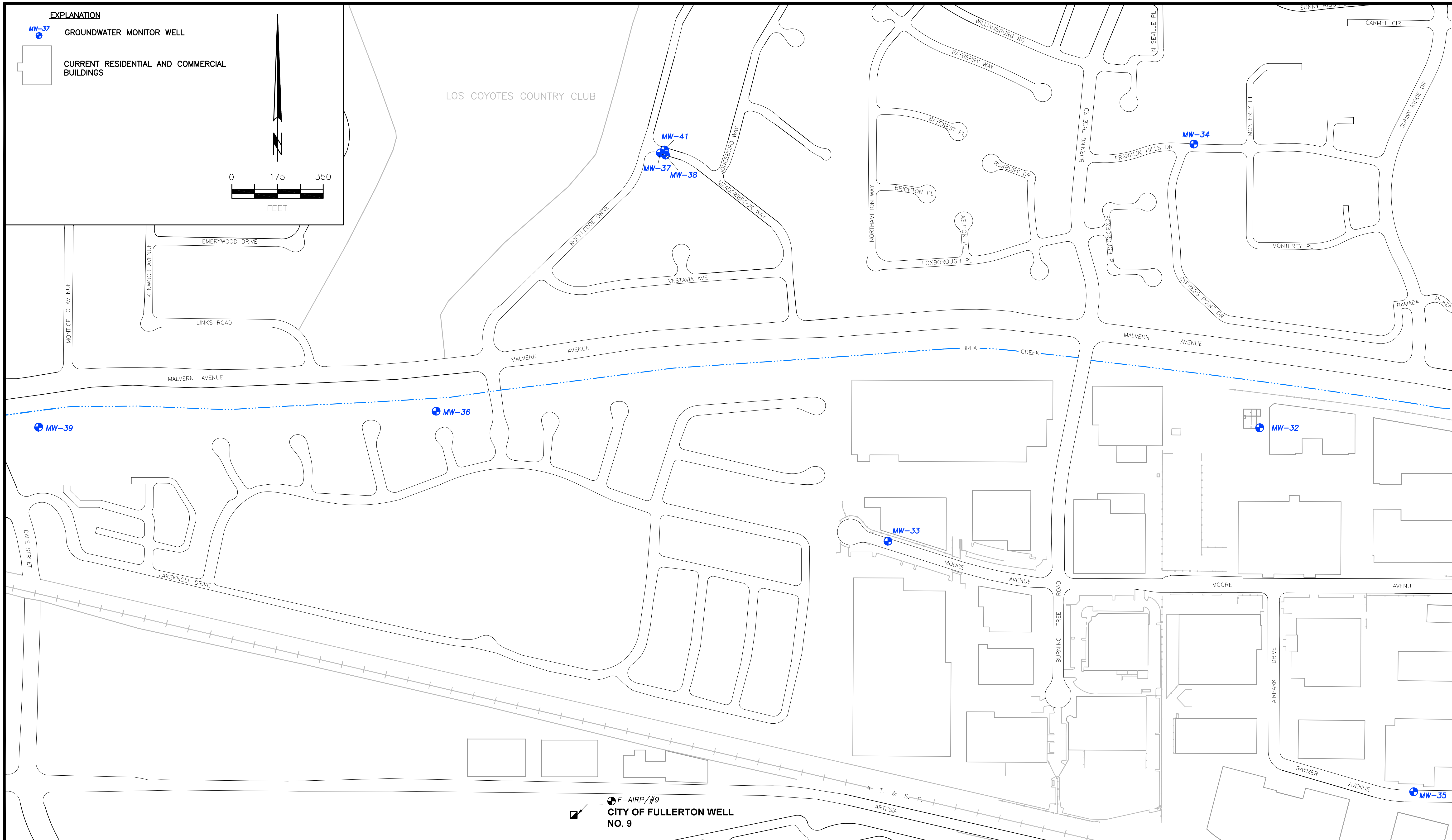
TABLE 7
CITY OF FULLERTON WELL NO. 9 ELECTRICAL USE

Date	Time	Packer Status	Electric Meter Reading (kW-Hr)	Electricity Used (kW-Hr)	Volume of Water Pumped (gallons*1,000)	Electrical Use (kW-hr/1,000 gallons pumped)
11/29/16	12:00	Uninflated	12,679	--	--	--
11/30/16	7:37	Uninflated	12,734	55	2,644	0.021
12/5/16	9:00	Uninflated	13,071	337	16,268	0.021
12/9/16	14:45	Inflated	13,354	--	--	--
12/19/16	11:30	Inflated	14,011	657	30,021	0.022
Increase in Electrical Use per Volume of Extracted Water =						5.6%

FOOTNOTES:

(--) = Parameter not calculated

kW-Hr = Kilowatt-Hour

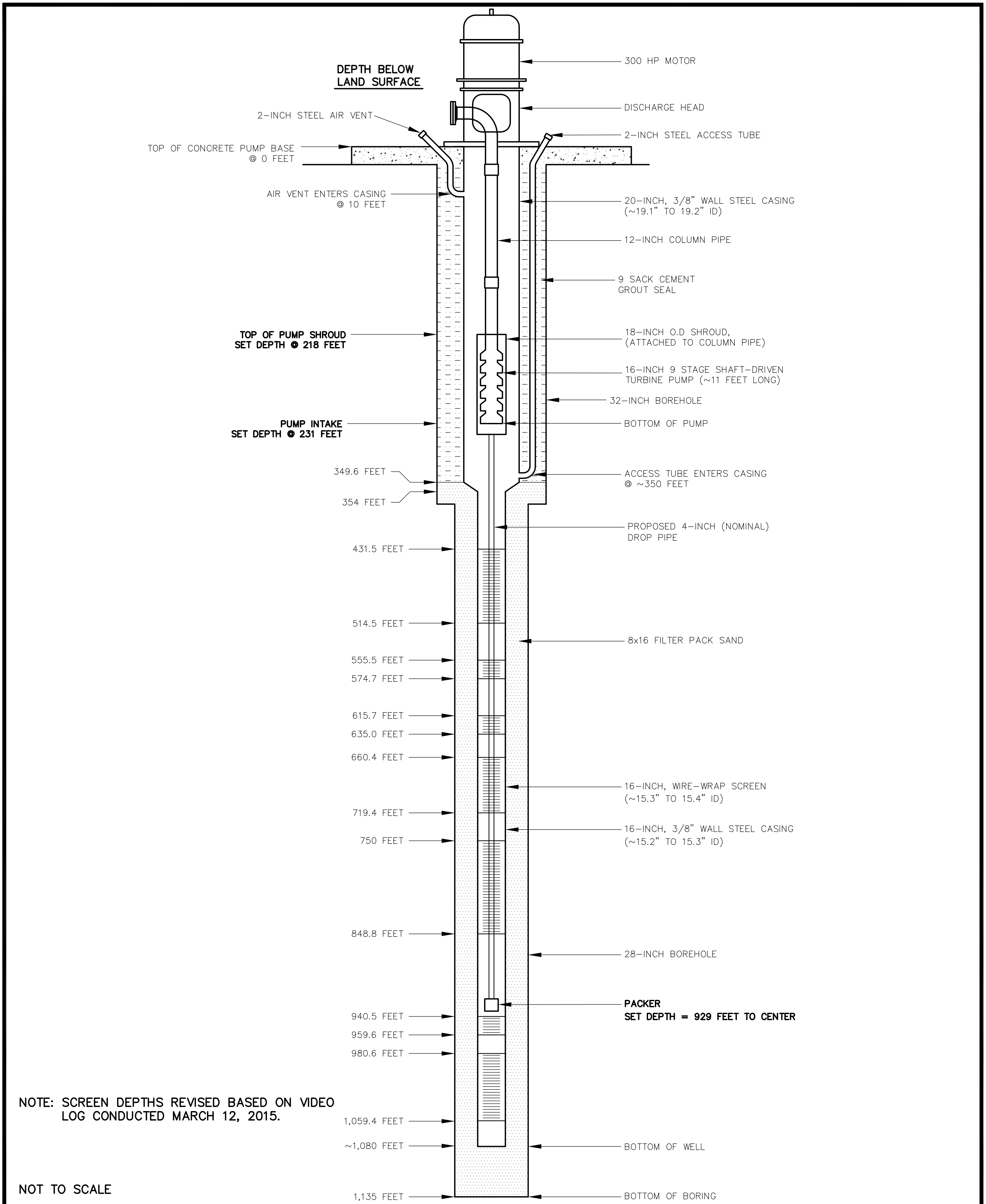


Jun 08, 2016 – 3:39pm ess – T:\2016\500-599\532 Raytheon\Hydrogeology\410-9632.dwg

06/16	RPT NO. 532.80	410-9632	A

HARGIS + ASSOCIATES, INC
Hydrogeology/Engineering

FIGURE 1.
WELL AND PIEZOMETER LOCATIONS



1/17	RPT NO. 532.03	710-0901	B

HARGIS + ASSOCIATES, INC.
Hydrogeology/Engineering

FIGURE 2.
PUMP AND PACKER RESET DIAGRAM
FULLERTON WELL #9

HARGIS + ASSOCIATES, INC.

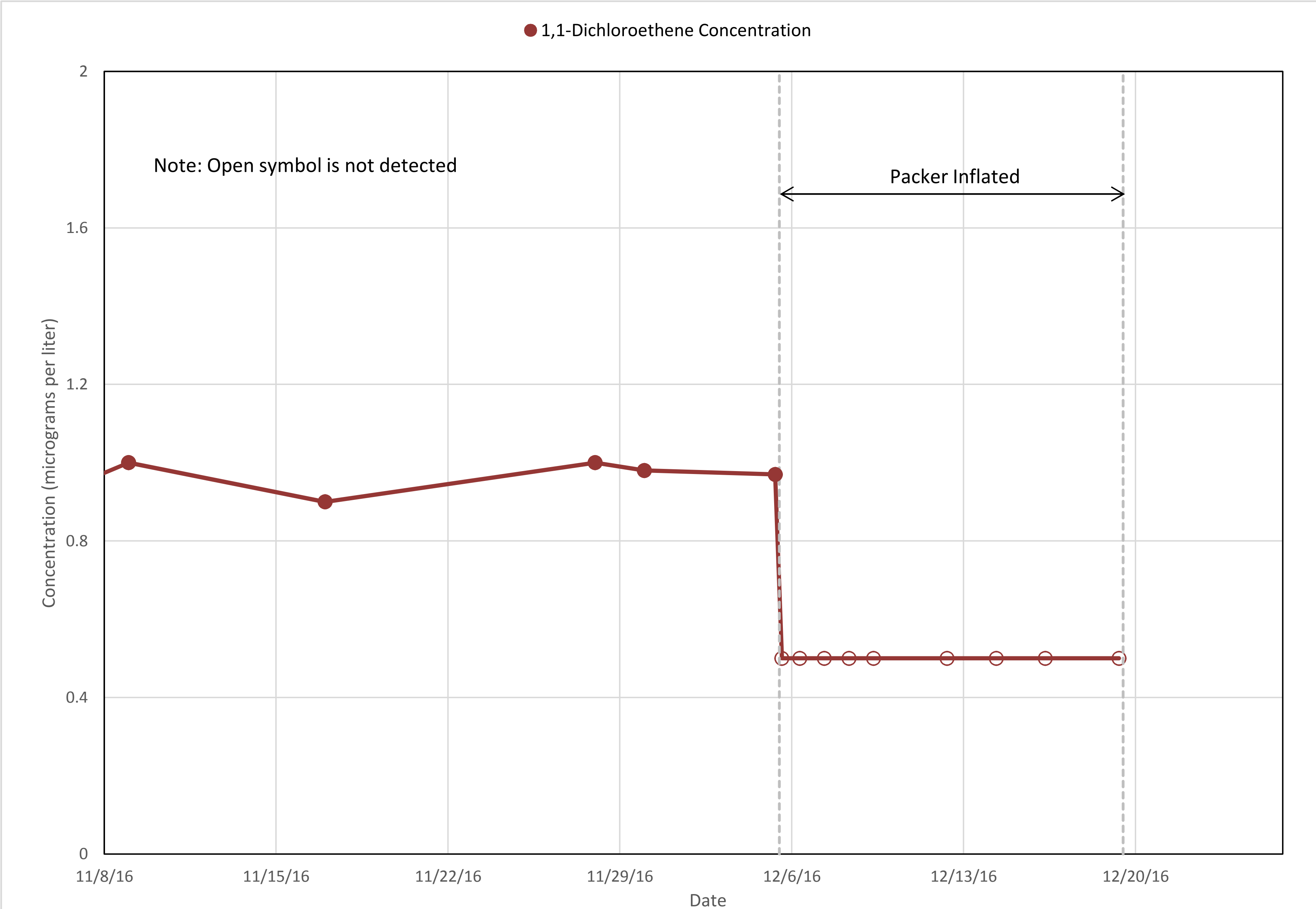


FIGURE 3: 1,1-DICHLOROETHENE CONCENTRATIONS, CITY OF FULLERTON PRODUCTION WELL NO. 9

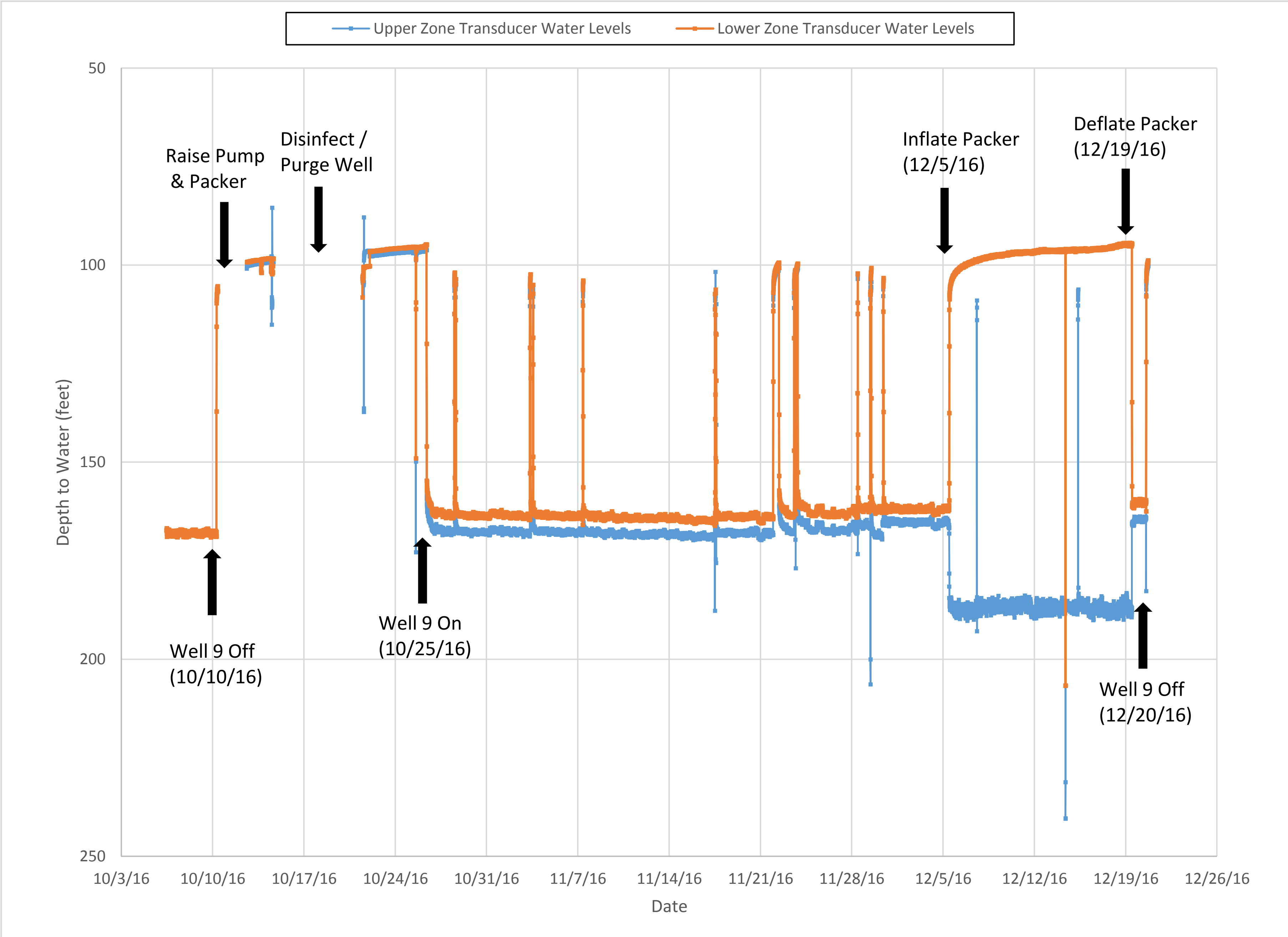


FIGURE 4. WATER LEVELS, CITY OF FULLERTON PRODUCTION WELL NO. 9

ATTACHMENT 3

SIMFLO PUMP VENDOR LITERATURE

Pump Data Sheet - SIMFLO PUMPS INC.

Company: Layne
Name: David
Date: 09/07/2017

SIMFLO PUMP

Pump:

Size:	SK16C (stages: 11)	Dimensions:	
Type:	VERTTURBINE	Suction:	12 in
Synch Speed:	1200 rpm	Discharge:	12 in
Dia:	12.88 in	Vertical Turbine:	
Curve:		Eye Area:	78.6 in²
		Bowl Size:	16 in
Specific Speeds: Ns:	3712	Max Lateral:	0.75 in
Nss:	7986	Thrust K Factor:	---

Search Criteria:

Flow:	2500 US gpm	Near Miss:	---
Head:	425 ft	Static Head:	0 ft

Fluid:

Name:	Water		
SG:	1	Vapor Pressure:	0.256 psi a
Density:	62.4 lb/ft³	Atm Pressure:	14.7 psi a
Viscosity:	1.1 cP		
Temperature:	60 °F		

Pump Limits:

Temperature:	---	Sphere Size:	1 in
Wkg Pressure:	---		

Motor:

Standard:	US	Size:	350 hp
Enclosure:	TYPE 1	Speed:	1200 rpm
Frame:	----		
Sizing Criteria:	Max Power on Design Curve		

Pump Selection Warnings:
None

--- Duty Point ---

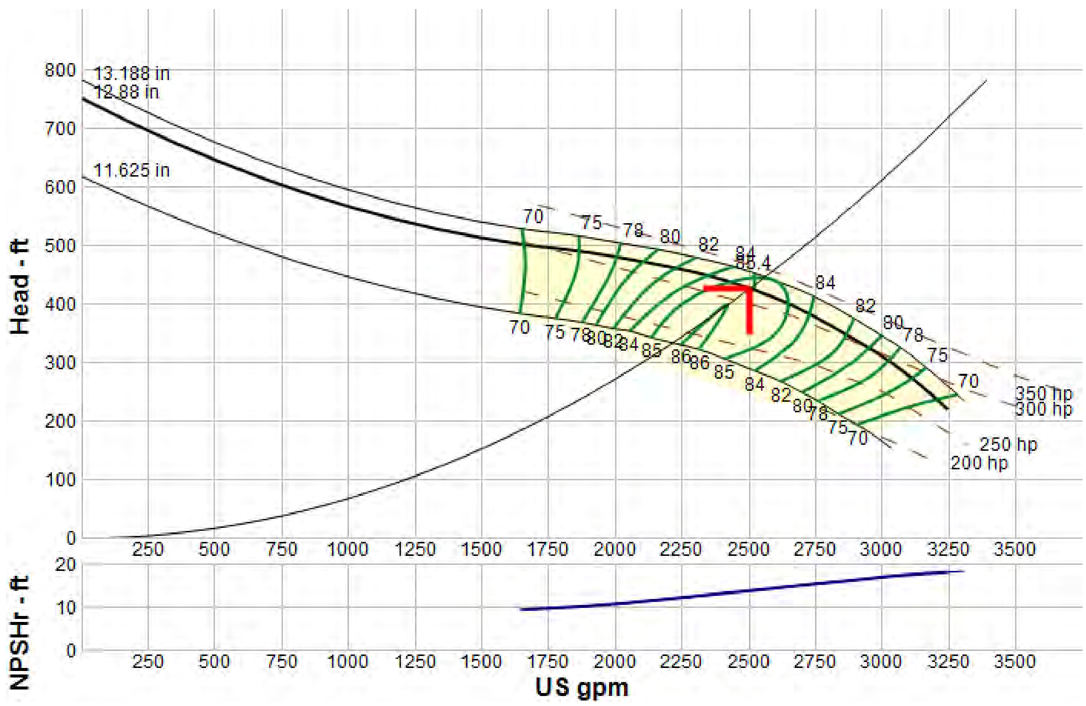
Flow:	2501 US gpm
Head:	425 ft
Eff:	85.3%
Power:	315 hp
NPSHr:	13.9 ft
Speed:	1160 rpm

--- Design Curve ---

Shutoff Head: 749 ft
Shutoff dP: 325 psi
Min Flow: --- US gpm
BEP: 85.4% @ 2518 US gpm
NOL Power:
315 hp @ 2344 US gpm

--- Max Curve ---

Max Power:
340 hp @ 2740 US gpm



Performance Evaluation:

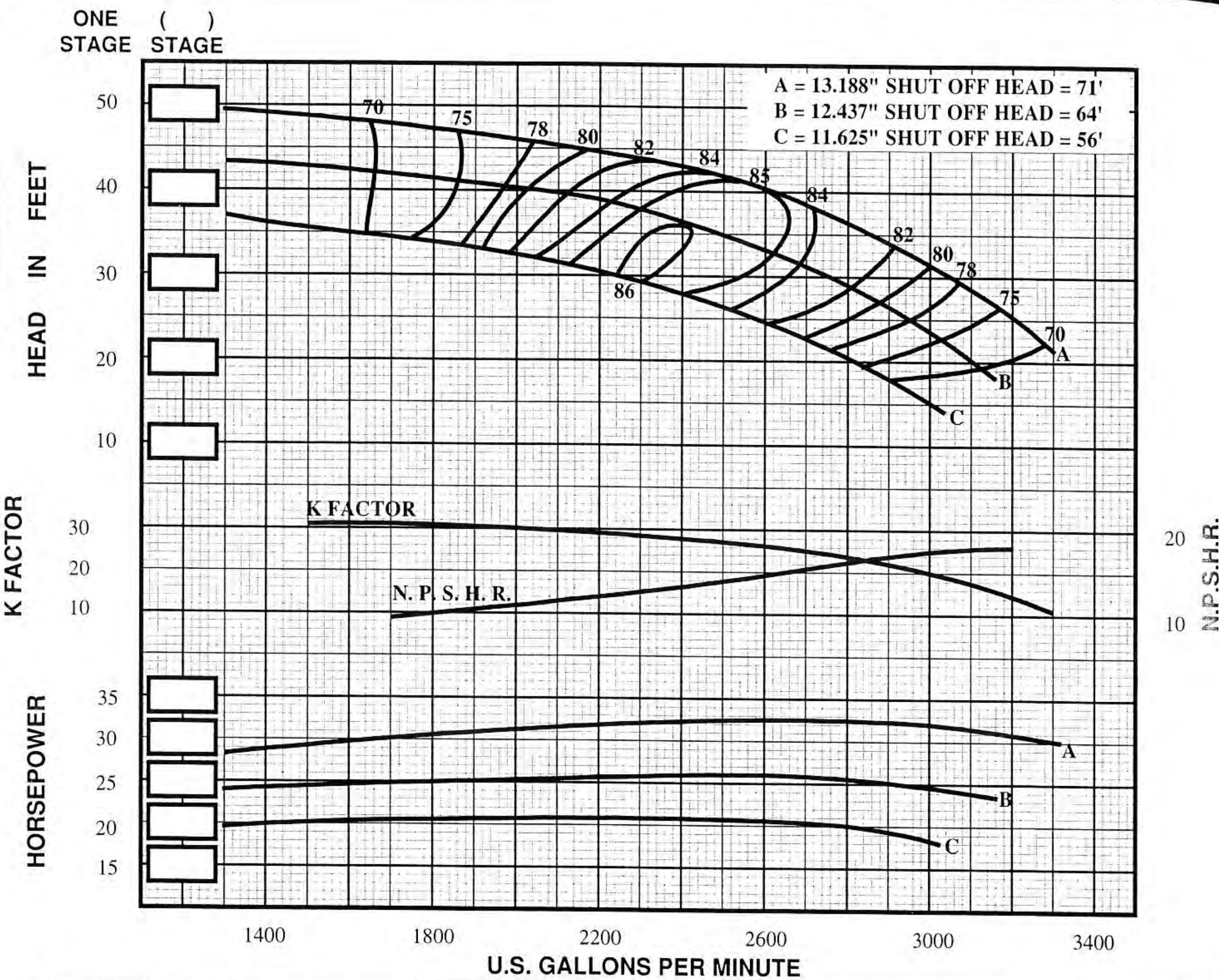
Flow	Speed	Head	Efficiency	Power	NPSHr
US gpm	rpm	ft	%	hp	ft
3000	1160	309	78.6	297	17.1
2500	1160	425	85.3	315	13.9
2000	1160	479	78	311	10.8
1500	1160	---	---	---	---
1000	1160	---	---	---	---

Selected from catalog: Simflo Pumps.60, Vers 2.1

SIMFLO PUMPS

SK16C

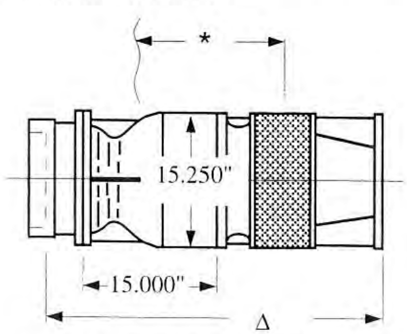
1160 R.P.M.



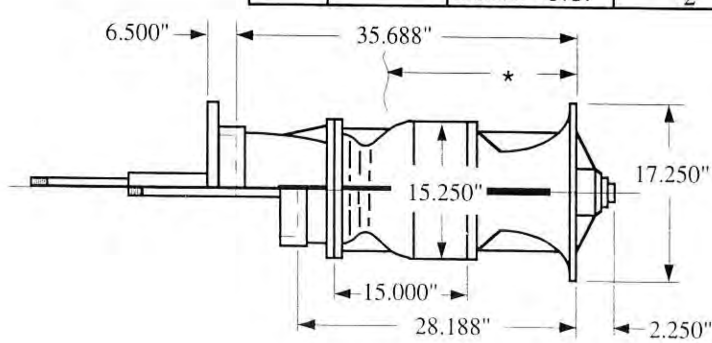
IMPELLER TYPE	= ENCLOSED	STD. SHAFT DIA.	= 1.937"
IMPELLER NO.	= SK16C	MAX. SHAFT DIA.	= 2.187"
IMPELLER WT. - LBS.	= 39.0	STD. LATERAL	= .750"
ONE STAGE WT. - LBS.	= 600.0	DISCHARGE SIZES	= 12",14"
ADD'L STAGE WT. - LBS.	= 250.0	SUCTION SIZES	= 12", BELL
MAX. SPHERE SIZE	= 1.000"	ONE STAGE WR^2	= 4.966
MIN. SUBMERGENCE*	= 36"		=

Δ CONSULT FACTORY

NO. STAGES	EFF. CHANGE	MATERIAL	B.E.P. EFF. CHANGE
1	-3	IMP. - C.I.	0
2	-2	IMP. - NI-RI	-2
3	-1	IMP. - S.S.	-1
4	0	BOWL - BRZ.	-1
5	0	BOWL - NI-RI	-1
		BOWL - S.S.	-2



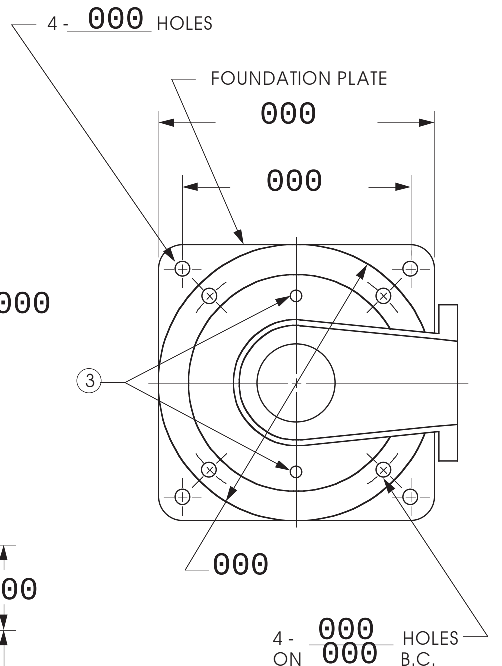
SUBMERSIBLE TURBINE

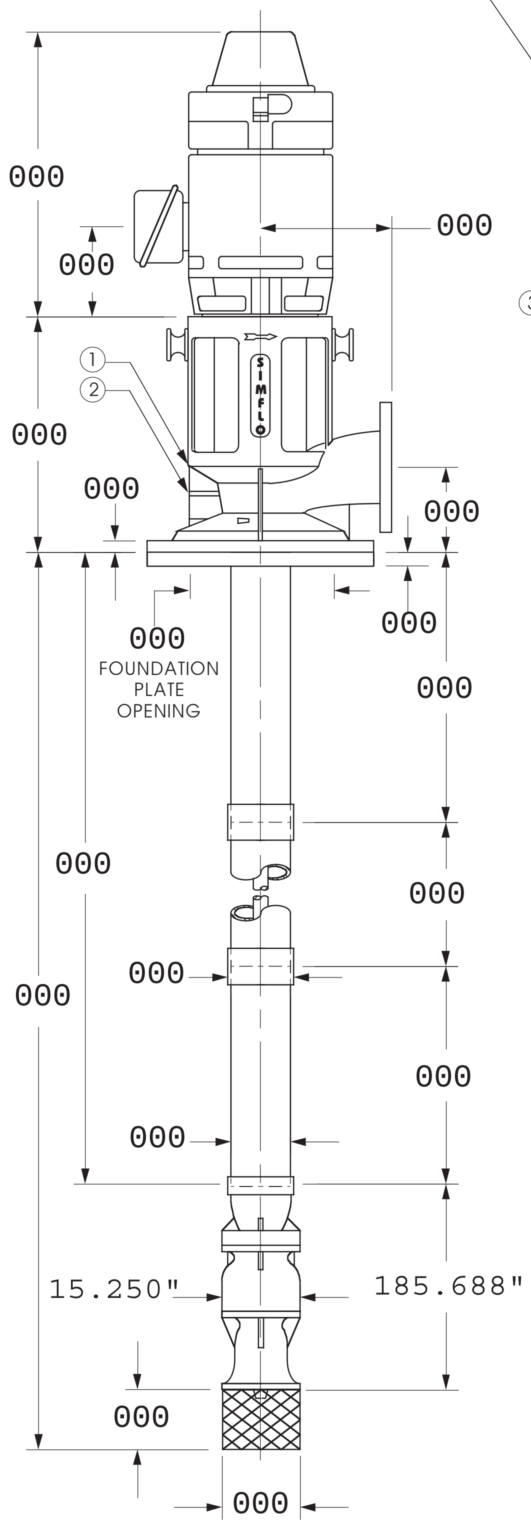


LINESHAFT TURBINE

SIMFLO PUMP

SHORT COUPLED PUMP WITH
CAST DISCHARGE HEAD





DATE 9/20/17

DISTRIBUTOR Layne Christensen Company

JOB SN115376

JOB/QUOTE # 14114

QUANTITY 1

G.P.M. 2500

T.D.H. 426'

STRAINER TYPE NA

BOWL MODEL # SK16C-11

COLUMN ASSY. NA

FOUNDATION PLATE NA

DISCHARGE HEAD NA

SEAL TYPE NA

IMP. DIA. 12.88"

IMP. TYPE Enclosed

SPECIAL
316SS Impellers, 416SS Collets
304SS Shaft Coupling
316SS Bolting

OTHER
NA

DISCHARGE FLANGE

NA

MOTOR

MAKE By Others

ENCLOSURE

N.R.R. or S.R.C.

H.P. **S.F.**

R.P.M. 1200

PHASE **CYCLE**

VOLTAGE

V.H.S. or V.S.S.

OTHER MOTOR INFO:

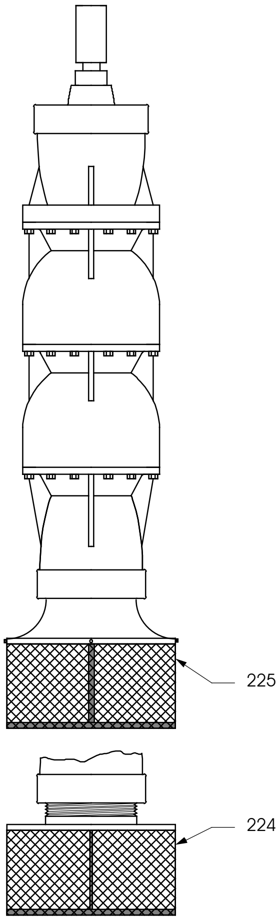
1 - 3/4" NPT DRAIN (1/2" NPT FOR S-050)
2 - 3/4" NPT ARV/PRELUBE (1/2" NPT FOR S-050)
3 - X" NPT HOLES ON Y" B.C.

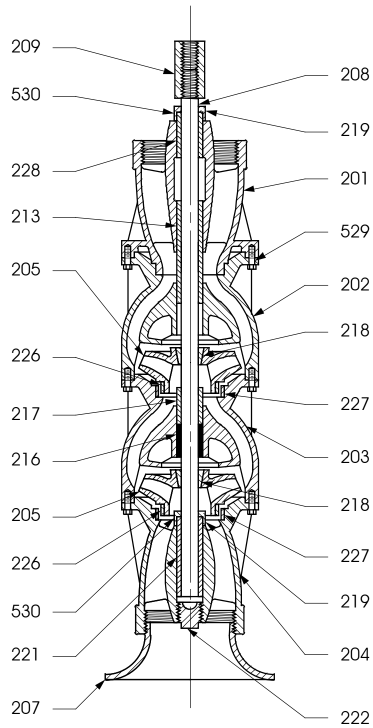
	X	Y
S-050	1/2	7.50
S-150	1/2	7.50
S-350	3/4	11.25
S-550	1	13.00
S-750	1	16.75

SIMFLO PUMPS

PRODUCT LUBE
BOWL ASSEMBLY

SECTION 902
PAGE 29
DATE 12/16/94
SUPERCEDES All Previous





DATE ________________
DISTRIBUTOR ________________

JOB ________________

JOB/QUOTE # ________________
QUANTITY ________________

CATALOG NUMBER	QUAN-TITY	PART NAME	STANDARD MATERIAL (A.S.T.M. DESIGNATION)	SPECIFICATION REQUIREMENT
201	1	CASE, DISCHARGE HOUSING	CAST IRON A-48 CLS 30	
202	1	BOWL, TOP HOUSING	CAST IRON A-48 CLS 30	
203		BOWL, INTERMEDIATE HOUSING	CAST IRON A-48 CLS 30	
204	1	CASE, SUCTION HOUSING	CAST IRON A-48 CLS 30	
205		IMPELLER (ENCLOSED) (SEMI-OPEN)	~~BRONZE B-584-836~~	316SS Impellers (-1% eff. entire assembly)
207		~~BELL,~~ SUCTION	CAST IRON A-48 CLS 30	
208	1	SHAFT, BOWL	SS A-582 GR 416	
209	1	COUPLING, BOWL SHAFT	~~STEEL A-108 GR 1018~~	304SS Coupling
213	1	BEARING, DISCHARGE CASE (LOWER)	BRONZE B-505-932	
216		~~BEARING, INTERMEDIATE BOWL~~	~~NEOPRENE~~	
217		BEARING, INTERMEDIATE BOWL	BRONZE B-505-932	
218		COLLET, IMPELLER	~~STEEL A-108 GR 1020~~	416SS Collet
219		COLLAR, SAND	BRONZE B-584-836	
530	2	SET SCREW, SAND COLLAR	SS GR 416	
221	1	BEARING, SUCTION CASE	BRONZE B-584-836	
222	1	PLUG, GREASE	COMMERCIAL	
529		SCREW, CAP	~~COMMERCIAL~~	316SS Bolting
224		~~SCREEN, BASKET (THREADED)~~	~~FAB. STEEL~~	
225		~~SCREEN, BASKET (CLIP ON)~~	~~FAB. STEEL~~	
226		~~RING, IMPELLER WEAR~~	~~BRONZE B-584-836~~	
227		~~RING, BOWL WEAR~~	~~CAST IRON A-48 CLS 30~~	
228	1	BEARING, DISCHARGE CASE (UPPER)	BRONZE B-505-932	
230		~~SCREEN, CONE (THREADED) (NOT SHOWN)~~	~~ALUMINUM COATED STEEL~~	

ATTACHMENT 4

US MOTOR VENDOR LITERATURE

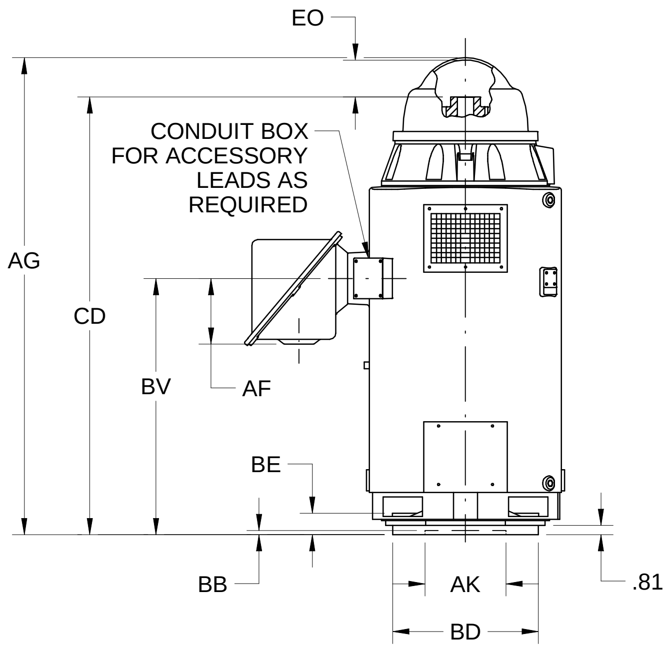
CURRENT	PHASE	CYCLES	VOLTS
AC	3	60	460

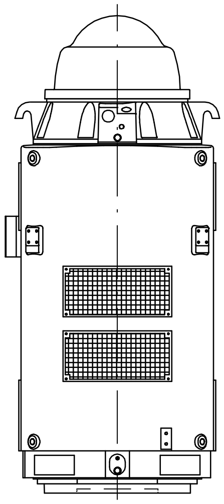
ITEM	QTY	HP	FRAME	SPEED	WEIGHT	TYPE	NMC Ref#	
A	1	350	5008P	1200	4100 lbs.	RUEI	1241539	

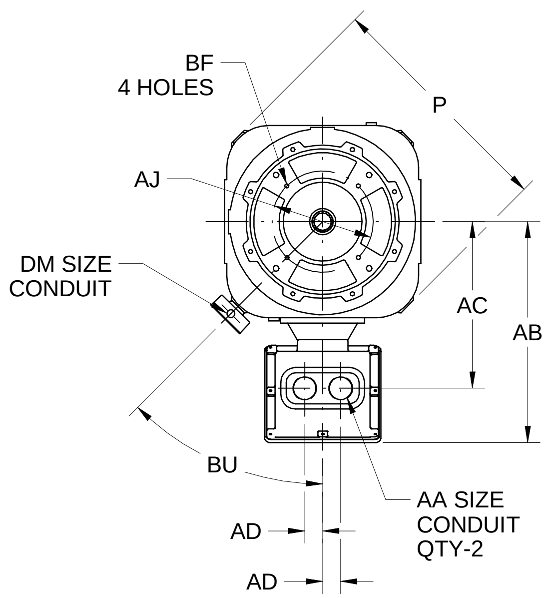
DESCRIPTION:

- TITAN® Vertical HOLLOSHAFT® Motor
- High Thrust ~ WPI Enclosure
- Random Wound
- 1.15 Service Factor on Sine Wave Power / 1.0 Service Factor on VFD Power
- Class "F" Insulation
- VPI-2000 Insulation Treatment
- 3300 Feet (1000 M) Altitude (Max)
- +40°C Ambient Temperature
- Premium Efficient
- Vertical Centrifugal Pump Application
- Inverter Duty NEMA MG1 Part 31 Variable Torque ~ 10:1 Speed Range
- Base Diameter: 24.5 Inches
- Coupling Size: 1-15/16" Bore, 1/2" Key
- Non-Reverse Ratchet
- Pricebook Thrust Value: 11000 lbs.
- "F" Rise @ 1.15 SF (by Resistance Method on Sine Wave Power)
- Direct-On-Line Start/VFD
- Continuous Duty
- Counter Clockwise Rotation Facing Opposite Drive End
- Shaft Ground Ring
- Insulated Bearing - Upper Bracket
- Special Balance
- Thermostats - Normally Closed

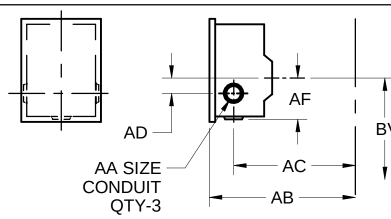
EFFECTIVE:	DIMENSION PRINT	PRINT:
22-JUL-15	WEATHER PROTECTED TYPE I	09-2657
SUPERSEDES:	FRAME: 5000PH, P, PA	SHEET:
10-SEP-13	BASIC TYPE: RU	1 OF 2







OPTIONAL 5600 CUBIC INCH CONDUIT BOX



OUTSIDE DIMENSIONS

HEIGHT: 24"
WIDTH: 18"
DEPTH: 14"

TOLERANCES	
FACE RUNOUT	.007 T.I.R.
PERMISSIBLE ECCENTRICITY OF MOUNTING RABBET	.007 T.I.R.
MAXIMUM SHAFT END PLAY	.010

FRAME	P	AG	BV	CD	EO
5008	40.00	63.88	27.00	57.06	6.42
5012		78.88	42.00	72.30	

FRAME	AJ	AK +.005	BB MIN	BD MAX	BE	BF
5000PH	14.750	13.500	.25	20.00	2.19	.69
5000P[3]	14.750	13.500		24.50		.69
	22.000					.94
5000PA	26.000	22.000		30.50		.81

VOLTS	C/BOX VOLUME (CU.IN.)	AB	AC	AD	AF	BU
0-4800	3400	36.50	27.88	3.00	10.94	45°
4801-6900	5600	36.13	30.13	4.00	10.81	

AA	DM
2 NPT	1/2 NPT
2 1/2 NPT	3/4 NPT
3 NPT	1 NPT
3 1/2 NPT	1 1/4 NPT
4 NPT	1 1/2 NPT

1. DIMENSIONS MAY VARY .25" DUE TO CASTING AND/OR FABRICATION VARIATIONS.
2. DIMENSIONS AND TOLERANCES ARE SHOWN IN INCHES.
3. 5000P HAS TWO BOLT CIRCLES.

IHP_DP_NMCA (MAR-2011) SOLIDEDGE

09-2657/B

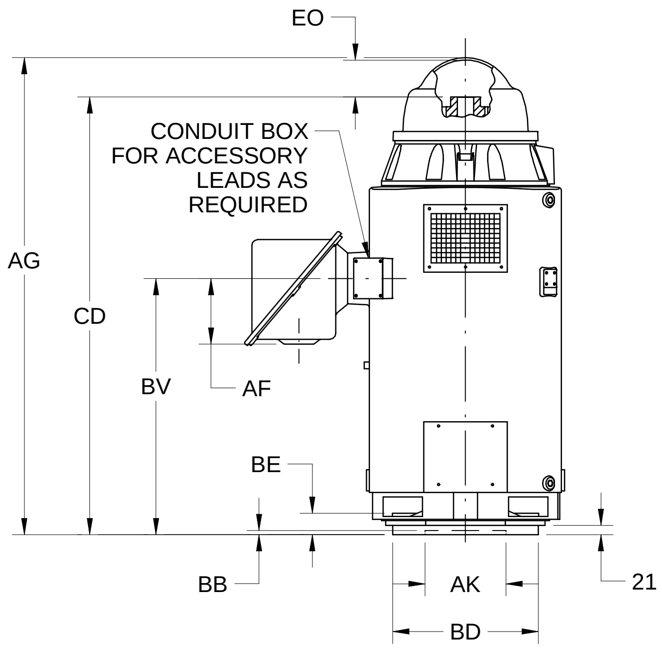
ISSUED BY R. KING

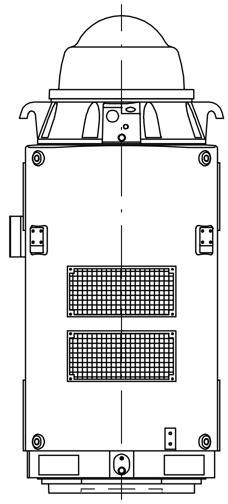
APPROVED BY C. CADE

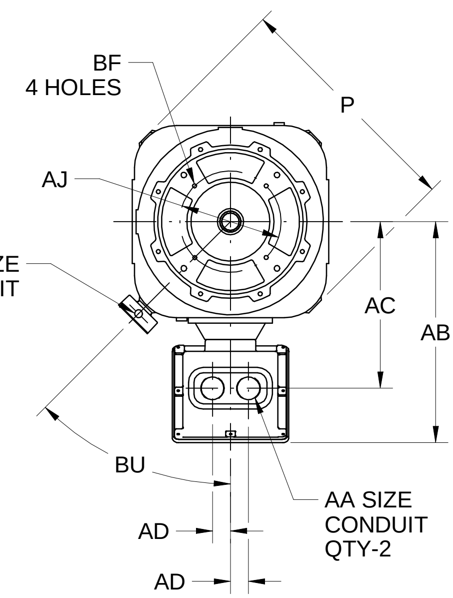
Nidec Motor Corporation
St. Louis, Missouri

US MOTORS

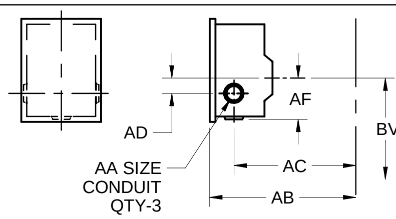
EFFECTIVE: 22-JUL-15	DIMENSION PRINT	PRINT: 09-2657
SUPERSEDES: 10-SEP-13	WEATHER PROTECTED TYPE I FRAME: 5000PH, P, PA BASIC TYPE: RU	SHEET: 2 OF 2







OPTIONAL 142240 CUBIC MM CONDUIT BOX



OUTSIDE DIMENSIONS

HEIGHT: 610mm
WIDTH: 457mm
DEPTH: 356mm

TOLERANCES	
FACE RUNOUT	.18 T.I.R.
PERMISSIBLE ECCENTRICITY OF MOUNTING RABBET	.18 T.I.R.
MAXIMUM SHAFT END PLAY	.25

FRAME	P	AG	BV	CD	EO
5008	1016	1623	686	1449	163
5012		2004	1067	1836	

FRAME	AJ	AK +.13	BB MIN	BD MAX	BE	BF
5000PH	374.65	342.90		508		18
5000P[3]	374.65	342.90	6	622	56	18
	558.80					24
5000PA	660.40	558.80		775		21

VOLTS	C/BOX VOLUME (CU.IN.)	AB	AC	AD	AF	BU
0-4800	3400	927	708	76	278	45°
4801-6900	5600	918	765	102	275	

AA
2 NPT
2 1/2 NPT
3 NPT
3 1/2 NPT
4 NPT

DM
1/2 NPT
3/4 NPT
1 NPT
1 1/4 NPT
1 1/2 NPT

1. DIMENSIONS MAY VARY .25" DUE TO CASTING AND/OR FABRICATION VARIATIONS.
2. DIMENSIONS AND TOLERANCES ARE SHOWN IN MILLIMETERS.
3. 5000P HAS TWO BOLT CIRCLES.

IHP_DP_NMCA (MAR-2011) SOLIDEDGE

09-2657/B

ISSUED BY R. KING
APPROVED BY C. CADE

Nidec Motor Corporation
St. Louis, Missouri

HOLLOSHAFT® Motors
Vertical A.C. Motors, High Thrust

Horsepower: 3 – 5000 HP

Speeds: 3600 – 400 RPM

Design Voltages: Three Phase / 208-6900 Vac / 50 or 60 Hz

Enclosures: Weather Protected Type I, Weather Protected Type II, Totally Enclosed Fan Cooled, and Hazardous Location

Efficiency Levels: Standard Efficient, Energy Efficient, and Premium Efficient

Product Overview and Options

The U.S. MOTORS® brand Vertical HOLLOSHAFT® motor has been a standard in the pumping industry since 1922. These motors are recognized for their longevity, reliability and ease of use. Unique configurations, tailored to a customer's specific requirements, can include enclosure design to minimize the effects of adverse conditions present in turbine, mix flow and propeller pump applications.

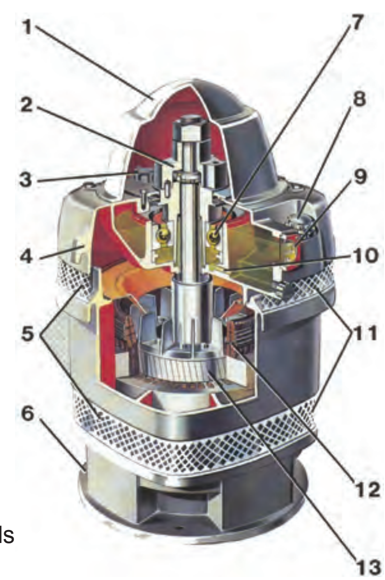
U.S. MOTORS® brand Vertical HOLLOSHAFT® motors are constructed of high quality materials and are manufactured in a state-of-the-art, ISO9000-2000 facility. Innovative, performance-focused design makes this motor the most trusted in the industry.

Product Features:

- Class F insulation, Class B rise at full load
- 1.15 Service Factor - typical for WPI and WPII enclosures
- 1.00 Service Factor - typical for TEFC and hazardous location enclosures
- Maximum 40°C ambient, 3,300 feet altitude
- Bearing capacities among highest in industry
- Multiple bearing configurations available for specific bearing life requirements.
  - Ball
  - Spherical Roller
  - Angular Contact
  - Plate Type

WPI 15-5000 HP
and WPII 300-5000 HP

Typical HOLLOSHAFT® Motor Construction:



1. **Lightweight Top Cover**
2. **Coupling** is readily accessible
3. **Lockbar** holds shaft during adjustments
4. **Lifting Lugs** positioned for stability
5. **Protected Air Openings** exceed NEMA WPI requirements
6. **Precision Machined Mounting Base,** ample clearance for mounting bolt installation
7. **Rugged Bearing** withstands heavy load thrusts
8. **Large Plug** simplifies oil fills
9. **Sight Gauge Window** for quick oil level reading
10. **Metered Oil Flow** minimizes churning
11. **Dual Air Flow** system for uniform cooling of motor top and bottom
12. **Windings** Protected by new, synthetic materials
13. **Solid Die Cast Rotor** with integral fan blades

Enclosure Types

Non-Reverse Backstop Ratchet Design, BALLOMATIC®

- First technology of its kind in the market
- Prevents reverse rotation within 4.5 degrees of rotation
- Unlimited depth setting
- Can be used in certain Hazardous Location applications

BALLOMATIC®
Backstop Ratchet

Weather Protected Type I (WPI)

Constructed to minimize the entrance of rain, snow and airborne particles. Enclosures exceed NEMA requirements. The ventilation system is designed to provide optimum cooling to the thrust bearing and electrical components and is available in all motor sizes.

Weather Protected Type II (WPII)

Enclosure offers protection against hostile outdoor environments. The special ventilation system minimizes the entrance of high velocity air, moisture and airborne particles into the motor's passages.

Unique design allows the use of standard internal components. Special enclosures can be adapted with minimum delay.

Totally Enclosed Fan Cooled (TEFC) and Hazardous Location

Non-sparking, non-reverse ratchet design. Available for severe environments where destructive dusts, vapors and other harmful substances are found. Perfect for use in hazardous locations where Underwriters Laboratories (UL®†) approval is necessary.

CORRO-DUTY®

Cast iron CORRO-DUTY® motors are available with external corrosion-resistant paint and hardware for extremely harsh environments.

TEFC and Hazardous
Location 3-2000 HP

4 Zone Design

U.S. MOTORS® brand vertical pump motors are designed with four functional zones. This design ensures easy installation and service and provides operator protection and convenience.

ZONE 1

Canopy cap allows easy access to the coupling, non-reverse ratchet and thrust bearing.

ZONE 2

Thrust bearings, generously sized oil reservoir, and large weather-protected air intake for continuous cooling to the motor and thrust bearings.

ZONE 3

Winding section develops the driving torque and houses the insulation systems.

ZONE 4

Compact mounting base designed for momentary upthrusts of the pump.

WPI 15-5000 HP
and WPII 300-5000 HP

† All marks shown within this document are properties of their respective owners.

NIDEC MOTOR CORPORATION

8050 W. Florissant Avenue | St. Louis, MO 63136
Phone: 888-637-7333 | Fax: 866-422-7758

SPECIFICATION GUIDE
Vertical Hollow and Solid Shaft High Thrust NEMA® Frame Motors
Weather Protected Type 1 – (WP-I)

Standards Referenced: NEMA® MG-1-2011, IEEE 112™-2004

1. General Requirements

   a. Scope – This specification covers NEMA frame vertically mounted, P-base, 3-phase, squirrel cage, AC induction motors. That are greater than 3 HP, less than 600 volts, and weather protected type 1.

   b. Service Conditions – Unless otherwise specified, motors conforming to this specification shall be suitable for operation in accordance with their rating under the following service conditions.

      i. Ambient temperature in a range of -29°C to 40°C (-20°F to 104°F).

      ii. Maximum altitude of 1000 meters (3300 feet) above sea level.

      iii. Indoor or outdoor installations.

      iv. Full voltage, across-the-line starting.

   c. Special Service Conditions

      i. High Ambient – Special engineering is required on motors in an ambient over 65°C.

      ii. Variable Frequency Drive (VFD)

      iii. High Altitude – Applications with altitudes above the standard service conditions require special design considerations.

      iv. Use with Variable Frequency Drive (VFD)

   d. Standards - All motors shall be in accordance with NEMA Standard MG1-2011, or the latest revision in so far as it is applicable.

2. Electrical Requirements

   a. Voltage and Frequency

      i. Standard voltages

         1. 60 cycle, 3 phase: 200, 230, 230/460, 460 and 575 volts are considered standard for ratings of 100 H.P. and below in maximum frame size of 405.

            a. 460 and 575 volts are standard above 100 HP and up to and including 447 frame

         2. 50 cycle, 3 phase: 190, 220, 190/380, 380 and 415 volts are all considered standard for ratings of 100 H.P. and below and in a maximum frame size of 405.

            a. 380 and 415 volts are standard above 100 HP and up to and including 447 frame.

      ii. Motors shall operate successfully under running conditions at rated load with variation in the voltage or the frequency not exceeding the following conditions:

         1. +/-10% rated voltage at rated constant volts/hertz ratio except for specific torque boost situations.

         2. Motors shall operate successfully under running conditions at rated load and volts/hertz ratio when the voltage unbalance at the motor terminals does not exceed one percent.

   b. Operating Characteristics - With rated volts/hertz ratio applied under standard service conditions, motor performance shall be as follows for critical operating characteristics:

      i. Torques - Motors shall meet or exceed the minimum locked rotor (starting) and breakdown torques specified in NEMA Standard MG1 Part 12 for Design B for the rating specified when on sine wave power.

      ii. Currents - Locked rotor (starting) currents shall not exceed NEMA Design B values.

      iii. Efficiency – Vertical motor efficiency shall be determined according to NEMA standard MG1 Part 12, IEEE Test Procedure 112 Method B, using accuracy improvement by segregated loss determination including stray load loss measurements. Efficiency calculations include friction losses due to high thrust bearings.

      iv. Temperature Rise - The temperature rise, by resistance, shall meet Class B requirements at 1.0 service factor and standard conditions and Class F requirements at 1.15 service factor.

   c. Service Factor and Ambient - Standard motors shall be rated for a 1.15 service factor on sine wave power in a 40°C ambient.

d. Insulation

i. Standard motors shall utilize the U.S. Electrical Motors Insulife 1000 insulation system which consists of at a minimum Class F or better insulation materials. This utilizes 100% solid polyester resins completely impregnating slot and end turns. The standard insulation material is non-hypogrospic Class F (155°C), suitable for WP-1 motors in a relatively dry environment. One dip and bake in polyester resin.

ii. Optional insulation systems:

1. Insulife 2000 includes an additional treatment of polyester varnish ideal for applications with high moisture content, such as tropical environments for fungus resistance. Two dips and bakes.

2. Vacuum Pressure Impregnation using 100% solid epoxy resins is available on 320 frames and larger

a. Insulife VPI 1000 – Single cycle

b. Insulife VPI 2000 – Double cycle that meets NEMA definition of moisture-resistant winding per NEMA MG1-1.27.1.

3. If inverter duty is specified special INVERTER GRADE® insulation is required.

a. INVERTER GRADE® insulation meets NEMA MG1, Parts 30 and 31. This includes additional phase paper between coils, extra bracing on end turns, and additional insulation treatments to protect motor winding from damaging effects that could occur when motor is used with a variable frequency drive.

3. Mechanical Requirements

a. Frame Size

i. Motors covered by this specification are 180 - 447 frame sizes.

b. Enclosure

i. Motors shall be weather protected type I (WPI)

ii. Material - Motor frame, endshields and inner bearing caps shall be cast iron construction for motors larger than 280 frame. Fan cover shall be constructed of plastic, steel, aluminum, or cast iron depending on exact frame size. Frames shall be aluminum construction 180-280 frames.

c. Bearings

i. Standard high thrust motor shall be supplied with an angular contact thrust bearing and ball type guide bearing.

ii. Optional Bearing Arrangements:

1. 175% extra high thrust bearings. These are two angular contact bearings in tandem are available on 324 frames and above.

2. 300% extra high thrust bearings. This is a spherical roller type bearing that is spring loaded. This is available on 444 frames and larger. These required that motor to experience a minimum continuous down thrust during operation to correctly position the bearings to run.

3. Back-to-back bearings are available on 324 frames and larger for up-thrust protection. This arrangement consists of two angular contact bearings mounted in opposite directions (back-to-back).

4. Up-thrust – 30% momentary up-thrust protection (of standard high-thrust value -- NOT extra-high thrust value) is provided as standard. When up-thrust protection is supplied on vertical HOLLOSHAFT® motors, the drive couplings must be bolted together and the self release feature shall not apply; however, the non-reverse ratchet can be furnished.

    a. Continuous up-thrust protection can be accommodated for the same thrust ratings as standard down thrust by using back-to-back bearing arrangement.

iii. See Table 3.c - 1 for standard bearing arrangement and lubrication.

STANDARD BEARING LUBRICATION

FRAME	UPPER BEARING	LOWER BEARING	THRUST CAPACITY
180 – 280	GREASE	GREASE **	HIGH
320 – 440	OIL	GREASE	HIGH

** Thrust bearing located in lower bearing

Table 3.c – 1

d. Conduit Box - shall be gasketed between the conduit box halves. The conduit box shall be oversize as compared to NEMA type 4 requirements and diagonally split and rotatable in 90 degree increments except on aluminum frames. Conduit boxes shall be aluminum on frames 180-280, steel for frames 320 - 445. 447 frame shall have a cast iron conduit box as standard. Cast iron conduit boxes are available as an option.

e. External screws and bolts - shall be grade five, hex heads and be plated to resist corrosion.

f. Motor Shaft – 1045 Hot rolled Steel. Available with solid shaft or HOLLOSHAFT®

g. External Paint - shall be corrosion resistant - mill and chemical duty paint.

h. Nameplate - shall be of stainless steel and stamped per NEMA Standard MG1 Part 10 and Part 31.

i. Motor Vibration

   i. Standard and refined vibration per table 3.j – 1.

VIBRATION LEVEL

	STANDARD	REFINED
Number of Poles	Velocity (IPS-PEAK)	Velocity (IPS-PEAK)
2	0.15	0.10
4	0.15	0.08
6	0.15	0.08
8	0.12	0.06
10	0.09	0.05
12	0.08	0.04

Table 3.j - 1

4. Optional Features

   a. Non-Reversing Ratchet – BALLOMATIC® type

      i. Standard direction is counter clockwise as viewed from opposite drive end.
      ii. Clock wise rotation ratchets may also be requested on 4 – pole and slower 400 frame and larger.

   b. Accessory Conduit Boxes

      i. NEMA type 4 enclosure to terminate leads of accessories such as space heaters, thermostats, etc.
      ii. Cast iron construction

         1. Larger boxes shall have steel covers.

      iii. Multiple opening sizes and positions

   c. Ingress Protection

      i. INPRO/SEAL® – For IP55 bearing ingress protection on drive end bearing.
      ii. Shaft Slinger – For IP54 bearing ingress protection.

   d. Grounding Provisions

      i. Grounding lug available in main conduit box
      ii. Shaft grounding ring on lower bearing cap

         1. Inpro-MGS for shaft grounding and IP55 bearing ingress protection.
         2. Suggest use of insulated upper bearing on upper bracket with shaft grounding device.

iii. Grounding on frame

1. Grounding pad 400 frame and larger
2. Grounding terminal

e. Insulated bearings – BELZONA® type insulation

i. Either one or both bearings can be insulated.

1. If both bearings are insulated, a grounding ring is required to be installed to dissipate shaft currents.

f. Space heaters – Silicone rubber “strip – type” low-watt, density-type space heaters. Space heaters are wrapped around and bonded to the end turns on drive end.

g. Shaft Material – shall be 4140 or 17-4PH High tensile strength steel

h. Stainless Steel Hardware

i. Thermal Protection

i. Bearings - One bearing protective device shall available on the upper bracket only on 320 frame and above

1. RTD type – 10 ohm copper, 120 ohm nickel, 100 ohm platinum, 100 ohm precision platinum

2. Thermocouple – Type J, T, E, and K.

ii. Windings

1. Thermostats – Snap action, bimetallic, temperature actuated switches installed in the connection end-turns of the motor winding. Their purpose is to activate a warning device (N.O.) or shut down the motor (N.C.) upon excessive winding temperatures. Leads are normally brought out to the main conduit box on 460 volt motors. They are available with normally closed contacts for automatic reset. Overheat protectors with normally open contacts, for use in alarm or warning circuits, are available upon request.

2. Thermistors (embedded in winging) – Winding thermistors are a nonlinear resistance temperature detector made of semiconductor material and embedded in the end turns of the motor winding, one per phase. They are a PTC type device (Positive Temperature Coefficient).

   a. Standard thermistors are SIEMENS® type B59155. Three thermistors are installed in the winding with 6 leads brought to the main conduit box. Control module shall be supplied by others.

   b. This accessory provides NEMA Type 1 (winding - running and locked rotor over temperature) protection for motors in the 182 through 447 frame size.

c. THERMAL SENTRY® system is a PTC type thermistor that includes the control module.

   i. Available on 400 frame and larger

   ii. Control must be separately excited by a 24 to 240 AC/DC voltage source.

3. Thermocouples - A thermocouple consists of two dissimilar conductors welded together into a junction. This is inserted into the motor winding -- 2 per phase / 6 per motor. Thermocouple leads are brought out to terminal strip connections in an accessory conduit box, which is included in its price. These accessory signal wires leads are connected to an input instrument (supplied by others) to form a reference junction. Heating of the thermocouple imbedded in the winding generates a thermoelectric potential (EMF) proportional to the temperature difference between the two points, indicating the temperature of the embedded thermocouple.

   a. Available 324 frame and larger.

4. Resistance Temperature Detectors (RTDs) - An RTD is a sensing element consisting of a precision wound wire coil of pure metal. Recognized for their accuracy, the RTD's resistance increases with temperature rise in a known and highly repeatable manner. Two RTDs per phase/6 per motor are our standard offering. Accessory lead (signal) wires are connected to terminal strip connectors in an accessory conduit box. When connected to an input instrument or monitor (supplied by others), RTD temperature can be monitored. A variety of RTDs are offered to industry standard curves as shown in table 4.L.ii.4 – 1.

   a. Available 324 frame and larger.

