B2-200
OSEC® SYSTEM

BOOK NO. IM 85.035AA UA   ISSUE B

B2-200 OSEC® SYSTEM

EQUIPMENT SERIAL NO. ________________

DATE OF START-UP ____________________

START-UP BY __________________________

Prompt service available from nationwide authorized service contractors.

ORDERING INFORMATION

In order for us to fill your order immediately and correctly, please order material by description and part number, as shown in this book. Also, please specify the serial number of the equipment on which the parts will be installed.

WARRANTY

Seller warrants for a period of one year after shipment that the equipment or material of its manufacture is free from defects in workmanship and materials. Corrosion or other decomposition by chemical action is specifically excluded as a defect covered hereunder, except this exclusion shall not apply to chlorination equipment. Seller does not warrant (a) damage caused by use of the items for purposes other than those for which they were designed, (b) damage caused by unauthorized attachments or modifications, (c) products subject to any abuse, misuse, negligence or accident, (d) products where parts not made, supplied, or approved by Seller are used and in the sole judgement of the Seller such use affects the products' performance, stability or reliability, and (e) products that have been altered or repaired in a manner in which, in the sole judgement of Seller, affects the products' performance, stability or reliability. **SELLER MAKES NO OTHER WARRANTY OF ANY KIND, AND THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR OF FITNESS OF THE MATERIAL OR EQUIPMENT FOR ANY PARTICULAR PURPOSE EVEN IF THAT PURPOSE IS KNOWN TO SELLER.** If Buyer discovers a defect in material or workmanship, it must promptly notify Seller in writing; Seller reserves the right to require the return of such defective parts to Seller, transportation charges prepaid, to verify such defect before this warranty is applicable. In no event shall such notification be received by Seller later than 13 months after the date of shipment. No action for breach of warranty shall be brought more than 15 months after the date of shipment of the equipment or material.

LIMITATION OF BUYER'S REMEDIES. The **EXCLUSIVE REMEDY** for any breach of warranty is the replacement f.o.b. shipping point of the defective part or parts of the material or equipment. Any equipment or material repaired or replaced under warranty shall carry the balance of the original warranty period, or a minimum of three months. Seller shall not be liable for any liquidated, special, incidental or consequential damages, including without limitation, loss of profits, loss of savings or revenue, loss of use of the material or equipment or any associated material or equipment, the cost of substitute material or equipment, claims of third parties, damage to property, or goodwill, whether based upon breach of warranty, breach of contract, negligence, strict tort, or any other legal theory; provided, however, that such limitation shall not apply to claims for personal injury.

Statements and instructions set forth herein are based upon the best information and practices known to U.S. Filter/Wallace & Tiernan, Inc., but it should not be assumed that every acceptable safety procedure is contained herein. Of necessity this company cannot guarantee that actions in accordance with such statements and instructions will result in the complete elimination of hazards and it assumes no liability for accidents that may occur.

USFilter
WALLACE & TIERNAN PRODUCTS
1901 West Garden Road, Vineland, NJ 08360

INTRODUCTION

The OSEC® (On Site Electrolytic Chlorination) hypochlorite generation equipment described in this manual is designed for the continuous production of sodium hypochlorite from brine. The sodium hypochlorite is used in the disinfection of water supplies, being an alternative to the use of gaseous chlorination. The sodium hypochlorite produced by the OSEC method is of much lower concentration than normal commercial supplies and is thus far less hazardous to handle and is not subject to the same degree of decomposition.

This manual describes the B2-200 OSEC system, producing outputs of between 260 and 500 lbs/day (118 and 227 kg/day) of equivalent chlorine. The manual has been produced to enable the user to obtain the maximum service from the equipment and comprises a full system description including installation, operation, maintenance, and spare parts information.

U.S. Filter/Wallace & Tiernan's (USF/W&T) guarantee is conditional upon the equipment being used in accordance with the instructions herein. It is therefore recommended that these instructions be read and fully understood before the equipment is placed in service.

WARNING: TO PREVENT POSSIBLE PERSONAL INJURY OR DAMAGE TO EQUIPMENT, THIS EQUIPMENT SHOULD BE INSTALLED, OPERATED, AND SERVICED BY TRAINED, QUALIFIED PERSONNEL WHO ARE THOROUGHLY FAMILIAR WITH THE ENTIRE CONTENTS OF THIS INSTRUCTION BOOK AND SAFETY PROCEDURES.

NOTE: When ordering material, always specify model and serial number of apparatus.

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VERY IMPORTANT SAFETY PRECAUTIONS

This page provides important safety precautions to be considered during the installation, operation, and maintenance of this equipment.

WARNING

HYDROCHLORIC ACID

HYDROCHLORIC ACID IS USED FOR ACID CLEANING THE ELECTRODES OF THE ELECTRO-CHLORINATOR AS PART OF THE LONG-TERM SERVICING PROCEDURES. THE STORAGE OF ANY ACID AND THE RELEVANT HANDLING FACILITIES MUST BE COMPLETELY SEPARATE FROM THE SODIUM HYPOCHLORITE FACILITIES. HYDROCHLORIC ACID FUMES EXCESSIVELY IN ITS CONCENTRATED FORM AND GREAT CARE MUST BE TAKEN WHEN HANDLING CARBOYS OF ACID. EVERY POSSIBLE SAFEGUARD MUST BE TAKEN TO ENSURE THAT THE ACID DOES NOT COME INTO CONTACT WITH THE HYPOCHLORITE SOLUTION AS THIS WILL RESULT IN CHLORINE GAS BEING PRODUCED. ANY SPILLAGE OF ACID, WHETHER DILUTE OR NOT, SHOULD BE IMMEDIATELY FLUSHED AWAY WITH COPIOUS QUANTITIES OF WATER.

PERSONNEL MUST BE MADE AWARE OF THE DANGERS OF HANDLING CONCENTRATED ACID AND THE PREPARATION OF DILUTE SOLUTIONS. THE PERSONNEL MUST WEAR CHEMICAL GOGGLES, PROTECTIVE CLOTHING, RUBBER BOOTS, AND GLOVES. SPLASHES IN THE EYES MUST BE DEALT WITH IMMEDIATELY BY PROLONGED IRRIGATION WITH RUNNING WATER. MEDICAL ADVICE SHOULD BE SOUGHT AS SOON AS POSSIBLE. SIMILARLY, SPLASHES TO THE SKIN OR CLOTHING SHOULD ALSO BE IMMEDIATELY WASHED IN RUNNING WATER. WARNING NOTICES POINTING OUT THE DANGERS AND DISPLAYING THE PREVIOUS POINTS SHOULD BE PROMINENTLY POSTED WHEREVER ACID IS STORED OR HANDLED.

SODIUM HYPOCHLORITE

THE STRENGTH OF THE HYPOCHLORITE SOLUTION GENERATED BY THE OSEC UNIT AND STORED IN THE BULK TANK IS APPROXIMATELY 0.8% W/W. ALTHOUGH THIS SOLUTION IS CONSIDERABLY WEAKER THAN NORMAL COMMERCIAL BULK SUPPLIES (15% W/W), CARE SHOULD STILL BE TAKEN WITH HANDLING. THE SODIUM HYPOCHLORITE IS SLIGHTLY ALKALINE AND FORMS AN OXIDIZING AND BLEACHING AGENT THAT IS CORROSIVE AND MAY CAUSE DAMAGE TO SKIN AND CLOTHING ON CONTACT.

MIXING OF THE CHEMICAL WITH ANY FORM OF ACID MUST BE AVOIDED AS HIGHLY TOXIC CHLORINE GAS WOULD BE GENERATED. WARNING NOTICES SIMILAR TO THOSE DISPLAYED FOR THE ACID EQUIPMENT SHOULD BE PROMINENTLY POSTED IN AREAS WHERE HYPOCHLORITE IS GENERATED AND STORED.

VERY IMPORTANT SAFETY PRECAUTIONS (CONT'D)

ELECTRICAL SAFETY

THE ELECTRICAL POWER IN THIS EQUIPMENT IS AT A VOLTAGE HIGH ENOUGH TO ENDANGER LIFE. BEFORE CARRYING OUT MAINTENANCE OR REPAIR, PERSONS CONCERNED MUST ENSURE THAT THE EQUIPMENT IS ISOLATED FROM THE ELECTRICAL SUPPLY AND TESTS MADE TO VERIFY THAT THE ISOLATION IS COMPLETE.