RTD ELEMENT	NO. OF WIRES	RESISTANCE
NICKEL (1)	2	120 OHMS @ 0°C
COPPER	3	10 OHMS @ 25°C
PLATINUM (2)	3	100 OHMS @ 0°C
PRECISION PLATINUM (3)	3	100 OHMS @ 0°C
NICKEL / IRON	2	676 OHMS @ 25°C

(1) USEM standard supply if not specified at time of order.
(2) TCR rating .00392
(3) TCR rating of .00385 (DIN & IEC STD.)

j. Vibration Detectors

1. Standard vibration switch shall be ROBERTSHAW® 366A8 type.

2. Ability to arrange to accommodate one vibration sensor or switch on upper bracket of 324 frame and larger.

3. Other sensors or switches may be approved for application.

5. Tests

a. All motors shall be tested to insure correct operation. More extensive testing may be available but is not standard.

b. Common additional testing:

i. Short commercial test – This test consists of no-load current, locked rotor current, winding resistance, and high potential tests.

ii. Complete initial test - Tested per IEEE Standard 112, method B, dynamometer test. This test consists of full-load heat run, percent slip, no-load current, full-load current, locked rotor current, lock rotor torque, breakdown torque (calculated), efficiency and power factor at 100%, 75%, and 50% full load, insulation resistance per IEEE Standard 43, winding resistance and high potential.

iii. Sound Test -- This shall be a no-load test performed in accordance with ANSI S12.51 and NEMA MG-1.

6. Warranty

a. Standard warranty on sine wave power for a premium efficient motor shall be 36 months from date installed or 42 months from manufactured date whichever comes first.

b. Standard warranty on sine wave power for an energy efficient motor shall be 24 months from date installed or 30 months from manufactured date whichever comes first.

c. Standard warranty on sine wave power for a standard efficient motor shall be 12 months from date installed or 18 months from manufactured date whichever comes first.

d. Special warranty applies for motors used with Variable Frequency Drives.

HARGIS + ASSOCIATES, INC.

ATTACHMENT 5

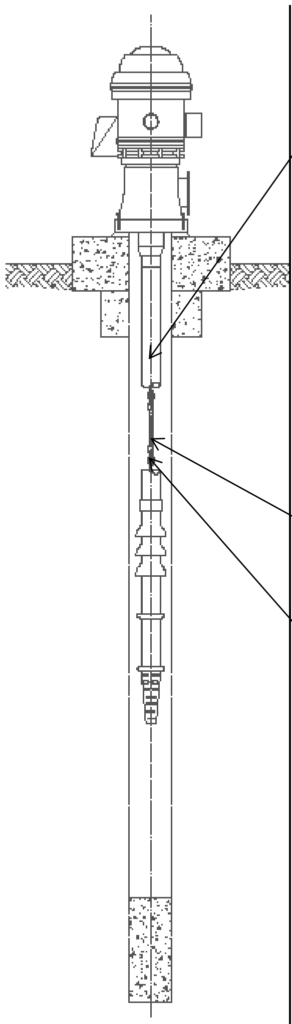
COLUMN PIPE VENDOR LITERATURE

(Layne Proposal Sheet)

Fullerton #9

CASING ID: 19.2" X 15.2"

WATER LUBRICATED X **OIL LUBRICATED**



COLUMN PIPE: **ASTM #:** A53 GRADE B

12"	**SIZE**	9'11-1/4"	**LENGTH**	STRAIGHT	**THREAD**
.375"	**Wall**				
12-3/4"	**Column OD**	Epoxy	**LINING**	Epoxy	**COATING**

OIL TUBE: **ASTM #:**

N/A	**SIZE**	N/A	**RH or LH**	N/A	**THREAD**

COLUMN COUPLING: **ASTM #:** A108 GRADE 1020

12"	**SIZE**	STRAIGHT	**THREAD**	(NPS - 8 TRD Per Inch)

SHAFT: **ASTM #:** A582-416

1-15/16"	**SIZE**	416SS	**GRADE**	10THD	**THREAD**

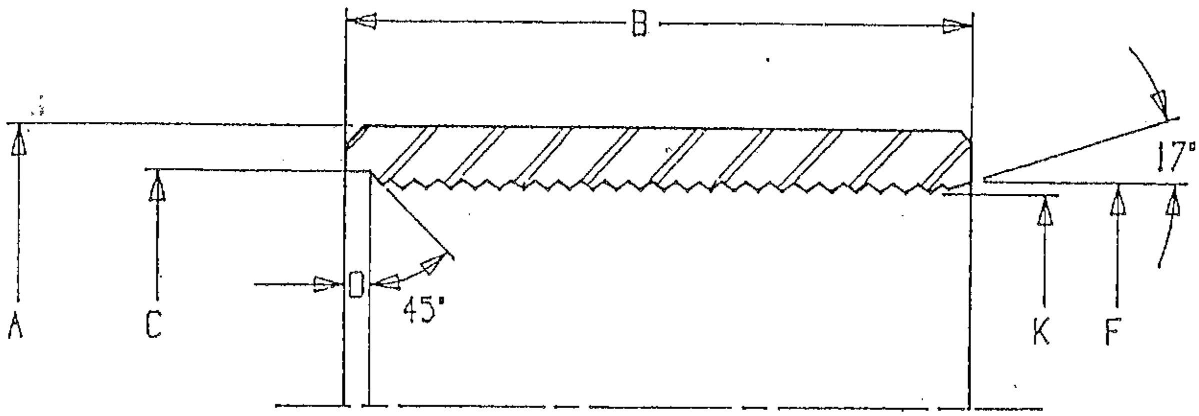
SHAFT COUPLING: **ASTM #** A582-304 made from solid bar stock

1-15/16"	**SIZE**	304SS	**GRADE**	10THD	**THREAD**

RETAINERS & INSERT:

12" x 1-15/16"	**SIZE**	DROP IN	**DROP IN or THREADED**
304SS	**BRONZE or STAINLESS**	NEOPRENE	**NEOPRENE or VESCONITE**

Pump column pipe furnished is per ASTM A53 Grade B or better standards; ERW unless otherwise specified; wall thickness as specified; and is threaded and coupled 8 TPI conforming to AWWA E103. Column pipe couplings are also manufactured from ASTM A108 Grade 1020 steel in accordance with industry standards.



PIPE SIZE	CPLG OD A	TOTAL LENGTH ±1/16 B	C'BORE DIA C	C'BORE LENGTH D	CHAMFER DIA F	THREAD DATA (NOTE 1) MINOR DIA K	PITCH DIA +.010 -.000	BASIC MAJ DIA	PART NUMBER
2-1/2	3-1/4	2-7/8	2.92 2.96	1/8	2.86 2.90	2.692 2.702	2.767	2.862	0396
3	4	3-1/8	3.54 3.58	1/8	3.50 3.54	3.317 3.327	3.392	3.487	0397
4	5	3-5/8	4.54 4.58	1/8	4.50 4.54	4.319 4.329	4.392	4.487	0398
5	6-1/4	4-1/8	5.60 5.64	1/4	5.74 5.78	5.380 5.392	5.455	5.550	0399
6	7-5/16	4-1/8	6.66 6.70	1/4	6.62 6.66	6.440 6.454	6.517	6.612	0400
8	9-1/2	4-5/8	8.66 8.70	1/4	8.62 8.66	8.440 8.454	8.517	8.612	0401
10	11-3/4	6-1/8	10.80 10.84	1/4	10.74 10.78	10.566 10.580	10.642	10.737	0402
12	14	6-1/8	12.80 12.84	1/4	12.74 12.78	12.542 12.554	12.642	12.737	0403
14	15	6-3/8	14.04 14.08	1/4	14.00 14.04	13.792 13.804	13.892	13.987	0404
16	17	6-1/2	16.04 16.08	3/8	16.00 16.04	15.792 15.804	15.892	15.987	0405

NOTES:

1. THREAD FORM IS TRUNCATED AMERICAN STD. STRAIGHT PIPE (NPS) - 8 THDS/IN.
2. SUBSTITUTE LAYNE 'J' CPLG IF DUCTILE IRON IS ACCEPTABLE.
3. USE PURCHASED 'J' CPLG IF STEEL IS REQUIRED.
4. DIMENSIONS SHOWN MATCH PURCHASED 'J' CPLGS.

REV	ER NO	BY	CHK	APP	DATE
C	3448	DMG	RT	RT	10-8-90

STANDARD PARTS

LAYNE & BOWLER
A DIVISION OF THE MARLEY COMPANY
MEMPHIS, TENNESSEE

PIPE COUPLING ('J' THREAD)

DRAWN BY	DATE	SUPERSEDES	PART NUMBER
DMG	10/4/90	REV 'B'	V2570396 THRU V2570405

3M™ Scotchkote™ Fusion-Bonded Epoxy Coating 6233W

Data Sheet

Product Description

3M™ Scotchkote™ Fusion-Bonded Epoxy Coating 6233W is a one-part, heat curable, thermosetting epoxy coating powder designed for corrosion protection of drinking water pipes, valves, fittings, and couplers.

Properties

Property	Value
Specific Gravity Film Powder	 1.36 1.44
Coverage based on film	141 ft²/lb/mil (0.735 m²/kg/mm)
Color	Govt. Color 14272/Green
6233W-4G Gel Time @ 400°F/205°C Cure Time @ 450°F/232°C	 9.5 seconds ± 20% 30 seconds
6233W-8G Gel Time @ 400°F/205°C Cure Time @ 450°F/232°C	 17 seconds ± 20% 90 seconds
6233W-11G Gel Time @ 400°F/205°C Cure Time @ 450°F/232°C	 25 seconds ± 20% 110 seconds
Shelf life @ 27°C/80°F	12 months

Temperature Operating Range

The Scotchkote 6233W coating, when properly applied, should perform in a satisfactory manner on pipelines operating between -100°F/-73°C to 230°F/110°C. For temperatures between +170°F/77°C to 230°F/110°C, laboratory tests indicate that the thicker coatings may improve the service capability. However, it is difficult to accurately predict field performance from the laboratory data due to the wide variation in actual field conditions. Soil types, moisture content, temperatures, coating thickness and other factors specific to the area all influence the coating performance and the upper temperature operating limit.

Scotchkote 6233W meets the requirements of AWWA C213 and C550.

Scotchkote 6233W has been tested and certified to NSF/ANSI Standard 61, Drinking Water System Components. For NSF certified applications, the max approved thickness is 50 mil (1.25 mm), and the max approved operating temperature is 140°F/60°C.

3M™ Scotchkote™ Fusion-Bonded Epoxy Coating 6233W Test Data

Property	Test Description			Typical Value
Impact	ASTM G14 (modified) 1/8 in (3.2 mm) thick plate 3/8 in (9.5 mm) thick plate			 160 in•lbs (18.1 J) 59 in•lbs (6.7 J)
Cathodic Disbondment	CAN/CSA-Z245.20-12.8 48 hours, 1.5 volt, 3% NaCl 149°F/65°C 28 day, 1.5 volt, 3% NaCl 73°F/23°C 28 day, 1.5 volt, 3% NaCl 149°F/65°C			 2.3 mm r 2.5 mm r 4.9 mm r
Hot Water Resistance	24 hours, CAN/CSA-Z245.20-12.14, 203°F/95°C 48 hours, CAN/CSA-Z245.20-12.14, 167°F/75°C			1 rating 1 rating
Bendability (Mandrel Bend)	Temperature 73°F/23°C -22°F/-30°C	Pipe Diameters <10.5 <19.1	°/PD 5.5 >3.0	% Elongation 4.8 >2.6
Compressive Strength	ASTM D 695			>10,000 psi (705 kg/cm²)
Penetration	ASTM G 17 -40° to 200°F/-40° to 93°C			0
Thermal Shock	-320° to 310°F/-195° to 154°C Coated pipe			No visible effects 10 Cycles
Dialectric Strength	1180 V/mil/46 kV/mm			

Note: The typical values in this data sheet are based on lab prepared samples. Values shown are not to be interpreted as product specifications.

Handling and Safety Precautions

Read all Health Hazard, Precautionary and First Aid, Material Safety Data Sheet, and/or product label prior to handling or use.

Ordering Information/Customer Service

For ordering technical or product information, or a copy of the Material Safety Data Sheet, call:
Phone: 800/722-6721
Fax: 877/601-1305

Important Notice

All statements, technical information, and recommendations related to 3M's products are based on information believed to be reliable, but the accuracy or completeness is not guaranteed. Before using this product, you must evaluate it and determine if it is suitable for your intended application. You assume all risks and liability associated with such use. Any statements related to the product which are not contained in 3M's current publications, or any contrary statements contained on your purchase order shall have no force or effect unless expressly agreed upon, in writing, by an authorized officer of 3M.

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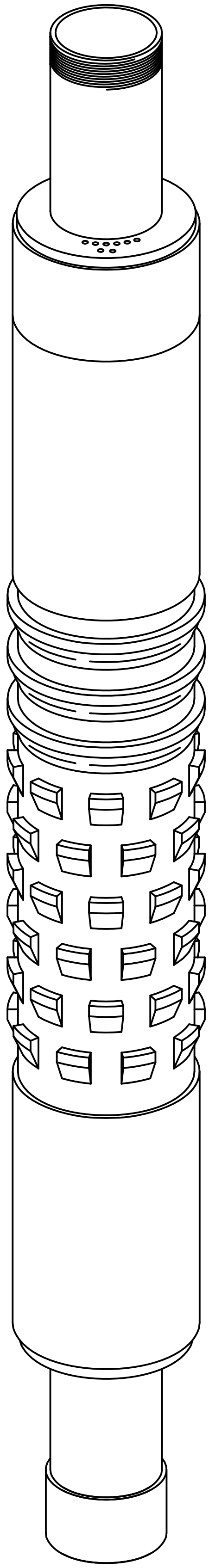
HARGIS + ASSOCIATES, INC.

ATTACHMENT 6

PACKER VENDOR LITERATURE



BASKI

Baski, Inc.
Denver CO
800-55-BASKI

FCP sample.dwg

11/08 ©

Flow Control Packer

All metal parts: stainless Steel 304L and 316L
Rubber is natural rubber with polyester reinforcing
4” nominal pipe going thru the packer
Liquid inflation chamber between 4.5” and ID of the packer
Nitrogen inflation – minimum inflation pressure to separate the zones requires of 50 psi above the largest hydrostatic pressure above or below the packer
Flow control grooving is used to prevent water hammer if the packer is deflated while there is a pressure difference in the zones separated by the packer
Twin inflation lines ensure the potential of reducing the packer pressure below hydrostatic pressure if the packer takes on memory of its shape after several years inflated
Overall length of 11-12 ft
13.5” OD for approximately 100 inches with exposed rubber for 60 inches
4” sch 80 going thru the packer with 4.5” API 8rnd Short casing threads on both ends

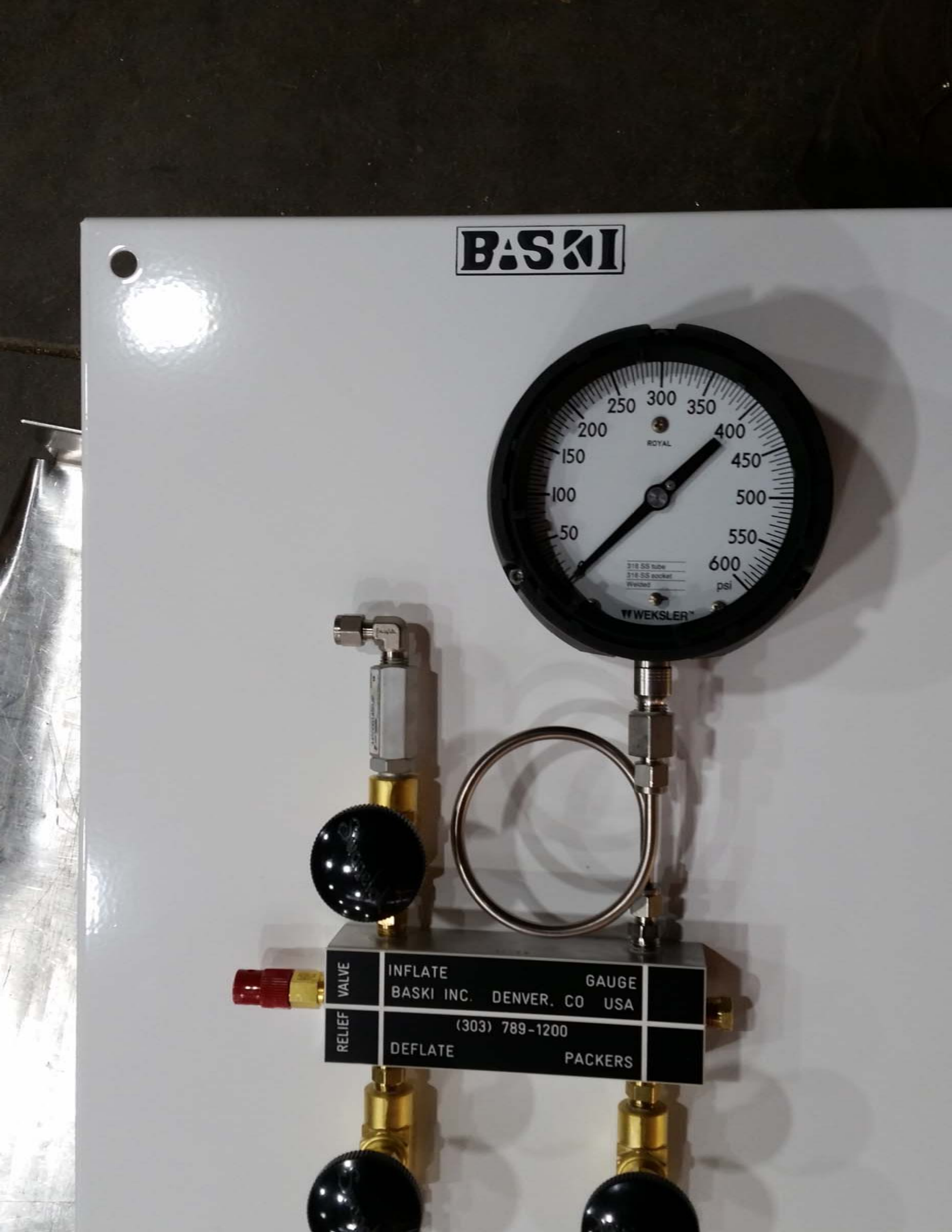

BASKI
250 300 350
200 400
ROYAL
150 450
100 500
50 550
600
316 SS tube
316 SS socket
Welded
psi
WEKSLER
RELIEF VALVE
INFLATE
GAUGE
BASKI INC. DENVER, CO USA
(303) 789-1200
DEFLATE
PACKERS

Exhibit D

Technical Memorandum dated November 28, 2018

[see attached]

HARGIS + ASSOCIATES, INC.
HYDROGEOLOGY • ENGINEERING

La Jolla Gateway
9171 Towne Centre Drive, Suite 375
San Diego, CA 92122
Phone: 858.455.6500
Fax: 858.455.6533

Technical Memorandum

Via: EMAIL | Project No: 532.83

Date: November 28, 2018

To: Ms. Tiffany Foo
CITY OF FULLERTON - PUBLIC WORKS DEPARTMENT
Water Engineering Division
303 W. Commonwealth Avenue
Fullerton, CA 92832-2728

cc: Mr. Paul E. Brewer, Raytheon Company
Mr. Danny Samorano, Raytheon, Company

From:

Jim Schwall, PE CH5044

Re: Basis of Design for Electrical Service and Motor Control Equipment, City of Fullerton Production Well No. 9, Former Raytheon Company (Formerly Hughes Aircraft Company) Site, 1901 West Malvern Avenue, Fullerton, California

---

This memorandum has been prepared by Hargis + Associates, Inc. (H+A) on behalf of the Raytheon Company to provide the basis of design for proposed new well electrical service equipment at the City of Fullerton's Production Well No. 9 (Well 9). The well equipment outlined in this memo is a voluntary effort and includes installation of electrical service equipment and motor control equipment.

Well 9 is located on the north boundary of the Fullerton Airport (Figure 1) and is routinely used for municipal water supply. Well 9 is approximately 1,080 feet deep and was constructed with 7 separate screen intervals (Figure 2). Well 9 is currently fitted with a nominal 16 inch shaft driven turbine pump with 15 inch diameter bowls with intake set at approximately 231 feet.

The design basis was for well mechanical components and well motor, design and vendor data was previously provided (H+A, 2017b) and approved by the City of Fullerton. Based on the design requirements for new well pump and motor, the electrical service and motor control electrical equipment were evaluated to ensure reliable operation of Well 9. It was determined based on consultation between City of Fullerton, Raytheon Company, and Raytheon's technical representatives that the electrical service equipment and motor control equipment should be updated to support the new well motor and address potential issues with the aged electrical equipment at Well 9. The basis of design for the service equipment and motor control has been provided and includes: design drawings, electrical specifications, and vendor data.

DESIGN BASIS: The basis of design for Well 9 is based on requirements provided by the City of Fullerton, and hydraulic properties of the groundwater system (H+A, 2017a and 2017b). The pump motor is an US Motors, Nidec Motor Corporation, 350 Horsepower, Premium Efficiency, 1200 RPM, Weather Protected Type 1, Frame 5000PH. Well 9 will continued to be controlled using the same control philosophy and remote telemetry as the current well installation.

PROPOSED EQUIPMENT: The proposed Well 9 service equipment and motor control equipment selected based on the basis of deign include the following:

1. Well Electrical Service Equipment (SES-100): Square D Custom Switchboard QED-2 Switchboard. Designed and Tested in accordance with Underwriters Laboratories (UL) 891/National Electric Code/Nation Electrical Manufacturers Association (NEMA) PB-2. System ampacity rating 800 amperes, with maximum fault current (RMS) – 42k amperes. The enclosure will be NEMA 3R. Design drawings and specifications have been provided (Attachment 1). Data sheets and shop drawings have been summarized (Attachment 2). The well electrical service equipment replacement supports changing the main circuit breaker with current industry-standard component. The main breaker is being from increased from 600 amperes to 800 amperes and supports the 50-horsepower increase in pump motor size.

2. Motor Control Center (MCC-100): Square D Model 6 LVMCC- Model 6 MCC –Industrial Package. System voltage 480 volts, 3 phase, 3-wire. System ampacity 800 amperes, with maximum fault current (RMS) – 42k amperes. The enclosure will be NEMA 3R. Class 1, Type B wiring. MCC to include 10 kVA transformer and lighting circuit breaker panel. The MCC will include an empty section for installation of SCADA equipment. Design drawings and specifications have been provided (Attachment 1). Data sheets and shop drawings have been summarized (Attachment 2). The new motor control center supports changing the solid-state motor starter which is current industry-standard component.

3. Solid State Starter (SSS): Square D Altistart 48. Rated for 350 horsepower motor. Voltage 480, 3 phase. Design drawings and specifications have been provided (Attachment 1). Data sheets and shop drawings have been summarized (Attachment 2). The new solid-state motor starter supports the 50-horsepower increase in pump motor size.

4. Supervisory Control and Data Acquisition (SCADA) System: SCADA equipment to be provided by the City of Fullerton to be installed in empty MCC section by the well contractor. Programming, testing of SCADA system will be the responsibility of City of Fullerton. Reference drawings have been provided (Attachment 1).

5. Instrumentation: Existing well instrumentation will be reused with no modification to the instrumentation other than to modify conduit and wiring per the design drawings and terminate field devices in new motor control equipment cabinet.

Figures

Figure 1. Well and Piezometer Locations
Figure 2. Proposed Pump and Packer Diagram Fullerton Well #9

Attachments

Attachment 1: CivilTec Engineering Inc. - City of Fullerton Well 9 Electrical Improvements Design Drawings dated October 2018 and City of Fullerton Well No. 9 Electrical Improvements Electrical and Instrumentation Specifications
Attachment 2: Square D Shop Drawings and Vendor Literature

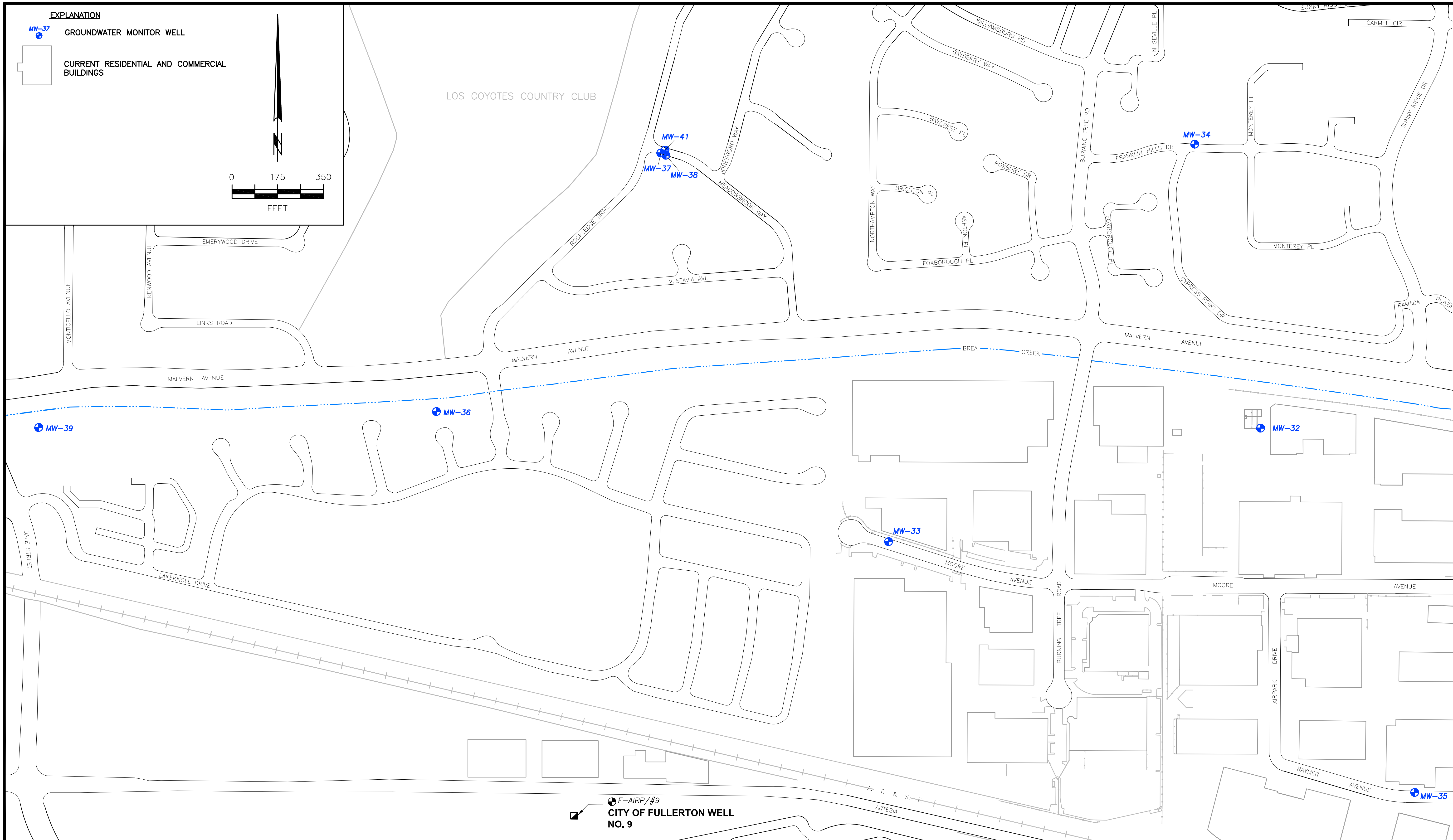
References

Hargis + Associates, Inc., 2017. Technical Memorandum to P. Nguyen, City of Fullerton, Re: Summary of Second Packer Test Results, October through December 2016, City of Fullerton Production Well No. 9, Former Raytheon Company (Formerly Hughes Aircraft Company) Site, 1901 West Malvern Avenue, Fullerton, California, dated February 21, 2017.

______, 2017b. Technical Memorandum to T. Foo, City of Fullerton, Re: Basis of Design for Well Equipment, City of Fullerton Production Well No. 9, Former Raytheon Company (Formerly Hughes Aircraft Company) Site, 1901 West Malvern Avenue, Fullerton, California – Revision 1.0. November 15, 2017.

City of Fullerton accepts this Basis of Design.

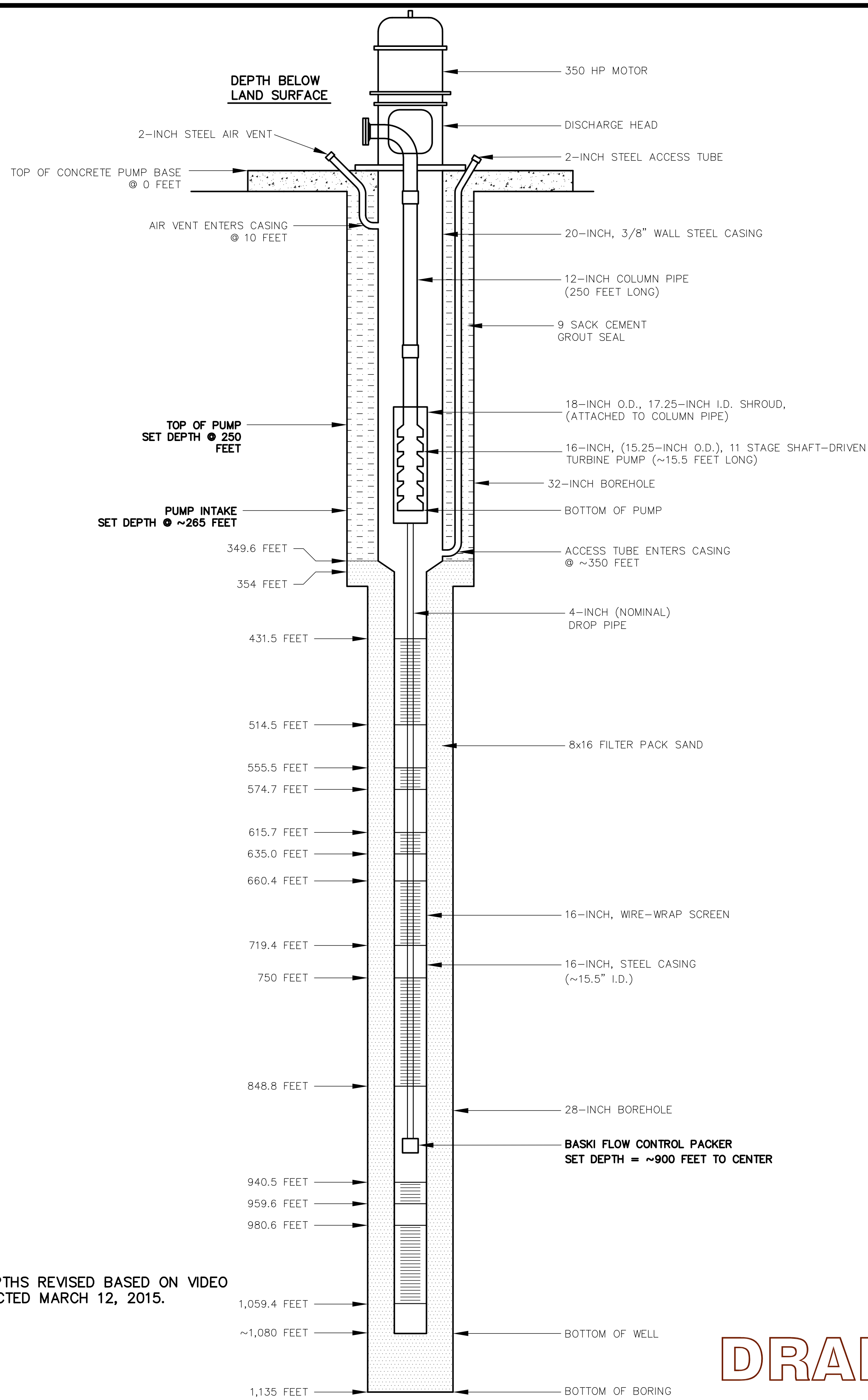
Signature 12/05/18
Date



HARGIS + ASSOCIATES, INC
Hydrogeology/Engineering

06/16	RPT NO. 532.80	410-9632	A

FIGURE 1.
WELL AND PIEZOMETER LOCATIONS



NOTE: SCREEN DEPTHS REVISED BASED ON VIDEO LOG CONDUCTED MARCH 12, 2015.

NOT TO SCALE

DRAFT

Sep 26, 2017 - 2:55pm adh - \\SANDIEGO-FS01\dfs\sandiego\H+A GRAPHIC-FILES\2017\500-599\532 Raytheon\Hydrogeology\WellDiag\710-0901.dwg

9/17	RPT NO. 532.03	710-0901	B

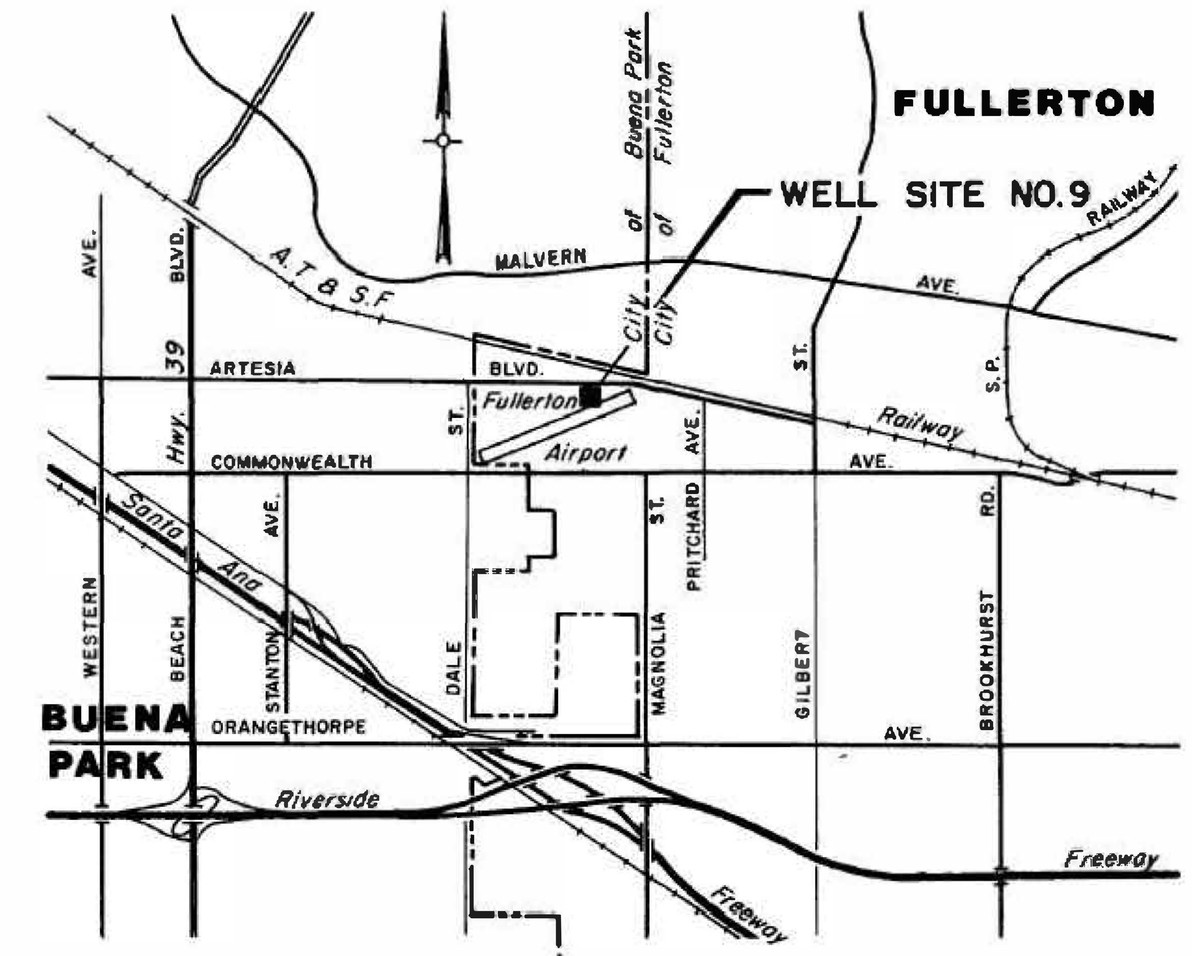
HARGIS + ASSOCIATES, INC.
Hydrogeology/Engineering

FIGURE 2.
PROPOSED PUMP AND PACKER DIAGRAM
FULLERTON WELL #9

ATTACHMENT 1

CIVILTECH ENGINEERING INC. – CITY OF FULLERTON WELL 9
ELECTRICAL IMPROVEMENTS DESIGN DRAWINGS DATED OCTOBER 2018
AND CITY OF FULLERTON WELL NO. 9 ELECTRICAL IMPROVEMENTS
ELECTRICAL AND INSTRUMENTATION SPECIFICATIONS

CITY OF FULLERTON
WELL 9 ELECTRICAL IMPROVEMENTS



WELL SITE NO. 9
LOCATION MAP
NO SCALE

ABBREVIATIONS

A	AMPERE
AF	AMPERE FRAME OR FUSE
APPROX	APPROXIMATELY
AT	AMPERE TRIP
AWG	AMERICAN WIRE GAUGE
AC	ALTERNATING CURRENT
AS	AMPERE SWITCH
AM	AMPERE METER
ADJ	ADJUSTABLE
AFF	ABOVE FINISHED FLOOR
AIC	AMPERE INTERRUPTING CURRENT IN RMS SYM CURRENT
AUTO	AUTOMATIC
A-B	ALLEN-BRADLEY
BLK	BLACK
BC	BARE COPPER
BLDG	BUILDING
BKR	BREAKER
BP	BOOSTER PUMP
CKT	CIRCUIT
CT	CURRENT TRANSFORMER
CO	COMPANY
CR	CONTROL RELAY
CAT	CATALOGUE
C-H	CROUSE-HINDS
C	CYCLE OR CONDUIT
COMM	COMMUNICATION
CS	CONTROL SWITCH
CONC	CONCRETE
CPT	CONTROL POWER TRANSFORMER
CWP	COLD WATER PIPE
DIA	DIAMETER
DIAG	DIAGRAM
DIV	DIVISION
DWG	DRAWING
DC	DIRECT CURRENT
DPDT	DOUBLE-POLE DOUBLE-THROW
DIST	DISTRIBUTION
DIM	DIMENSION
DISC	DISCONNECT
DS	DISCONNECT SWITCH
DM	DEMAND
EA	EACH
ELEC	ELECTRICAL
ELEV	ELEVATION
EQUIP	EQUIPMENT
ETM	ELAPSE TIME METER
EXIST	EXISTING
(E)	EXISTING
FLA	FULL LOAD AMPS
FLEX	FLEXIBLE
FLS	FLOW SENSING SIGNALING RELAY
FVNR	FULL VOLTAGE, NON-REVERSING
F	FUSE
FT	FOOT OR FEET OR FLOW TRANSMITTER
FWD	FORWARD
GA	GAUGE
GALV	GALVANIZED
GFI	GROUND FAULT INTERRUPTING
GND	GROUND
GRS	GALVANIZED RIDGID STEEL CONDUIT
HV	HIGH VOLTAGE
HT	HEIGHT
HP	HORSEPOWER
HPS	HIGH PRESSURE SWITCH
HTR	HEATER
HZ	HERTZ
HOA	HAND-OFF-AUTO
INSTR	INSTRUMENT
JB	JUNCTION BOX
JCT	JUNCTION
KVA	KILO-VOLT AMPERE
KW	KILOWATT
KV	KILOVOLT
LA	LIGHTNING ARRESTER
LOS	LOCK OUT STOP
LTG	LIGHTING
LVL	LEVEL
LPS	LOW SUCTION PRESSURE SWITCH
MAX	MAXIMUM
MCC	MOTOR CONTROL CENTER
MCM	KILO CIRCULAR MILS
MCP	MOTOR CIRCUIT PROTECTOR
MH	MOUNTING HEIGHT
MIN	MINIMUM
MISC	MISCELLANEOUS
MTD	MOUNTED
MTG	MOUNTING
MTR	MOTOR
mA	MILLIAMPERE
MAG	MAGNET, MAGNETIC
MAINT	MAINTENANCE
MFR	MANUFACTURER
NC	NORMALLY CLOSED
NEC	NATIONAL ELECTRICAL CODE
No.	NUMBER
N	NEUTRAL
NO	NORMALLY OPEN
NTS	NOT TO SCALE
NA	NOT APPLICABLE
NEMA	NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION
NIC	NOT IN CONTRACT
OC	OVERCURRENT
OL	OVERLOAD
P/B	PULL BOX
PB	PUSHBUTTON
P	POLE
PNL	PANEL
PVC	POLYVINYL CHLORIDE
PWR	POWER
PR	PAIR
PH	PHASE
PT	PRESSURE TRANSMITTER
PS	PRESSURE SWITCH
REM	REMOTE
RCPT	RECEPTACLE
REQ'D	REQUIRED
REV	REVISION
RM	ROOM
RMS	ROOT MEAN SQUARE
RQMTS	REQUIREMENTS
SA	SURGE ARRESTER
SCE	SOUTHERN CALIFORNIA EDISON COMPANY
SEL	SELECTOR
SPEC	SPECIFICATIONS
SHT	SHEET
SECT	SECTION
SHLD	SHIELD
SN	SOLENOID
SW	SWITCH
SWBD	SWITCHBOARD
SYM	SYMETRICAL
SST	STAINLESS STEEL
STP	STOP
STL	STEEL
SYS	SYSTEM
SH TR	SHUNT TRIP
SIG	SIGNAL
SQ-D	SQUARE-D COMPANY
TB	TERMINAL BLOCK
TD	TIME DELAY
TYP	TYPICAL
TEMP	TEMPERATURE
TERM	TERMINAL
TEFC	
TEL	TELEPHONE
TEL	TELEPHONE
TSP	TWISTED SHIELDED PAIR
UG	UNDERGROUND
UON	UNLESS OTHERWISE NOTED
UV	UNDERVOLTAGE
V	VOLTS
VA	VOLT AMPERE
VD	VOLTAGE DROP
W	WATT OR WEST
W/	WITH
WP	WEATHERPROOF
XFMR	TRANSFORMER
XFR	TRANSFER
XMTR	TRANSMITTER
XDCR	TRANSDUCER
@	AT
&	AND
Ø	PHASE
%Z	PERCENT IMPEDANCE
3/C	CONDUCTOR, MULTIPLE (NUMBER INDICATED)

GENERAL NOTES

1. BIDDERS SHALL VISIT THE JOB SITE TO MAKE THEMSELVES THOROUGHLY FAMILIAR WITH THE EXISTING CONDITIONS AND SHALL BE FAMILIAR WITH THE EXTENT OF WORK TO BE DONE ON THE DRAWINGS AND SPECIFICATIONS BEFORE SUBMITTING THE BID. ANY DISCREPANCIES SHALL BE BROUGHT TO THE ATTENTION OF THE CITY TO TAKE APPROPRIATE ACTIONS FOR THE BID.

2. DESCRIPTION OF WORK: THE SCOPE OF WORK COVERED BY THIS SECTION CONSISTS OF PROVIDING ALL LABOR, MATERIALS, EQUIPMENT, AND SUPERVISION TO COMPLETE THE CONSTRUCTION OF THE COMPLETE FUNCTIONING ELECTRICAL SYSTEMS IN ACCORDANCE WITH THESE SPECIFICATIONS AND DRAWINGS, TO OPERATE SAFELY AND SATISFACTORILY.

3. DRAWINGS ARE ESSENTIALLY DIAGRAMMATIC. VERIFY THE INFORMATION AGAINST FIELD CONDITIONS. PROVIDE CLARIFYING DETAILS WHERE REQUIRED BY THE INSPECTING OFFICER AND OBTAIN THE ENGINEER'S AND THE INSPECTOR'S APPROVAL PRIOR TO INSTALLATION.

4. CODE REQUIREMENTS: ALL WORK SHALL CONFORM WITH THE NATIONAL ELECTRICAL CODE 2014 EDITION; CALIFORNIA CODE OF REGULATIONS, TITLE 24 PART 3 (2016 EDITION); CAL/OSHA TITLE 8, CHAPTER 4, SUBCHAPTER 5, ELECTRICAL SAFETY ORDERS;THE AMERICANS DISABILITIES ACT (1990) AND AMENDMENT (2008); AND OTHER AUTHORITIES HAVING JURISDICTION. RESOLVE CODE CONFLICTS PRIOR TO INSTALLATION. ANY CONFLICTS BETWEEN THE REQUIREMENTS, SHALL BE GOVERNED BY THE MOST STRINGENT REQUIREMENT.

5. EXISTING CONDITION: ALL EXISTING CONDITIONS SHOWN ON THE DRAWINGS ARE TAKEN FROM EXISTING AVAILABLE DRAWINGS WHICH MAY NOT REFLECT THE EXACT AS-BUILT CONDITIONS. CONTRACTOR SHALL INCLUDE IN HIS BID TO PERFORM FIELD INVESTIGATIONS AS NECESSARY TO IDENTIFY THE EXACT LOCATIONS, NUMBERS, SIZES, AND EXISTING FUNCTIONING OF THE ITEMS TO REMAIN AND RECONNECTED TO THE NEW SYSTEM AS REQUIRED FOR THE NEW CONSTRUCTION. ANY CONFLICTS SHALL BE RESOLVED PRIOR TO COMMENCE ANY WORK.

6. UTILITY INTERRUPTIONS: NO LIVE LINE WORKS ALLOWED FOR THIS PROJECT. DEENERGIZE THE EQUIPMENT OR COMPONENTS PRIOR TO START ANY WORK. WHEN AN INTERRUPTION IS NECESSARY TO THE SYSTEMS, THE CONTRACTOR SHALL NOTIFY THE CONSTRUCTION MANAGER IN WRITING AT LEAST 48 HOURS IN ADVANCE AND FOLLOW HIS INSTRUCTIONS TO ARRANGE THE OUTAGE SCHEDULES. ANY OVERTIME PAY DUE TO THE OUTAGES OR FOR ANY NON-REGULAR HOUR WORKING SHALL BE INCLUDED IN THE BID.

7. CONTRACTOR SHALL FURNISH SOLID STATE DEVICES WHERE AVAILABLE AND WHERE APPLICABLE. ONLY THE CITY APPROVED DEVICES SHALL BE USED. SOLID STATE TIME DELAY RELAYS SHALL BE USED UNLESS MOTOR DRIVEN UNITS ARE SPECIFIED OR PERMITTED. PNEUMATIC TIMING DEVICES SHALL NOT BE USED.

8. FLOOR OPENING LOCATIONS FOR ELECTRICAL CONDUITS SHALL BE VERIFIED OR SPECIFIED PRIOR TO CONSTRUCTION. ADJUST OPENING LOCATIONS AND COMPONENT LOCATIONS AS REQUIRED FOR EQUIPMENT TO BE FURNISHED.

9. CONDUIT SYSTEM: CONDUIT RISERS SHALL BE STUBBED UP 6 INCHES MINIMUM AND THEY SHALL BE MIN. 40MIL PVC COATED GALVANIZED RIGID STEEL TYPE. SCHED 40 PVC CONDUIT SHALL BE USED FOR THE UNDERGROUND INSTALLATION. USE GALVANIZED RIGID STEEL CONDUITS FOR ALL THE ABOVE GROUND AREA INSTALLATION. MATERIALS OF THE CONDUIT FITTINGS AND BOXES SHALL MATCH THE CONDUIT.
   CONDUITS TERMINATING AT MOTOR CONTROL CENTER AND CONTROL CABINET, SHALL BE EQUIPPED WITH A GROUNDING BUSHING 'OZ' TYPE GB.
   ALL CONDUITS SHALL BE RECESSED IN WALL, CLG OR UNDERGROUND, IF APPLICABLE.

10. CONDUCTORS SHALL BE STRANDED COPPER WITH THHN/THWN INSULATION.

11. OUTDOOR NAMEPLATES SHALL BE PROVIDED IN ACCORDANCE WITH THE BASIC ELECTRICAL SPECIFICATIONS. THEY SHALL BE ENGRAVED OR STAMPED STAINLESS STEEL WITH 1/8" LETTERING AND THEY SHALL BE FASTENED WITH STAINLESS STEEL DRIVE SCREWS.

12. MOTOR LEADS SHALL BE ENCLOSED IN LIQUID-TIGHT FLEXIBLE METAL CONDUIT FROM RIGID CONDUIT IN PUMP BASE TO MOTOR TERMINAL BOX.

13. PROVIDE SEPARATE GROUNDING CONDUCTORS IN ALL THE CONDUITS REGARDLESS ANY OTHER INDICATIONS. SIZE THE GROUNDING CONDUCTORS PER NEC REQUIREMENTS.

14. CIRCUIT BREAKERS SHALL BE 100% RATED TYPE, IF AVAILABLE FOR THE SIZE. MINIMUM INTERRUPTING CAPACITY OF EACH PROTECTIVE DEVICE IN THE SWITCHBOARD AND MCC SHALL BE 42,000 SYMMETRICAL AMPERES.

15. ALL THE CONTROL RELAYS SHALL BE MACHINE TOOL GRADE RELAYS, UNLESS OTHERWISE INDICATED.

16. A FEW JUNCTION BOXES ARE SHOWN ON THE DRAWINGS FOR A CLARIFICATION FOR THE CONDUIT SYSTEM. CONTRACTOR SHALL PROVIDE ADDITIONAL BOXES AS REQUIRED FOR THE CONDUIT SYSTEM. ALL THE JUNCTION BOXES AND THE DEVICE ENCLOSURES SHALL BE CAST ALUMINUM OR CAST IRON, WATERPROOF TYPE. THE JUNCTION BOXES AND ENCLOSURES SHALL BE SIZED PROPERLY TO EXCEED THE NEC REQUIREMENTS.

17. FINAL CONNECTIONS TO MOTORS AND THE CONTROL EQUIPMENT OR FIELD DEVICES SHALL BE LIQUID-TIGHT FLEXIBLE CONDUITS, REGARDLESS ANY OTHER INDICATIONS ON THE DRAWINGS. THE FLEXIBLE CONDUIT LENGTH FOR THE FINAL CONNECTIONS SHALL BE MAXIMUM 18".

18. INSTRUMENTATION CONDUCTORS SHALL RUN IN SEPARATE CONDUITS FROM THOSE CONTAINING A.C. POWER CONDUCTORS. INSTRUMENTATION CONDUCTORS SHALL BE CONTINUOUS. NO CABLE SPLICING IS ALLOWED. PROVIDE FIELD CONDUCTORS FOR THE SENSORS, TRANSDUCERS, TRANSMITTERS, AND CONTROLLERS SHALL BE PROVIDED BY THE SENSOR OR DEVICE MANUFACTURES' REQUIREMENTS AND INSTRUCTIONS, REGARDLESS ANY INDICATIONS ON THESE DRAWINGS. PROVIDE CKT CONDITIONING MATERIALS AS NECESSARY TO MEET THE DEVICE MFR'S REQUIREMENTS FOR THE PROPER FUNCTIONING OF THE DEVICES.

19. UNLESS AS NOTED OTHERWISE, MINIMUM SIZE OF CONDUIT SHALL BE 3/4" AND MINIMUM SIZE OF CONDUCTOR SHALL BE AWG #12.

20. UNLESS OTHERWISE NOTED (SUCH AS "EXISTING" OR "(E)"), ALL THE ITEMS SHOWN ON THE DRAWINGS ARE NEW INSTALLATION.

21. IDENTIFICATIONS: COMPLETE IDENTIFICATION OF PROJECT ELECTRICAL COMPONENTS IS REQUIRED. IDENTIFY ALL EQUIPMENT,PANELS, DISCONNECTS, CONDUIT RUNS, CONTROL DEVICES, ETC. WITH THE NOMENCLATURE REQUIRED, USING PLASTIC LAMINATE NAMEPLATE. STENCILLED DESIGNATIONS FOR CONDUIT RUNS ON 25' CENTERS AND ON BOTH SIDES OF WALL AND FLOOR PENETRATIONS. INDICATE CIRCUIT DESIGNATION AND NUMBER ON ALL CONDUCTORS WITH PREMARKED, SELF-ADHESIVE, WRAPAROUND CLOTH WIRE MARKERS IN EVERY ACCESSIBLE ENCLOSURES INCLUDING EVERY OUTLET BOX OR JUNCTION BOX. CONSULT THE ENGINEER FOR COLOR REQUIREMENTS FOR THE NAMEPLATES, STENCILS, TAGS, AND LETTERING. INSTALL TYPEWRITTEN DIRECTORIES OF ALL CIRCUITS REFLECTING ALL CHANGES, ON INSIDE OF EACH PANEL.

22. PROVIDE MATERIALS AS NECESSARY FOR MOUNTING ALL THE EQUIPMENT AND COMPONENTS.

23. RECORD DRAWINGS: THE CONTRACTOR SHALL PROVIDE AND KEEP UP-TO-DATE A COMPLETE "AS-BUILT" RECORD SET OF DRAWINGS WHICH SHALL SHOW EVERY CHANGE FROM THE ORIGINAL DRAWINGS AND THE EXACT "AS-BUILT" LOCATIONS AND SIZES OF THIS TRADE. UPON COMPLETION OF THE WORK, THIS SET OF DRAWINGS SHALL BE DELIVERED TO THE CITY.

GENERAL NOTES (CONTINUED)

24. PRELIMINARY OPERATION: THE CITY RESERVES THE RIGHT TO OPERATE PORTIONS OF THE ELECTRICAL SYSTEM ON A PRELIMINARY BASIS WITHOUT VOIDING THE GUARANTEE OR RELIEVING THE CONTRACTOR OF HIS RESPONSIBILITIES.

25. OPERATIONAL TESTS: UPON COMPLETION OF ALL THE INSTALLATION, THE CONTRACTOR SHALL CONDUCT AN OPERATING TEST TO ADJUST AND TEST ALL CIRCUITS, AND ANY OTHER ELECTRICAL ITEMS TO INSURE ALL THE ELECTRICAL SYSTEMS ARE IN A SATISFACTORY OPERATING CONDITION. ITEMS IN NEED OF CORRECTIONS OR DISCOVERED DEFECTS DURING SUCH TESTING, SHALL BE IMMEDIATELY REPAIRED THEN SHALL BE RETESTED. ALL SUCH REPAIRS OR REPLACEMENTS SHALL BE DONE AT NO COST TO THE CITY.

26. COORDINATE WITH SCE FOR THE NEW CONSTRUCTION.

SPECIAL NOTE FOR EQUIPMENT ANCHORAGE:

ALL EQUIPMENT SHALL BE BRACED OR ANCHORED TO RESIST A HORIZONTAL FORCE ACTING IN ANY DIRECTION USING THE FOLLOWING CRITERIA: FIXED EQUIPMENT ON GRADE 30% OF OPERATING WEIGHT FIXED EQUIPMENT ON STRUCTURE 45% OF OPERATING WEIGHT EMERGENCY POWER EQUIPMENT ON GRADE 40% OF OPERATING WEIGHT EMERGENCY POWER EQUIPMENT ON STRUCTURE 60% OF OPERATING WEIGHT FOR FLEXIBLY MOUNTED EQUIPMENT USE 4 X THE ABOVE VALUES. SIMULTANEOUS VERTICAL FORCE USE 1/3 X HORIZONTAL FORCE.

FOR EQUIPMENT WEIGHING MORE THAN 400 POUNDS AND WHERE ANCHORAGE DETAILS ARE NOT SHOWN ON THE DRAWING. THE CONTRACTOR SHALL SUBMIT ISOLATION/ANCHORAGE DETAIL FOR APPROVAL BY THE ENGINEER PRIOR TO INSTALLATION. THE DETAILS SHOULD INCLUDE ALL ELEMENTS TO BE FURNISHED BETWEEN THE EQUIPMENT AND BUILDING STRUCTURE TO PROVIDE THE REQUIRED SUPPORT.

FOR EQUIPMENT WEIGHING LESS THAN 400 POUNDS AND WHERE ANCHORAGE DETAILS ARE NOT SHOWN ON THE DRAWINGS. THE FIELD INSTALLATION SHALL BE SUBJECT TO THE APPROVAL OF THE RESPONSIBLE ENGINEER AND THE FIELD INSPECTOR.

ALL CALCULATIONS SHALL CONFORM TO THE CRITERIA ABOVE AND THE MINIMUM STANDARDS OF 2016 CALIFORNIA BUILDING CODE.

SYMBOLS

DIAGRAMS

Symbol	Description
250	3-PHASE MOTOR, 250 HORSE POWER.
1/2	1-PHASE MOTOR, 1/2 HORSE POWER.
	HAND-OFF-AUTO (HOA) SWITCH
ETM	ELAPSE TIME METER, CRAMER MOD # 635E&S
	FIELD WIRING (BY CONTRACTOR OR RESPONSIBLE VENDOR)
	INTERNAL PANEL WIRING (BY CONTRACTOR OR RESPONSIBLE VENDOR)
	SPLICE
G	PILOT LIGHT, LED TYPE, NEMA 4, OIL TIGHT, PUSH-TO-TEST. G: GREEN, A: AMBER, R: RED, W: WHITE.
	GROUNDING
CR	CONTROL RELAY WITH RELAY SOCKET
TD	TIME DELAY RELAY WITH RELAY SOCKET
SSS	SOLID-STATE-SOFT(REDUCED VOLTAGE)-STARTER
	NORMALLY OPEN CONTACT
	NORMALLY CLOSED CONTACT
H O A; XOO, OFF, OOX, XOO, OOX	HAND-OFF-AUTO 3-POSITION SELECTOR SWITCH
LS	LIMIT SWITCH-NORMALLY OPENED
HPS	HIGH PRESSURE SWITCH, CLOSE ON RISING PRESSURE
	CIRCUIT BREAKER
	OPEN AFTER DELAY ON ENERGIZATION
	CLOSE AFTER DELAY ON ENERGIZATION

PLANS

Symbol	Description
J	JUNCTION BOX OR PULL BOX SIZED PER NEC.
	3/4"C-2#12+1#12GND. (HASH MARK INDICATE NUMBER OF #12 CONDUCTORS PLUS #12 GROUND CONDUCTOR, UNLESS OTHERWISE NOTED.)
	CONDUIT HIDDEN IN WALL, CLG OR UNDERGROUND
	OVERHEAD OR EXPOSED ABOVE GROUND CONDUIT.
	CONDUIT UP TOWARD VIEWER
	CONDUIT DOWN AWAY FROM VIEWER.
XX	HOME RUN, P=PANEL, 6=CIRCUIT, M=MCC, 3=SECTION 3.
	LIQUID-TIGHT FLEXIBLE CONDUIT.
	CONVENIENCE RECEPTACLE OUTLET, DUPLEX 125V, 2 POLES, 3 WIRES, GROUNDING TYPE.

SHEET INDEX

SHEET	TITLE
1	TITLE SHEET
2	ELECTRICAL SINGLE LINE DIAGRAM
3	ELECTRICAL CONTROL SCHEMATICS
4	ELECTRICAL PLAN
5	ELECTRICAL DETAILS
6	PID SYMBOLS AND LEGEND
7	P&ID
8	SCADA SYSTEM REFERENCE

No.	DATE:	REVISION:	APP.
2			
1			
0	10/18	ORIGINAL ISSUE	

NOTICE TO CONTRACTORS:
THE CONTRACTOR IS REQUIRED TO TAKE DUE PRECAUTIONARY MEASURES TO PROTECT THE UTILITY LINES SHOWN AND ANY OTHER LINES NOT OF RECORD OR NOT SHOWN ON THESE PLANS. THE CONTRACTOR SHALL BE RESPONSIBLE FOR NOTIFYING "BLUE STAKE" AT 1-800-STAKE IT (1-800-782-5348) TWO WORKING DAYS PRIOR TO ANY EXCAVATION OR CONSTRUCTION.

0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING ITEMS ARE NOT TO SCALE

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REGISTERED PROFESSIONAL ENGINEER CERTIFICATE 170.. STEP.. ELECTRICAL ARIZONA U.S.A.
PRELIMINARY
EXPIRES 12/31/2019

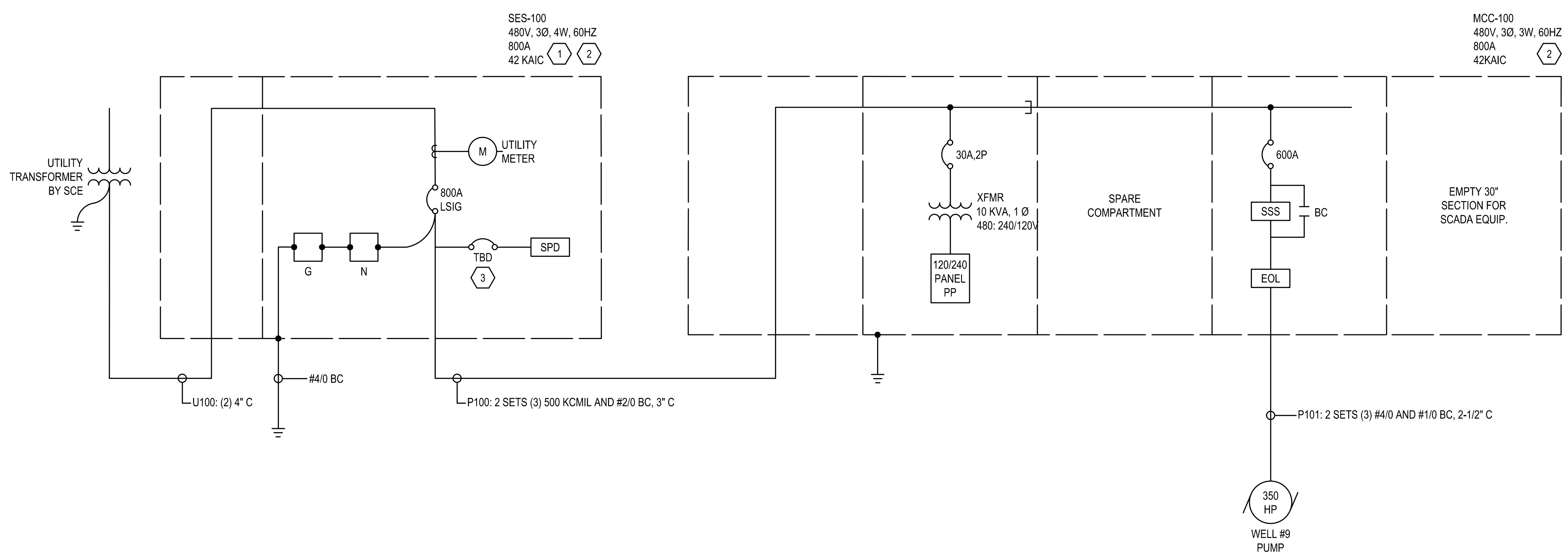
CIVILTEC engineering inc.
Civil, Water, Wastewater, Drainage, and Transportation Engineering
Construction Management • Surveying
California • Arizona
118 West Lime Avenue
Monrovia, CA 91016
Phone: 626.357.0588
Fax: 626.303.7957
Web: www.civiltec.com

CITY OF FULLERTON

TITLE SHEET

E-1

DE: SKY	CH: SKY	DR: TK/GG	JN: 2018156.00	SHEET 1 OF 8



KEYED NOTES

1. SHORT CIRCUIT RATING PER SOUTHERN CALIFORNIA EDISON TABLE I-5.
2. SES AND MCC SHALL BE MANUFACTURED BY SCHNEIDER SQUARE-D.
3. CIRCUIT BREAKER SIZE TO BE DETERMINED BY SPD MANUFACTURER.