WHEN SUPPLIES CANNOT BE DISCONNECTED, FUNCTIONAL TESTING, MAINTENANCE AND REPAIR OF THE ELECTRICAL UNITS IS TO BE UNDERTAKEN ONLY BY PERSONS FULLY AWARE OF THE DANGER, AND WHO HAVE TAKEN ADEQUATE PRECAUTIONS.

HYDROGEN GAS

THE PROCESS OF CONVERTING BRINE INTO SODIUM HYPOCHLORITE GENERATES HYDROGEN GAS, WHICH IS SAFELY EXHAUSTED TO ATMOSPHERE AT THE EXTERNAL HYPOCHLORITE STORAGE TANKS, HAVING BEEN DILUTED WITH AIR TO REDUCE ITS CONCENTRATION. HOWEVER, TO ENSURE PLANT SAFETY, WARNING NOTICES SHOULD BE DISPLAYED FORBIDDING SMOKING OR ANY OPEN FLAME IN THE VICINITY OF THE STORAGE TANKS. THE EQUIPMENT SHOULD BE REGULARLY CHECKED TO ENSURE THAT NO GAS LEAKAGES OCCUR. DO NOT CHECK WITH A MATCH OR OPEN LIGHT. USE A SPECIFIC SENSITIVE HYDROGEN DETECTOR.

NO ATTEMPT MUST BE MADE TO EXTRACT SODIUM HYPOCHLORITE AT ANY POINT PRIOR TO THE STORAGE TANK, APART FROM SMALL VOLUME SAMPLES TAKEN AT THE HYPOCHLORITE OUTLET SAMPLE VALVE FOR PURELY ANALYTICAL PURPOSES. THIS IS TO PREVENT THE HYDROGEN, WHICH IS CONTAINED IN THE HYPOCHLORITE BEFORE REACHING THE TANK, FROM BEING RELEASED INTO THE ATMOSPHERE IN AN UNDILUTED FORM, WITH CONSEQUENT RISK OF IGNITION.

GENERAL

TO AVOID POSSIBLE SEVERE PERSONAL INJURY OR EQUIPMENT DAMAGE, OBSERVE THE FOLLOWING:

TO ENSURE PROPER AND SAFE OPERATION OF THIS EQUIPMENT, USE ONLY U.S. FILTER LISTED PARTS, EXCEPT FOR COMMERCIALLY AVAILABLE PARTS AS IDENTIFIED BY COMPLETE DESCRIPTION ON ACCOMPANYING PARTS LIST. THE USE OF UNLISTED PARTS CAN RESULT IN EQUIPMENT MALFUNCTIONS, CAUSING POSSIBLE SEVERE PERSONAL INJURY.

THIS EQUIPMENT SHOULD BE INSTALLED, OPERATED, AND SERVICED ONLY BY TRAINED QUALIFIED PERSONNEL WHO ARE THOROUGHLY FAMILIAR WITH THE ENTIRE CONTENTS OF THE INSTRUCTION BOOK PROVIDED.

VERY IMPORTANT SAFETY PRECAUTIONS (CONT'D)

DO NOT DISCARD THIS INSTRUCTION BOOK UPON COMPLETION OF INSTALLATION. INFORMATION PROVIDED IS ESSENTIAL FOR PROPER AND SAFE OPERATION AND MAINTENANCE.

ADDITIONAL OR REPLACEMENT COPIES OF THIS INSTRUCTION BOOK ARE AVAILABLE FROM:

USFILTER'S WALLACE & TIERNAN PRODUCTS
1901 W. GARDEN ROAD
VINELAND, NEW JERSEY 08360
PHONE: (856) 507-9000
FAX: (856) 507-4125

NOTE

Minor part number changes may be incorporated into USF/W&T products from time to time that are not immediately reflected in the instruction book. If such a change has apparently been made in your equipment and does not appear to be reflected in your instruction book, contact your local USF/W&T sales office for information.

Please include the equipment serial number in all correspondence. It is essential for effective communication and proper equipment identification.

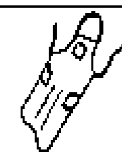
NOTES ON PROTECTIVE EQUIPMENT AND CLOTHING

The following Warning appears in several locations in this book. It is general in nature due to the variety of hazardous liquids this equipment is capable of handling.

> **WARNING:** WHEN DEALING WITH HAZARDOUS MATERIAL, IT IS THE RESPONSIBILITY OF THE EQUIPMENT USER TO OBTAIN AND FOLLOW ALL SAFETY PRECAUTIONS RECOMMENDED BY THE MATERIAL MANUFACTURER/SUPPLIER.

It is good general practice to make use of protective equipment when handling any hazardous material.

IT IS RECOMMENDED THAT SUCH PROTECTIVE EQUIPMENT BE USED BY ALL PERSONS SERVICING THIS PUMP, ASSOCIATED PIPING, TUBING, VALVES, AND ACCESSORIES, WHEN THE EQUIPMENT IS HANDLING ANY HAZARDOUS MATERIAL.

1. Goggles, flexible fitting, hooded ventilation (per ANSI Z87.1)	
2. Face Shield (per ANSI Z87.1)	
3. Chemical Apron	
4. Chemical Gloves	

NOTE: (1) ANSI Z87.1 “practice for occupational.......eye and face protection” recommends goggles (#1 above) as the “preferred protection” when handling chemicals that present a hazard from splash, acid burns or fumes; for severe exposure, a face shield (#2 above) over the goggles is recommended.

(2) An eye flushing fountain and a deluge-type shower may be recommended or required by insurance carriers or governmental safety agencies, which should be consulted for specific requirements.

ANODE WARRANTY CONDITIONS

The anodes used in the electrolyzer are warranted for five calendar years after installation and commissioning unless stated otherwise at the time of tender or unless there is a temperature variance as mentioned in the first item below.

USF/W&T will replace or refurbish the anodes during the period after installation and commissioning, either option at the spare parts price in effect at the time of replacement, less a percentage equal to that portion of the expected life that was not obtained from the anodes being replaced. The warranty and conditions current at the time of replacement will then apply.

Anode life is dependent upon many factors, the warranty is therefore conditional upon correct operation of the equipment in accordance with the Instruction Manual and subject to the following conditions:

- A five-year warranty will apply if the temperature of the incoming electrolyte does not fall below 50°F (10°C) (except for a maximum start-up period of 20 minutes, which shall be further limited to a maximum of four starts on any one day). To achieve this condition on an electrolyzer fitted with a standard heat exchanger, the inlet water must not fall below 43.7°F (6.5°C).
- The salinity of the electrolyte must be above 18,000 mg/l chloride (Cl_2) unless otherwise specified by USF/W&T. The sulfate (SO_4) content must be less than $1/7^{th}$ of the Cl_2 content.
- The manganese level in the electrolyte entering the electrolyzer must not exceed 10 mg/l at any time.
- The electrolyte must contain less than 2 mg/l fluoride (F).
- The electrolyzer, as specified, must not be operated at a current above the figure shown in the Instruction Manual.
- The operational log, as shown in this Instruction Manual, must be maintained with the time periods specified.
- A monthly log of water analysis must be maintained by water authorities and, in the case of other users, as determined by agreement with USF/W&T.
- Salt quality must be to the following specifications:

Water insolubles:	0.1% maximum
Calcium sulfate:	0.14% maximum
Magnesium sulfate:	0.02% maximum
Magnesium chloride:	0.1% maximum
Sodium chloride:	99.82% maximum

- Acid cleaning is to be carried out if current efficiency falls below the normal by more than five percent.
- Water hardness leaving the softener must not exceed 17 mg/l of calcium carbonate ($CaCo_3$).
- If it is found that the performance of the anode coatings has been impaired by organic contaminants in the electrolyte, causing (directly or indirectly) blinding or reduced coating life, the anode coating lifetime guarantee will not apply. It is recommended that the total organic content in the electrolyte should be less than 10 mg/kg, the actual limit being dependent on the species.
- Brine dilution shall normally be a nominal 10:1, this may be increased to a nominal 12:1, providing the incoming electrolyte is always above 50°F (10°C).

REGIONAL OFFICES

INSTALLATION, OPERATION, MAINTENANCE, AND SERVICE INFORMATION

Direct any questions concerning this equipment that are not answered in the instruction book to the Reseller from whom the equipment was purchased. If the equipment was purchased directly from USFilter's Wallace & Tiernan Products (USF/W&T), contact the office indicated below.

UNITED STATES

1901 West Garden Road
Vineland, NJ 08360
TEL: (856) 507-9000
FAX: (856) 507-4125

CANADA

If the equipment was purchased directly from USF/W&T Canada, contact the nearest office indicated below.