LOAD CALCULATION:

	HP	KVA	AMPS
350 HP WELL PUMP	350	-	413
10 KVA TRANSFORMER	-	10	21
SUBTOTAL			434
25% OF LARGEST MOTOR			104
TOTAL			538
USE			800

120/240 VAC, 1 PHASE,
3 WIRE,
60A, 2P MAIN BKR

LIGHTING PANEL PP

10 KAIC

CONDUCTORS	CABLE#	CKT#	LOAD	BKR SIZE	VA	CONF.	VA	BKR SIZE	LOAD	CKT#	CABLE#	CONDUCTORS
2-#12 + #12G, 3/4"C	P201	1	SCADA SYSTEM	20/1	600		180	20/1	CONVENIENCE RECPT.	2	P202	2#12 + #12G, 3/4"C
		3	SPARE	20/1			1140	20/1	CHLORINATOR	4	P204	2#12 + #12G, 3/4"C
		5	SPARE	20/1				20/1	SPARE	6		
		7		-				-		8		
		9		-				-		10		
		11		-				-		12		
				SUBTOTAL:	1920	S/N						
				TOTAL:								
				AMPS@120V:	8.00	AMPS						

No.	DATE:	REVISION:	APP.
2			
1			
0	10/18	ORIGINAL ISSUE	

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PRELIMINARY
EXPIRES 12/31/2019

CIVILTEC engineering inc.
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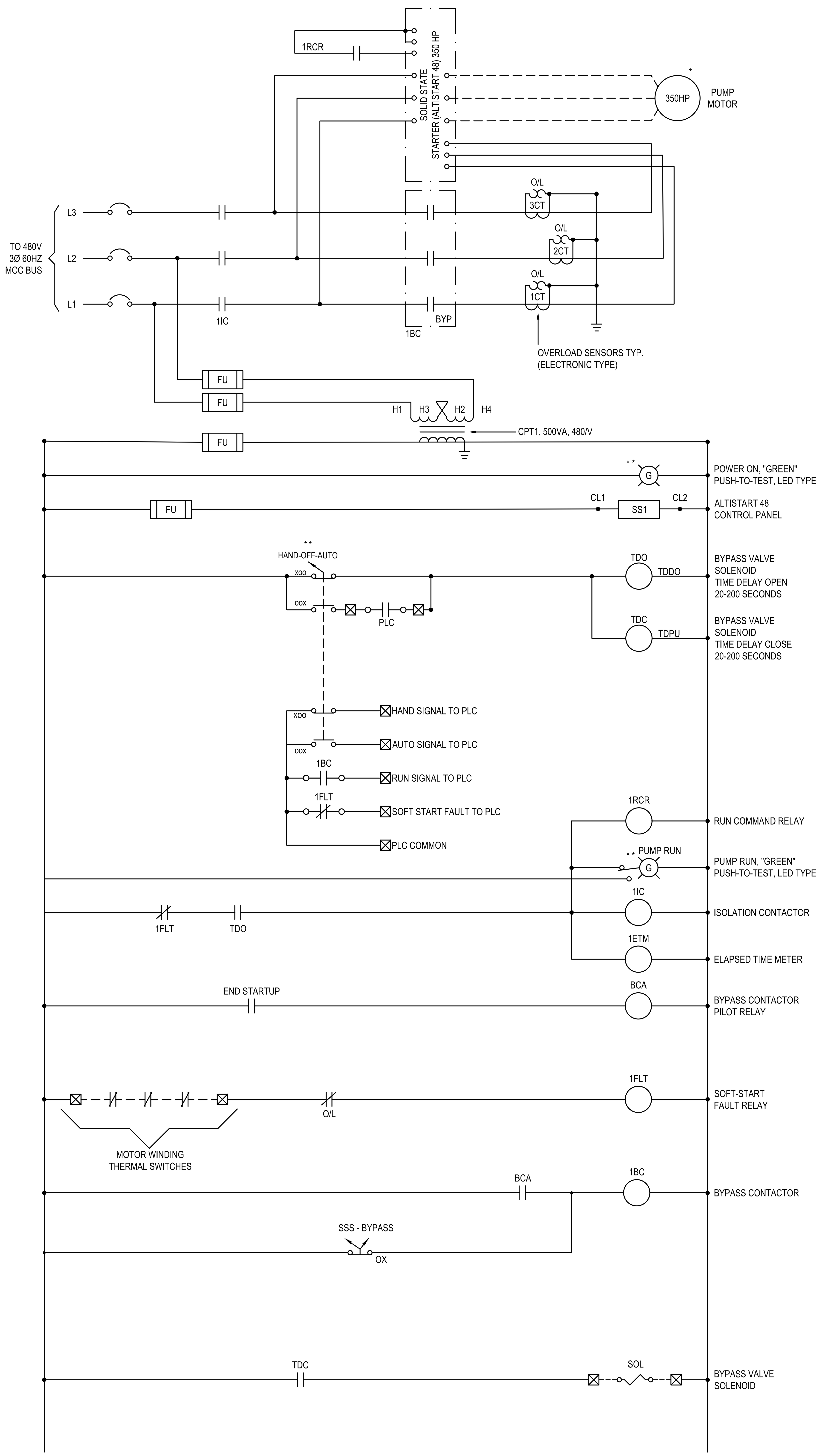
CITY OF FULLERTON

WELL NO. 9 IMPROVEMENTS
ELECTRICAL SINGLE LINE DIAGRAM

E-2

DE: SKY	CH: SKY	DR: TK/GG	JN: 2018156.00	SHEET 2 OF 8

X:\2018\2018156.00-Layne-Fullerton Well No. 9 Electrical Improvements\DWG\Sheets\Well\2018156.00-E-2 Electrical Single Line Diagram.dwg | 11/2/2018 11:48 AM



CONTROL SCHEMATIC – PUMP MOTOR NO. 9

GENERAL NOTES:

1. MOTOR IS CONTINUOUSLY LUBRICATED. NO SOLENOID CONTROLLED LUBRICATION SYSTEM IS REQUIRED.
2. MOTOR IS FURNISHED WITH (3) WINDING TEMPERATURE THERMAL SWITCHES TO TRIP ON OVERTEMPERATURE. NO MOTOR HEATER IS SUPPLIED.
3. BYPASS VALVE NORMALLY OPEN TO WASTE. ENERGIZING BYPASS VALVE SOLENOID CLOSES VALVE TO BEGIN NORMAL PUMPING OPERATION.
4. BYPASS VALVE SOLENOID CLOSE DELAY IS ADJUSTABLE FROM 20-200 SECONDS TO BEGIN NORMAL PUMPING OPERATIONS.
5. BYPASS VALVE SOLENOID OPEN DELAY IS ADJUSTABLE FROM 20-200 SECONDS TO ALLOW PUMP TO RUN LONGER WITH WASTE VALVE OPEN PRIOR TO SHUTDOWN.

SEQUENCE OF OPERATION:

1. WELL GETS A RUN START COMMAND FROM PLC.
2. MOTOR STARTS UNDER SOFT-START CONTROL.
3. MOTOR COMES UP TO SPEED AND SWITCHES TO BYPASS CONTACTOR. WELL PUMPS TO WASTE LINE.
4. AFTER TIME DELAY BYPASS VALVE CLOSES AND NORMAL PUMPING BEGINS.
5. WHEN WELL LOSES RUN START COMMAND WASTE VALVE IMMEDIATELY OPENS AND WELL PUMPS TO WASTE.
6. AFTER TIME DELAY MOTOR SHUTS DOWN WITH WASTE LINE OPEN FOR NEXT PUMPING CYCLE.

No.	DATE:	REVISION:	APP.
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1			
0	10/18	ORIGINAL ISSUE	

NOTICE TO CONTRACTORS:
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0 1/2 1
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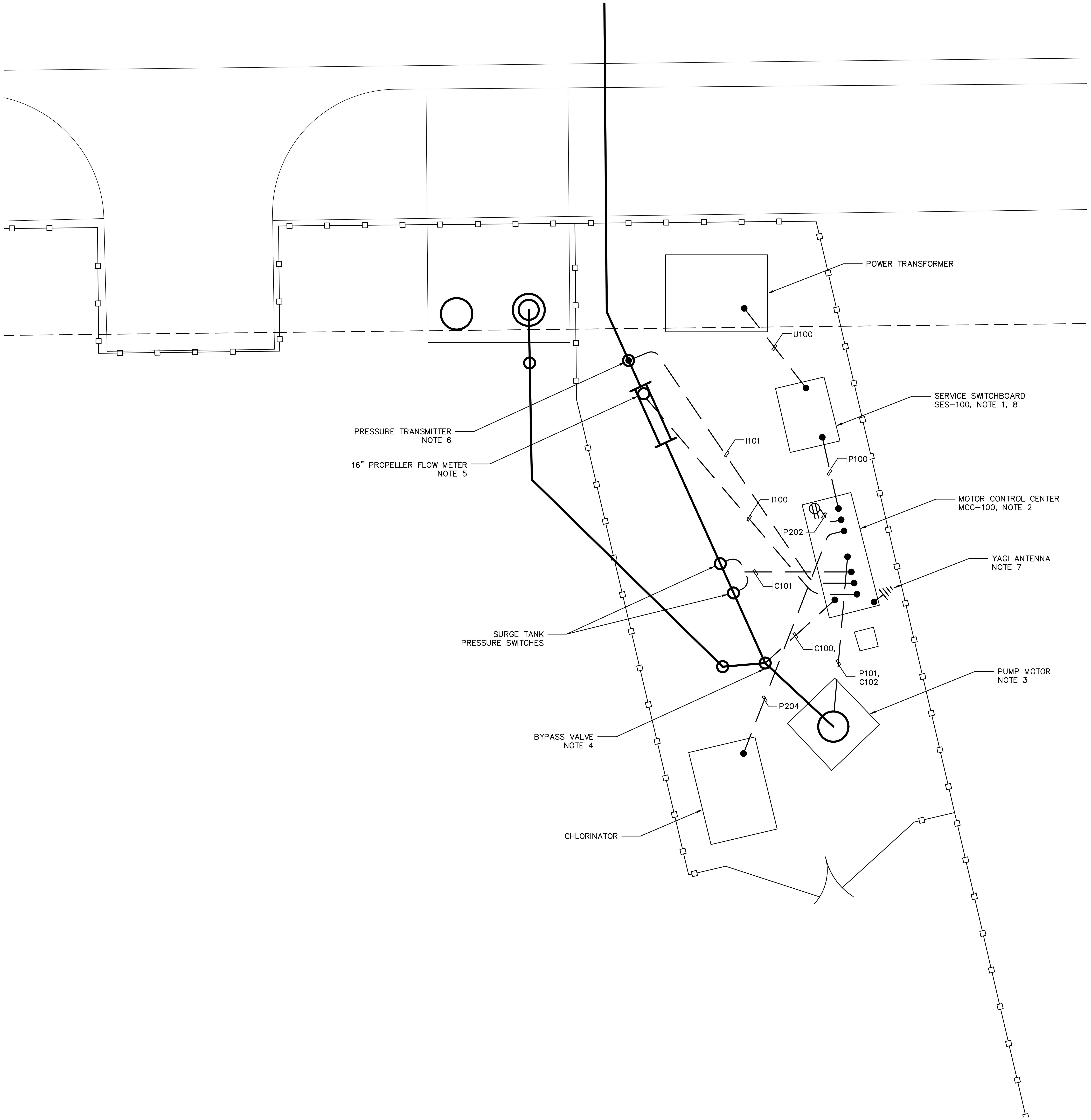
CITY OF FULLERTON

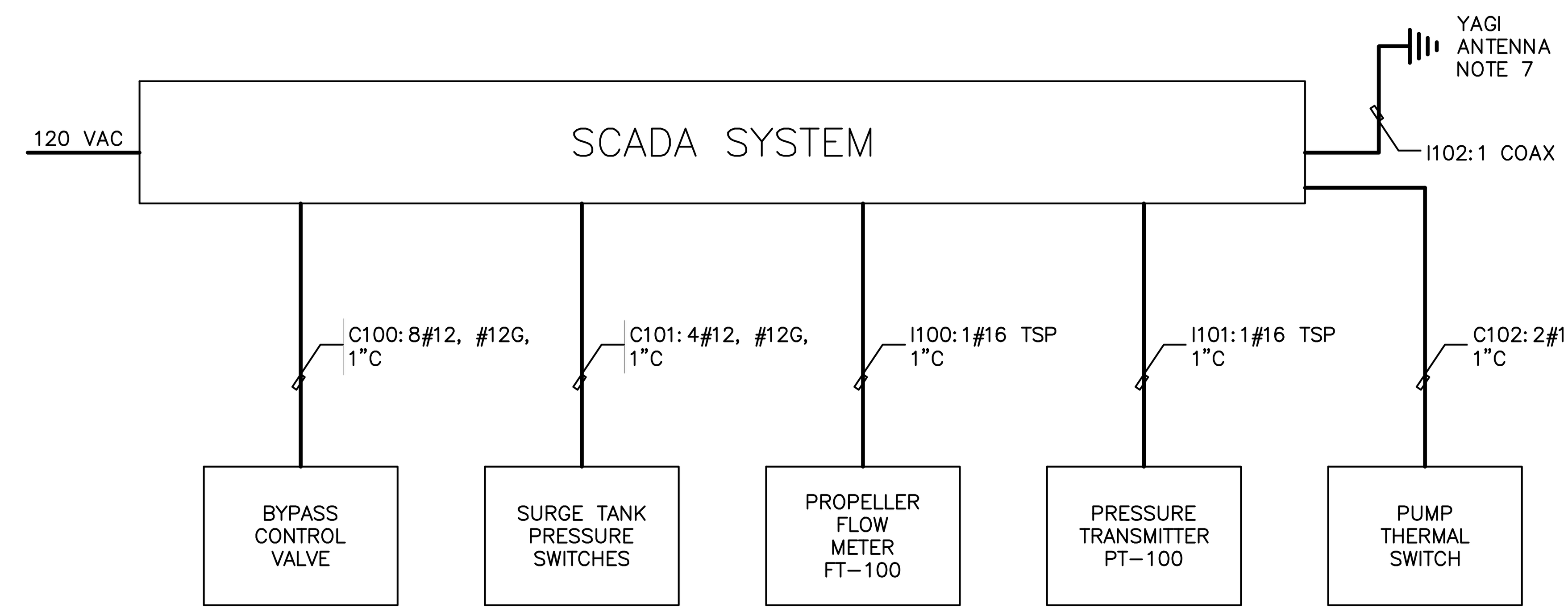
WELL NO. 9 IMPROVEMENTS
ELECTRICAL CONTROL SCHEMATICS

E-3

DE: SKY | CH: SKY | DR: TK/GG | JN: 2018156.00 | SHEET 3 OF 8



ELECTRICAL SITE PLAN
SCALE: 1"=4'



CONTROL SINGLE LINE DIAGRAM
NO SCALE

KEYED NOTES:

1. DISCONNECT AND REMOVE EXISTING SERVICE SWITCHBOARD (SSB). INSTALL AND CONNECT NEW SERVICE SWITCHBOARD. CONTRACTOR MAY USE EXISTING CONDUITS BETWEEN TRANSFORMER AND NEW SWITCHBOARD.
2. DISCONNECT AND REMOVE EXISTING MOTOR CONTROL CENTER (MCC). DISCONNECT AND REMOVE SCADA PANEL FROM LAST COMPARTMENT FOR REUSE. INSTALL SCADA IN NEW MCC. INSTALL AND CONNECT NEW MCC ON PAD. SOME MODIFICATIONS OF ORIGINAL PAD MAY BE REQUIRED. CONTRACTOR MAY USE EXISTING CONDUITS BETWEEN AFFECTED EQUIPMENT.
3. INSTALL NEW CONDUIT AND CABLE TO NEW PUMP MOTOR. CONTRACTOR MAY USE AND MODIFY EXISTING CONDUIT RUN IN APPROPRIATE.
4. INSTALL NEW CONDUIT AND CABLE TO EXISTING BYPASS VALVE. CONTRACTOR MAY USE AND MODIFY EXISTING CONDUIT RUN IF APPROPRIATE.
5. INSTALL NEW CONDUIT AND CABLE TO EXISTING PROPELLER FLOW METER. CONTRACTOR MAY USE AND MODIFY EXISTING CONDUIT RUN IF APPROPRIATE.
6. INSTALL NEW CONDUIT AND CABLE TO PRESSURE TRANSMITTER. CONTRACTOR MAY USE AND MODIFY EXISTING CONDUIT RUN IF APPROPRIATE.
7. REMOVE YAGI ANTENNA FROM OLD MCC AND ATTACH TO NEW MCC IN SAME PHYSICAL ORIENTATION. INSTALL AND CONNECT NEW COAX CABLE CONNECTION TO RELOCATED SCADA SYSTEM.
8. INSTALL NEW GROUND ROD TO COMPLETE GROUNDING CONNECTION TO NEW SES.

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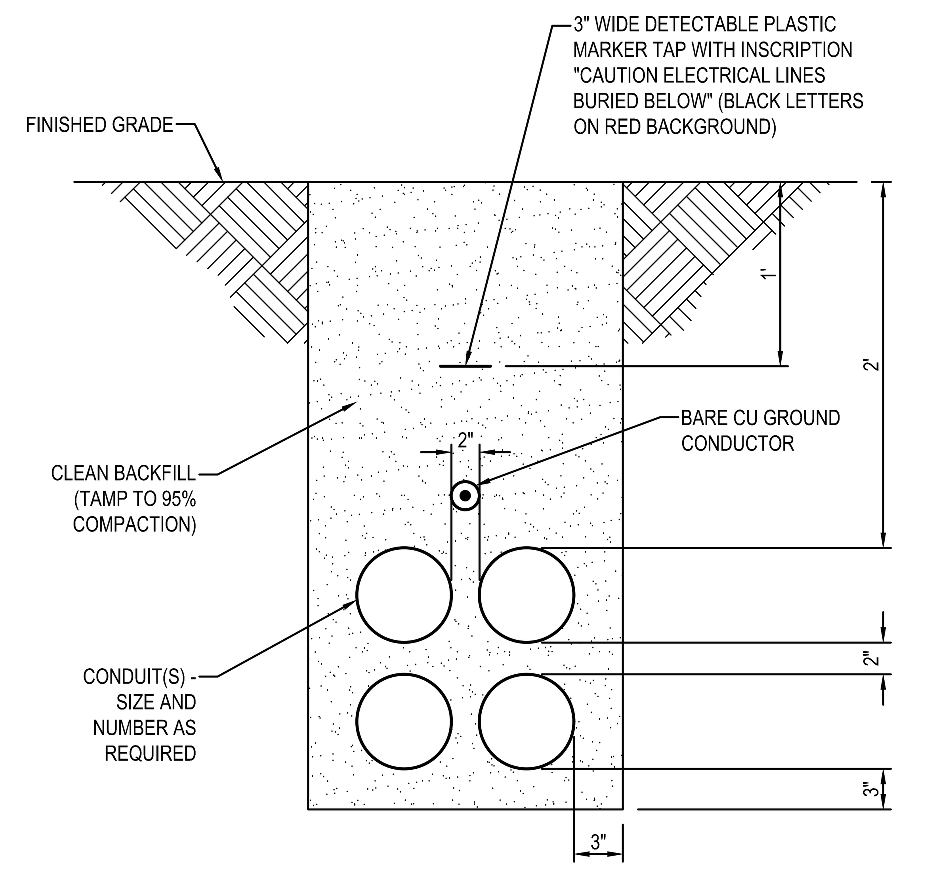
CITY OF FULLERTON

WELL NO. 9 IMPROVEMENTS ELECTRICAL PLAN

E-4

DE: SKY	CH: SKY	DR: TK/GG	JN: 2018156.00	SHEET 4 OF 8

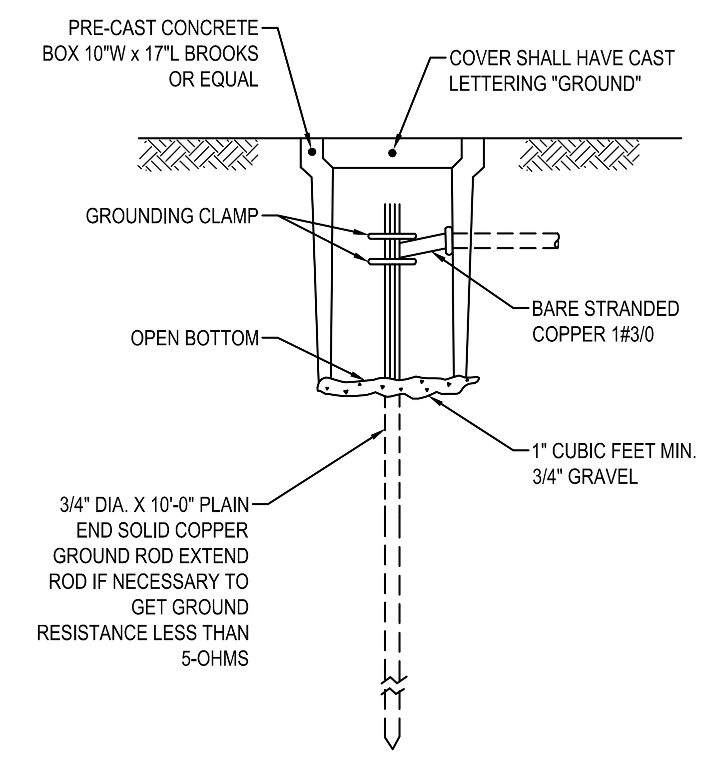
X:\2018\2018156.00-Layne-Fullerton Well No. 9 Electrical Improvements\DWG\Sheets\Well\2018156.00-E-4 ELECTRICAL PLAN.dwg | 11/2/2018 11:50 AM



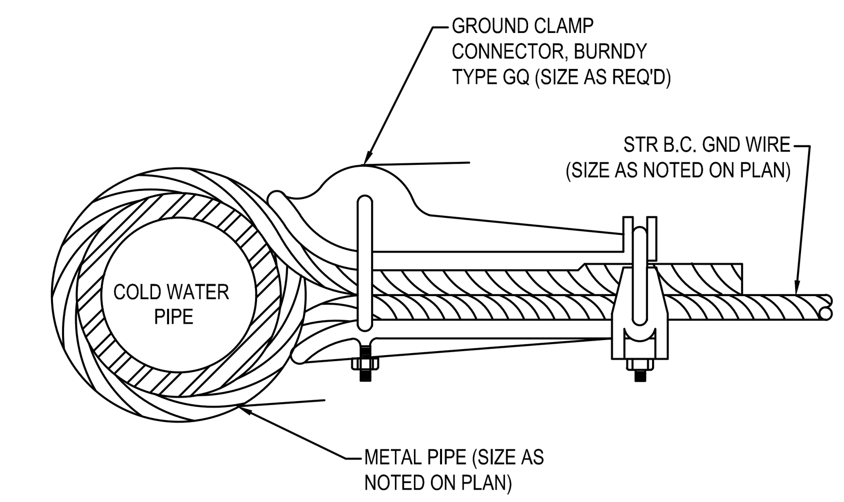
NOTES:

1. GROUND CONDUCTOR SHALL RUN CONTINUOUSLY THROUGH MANHOLES AND SHALL CONTINUE FROM DUCTBANK INTO SWITCHGEAR OR BUILDING GROUNDING SYSTEM AND SHALL BE BONDED ON EACH METAL CONDUIT. SIZE TO BE #4/0 UNLESS OTHERWISE INDICATED ON PLANS.
2. ALL DIMENSIONS ARE MINIMUM.

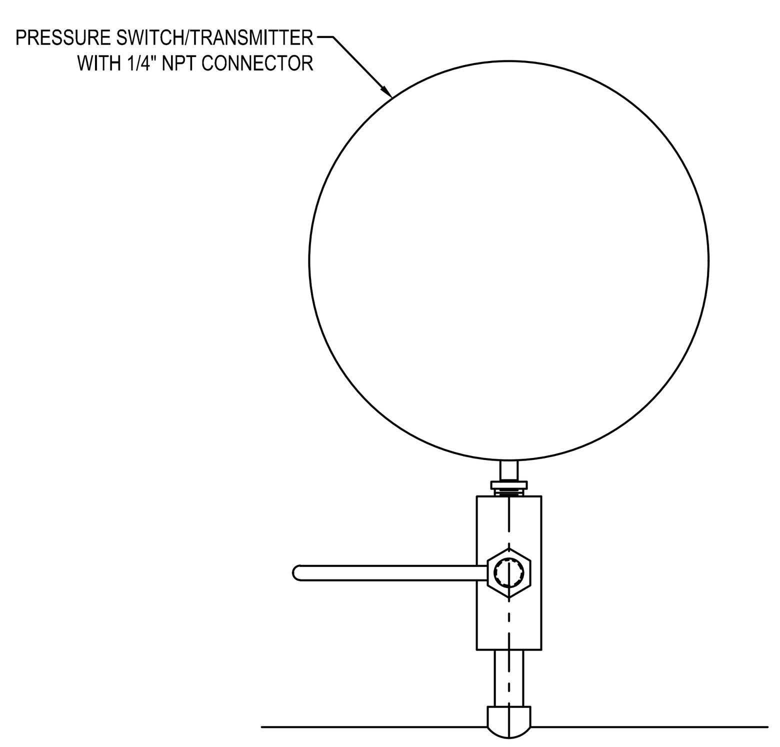
DUCTBANK – DIRECT BURIED
NOT TO SCALE



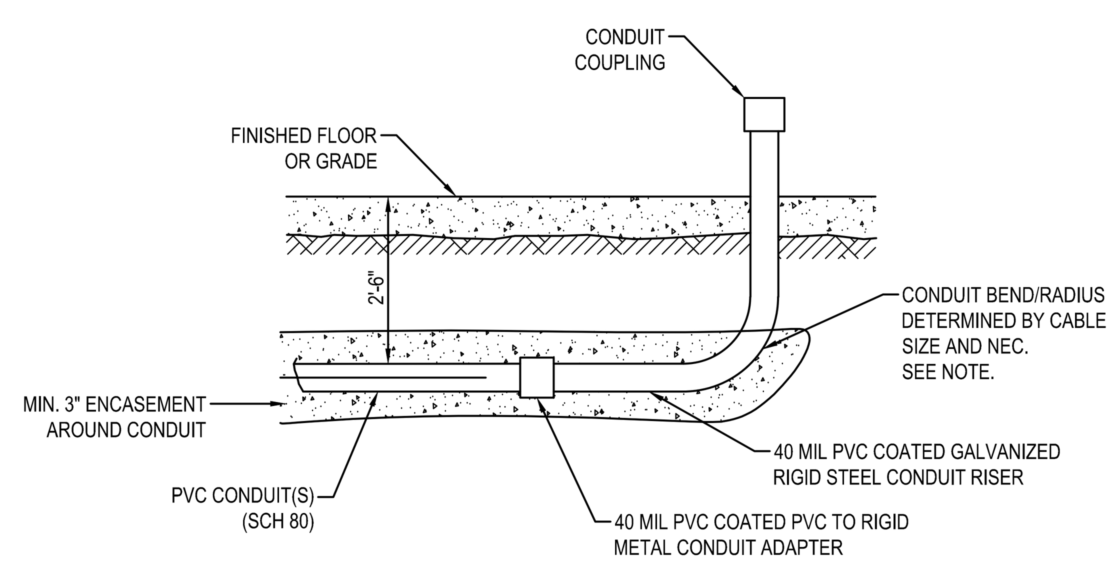
GROUND ROD DETAIL
NOT TO SCALE



UNDERGROUND GROUND CONNECTION TO METAL PIPE (CWP)
NOT TO SCALE

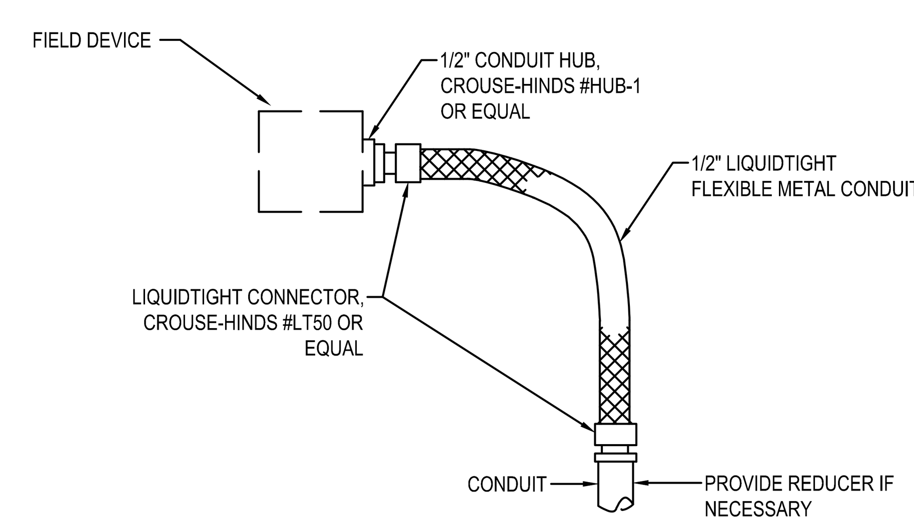


PRESSURE SWITCH/TRANSMITTER MTG DETAIL
NOT TO SCALE



PROVIDE THE SERVICE CONDUIT PER THE UTILITY RQMTS, REGARDLESS SHOWN.

UNDERGROUND CONDUIT AND CONDUIT STUB–UP
NOT TO SCALE



FIELD DEVICE CONNECTION DETAILS
NOT TO SCALE

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CITY OF FULLERTON

WELL NO. 9 IMPROVEMENTS
ELECTRICAL DETAILS

E-5

DE: SKY | CH: SKY | DR: TK/GG | JN: 2018156.00 | SHEET 5 OF 8

ISA INSTRUMENT IDENTIFICATION TABLE

	FIRST LETTERS		SUCCEEDING LETTERS		
	MEASURED OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYZER		ALARM		AUTO
B	BURNER, COMBUSTION				
C	CONDUCTIVITY			CONTROL	CLOSED
D	DENSITY	DIFFERENTIAL			
E	VOLTAGE		ELEMENT		
F	FLOW	RATIO			
G	GAUGE		GLASS, VIEWING DEVICE		
H	HAND				HIGH
I	CURRENT		INDICATE		
J	POWER	SCAN			
K	TIME, TIME SCHED.	TIME RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT		LOW
M	MOTION				MIDDLE
N	INTRUSION				NORMAL
O	TORQUE		ORIFICE, RESTRICTION		OPEN
P	PRESSURE		POINT CONNECTION		STOP
Q	QUANTITY	INTEGRATE, TOTALIZE			
R	RADIATION		RECORD, OR PRINT		RUN OR REMOTE
S	SPEED, FREQUENCY	SAFETY		SWITCH	START
T	TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V	VIBRATION			VALVE, LOUVER	
W	WEIGHT		WELL		
X	MOTOR	X-AXIS	UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED
Y	EVENT, STATE, OR PRESENCE	Y-AXIS		RELAY, COMPUTE, CONVERT	
Z	POSITION	Z-AXIS		DRIVER, ACTUATOR, FINAL CONTROL ELEMENT	

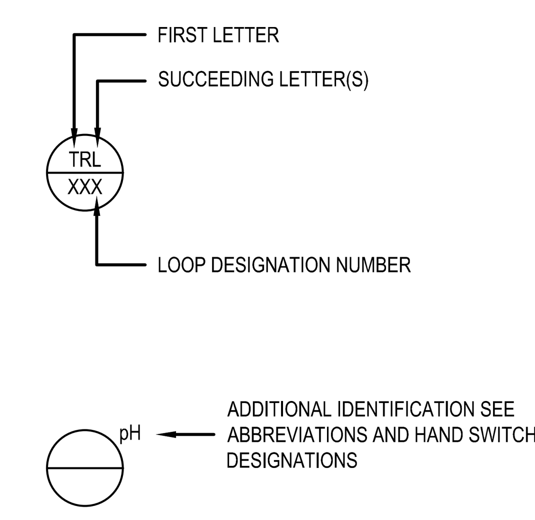
P&ID ABBREVIATIONS

A	AMPERE
AFD	ADJUSTABLE FREQUENCY DRIVE
AI	ANALOG INPUT
AIC	AMPS INTERRUPTING CAPACITY
ARV	AIR RELIEF VALVE
AO	ANALOG OUTPUT
AS	AIR SUPPLY
ATS	AUTOMATIC TRANSFER SWITCH
AUTO	AUTOMATIC
CB	CIRCUIT BREAKER
CL2	CHLORINE
CON	CONTACTOR
CU	COPPER
CV	CONTROL VALVE
DCS	DISTRIBUTED CONTROL SYSTEM
DI	DISCRETE INPUT
DO	DISSOLVED OXYGEN, DISCRETE OUTPUT
DP	DIFFERENTIAL PRESSURE
DWG	DRAWING
EGO	EMERGENCY GAS OFF
ETM	ELAPSED TIME METER
ETMf	ELAPSED TIME METER (FAST SPEED)
ETMs	ELAPSED TIME METER (SLOW SPEED)
EOL	ELECTRONIC OVERLOAD
EXIST	EXISTING
FA	FOUL AIR
FC	FAIL CLOSED
FE	FINAL EFFLUENT
FR	FORWARD-REVERSE
FS	FLOAT SWITCH
FVNR	FULL VOLTAGE NON-REVERSING
FW	FINISHED WATER
GND	GROUND
GAL	GALLONS
GPD	GALLONS PER DAY
GPH	GALLONS PER HOUR
GPM	GALLONS PER MINUTE
H, HI	HIGH
H2S	HYDROGEN SULFIDE
HMI	HUMAN MACHINE INTERFACE
HOA	HAND-OFF-AUTO
I	CURRENT
IO	INPUT/OUTPUT
IOE	INTERNAL-OFF-EXTERNAL

JB	JUNCTION BOX
L, LO	LOW
LAN	LOCAL AREA NETWORK
LC	LOOP CONTROLLER
LCP	LOCAL CONTROL PANEL
LOS	LOCK-OFF-STOP
LR	LOCAL/REMOTE
LS	LEVEL (i.e., FLOAT) SWITCH
M	MOTOR
MA	MANUAL/AUTO
mA	MILLIAMP
MC	MANUFACTURE CABLE
MCC	MOTOR CONTROL CENTER
MCP	MOTOR CIRCUIT PROTECTOR
MFR(S)	MANUFACTURER(S)
MGD	MILLION GALLONS PER DAY
MGL	MILLIGRAMS PER LITER
MH	MANHOLE
MLR	MIXED LIQUOR RETURN
MO	MOISTURE
MOD	MODULATED
MTU	MASTER TELEMETRY UNIT
NPW	NON-POTABLE WATER
NS	NITROGEN SUPPLY
NTU	TURBIDITY
O/C	OPEN / CLOSE
OCA	OPEN-CLOSE-AUTO
OCR	OPEN-CLOSE-REMOTE
OIT	OPERATOR INTERFACE TERMINAL
OL	OVERLOAD
OO	ON/OFF (MAINTAINED)
OOA	ON-OFF-AUTO
OOR	ON-OFF-REMOTE
OSC	OPEN-STOP-CLOSE
PAH	PRESSURE ALARM HIGH
PER	PERMISSIVE
PLC	PROGRAMMABLE LOGIC CONTROLLER
PNL	PANEL
PO	PULSE OUTPUT
POS	POSITION
POT	POTENTIOMETER
PPG	POUNDS PER GALLON
PPH	POUNDS PER HOUR
PPM	PARTS PER MILLION
PR	PAIR

PRES	PRESSURE
PS	PRESSURE SWITCH
PSI	POUNDS PER SQUARE INCH
PV	PROCESS VARIABLE
RAS	RETURN ACTIVATED SLUDGE
RAW	RAW WATER
REM	REMOTE
RF	RADIO FREQUENCY
RIO	REMOTE INPUT OUTPUT
RS	RAW SEWAGE
RSP	RAW SEWAGE PUMP
RST	RESET
RTD	RESISTANCE TEMPERATURE DETECTOR
RTU	REMOTE TELEMETRY UNIT
RUNf	RUN (FAST SPEED)
RUNs	RUN (SLOW SPEED)
SB	SLUDGE BLANKET
SEQ	SERVICE ENTRANCE EQUIPMENT
SES	SERVICE ENTRANCE SECTION
SLC	SINGLE LOOP CONTROLLER
SLOS	START-LOCK-OFF-STOP
SO2	SULFUR DIOXIDE
SOV	SOLENOID OPERATED VALVE
SP	SET POINT
SPD	SPEED
SPR	SPARE
SS	START/STOP (MAINTAINED)
SSS	SOLID STATE STARTER (SOFT START)
STR	MOTOR STARTER
TAH	TEMPERATURE ALARM HIGH
T/M	TEMPERATURE AND/OR MOISTURE
TEMP	TEMPERATURE
TS	TEMPERATURE SWITCH
TSS	TOTAL SUSPENDED SOLIDS
UG	UNDERGROUND
USD	UP/STOP/DOWN
V	VOLT
VFD	VARIABLE FREQUENCY DRIVE
W	WATER
WAS	WASTE ACTIVATED SLUDGE
WW	WASTEWATER
XMTR	TRANSMITTER
ZS	POSITION (i.e. LIMIT) SWITCH

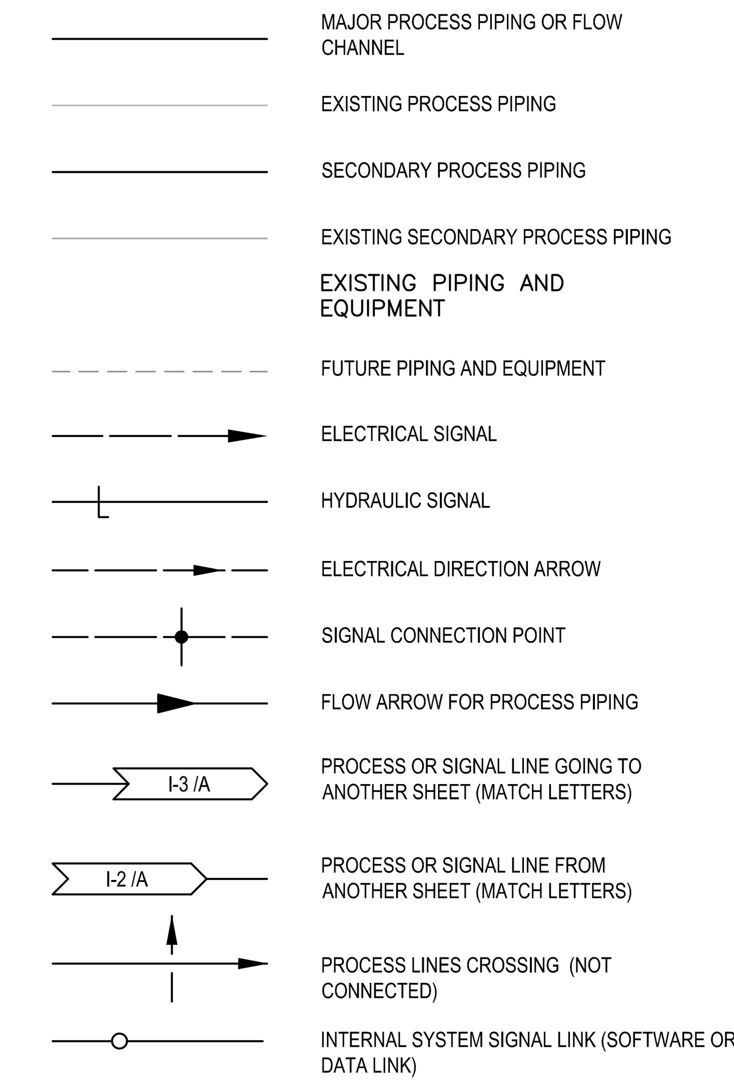
TAG NUMBERS & DESIGNATIONS



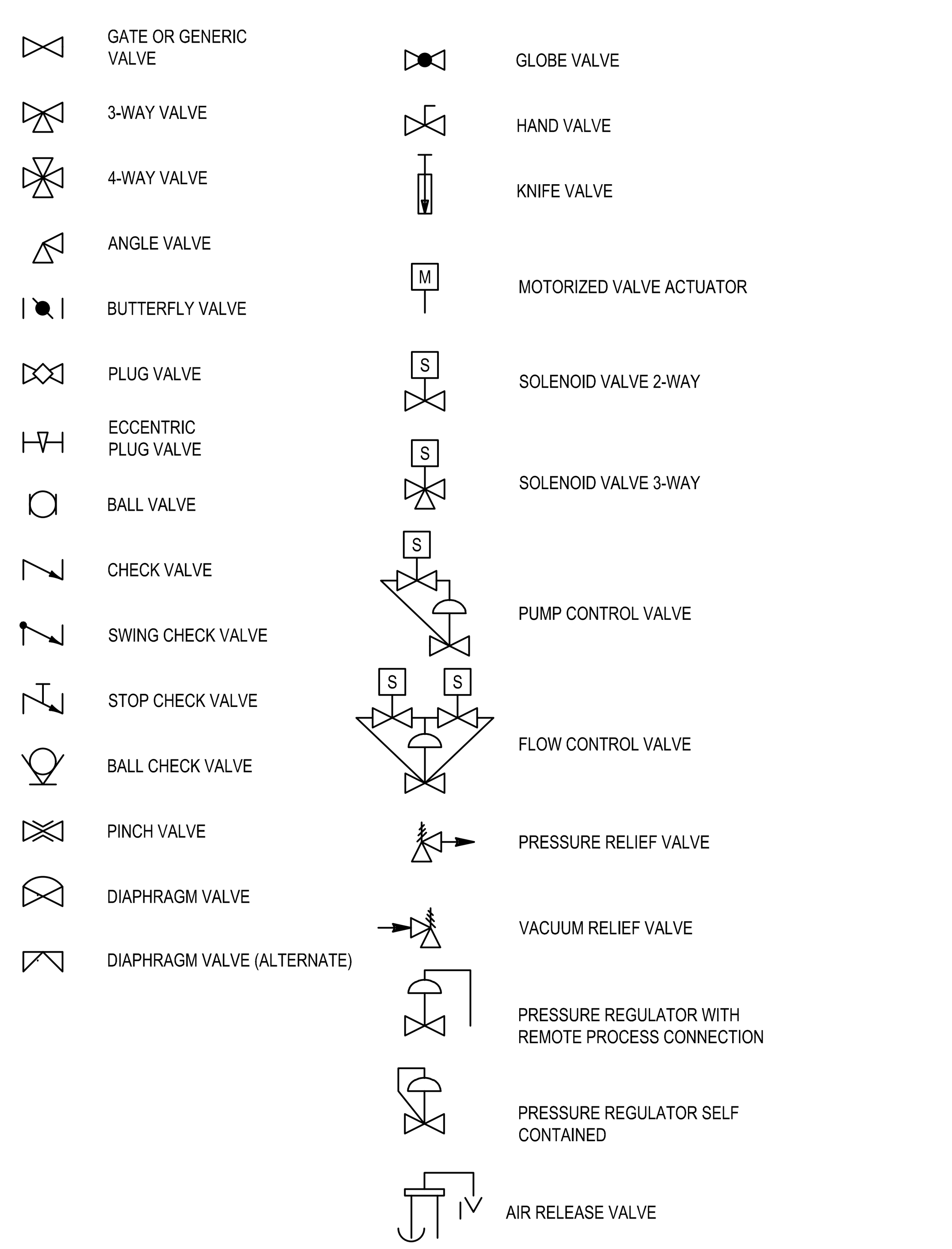
HAND SWITCH DESIGNATIONS

ES HOA	EMERGENCY STOP
HOR	HAND-OFF-AUTO
HORA	HAND-OFF-REMOTE
JOA LOR	HAND-OFF-REMOTE-AUTO
LR	JOG-OFF-AUTO
OC	LOCAL-OFF-REMOTE
OO	LOCAL-REMOTE
S/S	OPEN-CLOSE
	ON-OFF
	START STOP PUSH BUTTONS

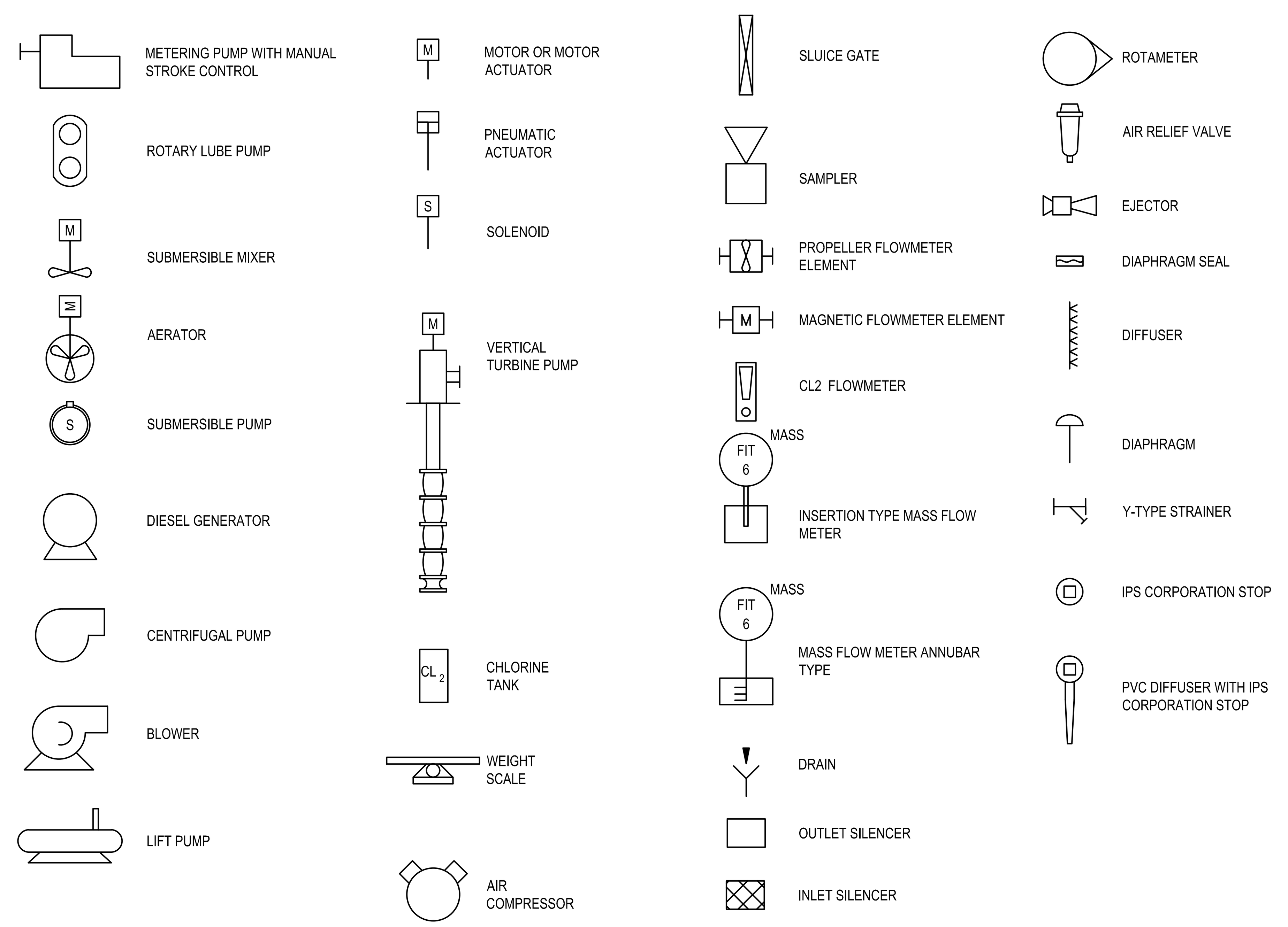
LINE SYMBOLS



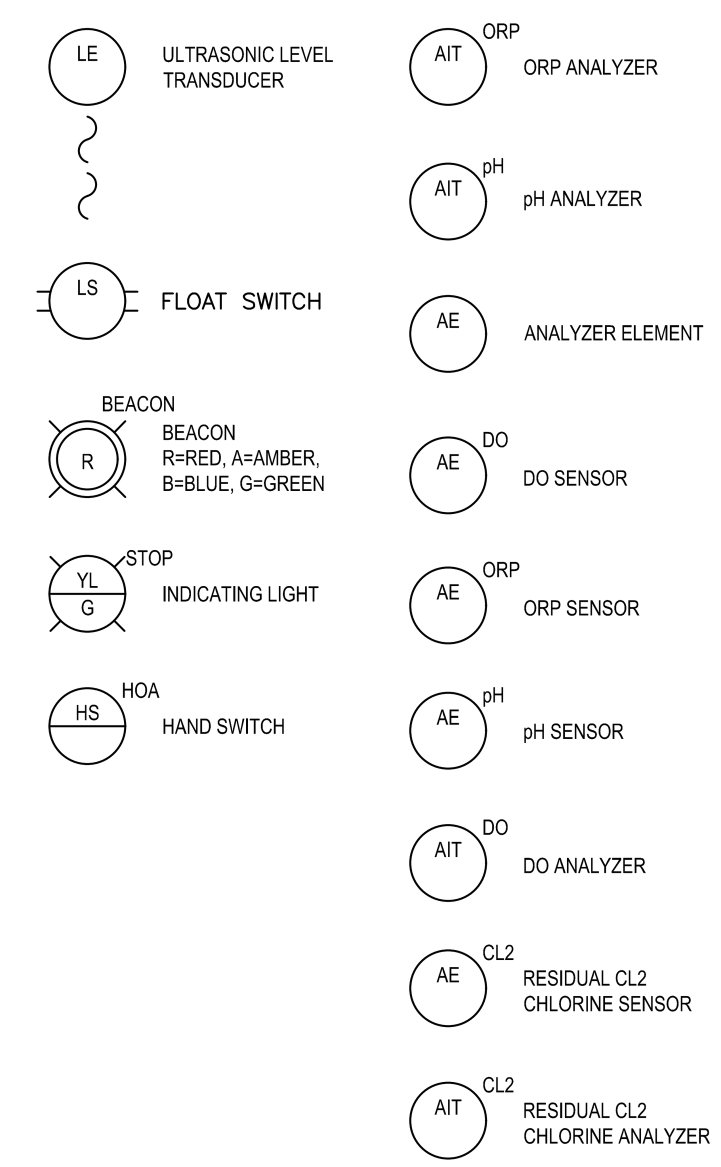
P&ID VALVE SYMBOLS



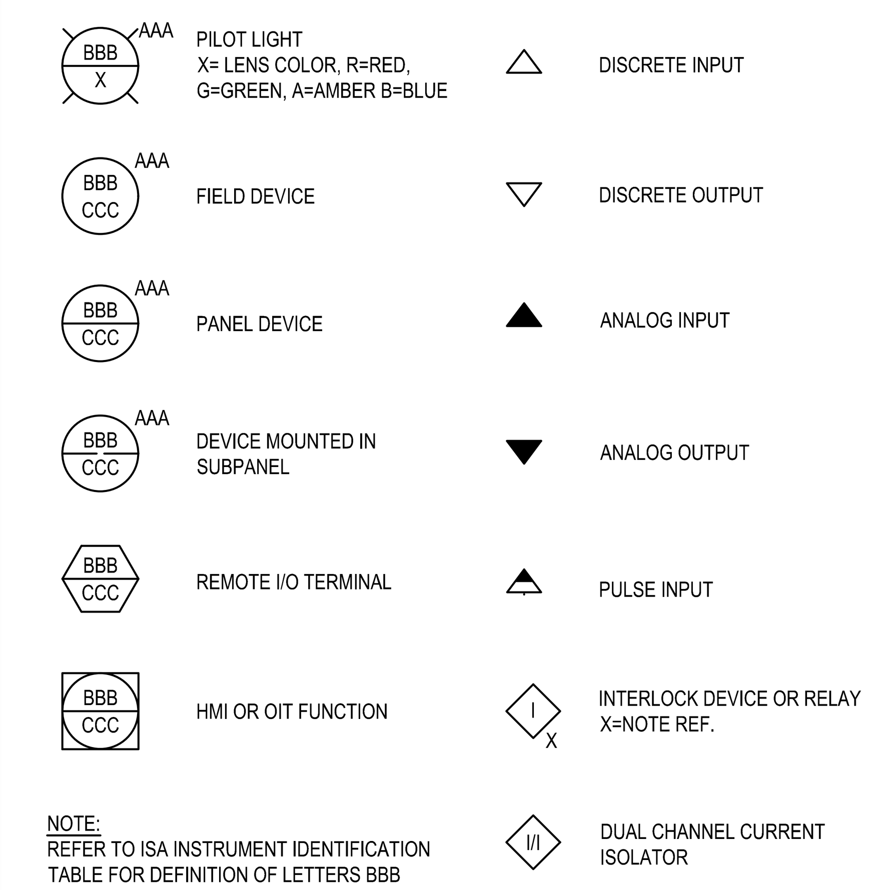
P&ID EQUIPMENT AND PROCESS SYMBOLS



SENSING, INDICATION, & CONTROL SYMBOLS



P&ID INTERFACE SYMBOLS



NOTE:
REFER TO ISA INSTRUMENT IDENTIFICATION TABLE FOR DEFINITION OF LETTERS BBB INSIDE THE BUBBLES. CCC REPRESENTS LOOP ID (IF USED). SEE ABBREVIATIONS LIST FOR SUPERSCRIPT AAA.

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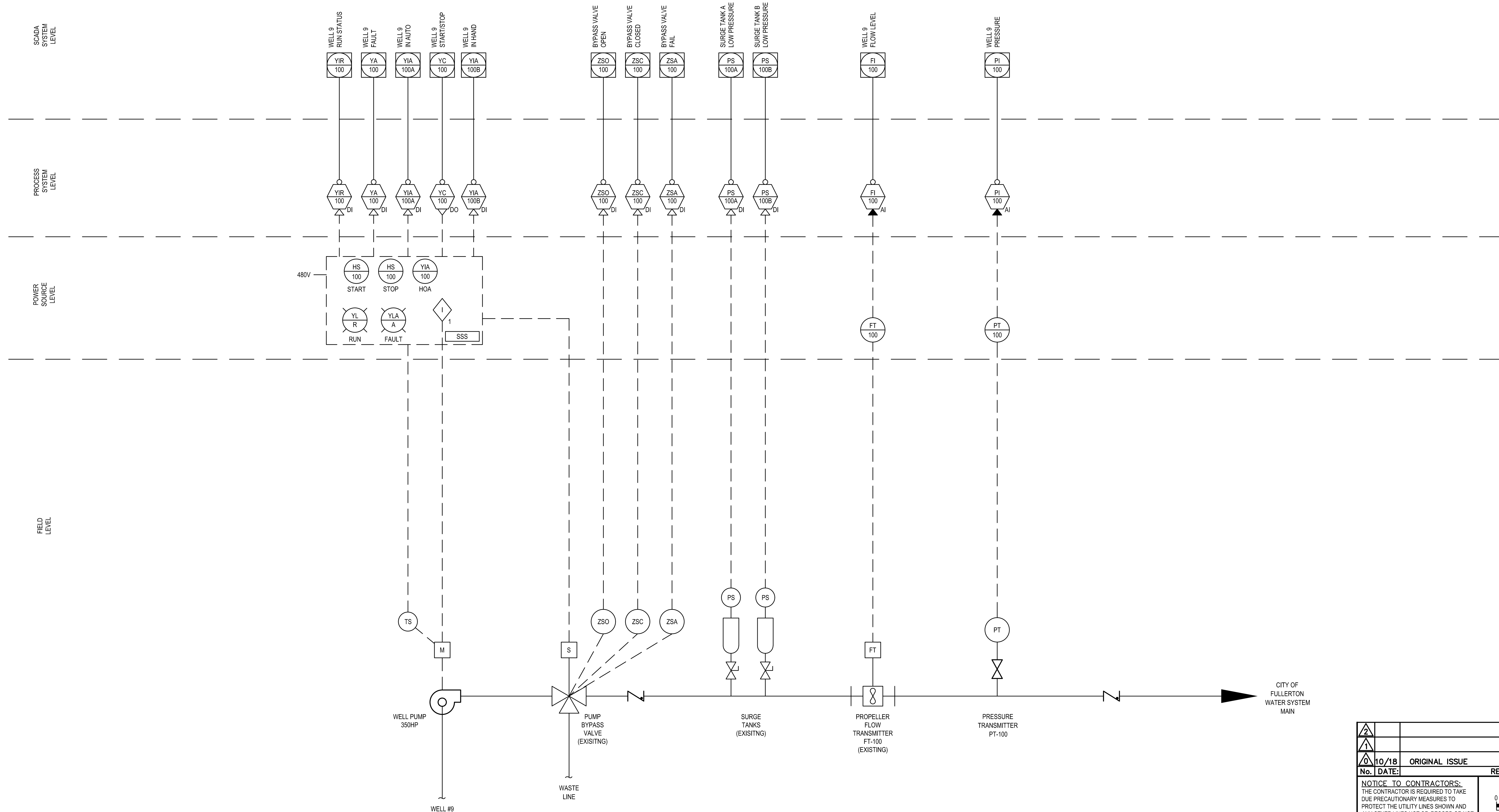
WELL NO. 9 IMPROVEMENTS
PID SYMBOLS AND LEGEND

I–1

DE: SKY	CH: SKY	DR: TK/GG	JN: 2018156.00	SHEET 6 OF 8



I

INTERLOCK NOTES:

BYPASS VALVE SHALL BE NORMALLY OPEN IN BYPASS POSITION (DRAIN TO WASTE). UPON PUMP START COMMAND MOTOR SHALL START AND RUN FOR 180 SECONDS BEFORE BYPASS VALVE CLOSES AND NORMAL PUMPING PROCESS BEGINS.