ONTARIO

250 Royal Crest Court
Markham, Ontario
L3R3S1
(905) 944-2800

QUEBEC

243 Blvd. Brien
Bureau 210
Repentigny, Quebec
(514) 582-4266

MEXICO

If the equipment was purchased directly from USF/W&T de Mexico, contact the office indicated below.

Via Jose Lopez Portillo 321
Col. Sta. Maria Cuautepec
Tultitlan, Edo. de Mexico
54900 Mexico
TEL: 525 879 0260
FAX: 525 875 2171

SECTION 1 - TECHNICAL DATA

List of Contents

1.1 General Description

An OSEC (On Site Electrolytic Chlorination) system is designed to produce a supply of sodium hypochlorite solution (NaOCl), which is used in the chlorination for disinfection purposes of swimming pools or potable water supplies. The hypochlorite is generated electrolytically from a solution of brine and softened water by an OSEC electrolyzer. The typical OSEC system (see Dwg. 85.035.110.010) contains six main items of equipment:

- Water Softener — Provides the softened water supply to the brine equipment and to the electrolyzer.
- Salt Saturator — Produces the concentrated brine solution used by the electrolyzer.
- Brine Pump — Meters the brine from the saturator to the electrolyzer.
- Electrolyzer — Generates the hypochlorite solution.
- Transformer/Rectifier Unit — Provides the low voltage/high current DC supply to the electrolyzer to effect the electrolysis.
- Storage Tank

The water softener, salt saturator, transformer/rectifier, and storage tank equipment are all proprietary items of other than USF/W&T manufacture. These items are briefly described in the following pages as an aid to understanding the overall system concept, but, for full details, reference should be made to the manufacturers' literature supplied with their equipment. The brine pump is fully described in a separate publication supplied with the pump.

The hypochlorite generation system is under the control of a dedicated, programmable logic controller-based panel, mounted remotely from the electrolyzer, the controller responding to status signals from various plant monitors to control the hypochlorite generation efficiently and safely. The control system also provides a diagram of the generation plant, being equipped with the various status and alarm lamps associated with the control monitors. The generation is primarily under the control of the level switches at the storage tank, starting up the generation when the low level is reached and shutting down when the high level is reached. This generation is inhibited so that it operates mainly during off-peak electricity hours to keep the generation costs to a minimum. Overrides are built into the control system to provide limited tank top-up facilities if the level is falling too low or to fulfill an expected demand.

1.2 Water Softener

The saturated brine and the dilution water, used by the electrolyzer to produce the sodium hypochlorite solution, must be as ‘soft’ as possible (maximum 25 mg/l of $CaC0_3$) to eliminate the build-up of deposits on the electrolyzer electrodes during electrolysis, as these deposits would seriously impair the efficiency of the OSEC unit. To provide sufficient capacity for the salt saturator and the electrolyzer, a twin-cylinder softener is used. The unit operates from a mains water supply and its softened water output feeds into a common supply line to the saturator and electrolyzer.

The softener consists of two cylinders incorporating ultra-fine particle resin beds in which the ion exchange takes place to remove the hardness elements from the water supply. This process involves passing the mains water through a resin bed charged with sodium ions. As the water flows through the bed, the hardness ions in the water, such as calcium and magnesium, are exchanged for the ‘soft’ sodium ions attached to the resin particles. This exchange takes place whenever water is drawn through the softener by the demands of the saturator or electrolyzer until the resin bed is exhausted of sodium and requires regeneration.

The two cylinders are arranged so that only one cylinder is in use at a time, the other being left in a standby condition. A meter unit on top of the cylinders that registers the flow of water through the cylinder. When the cylinder in use nears exhaustion, this meter unit initiates the changeover to the standby cylinder. While this new cylinder is in service, the previously exhausted cylinder is automatically regenerated and left on standby ready for the next changeover.

This changeover from one cylinder to the other is effected by means of water-operated servo valves. These valves, in turn, are controlled by the meter unit atop the cylinders. The meter unit incorporates a small turbine that spins as softened water is drawn through the cylinder, the turbine being arranged to drive the meter. The regeneration of the exhausted resin bed in the cylinder, when initiated by the meter, is achieved back flushing with brine solution, this being drawn automatically via a non-return valve from the salt saturator unit. The brine, as it is reverse-flushed through the resin bed, picks up the hardness elements that have been deposited and discharges them into a convenient drain. This brine regeneration is followed by a backwash with softened water to flush away any remaining brine. The brine regeneration and backwash cycle takes approximately 11 minutes. All functions within the softener are carried out using water pressure as a power source, no electrical connections being required. For a full description of the water softener, refer to the manufacturer’s manual supplied with the equipment.