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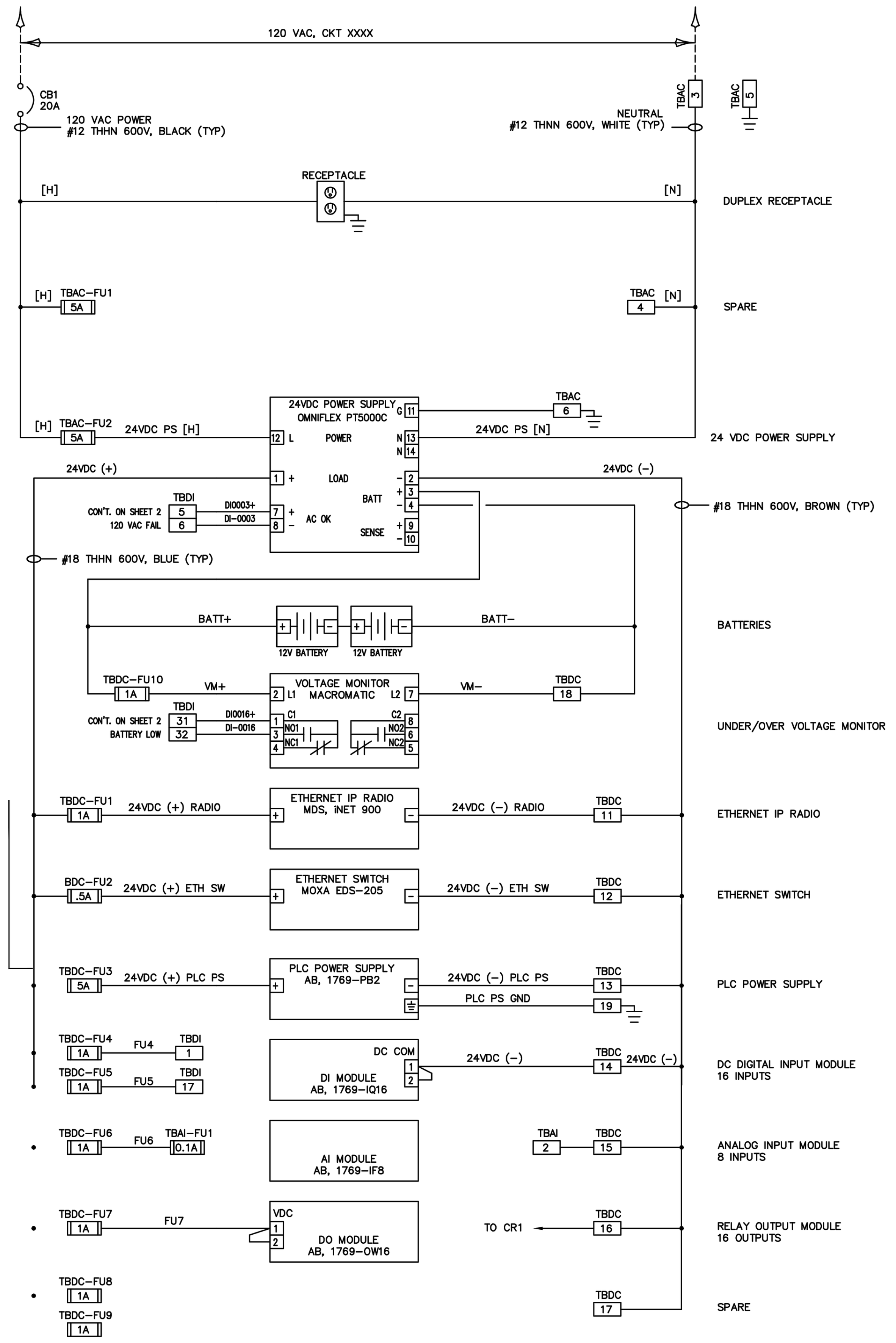
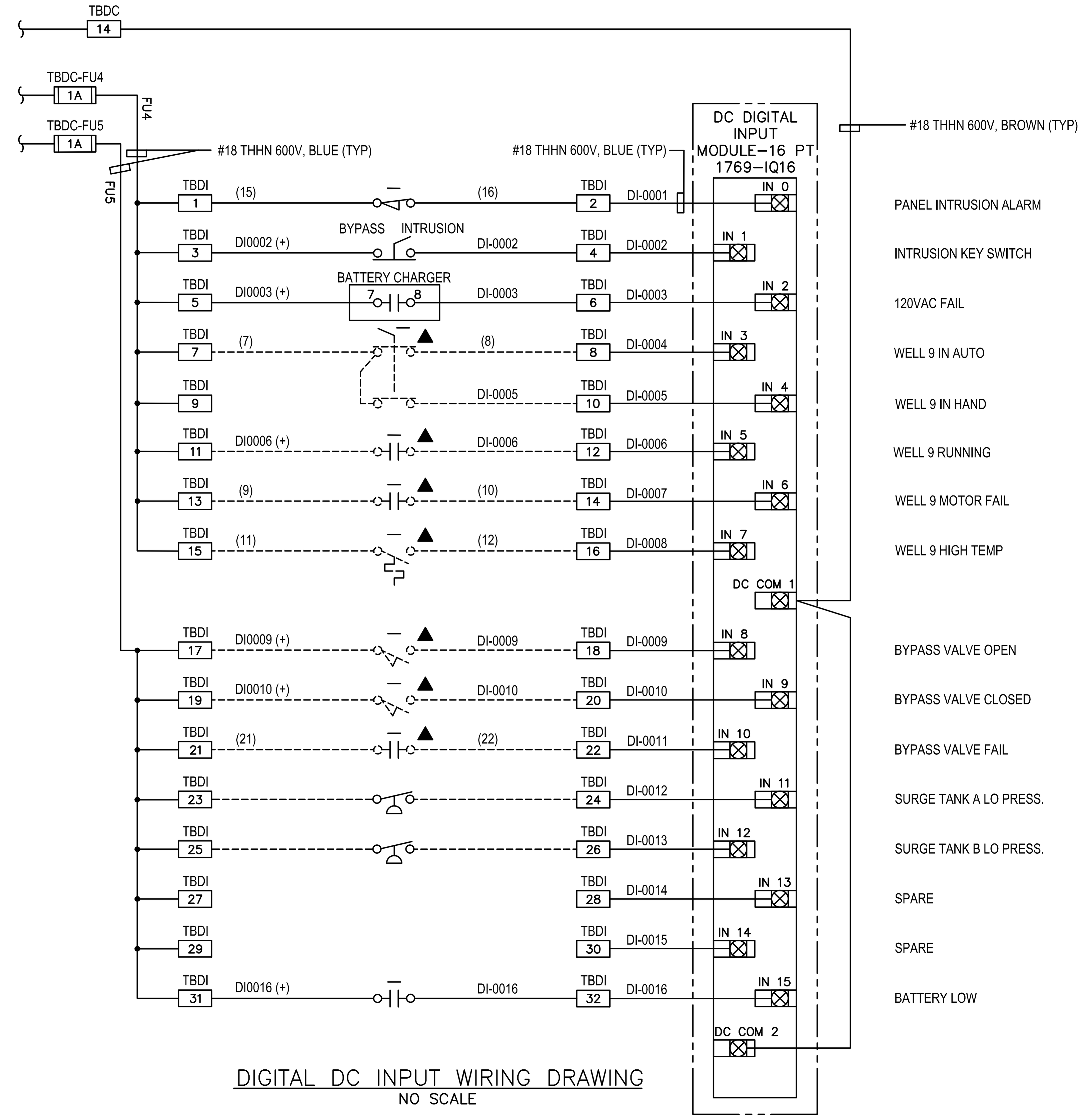
P&ID

I-2

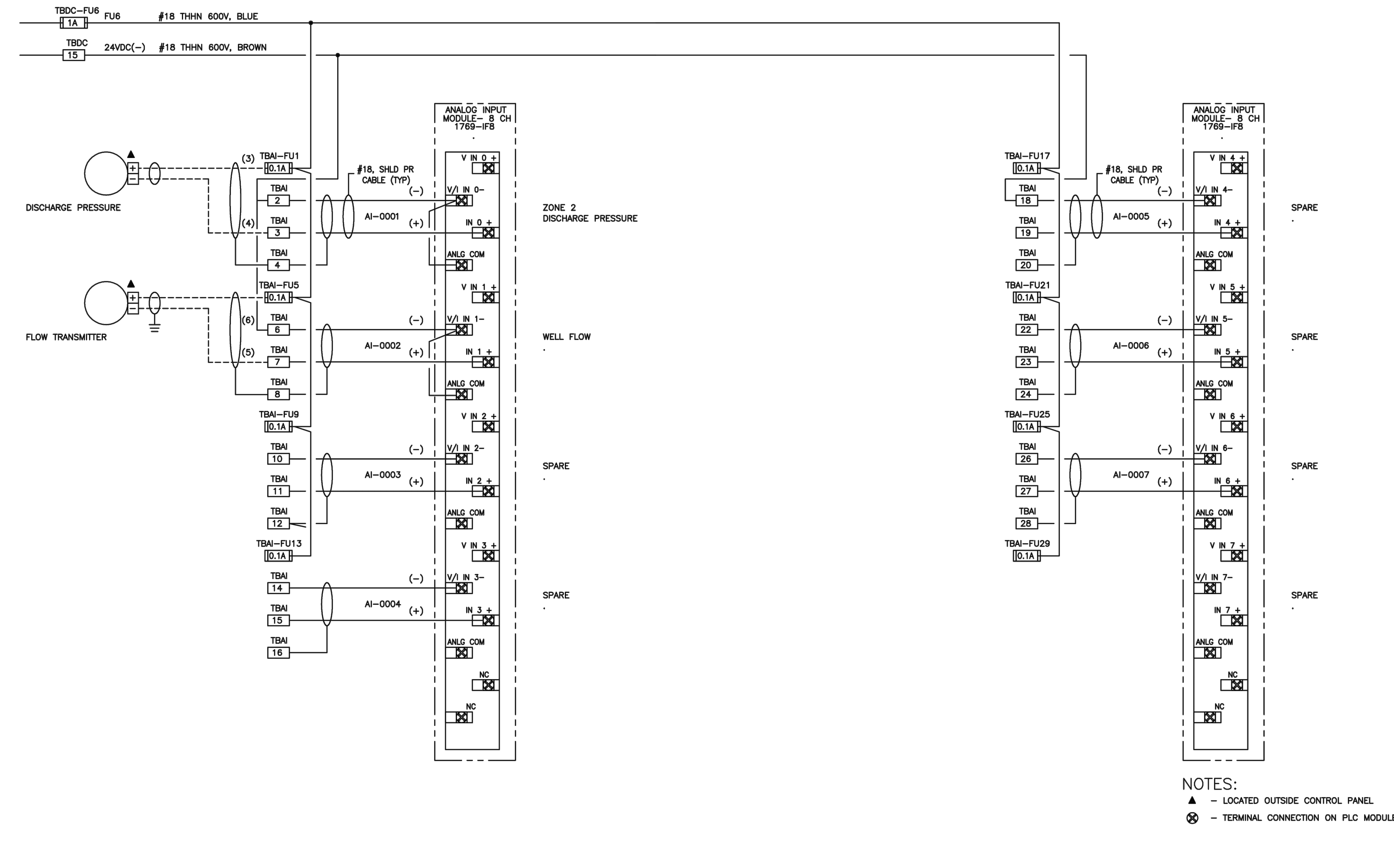
DE: SKY | CH: SKY | DR: TK/GG | JN: 2018156.00 | SHEET 7 OF 8



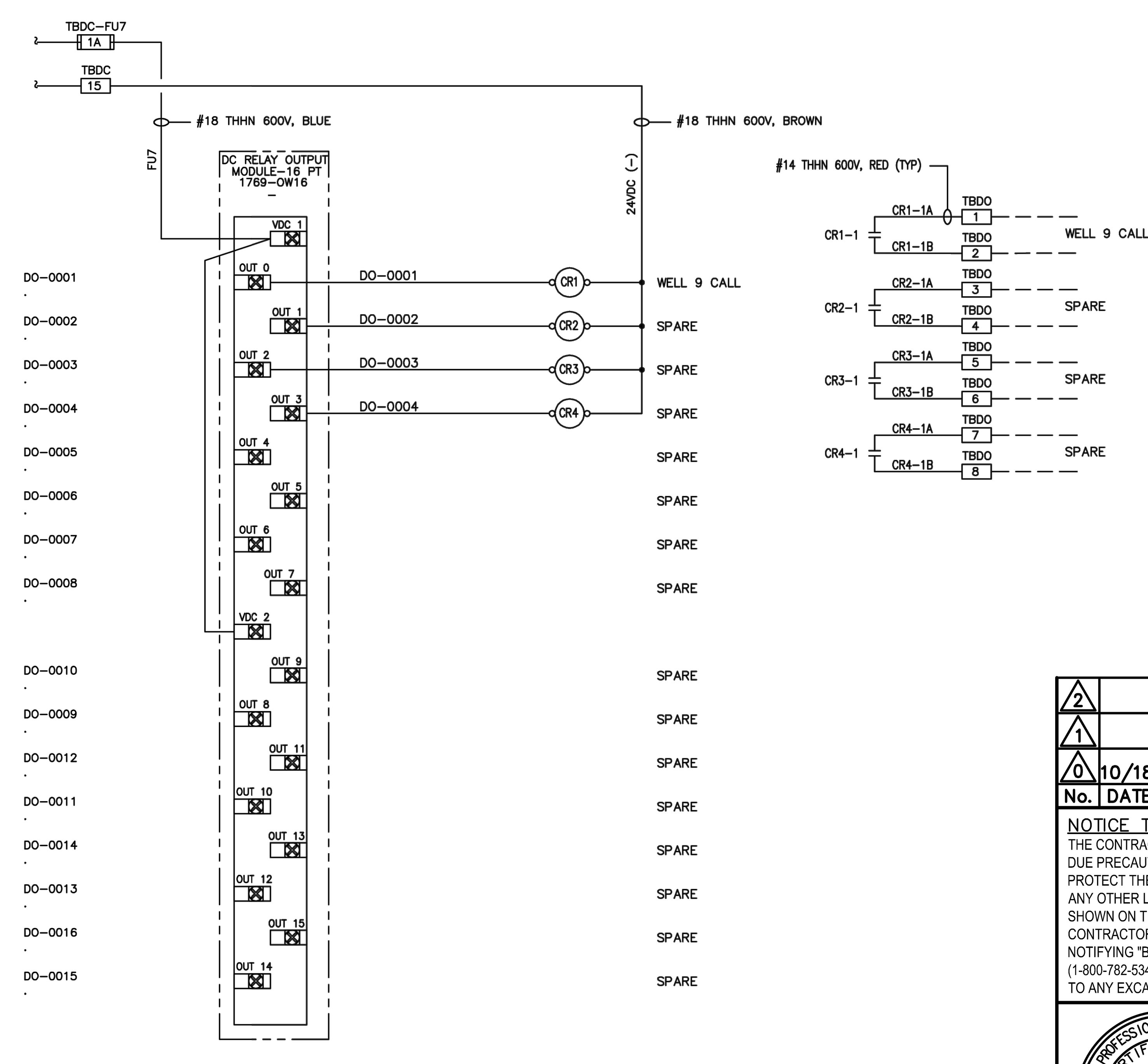
POWER DISTRIBUTION WIRING DIAGRAM
NO SCALE



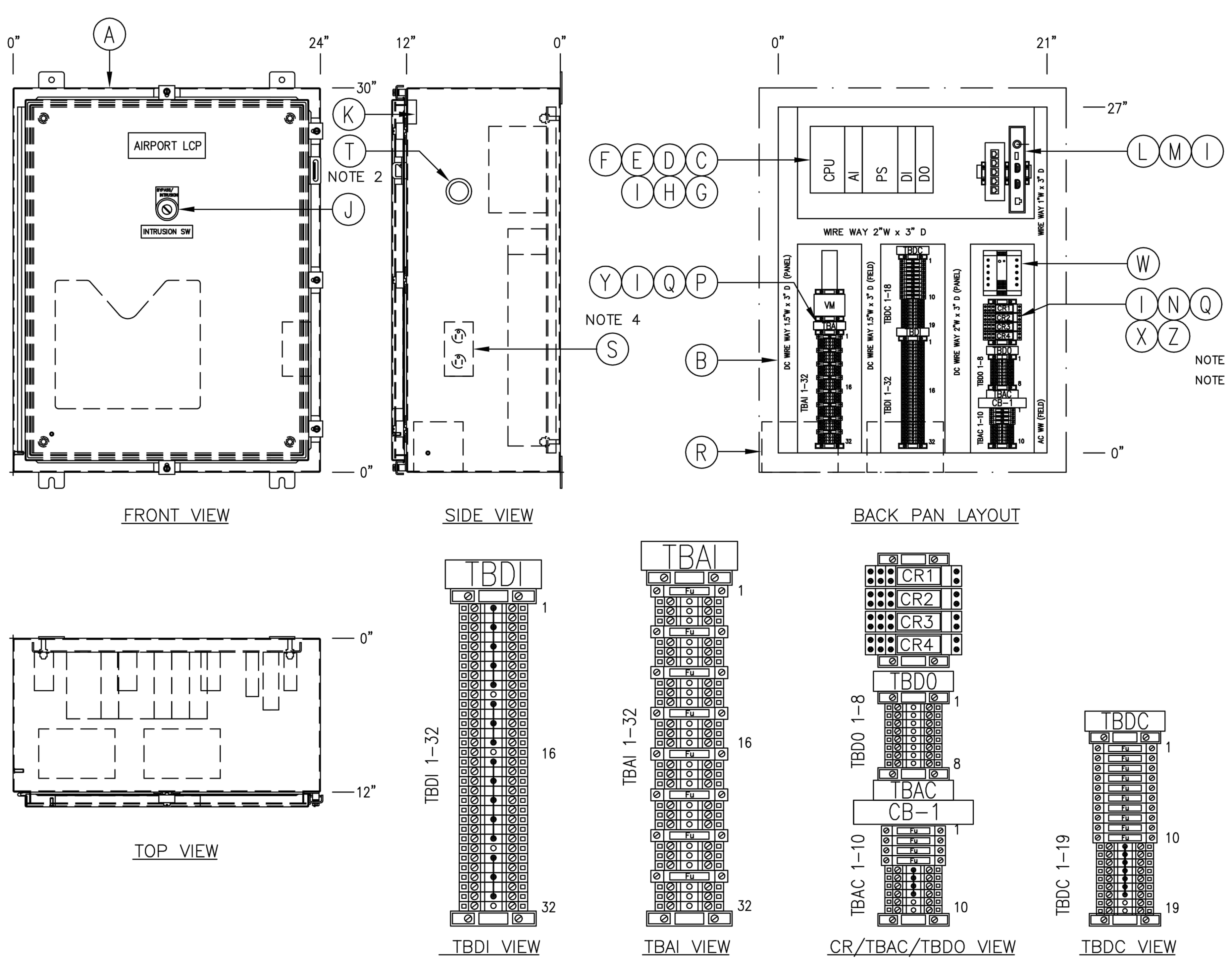
DIGITAL DC INPUT WIRING DRAWING
NO SCALE



ANALOG INPUT WIRING DRAWING
NO SCALE



DC RELAY OUTPUT WIRING DRAWING
NO SCALE



FABRICATION DRAWING
NO SCALE

BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	MANFGR.	MODEL NO.
A	–	ENCLOSURE 30"x24"x12"	EXISTING	EXISTING
B	1	MOUNTING PANEL (27" X 21")	HOFFMAN	30P24
C	1	PLC CONTROLLER, RS232 & ETHERNET/IP	ALLEN BRADLEY	1769–L32E
D	1	PLC POWER SUPPLY 2A @ 5V	ALLEN BRADLEY	1769–PB2
E	1	DIGITAL INPUT MODULE, 16 PT., 24 VDC	ALLEN BRADLEY	1769–IQ16
F	1	DC RELAY OUTPUT MODULE, 16 PT., 24 VDC	ALLEN BRADLEY	1769–OW16
G	1	ANALOG INPUT MODULE8 CH, mA	ALLEN BRADLEY	1769–IF8
H	1	PLC RIGHT END CAP	ALLEN BRADLEY	1769–ECR
I	1	DIN RAIL	ALLEN BRADLEY	199–DR1
J	1	2–POSITION SEL SW, KEY OPERATED	ALLEN BRADLEY	800T–H32A
K	1	INDUSTRIAL DOOR ACTIVATED SWITCH	HOFFMAN	A–LFWD
L	1	SPREAD SPECTRUM RADIO, IP/ETHERNET	MDS	iNET 900
M	1	ETHERNET SWITCH, 5 PORT, 10/100	MOXA	EDS–205
N	1	CIRCUIT BREAKER, 120 VAC. 20A	ALLEN BRADLEY	1492–SPU1B200
P	A/R	24VDC FUSED TERMINAL BLOCK W/ INDICATOR	ENTRELEC	115 663 R2300
Q	A/R	TERMINAL BLOCK, GREY	ENTRELEC	115 116 R0700
R	2	BATTERY, 12V	POWERSONIC	PS12120
S	1	DUPLEX RECEPTACLE	–	–
T	1	LIGHTNING ARRESTOR, BULKHEAD MOUNT	POLYPHASER	IS–B50LN–C2
V	1	YAGI ANTENNA	KATHREIN	TY–900N
W	1	24VDC POWER SUPPLY 4A W/CHARGER	OMNIFLEX PT5000C	C2177A
X	4	RELAY W/ SOCKET, SPDT, 24VDC COIL	IDEC	RH1B–UL24V/ SH1B–05
Y	1	UNDER/OVERVOLTAGE MONITOR, 24VDC W/ SKT	MACROMATIC	VMKP024D/ 70169–D
Z	A/R	120VAC FUSED TERM. BLOCK W/ INDICATOR	ENTRELEC	115 661 R2100
A1	–	NOT USED	–	–
B1	–	NOT USED	–	–

NOTES:
1. NAMEPLATES SHALL BE LAMINATED PLASTIC WITH WHITE LETTERS AND BLACK BACKGOUND.
2. LIGHTNING ARRESTOR TO BE MOUNTED ON THE SIDE OF THE ENCLOSURE. LOCATION TO BE DETERMINED IN THE FIELD.
3. ANTENNA TO BE MOUNTED OUTSIDE THE ENCLSURE. LOCATION TO BE DETERMINED IN THE FIELD.
4. RECEPTACLE TO BE STUD MOUNTED ON THE SIDE OF THE EXISTING ENCLOSURE.

SHEET NOTES:
1. THIS DRAWING IS FOR REFERENCE ONLY AND DOCUMENTS THE DESIGN AND WIRING OF THE EXISTING SCADA SYSTEM. SCADA CONTROL PANEL TO BE REMOVED FROM OLD MCC, INSTALLED IN NEW MCC, AND RECONNECTED IN SAME GENERAL MANNER.

No.	DATE:	REVISION:	APP.
2			
1			
0	10/18	ORIGINAL ISSUE	

NOTICE TO CONTRACTORS:
THE CONTRACTOR IS REQUIRED TO TAKE DUE PRECAUTIONARY MEASURES TO PROTECT THE UTILITY LINES SHOWN AND ANY OTHER LINES NOT OF RECORD OR NOT SHOWN ON THESE PLANS. THE CONTRACTOR SHALL BE RESPONSIBLE FOR NOTIFYING "BLUE STAKE" AT 1-800-STAKE IT (1-800-782-5348) TWO WORKING DAYS PRIOR TO ANY EXCAVATION OR CONSTRUCTION.

0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING ITEMS ARE NOT TO SCALE

811 Know what's below. Call before you dig.

REGISTERED PROFESSIONAL ENGINEER CERTIFICATE 170 STEP ... ELECTRICAL ... ARIZONA U.S.A.
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Fax: 626.303.7957
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CITY OF FULLERTON

WELL NO. 9 IMPROVEMENTS
SCADA SYSTEM REFERENCE

I–3

DE: SKY | CH: SKY | DR: TK/GG | JN: 2018156.00 | SHEET 8 OF 8

CITY OF FULLERTON
WELL NO. 9 ELECTRICAL IMPROVEMENTS
ELECTRICAL AND INSTRUMENTATION SPECIFICATIONS

DIVISION 26 - ELECTRICAL

26 00 00	General Electrical Requirements
26 00 50	Basic Materials and Methods
26 00 60	Electrical Demolition
26 01 27	Electrical Acceptance Testing
26 05 19	Low-Voltage Electrical Power Cables
26 05 23	Control-Voltage Electrical Power Cables
26 05 26	Grounding and Bonding for Electrical Systems
26 05 33	Conduit for Electrical Systems
26 05 53	Identification for Electrical Systems
26 05 83	Wiring Connections
26 09 16	Electrical Controls and Relays
26 22 11	Dry Type Low-Voltage Transformers
26 24 13	Switchboards
26 24 16	Panelboards
26 24 19	Motor Control Centers (MCC)
26 27 16	Electrical Cabinets and Enclosures
26 29 13	Solid State Starter

DIVISION 40 - PROCESS INTEGRATION

40 73 26	Pressure Transmitters
40 90 00	Instrumentation and Control for Process Systems
40 94 44	Programmable Logic Process Controller Cabinet

SECTION 26 00 00 - GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes

1. Work and materials necessary for erecting a complete electrical and instrumentation system, tested and ready for continuous use.

B. Related Sections

1. Division 0 Procurement and Contracting Requirements
2. Division 1 General Requirements
3. Division 2 Site Construction
4. Division 3 Concrete
5. Division 9 Finishes
6. Division 11 Equipment
7. Division 13 Special Construction
8. Division 22 Plumbing
9. Division 27 Communications
10. Division 40 Process Integration

1.02 DEFINITIONS

A. The term “Provide” means “Furnish and Install”.

1.03 SYSTEM DESCRIPTION

A. Design Requirements

1. If any contradictions, contrasts, or inconsistency appears, the most strict criteria noted and the collective requirements in any and all of the project documents shall apply.

1.04 SUBMITTALS

A. Intent

1. Organize work so that a complete electrical, instrumentation, and control system for the facility will be provided and will be supported by accurate shop drawings, record drawings, and O&M manuals.
2. Submit detailed shop drawings and data prepared and organized by the suppliers. Provide quantity of submittal sets in accordance with the requirements of Division 1.
3. Submittals shall be neatly grouped and organized by specification section number, and sub-section. Related information shall be highlighted, and the specific product shall be

marked. All submittals shall be complete, and presented in one package. Incomplete submittals will be returned without review. If a portion of the project requires a fast track schedule, that portion only may be submitted earlier under a separate cover letter.

4. Work performed or equipment provided without engineer approved submittals is done at contractor's risk. Cost to re-work or re-supply will be born solely by the contractor.

B. Product Data

1. A complete list of the equipment and materials, including the manufacturer's name, product specification, descriptive data, technical literature, performance charts, catalog cuts, installation instructions, and spare part recommendations for each different item of the equipment specified. The above shall clearly show all the specified requirements as described in the Specifications including but not limited to specific UL and NEMA rating, technical capabilities, test result verifications, and acceptance letters.

2. Submittals not in compliance with the specifications must include the following information:

   a. Reason for non-compliance or variance

   b. Calculations and drawings for redesign of related components including detail drawings showing internal and assembly details, with installation instructions.

   c. Proposed layout showing any modifications or exceptions to related work made necessary by this work, with calculations and drawings showing such modifications or exceptions.

C. Shop Drawings

1. Drawings containing complete wiring and schematic diagrams, control diagrams, and any other details required to demonstrate that the system has been coordinated and will operate as intended. Drawings shall show proposed layout, anchoring, support, and appurtenances of equipment, and equipment relationship to other parts of the work including clearances for maintenance and operations.

D. Utility Coordination

1. Submit copies of service entrance shop drawings to the utility, per utility submittal requirements, prior to submittal to the Engineer. Obtain written approval from the power utility company that the service entrance equipment is acceptable prior to release the order to the supplier for fabrication. Provide a copy of the approval letter from the utility with the submittal.

E. Closeout Submittals

1. Provide "Record Drawings" of the electrical, control, and instrumentation work to include:

   a. Step-by-step procedure manuals for the installation, operation start-up, and maintenance of the equipment.

   b. Installation, operating, troubleshooting, and maintenance and overhaul instructions in complete detail.

c. Possible breakdowns and repairs, and troubleshooting guides, as well as simplified wiring and control diagrams of the system installed. This shall provide the Owner with comprehensive information on all systems and components to enable operation, service, maintenance and repair.

d. Exploded or other detailed views of all equipment, devices, assemblies, and accessory components shall be included, together with complete parts lists and ordering instructions.

2. Provide an "As Built" set of Plans to Owner. Maintain at all times a marked up set of Plans showing the following information:

a. Actual installed circuit numbers, conduit sizes, cable tray routing, number of conductors, conductor sizes (larger than #12 AWG), and all other deviations from the design Plans.

b. Underground conduit, duct banks, and concealed items dimensioned on the Plans from permanent, visible, building features.

c. Actual motor size, starter size, and overload heater size, along with all other protective equipment for all 480 V and 4160 V motor circuits.

d. Conductor identification and panel schedules.

1.05 QUALITY ASSURANCE

A. Regulatory Requirements

1. Electrical work, including connection to electrical equipment integral with mechanical equipment, shall be performed in accordance with the latest published regulations, codes, and standards, of the following:

a. National Electrical Code (NEC)

b. State and local codes

c. Institute of Electrical and Electronic Engineers (IEEE)

d. American National Standards Institute (ANSI)

e. American Society for Testing and Materials (ASTM)

f. Insulated Cable Engineers Association (ICEA)

g. National Electrical Manufacturers Association (NEMA) Standards

h. Federal Occupational Safety and Health Act (OSHA)

i. National Fire Protection Association (NFPA)

j. National Electrical Testing Association (NETA)

1.06 DELIVERY, STORAGE, AND HANDLING

A. Electrical panels, switchgear, motor control centers, and other electrical equipment, shall be shipped in sealed dust and moisture proof plastic sheet enclosures, and the seal maintained until units are installed. Said units shall be new and free of any dirt, dust, water, grease, rust, damaged parts or components.

1.07 PROJECT/SITE CONDITIONS

A. Verify site conditions before bidding or performing work.

1.08 SCHEDULING

A. Maintain a work schedule showing work to be performed, sequence of work, major milestones, and manpower loading. Coordinate schedule requirements with other trades. Provide adequate staff to perform the work in the time required by the schedule.

1.09 SYSTEM STARTUP

A. After installation and testing of all electrical and instrumentation equipment and systems, energize all equipment and leave ready for continuous operation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers and model numbers shown on Plans or listed in the specifications are intended to establish a minimum standard of quality and acceptability.

2.02 MATERIALS

A. Materials, equipment, and parts comprising any unit, or part thereof, specified or indicated on the Plans, shall be new and unused, of current manufacture, and of highest grade consistent with the state of the art. Damaged materials, equipment, and parts are not considered to be new and unused, and will not be accepted.

2.03 MANUFACTURED UNITS

A. The fabricator of major components and manufactured units, such as distribution panel boards, switchgear, and motor control centers, shall also be the manufacturer of the major devices therein.

B. Electrical equipment provided with mechanical equipment assemblies shall be in compliance with this specification.

2.04 EQUIPMENT

A. Minimum sizes of equipment, and electrical devices, are indicated but it is not intended to show every offset and fitting, nor every structural or mechanical difficulty that will be encountered during the installation of the work.

B. Electrical equipment shall be capable of operating successfully at full-rated load, without failure, at an ambient air temperature of 60 degrees C, and specifically rated for the altitude indicated on the Plans. Provide air conditioning to meet the manufacturers’ operating temperature for electrical equipment not rated for operation at that temperature.

C. When applicable, the material used in the performance of the electrical work shall be listed by the Underwriters' Laboratories, Inc. (UL) for the class of service for which they are intended.

D. Provide nameplates where indicated elsewhere in these specifications or on the Plans. Nameplates shall be black laminate with white letters and fastened to the various devices with round head stainless steel screws. Provide nameplates for each disconnecting means for service, feeder, branch, or equipment conductors, indicating its purpose.

2.05 FABRICATION

A. Shop Assembly

1. Equipment assemblies, such as Service Entrance Sections, Switchgear, Switchboards, Control and Distribution Panels, and other custom fabricated electrical enclosures shall bear a UL label as a complete assembly. The UL label on the individual components making up the assembly will not be considered sufficient to meet the present requirement. Whenever a generic UL label does not apply for the assembly, a serialized UL label shall be affixed to the assembly, and the serial number shall be submitted with the assembly record shop drawings.

2. Custom fabricated electrical control panels, and enclosures, shall bear a UL label affixed by a local UL inspector.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Site Verification of Conditions

1. Verify site conditions before bidding or performing work.

3.02 INSTALLATION

A. Coordinate work with other trades and with certified vendor shop drawing submittals.

B. Provide equipment in accordance with the manufacturers' requirements.

C. Identify each conductor as required by the Contract Documents.

D. Equipment Access:

1. Install equipment so it is readily accessible for operation and maintenance.

2. Equipment shall not be blocked or concealed.

3. Do not install electrical equipment such that it interferes with normal maintenance requirements of other equipment.

E. Equipment shall be installed plumb, square and true with the building construction, and shall be securely fastened.

F. Outdoor wall-mounted equipment, and indoor equipment mounted on earth, or water bearing walls, shall be provided with corrosion-resistant spacers to maintain ¼-inch separation between the equipment and the wall.

G. Arrange for the building in of equipment during structure construction. Where equipment cannot be built-in during construction, arrange for sleeves, box-outs, and other openings, as required to allow installation of equipment after structure construction is complete.

H. Verify that equipment will fit support layouts indicated.

I. Screen or seal all openings into outdoor equipment to prevent the entrance of rodents and insects.

J. Equipment fabricated from aluminum shall not be imbedded in earth or concrete.

K. Provide all necessary anchoring devices and supports.

1. Use supports as detailed on the Plans and as specified.
2. Supports and anchoring devices shall be rated and sized based on dimensions and weights verified from approved equipment submittals.
3. Hardware shall be stainless steel.
4. Do not cut, or weld to, building structural members.
5. Do not mount safety switches and external equipment to other equipment enclosures, unless enclosure mounting surface is properly braced to accept mounting of external equipment.

L. Verify exact rough-in location and dimensions for connection to electrical items furnished by others.

1. Obtain shop drawings from those furnishing the equipment.
2. Proceeding without proper information may require the Contractor to remove and replace work that does not meet the conditions imposed by the equipment supplied.
3. Provide sleeves wherever openings are required through new concrete or masonry members. Place sleeves accurately and coordinate locations with the Engineer.
4. Do not endanger the stability of any structural member by cutting, digging, chasing, or drilling and shall not, at any time, cut or alter the work without the Engineer's written consent.
    a. Provide additional reinforcing if required.
    b. Use proper tools and methods to cut, core drill, or make other penetrations.
    c. Restore walls, ceilings, or floors to their original condition.

M. Do not use equipment that exceeds the indicated dimensions except as approved in writing by the Engineer.

N. Do not use equipment or arrangements of equipment that reduce required clearances or exceed the space allocation.

O. Work indicated on the Plans is approximately to scale, but actual dimensions and detailed Plans should be followed as closely as field conditions permit. Field verification of scale dimensions on Plans is governed by field conditions. Installation of systems and equipment is subject to clarification as indicated in reviewed shop drawings and field coordination.

P. Discrepancies indicated on different Plans, between Plans and actual field conditions, or between Plans and Contract Documents shall be promptly brought to the attention of the Engineer for clarification, prior to purchasing and installing equipment.

Q. Adjust the alignment of equipment and conduit to accommodate architectural changes or to avoid work of other trades.

R. Provide parts and pieces necessary to the installation of equipment, in accordance with the best practice of the trade, and in conformance with the requirements of these Contract Documents.

S. Items not specifically mentioned in these Contract Documents, or noted on the Plans, or indicated on reviewed shop drawings, but which are obviously necessary to make a complete working installation, shall be deemed to be included herein.

T. Lay out and install electrical work prior to placing floors and walls. Provide sleeves and openings through floors and walls, required for installation of conduits. Sleeves shall be rigidly supported and suitably packed, or sealed, to prevent ingress of wet concrete. Spacers shall be installed in order to prevent conduit movement. Dimensions indicated for electrical equipment and their installation are restrictive dimensions.

U. Provide inserts and hangers required to support conduits and other electrical equipment. Coordinate inserts and hangers with other trades. Replace inserts, hangers, sleeves, or other mounting hardware which are improperly placed.

V. Perform necessary saw cutting, core drilling, excavating, removal, shoring, backfilling, and other work required for the proper installation of conduits, whether inside, or outside of the buildings and structures. Use core drills to make circular holes.

W. TEMPORARY POWER

1. Provide and maintain temporary power and lighting systems needed for construction. Work shall include:

   a. Weatherproof panel(s) for the Contractor's main breakers and distribution system.

   b. Conduit and cable.

2. Use ground fault interrupting equipment.

3. Connections shall be watertight, with wiring done with Type SO portable cable.

4. Route and support cables to avoid mechanical damage.

5. Remove temporary power equipment and devices upon completion of construction.

X. CORROSION PROTECTION

1. Wherever dissimilar metals, except conduit and conduit fittings, come in contact, the Contractor shall isolate these metals, as required, with neoprene washers, 9 mil polyethylene tape, or gaskets. Where fastening conduit, electro plated, or equivalent fasteners and stainless-steel bolts shall be used.

3.03 REPAIR/RESTORATION

A. Repair damage caused by construction or demolition work to restore damaged areas to original condition.

B. Factory finishes damaged during shipping, or construction, shall be restored to original new condition. Rust shall be removed, and bare metal surfaces shall be primed and painted to match the original surrounding finish.

3.04 FIELD QUALITY CONTROL

A. Site Tests

1. The electrical work shall be free from improper grounds and from short circuits. Visually compare the conductor connections with connection diagrams. Perform individual circuit continuity checks using electrical circuit testers. Demonstrate proper operation of the energized electrical and mechanical devices. Correct any wiring deficiencies.

3.05 ADJUSTING

A. Calibrate and set all adjustable electrical equipment including circuit breakers, motor circuit protectors, overload relays. Align photo cells and lights to achieve desired effects.

3.06 CLEANING

A. Relays, starters, circuit breakers, switches, contacts, insulators, mechanisms, and buses shall be free of dust, dirt, oil, moisture, metal shavings, and other debris before testing and energizing equipment. Vacuum and wipe down inside and outside of electrical enclosures and control panels.

3.07 PROTECTION

A. Once equipment is installed, it shall be protected at all times with plastic sheet covers until the area is free of dirt, dust, paint spray, water, and other trades. Provide heat to eliminate condensation.

END OF SECTION

SECTION 26 00 50 - BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.01 DESCRIPTION

A. This section consists of general electrical materials and methods. Electrical materials that are a part of equipment specified under other sections shall meet the requirements of this section, unless part of larger factory-assembled equipment.

1.02 SUBMITTALS

A. Submit manufacturer's literature for raceways and fittings, boxes, wires and cables, wiring devices, nameplates, legend plates, labels, panelboards, and safety switches, service entrance equipment, control panels and any other electrical component utilized in this project.

1.03 QUALITY ASSURANCE

A. Refer to Section 26 00 00.

1.04 SPARE PARTS

A. Provide spare components as indicated on drawings and elsewhere herein.

PART 2 - PRODUCTS

2.01 BASIC MATERIALS

A. Electrical safety switches, distribution and control equipment shall be rated for heavy duty service.

B. Wiring devices shall be specifications grade.

2.02 MISCELLANEOUS METAL AND MOUNTING CHANNELS

A. Metal Framing:

1. Unless otherwise shown, mounting channels shall be cold rolled from mild strip steel, 12-gauge, 1-5/8 inches by 1-5/8 inches, with a galvanized finish by Unistrut, Unistrut P-1000, as manufactured by Unistrut, or equal.
2. Screws, bolts, washers and nuts shall be stainless steel. Parts and brackets for assembly of channels shall be hot dipped galvanized.

B. Miscellaneous Metal: Galvanized steel, unless otherwise shown.

2.03 NAMEPLATES, LEGEND PLATES, AND LABELS

A. Nameplates: Laminated sheet plastic, approximately 1/16 inch-thick, with engraved white letters on a black background, with adhesive backing and mounting screw holes. Stainless steel or brass screws, minimum height of letters, 5/16 inch. Card holders are not acceptable.

B. Legend Plates: Type KN-3 standard legend plates, Square D, or equal.

C. Control Wire Markers: Heat shrink sleeve types, manufactured by W.H. Brady Company, or equal.

PART 3 - EXECUTION

3.01 BASIC MATERIALS

A. The completed installation shall conform to all applicable federal, state, and local code ordinances and regulations. Contractor shall obtain necessary permits and inspections required by the governing authorities. Work shall be done in a neat, workmanlike, finished and safe manner, according to the latest published N.E.C.A. standards of installation, under competent supervision. Install grounding as required by the National Electrical Code.

3.02 MISCELLANEOUS METAL AND MOUNTING CHANNELS

A. Install where electrical equipment is to be surface mounted to walls and where indicated on Drawings. Where two or more devices are to be installed side by side, support on metal framing, bolt together, and brace as required to form a rigid structure.

B. Clean cuts and welds. Coat unpainted surfaces with cold application zinc galvanizing. Coat cuts and welds on painted surfaces with zinc chromate primer and finish to match existing paint.

3.03 NAMEPLATES, LEGEND PLATES, AND LABELS

A. Nameplates: Identify panels, switchgear, regulators, load-break junction boxes, disconnect switches, and component enclosures. Fasten nameplates with stainless steel, self-tapping screws or rivets.

1. Panels: Identify panel number, voltage and amperage of panel bus.
2. Switchgear: Identify equipment, voltage, amperage and phase and number of wires.
3. Safety Switches and Relays: Identify equipment controlled and circuits from which they are fed.

B. Legend Plates: Install on selector switches, pushbuttons, pilot lights, starters, and other components.

C. Control Wire Markers: Install at both ends of each control wire interconnecting between such items as control panels, sensors, and control devices, and each end of control wires within control panels, and other such enclosures. Wiring markers shall correspond to control wire numbers on approved wiring diagrams.

END OF SECTION

SECTION 26 00 60 - ELECTRICAL DEMOLITION

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Demolition of existing electrical shall be as indicated on the Drawings or as indicated elsewhere herein.

B. Demolition information shown on the Drawings is based on visual field examination and existing record drawings. The Contractor is responsible for verification of all items indicated or not. All items affected that are not indicated on the Drawings shall be brought to the Engineer's attention before demolition for direction.

C. The Contractor shall confine demolition work to the item specifically identified on the drawings. The Contractor shall be liable for any other damage he may inflict to the existing installations.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Care shall be taken in demolition or removal of items as indicated on drawings as being returned to the Owner. The Contractor shall notify the Owner prior to removing existing equipment.

B. Whether indicated on the drawings or not, the Contractor shall provide patching material to fill voids where demolition has taken place. Patching materials shall match, as nearly as practical, the existing original structure material for each surface being patched.

PART 3 - EXECUTION

3.01 COORDINATION

A. The Contractor shall verify existing field conditions, measurement, circuitry etc. as indicated on Drawings prior to performing any demolition.

B. The Contractor shall verify that abandoned or demolished wiring and electrical equipment serve only abandoned facilities. If demolished or abandoned electrical is necessary for proper operation of facilities to remain in service, the Contractor shall immediately notify the Engineer for direction.

C. Demolition shall not be performed without coordinating with new construction to limit down time and ease of switchover. The Contractor must coordinate with the Engineer and the Owner prior to any demolition.

D. Prior to performing any demolition work, the Contractor shall provide temporary wiring and connections to maintain existing systems in service during construction. Temporary wiring shall conform to the National Electrical Code.

3.02 PERFORMANCE

A. General: The means and methods of performing electrical demolition and removal operations are the sole responsibility of the Contractor. However, equipment used, and methods of demolition and removal will be subject to approval of the Engineer.

   1. Remove exposed abandoned conduit systems.

   2. Remove wiring in abandoned conduit systems to source of power supply, where indicated.

   3. In exposed through-structure conduit or foundation locations, cut conduits and foundation below the finished structure surfaces in order to perform adequate surface patching.

   4. Maintain electrical continuity of existing electrical installations which remain active. Modify installations as necessary to maintain continuity and provide adequate access as required by the National Electrical Code.

   5. Extend existing installations using materials and methods compatible with existing electrical installations, and as specified elsewhere herein.

   6. Disconnect and leave in place electrical devices and equipment serving utilization equipment that has been removed or demolished.

B. Cutting: Perform cutting work of existing structure materials by such methods as will prevent extensive damage beyond the immediate area of cutting.

C. Unless otherwise indicated existing, electrical equipment, conduit, wire, etc. indicated for demolition shall be removed and disposed of in a lawful manner, off Site.

D. The Contractor shall move existing electrical equipment required to be returned to the Owner, to locations as directed by the Owner. Care shall be taken to ensure existing electrical equipment being returned to the Owner does not become damaged. The Contractor shall provide a means for storing and or stacking of the returned equipment prior to moving to final location, if necessary.

E. Items Abandoned in Place:

   1. All items to be abandoned in place shall be de-energized.

   2. Connections shown or otherwise indicated as disconnected shall be removed with lugs left in place and with all conduit and cable openings properly plugged and sealed as required by the NEC.

   3. Any abandoned in-place equipment damaged by Contractor shall be repaired and restored to its original condition.

END OF SECTION

SECTION 26 01 27 - ELECTRICAL ACCEPTANCE TESTING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes

1. Requirements for electrical acceptance testing of electrical equipment and materials.
2. It is the intent of the tests described herein to assure that all electrical equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with design specifications.
3. Acceptance testing performed by equipment vendors at the point of manufacturer must conform to all requirements of this specification. Testing performed at the point of manufacture which conforms to generally accepted industry practices is also acceptable so long as adequate test result documentation is provided.

B. Scope

1. All of the Acceptance Tests are required to be performed whether they are described in this Section or other applicable Sections. At a minimum, the following electrical systems are to be tested:
   a. Main Distribution Panel
   b. Panelboards, Power and Lighting/Receptacle
   c. Transformers, Dry Type
   d. Feeders
   e. Automatic Transfer Switch and Generator
   f. Transient Voltage Surge Suppression Systems (Surge Protective Devices)
   g. Grounding and Bonding System
   h. Lighting Fixture and associated controls
   i. Other systems as listed under Part 3 of this specification

C. Related Documents

1. Drawings and general provisions of the contract, including General and Supplementary Conditions and other Division 1 Specification sections, apply to the work of this section.
2. All work performed under this Section of the work is subject to all requirements contained under Section 26 00 00 "General Electrical Requirements".
3. All Division 26 specifications for electrical equipment provided for this project that requires electrical acceptance testing.

1.02 REFERENCES

A. NETA ATS – Acceptance Testing Specifications, 2003 Edition

B. NFPA 70 – National Electrical Code, 2011 Edition

C. Incorporated by reference all Codes, Standards, and Specifications referred to in the “APPLICABLE REFERENCES” section of NETA ATS-2003.

1.03 DEFINITIONS

A. NETA International Electrical Testing Association Inc.

B. NEC National Electrical Code

1.04 SYSTEM DESCRIPTION

A. Conditions

1. Provide all items, articles, materials, operations or methods listed, mentioned or scheduled on drawings and/or herein including all labor, materials, equipment and incidentals necessary and required for Electrical Acceptance Testing.
2. Following established procedures, equipment shall be energized after certification by the testing organization that the installation is satisfactory.
3. Correct or replace any current-carrying circuit, electrical equipment, or system which is defective or grounded and correct all other troubles encountered by these tests. All defects, whether through faulty workmanship or materials furnished, shall be corrected under this Section at the Contractors expense.

1.05 SUBMITTALS

A. Test Report Forms

1. All test reports shall be submitted using NETA or approved similar format and, where appropriate, test forms. Reports shall be legible using permanent ink. Pencil is not acceptable.
2. Provide for engineers review and approval a copy of each test form to be used on the project. No testing shall be started prior to approval of all test forms.
3. All test reports shall include the following information:
   a. Summary/Description of the Project
   b. Description of equipment tested.
   c. Description of the tests.
   d. Test data and analysis of the data indicating whether the equipment passed or failed the test.
4. All test data records shall include the following minimum requirements:
   a. Equipment identification including tag numbers.
   b. Humidity, temperature, and other conditions that may affect the results of the tests and/or calibrations.
   c. Date of inspections, tests, maintenance, and/or calibrations.

d. Identification of the testing technician and their employer.

e. Indication of inspections, tests, maintenance, and/or calibrations to be performed and recorded.

f. Indication of expected results when calibrations are to be performed.

g. Indication of “as-found” and “as-left” results, as applicable.

h. Sufficient spaces to allow all results and comments to be indicated.

B. Closeout Submittals

1. Provide one copy each to engineer and owner of all testing reports organized as follows:

a. Bind report in 3-ring binder(s).

b. Identify project name, description, testing organizations name, and submittal date on front face and back cover of binder.

c. Provide all test reports, organized by equipment tag number.

d. Separate different equipment numbers with colored or numbered tabs.

e. Provide an index/table of contents.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Any materials provided as part of the testing shall be new, unused, and in manufacturer’s original packing.

2.02 TEST INSTRUMENT CALIBRATION

A. Contractor performing the testing shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy for each test instrument calibrated.

B. Contractor performing the testing shall maintain up-to-date instrument calibration instructions and procedures for each test instrument calibrated.

C. It is preferred that instrument calibration accuracy be directly traceable to the National Institute of Standards and Technology (NIST).

D. Instruments shall be calibrated in accordance with the following frequency schedule:

1. Field instruments: Analog, 12 months maximum. Digital, 12 months maximum

2. Laboratory instruments: 12 months maximum

3. Leased specialty equipment: 12 months maximum.

E. Dated calibration labels shall be visible on all test equipment.

F. Records, which show date and results of instruments calibrated or tested, must be kept up to date.

G. Calibrating standard shall be better accuracy than that of the instrument tested.

PART 3 - EXECUTION

3.01 QUALIFICATIONS

A. It is preferred that the testing organization shall be an independent, third party entity which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems being evaluated. When such testing organization is used, it must meet the following requirements:

1. The testing organization shall be regularly engaged in the testing of electrical equipment, devices, installations, and systems.

2. The testing organization shall use technicians who are regularly employed for testing purposes.

3. The testing organization shall be a member of NETA or be able to prove qualifications equal to or better than required for membership in NETA.

4. Submit appropriate documentation demonstrating that the testing organization meets the requirements listed above.

5. Technicians performing these electrical tests and inspections shall be trained and experienced concerning the apparatus and systems being evaluated. These individuals shall be capable of conducting the tests in a safe manner and with complete knowledge of the hazards involved. They must evaluate the test data and make a judgment on the serviceability of the specific equipment.

6. Technicians shall be certified in accordance with ANSI/NETA ETT-2000, “Standard for Certification of Electrical Testing Personnel”. Each on-site crew leader shall hold a current certification, Level III or higher, in electrical testing.

B. Contractor may perform the electrical acceptance testing under the following conditions:

1. Contractor’s personnel performing the testing and their testing equipment meets all other requirements of this specification.

2. Written approval is received from engineer after review of testing personnel qualifications. At a minimum, contractor’s testing personnel must have specific instruction on the testing instruments, accessories, and tests being performed and must be able to evaluate the test results.

3.02 NOTIFICATION

A. Notify engineer and construction manager at least 2 days prior to testing so that they may be present during testing.

3.03 SAFETY AND PRECAUTIONS

A. Safety practices shall include, but are not limited to, the following requirements:

1. Occupational Safety and Health Act OSHA

2. Accident Prevention Manual for Industrial Operations, National Safety Council, Chapter 4

3. Applicable State and Local safety operating procedures

4. NETA Safety/Accident Prevention Program

5. National Fire Protection Association –NFPA 70E

6. ANSI Z244.1 American National Standards for Personnel Protection

B. All tests shall be performed with apparatus de-energized except where otherwise specifically specified.

C. The testing firm shall have a designated safety representative on the project to supervise operations with respect to safety.

3.04 EQUIPMENT TESTING REQUIREMENTS

A. The intent of this specification is not to duplicate testing performed at the point of manufacture or to impose additional burden on the contractor which does not benefit the project. The intent is to verify that electrical equipment has been securely fastened down, supported, and installed in accordance with the manufacturer's requirements. The intent is also to verify that all electrical connections are correctly torqued, properly aligned, properly insulated, and properly supported and that equipment is clean and ready for operation.

B. Except as noted below or as approved by engineer, test the following equipment and assemblies in full accordance with NETA-ATS 2003.

C. Cables, Low-Voltage, 600 Volt Maximum

1. Perform tests only on cables size #4 AWG and larger.

D. Circuit Breakers, Air, Insulated-Case, Molded-Case

1. Perform visual and mechanical inspections in accordance with NETA for all circuit breakers.

2. Perform electrical tests only on circuit breakers rated 100 amps or higher provided in power distribution and lighting/receptacle panelboards.

3. No testing is required for circuit breakers provided as part of any of the following:

a. A UL listed control panel.

b. UL listed factory supplied motor control centers.

c. Stand-alone combination motor starters.

E. Surge Arresters, Low-Voltage Surge Protection Devices

3.05 CONSTRUCTION

A. Interface with Other Work

1. Coordinate all testing activities with other disciplines. Retest any equipment disturbed or damaged in any manner after initial testing.

3.06 CLOSEOUT REPORT

A. Provide comprehensive bound test report in accordance with Part 1 of this specification.

END OF SECTION

SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section covers the furnishing and installation of 600 Volt Class cables and conductors, terminations and splicing, and pulling lubricants.

1.02 SUBMITTALS

A. Products shall be submitted in accordance with Section 26 00 00, and elsewhere in the Contract Documents, prior to installation.

1.03 REFERENCES

A. Insulated Cable Engineers Association/National Electrical Manufacturers Association (ICEA/NEMA):

1. S-68-516/WC 8, ethylene-propylene rubber-insulated wire and cable for the transmission and distribution of electrical energy.
2. S-61-402/WC 5, thermoplastic-insulated wire and cable for the transmission and distribution of electrical energy.
3. S-66-524/WC 7, cross-linked thermosetting-polyethylene-insulated wire and cable for transmission and distribution of electrical energy.

B. Underwriters Laboratory, Inc.

1. 44, rubber insulated wires and cables.
2. 83, thermoplastic-insulated wires and cables.
3. 486A, wire connectors and soldering lugs for use with copper conductors.
4. 486B, wire connectors for use with aluminum conductors.
5. 510, insulating tape.

C. National Electrical Code

PART 2 - PRODUCTS

2.01 ACCEPTED MANUFACTURERS

A. Conductors and Multi Conductor Cables (MCC), subject to compliance with Contract Documents, the following manufacturers are acceptable: American Insulated Wire Corporation, Cablec Corporation, Okonite Company, Southwire Company, or equal.

2.02 CONDUCTORS

A. Wire sizes shall be American Wire Gauge (AWG) sizes with Class B stranded construction. Number 2 AWG and smaller shall be factory color coded with a separate color for each phase and neutral, which shall be used consistently throughout the system. Larger cables shall be coded by the use of colored tape. Conductors sized # 1 and larger shall be Type 2, rated for 90 degrees C. All circuit conductors, #6 or smaller shall be "THWN" stranded copper. All other conductors shall be "XHHW-2" stranded copper.

B. Individual or multiple conductor cables for power, control, and alarm circuits of 480 volts or less shall be insulated for not less than 600 volts and shall have insulation type as indicated on the Drawings. "THHW" shall conform to ICEA S-61-402/NEMA WC 5 and UL 83 and "XHHW" shall conform to ICEA S-66-524/NEMA WC 7 and UL 44. Where wire size is not indicated, they shall be of the size required by the NEC, except that no wire external to panels and motor control centers shall be less than No. 12 AWG, unless specifically noted on the Drawings. Panel control wiring shall not be less than No. 14 AWG.

C. All wiring shall be as indicated on the Drawings. Wires shall be new and shall be soft drawn copper with not less than 97 percent conductivity. The wire and cable shall have size, grade of insulation, voltage, and manufacturer's name permanently marked on the outer covering at not more than 2-foot intervals. All wires shall conform to the latest Standards of the ASTM, and ICEA, and shall be tested for their full length by these Standards. Insulation thickness shall be not less than that specified by the National Electrical Code.

D. Power conductors for lighting and receptacles only may utilize "THWN" solid conductors.

2.03 TERMINATIONS AND SPLICES

A. Cable shall be rated 600 volts. Other parts of cable systems such as splices and terminations shall be rated at not less than 600 volts. Splicing shall join conductors mechanically and electrically to provide a complete circuit prior to installation of insulation.

B. Splices in wires No. 10 AWG and smaller shall be made with an insulated, solderless, pressure type connector, Type I, Class 1, Grade B, Style G, or Type II, Class 1 of FS W-S-610 and conforming to the applicable requirements of UL 486A.

C. Splices in wires No. 8 AWG and larger shall be made with non-insulated, solderless, pressure type connector, Type II, Class 2 of FS W-S-610, conforming to the applicable requirements of UL 486A and UL 486B. They shall then be covered with an insulation and jacket material equivalent to the conductor insulation and jacket.

D. Insulated conductor splices below grade or in wet locations shall be sealed type conforming to ANSI C119.1 or shall be waterproofed by a sealant-filled, thick wall, heat shrinkable, thermosetting tubing or by pouring a thermosetting resin into a mold that surrounds the joined conductors.

E. Bare conductor splices in wet locations or below grade shall be of the exothermic type.

2.04 PULLING LUBRICANT

A. All cables shall be properly coated with pulling compound such as ClearGluide, Aqua Gel, Polywater, or equal before being pulled into conduits so as to prevent mechanical damage to the cables during installation. "Yellow 77" is not acceptable.

B. Other lubricants to be substituted must be accompanied by a statement from the cable manufacturer as to its acceptable use with the cable being installed.

2.05 IDENTIFICATION

A. All conductors shall be numbered with "tube sleeve" type tags with heat impressed letters and numbers.

B. Color code all wiring as follows:

1. Lighting and power wiring:

CONDUCTOR	120/208 VAC	480VAC	24V DC	120 VAC Control/ Power
Phase 1	Black	Brown	Blue	Red
Phase 2	Red	Orange	(-) Blue w/ white stripe	
Phase 3	Blue	Yellow		
Neutrals	White	White or Gray		White

2. Color code ends of feeder phase conductors only.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The pulling tension and side-wall pressures, as recommended by the cable manufacturer, shall not be exceeded.

B. As far as practical, all circuits shall be continuous from origin to termination without splices in intermediate pull boxes. Sufficient slack shall be left at the termination to make proper connections. In no case shall a splice be pulled into the conduit. Conductor splicing shall not be permitted without the Engineer's approval.

C. Install all cables in conduit.

D. Each feeder and branch circuit shall be installed in its own individual conduit unless combining feeder and branch circuits is permitted as defined in the following:

1. As specifically indicated on the Drawings.

2. For lighting, multiple branch circuits may be installed in a conduit as allowed by the NEC and with the wire ampacity derated in accordance with the requirements of the NEC. Conduit fill shall not exceed the limits established by the NEC.

3. When field conditions dictate and written permission is obtained from the Engineer.

E. Feeder and branch circuits shall be isolated from each other and from all instrumentation and control circuits.

F. Control circuits shall be isolated from all other feeder, branch and instrumentation circuits, except as noted below.

1. 12 V DC, 24 V DC and 48 V DC control circuits may be combined in common conduit.
2. 125 V DC control circuits shall be isolated from all other DC and AC control circuits.
3. 120 V AC control circuits shall be isolated from all DC control circuits.

G. Make splices only at pull or junction boxes.

1. Crimp or indented-type connectors are not allowed, except for control circuits landed on terminal strips.

3.02 TESTING

A. In accordance with Specification 26 01 27 – ELECTRICAL ACCEPTANCE TESTING.

END OF SECTION

SECTION 26 05 23 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section covers cable use for process signal and controls.

1.02 SUBMITTALS

A. Products shall be submitted in accordance with Section 26 00 00, and elsewhere in the Contract Documents, prior to installation.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with Contract Documents, the instrumentation cables shall be as manufactured by Belden, Okonite, or equal.

2.02 INSTRUMENTATION CABLE

A. Instrument cable shall be Type TC and have the number of individually shielded twisted pairs indicated on the Drawings and shall be insulated for not less than 600 volts. Unless otherwise indicated, conductor size shall be No. 18 AWG minimum. Shielded, grounded instrumentation cable shall be used for all analog signals.

B. The jacket shall be flame retardant with 90 degrees C temperature rating. The cable shield shall be a minimum of 2.3 mil aluminum or copper tape overlapped to provide 100 percent coverage and a tinned copper drain wire.

C. The conductors shall be bare soft annealed copper, Class B, 7-strand minimum concentric lay with 15 mils nominal thickness, nylon jacket, 4 mil nominal thickness, 90 degrees C temperature rating. One conductor within each pair shall be numerically identified.

D. Pairs shall be assembled with a nominal 2-inch lay and shall then be group shielded with a minimum of 1.3 mil aluminum or copper tape overlapped to provide 100 percent coverage. All group shields shall be completely isolated from each other.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Feeder and branch circuits shall be isolated from each other, and from instrumentation and control circuits. Instrumentation cables shall be installed in separate raceways from other cables and wiring. This includes portions running through manholes. Instrumentation cable shall be continuous between instruments or between field devices and instrument enclosures. There shall be no intermediate splices or terminal boards, unless otherwise shown on the Drawings.

B. Maintain electrical continuity of the shield when splicing twisted shielded pair conductors. Drain wires shall be terminated inside enclosures at grounded terminal blocks. Only one end of each instrument loop cable drain wire shall be grounded. Ground drain wire of shielded conductors at one end only.

C. Terminate instrumentation and control wiring, including spare wires, at control panels and motor control centers on terminal boards mounted inside the equipment.

1. Contractor shall supply terminal boards as required.
2. Do not field wire directly to devices.

END OF SECTION

SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. A ground grid system consisting of the indicated configuration of copper wires, and ground rods, or concrete encased grounding electrodes ("UFERs") shall be provided to minimize station potential gradient irregularities and drain leakage and fault currents to earth.

B. Whether indicated on the Drawings or not, neutral conductors, cable shields, metallic conduits, cable terminations, junction boxes, poles, surge arresters, and other noncurrent-carrying metallic parts of equipment shall be grounded.

1.02 SUBMITTALS

A. Products shall be submitted in accordance with Section 26 00 00, and elsewhere in the Contract Documents, prior to installation.

1.03 REFERENCES

A. National Electrical Code (NEC) Article 250.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

2.02 GROUND RODS

A. Ground rods shall be copper-clad steel conforming to UL 467, 3/4 inch in diameter by 10 feet in length.

2.03 CONNECTIONS

A. Connections above grade shall be made with bolted solderless connectors, and those below grade shall be made by a fusion-welding process. In lieu of a fusion-welding process, a compression ground grid connector of a type which uses a hydraulic compression tool to provide the correct circumferential pressure may be used. Tools and dies shall be as recommended by the manufacturer. An embossing die code or other standard method shall provide visible indication that a connector has been adequately compressed on the ground wire.

2.04 GROUNDING ELECTRODE CONDUCTOR

A. Service entrance ground wires shall be sized in accordance with NEC Table 250.66, unless otherwise indicated on the Drawings. After being located to provide maximum physical protection, exposed ground wires shall be securely attached to structural supports at not more than 2-foot intervals with suitable fasteners. Bends greater than 45 degrees in ground wires are not permitted. Routing of ground conductors through concrete should be avoided, except where specifically called for in these Documents. When concrete penetration is necessary, nonmetallic conduit shall be cast flush with the points of concrete entrance and exit, so as to provide an opening for the ground wire. The opening shall be sealed with a suitable compound after installation of the ground wire.

2.05 EQUIPMENT GROUNDING CONDUCTOR

A. Neutral conductors shall be grounded where indicated. Equipment grounding conductors shall be sized in accordance with NEC Table 250.122, unless otherwise indicated. Ground wires shall be protected by conduit, where such wires run exposed above grade in non-fence-enclosed areas, or are run through concrete construction. Where concrete penetration is necessary, nonmetallic conduit shall be cast flush with the points of concrete entrance and exit, so as to provide an opening for the ground wire. The opening shall be sealed with a suitable compound after installation of the ground wire. Bends greater than 45 degrees in ground wire connections to the ground rods, or counterpoises are not permitted.

2.06 EQUIPMENT GROUNDING

A. Equipment frames of motor housings, metallic tanks, metallic equipment enclosures, metal splicing boxes, chain-link fencing, and other metallic noncurrent-carrying metal items, shall be grounded. Connections to earth shall be made in the same manner as required for system grounding. Equipment or devices operating at less than 750 volts may be connected to secondary neutral grounding electrodes.

2.07 SURGE ARRESTER GROUNDING

A. Surge arresters shall be grounded. Resistance to ground for intermediate-class arresters shall be not more than 10 ohms and for distribution-class arresters shall be not more than 25 ohms. Ground wire connections shall be not less than No. 4 AWG for distribution arresters and No. 1/0 AWG for intermediate arresters. Connections to earth shall be made in the same manner as required for neutral conductors. Surge arrester grounds may use the same ground wires provided for equipment operating at more than 750 volts. Surge arrester and secondary neutral grounds shall be separate from and independent of each other but both grounds shall be bonded together below grade at the ground rods or may utilize a common counterpoise.

2.08 METALLIC STRUCTURES

A. Metallic structures and buildings shall be grounded per NEC.

2.09 GROUNDING RINGS

A. When required, grounding rings shall be installed using bare copper cable with ground rods at least 25 feet intervals using thermoweld connecting means as indicated on Drawings in accordance with NEC requirements.

PART 3 - EXECUTION

3.01 INSTALLATION

A. It is the intent of these Contract Documents that all device and equipment grounds shall be run as a separate conductor in the conduit from the equipment to the distribution panels or system ground. Wireways and enclosures shall be properly bonded and grounded, and ground conductors shall be run for all circuits.

B. Equipment cases and devices shall be grounded. Ground rods shall be driven, and concrete encased conduits installed, before a building, or structure is built, and ground conductors brought through the concrete to accessible points for grounding equipment. These systems shall be installed at each structure, where panelboards are installed.

C. Duct banks shall contain a bare copper ground conductor. The system ground conductors shall run continuously in duct banks, through handholes and other raceway boxes. The system ground shall be connected to the structure grounding systems to provide a continuous grounding system. Each metallic raceway, panel, switchboard, and other metallic devices associated with the electrical and control systems shall be bonded to this grounding system.

D. Ground rod shall be installed not less than 6 inches below grade. In counterpoise systems, tops of ground rods shall be approximately at elevations of counterpoises. Where the specified ground resistance cannot be met with the indicated number of ground rods, additional ground rods, longer ground rods, or deep-driven sectional rods shall be installed and connected until the specified resistance is obtained, except that not more than three additional ground rods shall be required at any one installation. Ground rods shall be spaced as evenly as possible at least 6 feet apart and connected below grade. Equipment, neutral, and surge arrester ground wires shall be connected to the ground grid as indicated.

E. A resistance of not greater than 25 ohms shall be provided, unless otherwise specified. Ground resistances shall be measured as herein described. Resistances of systems requiring separate ground rods, rather than a counterpoise, shall be measured separately before bonding below grade. The combined ground resistance of separate systems bonded together below grade may be used to meet the specified ground resistance, but the minimum number of rods indicated must still be provided.

3.02 TESTS

A. Test the grounding and bonding system in accordance with Specification 26 01 27 – ELECTRICAL ACCEPTANCE TESTING.

B. No part of the electrical system shall be energized until all station grounding system components have been tested and demonstrated to comply with the requirements specified, and until associated test reports have been submitted and approved.

3.03 TEST RESULTS

A. Perform the above tests and submit a certified test report prior to energizing the equipment.

END OF SECTION

SECTION 26 05 33 - CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Furnish and install conduits as required, and as shown on the Drawings. Materials employed shall be as shown on the Drawings.

1.02 SUBMITTALS

A. Submit product literature including manufacturer part number, model number, material, size, and specifications. Material shall not be installed until the Engineer has reviewed the submittal data.

B. Shop Drawings shall be submitted for review and acceptance showing routing, conduit size, and number and size of wires in each conduit before installation of conduit and any related work.

C. Proposed routing of conduits buried under floor slabs-on-grade.

D. Identify conduit by tag number of equipment served or by circuit schedule number.

E. Proposed routing and details of construction including conduit and rebar embedded in floor slabs, columns, etc. Identify conduit by tag number of equipment served or by circuit schedule number.

F. Proposed location and details of construction for openings in slabs and walls for raceway runs.

G. Refer to Section 26 00 00 for further submittal requirements.

1.03 REFERENCES

A. American National Standards Institute (ANSI): C80.1, Rigid Steel Conduit - Zinc-Coated.

B. National Electric Manufacturers Association (NEMA): RN-1, Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit.

C. Underwriters Laboratories Inc. (UL):

1. 1, Flexible Metal Conduit.
2. 6, Rigid Metal Conduit.
3. 360, Liquid-Tight Flexible Steel Conduit.
4. 467, Grounding and Bonding Equipment.
5. 514, Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers.
6. 651, Schedule 40 and 80 Rigid PVC Conduit.
7. 870, Wireways, Auxiliary Gutters, and Associated Fittings.

8. 884, Underfloor Raceways and Fittings.

9. 886, Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations.

PART 2 - PRODUCTS

2.01 RACEWAYS

A. Exposed conduit in an unclassified or hazardous area shall be galvanized rigid steel (GRS) unless specifically indicated otherwise on the Drawings. Conduits in the corrosive areas shall be PVC coated GRS unless otherwise indicated. Underground and/or concrete encased conduits shall be PVC, unless otherwise indicated. All wiring, except as otherwise noted, shall be in conduit. Conduit size shall not be less than the National Electrical Code (NEC) size required for the conductors therein and shall not be smaller than 3/4-inch. No underground conduit shall be less than one inch.

B. Condulet type fittings shall be Crouse-Hinds, Appleton, or equal with wedge nut covers. All condulets located outdoors or in wet locations shall be weathertight.

C. In unclassified areas, flexible conduit shall be grounding type, weatherproof, corrosion resistant, and watertight.

D. Couplings, connectors, and fittings shall be standard types specifically designed and manufactured for the purpose. They shall be installed to provide a firm mechanical assembly and electrical conductivity throughout.

E. Expansion fittings shall be OZ type AX with jumper for exposed locations and type DX at structural expansion joints, Spring City, or equal. Conduits shall have expansion fittings in accordance with NEC.

F. The conduits and fittings shall be supported per NEC requirements as a minimum.

2.02 GALVANIZED RIGID STEEL (GRS)

A. Conduit and couplings shall be hot-dipped galvanized with zinc coated threads and outer coating of zinc bichromate, in accordance with ANSI C80.1 standards, as manufactured by Jones & Laughlin Steel Corporation, Allied Tube & Conduit Corporation, Triangle PWC, or equal.

B. Steel conduit shall not be buried in earth without concrete encasement and additional corrosion protection. A half-lapped rapping of 20 mil PVC based corrosion protection tape shall be used.

2.03 PVC COATED GALVANIZED RIGID STEEL (PVC-GRS)

A. PVC coated GRS conduit shall be installed where shown on the Drawings or elsewhere specified and shall conform to NEMA RN-1 and ANSI C80.1 standards.

B. The zinc surface of the conduit shall remain intact and undisturbed on both the inside and the outside of the conduit throughout the preparation and application processing. A Polyvinyl Chloride (PVC) coating shall be bonded to the galvanized outer surface of the conduit. The bond between the PVC coating and the conduit surface shall be greater than the tensile strength of the plastic. The thickness of the PVC coating shall be a minimum of 0.040-inch (40 mil).

C. A loose coupling shall be furnished with each length of conduit. A PVC coating shall be bonded to the outer surface of the coupling and a PVC sleeve equal to the outside diameter of the uncoated conduit shall extend beyond both ends of the coupling approximately one pipe diameter or 1-1/2 inches, whichever is smaller. The wall thickness of the coating on the coupling and the sleeve shall be a minimum of 0.040-inch (40 mil).

D. A PVC coating shall be bonded to the inner and outer surface of all conduit bodies and fittings and a PVC sleeve shall extend from all hubs. The wall thickness of the coating on conduit bodies and fittings and the sleeve walls shall be identical to those on couplings in length and thickness. The covers on all conduit bodies shall be coated on both sides and shall be designed to be completely interchangeable. The inside of conduit bodies shall remain undisturbed in the processing.

E. Type 304 stainless steel screws shall be furnished and used to attach the cover to the conduit body. All coated material shall be installed and patched according to the manufacturer's recommended installation and patching instructions.