1.3 Salt Saturator

The salt saturator is sized both to suit the brine requirements of the electrolyzer and to provide the necessary number of days storage before recharging, as stipulated by the customer. The units contain a substantial quantity of salt arranged above a filter bed constructed from layers of gravel. The tank is fed from the softened water supply and this water is drawn through the salt reservoir by the action of the brine pump that feeds the electrolyzer. As the water is drawn through the salt reservoir, it absorbs the salt until it becomes saturated and can absorb no more material. It is drawn from the bottom of the tank, the layers of gravel preventing any undissolved solids from passing through to the pump. The brine outlet of the saturator is usually fitted with a calibration column to enable the output of the brine pump to be precisely set to meet the flow requirements of the electrolyzer. For further details of the proprietary saturators, refer to the manufacturer's literature supplied with the equipment.

1.4 Brine Pump

The brine pumps meter the brine solution from the saturator to the electrolyzer. The pumps are mounted remotely from the electrolyzer, usually adjacent to the saturator, to avoid long suction lines. The pumps used are usually USF/W&T precision dosing pumps equipped with diaphragm-type liquid ends and manual stroke controls, which enable the percentage of the maximum stroke to be adjusted. These adjust the output capacity of the pumps so that they can be precisely set to match the brine flow rate required by the electrolyzer.

Three different capacities of pump are used for the range of B2-200 electrolyzer capacities. The smallest capacity pump has a maximum output in excess of 22 gal/hour (82 liters/hour) and is used for electro-chlorinators with outputs of between 260 and 352 lbs/day (118 and 160 kg/day) of equivalent chlorine. The next highest capacity pump, with a maximum output in excess of 25 gal/hour (94 liters/hour), is used for electro-chlorinators with outputs between 370 and 409 lbs/day (168 and 185 kg/day). The highest capacity pump, with a maximum output in excess of 31 gal/hour (116 liters/hour), is used for the electro-chlorinators with outputs from 425 lbs/day (193 kg/day) up to a maximum of 500 lbs/day (227 kg/day).

The pump discharges are fitted with pulsation dampers to smooth the pumping pulses and thus provide a steady indication at the brine flowmeter on the electrolyzer. The discharges are also fitted with pressure relief valves set to relieve at a nominal 36 psig (2.5 bar) pressure.

For full details, refer to the separate publication supplied with the pump.

1.5 Transformer/Rectifier Unit

The transformer/rectifier unit is usually located in a room adjoining the electrolyzer plant room to avoid the chance of it being subject to water or chemical splashes when servicing the electrolyzer. The unit comprises a three-phase, step-down transformer and an air-cooled rectifier, all contained in a heavy-duty, epoxy-coated, sheet steel cabinet. The incoming 440 V, 60 Hz, three-phase supply is fed, via an isolator and contactor, to a motor-driven, three-phase variable transformer. Each output phase of the variable transformer feeds the primaries of a heavy-duty, three-phase, step-down transformer, the output phases of which are full wave rectified and combined to provide the DC supply for electrolysis.

The rectifier unit produces a voltage of 32V DC at a current rating to suit the size of electrolyzer supplied, the operating currents required for the different capacities being shown in the electrolyzer data sheet (Table 1.1, located at the end of this section), varying from 780A for the smallest unit up to 1500A for the largest.

A shunt placed in series with the positive DC output lead generates a millivolt signal that is used not only to operate the ammeter but also to power a constant current controller for the rectifier control circuitry. This constant current controller processes the millivolt signal and compares it with a reference voltage set by the output current setting potentiometer. If the signal is outside the reference level, the controller feeds a signal to the drive motor of the variable transformer.

In these units, each phase of the primary winding of the main step-down transformer is connected in series with a pair of saturable reactors. The reactors are connected across a DC supply derived from the secondary of the motor-driven variable transformer. By varying the output of the variable transformer, and thus the DC control voltage applied to the reactors, the degree of magnetism of the soft iron cores of the reactors is changed. This, in turn, changes the inductance of the reactors and therefore the current flowing through the primaries of the main step-down transformer. In this way, the output voltage of the secondary, and the rectified DC applied to the electrolyzer, are adjusted to maintain the electrolyzer current at set value.