F. Conduit straps shall be PVC coated or stainless steel.

G. PVC coated conduit and fittings shall be as manufactured by Kor Kap Corporation, Occidental Coating Company, Rob-Roy, or equal.

H. PVC coated flexible conduits shall be liquid and vaportight and manufactured in accordance with UL 360 standards.

2.04 RIGID NONMETALLIC - PVC

A. Where specifically indicated on the Drawings, or elsewhere specified, conduit may be high density Schedule 40, 90 degrees C, heavy-duty PVC. The conduit shall be manufactured from virgin polyvinyl chloride compound which meets ASTM D1784, NEMA TC-2, ANSI C33.91, and UL 651 standards. Smoke emissions shall be limited to less than 6 grams per 100 grams of material tested.

B. Where conduit concrete encasement is indicated on the Drawings, conduit supports shall be installed at five foot intervals. PVC conduit shall be manufactured by Carlon, Triangle Conduit & Cable, or equal.

2.05 INTERMEDIATE METAL CONDUIT

A. Conduit and couplings shall be galvanized intermediate metal conduit manufactured in accordance with UL 1242 and as manufactured by Allied Tube & Conduit Corporation, Jones & Laughlin Steel Corporation, or equal.

B. Intermediate metal conduit shall not be buried without concrete encasement. Threadless couplings and connectors shall not be used.

2.06 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

A. Liquid-tight flexible metal conduit shall be liquid and vaportight, oil and ultraviolet ray resistant and manufactured in accordance with UL 360 standards. Liquidtight flexible metal conduit shall be formed of a continuous, spiral wound, galvanized steel core with an extruded PVC jacket. The PVC jacket shall be rated for high ambient heat applications, 90 degrees Celsius.

B. For corrosive locations, liquidtight flexible metal conduit shall be formed of a continuous, spiral wound, aluminum core with an extruded PVC jacket. The PVC jacket shall be impervious to corrosive liquids and vapors.

C. An external bonding conductor shall be required for flexible conduit connections containing circuits rated at 60 amps or greater and for sizes 1 1/2 " or larger. Flexible conduit and connectors for 1 1/4" and smaller shall be listed for grounding.

D. Connectors for liquid-tight flexible conduit shall be galvanized, furnished with a sealing ring and locknut, and suitable for wet locations.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Conduit runs are schematic only and shall be modified as required to suit field conditions, subject to review and acceptance by the Engineer.

B. Conduit shall run continuously between outlets and shall be provided with junction boxes where connections are made. Couplings, connectors, and fittings shall be acceptable types designed and manufactured for the purpose, and shall provide a firm mechanical assembly, and electrical conductivity throughout.

C. Conduit runs shall be straight and true. Elbows, offsets, and bends shall be uniform and symmetrical. Changes in direction shall be made with long radius bends, or with fittings of the condulet type.

D. Conduit runs in buildings and structures shall be exposed except as specifically noted or accepted by the Engineer.

E. Conduit runs shall not interfere with the proper and safe operation of equipment and shall not block or interfere with ingress or egress, including equipment removal hatches.

F. Exposed conduits shall be securely fastened with clamps, or straps, intended for conduit use. All exposed conduit shall be run on the walls and ceiling only and shall be parallel to the planes of the walls or ceiling. No diagonal runs will be permitted. Flexible conduit shall be used only for short lengths required to facilitate connections between rigid conduit to motors from junction boxes, or control equipment.

G. Conduit runs on water-bearing walls shall be supported one inch away from the wall on an accepted channel. When channel galvanizing, or other coating, is cut or otherwise damaged, it shall be field coated to original condition. No conduit shall be run in water-bearing walls, unless specifically designated otherwise.

H. Conduit shall be thoroughly reamed to remove burrs. IMC or GRS shall be reamed during the threading process, and Rigid Nonmetallic PVC shall be reamed before applying fittings. A zinc rich cold galvanizing shall be used to restore corrosion protection on field cut threads. Bushings and lock nuts or hubs shall be used at conduit termination's. The total number of bends in any run between pull points shall not exceed 360 degrees. Junction boxes and pull boxes shall be installed at points acceptable to the Engineer. Conduit ends shall be plugged to prevent the entrance of moisture or debris during construction. All spare conduits shall be adequately capped and shall contain a suitable pull string.

I. Joints shall be set up tight. Hangers and fastenings shall be secure, and of a type appropriate in design, and dimensions, for the particular application.

J. Conduit runs shall be cleaned and internally sized (obstruction tested) so that no foreign objects, or obstructions remain in the conduit prior to pulling in conductors.

K. After installation of complete conduit runs 2 inches and larger, conduits shall be snaked with a conduit cleaner equipped with a cylindrical mandrel of a diameter not less than 85 percent of the nominal diameter of the conduit. Conduits through which the mandrel will not pass shall not be used.

L. Expansion fittings shall be installed across all expansion joints and at other locations where necessary to compensate for thermal expansion and contraction.

M. Provide trenching, backfill, and compaction for conduits installed underground.

N. Unless approved in advance by the Engineer, all conduits which transition from underground to aboveground will utilize galvanized rigid steel conduit for the bend from horizontal to vertical and for the extension above the ground. Factory 90-degree GRS bends shall be used. GRS bends and conduits shall be half lapped with 20 mil PVC tape in non-corrosive areas and shall be PVC coated rigid steel in corrosive areas. Tape wrapping shall extend a minimum 6 inches above top of slab or above finished grade.

O. Liquid tight flexible metallic conduit 1-1/2 inch and larger shall be provided with grounding style bushings and shall have an external ground wire sized and installed in accordance with the NEC.

END OF SECTION

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Electrical identification work specified in this section covers the following:

1. Buried cable warnings
2. Electrical power, control and communication conductors
3. Operational instructions and warnings
4. Danger signs
5. Equipment/system identification signs

1.02 SUBMITTALS

A. Submittals to the engineer shall include the following:

1. Manufacturers data on electrical identification materials and products
2. Samples of each color, lettering style and other graphic representation required for each identification material or system

1.03 MANUFACTURERS

A. Subject to compliance with requirements, manufacturers offering electrical identification products maybe incorporated in the work include, but not limited to, the following:

1. Brady, W.H. Co.
2. Ideal Industries, Inc.
3. Panduit Corp.
4. or, equal

1.04 QUALITY COMPLIANCE

A. Comply with applicable requirements of UL Std. 969, "Marking and Labeling Systems", pertaining to electrical identification systems.

B. Comply with applicable requirements of NEMA Std. No's WC-1 and WC-2 pertaining to identification of power and control conductors.

PART 2 - PRODUCTS

2.01 GENERAL

A. Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for an application, selection is Installer's option, but provide single selection for each application.

2.02 CONDUIT MARKERS

A. Conduit tags shall be 1-1/2-inch diameter, round, aluminum tags, laser engraved or standard engraving with the conduit number. Punched or stamped lettering is not allowed. Font shall be 1/4-inch Arial or Helvetica. The conduit tags shall be manufactured by Brady, Catalog No. 49900 or equal.

B. Each tag shall be attached with nylon-coated 48-mil stainless steel wire and fasteners, as manufactured by Brady, Catalog No. 38091, and brass wire clamps, double ferrule design, as manufactured by Brady Catalog No. 38090 to secure the stainless steel wire or equal.

C. Unless otherwise indicated or required by governing regulations, provide white markers with black letters.

2.03 CABLE AND CONDUCTOR WIRE MARKERS

A. Cable and conductor wire markers shall be self laminating vinyl on white background, printed using a Brady TLS2200 printer, Seton printer, or equal. Handwritten wire markers are not acceptable.

2.04 SELF-ADHESIVE PLASTIC SIGNS

A. Provide manufacturer's standard, self-adhesive or pressure-sensitive, pre-printed, flexible vinyl signs for operational instructions or warnings; of sizes suitable for application areas and adequate for visibility, with proper wording for each application, e.g., 208V, EXHAUST FAN, RECTIFIER.

B. Unless otherwise indicated or required by governing regulations, provide white signs with black lettering.

2.05 LETTERING AND GRAPHICS

A. Coordinate names, abbreviations and other designations used in electrical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of electrical systems and equipment. Comply with ANSI A13.1 pertaining to minimum sizes for letters and numbers.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install electrical identification products as indicated, in accordance with manufacturer's written instructions, and requirements of NEC.

B. Where identification is to be applied to surfaces that require finish, install identification after completion of painting.

C. Comply with governing regulations and requests of governing authorities for identification of electrical work.

3.02 CONDUIT IDENTIFICATION

A. Where electrical conduit is exposed in spaces with exposed mechanical piping that is identified by a color-coded method, apply color-coded identification on electrical conduit in manner similar to piping identification. Except as otherwise indicated, use white as coded color for conduit.

3.03 CABLE/CONDUCTOR IDENTIFICATION

A. Apply cable/conductor identification, including voltage, phase and feeder number, on each cable/conductor in each box/enclosure/cabinet where wires of more than one circuit or communication/signal system are present, except where another form of identification (such as color-coded conductors) is provided. Match identification with marking system used in panelboards, shop drawings, contract documents, and similar previously established identification for project's electrical work.

3.04 EQUIPMENT/SYSTEM IDENTIFICATION

A. Install engraved plastic-laminate sign on each major unit of electrical equipment in building; including central or master unit of each electrical system including communication-control-signal systems, unless unit is specified with its own self-explanatory identification or signal system. Except as otherwise indicated, provide single line of text, 1/2” high lettering on 1-1/2” high sign (2” high where 2 lines are required), white lettering in black field. Provide text matching terminology and numbering of the contract documents and shop drawings. Provide signs for each unit of the following categories of electrical work:

1. Panelboards, electrical cabinets and enclosures.

2. Access panel/doors to electrical facilities.

3. Major electrical switchgear.

B. Install signs at locations indicated or, where not otherwise indicated, at location for best convenience of viewing without interference with operation and maintenance of equipment. Secure to substrate with brass or stainless steel screws, except use adhesive where screws should not or cannot penetrate the substrate.

3.05 CIRCUIT IDENTIFICATION

A. The 3-phase wires shall be identified at the switchgear, panelboards and motor control centers as Phases A, B, and C. At 277/480V, Phase A shall be brown, Phase B shall be orange, and Phase C shall be yellow. The neutral shall be gray or white.

B. In addition to color coding all conductors, each conductor shall be identified in each pull box, manhole, panelboard, cable tray, or termination with circuit identification markers. This identification is applicable to all power, control, alarm, and instrumentation conductors and these markings shall be recorded on the Record Documents. Markers shall be slip-on PVC sleeve type as manufactured by Brady, Seton, or equal.

C. Markers for other cabling shall be B-292 vinyl as manufactured by Brady, Seton, or equal.

3.06 AUTOMATIC EQUIPMENT WARNING SIGNS

A. Permanent warning signs shall be mounted at all mechanical equipment that may be started automatically or from remote locations. Signs shall be in accordance with OSHA regulations and shall be suitable for exterior use. The warning signs shall be fastened with round head brass screws or bolts, located and mounted in a manner acceptable to the Engineer.

B. Warning signs shall be 7 inches high by 10 inches wide, colored yellow and black, on not less than 18 gauge vitreous enameling stock. Sign shall read:

CAUTION
THIS EQUIPMENT STARTS
AUTOMATICALLY
BY REMOTE CONTROL

3.07 HIGH VOLTAGE WARNING SIGNS

A. Permanent and conspicuous warning signs shall be mounted on all equipment, doorways to equipment rooms, pull boxes, manholes, where the voltage exceeds 600 volts.

B. Signs shall be in accordance with OSHA regulation and shall be suitable for exterior use. The warning signs shall be fastened with round head brass screws or bolts, located and mounted in a manner acceptable to the Engineer.

C. Signs shall be 7 inches high by 10 inches wide, colored red and white, on not less than 18 gauge vitreous enameling stock. Sign shall read:

WARNING
HIGH VOLTAGE
KEEP OUT

3.08 CONDUCTOR FASTENERS

A. Glue-on type conductor fasteners shall not be used in any panels, panelboards, switchboards, switchgear, motor control centers, or other enclosures containing electrical devices and/or conductors.

END OF SECTION

SECTION 26 05 83 - WIRING CONNECTIONS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section covers terminal blocks for control and other wiring.

1.02 SUBMITTALS

A. Products shall be submitted in accordance with Section 26 00 00, and elsewhere in the Contract Documents, prior to installation.

1.03 MANUFACTURERS

A. Terminal blocks shall be Entrelec, Phoenix Contact, Allen-Bradley, or equal.

B. Surge protection blocks shall be MTL, Phoenix Contact, Termatrab, or equal.

C. Power distribution blocks shall be Gould, Allen-Bradley Corporation, Marathon, Ilsco, or equal.

PART 2 - PRODUCTS

2.01 TERMINAL BLOCKS

A. Terminal blocks shall mount on standard DIN rail and be of the size required for conductors therein. A minimum of 25 percent spares shall be provided in each terminal box. No more than 2 conductors shall be allowed per termination. Jumper bar assemblies shall be installed for interconnecting terminal blocks, distributing power and signal commons. Terminal blocks shall be U.L. rated for 600 Volts, and 30 Amps, minimum.

B. Grounding terminal blocks shall be provided for instrumentation cable shields. The terminal blocks shall have distinctive 2-color bodies, and shall be mounted to the DIN rail with metal screw down type clamps, providing a positive ground connection. One grounding terminal block shall be installed for every 2 instrument cables terminated. Grounding terminal blocks shall be U.L. rated for 600 Volts, and 20 Amps, minimum.

C. Terminal blocks shall be available in a variety of colors, including red, green, blue, gray, black, yellow, and orange.

D. DIN mount fuse holders shall have blown fuse indicators for DC and AC circuits. Fuse holders shall be of the compression clamp type. Fuse holders shall be U.L. listed, and rated for 600 Volts. Fuse sizes shall not exceed the U.L. current rating for the fuse holders.

E. DIN rail shall be prepunched, zinc bichromate plated steel. Symmetrical DIN rail shall be 35mmX7.5mm, minimum.

F. Terminal blocks for 4 to 20 milliamp signals shall have knife disconnect switches, and accessible test points for testing and measurement of current loop signals, without the need for removing wire terminations.

2.02 SURGE PROTECTION BLOCKS (SPB)

A. Analog inputs and outputs shall be terminated at surge protection blocks (SPB). The SPBs shall be designed for a working voltage of 32 volts, and shall be fused.

B. SPBs shall provide full hybrid line to line protection, and shall have a GDT rating of 10,000 A (8/20µs pulse waveform).

C. SPBs shall be UL94 V-2 listed.

2.03 POWER DISTRIBUTION BLOCKS (PDB)

A. PDBs shall be Electro-tin plated and manufactured from high strength 6061-T6 aluminum alloy.

B. PDBs shall be UL Recognized rated 90º C and CSA Certified.

C. PDBs shall provide flexibility in using the connector as an in line splice or to reduce conductor size.

D. PDBs shall be rated for 600 Volts and dual rated for Copper and Aluminum Conductor.

E. PDBs shall have the sizes and ratings as shown on the Drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Each terminal block and fuse holder shall be identified with the circuit number, or conductor number, corresponding to the identification appearing on the shop Drawings for the equipment, or system.

B. Terminal block and fuse holder markers shall be computer printed plastic-type, with permanent markings.

C. End clamps and end sections shall be installed on each terminal block and fuse holder assembly.

D. Terminal blocks for DC voltages shall be blue, and AC voltages shall be gray.

END OF SECTION

SECTION 26 09 16 - ELECTRICAL CONTROLS AND RELAYS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This Section includes the following:

1. Pushbutton and Selector Switches
2. Relays
3. Alarms
4. Intrinsic Safety Barriers
5. Wireways
6. Watthour Transducers
7. Elapsed Time Meters and Time Clocks

1.02 RELATED SECTIONS

A. Section 26 00 00 - General Electrical Requirements

B. Section 26 27 16 – Electrical Cabinets and Enclosures

1.03 REFERENCES

A. NEMA ICS 1 - General Standards for Industrial Control Systems.

B. NEMA ICS 2 - Standards for Industrial Control Devices, Controllers and Assemblies.

C. NEMA ICS 6 - Enclosures for Industrial Controls and Systems.

D. NEMA ST 1 - Standard for Specialty Transformers (Except General purpose Type).

1.04 SUBMITTALS

A. Data - a complete list of equipment and material including manufacturer's descriptive data and technical literature, performance charts, catalog cuts and installation instructions, spare parts data for each different item of equipment specified. The data shall include a complete Bill of Materials.

B. Drawings - containing complete wiring and schematic diagrams, control diagrams, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout, anchorage, support and appurtenances of equipment and equipment relationship to other parts of the work including clearances for maintenance and operations.

C. Submit shop drawings in accordance with the Contract Documents, and NEMA ICS 1 specifications indicating control panel layouts, wiring connections and diagrams, dimensions, support points.

1.05 PROJECT RECORD DOCUMENTS

A. Submit record documents in accordance with the Contract Documents.

B. Accurately record actual locations of control equipment. Revise diagrams included in Drawings to reflect actual control device connections.

1.06 OPERATION AND MAINTENANCE DATA

A. Submit operation data in accordance with the Contract Documents.

B. Include instructions for adjusting and resetting time delay relays, timers, and counters.

C. Submit maintenance data in accordance with the Contract Documents.

D. Include recommended preventative maintenance procedures and materials.

PART 2 - PRODUCTS

2.01 PUSHBUTTONS AND SELECTOR SWITCHES

A. Pushbuttons, pilot lights and selector switches shall be of the full size, heavy-duty industrial, oil tight, 120 volt, with interchangeable pilot lights, plug-in construction, double break silver contacts, chrome plated lock rings, with modular contacts, and NEMA rating equal to that of the enclosure on which devices are installed. All components shall be flush mounted on front of panel, unless otherwise noted.

B. Provide individual legend plates for indication of switch, pushbutton, and light function (e.g., Open, Closed, Hand-Off-Auto). A list shall be submitted for review and approval.

C. Pilot lights shall be high intensity LED type. Pilot lights shall have clear lenses and LED lamps colored as shown on the Drawings. Common, remote push-to-test circuitry shall be provided for each control panel to simultaneously test all indicating lights on the panel using a single pushbutton when there are 10 or more lights on the panel. Control panels with less than 10 lights shall utilize individual push-to-test lights and control circuitry.

D. Pushbuttons shall be maintained or momentary as required and as shown on the Drawings. Provide extended head pushbutton for all stop functions, mushroom head for emergency stop functions, and flush head pushbuttons for all other functions. Where indicated on the Drawings pushbuttons shall be illuminated type. Provide locking mechanism for all lock out functions. Selector switches shall have black knob operator, be maintained contact type unless noted otherwise, number and arrangement as required to perform intended functions specified but not less than one double pole, double throw, double break contact per switch. Contact rating shall be compatible with AC or DC throughput current of devices simultaneously operated by the switch contact but not less than 10 amperes resistive at 120 volts AC or DC continuous.

E. Potentiometers shall be provided with operators and resistive elements of the type and quantity indicated on the Drawings and as required with legend plates indicating percent of span.

F. The above devices shall be manufactured by Square D, Allen Bradley, General Electric, or equal.

2.02 RELAYS

A. TIMING RELAYS shall be heavy duty, have 250V/5A rated contacts, solid state design, poles as required per application, -10°C to +60°C, have timing repeatability of ±2.0% of setting, and be UL listed. The range shall be determined from the control descriptions and or schematic drawings. Provide mounting accessories, as required. The timing relays shall be manufactured by Allen Bradley, Schneider Square D, Eaton Cutler Hammer, or equal.

B. CONTROL RELAYS shall be of the plug-in socket base type with dust-proof plastic enclosures, with silver-cadmium oxide contacts rated 250-volt, 10 amperes, with contact arrangement and operating coils of the proper voltage as required by the control circuit sequence. Relays shall have indicating lamp to show energized state. Each relay shall have a minimum of two double pole, double throw contacts, or as required. Control relays shall be Allen Bradley, Schneider Square D, Eaton Cutler Hammer, or equal.

C. ALTERNATING RELAYS shall be UL listed, 120 VAC, with contacts rated for 10 amperes at 250 VAC, life expectancy of 100,000 operations, load indicating LEDs, and switch for load locking and load selecting options. Alternating relays shall be manufactured by TimeMark models 261, 271, and 471, Diversified Electronics model ARA, A.T.C. model “AR”, or equal.

2.03 ALARMS

A. AUDIBLE ALARMS shall be UL listed, 120 VAC, with solid state circuitry, vibrating horn, non-metallic corrosion resistant housing, with required mounting hardware, suitable for outdoor use capable of producing 100 dB at 10 feet. The audible alarm shall be manufactured by Federal Signal model 350, Edwards model 870-EX, or equal.

B. ROTATING BEACONS for interior and/or exterior locations shall be UL listed, 120 VAC, with motor and cooling fan, rotating lights at 60 times per minute minimum, capable of producing 36000 candlepower with required mounting hardware. Lens color shall be verified at the time of construction. The rotating beacons shall be manufactured by Federal Signal model 371L or equal.

C. ROTATING BEACONS for corrosive and/or hazardous locations shall be UL listed, 120 VAC, with solid state circuitry, rotating lights at 60 times per minute minimum, suitable for outdoor use capable of producing 36000 candlepower with required mounting hardware. Lens color shall be verified at the time of construction. The rotating beacons shall be manufactured by Edwards model 52EX or equal.

D. STROBE BEACONS shall be UL listed, NEMA 4X, 120 VAC, flashing at 80 times per minute minimum, producing peak candlepower of 520,000, effective candlepower of 165, with required mounting hardware. Lens color shall be verified at the time of construction. The rotating beacons shall be manufactured by Federal Signal model 151XST, Edwards model 92EX, or equal.

2.04 INTRINSIC SAFETY BARRIERS

A. INTRINSIC SAFETY BARRIERS shall permit connection of devices located in a hazardous area to other devices located in a safe area. Intrinsic safety barriers shall be EMC compliant, 10 to 35 V dc, 35 mA output current, hazardous area terminals identified by blue labels, terminals accommodating conductors up to 12 AWG, ambient temperature rating of –20 to +60°C. The intrinsic safety barriers shall be manufactured by MTL Inc., Ronan Engineering Co., R. Stahl Inc., A.T.C., or equal.

2.05 WIREWAYS

A. WIREWAYS shall be PVC, snap-in slot design, with non-slip cover. Safe area wireways shall be light gray and marked "Safe Area Wiring." Hazardous area wireways shall be intrinsic blue and marked "Hazardous Area Wiring." The wireways shall be manufactured by Panduit Corporation, or equal.

2.06 WATTHOUR TRANSDUCERS

A. WATTHOUR TRANSDUCERS for active or reactive power shall be DIN rail and surface mount, single phase or three phase with balanced or unbalanced load, electrically isolated input and output signals, 4 to 20 mA output signal, 0-10 mA to 0-10 A input current, 0-10 V to 0-600 VAC input voltage, 16-500 Hz selectable frequency. The watthour transducers shall be manufactured by Sineax model PQ502, or equal.

2.07 ELAPSED TIME METERS AND TIME CLOCKS

A. ELAPSED TIME METERS shall be self powered, non-reset, solid state counter which provides silent, accurate and noise immune operation. Elapsed time meters shall require no external power, five-year minimum battery life, 120 VAC power, accessories for panel mounting, nameplate below LCD display reading "HOURS", liquid crystal display with 6 digits approximately 2 inches high with 50,000 hour minimum display life and indication of sufficient battery power. The elapsed time meters shall be manufactured by Durant, Automatic Timing and Controls a Division of Sycon Corp., or equal.

B. TIME CLOCKS shall be microprocessor based, have 24-hour time control, up to 24 operations per day, programmable from panel face keys, skip-a-day feature allowing schedule to be skipped for one to seven days, SPDT switch contact rated at 15 amps at 120 V AC, with battery carryover to maintain time and program during power outage for 275 hours. The time clocks shall be manufactured by Tork, Paragon Electric Company, or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Fasteners shall be type 304 stainless steel.

B. Install devices in strict accordance with NEC requirements and per manufacturers recommendation.

C. Coordinate with other trades as necessary during installation of these devices.

3.02 ACCEPTANCE

A. All installations are subject to evaluation in accordance with NEC requirements and manufacturers recommendations. Contractor shall remove the unacceptable work and correct work at no charge to Owner.

END OF SECTION

SECTION 26 22 11 – DRY TYPE, LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section covers dry type transformers used for low voltage, single and three phase, power distribution and lighting.

1.02 SUBMITTALS

A. Products shall be submitted in accordance with **Section 26 00 00**, and elsewhere in the Contract Documents, prior to installation.

1.03 QUALITY ASSURANCE

A. ANSI C57.12.01, dry-type transformers

B. ANSI C89.2, dry-type transformers

C. NEMA ST-20, dry-type transformers

D. UL-506, specialty transformers

PART 2 - PRODUCTS

2.01 DISTRIBUTION - LOW VOLTAGE LIGHTING AND POWER

A. Transformers shall be premium high efficiency quiet type and shall be installed where indicated on the Plans. The primary winding of the transformers shall have two 2-1/2 percent taps above, and below normal.

B. The transformers shall have a BIL of 10 KV with a temperature class of 185 degrees C for transformers up to 25 KVA, and a temperature class of 220 degrees C for larger transformers.

C. The sound level shall not exceed 44 dBa measured at 5 feet from the transformer after installation. Core and coil assemblies 30 KVA and larger, shall be mounted on rubber vibration isolators, designed to reduce harmonics generated noise.

D. Transformers shall be types manufactured by Schneider Square D.

2.02 FERRO RESONANT ISOLATION TRANSFORMERS

A. Ferro resonant isolation transformers shall be provided where indicated on the Plans. Regulation shall be +3 percent for an input range of +10 percent. Common mode noise rejection shall be better than 120 dB with transverse mode noise rejection better than 60 dB. Voltage spike attenuation shall be better than 250:1.

B. Isolation transformers shall be as manufactured by Shape Magnetronics, Control Concepts, Inc., or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Transformers shall be installed as indicated on the Plans, and in accordance with the manufacturer’s instructions and recommendations. Contractor shall provide painted metal wall brackets, when required.

B. Grounding shall be provided per NEC, and **Section 26 05 26**.

END OF SECTION

SECTION 26 24 13 – SWITCHBOARDS

PART 1 - GENERAL

1.01 SCOPE

A. The Contractor shall furnish and install, where indicated, a free-standing, dead-front type low-voltage distribution switchboard, utilizing group mounted circuit protective devices as specified herein, and as shown on the contract drawings.

1.02 RELATED SECTIONS

A. Section 26 62 53 - Service Entrance Station

B. Section 26 28 16 - Enclosed Switches and Circuit Breakers

1.03 REFERENCES

A. The low-voltage distribution switchboards and all components shall be designed, manufactured and tested in accordance with the latest applicable following standards:

1. NEMA PB-2
2. UL Standard 891.

1.04 SUBMITTALS

A. The following information shall be submitted to the Engineer for review:

1. Master drawing index
2. Front view elevation
3. Floor plan
4. Top view
5. Single line
6. Schematic diagram
7. Nameplate schedule
8. Component list
9. Conduit entry/exit locations
10. Assembly ratings including:
    a. Short-circuit rating
    b. Voltage
    c. Continuous current
11. Major component ratings including:
    a. Voltage

b. Continuous current

c. Interrupting ratings

12. Cable terminal sizes.

13. Busway connection

14. Connection details between close-coupled assemblies

15. Composite floor plan of close-coupled assemblies

16. Key interlock scheme drawing and sequence of operations.

B. Submit copies of the following information for record purposes:

1. Final as-built drawings and information for items listed in section 1.04, A

2. Wiring diagrams

3. Certified production test reports

4. Installation information

5. Seismic certification and equipment anchorage details.

1.05 QUALIFICATIONS

A. The manufacturer of the assembly shall be the manufacturer of the circuit protective devices within the assembly.

B. For the equipment specified herein, the manufacturer shall be ISO 9000, 9001 or 9002 certified.

C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

1.06 REGULATORY REQUIREMENTS

A. The low-voltage switchboard shall be UL labeled.

1.07 DELIVERY, STORAGE AND HANDLING

A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

1.08 OPERATION AND MAINTENANCE MANUALS

A. Provide Operation and Maintenance manuals as specified in **Sections 01 78 23 and 26 00 00**.

B. Operation and maintenance manuals shall include the following information:

1. Instruction books and/or leaflets

2. Recommended renewal parts list

3. Drawings and information required by section 1.04.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Schneider Square D.

2.02 RATINGS

A. The assembly shall be rated to withstand mechanical forces exerted during short-circuit conditions when connected directly to a power source having available fault current of 65,000 amperes symmetrical at rated voltage. Rating should be 65,000 unless otherwise noted on the drawings.

B. Voltage rating to be as indicated on the drawings.

2.03 CONSTRUCTION

A. Switchboard shall consist of the required number of vertical sections bolted together to form a rigid assembly. The sides and rear shall be covered with removable bolt-on covers. All edges of front covers or hinged front panels shall be formed. Provide adequate ventilation within the enclosure.

B. All sections of the switchboard shall be rear aligned with depth as shown on the drawings. All protective devices shall be group mounted. Devices shall be front removable and load connections front accessible enabling switchboard to be mounted against a wall.

C. The assembly shall be provided with adequate lifting means.

D. The switchboard shall be UL listed.

2.04 BUS

A. All bus bars shall be silver-plated copper. Main horizontal bus bars shall be mounted with all three phases arranged in the same vertical plane. Bus sizing shall be based on NEMA current density of 1000A per square inch.

B. Provide a full capacity neutral bus where a neutral bus is indicated on the drawings.

C. A copper ground bus (minimum 1/4 x 2 inch), shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchboard.

D. All hardware used on conductors shall be high-tensile strength and zinc-plated. All bus joints shall be provided with conical spring-type washers.

2.05 WIRING/TERMINATIONS

A. Small wiring, necessary fuse blocks and terminal blocks within the switchboard shall be furnished as required. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.

B. Mechanical-type terminals shall be provided for all line and load terminations suitable for copper or aluminum cable rated for 75 degrees C of the size as indicated on the drawings.

C. Lugs shall be provided in the incoming line section for connection of the main grounding conductor. Additional lugs for connection of other grounding conductors shall be provided as indicated on the drawings.

D. All control wire shall be type SIS, bundled and secured with nylon ties. Insulated locking spade terminals shall be provided for all control connections, except where saddle type terminals are provided integral to a device. All current transformer secondary leads shall first be connected to conveniently accessible short-circuit terminal blocks before connecting to any other device. All groups of control wires leaving the switchboard shall be provided with terminals blocks with suitable numbering strips. Provide wire markers at each end of all control wiring.

2.06 MOLDED CASE PROTECTIVE DEVICES

A. Main, tie, and feeder protective devices shall be molded case circuit breakers with inverse time and instantaneous tripping characteristics and shall have ground fault protection where indicated or as required by NEC.

B. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make/quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. Contacts shall be non-welding silver alloy, and arc extinction shall be accomplished by means of DE-ION arc chutes. A push-to-trip button on the front of the circuit breaker shall provide a local manual means to exercise the trip mechanism.

C. Circuit breakers shall have a minimum symmetrical interrupting capacity as indicated on the drawings.

D. Where indicated circuit breakers shall be UL listed for series application.

E. Where indicated circuit breakers shall be current limiting.

F. Circuit breakers 400 ampere frame and below shall be thermal-magnetic trip units and inverse time-current characteristics.

G. Circuit breakers 600 ampere through 1200-ampere frame shall be microprocessor-based with RMS sensing trip units.

2.07 ACCESSORIES

A. Provide shunt trips, bell alarms and auxiliary switches as shown on the Plans.

B. Circuit Breaker Energy Monitoring

C. Provide transient voltage surge suppression as specified in **Section 16480**.

2.08 MISCELLANEOUS DEVICES

A. Control power transformers with primary and secondary protection shall be provided, as indicated on the drawings, or as required for proper operation of the equipment.

B. Each section of the switchboard shall be provided with a space heater thermostatically controlled. Power for the space heaters shall be obtained from a control power transformer within the switchboard. Supply voltage shall be 120 volts AC.

2.09 CUSTOMER METERING

A. Where indicated on the Plans, provide a separate customer metering compartment with front hinged door and include the following:

B. Current transformers for each meter. Current transformers shall be wired to shorting-type terminal blocks.

2.10 ENCLOSURES

A. Outdoor NEMA 3R Enclosure

1. Outdoor enclosure shall be non-walk-in and meet applicable NEMA 3R UL requirements.
2. Enclosure shall have sloping roof downward toward rear.
3. Outer sections shall be the same widths as indoor structures, except each end of the outdoor assembly shall have an end trim.
4. The enclosure shall be provided with bolt-on rear covers for each section.
5. Doors shall have provisions for padlocking.
6. Ventilating openings shall be provided complete with replaceable fiber glass air filters.
7. Provide space heaters thermostatically controlled for each structure with adequate wattage to prevent the accumulation of moisture.
8. Power for space heaters, shall be obtained from a control power transformer within the switchboard.

2.11 NAMEPLATES

A. Engraved nameplates, mounted on the face of the assembly, shall be furnished for all main and feeder circuits as indicated on the drawings. Nameplates shall be laminated plastic, black characters on white background. Characters shall be 3/16-inch high, minimum. Nameplates shall give item designation and circuit number as well as frame ampere size and appropriate trip rating. Furnish master nameplate giving switchboard designation, voltage ampere rating, short-circuit rating, manufacturer's name, general order number, and item number.

B. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.

2.12 FINISH

A. All exterior and interior steel surfaces of the switchboard shall be properly cleaned and provided with a rust-inhibiting phosphatized coating. Color and finish of the switchboard shall be ANSI 61 light gray.

PART 3 - EXECUTION

3.01 FACTORY TESTING

A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards.

1. The switchboard shall be completely assembled, wired, adjusted, and tested at the factory. After assembly, the complete switchboard will be tested for operation under simulated service conditions to assure the accuracy of the wiring and the functioning of all equipment. The main circuits shall be given a dielectric test of 2200 volts for one (1) minute between live parts and ground, and between opposite polarities. The wiring and control circuits shall be given a dielectric test of 1500 volts for one (1) minute between live parts and ground.

2. The manufacturer shall provide certified copies of factory test reports.

3.02 INSTALLATION

A. The Contractor shall install all equipment per the manufacturer's instructions, Contract Documents, and National Electrical Code.

B. The assembly shall be provided with adequate lifting means and shall be capable of being moved into installation position and bolted directly to the floor without the use of floor sills provided the floor is level to 1/8 inch per 3-foot distance in any direction. All necessary hardware to secure the assembly in place shall be provided by the Contractor.

3.03 FIELD ADJUSTMENTS

A. The Contractor shall perform field adjustments of the protective devices as required to place the equipment in final operating condition. The settings shall be in accordance with the approved short-circuit study, protective device evaluation study and protective device coordination study.

B. Necessary field settings of devices and adjustments and minor modifications to equipment to accomplish conformance with an approved short circuit and protective device coordination study shall be carried out by the Contractor at no additional cost to the owner.

3.04 MANUFACTURER'S CERTIFICATION

A. A certified test report of all standard production tests shall be available to the Engineer upon request.

3.05 TRAINING

A. The Contractor shall provide a training session for up to 6 Owner's representatives for 1 normal work days at a jobsite location determined by the Owner.

B. The training session shall be conducted by a manufacturer's qualified representative. The training program shall consist of instruction on operation of the assembly, circuit breakers, fused switches, and major components within the assembly.

END OF SECTION

SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Panelboards furnished in accordance with the Plans and this specification.

1. Service entrance rated main distribution panelboards.
2. Distribution panelboards.
3. Lighting and appliance branch circuit panelboards.
4. Electronic Power Metering on panelboards per Section 2.05, when specified.

1.02 RELATED SECTIONS

A. Section 26 00 00 – General Electrical Requirements

B. Section 26 05 53 – Identification for Electrical Systems

1.03 CODES, STANDARDS, AND REGULATORY REQUIREMENTS

A. All parts, materials, assembly, installation, testing and commissioning shall meet the requirements of the latest edition of the following Codes and Standards, and Regulatory agencies. In case of the conflict between the codes' requirement, the most stringent shall apply.

1. Underwriters' Laboratories:
   a. Panelboards: UL 67
   b. Enclosures for Electrical Equipment: UL 50
   c. Molded Case Circuit breakers and Circuit Breaker Enclosures: UL489
2. FS W-C-375 - Circuit Breakers, Molded Case, Branch Circuit and Service.
3. FS W-P-115 - Power Distribution Panel.
4. NEMA AB 1 - Molded Case Circuit Breakers.
5. NEMA PB 1 - Panelboards.
6. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
7. NEMA PB 1.2 - Application Guide for Ground-fault Protective Devices for Equipment.
8. NFPA 70 - National Electrical Code.
9. UBC - Uniform Building Code.
10. NETA - International Electrical Testing Association.

1.04 SUBMITTALS

A. Shop drawings for equipment and component devices.

B. Include outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker arrangement, sizes and numbering system.

C. Include information on all the accessories, locking hardware, shunt trip, under-voltage release mechanism, typical thermal magnetic curves for each size and type.

1.05 SPARE PARTS

A. Keys: Furnish two door keys for each panelboard.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Schneider Square D

2.02 BUS AND HARDWARE

A. Panelboards shall be completely factory assembled and equipped with the type, size and number of branch circuit breakers, arranged and numbered as shown on the Plans. Panelboards shall be fully rated. Series rated panelboards are not acceptable.

B. All multi-pole breakers shall be common trip. Branch circuits shall be arranged using double row construction. Bus sequence shall be ABC top to bottom, left to right for both top and bottom fed panels. Provisions or space for future breakers shall be located at the bottom of the panel and be fully bussed, complete with all necessary mounting hardware. Use at least 100 ampere breaker-connecting bus straps and mounting hardware.

C. Where SPARE is indicated on the panel schedule(s), the specified circuit breaker and at least 100 ampere branch-circuit busing and mounting hardware shall be installed.

D. Where SPACE is indicated on the panel schedule(s), 100 ampere branch-circuit busing and mounting hardware shall be installed, ready for future installation of circuit breakers, furnished by others. At least 20% spare pole spaces, grouped in multiples of three, shall be provided in each panelboard, for future installation by the Owner. Provide single pole filler plates in the spaces, as required.

E. A nameplate shall be provided and located near the top of the front trim on the exterior surface, listing panel type and ratings, as required by UL. Each circuit shall be permanently numbered to agree with the panel schedule, using plastic or metal buttons mounted adjacent to the breaker and secured by rivets or grommets with an engraved or depressed number. Adhesive numbering tape, painted numbers, or use of more than one number per breaker is not acceptable.

F. Main vertical bus bars shall be copper and silver or tin plated per UL requirements. Bus bars shall be supported by glass-filled polyester-type insulators. All bolts, used to connect current-carrying parts together, shall be accessible for tightening from the front of the panel. Bus bars shall be factory drilled and tapped with spacing arranged to permit breaker interchange, from the front, while the panel is energized.

G. Neutral bus shall be copper and insulated from the cabinet and all other parts. It shall be rigidly mounted in the panel and shall be provided with a solderless cable connector for each circuit breaker and each space in the panelboard and the main connecting lug(s).

H. A 1/4-inch (8mm) thick copper equipment ground bus, of sufficient width and length, shall be solidly bolted and grounded to the enclosure at the bottom and shall leave clear space for the bottom cable entries. The bus shall be drilled and tapped for 1/4" (8mm) - #20 machine screws in number to agree with branch circuits and spaces. A solderless connector, for No. 2 to No. 4/0 cable size, shall be bolted to the ground bus.

I. Copper bus bars shall be of sufficient size to provide a current density of not more than 1000 amperes per square inch of cross section, and not more than 200 amperes per square inch at bolted connections.

J. Minimum Short Circuit Rating for Bus Bracing: The bus shall be braced for the minimum symmetrical short circuit rating of the panel, as shown on the panel schedule.

K. Provide main bus pressure connectors (main lugs) and separately supported sub-feed pressure connectors (lug landings) where noted. Provide additional bottom raceway space to accommodate pressure connectors and lug landings. In no instance shall the gutter space be less than required by NFPA-70.

L. Provide Transient Voltage Surge Suppression where required on Plans.

M. Where required on Plans, provide re-installed locking devices for locking each circuit breaker in the OPEN position, by means of a padlock. Locking devices shall not be removable from the front of the panel with the trim in place. Attachment of the locking device to the panel with adhesives is not acceptable.

2.03 CIRCUIT BREAKERS

A. Molded Case Circuit Breakers: NEMA AB 1; provide bolt-on type circuit breakers with integral thermal and instantaneous magnetic trip in each pole and common trip handle for all poles. Provide circuit breakers, UL listed as Type HACR, for air conditioning equipment branch circuits. Provide circuit breakers, UL listed as Type SWD, for lighting circuits. Provide UL Class A ground fault interrupter circuit breakers where shown on Plans.

B. Instantaneous magnetic trips shall be accessible and adjustable from the front of the breaker on frame sizes above 100 amperes.

C. All breakers shall be rigidly mounted, separately removable and independent of trim plates for their support. Breakers shall be bolt on type.

D. The minimum width of one pole shall be 1-3/8 inches. The breaker shall be "E" frame minimum.

E. The minimum symmetrical interrupting rating for molded-case circuit breakers shall be as specified on the panel schedule(s). Series rated breakers are not acceptable.

2.04 CABINETS (BOXES)

A. All details of construction and methods of assembly shall meet the requirements of the "Enclosures for Electrical Equipment" of the Underwriters' Laboratories. The panel box shall not be less than 20" wide, 4.5" deep and of sufficient height to enclose the specified main and branch circuit breakers, buses, metering equipment and wire gutter. The panelboard enclosure shall be fabricated from code-gauge galvanized or galvanized-annealed steel without knockouts and with full front flange. The panel front shall be as shown on the plans and fabricated from cold rolled steel. Surface mounted panel boxes shall be finished with an ANSI-61 light grey baked enamel. There shall be no screws projecting into the wiring raceways. The panelboard enclosure type shall be coordinated with the environment and location shown on the plans.

B. The front trim shall have full-length hinged outer door designed to expose the wiring raceways and breakers, when open. Another, inner hinged door shall expose breakers only, when open, making this a door-in-door construction. Both doors shall open to the right.

C. Both doors shall be provided with concealed butt or piano hinges. A suitable latch, which can be operated without tools, shall be provided to properly hold the inner door closed. For doors 30 inches (765mm) high or less, a flush-type latch is satisfactory. For doors more than 30 inches (765) high, a vault-type handle shall be provided with a three-point latch that holds the door closed at the top and bottom. The outer door shall be secured with at least four (4) captured oval head machine screws.

D. A sturdy metal frame, with a clear plastic cover, for an 8-1/2 inch x 11 inch panel schedule, shall be attached inside of the panel door with the RTV adhesive.

E. Panel trim and doors, and surface mounted cabinets shall be thoroughly cleaned, given a rust-inhibiting treatment, and finished with an ANSI-61 light grey baked enamel.

F. All panelboards shall bear the Underwriters' Laboratories label.

2.05 ELECTRONIC POWER METERING

A. The panelboard shall be provided with the electronic power metering, where shown on Plans

1. A digital electronic power shall be used. The meter shall measure the real-time RMS values of the phase currents (Ampere), Ampere demand, phase and line voltages (Volts), KW, KW demand, KWHR, KVA, KVA demand, KVAR, KVAR demand, power factor, and frequency.
2. A communications module shall be provided using an industry standard RS-232 or RS-485 serial bus. Modbus RTU shall be the protocol.
3. The electronic power meter shall have non-volatile memory to record at least 100 time-stamped alarms and events.
4. All potential, control power and current transformers shall be completely installed and wired to the power meter in the panelboard.
5. The electronic power meter shall be Multilin PQM, Siemens Model 4700 Power Meter, Power Measurement Ltd. Model 3710 ACM, or approved equal.

2.06 EXCEPTIONS

A. The bidders shall list all the exceptions taken from the specification with their quote. If no exceptions are listed with the bid, it is understood that the bidder shall meet all the requirements of this specification and applicable Codes and Standards.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install panelboards plumb and flush with wall finishes, in conformance with NEMA PB 1.1. Where surface mounted, provide suitable supports and rack all branch circuit conduits. Where mounted on concrete wall, install with ½" (15mm) steel spacers behind the panel. All mounting attachments and connections shall be designed in conformance with the minimum lateral seismic force of 0.5g per the most current adopted version of the UBC.

B. Height: Install top of trim 78 inches above finished floor, unless otherwise noted on drawings.

C. Provide filler plates for unused spaces in panelboards.

D. Provide typed or neatly hand printed 8-1/2x11-inch circuit directory for each panelboard, in the format as shown on the drawings. Revise directory to reflect circuiting changes required to balance phase loads.

3.02 QUALITY CONTROL

A. Owner reserves the right to witness any of the following tests conducted by the contractor and shall be notified in advance of these tests. Test in accordance with Specification 26 01 27 – ELECTRICAL ACCEPTANCE TESTING.

B. Measure steady state load currents at each panelboard feeder. Should the difference at any panelboard between phases exceed 20 percent, rearrange circuits in the panelboard to balance the phase loads within 20 percent. Maintain proper phasing for multi-wire branch circuits.

3.03 FINAL SUBMITTALS

A. After completion of the installation, wiring and testing, submit the following information within two weeks of the equipment acceptance.

1. As-Built Panel Schedules.
2. Copy of the certified test report described in Section 3.02.

END OF SECTION

SECTION 26 24 19 – MOTOR CONTROL CENTERS (MCC)

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish and install, ready to use, motor control centers for use as indicated on the Plans and specified herein.

B. Circuit breaker ratings, and modifications, shall be as indicated on the Plans.

C. MCP ratings, and modification, shall be as indicated on the Plans.

1.02 SUBMITTALS

A. The motor control centers shall meet the requirements of the latest edition of Standards for Industrial Control No. ICS published by the National Electrical Manufacturers Association. The following minimum information and drawings shall be submitted for review:

1. Plan, front, side views and overall dimension of each motor control center.
2. Weight.
3. Internal wiring diagram of each plug-in unit.
4. Internal wiring diagram of the motor control centers.
5. External connection diagram showing the wiring to the external controls and devices associated with the motor control center.
6. A one-line and a schematic diagram for each motor control center.
7. Bill of material list and Manufacturer's Product Data.
8. Installation instructions.
9. Manufacturer's certification that the following items are capable of interrupting and/or withstanding the specified short circuit condition:
    a. Bus bar bracing
    b. Feeder tap units
    c. Starter units

B. Product information shall be submitted in accordance with **Section 26 00 00**, and elsewhere in the Contract Documents.

PART 2 - PRODUCTS

2.01 MOTOR CONTROL CENTERS (MCC)

A. The motor control center fabricator shall be the manufacturer of the major components therein, such as circuit breakers and starters. Engineered motor control centers shall be by the component and housing manufacturer. The manufacturer shall comply with equipment specifications contained elsewhere in these Contract Documents.

B. Each component, as well as the complete assembly, shall be constructed and tested in accordance with latest NEMA Standards for Industrial Control. The type of construction of the control centers shall be NEMA Class II, Type B. Lifting eyes shall be provided on each section to facilitate handling.

C. Unit doors shall be mounted on the stationary structure and hinged on the side away from the vertical wireway. They shall be held closed with slotted thumbscrews.

D. Unit doors shall have positive action linkage with disconnect operating mechanism. Mechanism shall be designed so that it can be locked in the OFF position with up to 3 padlocks. When the handle is not padlocked, it shall be possible to open the door by releasing the door interlock with a small tool. The control units shall be of the plug-in type. When doors are closed, the operating mechanism shall clearly indicate the ON or OFF position of the disconnect, and the door interlock mechanism shall engage. The disconnect operating mechanism shall be designed against inadvertent operation when the door is open. Each plug-in unit door shall be provided with a nameplate, specified elsewhere herein, that indicates the circuit number and circuit name. The nameplate shall be attached to the door with brass or stainless screws. Each motor starter door shall be provided with an externally operated manual reset pushbutton for the overload relay.

E. It shall be possible to install up to 6 NEMA size one units in one vertical section. Units shall be completely enclosed with sheet steel. A small wireway shall be provided inside the unit, so all wiring can be laid in place without removing barriers or plates. Each vertical section that holds the units shall be rigidly formed of minimum 12 gauge, cold-rolled sheet steel. The vertical front-of-board-construction shall be supplied with minimum 20-inch depth.

F. Continuous horizontal wiring troughs shall be provided at both top and bottom of each section. These troughs shall line up to form a continuous wireway for the full length of the MCC. A large continuous, full-height vertical wiring trough shall be provided in the right side of each section.

G. All starter wiring, control, and power shall be terminated in terminal strips in this trough for size 2 and smaller starters. Size 3 and larger starters shall have control leads terminating on the terminal strips in the trough. Terminal strips shall be split-type to facilitate wiring connections without disconnecting factory or field conductors. Terminal strips shall be rated to accept conductor sizes as indicated on the Plans.

H. Bus bars shall be silver plated copper, and shall be of the ampacity indicated on the Plans. Unit bus bar stabs shall insure high contact pressure. The vertical bus bars shall be effectively isolated from accidental contact by plastic insulating medium. Horizontal bus shall be silver-plated at every joint. The entire vertical bus shall be silver-plated copper.

I. Bus bar supports shall be of high impact strength, non-carbonizing insulating material mounted on padded steel brackets and shall provide adequate dielectric strength and creepage distance. The bus structure shall be capable of withstanding short circuit current in accordance with NEMA standards, and as indicated on the Plans.

J. Horizontal bus amperage rating shall be as indicated on the Plans.

K. Each section shall be equipped with horizontal ground bus that shall be continuous across the MCC.

L. The MCCs shall be supplied as indicated on the Plans, and as specified herein and in accordance with NEMA Standard Pub. IS 1.1, latest edition. The MCCs shall be enclosed in NEMA Type 1 gasketed industrial use enclosures, unless otherwise shown. NEMA 3R enclosures shall provide sufficient depth for air conditioning units to be mounted on the end of the structures. If the MCCs contain VFDs or Solid State Starters that require cooling, their respective sections shall be louvered top and bottom, and fans shall remove heat from within the sections.

M. All metal surfaces and structural parts shall be given a phosphatizing, or equal, treatment prior to painting. The control centers shall then be given a gun-metal gray undercoat which is equal to zinc chromate. The exterior of the enclosure shall be finished in standard ANSI Grey.

N. Spaces for future combination starters shall have all the hardware necessary so that a future plug-in control unit can be installed without having to modify the vertical sections. The number of spaces for future control units shall be as indicated on the Plans.

O. Devices, such as, but not limited to, starters, circuit breaker, relays, timers, conductors, shall conform to other sections of these Contract Documents.

P. Provide customer metering instruments, as indicated on the Plans. Unless otherwise indicated on the Plans, metering units shall be electronic, capable of displaying volts line-to-line and line-to-neutral, and amps per phase.

Q. Each section shall be equipped with horizontal neutral bus that shall be continuous across the MCC if the MCC is designated as 277/480 volt 4 wire.

R. MCCs shall be as manufactured by Schneider Square D.

PART 3 - EXECUTION

3.01 GENERAL

A. The MCCs shall be erected in accordance with the recommendations of the manufacturer and with the details specified herein.

B. Cables larger than No. 6 AWG, which hang from their vertical connections, shall be supported within 2 feet of the connection.

C. The motor overload relays shall be provided and sized based on the actual full load amperes of the motor connected to the starter.

D. The motor circuit protectors shall be adjusted to the lowest settings that do not cause false tripping.

3.02 FIELD TESTS

A. MCCs shall be tested in accordance with **Section 26 24 21**.

END OF SECTION

SECTION 26 27 16 - ELECTRICAL CABINETS AND ENCLOSURES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This specification includes enclosures to house electrical controls, instruments, terminal blocks, and serve as junction boxes where shown on the Drawings.

1.02 SUBMITTALS

A. Products shall be submitted in accordance with Section 26 00 00, and elsewhere in the Contract Documents, prior to installation.

1.03 MANUFACTURERS

A. Enclosures shall be manufactured by Hammond, Hoffman, Rittal, or equal.

PART 2 - PRODUCTS

2.01 STEEL

A. Enclosures shall be fabricated from 14 gauge steel with seams that are continuously welded. Doors shall have full length piano hinges with the door removable by pulling the hinge pin.

B. A rolled lip shall be provided around three sides of the door and around all sides of the enclosure opening. The gasket shall be attached with oil-resistant adhesive and held in place with steel retaining strips. Exterior hardware, such as clamps, screws, and hinge pins, shall be of stainless steel for outdoor installations. A hasp and staple shall be provided for padlocking. Each enclosure shall have a print pocket. All wires entering or leaving the enclosure shall terminate on terminal strips. All wires and terminals shall be clearly identified as specified elsewhere in these specifications.

C. Finish shall be white enamel interior, light gray enamel, ANSI 61 exterior, over phosphatized surfaces. Special finishes and colors shall be furnished for wet locations. Drawings should be checked for special conditions.

2.02 NEMA RATING

A. Unless otherwise indicated on the Drawings, enclosures shall be NEMA 12 for indoors, NEMA 4X for corrosive areas, and NEMA 4 for outdoor installations. NEMA 4X enclosures shall be stainless steel, unless noted otherwise. NEMA 4 enclosures shall also be used in wet or wash down areas.

2.03 FIBERGLASS

A. Where specified on drawings to be NEMA 4X non-metallic, enclosures shall be heavy-duty, compression molded, fiberglass reinforced polyester, high impact, heat resistant, NEMA 4X.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Enclosures shall be installed as indicated on the Drawings, and according to manufacturer's instructions.

B. Enclosures shall be properly grounded and shall include ground straps connected to hinged doors and accessories.

END OF SECTION

26 29 13: SOLID STATE MOTOR CONTROLLERS

PART 1: GENERAL

1.01 SUMMARY

A. This specification provides the requirements for a solid-state motor controller factory integrated with branch circuit protection, power circuit components, control components, and door mounted operator devices into an enclosure, herein referred to as SSS panel.

1.02 RELATED SECTIONS NA

1.03 REFERENCES

A. NFPA 70® – National Electric Code® (NEC®)

B. UL 50 – UL Standard for Safety for Enclosures for Electrical Equipment

C. UL 508A – UL Standard for Safety for Industrial Control Panels

D. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum)

1.04 SUBMITTALS

A. A submittal package shall be furnished to the Engineer for approval prior to factory assembly of the SSS. The submittal package shall consist of the following:

1. Elementary diagrams showing factory power and control wiring along with field wiring connections for line and load power connections and control wiring connections.

2. Outline diagrams showing the overall enclosure and mounting dimensions with front and side views and weights as a minimum. The outline drawings shall also include conduit entry/exit locations along with intended conduit sizes.

3. Voltage, horsepower, current rating, and product features will be furnished from standard catalog sheets.

1.05 INTALLATION, OPERATION AND MAINTENANCE DATA

A. Manufacturer shall provide a copy of installation, operation and maintenance procedures to owner.

B. Instruction manual shall include programming manuals, wiring diagrams, operating, and maintenance instructions.

1.06 QUALITY ASSURANCE

A. Manufacturer shall have specialized in the manufacture and assembly of low voltage control panels for 20 years.

B. Low voltage SSS shall be listed and/or classified by Underwriters Laboratories in accordance with standards listed in Article 1.03 of this specification.

C. All SSS shall be 100% factory tested to ensure proper performance.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Contractor shall store, protect, and handle products in accordance with recommended practices listed in manufacturer's Installation and Maintenance Manuals.

B. Contractor shall inspect and report concealed damage to carrier within 48 hours.

C. Contractor shall store in a clean, dry space. Cover with heavy canvas or plastic to keep out dirt, water, construction debris, and traffic. Heat enclosures to prevent condensation.

D. Contractor shall handle in accordance with manufacturer's recommendations to avoid damaging equipment, installed devices, and finish. [Lift only by installed lifting eyes.]

1.08 PROJECT CONDITIONS (SITE ENVIRONMENTAL CONDITIONS)

A. Follow (standards) service conditions before, during and after installation.

B. Equipment shall be located in well - ventilated areas, free from excess humidity, dust and dirt and away from hazardous materials. Indoor locations shall be protected to prevent moisture from entering enclosure.

C. The SSS panel shall be designed to operate in an ambient temperature range from 0°C to 40°C.

D. Storage temperatures shall be between -25°C to 65°C.

E. The SSS panel shall be suitable for operation at altitudes up to 3,280 feet without de-rating.

1.09 WARRANTY

A. The manufacturer warranty the materials and workmanship of the SSS to be free from defect for a period of twelve (12) months after start-up or eighteen (18) months after shipment, whichever occurs first.

1.10 FIELD MEASUREMENTS

A. Contractor shall make all necessary field measurements to verify that equipment shall fit in allocated space in full compliance with minimum required clearances specified in National Electrical Code.

PART 2: PRODUCT

2.01 MANUFACTURERS

A. General Electric products have been used as the basis of design for RVSS. Approved manufacturers listed below are allowed on condition of meeting the specified conditions including the available space for the equipment (including Code required working clearances).

1. Schneider Square D.

2.02 ELECTRICAL RATINGS

A. Provide equipment rated as indicated on drawings or as specified below.

B. Input voltage ratings shall be 460VAC +10% and –15%.

C. Input frequency shall be from 45Hz to 65Hz with Auto Tracking Frequency range.

D. The SSS panel will have a fault withstand rating that is based on customer supplied fusing / breaker for non-combination style devices.

E. The SSS panel output current ratings shall be capable of continuous operation at a minimum of 100% rated motor full-load current in accordance with NEC® Table 430.150.

F. The SSS shall provide Class 10 overload current capacity.

2.03 DESCRIPTION

A. Refer to Contract Drawings for actual layout and location of equipment and components; current ratings of devices, bus bars, and components; voltage ratings of devices, components and assemblies; interrupting and withstand ratings of devices, buses, and components; and other required details.

B. The soft starter shall be capable of operating a NEMA design B squirrel cage induction motor with a full load current equal to or less than the continuous output current rating of the soft starter.

C. The soft starter shall be microprocessor controlled and shall consist of a power section, logic board, and field wiring interface terminal board for ease of access to control and power wiring as well as maintenance requirements. The soft starter shall consist of the following general components:

   a. Three sets of back-to-back phased controlled power semiconductors rated 1400 PIV to 500V, 1600 PIV to 600V and 1800 PIV to 690V.

   b. Integral thermal sensor to trip and disengage the soft starter on heat sink over temperature.

   c. Programmable keypad and alphanumerical LCD display that indicates present mode of operation. The LCD keypad shall display programming and diagnostic data in full text.

   d. LED indicators to show the following: On, Start, Run, Soft Stop, Stop, Save/Slow Speed, Dual Set/Reverse, & Fault.

   e. Modbus RTU communications port.

D. The soft starter input power section shall be designed to operate at either 230Vac, 460 Vac or 575 Vac three phase input voltages.

E. The soft starter output power section shall be designed for three phase NEMA design B squirrel cage induction motor with amperage ratings from 8A through 820A depending on actual configuration.

F. SSS panels will include control power that is 120 Vac via a control power transformer.

G. All SSS panels and enclosures will meet UL508A.

H. The SSS panel shall include a Mag-Break motor circuit protector with a through-the-door handle interlocked to the enclosure door to provide a local and lockable means of removing all input power from the SSS panel.

I. Branch circuit protection fuses shall be provided to protect the SSS [and bypass starter]. Fuses shall be sized to provide proper branch circuit protection and be coordinated with other power circuit components.

J. The SSS panel shall be either a separate NEMA Type 3R enclosure or enclosed within a NEMA Type 3R motor control center.

K. The SSS panel will include door mounted operator devices and a through the door keypad to facilitate programming, control functions and diagnostics.

L. If identified on the contract drawings the SSS panel will include a line isolation contactor to remove three phase power from the starter and motor during stop and fault conditions.

M. If identified on the drawings or normally provided by the manufacturer, an AC3 rated Bypass Starter with Class 10 motor overload relay will be included and controlled by the SSS to allow cooler and more efficient operation during run conditions. This will also allow the SSS panel to run the motor using a full voltage, non-reversing starter in the event the SSS trips.

2.04 PROTECTIVE AND DIAGNOSTIC FEATURES

In the event of a fault, the soft starter will have tripped. Faults must be reset to restart operation once their cause has been rectified. The soft starter shall offer the following Faults list:

A. External Fault (by a digital input)

B. Frequency out of Range

C. Heat Sink Over Temperature

D. Long Start Time

E. Overcurrent / Jam

F. Overload

G. Overvoltage

H. Phase Loss

I. Phase Sequence

J. Shorted SCR

K. Slow Speed Time

L. Thermistor Trip

M. Too Many Starts

N. Undercurrent

O. Undervoltage

P. Wrong Motor Connection

Q. Wrong Parameters

R. Wrong Wiring Connection

2.05 FEATURES AND ADJUSTMENTS

A. The SSS panel will be factory programmed to operate all specified optional devices.

B. The SSS will include four (4) user selectable Start (4) user selectable and Stop curves to match starting characteristics to load.

C. The SSS will include an 80% Kickstart voltage with adjustable Kickstart time.

D. The SSS will include user programmable Starting Voltage.

E. The SSS will include user programmable Starting Current.

F. The SSS will include user programmable Current Limit.

G. The SSS will include user programmable Acceleration and Deceleration times.

H. The SSS will include user programmable Auto Reset for Phase Loss and Undervoltage Fault.

I. The SSS will include Dual Setting functionality to allow setting a second set of basic motor parameters.

J. For diagnostic assistance, the SSS shall record and store in its memory run status and fault type of the past 10 faults and provided detailed information on soft starter operating conditions at the time of fault.

K. The SSS shall contain an energy savings function that when selected, automatically reduces the SSS output voltage at steady state operation to the level only required to meet the torque requirement of the load. This function is not available with bypass style panels.

L. Three user programmable inputs with the following functions:

  a. Energy Savings Mode, Slow Speed or Reset.

  b. Dual Adjust, Reversing or Reset.

  c. External Fault

M. The Soft Starter shall have one (1) dedicated thermistor input that is programmable for PTC or NTC type thermistors.

N. The SSS shall provide an adjustable 4-20ma analog output signal that is proportional the motor current.

2.06 OPERATOR CONTROLS

A. The SSS control power and digital inputs will be 120 Vac.

B. The SSS panel shall have a control terminal strip for field I/O wiring.

C. The SSS will include two (2) customer safety interlocks.

D. The SSS will include fault relay outputs.

E. The SSS will include auxiliary run relay outputs.

F. The SSS will include three (3) programmable logic inputs.

G. The SSS will include one (1) scalable analog output.

H. All RVSS panel door mounted operators will be 22mm industrial rated devices.

1. Operator controls and indicating devices shall include: SSS Keypad, Fault Light, Hand-Off-Auto Switch, Run Light and Fault Lights, Elapsed Time Meter.

2. Panels with AC3 rated Bypass Starters shall include an Auto-Off-Bypass selector switch.

2.07 KEYPAD INTERFACE AND STATUS LEDS

A. The Soft Starter shall be supplied with a backlit alphanumeric Liquid Crystal Display (LCD) Multi-Function Keypad. The Keypad shall be capable of programming and monitoring the Soft starter.

Keypad shall be divided into 3 functional groups:

a. Graphical display shall two lines of 16 alphanumeric characters each with full text programming. Codes are not accepted.

b. LED’s – To display soft starter functions.

c. Navigation keys to program soft starter, display operational data, and faults.

B. The Soft Starter shall have Indication LED’s as follows:

a. Green – The soft starter is “On”.

b. Red – The soft starter is in “Stop” mode.

c. Yellow – The soft starter is in “Start” mode.

d. Yellow – The soft starter is in “Save” or “Slow Speed” mode.

e. Green – The soft starter is in “Run” mode.

f. Green – The soft starter is in “Reverse” mode.

g. Yellow – The soft starter is in “Soft Stop” mode.

h. Red – The soft starter is in “Fault” mode.

C. The Soft Starter shall display operating data, fault information, and programming parameters in English.

D. The keypad shall display the last 10 faults and provides detailed information on soft starter operating conditions at the time of fault occurrence.

2.08 NETWORK COMMUNICATIONS

A. The SSS shall include Modbus RTU communication protocol.

PART 3: INSTALLATION AND EXECUTION

3.01 EXAMINATION

A. The contractor shall perform the following procedures:

1. Examine installation area to assure there is enough clearance to install panel.

2. Check concrete pads for uniformity and level surface.

3. Inspect for any physical damage

4. Verify that equipment is ready to install.

5. Verify that required utilities and control interfaces are available, in proper location and ready for use.

6. Beginning of installation means installer accepts conditions.

3.02 LOCATION AND INSTALLATION

A. The contractor shall perform the installation.

1. The contractor shall install SSS in accordance with standards listed in Article 1.08 of this specification.

2. Install per manufacturer's instructions outlined in installation, operation and maintenance documentation.

Install required safety labels.

3.03 START-UP AND TRAINING

A. Manufacturer shall have Factory Trained personnel at Field locations convenient to the installation site, available for Trouble-Shooting and/or Start-Up assistance.

END OF SECTION

SECTION 40 73 26

PRESSURE TRANSMITTERS

PART 1-GENERAL

A. The digital pressure transmitter is typically used in fluid process applications, both hygienic and industrial, for pressure, level, volume or mass measurement in liquids and gases.

B. 1.02 SUBMITTALS

A. Furnish complete Product Data, Shop Drawings, Test Reports, Operating Manuals, Record Drawings, Manufacturer's certifications, Manufacturer's Field Reports

B. Product Data:

1. Dimensional Drawings.
2. Materials of Construction.
3. Measurement accuracy.
4. Range and range ability.
5. Enclosure Rating.
6. Classification Rating.
7. Power.
8. Output options.

1.03 QUALITY ASSURANCE

A. Manufacture instruments facilities certified to the quality standards of ISO Standard 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Store all instruments in a dedicated structure with space conditioning to meet the recommended storage requirements provided by the Manufacturer.

1.05 PROJECT OR SITE CONDITIONS

A. Provide instruments suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, process and ambient temperature, and humidity conditions.

1.06 WARRANTY

A. The transmitter shall have a standard one year warranty from date of shipment and if the meter is commissioned by a factory certified technician, the warranty is extended to three years from the date of shipment.

1.07 MAINTENANCE

A. Provide all parts, materials, fluids, etc. necessary for maintenance and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

1.08 LIFECYCLE MANAGEMENT

A. Instrument documentation, like original calibration certificates, manuals and product status information shall be accessed via a web enabled system with a license. The instrument-specific information shall be accessed via its serial number. When services are provided by an authorized service provider the services information like subsequent field calibrations shall be archived and accessible via this web enabled system.

PART 2-PRODUCTS

2.01 MANUFACTURER

A. Endress+Hauser

B. Rosemount

C. ABB

D. Or equal

2.02 MANUFACTURED UNITS

A. The transmitter shall be a 2-wire, high-performance capacitive pressure transmitter with digital communications capabilities including HART, Profibus PA or Foundation Fieldbus as required by the plans.

B. Measure capacitance changes in the sensor as pressure varies and produces a linear 4-20mA DC output proportional to the pressure. The unit shall have self-diagnostic capability and non volatile memory.

C. Display shall be an integrally mounted 4-line LCD scaled with engineering units.

D. Transmitter shall have a static pressure limit at least 1.5 times the nominal pressure range. Unit shall use DC loop-power supply 10.5 to 45 VDC with self-diagnostic capability and a non-volatile memory.

E. Sensor shall be a high purity aluminum oxide ceramic element with no oil fill and an elastomer seal.

F. The unit shall be rated for process temperature of minus 40°F to 266°F (302 °F for 1 hour) and an ambient environment of minus 40 degrees F to 185 degrees F.

G. Reference accuracy shall be +/- .075% of calibrated span including non-linearity hysteresis an d non-reproducibility in accordance with IEC 60770. Total performance accuracy including non-linearity hysteresis and non-reproducibility in addition to thermal change of the zero point shall be +/- .2% URL.H. Unit shall have ATEX, FM, CSA or IECEx approvals as required.

2.03 ACCESSORIES

A. Mounting set for installation of the transmitter on a wall or pipe (2")

2.04 SOURCE QUALITY CONTROL

A. Factory calibration of each pressure sensor traceable to the National Institute of Standards and Technology (NIST).

B. A real-time computer generated printout of the actual verification data indicating apparent and actual pressures at 0 percent, 50 percent and 100 percent of the calibrated range shall be included with each device.

C. Provide ISA data sheet ISA-TR20.00.01. Use the latest revision of form 20P2201. Complete the form with all known data, and dash out the inapplicable fields. Incomplete data sheets submitted will be result in a rejected submittal.

2.05 SAFETY

A. All electrical equipment shall meet the requirements of ANSI/NFPA 70, NATIONAL ELECTRIC CODE, latest edition.

B. All devices shall be certified for use in hazardous areas: Class I, II, III Div. 1, 2, Groups A-G; temperature rating T6 (85° C)

C. Electrical equipment housing shall conform to NEMA 4x/6p classification.

PART 3-EXECUTION

3.01 EXAMINATION

A. Examine the complete set of plans, the process fluids, pressures, and temperatures and furnish instruments that are compatible with installed process condition.

B. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

3.02 INSTALLATION

A. As shown on installation details and mechanical Drawings.

B. As recommended by the manufacturer’s installation and operation manual.

3.03 FIELD QUALITY CONTROL

A. Demonstrate the performance of all instruments to the ENGINEER before commissioning.

B. ENGINEER to witness all instrument calibration verification in the field.

C. Each instrument shall be tested before commissioning and the ENGINEER shall witness the response in the PLC control system and associated registers.

3.04 ADJUSTING

A. Verify set-up and configurations of all instruments in accordance with the Manufacturer’s instructions.

3.05 PROTECTION

A. All instruments shall be fully protected after installation and before commissioning. Replace any instruments damaged before commissioning:

1. The ENGINEER shall be the sole party responsible for determining the corrective measures.

SECTION 40 90 00 - INSTRUMENTATION AND CONTROL FOR PROCESS SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide complete instrumentation and control systems as indicated on the Drawings, in the Specifications, and as required by other contract documents. These documents include descriptions of functional operation and performance, as well as standards, but do not necessarily enumerate detailed specifications for all components and devices which are necessary. However, all components and devices shall be furnished and installed as required to provide complete and operable systems for accomplishing the functions and meeting the performance requirements.

2. Scope of work includes:

a. Provide all instruments.

b. Provide all control panels, PLC panels, SCADA consoles.

c. Provide all communication equipment required to make the control system fully operational including but not limited to radios, antennas, switches, routers, hubs, protocol converters, communication cables, and communication racks and power supplies.

d. Provide all conduit, conductors, enclosures, materials, and labor to fully interconnect and make operational all control system components.

e. Provide power at proper voltage and ampacity to all system components.

f. Provide programming for the PLC and SCADA components.

g. Provide startup and commissioning assistance

h. Train Owner's personnel on proper use and maintenance of the control systems

i. Other equipment, materials, and work as necessary to achieve a fully tested and operational control system.

B. Products Supplied But Not Installed Under This Section

1. None

C. Products Installed But Not Supplied Under This Section

1. Instruments and controls provided loose for field installation by packaged equipment or skid-mounted equipment vendors.

D. Related Sections

1. All Division 26 specifications provided for this project.

2. All Division 40 specifications provided for this project.

3. Other division specifications provided for this project as they relate to submittals, concrete, structural, piping/plumbing, mechanical, and HVAC systems.

E. Allowances

1. Not applicable this section.

F. Unit Prices

1. Not applicable this section.

G. Measurement Procedures

1. Not applicable this section.

H. Special Payment Procedures

1. Not applicable this section.

I. Alternates/Alternatives

1. All alternates, alternatives, or proposed substitutions of materials or equipment must be approved by ENGINEER.

1.02 REFERENCES

1.03 DEFINITIONS

A. The word “provide” means “furnish and install”.

B. PLC means Programmable Logic Controller

C. SCADA means Supervisory Control and Data Acquisition System

1.04 SYSTEM DESCRIPTION

A. Design Requirements

1. Using sound engineering principals and current best design practices, provide engineering drawings and design documents specifying system components and detailing their interconnection and installation.

B. Performance Requirements

1. The instrumentation and control systems shall be furnished and installed complete and ready to operate, including all necessary interconnections and connections to sources of electrical power, air, water, drains and vents, with all required valves, switches and accessories as specified or as recommended for best operation by the manufacturer of the equipment furnished.

1.05 SUBMITTALS

A. General

1. Submittals for the equipment shall be provided in accordance with Section 26 00 00, and as required elsewhere in the Contract Documents.

B. Product Data

1. Detailed catalog information for all system components in sufficient detail so that ENGINEER has sufficient information to determine if the equipment is acceptable for the intended purpose. Minimum information shall be:

    a. Instrument or Equipment tag number

    b. Manufacturer

    c. Model number

    d. Materials of construction

    e. Materials in contact with process fluids

    f. Dimensional information

    g. Weight

    h. Power consumption with required voltage and ampacity

    i. Heat dissipation if greater than 200 watts

    j. Process connection information detailing connection size, type (threaded, flanged, socket weld, etc…)

    k. Recommended mounting details

    l. Recommended spare parts for one year of operation

2. Instrument Data Sheets in ISA S20 format for all instruments.

C. Shop Drawings

1. For complex control systems consisting of mechanical, electrical, and control components, provide the following:

    a. A Piping and Instrument Diagram in ISA format

    b. Electrical load calculations with conduit and conductor sizing

2. For integrated control panels or control assemblies, provide the following:

    a. Dimensioned layout of the control enclosure and mounted equipment and instruments.

    b. Full bill of material for all components with detailed catalog information on all components.

    c. 11”x17” fully developed schematic diagram(s) showing power and control wiring, terminal block assignments, and identifying field and enclosure wiring. Provide a drawing index and symbols and legend sheet with all schematics. Show all I/O card details including rack, slot, channel numbers, field termination points, and control power wiring. Label all conductors and identify conductor size and color. Identify all field devices by tag number and by description. Provide over current protection in accordance with NEC requirements.

    d. 11”x17” instrument loop drawings in ISA format for all analog control loops. Alternatively, multiple loops may be combined on a single analog input or analog output I/O card schematic diagram.

    e. Nameplate legend

f. Paint color and type for painted assemblies

3. Any special installation details.

D. Samples

1. Not applicable for this section

E. Quality Assurance/Control Submittals

1. Design Data, Test Reports

a. Submit calibration sheets for all field instruments containing the following information:

1) Instrument tag number

2) Instrument manufacturer and model number

3) Person who performed the calibration

4) Manufacturer, model and serial number of the calibrating device

5) Date that calibrating device was last calibrated

6) For analog instruments, process range and associated analog signal in at least 5 increments (For example: 4.00 maDC/0 psig, 8.00 maDC/25 psig, 12.00 maDC/50 psig, 16.00 maDC/75 psig, 20.00 maDC/100 psig)

7) For switches, process values at which the switch changes state and at which the switch resets.

8) For instruments calibrated by manufacturer, manufacturer’s calibration report is acceptable as proof of calibration.

b. Factory acceptance test reports on all fabricated control panels or assemblies containing the following information:

1) Date of test

2) Test participants

3) Visual inspection of components

4) Successful application of power

5) Validation of all internal wiring

6) Validation of correct control operation

7) Validation of screen graphics or alarm operation (if applicable)

8) Validation of program installation into PLC’s and that I/O is functioning properly (if applicable)

2. Certificates, Manufacturer’s

a. UL 508 certification for all assembled control panels and assemblies

3. Instructions, Manufacturer’s Field

a. Furnish a complete Operations and Maintenance Manual for all assembled control panels and assemblies

4. Reports
    a. Not applicable to this section

F. Closeout Submittals
    1. Furnish Operations and Maintenance Manuals in 3-ring binders complete with the following:
        a. On front and spine of binders provide the project name, owners name and project number.
        b. Within the binder, identify the contractor and provide contact information
        c. Inside binders, provide a volume index and table of contents for each binder. Each instrument or control component tag number must be cross referenced to a specific binder tab.
        d. Furnish manufacturers complete operations and maintenance manuals for all discrete instruments and controls.
        e. Furnish custom Operations and Maintenance section for each custom control system, control panel, or fabricated assembly.
        f. Furnish “As-Built” loop and wiring diagrams.
        g. Furnish the written warranty
    2. Turn over all spare parts to owner with documentation showing which instrument or control system the spare parts are for.

G. Schedule
    1. Submit a detailed work schedule showing start/finish dates, task duration, task sequencing, critical path, and available float. Identify task predecessors and identify coordination activities with other trades.

H. Startup and Commissioning Plan
    1. Submit a detailed startup and commissioning plan for review by Owner and Engineer. Plan should include the following information:
        a. The order in which the various lift station systems will be started up
        b. What work must be performed prior to the startup
        c. What documentation will be maintained by the contractor and provided to the owner validating that the startup was performed in a safe and efficient manner.

1.06 QUALITY ASSURANCE

A. Qualifications
    1. Contractor performing the work shall have a minimum 5 years experience performing similar work in similar industries. All contractors’ personnel shall be trained and experienced in best current construction practices.

B. Regulatory Requirements
    1. Perform all work in accordance with all applicable national and local codes.

C. Certifications

1. Not applicable this section

D. Field Samples

1. Not applicable this section

E. Mock-Ups

1. Not applicable this section

F. Pre-Installation Meetings

1. Not applicable this section

1.07 DELIVERY, STORAGE, AND HANDLING

A. Packing, Shipping, Handling, and Unloading

1. Perform these activities in a manner which assures instruments and equipment will arrive undamaged and in proper working order. Replace any instrument or equipment damaged upon arrival at no additional cost to owner.

B. Acceptance at Site

1. Maintain a comprehensive log by instrument or equipment tag number of all received instruments or equipment

C. Storage and Protection

1. Store all instruments and equipment as recommended by manufacturer. Protect from physical damage, moisture, dirt/dust, or extremes of temperature

1.08 PROJECT/SITE CONDITIONS

A. Environmental Requirements

1. Follow any and all environmental requirements pertaining to the site
2. Maintain a safe and clean job site
3. Dispose of all trash and construction debris in an approved manner

B. Existing Conditions

1. Contractor is to examine the site and be thoroughly familiar with any site requirements which may affect the work or storage of instruments or equipment.

1.09 SEQUENCING

A. Coordinate all work with other trades.

1.10 SCHEDULING

A. Provide and maintain a detailed schedule for performance of the work identifying start/finish dates, durations, required preceding activities, and coordination with other trades. Organize procurement, deliveries, and staff labor to meet the overall construction schedule and to assure that other trades are not delayed.

1.11 WARRANTY

A. Instrumentation

1. One year from system acceptance by owner for all discrete instrumentation, control devices, or equipment. During this period, replace any defective or malfunctioning device with 15 working days after notification by owner.
2. One year from system acceptance by owner for the performance of the overall control system. Correct the defect within 15 working days after notification by owner. Warranty repair work includes but is not limited to the following:
    a. Improper sequencing or interlocking of equipment control systems
    b. Wiring errors or omissions
    c. Improper calibration of field instruments
    d. Improper operation of programmable logic controllers or operator interface terminals
    e. Improper operation of communications systems installed as part of the overall control system
    f. Unsafe operations or maintenance conditions
    g. Other system malfunctions which prevent or impair the plant from operating at design capacity, requires excessive operator intervention, or results in unsafe operating conditions.

1.12 SYSTEM STARTUP/COMMISSIONING

A. General

1. Provide labor, tools, and equipment to start up the facility in a safe and efficient manner.
2. Lift station shall be started up by system. A system is defined as a collection of mechanical, electrical, and controls equipment configured to perform a specific function or purpose. Examples may be a UV disinfection system, a dissolved oxygen blower system, a grit removal system, etc… The order in which the systems will be started shall be submitted by contractor in the startup plan and approved by owner and engineer. Any variance in this schedule must be approved by owner and engineer.
3. Unless approved otherwise by owner and engineer, contractor is to follow the startup sequence detailed below. The following work must be complete prior to beginning the startup:
    a. All mechanical equipment installed and tested in accordance with manufacturers recommendations.
    b. All motors must have been rotation checked.
    c. Electrical power is available and wired to all mechanical equipment
    d. All instruments must have been calibrated and installed in accordance with the manufacturer’s recommendations.

e. Control system communication systems are installed and fully operational. This includes DH+ networks, Modbus+ networks, Ethernet networks, radio telemetry systems, telephone systems, etc…

f. All power and control wiring must be installed, rung out, and validated to be in accordance with approved construction drawings.

g. Programmable logic controllers, SCADA computers, and Operator Interface Terminals all are installed, have their programs installed, and these devices are fully operational and functioning in their design configuration.

B. System Startup Sequence

1. By manipulation of the instrument or direct signal injection at the instrument, verify that the control signal (discrete or analog) is received at the programmable logic controller or by the hard-wired control circuit.

2. For motorized equipment, disconnect the power leads at the starter, VFD, or solid state motor controller.

3. Completely exercise the control circuit in Manual, Remote, and Automatic modes and verify that all interlocks and permissive interlocks are functioning correctly.

4. Verify that the programmable logic controller can start and stop the motor in Auto or Remote. Motors may be "bumped" by forcing PLC outputs but these program forces must be removed immediately afterward.

5. Verify that run status, signal levels, and alarms display properly on the OIT and the SCADA screens.

6. Reconnect the motor power leads.

7. Verify PID loop operating correctly (either direct or reverse) and adjust gain constants to achieve critically damped operation.

8. Configure the mechanical system for normal operation and leave system ready for normal operation.

9. Utilize colored tagging scheme to identify startup condition. Red is not ready for startup, yellow is mechanically and electrically ready but not yet tested or started up, and green is fully tested and ready for normal operation. Place these tags on all mechanical, electrical, instrumentation, and control components of each system.

10. As Lift Station systems are started up, coordinate and remedy any coordination or interface issues between systems.

C. Remedies for Damages

1. Contractor is liable for any and all damage done to mechanical or electrical equipment due to improper startup procedures and shall repair or replace any damaged equipment at owner's discretion without additional cost to owner.

2. Contractor is forbidden to jumper around any process or safety interlock either with wiring or within a PLC program without the express written permission of both the owner and engineer. All jumpers, hardwired and programmed, must be maintained in a log book. Entries shall include:

a. Name of person placing the jumper

b. Date of installation

c. Reason for installation

d. Approval of owner and engineer

e. Date of removal

f. Name of person removing the jumper

1.13 OWNER'S INSTRUCTIONS

A. Not applicable this section

1.14 MAINTENANCE

A. Extra Materials

1. Not required this section

B. Maintenance Service

1. Not required this section

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Approved manufacturers are listed in the other Electrical and Instrument Specification Sections.

2.02 EXISTING PRODUCTS

A. Not applicable this section

2.03 MATERIALS

A. All materials are to be new and the manufacturers most current model.

2.04 MANUFACTURED UNITS

A. Manufactured units are to be fully assembled and tested at the point of manufacture and delivered to the job site ready for installation and start-up.

B. Regulated dc power supplies for instrument loops shall be designed and arranged so that loss of one supply does not affect more than one instrument loop or system. Power supplies shall be suitable for an input voltage variation of plus or minus 10 percent, and the supply output shall be fused or short circuit protected. Output voltage regulation shall be as required by the instrumentation equipment being supplied. Multi-loop, or multi-system power supplies, will be acceptable if backup power supply units are provided which will automatically supply the load upon failure of the primary supply. The backup supply systems shall be designed so that either the primary or backup supply can be removed, repaired, and returned to service without disrupting the instrument system operation.

C. The power distribution from multi-loop supplies shall be selectively fused such that a fault in one instrument loop will be isolated from the other loops being fed from the same supply. Fuses shall be clearly labeled and located for easy access. Multi-loop supply systems shall be oversized for an additional 10 percent future load. Failure of a multi-loop supply shall be indicated on the respective instrument panel or enclosure.

2.05 EQUIPMENT

A. All equipment is to be new and the manufacturers most current model. All instruments and control devices and assemblies shall be standard devices constructed of corrosion-resistant materials enclosed in a water and dust proof case and mounted as specified in the individual application. Enclosures shall be manufacturer's standard color unless specified otherwise.

2.06 COMPONENTS

A. Not applicable this section

2.07 ACCESSORIES

A. Not applicable this section

2.08 MIXES

A. Not applicable this section

2.09 FABRICATION

A. Shop Assembly

1. Fabricate assemblies in accordance with approved drawings. Notify engineer and owner at least 5 working days prior to start of testing so that they may witness the testing if they choose to do so.

2.10 FINISHES

A. General

1. Finishes for all components, equipment, and fabricated assemblies must take into account the environment in which they will be installed. NEMA ratings must be appropriate for the environment. Ratings for all areas must be NEMA 4X.

B. Shop Finishing

1. Where called for in other sections, sandblast, prime, and paint assemblies.

2.11 SOURCE QUALITY CONTROL

A. Fabrication/Tolerances

1. In accordance with generally accepted manufacturing standards

B. Tests, Inspections

1. In accordance with generally accepted manufacturing standards

C. Verification of Performance

1. Not applicable this section

PART 3 - EXECUTION

3.01 ACCEPTABLE INSTALLERS

A. Contractors having a minimum 5 years experience in the design, procurement, and construction of industrial water/wastewater instrumentation and control systems.

3.02 EXAMINATION

A. Site Verification of Conditions

1. Visit job site and ascertain any environmental or physical conditions which may affect the performance of the work or the equipment requirements

3.03 PREPARATION

A. Protection

1. Not applicable this section

B. Surface Preparation

1. Not applicable this section

3.04 ERECTION

A. Provide 316 SST unistrut or structural supports for heavy equipment or assemblies. Prime and paint supports so that they are unaffected by the environment in which they are installed.

B. Securely fasten all panels and assemblies to their housekeeping pads or structural supports.

C. All interconnecting wiring shall be run in conduit in accordance with the division 26 sections requirements.

3.05 INSTALLATION

A. Install all instruments and controls in accordance with manufacturer’s recommendations and all applicable electrical codes and standards. Connect all required utilities including electrical power, air, hydraulics, etc…

B. Provide stainless steel tags for each instrument engraved with instrument tag number. Attach to instrument with stainless steel wire.

C. Provide engraved nameplates for all panel mounted instruments. Attach to panel with stainless steel screws.

3.06 APPLICATION

A. Not applicable this section

3.07 CONSTRUCTION

A. Special Techniques

1. In accordance with manufacturers recommended installation procedure

B. Interface with Other Work

1. Coordinate with all other trades

C. Sequences of Operation

1. Not applicable this section

D. Site Tolerances

1. Not applicable this section

3.08 REPAIR/RESTORATION

A. Repair any damages caused by the installation or erection to original condition.

3.09 RE-INSTALLATION

A. Not applicable this section.

3.10 FIELD QUALITY CONTROL

A. Site Tests

1. Test and calibrate instrumentation in accordance with other parts of this section

B. Inspection

1. Not required this section

C. Manufacturer's Field Services

1. If recommended by manufacturer, have equipment/control systems inspected, tested, and started up by manufacturer's representative.

3.11 ADJUSTING

A. Not required this section

3.12 CLEANING

A. Remove and dispose of construction debris daily. Wipe down and vacuum out all enclosures.

3.13 DEMONSTRATION/TRAINING

A. In accordance with the Startup part of this section.

B. Provide training of personnel in the operation and maintenance of the furnished control systems.

C. Training shall be provided as required elsewhere in the Contract Documents, but shall consist of at least eight hours, in a single, or multiple sessions, to accommodate the personnel schedules.

D. Coordinate with the Engineer, and the Owner, to schedule the training sessions at least 5 workings days in advance.

3.14 PROTECTION

A. Protect instrumentation and control equipment from environmental damage and from damage by other trades.

3.15 SCHEDULES

A. Not applicable this section.

END OF SECTION

SECTION 40 94 44 - PROGRAMMABLE LOGIC PROCESS CONTROLLER CABINET

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes

1. Programmable Logic Controller (PLC) cabinet used for monitoring and control of process variables and for communicating process status to a remote Supervisory Control and Data Acquisition System (SCADA) via external radio (Moscad ACE 3600RTU) or other communication path.
2. Programming of the Programmable Logic Controller (PLC) within cabinet.
3. Programming of the Operator Interface Terminal (OIT) within cabinet.
4. Programming of the existing Supervisory Control and Data Acquisition (SCADA) system to monitor and control the I/O points within the PLC cabinet.

1.02 REFERENCES

A. Not required for this specification.

1.03 DEFINITIONS

A. RTU Remote Telemetry Unit

B. PLC Programmable Logic Controller

C. OIT Operator Interface Terminal

D. SCADA Supervisory Control and Data Acquisition System

E. HMI Human Machine Interface

F. FAT Factory Acceptance Test

1.04 SYSTEM DESCRIPTION

A. Provide a fully functional system for monitoring and controlling the process including the PLC cabinet, all programming, and required communications with remote control stations via radio or land lines in accordance with the details and information shown in the contract drawings. Furnish and install all system components necessary for a complete and operable system. Any components required, but not shown on the Drawings, shall be furnished as needed to construct a fully operational system.

1.05 SUBMITTALS

A. Manufacturer's data on electrical characteristics, system component catalog information, system component specifications and warranty data, capabilities and physical properties.

B. Terminal block wiring diagrams showing connections to all devices; input and output (I/O), analog and discrete. The wiring diagrams shall indicate the I/O address point to be used in the PLC programs.

C. 11”x17” PLC cabinet shop drawings shall include:

1. Control system block diagram showing all major control components, the communication paths, and the means of communication.
2. Internal power distribution wiring
3. I/O wiring
4. Scaled physical component and PLC cabinet layout.
5. Cable and connector details for all communication cables including Ethernet, RS-232, RS-485, vendor proprietary (DH+, Modbus+, etc…), and radio-to-antenna cabling.
6. Comprehensive bill of materials complete with manufacturer, model, and quantities.

D. Calculations for all power supply ampacity requirements for all utilization voltages.

E. Calculations for maximum I/O which may be supported by the power supplies or by the processor addressing limitations.

F. List of recommended spare parts.

G. Factory acceptance procedure and schedule

H. Operations and Maintenance Manual

1. Provide 3 copies in 3-ring binders. Binder to include dividers, table of contents or index, manufacturer’s literature for all components provided, list of recommended spare parts, and factory acceptance test certification.
2. Label binder with OWNER’s project name, number, the name, address, phone number, and shop order of the PLC cabinet fabricator.
3. Manuals must be complete prior to shipment and be shipped with the PLC cabinet.

1.06 QUALITY ASSURANCE

A. Work to be performed by qualified contractor having extensive experience in the design, fabrication, installation, and programming of PLC’s and control systems.

1.07 DELIVERY, STORAGE, HANDLING

A. Store PLC cabinet and all related hardware protected from moisture and weather until installed. Repair or replace, at Owners option and at no cost to Owner, any component damaged during delivery, storage, or handling.

1.08 PROJECT/SITE CONDITIONS

A. Contractor is to familiarize himself with any and all site conditions which may affect performance of the work. These include requirements for support, ventilation, sufficient working clearances, and radiant heating situations.

1.09 SEQUENCING

A. Not required for this specification.

1.10 SCHEDULING

A. Coordinate supply, installation, and commissioning with other trades.

1.11 WARRANTY

A. All parts and components of the PLC cabinet for 12 months starting the day the system is fully operational and accepted as complete by owner. Repair or replace components within 5 working days of notification by OWNER. If OWNER uses a provided spare part and makes the repair themselves, replace the component within the same time period.

B. All custom programming for the PLC, OIT, and SCADA system. If the programming problem prevents the facility from operating in the automatic mode, correct the problem within 2 working days of notification by OWNER. Other programming corrections are to be made within 10 working days of notification by OWNER.

C. If a new revision of any purchased software is released during the warranty period, provide this new revision to OWNER at no additional cost to OWNER.

1.12 SYSTEM STARTUP

A. Energize all system components, install programming, test operations, demonstrate successful operation to OWNER, provide training to OWNER's personnel, and leave the system fully operational.

1.13 OWNERS INSTRUCTIONS

A. Not required for this specification.

1.14 COMMISSIONING

A. Provide personnel, tools, equipment, and accessories to fully test, debug, and commission the PLC cabinet and associated components. Specifically:

1. Validate that each I/O point is properly terminated and wired to the correct card and channel within the PLC.
2. Validate that all I/O is properly addressed and represented within the PLC and OIT.
3. Validate that all PLC programming functions as intended.
4. Validate that all OIT and SCADA programming functions as intended.
5. Validate that all communication paths including radio, telephone, and hard-wired function as intended.
6. Demonstrate to OWNER that these requirements have been met.

1.15 MAINTENANCE

A. Not required for this specification.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. PLC

1. Allen-Bradley 1769-L32E.

B. OIT

1. N/A.

C. Radio

1. MDS iNet 900

D. Ethernet Switch

1. Moxa

E. Antenna

1. Yagi Antenna, Kathrein TY-900N

F. Coaxial Surge Protector

1. Polyphaser IS-B50LN-C2

G. Power Supplies - Enclosed

1. Omniflex PT5000C-C2177A

H. Power Supplies – Open frame

1. Not allowed

I. Terminal Blocks

1. Entrelec

J. Relays

1. IDEC RH2B-UL24V/ SH1B-05

K. Signal Conditioners

1. Moore Industries
2. Phoenix Contact
3. Action Instruments
4. Approved equal (AGM is not approved)

L. Surge Protectors

1. MTL Surge Technologies
2. Phoenix Contact

3. Approved equal.

M. Enclosures

1. Hoffman

N. Uninterruptible Power Supplies

1. APC

2.02 EXISTING PRODUCTS

A. If the PLC cabinet will be installed as a node in an existing SCADA system, all hardware and software must match the OWNERS existing equipment.

2.03 MATERIALS

A. All materials shall be new and the manufacturers most current model unless contractor is matching older existing units as required by 2.02.A.

2.04 MANUFACTURED UNITS

A. The PLC cabinet shall be constructed with off-the-shelf components, available from local venders and Factory tested as a complete unit.

2.05 EQUIPMENT

A. Not required for this specification.

2.06 COMPONENTS

A. PLC

1. Rack or DIN rail mounted with sufficient space for an additional 25% I/O cards.
2. Provide with power supply.
3. The CPU shall have EEPROM storage for user-programmed instructions. The memory capacity shall be large enough to store the ladder logic program and for 100% growth in programming size.
4. Communication ports as required to communicate with OIT, radio, and other external devices.
5. Remote I/O communication modules if remote I/O is used.
6. Digital input cards shall be 24 volts DC, 16 channel, sinking style.
7. Digital outputs shall be 24 volts DC, 16 channel, directly wired to panel mounted relays so as to provide true dry contact outputs for field devices.
8. Analog inputs shall be 4-20 maDC, 4, 6, or 8 channel capable of accepting a mix of both single ended and double ended analog signals.
9. Analog outputs shall be 4-20 maDC, 4, 6, or 8 channel.
10. Swing arms, end caps, blank slot covers, and other accessories required to make a complete system.

11. Total I/O cards provided must be able to support 25% future I/O growth.
12. Provide with programming software unless directed otherwise by ENGINEER or OWNER.
13. The PLC programming software shall be provided with the user’s manuals, original diskettes, and licensing agreement for registration by the Owner. Cables, adapters, connectors, or other hardware required to connect to the PLC shall be provided to the Owner.

B. OIT

1. Flat panel, color display, touch screen or keypad style with sufficient memory to support all process requirements plus allow for a 100% growth in program size.
2. When PLC cabinet is located out-of-doors, mount OIT on a swing panel internal to the PLC cabinet so that the front door must be opened to access the OIT. When PLC cabinet is located indoors, mount OIT on the front door.
3. Provide with programming software unless directed otherwise by ENGINEER or OWNER.

C. Ethernet Switch

1. Industrial type
2. DIN rail mount
3. 24VDC power
4. Min. (2) spare ports

D. Power Supplies

1. DIN rail mounted, fully encapsulated, finger-safe construction providing 24 volts DC for I/O card and analog transmitter requirements. Supply to be sized for 100% future growth. Open frame style power supplies are not allowed.

E. Terminal Blocks and Accessories

1. DIN rail mounted.
2. Minimum .24” width.
3. Rated for 300 volts at 20 amps minimum.
4. Screw clamp style, spring clamp style not allowed.
5. Provide fuses, disconnect plugs, end caps, spacers, jumper bars, identification labels as required by contract drawings and as required to form a complete system.

F. Relays

1. DIN rail socket mounted so that relay may be removed without disturbing wiring.
2. Single 300 volt, 5 amp form “C” contact or as required by circuit requirements.
3. Indicating light which illuminates when relay is energized.

G. Surge Protectors

1. DIN rail mounted.
2. 32 VDC nominal operating voltage and capable of suppressing reasonable voltage surges on analog signal lines.
3. Damage caused to internal PLC cabinet components due to failure or inadequacy of the surge protector to be remedied by contractor at no additional cost to OWNER.

H. Enclosures

1. Sized to adequately house all PLC cabinet components with reasonable room for future growth.
2. Provide as non-ventilated or with ventilation or air conditioning as required by site environment and location.
3. Provide with lockable latch or handle.
4. NEMA 4X SS.
5. Provided with sub-panels and swing-panels as required by contract drawings or by component mounting requirements.

I. Wireway

1. Panduit or approved equal plastic wiring duct with cover sized per NEC to hold all internal wiring with room for 100% growth in conductor count.
2. Securely attach to sub-panel or side-panel with screws.
3. Allow a minimum of 2.5” between edge of wireway and terminal blocks for labeling conductors.

J. Conductors

1. 300 volt, flexible, stranded, minimum AWG #18, sized per NEC based on over current protection. Types MTW, SIS, or approved equal.
2. Color coded to identify specific voltages as follows:
    a. Black - 120 VAC hot
    b. White – 120 VAC neutral
    c. Green – Ground
    d. Red – 120 VAC signals
    e. Orange – +24 VDC power
    f. Brown – 24 VDC common
    g. Blue – 24 VDC signals
3. Internal 4-20 maDC wiring to be 2-conductor AWG #18 non-shielded cable.
4. Conductors between field terminal blocks and I/O cards may be multi-conductor or multi-pair AWG #18.

K. Uninterruptible Power Supply (UPS)

1. Capable of supporting complete PLC cabinet operation for a period of not less than 60 minutes after loss of normal 120 VAC power.
2. Provided with batteries and accessories to form a complete system.

2.07 ACCESSORIES

A. Internal light with door mounted switch.

B. Isolated ground bus.

C. Service receptacle rated 125 volts at 15 amps for connection of programming terminals.

D. Surge arrestor on incoming power.

E. Circuit breakers and fuses rated for available fault current and sized per NEC for the supplied load.

2.08 SPARES

A. Furnish a minimum of one (1) spare I/O module of each type, and one (1) power supply module.

B. Furnish twelve (12) fuses of each type and size, used in the power supply and I/O modules.

2.09 MIXES

A. Not required for this specification.

2.10 FABRICATION

A. The PLC cabinet enclosure, and all system components contained within, shall be UL listed as an assembly at the Factory.

2.11 FINISHES

A. Unless specified otherwise in this document, standard factory finish is acceptable.

2.12 SOURCE QUALITY CONTROL

A. Contractor to have a documented Quality Assurance/Quality Control program and to validate that the PLC cabinet was fabricated and tested in accordance with this program.

PART 3 - EXECUTION

3.01 ACCEPTABLE INSTALLERS

A. Project contractor.

3.02 EXAMINATION

A. Contractor to inspect the site for conditions which will affect the performance of this work and to coordinate activities with other trades.

3.03 ERECTION

A. In accordance with contract drawings and manufacturers recommendations.

3.04 INSTALLATION

A. Provide housekeeping pad or other means of support.

B. Firmly anchor PLC cabinet to housekeeping pad or support structure.

C. Ground PLC cabinet in accordance with contract drawings and the NEC.

D. Pull and terminate all conductors.

E. Energize, test, leave ready for operation.

3.05 APPLICATION

A. Not required for this specification.

3.06 CONSTRUCTION

A. All equipment, components, and accessories to be installed in accordance with manufacturers recommendations.

B. Mount all components to PLC cabinet sub-panel allowing sufficient room for wire terminations, labeling, and ventilation and in accordance with approved shop drawings.

C. Provide separate terminal block groupings as follows:

1. 120 VAC main incoming power. Provide terminals to land incoming power and to provide sufficient terminations for all neutral and ground conductors. Provide a single circuit breaker to disconnect incoming power. Provide circuit breakers for panel light, receptacles, UPS, and other loads. Provide a minimum of 2 spare breakers for future loads.
2. 120 VAC UPS power. Provide circuit breakers, neutral and ground terminals for all UPS loads. UPS will provide all power for the PLC components and other control devices and equipment. Provide a minimum of 2 spare circuit breakers for future loads.
3. 24 VDC power distribution.
4. Field wiring terminal blocks for all I/O cards. Wire I/O cards to these terminal blocks. In no instance may field wiring be terminated directly to I/O cards. Each digital and analog input channel must be protected by a fuse on the field termination blocks.

D. Each analog input field termination block grouping must support distribution of 24 volt DC power for 2-wire instruments or direct connection of 4-wire instruments. In addition, provide a means of disconnecting the AI+ signal. Generally, this requires a fused terminal for the +24 VDC, a terminal for the DC COMMON, a switched terminal for the AI+ connection, and a terminal for the AI- connection. Double high terminals with fuses and disconnects may be used.

E. Wire digital outputs directly to interposing relays. Wire the relay dry contact to field termination blocks.

F. Provide surge protectors for all analog inputs whose transmitters exist outside of the building that the PLC cabinet is located in or for all analog inputs if PLC cabinet is located out of doors.

G. Provide shelf or other means of support for the radio.

H. Provide shelf for UPS or install in bottom of PLC cabinet.

I. Run all conductors in plastic wiring duct or neatly bundle where not possible to run in wiring duct.

J. Label all conductors.

K. Label and identify all sub-panel components.

L. Mount external components including OIT and air conditioner.

M. Ground all panel and sub-panel components in accordance with the NEC. Terminate all shield grounds to the isolated ground bus.

3.07 REPAIR/RESTORATION

A. Touch up any paint or damage to enclosure, sub-panel, or components.

3.08 RE-INSTALLATION

A. Not required for this specification.

3.09 FIELD QUALITY CONTROL

A. Not required for this specification.

3.10 ADJUSTING

A. Not required for this specification.

3.11 CLEANING

A. Wipe down enclosure, sub-panel, and components.

B. Vacuum loose debris or blow out with low pressure air.

3.12 DEMONSTRATION

A. Conduct a Factory Acceptance Test (FAT) at location of fabrication. Provide OWNER and ENGINEER with 2 weeks notice prior to conducting this test. Demonstrate that fabrication is in accordance with specification and contract documents. Energize PLC cabinet and test for short circuits and incorrect wiring. Test every I/O point using a circuit simulator to demonstrate that wiring is correct. Download PLC and OIT programs and demonstrate successful communications between them. Correct all deficiencies and provide OWNER with test results.

B. If FAT is held more than 100 miles from OWNER's location, provide lodging and transportation for a minimum of 4 people to the FAT site location for the duration of the FAT.

C. After field installation, energize PLC cabinet and demonstrate proper operation of all components, communication systems, and programming.

D. Upon completion of the installation, start-up shall be performed by a factory-trained manufacturer representative. Operating and maintenance instruction books shall be supplied upon delivery of the unit and procedures explained to operating personnel.

E. Thoroughly test the PLC program and I/O. Each input and output signal shall be tested for correct indication and control function.

F. Program changes made as a result of start up testing and debugging shall be fully documented. Submit the latest program changes to the logic for review, and update the operation and maintenance manuals with the latest program print-out and diskette.

G. Proportional-Integral-Derivative (PID) loops shall be tested and tuned to provide a stable control over the process variable.

H. Install and complete any programming of the remote SCADA system and demonstrate successful operation to OWNER.

I. Turn over to OWNER all software licenses, documentation, shop manuals, and spare parts.

J. Provide document certifying successful startup testing to OWNER.

K. Provide a minimum of four (4) hours of training on the control system. Instruction shall include a description of the control system operation. Teach the Operators how to make control system parameter changes (set points, timer values, etc.), and show them how to enter, and change passwords to make these changes.

3.13 PROTECTION

A. Protect all equipment against damage from weather and other trades. Repair or replace any damaged components or systems.

END OF SECTION

ATTACHMENT 2

SQUARE D SHOP DRAWINGS AND VENDOR LITERATURE

Seq #	Qty	Product Description
1	1	**Designation :**

Product Details:
1-Square D Custom Swbd-QED-2 Switchboard

Square D Custom Swbd
Designed and Tested in accordance with:
UL 891/NATIONAL ELECTRIC CODE/NEMA PB-2
System Voltage - 480Y/277V 3Ph 4W 60Hz
System Ampacity - 800A
Source Description - Single Main
Bussing - Silver Plated Copper
Neutral Bus - 100%
Max Available Fault Current (RMS) - 42kA
Enclosure - Type 3R Non-Walk-in
Accessibility: Front Only
Equipment Nameplate White Surface/Black Letters, Adhesive (Field Installed)
Rodent Barrier
Exterior Paint Color - ANSI 49
Ground Lug provided for each device
Copper Ground Bus
Strip Heaters - Internal Power Source with Thermostat
Certified Test Report Required
Seismic Qualified

Dimensions
----
2 - 36" Wide Section(s)
1 - Dimensions: 72.00" W X 35.5" D X 91.5"H
2 - 35.5" Deep Enclosure(s)
Approximate Weight: 1692.00 lbs / 767.49 kgs

Incoming Requirements

Suitable for Use As Service Entrance
Entry Point: Left of Lineup, Through the Bottom
Connection Type: Cable
Reverse Feed
Hot Sequence Utility: Southern Cal Edison (CA)
Standard Door Pattern 1-30in Door, 2 Sockets
Power Meter - PM5563RD
3 CTs PM5563 w/ Display - 3 phase 4 wire wye 800A

Mains
----
1 - 800AS/800AT 480V 80% Rated 50 kA 3 Pole UL, Fixed Mounted Electronic Trip Circuit Breaker: Type PK
Ammeter Trip Unit, Long Time, Short Time, Instantaneous, Ground Fault
Padlock Attachment

Estimated days to ship, excluding transit: 30 working days after customer release to manufacturer. See Conditions of Sale.

Seq #	Qty	Product Description
2	1	**Designation :**

Product Details:
1-Model 6 LVMCC-Model 6 MCC - Industrial Package

System Voltage: 480V 3PH 3W 60Hz
Max Available Fault Current (RMS) - 42kA
Control Power - 120Vac
Outdoor Duty Type 3R Enclosure
1/4" x 1" Horizontal Ground Bus, Tin Plated Copper
800A Tin Plated Copper Horizontal Bus
Class 1 Type B Wiring

20" Deep Construction
65kA Bus Withstand Rating
Vertical Ground Bus, Tin Plated Copper
White Interior
Master Nameplate Engraved with Gray Surface/White Letters
Standard Exterior Paint ANSI 49
Equipment Mounting Height 72"
Manual Vertical Bus Shutters
Certified Test Report
Unit Nameplate Engraved with Gray Surface / White Letters
Seismic Qualified
Rodent Barriers
Engineered To Order (ETO)
1 - Section(s) with 600A Tin Plated Copper Vertical Bus
1 - Section(s) with 300A Tin Plated Copper Vertical Bus
3 - Section(s) with no Vertical Bus
3 - Strip Heater

DIMENSIONS AND WEIGHT

Dimensions: 140.00"W X 31.6"D X 94.5"H
Approximate Weight: 5140.00 lbs / 2331.50 kgs

INCOMING

Incoming Connection: Cable

MAIN

Main Lugs Bottom Entry 800A

DISTRIBUTION TRANSFORMERS

----

1 - 10 kVA, 1-Ph Distribution Transformer w/ 120/240 Volt Secondary
Circuit Breaker Primary Disconnect
Fishtape Unit Plugs
65kA Interrupting Rating

PANELBOARDS

----

18 Circuits NQ Panelboard w/ Main Circuit Breaker 120/240V 1Ph 3W 60Hz
Fishtape Unit Plugs
1 - Copper Interior
2 - QOB 2 Pole 20A
10 - QOB 1 Pole 20A

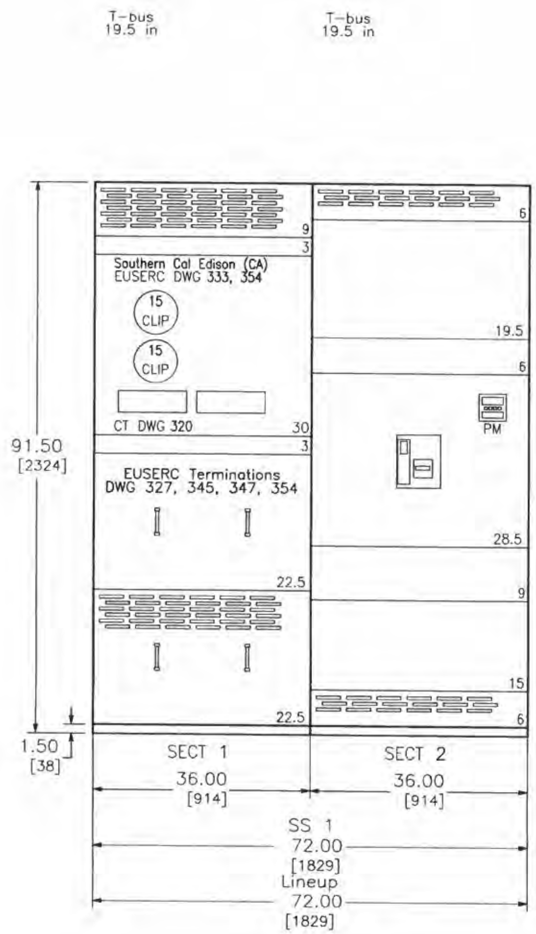
MISCELLANEOUS DEVICES

----

1 - 36" Configured Space
1 - 3" Configured Space
1 - 24" Configured Space
1 - 72" H x 20" W Empty Mounting Unit
1 - 72" H x 25" W Empty Mounting Unit
1 - 72" H x 25" W Special Unit
(1) 700A/3P MJL BREAKER (TAG#: NEED TAG?)
(1) MOUNTED IN UPPER LH CORNER (TAG#: NEED TAG?)
(1) NEED SADDLE AND HANDLE MECH (TAG#: NEED TAG?)

Estimated days to ship, excluding transit: 25 working days after customer release to manufacturer. See Conditions of Sale.

REV	DESCRIPTION	BY	DATE								
--	----	--	--/--/--	-	----	--	--/--/--	-	----	--	--/--/--
				-	----	--	--/--/--	-	----	--	--/--/--



SWITCHBOARD GENERAL NOTES

PRODUCT DESCRIPTION & RATINGS

Power System Data

480Y/277V 3Ph 4W 60Hz / 3 Phase Wye
Solidly Grounded
System Short Circuit Current Rating: 42kA RMS
Incoming Section 1 Cable Through the Bottom Left of Lineup

Bus System Data

800A Silver Plated Copper Main Bus
(2) .25x1.50 IN/6x38 mm Cu Bus Bar Per Phase/Neutral
(1) .25x.875 IN/6x22 mm Cu Ground Bus

Enclosure Data

Type 3R Free Standing
Exterior Paint Color: ANSI 49
Front Accessibility Only Required
Handling: Rollers
Rodent barriers
1.5H Corrosion Resist Base Channels
Nameplate Mounting Type: Adhesive (Field Installed)
Equipment Nameplate: White Surface/Black Letters
Strip Heater w. Thermostat
Base channels cannot be removed from EUSERC switchboard line-ups
Utility sealing hardware installed for unmetered bus compartments

Estimated Shipping Weight

Shipping Split 1 1692.00 lbs / 767.49 kgs
Complete Lineup 1692.00 lbs / 767.49 kgs

Code Standards

U.L. Deadfront and suitable for use as Service Entrance
when not more than six (6) disconnecting means are provided.

Rating Nameplates

ST1- Deadfront - Section Bus 800A
ST2- Service Entrance - Section Bus 800A

PRODUCT INFORMATION

Wiring

All wiring to be Machine Tool Wire type

Instruction Bulletins

Reference 80043-055 For Handling, Installation, Anchoring, Inspection And Maintenance Information

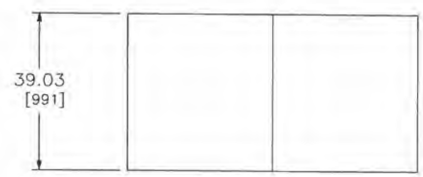
Product Accessories/Options

Certified Test Report
Seismic Qualified

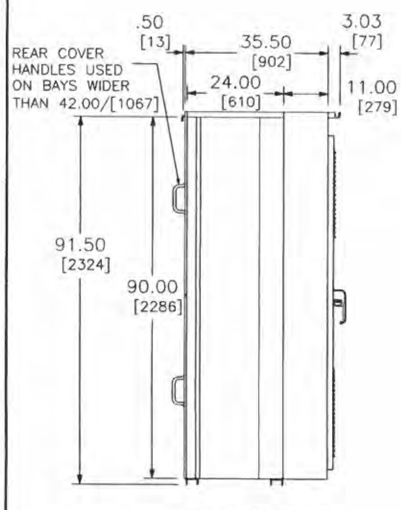
DUAL DIMENSIONS: INCHES / MILLIMETERS

JOB NAME:	CITY OF FULLERTON WELL 9		EQUIPMENT DESIGNATION:	
JOB LOCATION:			EQUIPMENT TYPE:	QED-2 Switchboard
DRAWN BY:	(Q2C)		DRAWING TYPE:	ELEVATION VIEW
ENGR:			SQUARE D by Schneider Electric	
DATE:	May 22 2018			
DRAWING STATUS:	QUOTE	NOT FOR CONSTRUCTION	DWG# FQ-290828-07305299-01	PG 1 OF 2 REV -

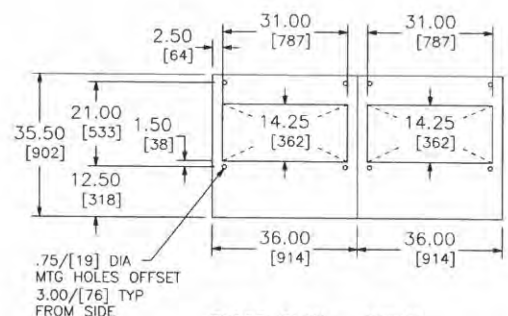
REV	DESCRIPTION	BY	DATE
-	----	--	--/--/--



TOP VIEW - FRONT



LEFT SIDE VIEW



FLOOR PLAN - FRONT

DUAL DIMENSIONS: INCHES / MILLIMETERS

NOTE:
A MINIMUM OF 2.00/[51] CLEARANCE BEHIND THE SWITCHBOARD IS REQUIRED FOR TOP COVER OVERHANG.

JOB NAME:	CITY OF FULLERTON WELL 9	EQUIPMENT DESIGNATION:	
JOB LOCATION:		EQUIPMENT TYPE:	QED-2 Switchboard
DRAWN BY:	(Q2C)	DRAWING TYPE:	SIDE, TOP VIEW & FLOOR PLAN
ENGR:		SQUARE D by Schneider Electric	
DATE:	May 22 2018		
DRAWING STATUS: QUOTE	NOT FOR CONSTRUCTION	DWG# FQ-290828-07305299-01	PG 2 OF 2 REV -

REV	DESCRIPTION	BY	DATE
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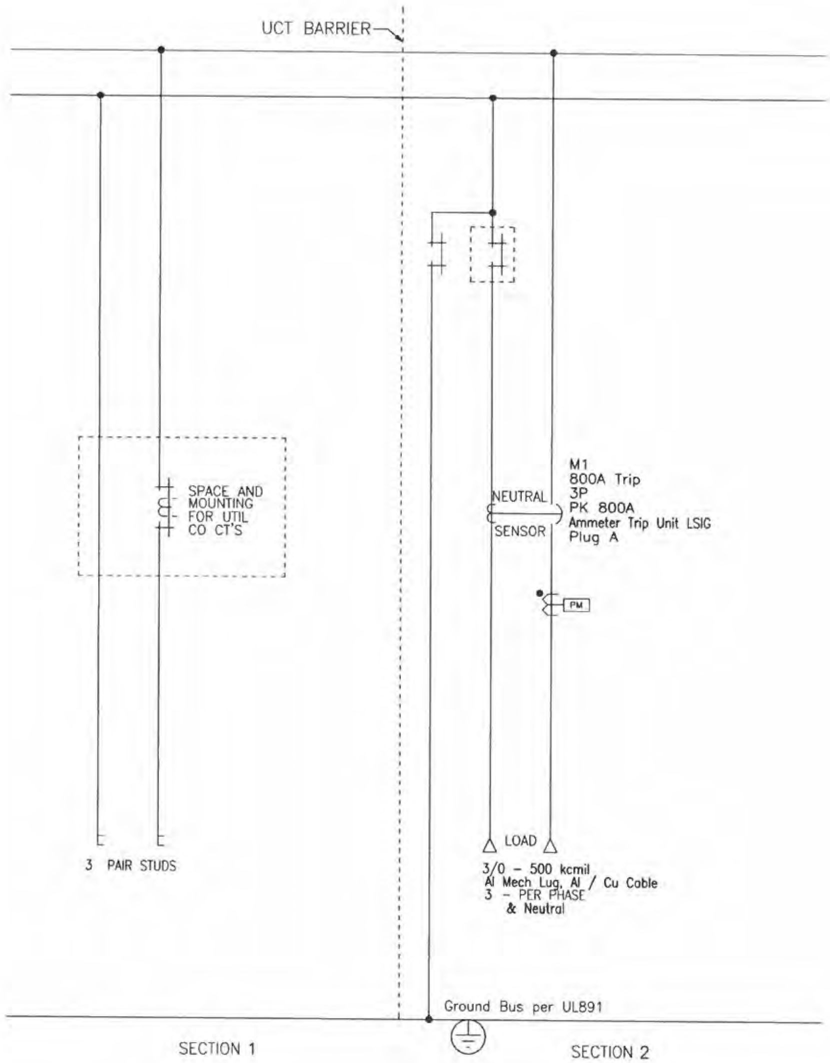

JOB NAME:	CITY OF FULLERTON WELL 9	EQUIPMENT DESIGNATION:	
JOB LOCATION:		EQUIPMENT TYPE:	QED-2 Switchboard
DRAWN BY:	(Q2C)	DRAWING TYPE:	ONE LINE
ENGR:		SQUARE D by Schneider Electric	
DATE:	May 22 2018		
DRAWING STATUS:	QUOTE	DWG# 0Q-290828-07305299-01	PG 1 OF 2 REV –

REV	DESCRIPTION	BY	DATE
–	----	--	--/--/--

POWER STYLE QED-2 SWITCHBOARD

SECT NO	CKT NO	GMD HEIGHT	DEVICE/FRAME RATING	TRIP AMP	FUSE/TRIP	#P	DESIGNATION	N/P	LUG/WIRE INFORMATION QTY	PHASE WIRE RANGE	QTY	NEUT WIRE RANGE	ACCESSORIES / NOTES
1	–	–	Strip Heater	–	–	–	–	–	–	–	–	–	SHR
1	UCT	–	800A	–	–	–	Southern Cal Edison (CA)	No	3	Pair Studs	3	Pair Studs	
2	–	–	Strip Heater	–	–	–	–	–	–	–	–	–	SHR
2	M1	–	PK 800A Plug A	800A	A-LSIG	3P		No	3	3/0 – 500 kcmil	3	3/0 – 500 kcmil	GF PLA,PM5K

LEGEND	
GF	Ground Fault
PLA	Padlock Attachment-Fixed
PM5K	Power Meter PM55XX
SHR	Strip Heater

NAMEPLATE INFORMATION:
MOUNTING TYPE: Adhesive (Field Installed)
EQUIPMENT: White Surface/Black Letters

JOB NAME: CITY OF FULLERTON WELL 9
JOB LOCATION:
DRAWN BY: (Q2C)
ENGR:
DATE: May 22 2018
DRAWING STATUS: QUOTE

EQUIPMENT DESIGNATION:
EQUIPMENT TYPE: QED-2 Switchboard
DRAWING TYPE: SCHEDULE

SQUARE D by Schneider Electric

DWG# 0Q-290828-07305299-01 PG 2 OF 2 REV –

REV	DESCRIPTION	BY	DATE		
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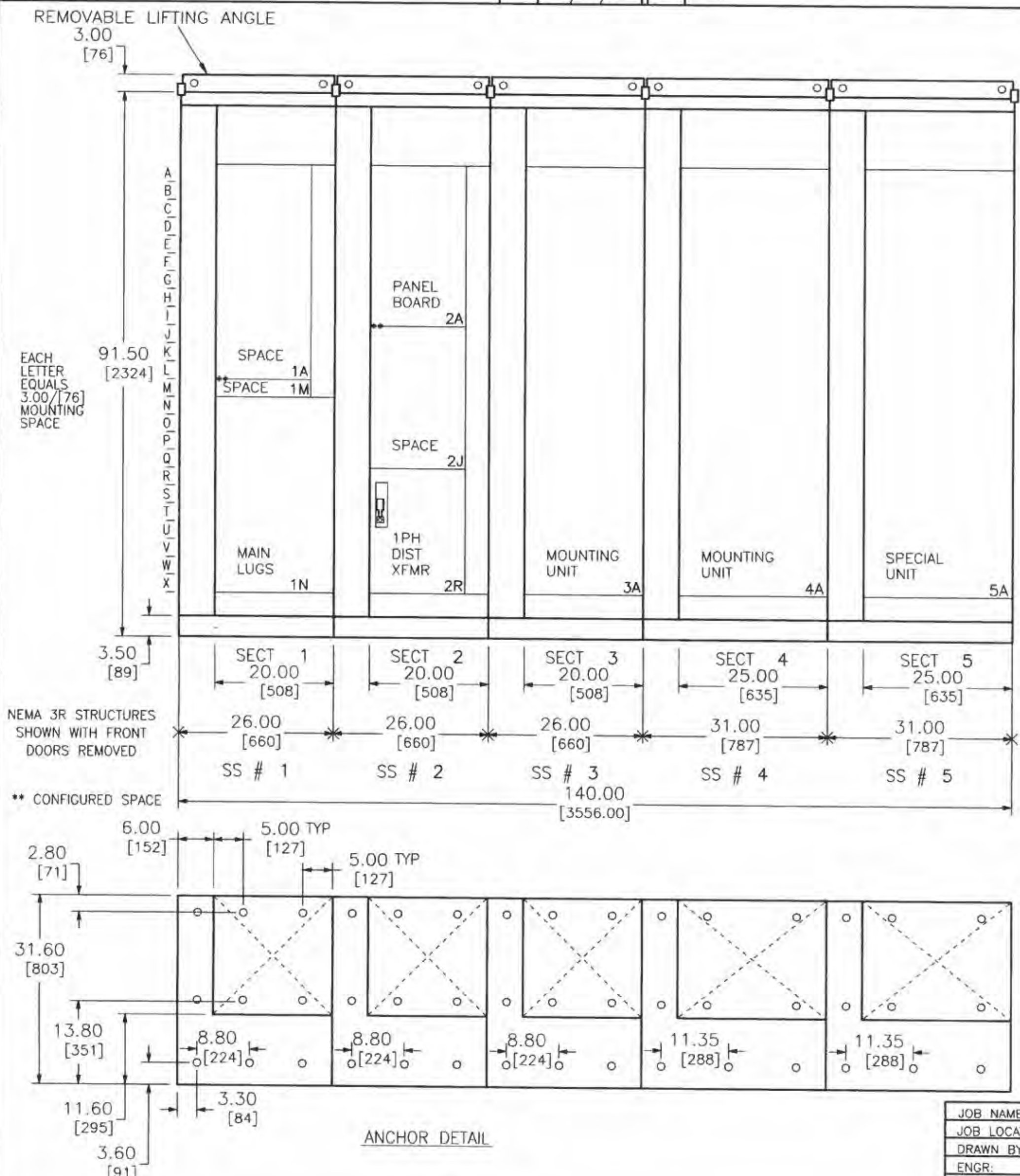


DUAL DIMENSIONS: INCHES MILLIMETERS

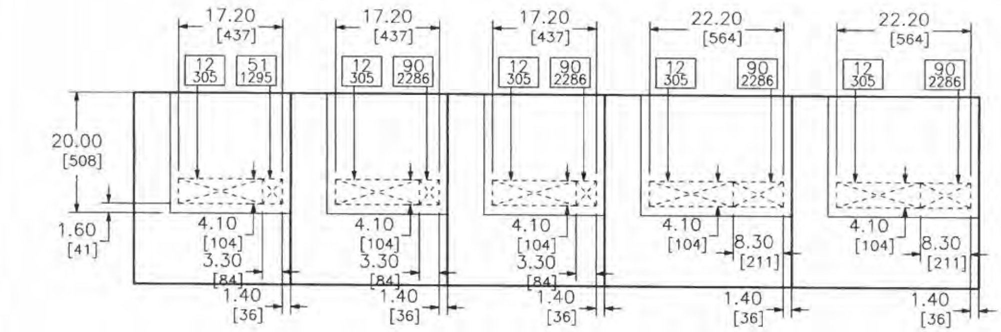
JOB NAME:	CITY OF FULLERTON WELL 9
JOB LOCATION:	
DRAWN BY:	(Q2C)
ENGR:	
DATE:	May 22 2018
DRAWING STATUS:	QUOTE

EQUIPMENT DESIGNATION:	
EQUIPMENT TYPE:	MODEL 6 MOTOR CONTROL CENTER
DRAWING TYPE:	ELEVATION

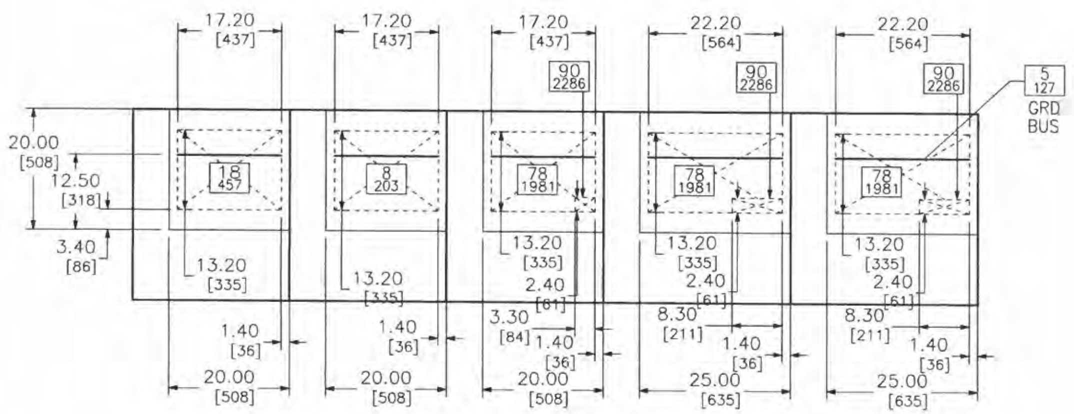
SQUARE D by Schneider Electric

DWG# FQ-290828-07311013-01 | PG 1 OF 3 | REV –

REV	DESCRIPTION	BY	DATE
–	----	--	--/--/--



TOP VIEW



FLOOR VIEW

CROSSED AREA REPRESENTS CONDUIT ENTRY AREA. NUMBERS IN BOXES INDICATE VERTICAL CLEARANCE TO NEAREST OBSTRUCTION.

DUAL DIMENSIONS: INCHES / MILLIMETERS

JOB NAME:	CITY OF FULLERTON WELL 9
JOB LOCATION:	
DRAWN BY:	(Q2C)
ENGR:	
DATE:	May 22 2018
DRAWING STATUS:	QUOTE

EQUIPMENT DESIGNATION:	
EQUIPMENT TYPE:	MODEL 6 MOTOR CONTROL CENTER
DRAWING TYPE:	ELEVATION

SQUARE D by Schneider Electric

DWG# FQ-290828-07311013-01 PG 2 OF 3 REV –

REV	DESCRIPTION	BY	DATE
-	----	--	--/--/--

GENERAL NOTES

Class 1 Type B Wiring

PRODUCT DESCRIPTION AND RATINGS

POWER SYSTEM DATA:

480V 3PH 3W 60Hz
SHORT CIRCUIT RATING: 42kA
POWER ENTERS: Main Lug Bottom Section 1
CONTROL POWER: 120Vac

BUS SYSTEM DATA:

MAIN HORIZONTAL BUS: 800 Amp Copper/Tin Plated / 1.5"
BUS BRACING: 65kA
VERTICAL BUS: 300 Amp Tin Plated Copper
HORIZONTAL GROUND BUS: .25" X 1.0" (6.35mm X 25.4mm) Tin Plated Copper
Units Securely Grounded To Structure

ENCLOSURE DATA:

ENCLOSURE TYPE: 20" DEEP Type 3R
EXTERIOR COLOR: Electrodeposition Finish ANSI 49 Medium Light Grey
INTERIOR COLOR: Electrodeposition Finish White
REMOVABLE 3" [76mm] LIFTING ANGLE

STRUCTURE MODIFICATIONS:

Ground Bus Lug : Main Section
Rodent Barriers 1,5
Manual Bus Shutters 1,2
Fishtape Unit Plugs 2
600A Vertical Bus 1
Copper Vertical Ground Bus 1,2
Master Nameplate 1
Strip Heater 3,4,5
Heater Thermostat (Red Dial)

EQUIPMENT WEIGHT:

SHIPPING SPLIT # 1: 1050.00 Lbs. (476.28 Kg.)
SHIPPING SPLIT # 2: 1050.00 Lbs. (476.28 Kg.)
SHIPPING SPLIT # 3: 1000.00 Lbs. (453.60 Kg.)
SHIPPING SPLIT # 4: 1020.00 Lbs. (462.67 Kg.)
SHIPPING SPLIT # 5: 1020.00 Lbs. (462.67 Kg.)
TOTAL LINEUP WEIGHT (APPROX): 5140.00 Lbs. (2331.50 Kg.)

PRODUCT ACCESSORIES:

Certified Test Report
Seismic Qualified IBC/ASCE7

JOB NAME:	CITY OF FULLERTON WELL 9	EQUIPMENT DESIGNATION:	
JOB LOCATION:		EQUIPMENT TYPE:	MODEL 6 MOTOR CONTROL CENTER
DRAWN BY:	(Q2C)	DRAWING TYPE:	ELEVATION
ENGR:		SQUARE D by Schneider Electric	
DATE:	May 22 2018		
DRAWING STATUS:	QUOTE	DWG# FQ-290828-07311013-01	PG 3 OF 3 REV -

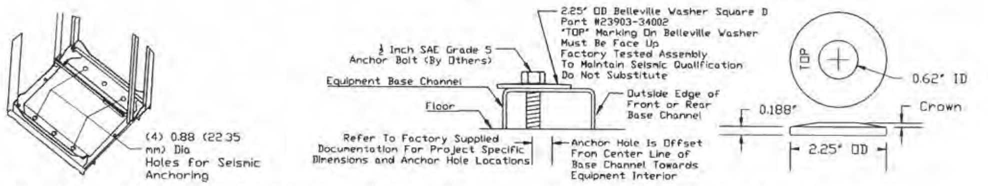
REV	DESCRIPTION	BY	DATE
–	----	--	--/--/--

REQUIREMENTS FOR SEISMIC RATING

ANCHORING CONDITIONS:

To Maintain Seismic Qualifications, Equipment Must Be Installed Per Installation Manual 80459–641–XX And Per Any Seismic Anchoring Details Provided By Others. Do Not Install Equipment Before Approved Seismic Anchoring Details Have Been Obtained And Site Preparations Have Been Made In Accordance With The Approved Seismic Anchoring Details. All Post–Installed Anchors Shall Be Approved For Seismic Loads.

Consideration Must Be Made For Conduit Entry Into Each Section When Developing Mounting Pad Reinforcement Locations. See Conduit Entry Details For Dimensional Information.



Each MCC Section Must Be Anchored At Four Locations (See Above Details). Anchor Bolt Mounting Points Are .88/[22] Diameter Holes Located 1.50/[38] Above The Base Of The MCC Section. Use Dimensions From The Anchor Detail To Determine Mounting Locations.

The Belleville Washer (Shown In Detail Above) Used For Anchoring Connections Is A Tested Component And Is Required To Maintain Position Retention Of The Equipment. The Slip Critical Connection Performance Of The Bolted Connection Was Established To The Shake Table Tested Seismic Capacity Of The Equipment As Shown On The Equipment Seismic Certificate Supplied At The Time Of Order.

CENTER OF GRAVITY:

The CG Information Provided Below Should Only Be Used For Seismic Anchoring Calculations.

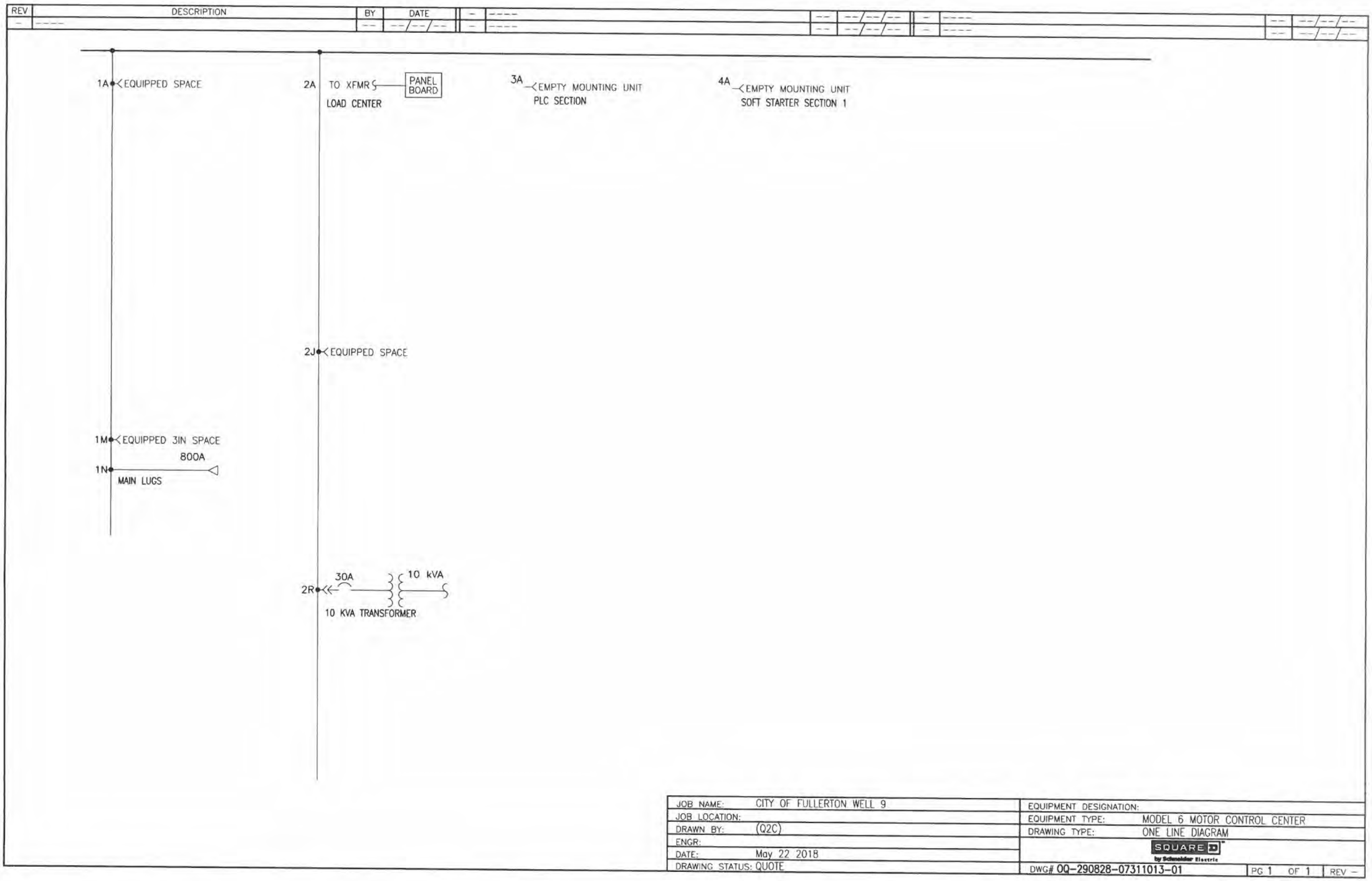
Elevation Center Of Gravity:	62.00/[1575] Up From Floor Except Masterpact NW Main Use 54.00/[1372] Up From Floor
Depth Center Of Gravity:	7.50/[191] or 10.00/[254] From Rear For 15.00/[381] or 20.00/[508] Deep Sections Respectively. Consult Factory For Sections Taller Than 94.50/[2400].
Vertical Center of Gravity:	Use Centerline Of Section From Left To Right

SECTION WEIGHTS:

The Weights Shown Below Should Only Be Used For Calculating Seismic Anchoring Requirements And Do Not Represent Actual Section Weights As Shipped.

1200 Lbs. (544.3 Kg.)	35.00/[889] Wide Sections
1300 Lbs. (589.7 Kg.)	20.00/[508] Wide Sections
1500 Lbs. (680.4 Kg.)	25.00/[635] And 30.00/[762] Wide Sections*
*1900 Lbs. (861.8 Kg.)	30.00/[762] Wide Section With Masterpact NW Main
2250 Lbs. (1020.6 Kg.)	50.00/[1270] Wide Section With 18 Pulse Drive
2750 Lbs. (1247.4 Kg.)	65.00/[1651] Wide Section With 18 Pulse Drive

JOB NAME:	CITY OF FULLERTON WELL 9	EQUIPMENT DESIGNATION:	
JOB LOCATION:		EQUIPMENT TYPE:	MODEL 6 MOTOR CONTROL CENTER
DRAWN BY:	(Q2C)	DRAWING TYPE:	SEISMIC
ENGR:		SQUARE D by Schneider Electric	
DATE:	May 22 2018		
DRAWING STATUS:	QUOTE	DWG# SQ-290828-07311013-01	PG 1 OF 1 REV –


REV
DESCRIPTION
BY
DATE
1A EQUIPPED SPACE
2A TO XFMR
PANEL BOARD
LOAD CENTER
3A EMPTY MOUNTING UNIT
PLC SECTION
4A EMPTY MOUNTING UNIT
SOFT STARTER SECTION 1
2J EQUIPPED SPACE
1M EQUIPPED 3IN SPACE
800A
1N
MAIN LUGS
30A
10 kVA
2R
10 KVA TRANSFORMER
JOB NAME: CITY OF FULLERTON WELL 9
JOB LOCATION:
DRAWN BY: (Q2C)
ENGR:
DATE: May 22 2018
DRAWING STATUS: QUOTE
EQUIPMENT DESIGNATION:
EQUIPMENT TYPE: MODEL 6 MOTOR CONTROL CENTER
DRAWING TYPE: ONE LINE DIAGRAM
SQUARE D
by Schneider Electric
DWG# 0Q-290828-07311013-01
PG 1 OF 1
REV -

REV	DESCRIPTION	BY	DATE
–	-----	--	--/--/--

UNIT LOC	UNIT NAMEPLATES (GRAY SURFACE/WHITE LETTERS)	UNIT TYPE	SIZE	HP	FRAME AMPS	TRIP AMPS	CONTROL SOURCE	VA	FUSE SIZE PRI	FUSE SIZE SEC	INTERLOCKS NO	INTERLOCKS NC	PILOT DEVICES: 30 mm ** ON LIGHT	OFF LIGHT	ADDL P/L	SS / PB	OTHER UNIT FEATURES	ELEMENTARY #
1A		SPACE																
1M		SPACE																
1N	MAIN LUGS	MAIN LUGS															1/0-500KCMIL 4 LUGS/PH, AL MECH LUG AL/CU CABLE	
2A	LOAD CENTER	PANEL BOARD	100A		QO												16 CIRCUITS, FISHTAPE UNIT PLUGS, FULLY RATED, NQ PANELBOARD, OMIT CONTROL STATION PLATE, STD WIRE LABELS	EQ-290828-07311013-01
2J		SPACE																
2R	10 KVA TRANSFORMER	1PH DIST XFMR	10 KVA		HJ 150	30											FISHTAPE UNIT PLUGS, SECONDARY WIRE TO PANELBOARD	EQ-290828-07311013-02
3A	PLC SECTION	MT UNIT																
4A	SOFT STARTER SECTION 1	MT UNIT																
5A	SOFT STARTER SECTION 2	SPECIAL UNIT															SPL	

MCC NAMEPLATE –
(GRAY SURFACE/WHITE LETTERS)

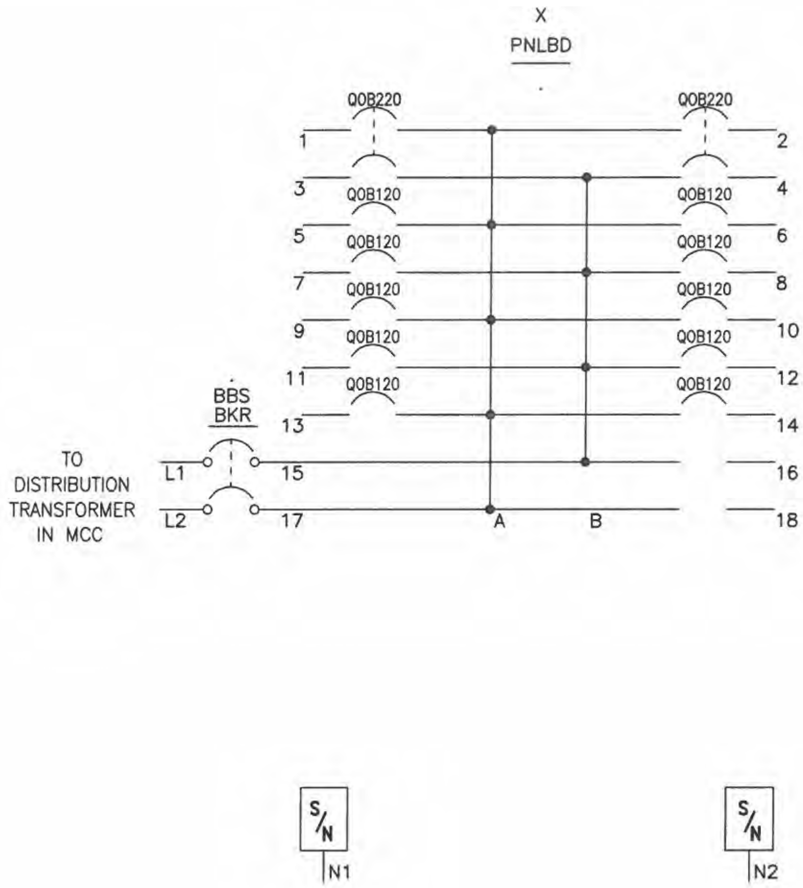
JOB NAME: CITY OF FULLERTON WELL 9
JOB LOCATION:
DRAWN BY: (Q2C)
ENGR:
DATE: May 22 2018
DRAWING STATUS: QUOTE

EQUIPMENT DESIGNATION:
EQUIPMENT TYPE: MODEL 6 MOTOR CONTROL CENTER
DRAWING TYPE: UNIT INFORMATION

SQUARE D by Schneider Electric

DWG# IQ-290828-07311013-01 PG 1 OF 1 REV –

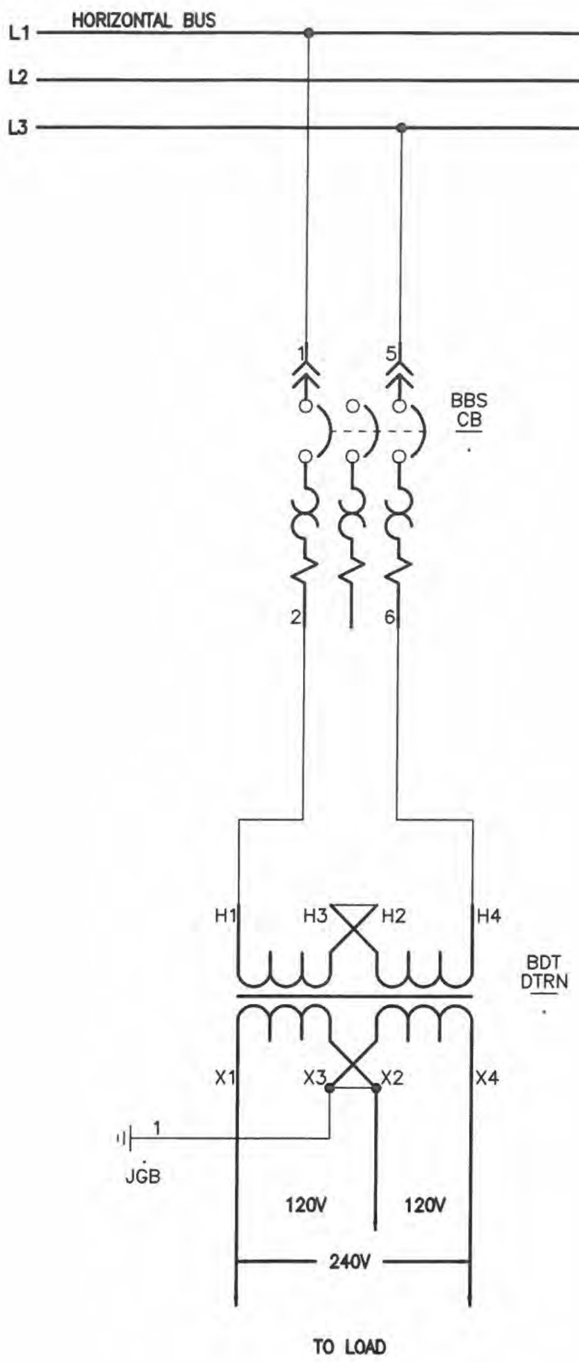
REV	DESCRIPTION	BY	DATE	-	----	--	--/--/--
-	----	--	--/--/--	-	----	--	--/--/--



Note: Connect GFI/EPD/EPE
Neutral to Panel Neutral

JOB NAME:	CITY OF FULLERTON WELL 9	EQUIPMENT DESIGNATION:	
JOB LOCATION:		EQUIPMENT TYPE:	MODEL 6 MOTOR CONTROL CENTER
DRAWN BY:	(Q2C)	DRAWING TYPE:	ELEMENTARY
ENGR:			SQUARE D by Schneider Electric
DATE:	May 22 2018		
DRAWING STATUS:	QUOTE	DWG# EQ-290828-07311013-01	PG 1 OF 1 REV -

REV	DESCRIPTION	BY	DATE	–	----	--	--/--/--
–	----	--	--/--/--	–	----	--	--/--/--



JOB NAME:	CITY OF FULLERTON WELL 9	EQUIPMENT DESIGNATION:	
JOB LOCATION:		EQUIPMENT TYPE:	MODEL 6 MOTOR CONTROL CENTER
DRAWN BY:	(Q2C)	DRAWING TYPE:	ELEMENTARY
ENGR:		SQUARE D by Schneider Electric	
DATE:	May 22 2018		
DRAWING STATUS:	QUOTE	DWG# EQ-290828-07311013-02	PG 1 OF 1 REV –

Soft start/soft stop units Altistart 48

for asynchronous motors

Catalog

October 2014

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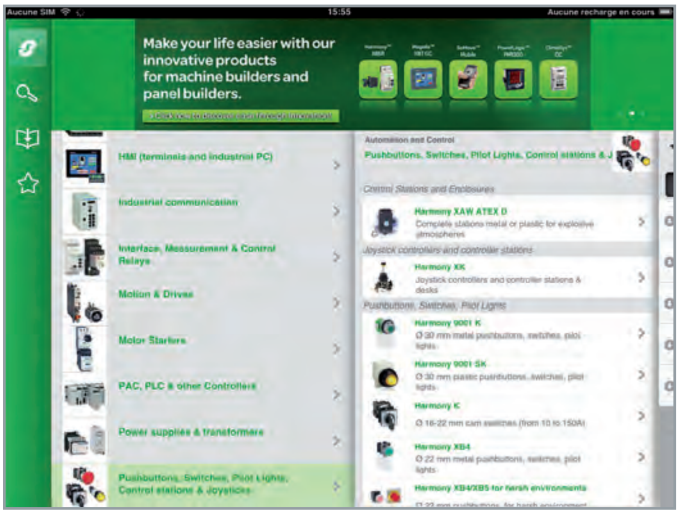

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General contents

Altistart 48 soft start/soft stop units

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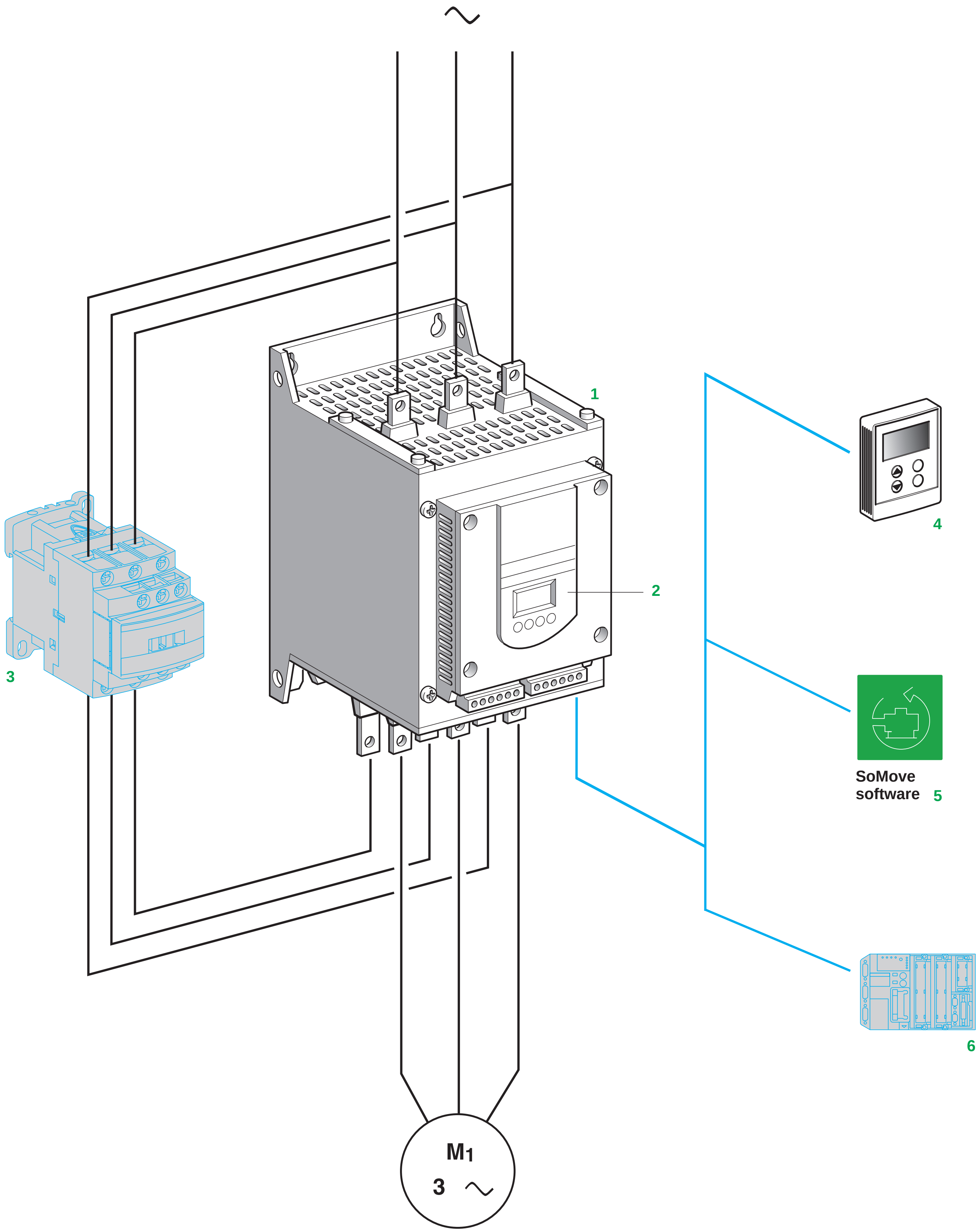
Soft starters for asynchronous motors

Applications		**Starting simple machines**	**Controlled starting and deceleration of simple machines**	**Controlled starting and deceleration of simple and complex machines**		
						
Power range for 50…60 Hz line supply (kW/*HP*) (connection to the motor power supply line)		**0.37…11/*0.5…15***	**0.75…15/*1…20***	**4…400/*3…500***	**3…630**	**3...900/*3...1,200***
	Single-phase 110…230 V (kW)	0.37…2.2	–	–		
	Three-phase 200…240 V (kW/*HP*)	–	0.75…7.5/*1…10*	–		
	Three-phase 200…480 V (kW/*HP*)	0.37…11/*0.5…15*	–	–		
	Three-phase 208…600 V (kW/*HP*)	–		4…400/*3…500*	–	
	Three-phase 208…690 V (kW/*HP*)	–		–		3…900/*3…1,200*
	Three-phase 230…415 V (kW)	–		–	3…630	–
	Three-phase 230…440 V (kW)	–		4…355	–	
	Three-phase 380…415 V (kW)	–	1.5…15	–		
	Three-phase 440...480 V (*HP*)	–	*2…20*	–		
Drive	Number of controlled phases	1	2	3		
	Type of control	–		Configurable voltage ramp	TCS (Torque Control System)	
	Operating cycle	–		Standard	Standard and severe	
Functions Bypass		Integrated		Integrated	Available as an option	
Number of I/Os	Analog inputs	–		1 PTC probe		
	Logic inputs	–		3	4	
	Analog outputs	–		–	1	
	Logic outputs	–		–	2	
	Relay outputs	–		2 (CO)	3	
Communication	Integrated	–		Modbus		
	Available as an option	–		–	Fipio, PROFIBUS DP, DeviceNet, Modbus TCP	
Standards and certifications		IEC/EN 60947-4-2 CE, UL, CSA, C-Tick, and CCC		IEC/EN 60947-4-2, EMC class A CE, UL, CSA, C-Tick, GOST, CCC	IEC/EN 60947-4-2, EMC class A and B CE, UL, CSA, DNV, C-Tick, GOST, CCC, NOM, SEPRO, and TCF	
References		ATS01N1●●●●	ATS01N2●●●●	ATS22●●●●	ATS48●●●Q	ATS48●●●Y
Pages		Please refer to the Altistart 01 catalog.		Please refer to the Altistart 22 catalog.	10	12

Soft starters for asynchronous motors

Altistart 48 soft start/soft stop units



References:
pages 10 to 13

Schneider Electric

Applications

The Altistart 48 soft start/soft stop unit is a controller with 6 thyristors used for torque-controlled soft starting and stopping of three-phase squirrel cage asynchronous motors, for power ratings between 4 and 900 kW.

It offers soft starting and deceleration functions along with machine and motor protection functions, as well as functions for communicating with control systems.
These functions are designed for use in the most common applications for centrifugal machines, pumps, fans, compressors and conveyors, which are primarily to be found in the construction, food and beverage and chemical industries. The high-performance algorithms of the Altistart 48 contribute significantly to its ruggedness, safety and ease of setup.

The Altistart 48 soft start/soft stop unit is a cost-effective solution which can:
- reduce machine operating costs by reducing mechanical stress and improving machine availability,
- reduce the stress on the electrical distribution system by reducing line current peaks and voltage drops during motor starts.
- The Altistart 48 soft start/soft stop unit offer comprises 2 ranges:
  - three-phase voltages 230 V to 415 V, 50/60 Hz,
  - three-phase voltages 208 V to 690 V, 50/60 Hz.

In each voltage range, the Altistart 48 soft start/soft stop units are sized for standard and severe applications.

Functions

The Altistart 48 soft start/soft stop unit **1** is supplied ready for use in a standard application with class 10 motor protection.

It comprises an integrated display terminal **2**, which can be used to modify the programming, adjustment or monitoring functions in order to adapt and customize the application to meet individual customer requirements.
- **Drive performance functions**:
  - exclusive Altistart torque control (patented by Schneider Electric),
  - constant control of the torque supplied to the motor during acceleration and deceleration periods (significantly reducing pressure surges),
  - ease of adjusting the ramp and the starting torque,
  - option of bypassing the starter using a contactor **3** at the end of the starting period whilst maintaining electronic protection (bypass function),
  - wide frequency tolerance for generator set power supplies,
  - option of connecting the starter to the motor delta terminals in series with each winding.
- **Machine and motor protection functions:**
  - built-in motor thermal protection,
  - processing of information from PTC thermal probes,
  - monitoring of the starting time,
  - motor preheating function,
  - protection against underloads and overcurrents in steady state.
- **Functions to ease integration into control systems:**
  - 4 logic inputs, 2 logic outputs, 3 relay outputs and 1 analog output,
  - plug-in I/O connectors,
  - function for configuring a second motor and easy-to-adapt settings,
  - display of electrical values, the state of the load and the operating time,
  - RS 485 serial link for connection to Modbus serial link.

Advantage of starting with Altistart 48

- Conventional electronic starting

To resolve problems such as:
- mechanical stress on starting,
- hydraulic transients on acceleration and deceleration in pumping applications, conventional electronic starting methods use a number of current limits, or switch several voltage ramps.

This makes adjustment complex and it has to be modified each time the load changes.

- Starting with the Altistart 48

Altistart 48 torque control enables starting without mechanical stress and smooth control of hydraulic transitions, with a single acceleration ramp.
Making adjustments is quick and easy, whatever the load.

Options

- A remote terminal can be mounted on the door of a wall-fixing or floor-standing enclosure **4**.
- SoMove setup software for PC **5**:

SoMove software incorporates various functions for the device setup phases:
- configuration preparation,
- commissioning,
- maintenance.

For more detailed information, please consult our “SoMove - Setup software for motor control devices” specialist catalogue which can be downloaded from our website www.schneider-electric.com.
- A wiring accessories offer making it easy to connect the starter to PLCs on a Modbus serial link connection **6**.
- Communication options for Ethernet, Fipio, DeviceNet and Profibus DP buses and networks.

Soft starters for asynchronous motors
Altistart 48 soft start/soft stop units

Selection criteria for an Altistart 48 soft start/soft stop unit

The Altistart 48 should be selected on the basis of 3 main criteria:

■ Two line supply voltage ranges are available for selection:
□ 3-phase AC supply: 230 – 415 V,
□ 3-phase AC supply: 208 – 690 V.

■ The power and nominal current on the motor rating plate.

■ The type of application and the operating cycle.
To simplify selection, applications are categorized as one of 2 types:
□ standard applications,
□ severe applications.
Standard or severe applications define the limit values of the current and the cycle for motor duties S1 and S4.

Standard application

In standard applications, the Altistart 48 is designed to provide:

■ Starting at 4 In for 23 seconds or at 3 In for 46 seconds from cold state (corresponding to motor duty S1).

■ Starting at 3 In for 23 seconds or at 4 In for 12 seconds with a load factor of 50% and 10 starts per hour or an equivalent thermal cycle (corresponding to motor duty S4).
The motor thermal protection must conform to protection class 10.
Example: centrifugal pump.

Severe application

In severe applications, the Altistart 48 is designed to provide:

■ Starting at 4 In for 48 seconds or at 3 In for 90 seconds from cold state (corresponding to motor duty S1).

■ Starting at 4 In for 25 seconds with a load factor of 50% and 5 starts per hour or an equivalent thermal cycle (corresponding to motor duty S4).
The motor thermal protection must conform to protection class 20.
Example: grinder.

Motor duties

S1 motor duty is based on starting followed by operation at constant load, making it possible to achieve thermal equilibrium.
S4 motor duty is based on a cycle consisting of starting, operation at constant load and an idle period.
This cycle is characterized by a load factor of 50%.

Selecting the starter

Once the appropriate application has been selected from the following page, select the starter from page 10 according to the supply voltage and the motor power.

Caution:
If the Altistart 48 is installed inside an enclosure, observe the mounting and derating recommendations.

Presentation:
page 4

References:
page 10

Application areas

Depending on the type of machine, the applications are categorized as standard or severe based on the starting characteristics, which are given as examples only, in the table below.

Type of machine	Application	Functions performed by the Altistart 48	Starting current (% In)	Starting time (s)
Centrifugal pump	Standard	Deceleration (reduction in pressure surges) Protection against underload or reversal of phase rotation direction	300	5 to 15
Piston pump	Standard	Control of pump priming and the pump's direction of rotation	350	5 to 10
Fan	Standard Severe if > 30 s	Detection of overloads caused by clogging or underloads (motor/fan transmission broken) Braking torque on stopping	300	10 to 40
Cold compressor	Standard	Protection, even for special motors	300	5 to 10
Screw compressor	Standard	Protection against reversal of phase rotation direction Contact for automatic draining on stopping	300	3 to 20
Centrifugal compressor	Standard Severe if > 30 s	Protection against reversal of phase rotation direction Contact for automatic draining on stopping	350	10 to 40
Piston compressor	Standard	Protection against reversal of phase rotation direction Contact for automatic draining on stopping	350	5 to 10
Conveyor, transporter	Standard	Monitoring of overloads for incident detection or underloads for break detection	300	3 to 10
Lifting screw	Standard	Monitoring of overloads for hard spot detection or underloads for break detection	300	3 to 10
Drag lift	Standard	Monitoring of overloads for jamming detection or underloads for break detection	400	2 to 10
Elevator	Standard	Monitoring of overloads for jamming detection or underloads for break detection Constant starting with variable load	350	5 to 10
Circular saw, band saw	Standard Severe if > 30 s	Braking for fast stop	300	10 to 60
Pulper, butchery knife	Severe	Torque control on starting	400	3 to 10
Agitator	Standard	The current display indicates the density of the material	350	5 to 20
Mixer	Standard	The current display indicates the density of the material	350	5 to 10
Grinder	Severe	Braking to limit vibrations during stopping, monitoring of overloads for jamming detection	450	5 to 60
Crusher	Severe	Braking to limit vibrations during stopping, monitoring of overloads for jamming detection	400	10 to 40
Refiner	Standard	Torque control on starting and stopping	300	5 to 30
Press	Severe	Braking to increase the number of cycles	400	20 to 60

Presentation:
page 4
References:
page 10

Soft starters for asynchronous motors

Altistart 48 soft start/soft stop units

Special uses

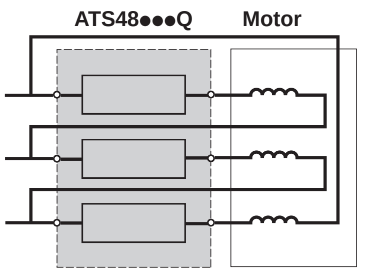
Other criteria can influence selection of the Altistart 48 rating:

Starter wired to the motor delta terminals

In addition to the most frequently encountered wiring layouts, where the starter is installed in the line supply of the motor and the motor is connected in star or delta configuration, the Altistart 48 ATS48●●●Q can be wired to the motor delta terminals in series with each winding (see figure below). The starter current is lower by a ratio of $\sqrt{3}$ than the line current absorbed by the motor. This type of installation enables a starter with a lower rating to be used.

Example: For a 400 V/110 kW motor with a line current of 195 A (current indicated on the rating plate for the delta connection), the current in each winding is equal to $195/\sqrt{3}$ i.e. 114 A.
Select the starter rating with a maximum permanent nominal current just above this current, i.e. 140 A (ATS48C14Q for a standard application).
To avoid the need to do this calculation, simply use the table on page 11.

This type of installation only permits freewheel stopping and is not compatible with the cascade and preheating functions.



Starter wired in series with the motor windings

Note: The nominal current and limiting current settings as well as the current displayed during operation are on-line values (so do not have to be calculated by the user).

Caution: For this type of installation, observe the wiring scheme and the associated recommendations.

Starter bypassed by a contactor

The starter can be bypassed by a contactor at the end of starting (to limit the heat dissipated by the starter). The bypass contactor is controlled by the starter, and the current measurements and protective mechanisms remain active when the starter is bypassed.
The starter is selected on the basis of the 3 main criteria and one of the following criteria:

- If the starter is bypassed at the end of starting, the motor is always started from cold state and the starter can be oversized by one rating.

Example: Select an ATS 48D17Q for an 11 kW motor in a standard 400 V application.

- If the starter needs to be able to operate without the bypass contactor at the end of starting, it does not have to be derated.

Example: Select an ATS 48D17Q for a 7.5 kW motor in a standard 400 V application.

Presentation:
page 4
References:
page 10

Schneider Electric

Soft starters for asynchronous motors

Altistart 48 soft start/soft stop units

Special uses (continued)

Motors in parallel

Motors may be connected in parallel provided that the power limit of the starter is not exceeded (the sum of the motor currents must be less than the nominal current of the starter chosen according to the type of application). Provide thermal protection for each motor.

Slip-ring motors

The Altistart 48 can operate with a bypassed rotor resistance motor or with a threshold resistor. The starting torque is modified according to the rotor resistance. If necessary, keep a low-value resistor in order to obtain the required torque to overcome the resistive torque on starting.
A bypassed slip-ring motor has very low starting torque. A high stator current is required to obtain sufficient starting torque.
Oversize the starter in order to have a limiting current 7 times that of the nominal current.

Note*: Ensure that the motor starting torque, equal to 7 times the nominal current, is greater than the resistive torque.*

Comment: The Altistart 48 torque control enables excellent soft starting despite the limiting current being 7 times the nominal current required to start the motor.

Dahlander motor and 2-speed motor

The Altistart 48 can operate with a 2-speed motor. A motor demagnetization period must elapse before changing from low speed to high speed in order to avoid antiphases between the line supply and the motor, which would generate very high currents.
Select the starter using the 3 main criteria.

Very long cable

Very long motor cables cause voltage drops due to the resistance of the cable. If the voltage drop is significant, it could affect the current consumption and the torque available. This must therefore be taken into account when selecting the motor and the starter.

Starters in parallel on the same line supply

If several starters are installed on the same line supply, line chokes should be installed between the transformer and the starter (see page 27).

Recommendations for use

Caution: Do not use the Altistart 48 upstream of loads other than motors (for example, transformers and resistors are forbidden).
Do not connect power factor correction capacitors to the terminals of a motor controlled by an Altistart 48.

Presentation:
page 4

References:
page 10

Soft starters for asynchronous motors

Altistart 48 soft start/soft stop units

Line voltage 230...415 V

Connection in the motor supply line

106762SE

ATS48D17Q

106761SE

ATS48C14Q

106758SE

ATS48M12Q

For standard applications

Motor		Starter 230...415 V - 50/60 Hz				
Motor power *(1)*		Nominal current (IcL) *(2)*	Factory setting current *(4)*	Dissipated power at nominal load	Reference	Weight
230 V	400 V					
kW	kW	A	A	W		kg/*lb*
4	7.5	17	14.8	59	**ATS48D17Q**	4.900/*10.803*
5.5	11	22	21	74	**ATS48D22Q**	4.900/*10.803*
7.5	15	32	28.5	104	**ATS48D32Q**	4.900/*10.803*
9	18.5	38	35	116	**ATS48D38Q**	4.900/*10.803*
11	22	47	42	142	**ATS48D47Q**	4.900/*10.803*
15	30	62	57	201	**ATS48D62Q**	8.300/*18.298*
18.5	37	75	69	245	**ATS48D75Q**	8.300/*18.298*
22	45	88	81	290	**ATS48D88Q**	8.300/*18.298*
30	55	110	100	322	**ATS48C11Q**	8.300/*18.298*
37	75	140	131	391	**ATS48C14Q**	12.400/*27.337*
45	90	170	162	479	**ATS48C17Q**	12.400/*27.337*
55	110	210	195	580	**ATS48C21Q**	18.200/*40.124*
75	132	250	233	695	**ATS48C25Q**	18.200/*40.124*
90	160	320	285	902	**ATS48C32Q**	18.200/*40.124*
110	220	410	388	1339	**ATS48C41Q**	51.400/*113.317*
132	250	480	437	1386	**ATS48C48Q**	51.400/*113.317*
160	315	590	560	1731	**ATS48C59Q**	51.400/*113.317*
–	355	660	605	1958	**ATS48C66Q**	51.400/*113.317*
220	400	790	675	2537	**ATS48C79Q**	115.000/*253.531*
250	500	1000	855	2865	**ATS48M10Q**	115.000/*253.531*
355	630	1200	1045	3497	**ATS48M12Q**	115.000/*253.531*

For severe applications

Motor		Starter 230...415 V - 50/60 Hz				
Motor power *(1)*		Nominal current *(3)*	Factory setting current *(4)*	Dissipated power at nominal load	Reference	Weight
230 V	400 V					
kW	kW	A	A	W		kg/*lb*
3	5.5	12	14.8	46	**ATS48D17Q**	4.900/*10.803*
4	7.5	17	21	59	**ATS48D22Q**	4.900/*10.803*
5.5	11	22	28.5	74	**ATS48D32Q**	4.900/*10.803*
7.5	15	32	35	99	**ATS48D38Q**	4.900/*10.803*
9	18.5	38	42	116	**ATS48D47Q**	4.900/*10.803*
11	22	47	57	153	**ATS48D62Q**	8.300/*18.298*
15	30	62	69	201	**ATS48D75Q**	8.300/*18.298*
18.5	37	75	81	245	**ATS48D88Q**	8.300/*18.298*
22	45	88	100	252	**ATS48C11Q**	8.300/*18.298*
30	55	110	131	306	**ATS48C14Q**	12.400/*27.337*
37	75	140	162	391	**ATS48C17Q**	12.400/*27.337*
45	90	170	195	468	**ATS48C21Q**	18.200/*40.124*
55	110	210	233	580	**ATS48C25Q**	18.200/*40.124*
75	132	250	285	695	**ATS48C32Q**	18.200/*40.124*
90	160	320	388	1017	**ATS48C41Q**	51.400/*113.317*
110	220	410	437	1172	**ATS48C48Q**	51.400/*113.317*
132	250	480	560	1386	**ATS48C59Q**	51.400/*113.317*
160	315	590	605	1731	**ATS48C66Q**	51.400/*113.317*
–	355	660	675	2073	**ATS48C79Q**	115.000/*253.531*
220	400	790	855	2225	**ATS48M10Q**	115.000/*253.531*
250	500	1000	1045	2865	**ATS48M12Q**	115.000/*253.531*

(1) Value indicated on the motor rating plate.
(2) Corresponds to the maximum continuous current in class 10. IcL corresponds to the starter rating.
(3) Corresponds to the maximum continuous current in class 20.
(4) The factory setting current corresponds to the nominal current of a standard 4-pole, 400 V, class 10 motor (standard application). Adjust it in line with the current indicated on the motor rating plate.

Presentation:
pages 4 and 5

Soft starters for asynchronous motors

Altistart 48 soft start/soft stop units

Line voltage 230...415 V

Connection to the motor delta terminals

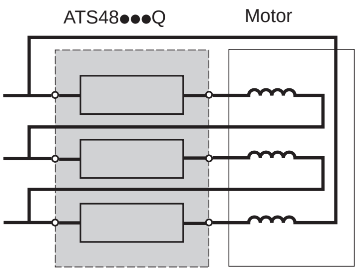


Figure 1
Special use:
starter connected to the motor delta terminals, in series with each winding.

For standard applications according to figure 1

Motor		Starter 230...415 V - 50/60 Hz				
Motor power *(1)*		Nominal current *(2)*	Factory setting current *(4)*	Dissipated power at nominal load	Reference	Weight
230 V	400 V					
kW	kW	A	A	W		kg/*lb*
7.5	15	29	14.8	59	**ATS48D17Q**	4.900/*10.803*
9	18.5	38	21	74	**ATS48D22Q**	4.900/*10.803*
15	22	55	28.5	104	**ATS48D32Q**	4.900/*10.803*
18.5	30	66	35	116	**ATS48D38Q**	4.900/*10.803*
22	45	81	42	142	**ATS48D47Q**	4.900/*10.803*
30	55	107	57	201	**ATS48D62Q**	8.300/*18.298*
37	55	130	69	245	**ATS48D75Q**	8.300/*18.298*
45	75	152	81	290	**ATS48D88Q**	8.300/*18.298*
55	90	191	100	322	**ATS48C11Q**	8.300/*18.298*
75	110	242	131	391	**ATS48C14Q**	12.400/*27.337*
90	132	294	162	479	**ATS48C17Q**	12.400/*27.337*
110	160	364	195	580	**ATS48C21Q**	18.200/*40.124*
132	220	433	233	695	**ATS48C25Q**	18.200/*40.124*
160	250	554	285	902	**ATS48C32Q**	18.200/*40.124*
220	315	710	388	1339	**ATS48C41Q**	51.400/*113.317*
250	355	831	437	1386	**ATS48C48Q**	51.400/*113.317*
–	400	1022	560	1731	**ATS48C59Q**	51.400/*113.317*
315	500	1143	605	1958	**ATS48C66Q**	51.400/*113.317*
355	630	1368	675	2537	**ATS48C79Q**	115.000/*253.531*
–	710	1732	855	2865	**ATS48M10Q**	115.000/*253.531*
500	–	2078	1045	3497	**ATS48M12Q**	115.000/*253.531*

For severe applications according to figure 1

Motor		Starter 230...415 V - 50/60 Hz				
Motor power *(1)*		Nominal current *(3)*	Factory setting current *(4)*	Dissipated power at nominal load	Reference	Weight
230 V	400 V					
kW	kW	A	A	W		kg/*lb*
5.5	11	22	14.8	46	**ATS48D17Q**	4.900/*10.803*
7.5	15	29	21	59	**ATS48D22Q**	4.900/*10.803*
9	18.5	38	28.5	74	**ATS48D32Q**	4.900/*10.803*
15	22	55	35	99	**ATS48D38Q**	4.900/*10.803*
18.5	30	66	42	116	**ATS48D47Q**	4.900/*10.803*
22	45	81	57	153	**ATS48D62Q**	8.300/*18.298*
30	55	107	69	201	**ATS48D75Q**	8.300/*18.298*
37	55	130	81	245	**ATS48D88Q**	8.300/*18.298*
45	75	152	100	252	**ATS48C11Q**	8.300/*18.298*
55	90	191	131	306	**ATS48C14Q**	12.400/*27.337*
75	110	242	162	391	**ATS48C17Q**	12.400/*27.337*
90	132	294	195	468	**ATS48C21Q**	18.200/*40.124*
110	160	364	233	580	**ATS48C25Q**	18.200/*40.124*
132	220	433	285	695	**ATS48C32Q**	18.200/*40.124*
160	250	554	388	1017	**ATS48C41Q**	51.400/*113.317*
220	315	710	437	1172	**ATS48C48Q**	51.400/*113.317*
250	355	831	560	1386	**ATS48C59Q**	51.400/*113.317*
–	400	1022	605	1731	**ATS48C66Q**	51.400/*113.317*
315	500	1143	675	2073	**ATS48C79Q**	115.000/*253.531*
355	630	1368	855	2225	**ATS48M10Q**	115.000/*253.531*
–	710	1732	1045	2865	**ATS48M12Q**	115.000/*253.531*

(1) Value indicated on the motor rating plate.
(2) Corresponds to the maximum continuous current in class 10.
(3) Corresponds to the maximum continuous current in class 20.
(4) For this type of connection, the factory setting current must be adjusted in line with the current indicated on the motor rating plate.

Presentation:
pages 4 and 5

Soft starters for asynchronous motors

Altistart 48 soft start/soft stop units

Line voltage 208...690 V

Motor power given in HP

106762SE

ATS48D17Y

106761SE

ATS48C14Y

106758SE

ATS48M12Y

For standard applications

Motor				Starter 208...690 V - 50/60 Hz				
Motor power *(1)*				Nominal current (IcL) *(2)*	Factory setting current *(4)*	Dissipated power at nominal load	Reference	Weight
208 V	230 V	460 V	575 V					
HP	HP	HP	HP	A	A	W		kg/lb
3	5	10	15	17	14	59	ATS48D17Y	4.900/10.803
5	7.5	15	20	22	21	74	ATS48D22Y	4.900/10.803
7.5	10	20	25	32	27	104	ATS48D32Y	4.900/10.803
10	–	25	30	38	34	116	ATS48D38Y	4.900/10.803
–	15	30	40	47	40	142	ATS48D47Y	4.900/10.803
15	20	40	50	62	52	201	ATS48D62Y	8.300/18.298
20	25	50	60	75	65	245	ATS48D75Y	8.300/18.298
25	30	60	75	88	77	290	ATS48D88Y	8.300/18.298
30	40	75	100	110	96	322	ATS48C11Y	8.300/18.298
40	50	100	125	140	124	391	ATS48C14Y	12.400/27.337
50	60	125	150	170	156	479	ATS48C17Y	12.400/27.337
60	75	150	200	210	180	580	ATS48C21Y	18.200/40.124
75	100	200	250	250	240	695	ATS48C25Y	18.200/40.124
100	125	250	300	320	302	902	ATS48C32Y	18.200/40.124
125	150	300	350	410	361	1339	ATS48C41Y	51.400/113.317
150	–	350	400	480	414	1386	ATS48C48Y	51.400/113.317
–	200	400	500	590	477	1731	ATS48C59Y	51.400/113.317
200	250	500	600	660	590	1958	ATS48C66Y	51.400/113.317
250	300	600	800	790	720	2537	ATS48C79Y	115.000/253.531
350	350	800	1000	1000	954	2865	ATS48M10Y	115.000/253.531
400	450	1000	1200	1200	1170	3497	ATS48M12Y	115.000/253.531

For severe applications

Motor				Starter 208...690 V - 50/60 Hz				
Motor power *(1)*				Nominal current *(3)*	Factory setting current *(4)*	Dissipated power at nominal load	Reference	Weight
208 V	230 V	460 V	575 V					
HP	HP	HP	HP	A	A	W		kg/lb
2	3	7.5	10	12	14	46	ATS48D17Y	4.900/10.803
3	5	10	15	17	21	59	ATS48D22Y	4.900/10.803
5	7.5	15	20	22	27	74	ATS48D32Y	4.900/10.803
7.5	10	20	25	32	34	99	ATS48D38Y	4.900/10.803
10	–	25	30	38	40	116	ATS48D47Y	4.900/10.803
–	15	30	40	47	52	153	ATS48D62Y	8.300/18.298
15	20	40	50	62	65	201	ATS48D75Y	8.300/18.298
20	25	50	60	75	77	245	ATS48D88Y	8.300/18.298
25	30	60	75	88	96	252	ATS48C11Y	8.300/18.298
30	40	75	100	110	124	306	ATS48C14Y	12.400/27.337
40	50	100	125	140	156	391	ATS48C17Y	12.400/27.337
50	60	125	150	170	180	468	ATS48C21Y	18.200/40.124
60	75	150	200	210	240	580	ATS48C25Y	18.200/40.124
75	100	200	250	250	302	695	ATS48C32Y	18.200/40.124
100	125	250	300	320	361	1017	ATS48C41Y	51.400/113.317
125	150	300	350	410	414	1172	ATS48C48Y	51.400/113.317
150	–	350	400	480	477	1386	ATS48C59Y	51.400/113.317
–	200	400	500	590	590	1731	ATS48C66Y	51.400/113.317
200	250	500	600	660	720	2073	ATS48C79Y	115.000/253.531
250	300	600	800	790	954	2225	ATS48M10Y	115.000/253.531
350	350	800	1000	1000	1170	2865	ATS48M12Y	115.000/253.531

(1) Value indicated on the motor rating plate.
(2) Corresponds to the maximum continuous current in class 10. IcL corresponds to the starter rating.
(3) Corresponds to the maximum continuous current in class 20.
(4) The factory setting current corresponds to the nominal current of a standard NEC, 460 V, class 10 motor (standard application). Adjust it in line with the current indicated on the motor rating plate.

Presentation:
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Soft starters for asynchronous motors

Altistart 48 soft start/soft stop units

Line voltage 208...690 V

Motor power in kW

For standard applications

Motor							Starter 208...690 V - 50/60 Hz				
Motor power *(1)*							Nominal current (IcL) *(2)*	Factory setting current *(4)*	Dissipated power at nominal load	Reference	Weight
230 V	400 V	440 V	500 V	525 V	660 V	690 V					
kW	kW	kW	kW	kW	kW	kW	A	A	W		kg/*lb*
4	7.5	7.5	9	9	11	15	17	14	59	**ATS48D17Y**	4.900/*10.803*
5.5	11	11	11	11	15	18.5	22	21	74	**ATS48D22Y**	4.900/*10.803*
7.5	15	15	18.5	18.5	22	22	32	27	104	**ATS48D32Y**	4.900/*10.803*
9	18.5	18.5	22	22	30	30	38	34	116	**ATS48D38Y**	4.900/*10.803*
11	22	22	30	30	37	37	47	40	142	**ATS48D47Y**	4.900/*10.803*
15	30	30	37	37	45	45	62	52	201	**ATS48D62Y**	8.300/*18.298*
18.5	37	37	45	45	55	55	75	65	245	**ATS48D75Y**	8.300/*18.298*
22	45	45	55	55	75	75	88	77	290	**ATS48D88Y**	8.300/*18.298*
30	55	55	75	75	90	90	110	96	322	**ATS48C11Y**	8.300/*18.298*
37	75	75	90	90	110	110	140	124	391	**ATS48C14Y**	12.400/*27.337*
45	90	90	110	110	132	160	170	156	479	**ATS48C17Y**	12.400/*27.337*
55	110	110	132	132	160	200	210	180	580	**ATS48C21Y**	18.200/*40.124*
75	132	132	160	160	220	250	250	240	695	**ATS48C25Y**	18.200/*40.124*
90	160	160	220	220	250	315	320	302	902	**ATS48C32Y**	18.200/*40.124*
110	220	220	250	250	355	400	410	361	1339	**ATS48C41Y**	51.400/*113.317*
132	250	250	315	315	400	500	480	414	1386	**ATS48C48Y**	51.400/*113.317*
160	315	355	400	400	560	560	590	477	1731	**ATS48C59Y**	51.400/*113.317*
–	355	400	–	–	630	630	660	590	1958	**ATS48C66Y**	51.400/*113.317*
220	400	500	500	500	710	710	790	720	2537	**ATS48C79Y**	115.000/*253.531*
250	500	630	630	630	900	900	1000	954	2865	**ATS48M10Y**	115.000/*253.531*
355	630	710	800	800	–	–	1200	1170	3497	**ATS48M12Y**	115.000/*253.531*

For severe applications

Motor							Starter 208...690 V - 50/60 Hz				
Motor power *(1)*							Nominal current *(3)*	Factory setting current *(4)*	Dissipated power at nominal load	Reference	Weight
230 V	400 V	440 V	500 V	525 V	660 V	690 V					
kW	kW	kW	kW	kW	kW	kW	A	A	W		kg/*lb*
3	5.5	5.5	7.5	7.5	9	11	12	14	46	**ATS48D17Y**	4.900/*10.803*
4	7.5	7.5	9	9	11	15	17	21	59	**ATS48D22Y**	4.900/*10.803*
5.5	11	11	11	11	15	18.5	22	27	74	**ATS48D32Y**	4.900/*10.803*
7.5	15	15	18.5	18.5	22	22	32	34	99	**ATS48D38Y**	4.900/*10.803*
9	18.5	18.5	22	22	30	30	38	40	116	**ATS48D47Y**	4.900/*10.803*
11	22	22	30	30	37	37	47	52	153	**ATS48D62Y**	8.300/*18.298*
15	30	30	37	37	45	45	62	65	201	**ATS48D75Y**	8.300/*18.298*
18.5	37	37	45	45	55	55	75	77	245	**ATS48D88Y**	8.300/*18.298*
22	45	45	55	55	75	75	88	96	252	**ATS48C11Y**	8.300/*18.298*
30	55	55	75	75	90	90	110	124	306	**ATS48C14Y**	12.400/*27.337*
37	75	75	90	90	110	110	140	156	391	**ATS48C17Y**	12.400/*27.337*
45	90	90	110	110	132	160	170	180	468	**ATS48C21Y**	18.200/*40.124*
55	110	110	132	132	160	200	210	240	580	**ATS48C25Y**	18.200/*40.124*
75	132	132	160	160	220	250	250	302	695	**ATS48C32Y**	18.200/*40.124*
90	160	160	220	220	250	315	320	361	1017	**ATS48C41Y**	51.400/*113.317*
110	220	220	250	250	355	400	410	414	1172	**ATS48C48Y**	51.400/*113.317*
132	250	250	315	315	400	500	480	477	1386	**ATS48C59Y**	51.400/*113.317*
160	315	355	400	400	560	560	590	590	1731	**ATS48C66Y**	51.400/*113.317*
–	355	400	–	–	630	630	660	720	2073	**ATS48C79Y**	115.000/*253.531*
220	400	500	500	500	710	710	790	954	2225	**ATS48M10Y**	115.000/*253.531*
250	500	630	630	630	900	900	1000	1170	2865	**ATS48M12Y**	115.000/*253.531*

(1) Value indicated on the motor rating plate.
(2) Corresponds to the maximum continuous current in class 10. IcL corresponds to the starter rating.
(3) Corresponds to the maximum continuous current in class 20.
(4) The factory setting current corresponds to the nominal current of a standard NEC, 460 V, class 10 motor (standard application). Adjust it in line with the current indicated on the motor rating plate.

Presentation:
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Soft starters for asynchronous motors

Altistart 48 soft start/soft stop units

230 V power supply

Type 1 coordination

Compatible components according to standards IEC 60947-4-1 and IEC 60947-4-2

Use either a circuit-breaker (light green columns), contactor, starter combination or a switch/fuse (dark green columns), contactor, starter combination

Motor		Starter *(1)*		Circuit-breaker		Type of contactor	Type of switch or switch disconnector (bare unit)	aM fuses			
		Class 10 Standard applications	Class 20 Severe applications	Reference	Rating			Unit reference *(3)*		Size	Rating
								Without striker	With striker		
kW	A				A						A
M1		A1		Q1		KM1, KM2, KM3					
3	11.5	–	**ATS48D17●**	**GV2L20**	18	**LC1D18**	**LS1D32**	**DF2CA16**	–	10 x 38	–
				NS80HMA	12.5	**LC1D18**	**LS1D32**	**DF2CA16**	–	10 x 38	16
4	14.5	**ATS48D17●**	**ATS48D22●**	**GV2L20**	18	**LC1D18**	**LS1D32**	**DF2CA16**	–	10 x 38	16
				NS80HMA	25	**LC1D18**	**LS1D32**	**DF2CA16**	–	10 x 38	16
5.5	20	**ATS48D22●**	**ATS48D32●**	**GV2L22**	25	**LC1D25**	**LS1D32**	**DF2CA25**	–	10 x 38	25
				NS80HMA	25	**LC1D25**	**LS1D32**	**DF2CA25**	–	10 x 38	25
7.5	27	**ATS48D32●**	**ATS48D38●**	**GV2L32**	32	**LC1D32**	**GK1EK**	**DF2EA32**	**DF3EA32**	14 x 51	32
				NS80HMA	50	**LC1D32**	**GK1EK**	**DF2EA32**	**DF3EA32**	14 x 51	32
9	32	**ATS48D38●**	**ATS48D47●**	**GV3L40**	40	**LC1D38**	**GK1EK**	**DF2EA40**	**DF3EA40**	14 x 51	40
				NS80HMA	50	**LC1D38**	**GK1EK**	**DF2EA40**	**DF3EA40**	14 x 51	40
11	39	**ATS48D47●**	**ATS48D62●**	**GV3L65**	65	**LC1D50A**	**GS1K**	**DF2FA50**	**DF3FA50**	22 x 58	50
				NS80HMA	50	**LC1D50A**	**GS1K**	**DF2FA50**	**DF3FA50**	22 x 58	50
15	52	**ATS48D62●**	**ATS48D75●**	**GV3L65**	65	**LC1D65A**	**GS1K**	**DF2FA80**	**DF3FA80**	22 x 58	80
				NS80HMA	80	**LC1D65A**	**GS1K**	**DF2FA80**	**DF3FA80**	22 x 58	80
18.5	64	**ATS48D75●**	**ATS48D88●**	***NS80HMA***	80	**LC1D80**	**GS1K**	**DF2FA80**	**DF3FA80**	22 x 58	80
22	75	**ATS48D88●**	**ATS48C11●**	***NSX100●MA*** *(2)*	100	**LC1D115**	**GS1K**	**DF2FA100**	**DF3FA100**	22 x 58	100
30	103	**ATS48C11●**	**ATS48C14●**	***NSX160●MA*** *(2)*	150	**LC1D115**	**GS1K**	**DF2FA125**	**DF4FA125**	22 x 58	125
37	126	**ATS48C14●**	**ATS48C17●**	***NSX160●MA*** *(2)*	150	**LC1D150**	**GS1L**	**DF2GA1161**	**DF4GA1161**	0	160
45	150	**ATS48C17●**	**ATS48C21●**	***NSX250●MA*** *(2)*	220	**LC1F185**	**GS1N**	**DF2HA1201**	**DF4HA1201**	1	200
55	182	**ATS48C21●**	**ATS48C25●**	***NSX250●MA*** *(2)*	220	**LC1F225**	**GS1N**	**DF2HA1201**	**DF4HA1201**	1	200
75	240	**ATS48C25●**	**ATS48C32●**	***NSX400●*** *(2)* ***Micrologic 1.3M***	320	**LC1F265**	**GS1QQ**	**DF2JA1251**	**DF4JA1251**	2	250
90	295	**ATS48C32●**	**ATS48C41●**	***NSX400●*** *(2)* ***Micrologic 1.3M***	320	**LC1F330**	**GS1QQ**	**DF2JA1311**	**DF4JA1311**	2	315
110	356	**ATS48C41●**	**ATS48C48●**	***NSX630●*** *(2)* ***Micrologic 1.3M***	500	**LC1F400**	**GS1S**	**DF2KA1401**	**DF4KA1401**	3	400
132	425	**ATS48C48●**	**ATS48C59●**	***NSX630●*** *(2)* ***Micrologic 1.3M***	500	**LC1F500**	**GS1S**	**DF2KA1501**	**DF4KA1501**	3	500
160	520	**ATS48C59●**	**ATS48C66●**	***NS630b●*** *(2)* ***Micrologic 5.0 LR Off***	630	**LC1F630**	**GS1S**	**DF2KA1631**	**DF4KA1631**	3	630
200	630	**ATS48C66●**	**ATS48C79●**	***NS800●*** *(2)* ***Micrologic 5.0 LR Off***	800	**LC1F800**	**GS1S**	**DF2KA1631**	**DF4KA1631**	3	630
220	700	**ATS48C79●**	**ATS48M10●**	***NS800●*** *(2)* ***Micrologic 5.0 LR Off***	800	**LC1F800**	**GS1V**	**DF2LA1801**	**DF4LA1801**	4	800
250	800	**ATS48M10●**	**ATS48M12●**	***NS1000●*** *(2)* ***Micrologic 5.0 LR Off***	1000	**LC1BM33**	**GS1V**	**DF2LA1101**	**DF4LA1101**	4	1000
355	1115	**ATS48M12●**	–	***NS1250●*** *(2)* ***Micrologic 5.0 LR Off***	1250	**LC1BP33**	–	**DF2LA1251**	**DF4LA1251**	4	1250

(1) Replace ● with Q or Y according to the starter's voltage range.
(2) Replace ● with F, N, H, S, L or LB according to the breaking capacity (see the breaking capacity table below).
(3) DF2CA, DF●EA, DF●FA: sold in lots of 20.
DF●GA, DF●KA: sold in lots of 3.
DF●LA: sold singly.

Maximum starter prospective short-circuit current according to standard IEC 60947-4-2

Starter	Iq (kA)
ATS48D17● to ATS48C32●	**50**
ATS48C41● to ATS48M12●	**70**

Breaking capacity of circuit-breakers according to standard IEC 60947-4-2

230 V	Icu (kA)
GV2L20	100
GV2L22, GV2L32, GV3L40, GV3L65	50

230 V	Icu (kA)					
	F	N	H	S	L	LB
NS80HMA	–	–	100 kA	–	–	–
NSX100/160/250	85 kA	90 kA	100 kA	120 kA	150 kA	–
NSX400/630	85 kA	90 kA	100 kA	120 kA	150 kA	–
NS630b/800L/LB	–	–	–	–	150 kA	200 kA
NS1000L	–	–	–	–	150 kA	–
NS1250	–	50 kA	70 kA	–	–	–

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Soft starters for asynchronous motors

Altistart 48 soft start/soft stop units
230 V power supply
Type 2 coordination

Compatible components according to standards IEC 60947-4-1 and IEC 60947-4-2: circuit-breakers, contactors, fast-acting fuses, starters

Combination: circuit-breaker, contactor, starter

Motor		Starter *(1)*		Circuit-breaker		Type of contactor
		Class 10 Standard applications	Class 20 Severe applications	Reference	Rating	
kW	A				A	
M1		A1		Q1		KM1, KM2, KM3
3	11.5	–	**ATS48D17●**	**GV2L20**	18	**LC1D40A**
				NS80HMA	12.5	**LC1D40**
4	14.5	**ATS48D17●**	**ATS48D22●**	**GV2L20**	18	**LC1D40A**
				NS80HMA	25	**LC1D40**
5.5	20	**ATS48D22●**	**ATS48D32●**	**GV2L22**	25	**LC1D40A**
				NS80HMA	25	**LC1D40**
7.5	27	**ATS48D32●**	**ATS48D38●**	**GV2L32**	32	**LC1D40A**
				NS80HMA	50	**LC1D80**
9	32	**ATS48D38●**	**ATS48D47●**	**GV3L40**	40	**LC1D80**
				NS80HMA	50	**LC1D80**
11	39	**ATS48D47●**	**ATS48D62●**	**GV3L65**	65	**LC1D80**
				NS80HMA	50	**LC1D80**
15	52	**ATS48D62●**	**ATS48D75●**	***NS80HMA***	80	**LC1D80**
18.5	64	**ATS48D75●**	**ATS48D88●**	***NS80HMA***	80	**LC1D80**
22	75	**ATS48D88●**	**ATS48C11●**	***NSX100●MA*** *(2)*	100	**LC1D115**
30	103	**ATS48C11●**	**ATS48C14●**	***NSX160●MA*** *(2)*	150	**LC1D115**
37	126	**ATS48C14●**	**ATS48C17●**	***NSX160●MA*** *(2)*	150	**LC1D150**
45	150	**ATS48C17●**	**ATS48C21●**	***NSX250●MA*** *(2)*	220	**LC1F185**
55	182	**ATS48C21●**	**ATS48C25●**	***NSX250●MA*** *(2)*	220	**LC1F225**
75	240	**ATS48C25●**	**ATS48C32●**	***NSX400●*** *(2)* ***Micrologic 1.3M***	320	**LC1F265**
90	295	**ATS48C32●**	**ATS48C41●**	***NSX400●*** *(2)* ***Micrologic 1.3M***	320	**LC1F330**
110	356	**ATS48C41●**	**ATS48C48●**	***NSX630●*** *(2)* ***Micrologic 1.3M***	500	**LC1F400**
132	425	**ATS48C48●**	**ATS48C59●**	***NSX630●*** *(2)* ***Micrologic 1.3M***	500	**LC1F500**
160	520	**ATS48C59●**	**ATS48C66●**	***NS630bL/LB Micrologic 5.0 LR Off***	630	**LC1F630**
200	626	**ATS48C66●**	**ATS48C79●**	***NS800L/LB Micrologic 5.0 LR Off***	800	**LC1F800**
220	700	**ATS48C79●**	**ATS48M10●**	***NS800L/LB Micrologic 5.0 LR Off***	800	**LC1F800**
250	800	**ATS48M10●**	**ATS48M12●**	***NS1000L Micrologic 5.0 LR Off***	1000	**LC1BM33**
355	1115	**ATS48M12●**	–	***NS1250●*** *(3)* ***Micrologic 5.0 LR Off***	1250	**LC1BP33**

(1) Replace ● with Q or Y according to the starter's voltage range.
(2) Replace ● with F, N, H, S, L or LB according to the breaking capacity (see the breaking capacity table on page 14).
(3) Type 2 coordination is only possible if the fast-acting fuses remain in the motor supply circuit and are not bypassed at the end of starting.

Maximum starter prospective short-circuit current according to standard IEC 60947-4-2

Starter	Iq (kA)
ATS48D17● to ATS48C79●	**50**
ATS48M10● and ATS48M12●	**85**

Fast-acting fuse (essential for type 2 coordination) and starter combinations

Starter	Fast-acting fuses with microswitch			
Reference	Unit reference *(4)*	Size	Rating	I²t
			A	kA².s
A1	Q3			
ATS48D17●	**DF3ER50**	14 x 51	50	2.3
ATS48D22● and ATS48D32●	**DF3FR80**	22 x 58	80	5.6
ATS48D38● and ATS48D47●	**DF3FR100**	22 x 58	100	12
ATS48D62● and ATS48D75●	**DF400125**	00	125	45
ATS48D88● and ATS48C11●	**DF400160**	00	160	82
ATS48C14● and ATS48C17●	**DF430400**	30	400	120
ATS48C21● to ATS48C32●	**DF431700**	31	700	490
ATS48D75●	**DF433800**	33	800	490
ATS48C48● and ATS48C59●	**DF4331000**	33	1000	900
ATS48C66●	**DF42331400**	2 x 33	1400	1200
ATS48C79●	**DF4441600**	44	1600	1600
ATS48M10● and ATS48M12●	**DF4442200**	44	2200	4100

(4) DF3ER, DF3FR: sold in lots of 10.
DF4: sold singly.

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Soft starters for asynchronous motors

Altistart 48 soft start/soft stop units

380 V, 400 V, 415 V power supply

Type 1 coordination

Compatible components according to standards IEC 60947-4-1 and IEC 60947-4-2

Use either a circuit-breaker (light green columns), contactor, starter combination or a switch/fuse (dark green columns), contactor, starter combination

Motor		Starter *(1)*		Circuit-breaker		Type of contactor	Type of switch or switch disconnector (bare unit)	aM fuses			
		Class 10 Standard applications	Class 20 Severe applications	Reference	Rating			Unit reference *(3)*		Size	Rating
kW	A				A			Without striker	With striker		A
M1		A1		Q1		KM1, KM2, KM3					
5.5	11	–	ATS48D17●	GV2L20	18	LC1D18	LS1D32	DF2CA16	–	10 x 38	16
				NS80HMA	12.5	LC1D18	LS1D32	DF2CA16	–	10 x 38	16
7.5	14.8	ATS48D17●	ATS48D22●	GV2L20	18	LC1D18	LS1D32	DF2CA16	–	10 x 38	16
				NS80HMA	25	LC1D18	LS1D32	DF2CA16	–	10 x 38	16
11	21	ATS48D22●	ATS48D32●	GV2L22	25	LC1D25	LS1D32	DF2CA25	–	10 x 38	25
				NS80HMA	25	LC1D25	LS1D32	DF2CA25	–	10 x 38	25
15	28.5	ATS48D32●	ATS48D38●	GV2L32	32	LC1D32	GK1EK	DF2EA32	DF3EA32	14 x 51	32
				NS80HMA	50	LC1D32	GK1EK	DF2EA32	DF3EA32	14 x 51	32
18.5	35	ATS48D38●	ATS48D47●	GV3L40	40	LC1D38	GK1EK	DF2EA40	DF3EA40	14 x 51	40
				NS80HMA	50	LC1D38	GK1EK	DF2EA40	DF3EA40	14 x 51	40
22	42	ATS48D47●	ATS48D62●	GV3L65	65	LC1D50A	GS1K	DF2FA50	DF3FA50	22 x 58	50
				NS80HMA	50	LC1D50A	GS1K	DF2FA50	DF3FA50	22 x 58	50
30	57	ATS48D62●	ATS48D75●	GV3L65	65	LC1D65A	GS1K	DF2FA80	DF3FA80	22 x 58	80
				NS80HMA	80	LC1D65A	GS1K	DF2FA80	DF3FA80	22 x 58	80
37	69	ATS48D75●	ATS48D88●	*NS80HMA*	80	LC1D80	GS1K	DF2FA80	DF3FA80	22 x 58	80
45	81	ATS48D88●	ATS48C11●	*NSX100●MA (2)*	100	LC1D115	GS1K	DF2FA100	DF3FA100	22 x 58	100
55	100	ATS48C11●	ATS48C14●	*NSX160●MA (2)*	150	LC1D115	GS1K	DF2FA125	DF4FA125	22 x 58	125
75	131	ATS48C14●	ATS48C17●	*NSX160●MA (2)*	150	LC1D150	GS1L	DF2GA1161	DF4GA1161	0	160
90	162	ATS48C17●	ATS48C21●	*NSX250●MA (2)*	220	LC1F185	GS1N	DF2HA1201	DF4HA1201	1	200
110	195	ATS48C21●	ATS48C25●	*NSX250●MA (2)*	220	LC1F225	GS1N	DF2HA1201	DF4HA1201	1	200
132	233	ATS48C25●	ATS48C32●	*NSX400● (2) Micrologic 1.3M*	320	LC1F265	GS1QQ	DF2JA1251	DF4JA1251	2	250
160	285	ATS48C32●	ATS48C41●	*NSX400● (2) Micrologic 1.3M*	320	LC1F330	GS1QQ	DF2JA1311	DF4JA1311	2	315
220	388	ATS48C41●	ATS48C48●	*NSX630● (2) Micrologic 1.3M*	500	LC1F400	GS1S	DF2KA1401	DF4KA1401	3	400
250	437	ATS48C48●	ATS48C59●	*NSX630● (2) Micrologic 1.3M*	500	LC1F500	GS1S	DF2KA1501	DF4KA1501	3	500
315	560	ATS48C59●	ATS48C66●	*NS630b● (2) Micrologic 5.0 LR Off*	630	LC1F630	GS1S	DF2KA1631	DF4KA1631	3	630
355	605	ATS48C66●	ATS48C79●	*NS800● (2) Micrologic 5.0 LR Off*	800	LC1F780	GS1V	DF2LA1631	DF4LA1631	4	630
400	675	ATS48C79●	ATS48M10●	*NS800● (2) Micrologic 5.0 LR Off*	800	LC1F780	GS1V	DF2LA1801	DF4LA1801	4	800
500	855	ATS48M10●	ATS48M12●	*NS1000● (2) Micrologic 5.0 LR Off*	1000	LC1BM33	GS1V	DF2LA1101	DF4LA1101	4	1000
630	1045	ATS48M12●	–	*NS1250● (2) Micrologic 5.0 LR Off*	1250	LC1BP33	–	DF2LA1251	DF4LA1251	4	1250

(1) Replace ● with Q or Y according to the starter's voltage range.
(2) Replace ● with F, N, H, S, L or LB according to the breaking capacity (see the breaking capacity table below).
(3) DF2CA, DF●EA, DF●FA: sold in lots of 20.
DF●GA, DF●KA: sold in lots of 3.
DF●LA: sold singly.

Maximum starter prospective short-circuit current according to standard IEC 60947-4-2

Starter	Iq (kA)
ATS48D17● to ATS48C32●	50
ATS48C41● to ATS48M12●	70

Breaking capacity of circuit-breakers according to standard IEC 60947-4-2

380 V, 400 V, 415 V	Icu (kA)
GV2L20, GV2L22, GV2L32, GV3L40, GV3L50, GV3L65	50

380 V, 400 V, 415 V	Icu (kA)					
	F	N	H	S	L	LB
NS80HMA	–	–	70	–	–	–
NSX100/160/250	36	50	70	100	150	–
NSX400/630	36	50	70	100	150	–
NS630b/800	–	50	70	–	150	200
NS1000	–	50	70	–	150	–
NS1250	–	50	70	–	–	–

Soft starters for asynchronous motors

Altistart 48 soft start/soft stop units

380 V, 400 V, 415 V power supply
Type 2 coordination

Compatible components according to standards IEC 60947-4-1 and IEC 60947-4-2: circuit-breakers, contactors, fast-acting fuses, starters

Combination: circuit-breaker, contactor, starter

Motor		Starter (1)		Circuit-breaker		Type of contactor
		Class 10	Class 20	Reference	Rating	
kW	A	Standard applications	Severe applications		A	
M1		A1		Q1		KM1, KM2, KM3
5.5	11	–	**ATS48D17●**	**GV2L20**	18	**LC1D25**
				NS80HMA	12.5	**LC1D40**
7.5	14.8	**ATS48D17●**	**ATS48D22●**	**GV2L20**	18	**LC1D25**
				NS80HMA	25	**LC1D40**
11	21	**ATS48D22●**	**ATS48D32●**	**GV2L22**	25	**LC1D25**
				NS80HMA	25	**LC1D40**
15	28.5	**ATS48D32●**	**ATS48D38●**	**GV2L32**	32	**LC1D32**
				NS80HMA	50	**LC1D80**
18.5	35	**ATS48D38●**	**ATS48D47●**	**GV3L40**	40	**LC1D50A**
				NS80HMA	50	**LC1D80**
22	42	**ATS48D47●**	**ATS48D62●**	**GV3L50**	50	**LC1D50A**
				NS80HMA	50	**LC1D80**
30	57	**ATS48D62●**	**ATS48D75●**	**GV3L65**	65	**LC1D65A**
				NS80HMA	80	**LC1D80**
37	69	**ATS48D75●**	**ATS48D88●**	***NS80HMA***	80	**LC1D80**
45	81	**ATS48D88●**	**ATS48C11●**	***NSX100●MA*** *(2)*	100	**LC1D115/F115**
55	100	**ATS48C11●**	**ATS48C14●**	***NSX160●MA*** *(2)*	150	**LC1D115/F115**
75	131	**ATS48C14●**	**ATS48C17●**	***NSX100●MA*** *(2)*	150	**LC1D150/F150**
90	162	**ATS48C17●**	**ATS48C21●**	***NSX250●MA*** *(2)*	220	**LC1F185**
110	195	**ATS48C21●**	**ATS48C25●**	***NSX250●MA*** *(2)*	220	**LC1F225**
132	233	**ATS48C25●**	**ATS48C32●**	***NSX400●*** *(2)* ***Micrologic 1.3M***	320	**LC1F265**
160	285	**ATS48C32●**	**ATS48C41●**	***NSX400●*** *(2)* ***Micrologic 1.3M***	320	**LC1F330**
220	388	**ATS48C41●**	**ATS48C48●**	***NSX630●*** *(2)* ***Micrologic 1.3M***	500	**LC1F500**
250	437	**ATS48C48●**	**ATS48C59●**	***NSX630●*** *(2)* ***Micrologic 1.3M***	500	**LC1F500**
315	560	**ATS48C59●**	**ATS48C66●**	***NS630bL Micrologic 5.0 LR Off***	630	**LC1F630**
355	605	**ATS48C66●**	**ATS48C79●**	***NS800L or LB Micrologic 5.0 LR Off***	800	**LC1F780**
400	675	**ATS48C79●**	**ATS48M10●**	***NS800L or LB Micrologic 5.0 LR Off***	800	**LC1F780**
500	855	**ATS48M10●**	**ATS48M12●**	***NS1000L Micrologic 5.0 LR Off***	1000	**LC1BM33**
630	1045	**ATS48M12●**	–	***NS1250*** *(3)* ***Micrologic 5.0 LR Off***	1250	**LC1BP33**

(1) Replace ● with Q or Y according to the starter's voltage range.
(2) Replace ● with F, N, H, S, L or LB according to the breaking capacity (see the breaking capacity table below).
(3) Type 2 coordination is only possible if the fast-acting fuses remain in the motor supply circuit and are not bypassed at the end of starting.

Maximum starter prospective short-circuit current according to standard IEC 60947-4-2

Starter	Iq (kA)
ATS48D17●	**50**
ATS48D22● to ATS48D47●	**40**
ATS48D62● to ATS48C79●	**50**
ATS48M10● and ATS48M12●	**85**

Fast-acting fuse (essential for type 2 coordination) and starter combinations

Starter	Fast-acting fuses with microswitch			
Reference	Unit reference *(4)*	Size	Rating	I²t
			A	kA².s
A1	Q3			
ATS48D17●	**DF3ER50**	14 x 51	50	2.3
ATS48D22● and ATS48D32●	**DF3FR80**	22 x 58	80	5.6
ATS48D38● and ATS48D47●	**DF3FR100**	22 x 58	100	12
ATS48D62● and ATS48D75●	**DF400125**	00	125	45
ATS48D88● and ATS48C11●	**DF400160**	00	160	82
ATS48C14● and ATS48C17●	**DF430400**	30	400	120
ATS48C21● to ATS48C32●	**DF431700**	31	700	490
ATS48D75●	**DF433800**	33	800	490
ATS48C48● and ATS48C59●	**DF4331000**	33	1000	900
ATS48C66●	**DF42331400**	2 x 33	1400	1200
ATS48C79●	**DF4441600**	44	1600	1600
ATS48M10● and ATS48M12●	**DF4442200**	44	2200	4100

(4) DF3ER, DF3FR: sold in lots of 10.
DF4: sold singly.

Breaking capacity of circuit-breakers according to standard IEC 60947-4-2

380 V, 400 V, 415 V	Icu (kA)
GV2L20, GV2L22, GV2L32, GV3L40, GV3L50, GV3L65	50

380 V, 400 V, 415 V	Icu (kA)					
	F	N	H	S	L	LB
NS80HMA	–	–	70	–	–	–
NSX100/160/250	36	50	70	100	150	–
NSX400/630	36	50	70	100	150	–
NS630b/800L/LB	–	–	–	–	150	200
NS1000L	–	–	–	–	150	–
NS1250	–	50	70	–	–	–

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Soft starters for asynchronous motors
Altistart 48 soft start/soft stop units
440 V power supply
Type 1 coordination

Compatible components according to standards IEC 60947-4-1 and IEC 60947-4-2

Use either a circuit-breaker (light green columns), contactor, starter combination or a switch/fuse (dark green columns), contactor, starter combination

Motor		Starter		Circuit-breaker		Type of contactor	Type of switch or switch disconnector (bare unit)	aM fuses			
		Class 10 Standard applications	Class 20 Severe applications	Reference	Rating			Unit reference (2) Without striker	With striker	Size	Rating
kW	A				A						A
M1		A1		Q1		KM1, KM2, KM3					
5.5	10.4	–	**ATS48D17Y**	***NSX100●MA** (1)*	12.5	**LC1D12**	**LS1D32**	**DF2CA16**	–	10 x 38	16
				NS80HMA	12.5	**LC1D12**	**LS1D32**	**DF2CA16**	–	10 x 38	16
7.5	13.7	**ATS48D17Y**	**ATS48D22Y**	***NSX100●MA** (1)*	25	**LC1D18**	**LS1D32**	**DF2CA16**	–	10 x 38	16
				NS80HMA	25	**LC1D18**	**LS1D32**	**DF2CA16**	–	10 x 38	16
11	20.1	**ATS48D22Y**	**ATS48D32Y**	***NSX100●MA** (1)*	25	**LC1D25**	**GK1EK**	**DF2EA25**	**DF3EA25**	14 x 51	25
				NS80HMA	25	**LC1D25**	**GK1EK**	**DF2EA25**	**DF3EA25**	14 x 51	25
15	26.5	**ATS48D32Y**	**ATS48D38Y**	***NSX100●MA** (1)*	50	**LC1D32**	**GK1EK**	**DF2EA32**	**DF3EA32**	14 x 51	32
				NS80HMA	50	**LC1D32**	**GK1EK**	**DF2EA32**	**DF3EA32**	14 x 51	32
18.5	32.8	**ATS48D38Y**	**ATS48D47Y**	***NSX100●MA** (1)*	50	**LC1D40A**	**GK1EK**	**DF2EA40**	**DF3EA40**	14 x 51	40
				NS80HMA	50	**LC1D40A**	**GK1EK**	**DF2EA40**	**DF3EA40**	14 x 51	40
22	39	**ATS48D47Y**	**ATS48D62Y**	***NSX100●MA** (1)*	50	**LC1D40A**	**GS1K**	**DF2FA50**	**DF3FA50**	22 x 58	50
				NS80HMA	50	**LC1D40A**	**GS1K**	**DF2FA50**	**DF3FA50**	22 x 58	50
30	52	**ATS48D62Y**	**ATS48D75Y**	***NSX100●MA** (1)*	100	**LC1D65A**	**GS1K**	**DF2FA80**	**DF3FA80**	22 x 58	80
				NS80HMA	80	**LC1D65A**	**GS1K**	**DF2FA80**	**DF3FA80**	22 x 58	80
37	64	**ATS48D75Y**	**ATS48D88Y**	***NSX100●MA** (1)*	100	**LC1D65A**	**GS1K**	**DF2FA80**	**DF3FA80**	22 x 58	80
				NS80HMA	80	**LC1D65A**	**GS1K**	**DF2FA80**	**DF3FA80**	22 x 58	80
45	76	**ATS48D88Y**	**ATS48C11Y**	***NSX100●MA** (1)*	100	**LC1D115**	**GS1K**	**DF2FA100**	**DF3FA100**	22 x 58	100
55	90	**ATS48C11Y**	**ATS48C14Y**	***NSX100●MA** (1)*	100	**LC1D115**	**GS1L**	**DF2GA1121**	**DF4GA1121**	0	125
75	125	**ATS48C14Y**	**ATS48C17Y**	***NSX160●MA** (1)*	150	**LC1D150**	**GS1L**	**DF2GA1161**	**DF4GA1161**	1	160
90	150	**ATS48C17Y**	**ATS48C21Y**	***NSX250●MA** (1)*	220	**LC1F185**	**GS1N**	**DF2HA1201**	**DF4HA1201**	1	200
110	178	**ATS48C21Y**	**ATS48C25Y**	***NSX250●MA** (1)*	220	**LC1F225**	**GS1N**	**DF2HA1251**	**DF4HA1251**	1	250
132	215	**ATS48C25Y**	**ATS48C32Y**	***NSX250●MA** (1)*	220	**LC1F265**	**GS1QQ**	**DF2JA1311**	**DF4JA1311**	2	315
160	256	**ATS48C32Y**	**ATS48C41Y**	***NSX400●** (1)* ***Micrologic 1.3M***	320	**LC1F265**	**GS1QQ**	**DF2JA1401**	**DF4JA1401**	2	315
220	353	**ATS48C41Y**	**ATS48C48Y**	***NSX630●** (1)* ***Micrologic 1.3M***	500	**LC1F400**	**GS1S**	**DF2KA1501**	**DF4KA1501**	3	500
250	401	**ATS48C48Y**	**ATS48C59Y**	***NSX630●** (1)* ***Micrologic 1.3M***	500	**LC1F400**	**GS1S**	**DF2KA1501**	**DF4KA1501**	3	500
355	549	**ATS48C59Y**	**ATS48C66Y**	***NS630b●** (1)* ***Micrologic 5.0 LR Off***	630	**LC1F630**	**GS1V**	**DF2LA1801**	**DF4LA1801**	4	800
400	611	**ATS48C66Y**	**ATS48C79Y**	***NS630b●** (1)* ***Micrologic 5.0 LR Off***	630	**LC1F630**	**GS1V**	**DF2LA1801**	**DF4LA1801**	4	800
500	780	**ATS48C79Y**	**ATS48M10Y**	***NS800●** (1)* ***Micrologic 5.0 LR Off***	800	**LC1F780**	**GS1V**	**DF2LA1801**	**DF4LA1801**	4	800
630	965	**ATS48M10Y**	**ATS48M12Y**	***NS1000●** (1)* ***Micrologic 5.0 LR Off***	1000	**LC1BP33**	**GS1V**	**DF2LA1101**	**DF4LA1101**	4	1000
710	1075	**ATS48M12Y**	–	***NS1250●** (1)* ***Micrologic 5.0 LR Off***	1250	**LC1BP33**	–	**DF2LA1251**	–	4	1250

(1) Replace ● with F, N, H, S, L or LB according to the breaking capacity (see the breaking capacity table below).
(2) DF2CA, DF●EA, DF●FA: sold in lots of 20.
DF●GA, DF●KA: sold in lots of 3.
DF●LA: sold singly.

Maximum starter prospective short-circuit current according to standard IEC 60947-4-2

Starter	Iq (kA)
ATS48D17Y to ATS48C32Y	**50**
ATS48C41Y to ATS48M12Y	**70**

Breaking capacity of circuit-breakers according to standard IEC 60947-4-2

440 V	Icu (kA)
GV2L20, GV2L22, GV2L32	20
GV3L40, GV3L65	50
GK3EF80	25

440 V	Icu (kA)					
	F	N	H	S	L	LB
NS80HMA	–	–	65	–	–	–
NSX100/160/250	35	50	65	90	130	–
NSX400/630	30	42	65	90	130	–
NS630b/800	–	50	65	–	130	200
NS1000	–	50	65	–	130	–
NS1250	–	50	65	–	–	–

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Soft starters for asynchronous motors
Altistart 48 soft start/soft stop units
440 V power supply
Type 2 coordination

Compatible components according to standards IEC 60947-4-1 and IEC 60947-4-2: circuit-breakers, contactors, fast-acting fuses, starters

Combination: circuit-breaker, contactor, starter

Motor		Starter		Circuit-breaker		Type of contactor
		Class 10 Standard applications	Class 20 Severe applications	Reference	Rating	
kW	A				A	
M1		A1		Q1		KM1, KM2, KM3
5.5	10.4	–	**ATS48D17Y**	***NS80HMA***	12.5	**LC1D40**
				NSX100●MA *(1)*	12.5	**LC1D80**
7.5	13.7	**ATS48D17Y**	**ATS48D22Y**	***NS80HMA***	25	**LC1D40**
				NSX100●MA *(1)*	25	**LC1D80**
11	20.1	**ATS48D22Y**	**ATS48D32Y**	***NS80HMA***	25	**LC1D40**
				NSX100●MA *(1)*	25	**LC1D80**
15	26.5	**ATS48D32Y**	**ATS48D38Y**	***NSX100●MA*** *(1)*	50	**LC1D80**
				NS80HMA	50	**LC1D80**
18.5	32.8	**ATS48D38Y**	**ATS48D47Y**	***NSX100●MA*** *(1)*	50	**LC1D80**
				NS80HMA	50	**LC1D80**
22	39	**ATS48D47Y**	**ATS48D62Y**	***NSX100●MA*** *(1)*	50	**LC1D80**
				NS80HMA	50	**LC1D80**
30	52	**ATS48D62Y**	**ATS48D75Y**	***NSX100●MA*** *(1)*	100	**LC1D80**
				NS80HMA	80	**LC1D80**
37	64	**ATS48D75Y**	**ATS48D88Y**	***NSX100●MA*** *(1)*	100	**LC1D80**
				NS80HMA	80	**LC1D80**
45	76	**ATS48D88Y**	**ATS48C11Y**	***NSX100●MA*** *(1)*	100	**LC1D115**
55	90	**ATS48C11Y**	**ATS48C14Y**	***NSX100●MA*** *(1)*	100	**LC1D115**
75	125	**ATS48C14Y**	**ATS48C17Y**	***NSX160●MA*** *(1)*	150	**LC1D150**
90	150	**ATS48C17Y**	**ATS48C21Y**	***NSX160●MA*** *(1)*	150	**LC1D150**
110	178	**ATS48C21Y**	**ATS48C25Y**	***NSX250●MA*** *(1)*	220	**LC1F185**
132	215	**ATS48C25Y**	**ATS48C32Y**	***NSX400●*** *(1)* ***Micrologic 1.3M***	320	**LC1F265**
160	256	**ATS48C32Y**	**ATS48C41Y**	***NSX400●*** *(1)* ***Micrologic 1.3M***	320	**LC1F265**
220	353	**ATS48C41Y**	**ATS48C48Y**	***NSX630●*** *(1)* ***Micrologic 1.3M***	500	**LC1F400**
250	401	**ATS48C48Y**	**ATS48C59Y**	***NSX630●*** *(1)* ***Micrologic 1.3M***	500	**LC1F500**
355	549	**ATS48C59Y**	**ATS48C66Y**	***NS630bL/LB Micrologic 5.0 LR Off***	630	**LC1F630**
400	611	**ATS48C66Y**	**ATS48C79Y**	***NS800L/LB Micrologic 5.0 LR Off***	800	**LC1F800**
500	780	**ATS48C79Y**	**ATS48M10Y**	***NS800L/LB Micrologic 5.0 LR Off***	800	**LC1F780**
630	965	**ATS48M10Y**	**ATS48M12Y**	***NS1000L Micrologic 5.0 LR Off***	1000	**LC1BP33**
710	1075	**ATS48M12Y**	–	***NS1250●*** *(1)(2)* ***Micrologic 5.0 LR Off***	1250	**LC1BP33**

(1) Replace ● with F, N, H, S, L or LB according to the breaking capacity (see the breaking capacity table on page 18).
(2) Type 2 coordination is only possible if the fast-acting fuses remain in the motor supply circuit and are not bypassed at the end of starting.

Maximum starter prospective short-circuit current according to standard IEC 60947-4-2

Starter	Iq (kA)
ATS48D17Y	**50**
ATS48D22Y to ATS48D47Y	**20**
ATS48D62Y and ATS48D75Y	**50**
ATS48D88Y and ATS48C41Y	**40**
ATS48C11Y to ATS48C32Y	**50**
ATS48C48Y to ATS48C79Y	**50**
ATS48M10Y and ATS48M12Y	**85**

Fast-acting fuse (essential for type 2 coordination) and starter combinations

Starter	Fast-acting fuses with microswitch			
Reference	Unit reference *(3)*	Size	Rating	I^2t
			A	$kA^2.s$
A1	Q3			
ATS48D17Y	**DF3ER50**	14 x 51	50	2.3
ATS48D22Y and ATS48D32Y	**DF3FR80**	22 x 58	80	5.6
ATS48D38Y and ATS48D47Y	**DF3FR100**	22 x 58	100	12
ATS48D62Y and ATS48D75Y	**DF400125**	00	125	45
ATS48D88Y and ATS48C11Y	**DF400160**	00	160	82
ATS48C14Y and ATS48C17Y	**DF430400**	30	400	120
ATS48C21Y to ATS48C32Y	**DF431700**	31	700	490
ATS48C41Y	**DF433800**	33	800	490
ATS48C48Y and ATS48C59Y	**DF4331000**	33	1000	900
ATS48C66Y	**DF42331400**	2 x 33	1400	1200
ATS48C79Y	**DF4441600**	44	1600	1600
ATS48M10Y and ATS48M12Y	**DF4442200**	44	2200	4100

(3) DF3ER, DF3FR: sold in lots of 10.
DF4: sold singly.

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Soft starters for asynchronous motors

Altistart 48 soft start/soft stop units

500 V power supply

Type 1 coordination

Compatible components according to standards IEC 60947-4-1 and IEC 60947-4-2

Use either a circuit-breaker (light green columns), contactor, starter combination or a switch/fuse (dark green columns), contactor, starter combination

Motor		Starter		Circuit-breaker		Type of contactor	Type of switch or switch disconnector (bare unit)	aM fuses			
		Class 10 Standard applications	Class 20 Severe applications	Reference	Rating			Unit reference (2)		Size	Rating
								Without striker	With striker		
kW	A				A						A
M1		A1		Q1		KM1, KM2, KM3					
7.5	12	–	ATS48D17Y	*GV2L16 + LA9LB920*	–	LC1D18	LS1D32	DF2CA16	–	10 x 38	16
				NS80HMA	12.5	LC1D32	–	–	–	–	–
				NSX100●MA (1)	12.5	LC1D40A	–	–	–	–	–
9	14	ATS48D17Y	ATS48D22Y	*GV2L20 + LA9LB920*	–	LC1D25	LS1D32	DF2CA16	–	10 x 38	16
				NS80HMA	25	LC1D32	–	–	–	–	–
				NSX100●MA (1)	25	LC1D40A	–	–	–	–	–
11	18.4	ATS48D22Y	ATS48D32Y	*GV2L22 + LA9LB920*	–	LC1D25	GK1EK	DF2EA25	DF3EA25	14 x 51	25
				NS80HMA	25	LC1D32	–	–	–	–	–
				NSX100●MA (1)	25	LC1D40A	–	–	–	–	–
18.5	28.5	ATS48D32Y	ATS48D38Y	*GV2L32 + LA9LB920*	–	LC1D32	GK1EK	DF2EA32	DF3EA32	14 x 51	32
				NS80HMA	50	LC1D40A	–	–	–	–	–
				NSX100●MA (1)	50	LC1D40A	–	–	–	–	–
22	33	ATS48D38Y	ATS48D47Y	*NS80HMA*	50	LC1D50A	GK1EK	DF2EA40	DF3EA40	14 x 51	40
				NSX100●MA (1)	50	LC1D50A	–	–	–	–	–
30	45	ATS48D47Y	ATS48D62Y	*NS80HMA*	50	LC1D50A	GS1K	DF2FA50	DF3FA50	22 x 58	50
				NSX100●MA (1)	50	LC1D50A	–	–	–	–	–
37	55	ATS48D62Y	ATS48D75Y	*NSX100●MA (1)*	100	LC1D65A	GS1K	DF2FA80	DF3FA80	22 x 58	80
45	65	ATS48D75Y	ATS48D88Y	*NSX100●MA (1)*	100	LC1D80	GS1K	DF2FA80	DF3FA80	22 x 58	80
55	80	ATS48D88Y	ATS48C11Y	*NSX100●MA (1)*	100	LC1D80	GS1K	DF2FA100	DF3FA100	22 x 58	100
75	105	ATS48C11Y	ATS48C14Y	*NSX160●MA (1)*	150	LC1D150/F115	GS1L	DF2GA1121	DF4GA1121	0	125
90	130	ATS48C14Y	ATS48C17Y	*NSX160●MA (1)*	150	LC1D150/F115	GS1L	DF2GA1161	DF4GA1161	0	160
110	156	ATS48C17Y	ATS48C21Y	*NSX250●MA (1)*	220	LC1F185	GS1N	DF2HA1201	DF4HA1201	1	200
132	207	ATS48C21Y	ATS48C25Y	*NSX250●MA (1)*	220	LC1F225	GS1N	DF2HA1251	DF4HA1251	1	250
160	257	ATS48C25Y	ATS48C32Y	*NSX400● (1) Micrologic 1.3M*	320	LC1F265	GS1QQ	DF2JA1311	DF4JA1311	2	315
220	310	ATS48C32Y	ATS48C41Y	*NSX630● (1) Micrologic 1.3M*	500	LC1F400	GS1QQ	DF2JA1401	DF4JA1401	2	400
250	360	ATS48C41Y	ATS48C48Y	*NSX630● (1) Micrologic 1.3M*	500	LC1F400	GS1S	DF2KA1501	DF4KA1501	3	500
315	460	ATS48C48Y	ATS48C59Y	*NSX630● (1) Micrologic 1.3M*	500	LC1F500	GS1S	DF2KA1631	DF4KA1631	3	630
400	540	ATS48C59Y	ATS48C66Y	*NS630b● (1) Micrologic 5.0 LR Off*	630	LC1F630	GS1V	DF2LA1801	DF4LA1801	4	800
450	630	ATS48C66Y	ATS48C79Y	*NS630b● (1) Micrologic 5.0 LR Off*	630	LC1F780	GS1V	DF2LA1801	DF4LA1801	4	800
500	680	ATS48C79Y	ATS48M10Y	*NS800● (1) Micrologic 5.0 LR Off*	800	LC1BL33	GS1V	DF2LA1801	DF4LA1801	4	800
630	850	ATS48M10Y	ATS48M12Y	*NS1000● (1) Micrologic 5.0 LR Off*	1000	LC1BP33	GS1V	DF2LA1101	DF4LA1101	4	1000
800	1100	ATS48M12Y	–	*NS1250● (1) Micrologic 5.0 LR Off*	1250	LC1BP33	–	DF2LA1251	–	4	1250

(1) Replace ● with N, H, S, L, R, HB1 or HB2 according to the breaking capacity (see the breaking capacity table below).

(2) DF2CA, DF●EA, DF●FA: sold in lots of 20. DF●GA, DF●KA: sold in lots of 3. DF●LA: sold singly.

Breaking capacity of circuit-breakers according to standard IEC 60947-4-2

500 V	Icu (kA)
GV2 + LA9LB920	100

500 V	Icu (kA)						
	N	H	S	L	R	HB1	HB2
NS80HMA	–	25	–	–	–	–	–
NSX100	36	50	65	70	80	85	100
NSX160	36	50	65	70	–	–	–
NSX250/400/630	36	50	65	70	80	85	100
NS630b/800/1000L	–	–	–	100	–	–	–
NS1250	40	50	–	–	–	–	–

Maximum starter prospective short-circuit current according to standard IEC 60947-4-2

Starter	Iq (kA)
ATS48D17Y to ATS48C32Y	50
ATS48C41Y to ATS48M12Y	70

Soft starters for asynchronous motors

Altistart 48 soft start/soft stop units

500 V power supply
Type 2 coordination

Compatible components according to standards IEC 60947-4-1 and IEC 60947-4-2: circuit-breakers, contactors, fast-acting fuses, starters

Combination: circuit-breaker, contactor, starter

Motor		Starter		Circuit-breaker		Type of contactor
		Class 10	Class 20	Reference	Rating	
kW	A	Standard applications	Severe applications		A	
M1		A1		Q1		KM1, KM2, KM3
7.5	12	–	**ATS48D17Y**	***GV2L16 + LA9LB920***	–	**LC1D25**
				NS80HMA	12.5	**LC1D40**
				NSX100●MA *(1)*	12.5	**LC1D80**
9	14	**ATS48D17Y**	**ATS48D22Y**	***GV2L20 + LA9LB920***	–	**LC1D25**
				NS80HMA	25	**LC1D40**
				NSX100●MA *(1)*	25	**LC1D80**
11	18.4	**ATS48D22Y**	**ATS48D32Y**	***GV2L22 + LA9LB920***	–	**LC1D25**
				NS80HMA	25	**LC1D40**
				NSX100●MA *(1)*	25	**LC1D80**
18.5	28.5	**ATS48D32Y**	**ATS48D38Y**	***GV2L32 + LA9LB920***	–	**LC1D25**
				NS80HMA	50	**LC1D40**
				NSX100●MA *(1)*	50	**LC1D80**
22	33	**ATS48D38Y**	**ATS48D47Y**	***NS80HMA***	50	**LC1D80**
				NSX100●MA *(1)*	50	**LC1D80**
30	45	**ATS48D47Y**	**ATS48D62Y**	***NS80HMA***	50	**LC1D80**
				NSX100●MA *(1)*	50	**LC1D80**
37	55	**ATS48D62Y**	**ATS48D75Y**	***NSX100●MA*** *(1)*	100	**LC1D150/F115**
45	65	**ATS48D75Y**	**ATS48D88Y**	***NSX100●MA*** *(1)*	100	**LC1D150/F115**
55	80	**ATS48D88Y**	**ATS48C11Y**	***NSX100●MA*** *(1)*	100	**LC1D150/F115**
75	105	**ATS48C11Y**	**ATS48C14Y**	***NSX160●MA*** *(1)*	150	**LC1F150**
90	130	**ATS48C14Y**	**ATS48C17Y**	***NSX160●MA*** *(1)*	150	**LC1F185**
110	156	**ATS48C17Y**	**ATS48C21Y**	***NSX250●MA*** *(1)*	220	**LC1F225**
132	207	**ATS48C21Y**	**ATS48C25Y**	***NSX250●MA*** *(1)*	220	**LC1F330**
160	257	**ATS48C25Y**	**ATS48C32Y**	***NSX400●*** *(1)* ***Micrologic 1.3M***	320	**LC1F400**
220	310	**ATS48C32Y**	**ATS48C41Y**	***NSX400●*** *(1)* ***Micrologic 1.3M***	320	**LC1F400**
250	360	**ATS48C41Y**	**ATS48C48Y**	***NSX630●*** *(1)* ***Micrologic 1.3M***	500	**LC1F500**
315	460	**ATS48C48Y**	**ATS48C59Y**	***NSX630●*** *(1)* ***Micrologic 1.3M***	500	**LC1F500**
400	540	**ATS48C59Y**	**ATS48C66Y**	***NS630bL Micrologic 5.0 LR Off***	630	**LC1F630**
450	630	**ATS48C66Y**	**ATS48C79Y**	***NS630bL Micrologic 5.0 LR Off***	630	**LC1F800**
500	680	**ATS48C79Y**	**ATS48M10Y**	***NS800L Micrologic 5.0 LR Off***	800	**LC1BL33**
630	850	**ATS48M10Y**	**ATS48M12Y**	***NS1000L Micrologic 5.0 LR Off***	1000	**LC1BP33**
800	1100	**ATS48M12Y**	–	***NS1250●*** *(1) (2)* ***Micrologic 5.0 LR Off***	1250	**LC1BP33**

(1) Replace ● with N, H, S, L, R, HB1 or HB2 according to the breaking capacity (see the breaking capacity table below).
(2) Type 2 coordination is only possible if the fast-acting fuses remain in the motor supply circuit and are not bypassed at the end of starting.

Maximum starter prospective short-circuit current according to standard IEC 60947-4-2

Starter	Iq (kA)
ATS48D17Y	**50**
ATS48D22Y to ATS48D47Y	**20**
ATS48D62Y and ATS48D75Y	**50**
ATS48D88Y	**40**
ATS48C11Y to ATS48C32Y	**50**
ATS48C41Y	**40**
ATS48C48Y to ATS48C79Y	**50**
ATS48M10Y and ATS48M12Y	**85**

Fast-acting fuse (essential for type 2 coordination) and starter combinations

Starter	Fast-acting fuses with microswitch			
Reference	Unit reference*(3)*	Size	Rating	I^2t
			A	$kA^2.s$
A1	Q3			
ATS48D17Y	**DF3ER50**	14 x 51	50	2.3
ATS48D22Y and ATS48D32Y	**DF3FR80**	22 x 58	80	5.6
ATS48D38Y and ATS48D47Y	**DF3FR100**	22 x 58	100	12
ATS48D62Y and ATS48D75Y	**DF400125**	00	125	45
ATS48D88Y and ATS48C11Y	**DF400160**	00	160	82
ATS48C14Y and ATS48C17Y	**DF430400**	30	400	120
ATS48C21Y to ATS48C32Y	**DF431700**	31	700	490
ATS48C41Y	**DF433800**	33	800	490
ATS48C48Y and ATS48C59Y	**DF4331000**	33	1000	900
ATS48C66Y	**DF42331400**	2 x 33	1400	1200
ATS48C79Y	**DF4441600**	44	1600	1600
ATS48M10Y and ATS48M12Y	**DF4442200**	44	2200	4100

Breaking capacity of circuit-breakers according to standard IEC 60947-4-2

500 V	Icu (kA)
GV2 + LA9LB920	100

500 V	Icu (kA)						
	N	H	S	L	R	HB1	HB2
NS80HMA	–	25	–	–	–	–	–
NSX100	36	50	65	70	80	85	100
NSX160	36	50	65	70	–	–	–
NSX250/400/630	36	50	65	70	80	85	100
NS630b/800/1000L	–	–	–	100	–	–	–
NS1250	40	50	–	–	–	–	–

(3) DF3ER, DF3FR: sold in lots of 10. DF4: sold singly.

Soft starters for asynchronous motors

Altistart 48 soft start/soft stop units
690 V power supply
Type 1 coordination

Compatible components according to standards IEC 60947-4-1 and IEC 60947-4-2

Use either a circuit-breaker (light green columns), contactor, starter combination or a switch/fuse (dark green columns), contactor, starter combination

Motor		Starter		Circuit-breaker		Type of contactor	Type of switch or switch disconnector (bare unit)	aM fuses			
		Class 10	Class 20	Reference	Rating			Unit reference *(2)*		Size	Rating
		Standard applications	Severe applications					Without striker	With striker		
kW	A				A						A
M1		A1		Q1		KM1, KM2, KM3					
11	12.1	–	**ATS48D17Y**	***GV2L16 + LA9LB920***	–	**LC1D18**	**GS1K**	**DF2FA16**	**DF3FA16**	22 x 58	16
15	16.5	**ATS48D17Y**	**ATS48D22Y**	***GV2L20 + LA9LB920***	–	**LC1D25**	**GS1K**	**DF2FA20**	**DF3FA20**	22 x 58	20
				NSX100●MA *(1)*	25	**LC1D25**	–	–	–	–	–
18.5	20.2	**ATS48D22Y**	**ATS48D32Y**	***GV2L22 + LA9LB920***	–	**LC1D32**	**GS1K**	**DF2FA25**	**DF3FA25**	22 x 58	25
				NSX100●MA *(1)*	50	**LC1D32**	–	–	–	–	–
22	24.2	**ATS48D32Y**	**ATS48D38Y**	***GV2L32 + LA9LB920***	–	**LC1D32**	**GS1K**	**DF2FA32**	**DF3FA32**	22 x 58	32
				NSX100●MA *(1)*	50	**LC1D40A**	–	–	–	–	–
30	33	**ATS48D38Y**	**ATS48D47Y**	***NSX100●MA*** *(1)*	50	**LC1D40A**	**GS1K**	**DF2FA40**	**DF3FA40**	22 x 58	40
37	40	**ATS48D47Y**	**ATS48D62Y**	***NSX100●MA*** *(1)*	50	**LC1D65A**	**GS1K**	**DF2FA50**	**DF3FA50**	22 x 58	50
45	49	**ATS48D62Y**	**ATS48D75Y**	***NSX100●MA*** *(1)*	100	**LC1D80**	–	–	–	–	–
55	58	**ATS48D75Y**	**ATS48D88Y**	***NSX100●MA*** *(1)*	100	**LC1D-115**	–	–	–	–	–
75	75.5	**ATS48D88Y**	**ATS48C11Y**	***NSX100●MA*** *(1)*	100	**LC1D-115**	–	–	–	–	–
90	94	**ATS48C11Y**	**ATS48C14Y**	***NSX160●MA*** *(1)*	150	**LC1D-150**	–	–	–	–	–
110	113	**ATS48C14Y**	**ATS48C17Y**	***NSX160L●MA*** *(1)*	150	**LC1D-150**	–	–	–	–	–
160	165	**ATS48C17Y**	**ATS48C21Y**	***NSX250●MA*** *(1)*	220	**LC1F-265**	–	–	–	–	–
200	203	**ATS48C21Y**	**ATS48C25Y**	***NSX400L●*** *(1)* ***Micrologic 1.3M***	320	**LC1F-330**	–	–	–	–	–
250	253	**ATS48C25Y**	**ATS48C32Y**	***NSX400●*** *(1)* ***Micrologic 1.3M***	320	**LC1F-400**	–	–	–	–	–
315	321	**ATS48C32Y**	**ATS48C41Y**	***NSX630●*** *(1)* ***Micrologic 1.3M***	500	**LC1F-500**	–	–	–	–	–
400	390	**ATS48C41Y**	**ATS48C48Y**	***NSX630LB Micrologic 1.3M***	500	**LC1F630**	–	–	–	–	–
500	490	**ATS48C48Y**	**ATS48C59Y**	***NS630bLB Micrologic 5.0 LR Off***	630	**LC1BL33**	–	–	–	–	–
560	549	**ATS48C59Y**	**ATS48C66Y**	***NS630bLB Micrologic 5.0 LR Off***	630	**LC1BL33**	–	–	–	–	–
630	605	**ATS48C66Y**	**ATS48C79Y**	***NS800LB Micrologic 5.0 LR Off***	800	**LC1BP33**	–	–	–	–	–
710	694	**ATS48C79Y**	**ATS48M10Y**	***NS800LB Micrologic 5.0 LR Off***	800	**LC1BP33**	–	–	–	–	–
900	880	**ATS48M10Y**	**ATS48M12Y**	***NS1000●*** *(1)* ***Micrologic 5.0 LR Off***	1000	**LC1BR33**	–	–	–	–	–
950	1000	**ATS48M12Y**	–	***NS1250●*** *(1)* ***Micrologic 5.0 LR Off***	1250	**LC1BR33**	–	–	–	–	–

(1) Replace ● with N, H, S, L, R, HB1, HB2 or LB according to the breaking capacity (see the breaking capacity table below).
(2) DF●FA: sold in lots of 10.

Maximum starter prospective short-circuit current according to standard IEC 60947-4-2

Starter	Iq (kA)
ATS48D17Y to ATS48C32Y	**50**
ATS48C41Y to ATS48M12Y	**70**

Breaking capacity of circuit-breakers according to standard IEC 60947-4-2

690 V	Icu (kA)
GV2 + LA9LB920	50

690 V	Icu (kA)							
	N	H	S	L	R	HB1	HB2	LB
NSX100	8	10	10	15	45	75	100	–
NSX160	8	10	10	15	–	–	–	–
NSX250	8	10	10	15	45	75	100	–
NSX400/630	10	10	20	25	45	75	100	–
NS630b/800LB	–	–	–	–	–	–	–	75
NS1250	30	42	–	–	–	–	–	–

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Soft starters for asynchronous motors

Altistart 48 soft start/soft stop units
690 V power supply
Type 2 coordination

Compatible components according to standards IEC 60947-4-1 and IEC 60947-4-2: circuit-breakers, contactors, fast-acting fuses, starters

Combination: circuit-breaker, contactor, starter

Motor		Starter		Circuit-breaker		Type of contactor
		Class 10	Class 20	Reference	Rating	
kW	A	Standard applications	Severe applications		A	
M1		A1		Q1		KM1, KM2, KM3
11	12.1	–	**ATS48D17Y**	***NSX100●MA*** *(1)*	25	**LC1D80**
15	16.5	**ATS48D17Y**	**ATS48D22Y**	***NSX100●MA*** *(1)*	25	**LC1D80**
18.5	20.2	**ATS48D22Y**	**ATS48D32Y**	***NSX100●MA*** *(1)*	25	**LC1D80**
22	24.2	**ATS48D32Y**	**ATS48D38Y**	***NSX100●MA*** *(1)*	25	**LC1D80**
30	33	**ATS48D38Y**	**ATS48D47Y**	***NSX100●MA*** *(1)*	50	**LC1D150/F115**
37	40	**ATS48D47Y**	**ATS48D62Y**	***NSX100●MA*** *(1)*	50	**LC1D150/F115**
45	49	**ATS48D62Y**	**ATS48D75Y**	***NSX100●MA*** *(1)*	100	**LC1D150/F115**
55	58	**ATS48D75Y**	**ATS48D88Y**	***NSX100●MA*** *(1)*	100	**LC1D150/F115**
75	75.5	**ATS48D88Y**	**ATS48C11Y**	***NSX100●MA*** *(1)*	100	**LC1D150/F115**
90	94	**ATS48C11Y**	**ATS48C14Y**	***NSX250●MA*** *(1)*	150	**LC1F150**
110	113	**ATS48C14Y**	**ATS48C17Y**	***NSX250●MA*** *(1)*	150	**LC1F185**
160	165	**ATS48C17Y**	**ATS48C21Y**	***NSX250●MA*** *(1)*	220	**LC1F330**
200	203	**ATS48C21Y**	**ATS48C25Y**	***NSX250●MA*** *(1)*	220	**LC1F330**
250	253	**ATS48C25Y**	**ATS48C32Y**	***NSX400●MA*** *(1)*	320	**LC1F400**
315	321	**ATS48C32Y**	**ATS48C41Y**	***NSX630●MA*** *(1)*	500	**LC1F500**
400	390	**ATS48C41Y**	**ATS48C48Y**	***NSX630●MA*** *(1)*	500	**LC1F630**
500	490	**ATS48C48Y**	**ATS48C59Y**	***NS630bLB Micrologic 5.0 LR Off***	630	**LC1F630**
560	549	**ATS48C59Y**	**ATS48C66Y**	***NS630bLB Micrologic 5.0 LR Off***	630	**LC1F630**
630	605	**ATS48C66Y**	**ATS48C79Y**	***NS800LB Micrologic 5.0 LR Off***	800	**LC1F780**
710	694	**ATS48C79Y**	**ATS48M10Y**	***NS800LB Micrologic 5.0 LR Off***	800	**LC1F780**
900	880	**ATS48M10Y**	**ATS48M12Y**	***NS1000*** *(2)* ***Micrologic 5.0 LR Off***	1000	**LC1BR33**
950	1000	**ATS48M12Y**	–	***NS1250*** *(2)* ***Micrologic 5.0 LR Off***	1250	**LC1BR33**

(1) Replace ● with HB1 or HB2 according to the breaking capacity (see the breaking capacity table below).
(2) Type 2 coordination is only possible if the fast-acting fuses remain in the motor supply circuit and are not bypassed at the end of starting.

Maximum starter prospective short-circuit current according to standard IEC 60947-4-2

Starter	Iq (kA)
ATS48D17Y	**50**
ATS48D22Y to ATS48D47Y	**20**
ATS48D62Y and ATS48D75Y	**50**
ATS48D88Y	**40**
ATS48C11Y to ATS48C32Y	**50**
ATS48C41Y	**40**
ATS48C48Y to ATS48C79Y	**50**
ATS48M10Y and ATS48M12Y	**85**
ATS48D17Y	**50**

Fast-acting fuse (essential for type 2 coordination) and starter combinations

Starter	Fast-acting fuses with microswitch			
Reference	Unit reference *(3)*	Size	Rating	I²t
			A	kA².s
A1	Q3			
ATS48D17Y	**DF3ER50**	14 x 51	50	2.3
ATS48D22Y and ATS48D32Y	**DF3FR80**	22 x 58	80	5.6
ATS48D38Y and ATS48D47Y	**DF3FR100**	22 x 58	100	12
ATS48D62Y and ATS48D75Y	**DF400125**	00	125	45
ATS48D88Y and ATS48C11Y	**DF400160**	00	160	82
ATS48C14Y and ATS48C17Y	**DF430400**	30	400	120
ATS48C21Y to ATS48C32Y	**DF431700**	31	700	490
ATS48C41Y	**DF433800**	33	800	490
ATS48C48Y and ATS48C59Y	**DF4331000**	33	1000	900
ATS48C66Y	**DF42331400**	2 x 33	1400	1200
ATS48C79Y	**DF4441600**	44	1600	1600
ATS48M10Y and ATS48M12Y	**DF4442200**	44	2200	4100

(3) DF3ER, DF3FR: sold in lots of 10.
DF4: sold singly.

Breaking capacity of circuit-breakers according to standard IEC 60947-4-2

690 V	Icu (kA)				
GV2 + LA9LB920	50				
690 V	**Icu (kA)**				
	N	**H**	**HB1**	**HB2**	**LB**
NSX100/250	–	–	75	100	–
NSX400/630	–	–	75	100	–
NS630b/800LB	–	–	–	–	75
NS1000/1250	30	42	–	–	–

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Soft starters for asynchronous motors

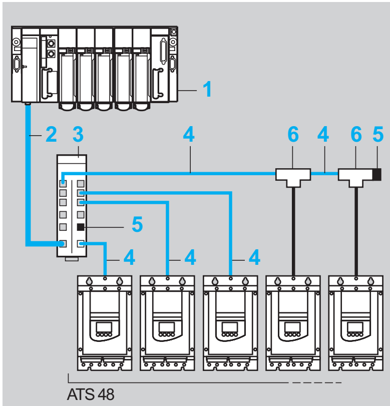
Altistart 48 soft start/soft stop units

Communication options

Modbus serial link

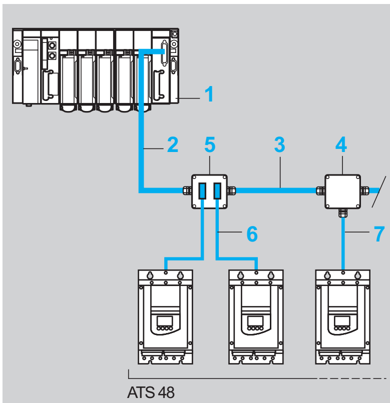
The Altistart 48 is connected directly to the Modbus bus via its RJ45 connector port.
This port supports the RS 485 (2-wire) standard and the Modbus RTU protocol.
The communication function provides access to the starter's configuration, adjustment, control and signaling functions.

Connections via splitter boxes and RJ45 connectors



1 PLC *(1)*.
2 Modbus cable depending on the controller or PLC type.
3 Modbus splitter box **LU9GC3**.
4 Modbus drop cables **VW3A8306R●●**.
5 Line terminators **VW3A8306RC**.
6 Modbus T-junction boxes **VW3A8306TF●●** (with cable).

Connections via tap junctions



1 PLC *(1)*.
2 Modbus cable depending on the controller or PLC type.
3 Modbus cable **TSXCSA●00**.
4 Junction box **TSXSCA50**.
5 Subscriber socket **TSXSCA62**.
6 Modbus drop cable **VW3A8306**.
7 Modbus drop cable **VW3A8306D30**.

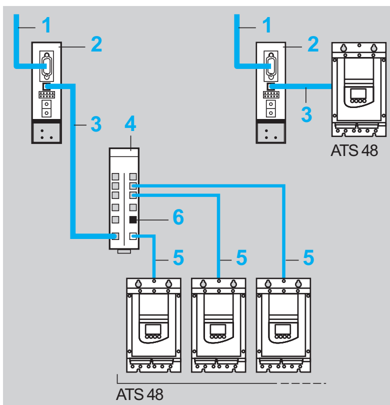
Connection via screw terminals

In this case, use a Modbus drop cable **VW3A8306D30** and line terminators **VW3A8306DRC**.

Other communication buses

The Altistart 48 can also be connected to Ethernet, Fipio, Profibus DP and DeviceNet networks via a module (bridge or gateway).
Communication on the network is used for:
- controlling,
- monitoring and,
- adjusting the connected Modbus devices.

Connection via modules



1 To network.
2 Communication modules.
3 Cables **VW3A8306R●●**, **VW3P07306R10** or **VW3A8306D30**.
4 Modbus splitter box **LU9GC3**.
5 Modbus drop cables **VW3A8306R●●**.
6 Line terminator **VW3A8306RC**.

(1) Please refer to our specialist "Modicon Premium automation platform" and "Modicon TSX Micro automation platform" catalogs.

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Soft starters for asynchronous motors

Altistart 48 soft start/soft stop units
Communication options

109038

LU9GC3

Modbus serial link

Connection accessories

Description			Reference	Weight kg/ *lb*
Tap junction 3 screw terminals and RC line terminator To be connected using cable VW3A8306D30			**TSXSCA50**	0.520/ *1.156*
Subscriber socket 2 x 15-way female SUB-D connectors and 2 sets of screw terminals, RC line terminator To be connected using cable VW3A8306			**TSXSCA62**	0.570/ *1.257*
Modbus splitter box 8 RJ45 connectors and 1 set of screw terminals			**LU9GC3**	0.500/ *1.102*
Line terminators (1)	For RJ45 connector	R = 120 Ω, C = 1 nf	**VW3A8306RC**	0.200/ *0.441*
		R = 150 Ω	**VW3A8306R**	0.200/ *0.441*
	For screw terminals	R = 120 Ω, C = 1 nf	**VW3A8306DRC**	0.200/ *0.441*
		R = 150 Ω	**VW3A8306DR**	0.200/ *0.441*
Modbus T-junction boxes		With integrated cable 0.3 m/*0.98 ft*	**VW3A8306TF03**	–
		With integrated cable 1 m/*3.28 ft*	**VW3A8306TF10**	–

Connection cables

Description	Length m/ *ft*	Connectors	Reference	Weight kg/ *lb*
Cables for Modbus bus	3/ *9.84*	1 RJ45 connector and a stripped end	**VW3A8306D30**	0.150/ *0.331*
	3/ *9.84*	1 RJ45 connector and 1 x 15-way male SUB-D connector for TSXSCA62	**VW3A8306**	0.150/ *0.331*
	0.3/ *0.98*	2 RJ45 connectors	**VW3A8306R03**	0.050/ *0.110*
	1/ *3.28*	2 RJ45 connectors	**VW3A8306R10**	0.050/ *0.110*
	3/ *9.84*	2 RJ45 connectors	**VW3A8306R30**	0.150/ *0.331*
Cables for Profibus DP	1/ *3.28*	2 RJ45 connectors	**VW3P07306R10**	0.050/ *0.110*
RS 485 double shielded twisted pair cables	100/ *328.08*	Supplied without connector	**TSXCSA100**	–
	200/ *656.17*	Supplied without connector	**TSXCSA200**	–
	500/ *1640.42*	Supplied without connector	**TSXCSA500**	–

Other communication buses

Description	Cables to be connected	Reference	Weight kg/ *lb*
Ethernet/Modbus bridge with 1 Ethernet 10baseT port (RJ45 type)	VW3A8306D30	**174CEV30010** *(2)*	0.500/ *1.102*
Fipio/Modbus gateway	VW3A8306R●●	**LUFP1**	0.240/ *0.529*
DeviceNet/Modbus gateway	VW3A8306R●●	**LUFP9**	0.240/ *0.529*
Profibus DP/Modbus gateway Parameters set using standard Profibus DP configurator, Hilscher Sycon type	VW3P07306R10	**LA9P307**	0.240/ *0.529*
Profibus DP/Modbus gateway Parameters set using ABC Configurator software	VW3A8306R●●	**LUFP7**	0.240/ *0.529*

(1) Sold in lots of 2.
(2) Please refer to the "Modicon Premium and PL7 software automation platform" catalog.

108816

LUFP1

108817

LA9P307

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Soft starters for asynchronous motors

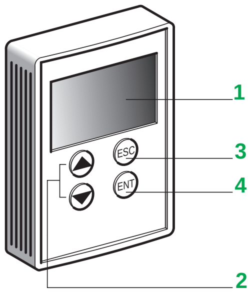
Altistart 48 soft start/soft stop units

Options: remote terminal, line chokes and DNV kits

Remote terminal

The terminal can be mounted on the door of a wall-fixing or floor-standing enclosure. It has the same signaling display and configuration buttons as the terminal integrated in the starter. A menu access locking switch is located on the rear of the terminal.

The option comprises:
- the remote terminal,
- a mounting kit containing a cover, screws and an IP 54 seal on the front panel,
- a connection cable 3 m/*9.84 ft* long, with a 9-way SUB-D connector at the terminal end and an RJ45 connector at the Altistart 48 end.



1 Information is displayed in the form of codes or values in three 7-segment displays.
2 Buttons for scrolling through the menus or modifying values.
3 "ESC": Button for exiting the menus (no confirmation).
4 "ENT": Confirm button for entering a menu or confirming the new value selected.

Line chokes

The use of line chokes is recommended in particular when installing several electronic starters on the same line supply. The inductance values are defined for a voltage drop between 3% and 5% of the nominal line voltage.
Install the line choke between the line contactor and the starter.

DNV kits

These kits enable ATS48D62●...48M12● starters to meet the requirements of the DNV certification body.
Each kit consists of the fixing pins and the parts necessary for mounting the starter (when mounting using the VW3G48107 kit a sling must be used, which is not included).

ATS48D17●...48D47● starters are DNV certified and it is not necessary to add an optional kit.

Protective covers for power terminals

To be used with eyelet connectors

ATS48C14● and ATS48C17● soft start/soft stop units have 9 unprotected power terminals. These terminals can be fitted with protective covers for compliance with IP 20 degree of protection.

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Schneider Electric

Soft starters for asynchronous motors

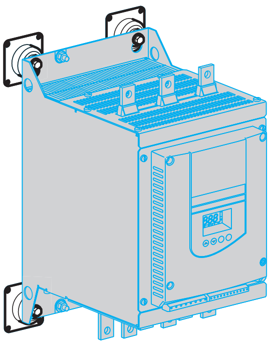
Altistart 48 soft start/soft stop units

Options: remote terminal, line chokes,
DNV kits, protective covers and documentation

106770

VW3G48101

538741



VW3G48106

PB111592

LA9F702

Remote terminal

Description	Reference	Weight kg/ *lb*
Remote terminal with a connection cable 3 m/*9.84 ft* long, with 9-way SUB-D connectors at the terminal end and RJ45 at the Altistart 48 end	**VW3G48101**	0.200/ *0.441*

Line chokes

For starters	Value of the choke mH	Nominal current A	Degree of protection	Reference	Weight kg/ *lb*
ATS48D17●	1.7	15	IP 20	**VZ1L015UM17T**	2.100/ *4.630*
ATS48D22●	0.8	30	IP 20	**VZ1L030U800T**	4.100/ *9.039*
ATS48D32● and 48D38●	0.6	40	IP 20	**VZ1L040U600T**	5.100/ *11.244*
ATS48D47● and 48D62●	0.35	70	IP 20	**VZ1L070U350T**	8.000/ *17.637*
ATS48D75●...48C14●	0.17	150	IP 00	**VZ1L150U170T**	14.900/ *32.849*
ATS48C17●...48C25●	0.1	250	IP 00	**VZ1L250U100T**	24.300/ *53.572*
ATS48C32●	0.075	325	IP 00	**VZ1L325U075T**	28.900/ *63.714*
ATS48C41● and 48C48●	0.045	530	IP 00	**VZ1L530U045T**	37.000/ *81.571*
ATS48C59●...48M10●	0.024	1025	IP 00	**VZ1LM10U024T**	66.000/ *145.505*
ATS48M12●	0.016	1435	IP 00	**VZ1LM14U016T**	80.000/ *176.370*

***Note:** Line chokes with IP 00 degree of protection must be fitted with a protective bar to protect personnel from electrical contact.*

DNV kits

For starters	Reference	Weight kg/ *lb*
ATS48D62●...48C17●	**VW3G48106**	0.600/ *1.323*
ATS48C21●...48C32●	**VW3G48107**	0.680/ *1.499*
ATS48C41●...48C66●	**VW3G48108**	3.400/ *7.496*
ATS48C79●...48M12●	**VW3G48109**	4.400/ *9.700*

Protective covers for power terminals

To be used with eyelet connectors

For starters	Number of covers per set	Reference	Weight kg/ *lb*
ATS48C14● and ATS48C17●	6 *(1)*	**LA9F702**	0.250/ *0.551*

(1) The starters have 9 unprotected power terminals.

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