The motor-driven variable transformer can be controlled either in an automatic mode using the constant current unit, as previously described, or in a manual mode. In the manual mode, the transformer is adjusted by a Raise/ Lower switch on the unit control panel. Moving the switch in the required direction provides a supply direct to the transformer drive motor to adjust it in the appropriate direction to change the output voltage and so vary the output of the main transformer, as previously described. This Raise/Lower switch is enabled only when the Auto/Man switch is in the Manual position.

The transformer/rectifier unit front panel is equipped with an ammeter and voltmeter to monitor the DC output. An additional voltmeter is fitted to monitor the voltage across each electrolyzer to check that they are in balance. This center-zero type voltmeter is fitted with pre-settable high and low voltage alarm contacts that are triggered if a measurable out-of-balance condition occurs. These alarm contacts provide a signal to the electrolyzer PLC control to light a specific alarm lamp and sound an audible alarm. They also initiate the shut down of the electrolyzer and rectifier unit.

1.6 Hypochlorite Storage Tank

The storage tank is usually sized to provide sufficient capacity for one full day of electrolyzer hypochlorite generation. The tank not only provides the storage for the generated hypochlorite, but also allows the hydrogen gas contained in the newly generated solution to detrain and be safely vented to atmosphere. This product tank must be suitable for 1% sodium hypochlorite at a temperature up to 104°F (40°C). The hypochlorite storage tank is usually manufactured from spirally wound, high-density, black polyethylene material or premium resin FRP with nexus veil.

The standard tank has a capacity of 6076 gallons (23,000 liters), sufficient for electro-chlorinators with up to 370 lbs/day (168 kg/day) output; however, larger sized tanks can be supplied to comply with customer requirements. For electro-chlorinators with outputs in excess of 370 lbs/day (168 kg/day), the use of two storage tanks connected in parallel may prove practical. These tanks should be piped together at their bases so that both tanks fill in unison. They also should be connected together at the top by duct work to ensure adequate dilution and discharge of the detrained hydrogen.

A typical arrangement of the standard tank is shown in Dwg. 85.035.170.030. For other sized tanks, refer to any drawings specific to the contract included in this manual. The tank is a closed-top design fitted with a 20-inch (500mm) diameter manway. Two 10-inch (250mm) diameter hydrogen venting blowers are floor mounted beside the tank. These are centrifugal, vertical jet type blowers, with blades and casings of PVC/GRP construction and with galvanized metalwork to resist corrosion. The outputs of the blowers are fitted with flap-type non-return valves.

The inlets to the two blowers are individually connected to their respective 10-inch (250mm) bore flanged connections at the top of the tank by use of plastic elbows and flexible couplings. A third 10-inch (250mm) bore flange at the top of the tank is fitted with a length of vertical pipe, complete with cowl and bird screen, to provide the air inlet to the tank. The outputs of the blowers are fitted with flap-type non-return valves and the exhausts are ducted away to suit site conditions, discharging the vented gas at a high level safely away from any building openings.

These blower systems ensure that the hydrogen gas detraining from the newly generated hypochlorite is diluted with sufficient air to reduce the hydrogen concentration to less than 25% of its lower explosive limit (LEL value 4% hydrogen volume in air) and so prevent the possibility of ignition.

The air flow into the tank to replace the hydrogen/air mixture being discharged is monitored by a sensitive air flow switch assembly, which senses the change in pressure in the inlet pipework when the blower is extracting and diluting the gas. The contacts of the air flow switch are connected back to the OSEC control. The duty blower is selected at the PLC control and operated automatically whenever the electrolyzer starts up.

In the event of a fault condition at the blower, leading to a failure of the air flow through the tank sensed by the switch, the standby blower is automatically started and a Duty Blower Failed alarm is raised. If the standby blower should then fail, the generation system is shut down until the alarm condition is cleared.

On external tanks, a ‘cat & mouse’-type level indicator is provided, comprising a vertically mounted, clear plastic tube containing an indicator slug attached to the side of the tank. This is connected by a cable to a float within the tank so that it responds in sympathy with the hypochlorite level and so provides a local contents level indication. From the overflow connection at the top of the tank, the overflow pipework is run to a nearby low-level overflow alarm tank fitted within the tank containment area, or to a separate tank on non-contained systems.

This overflow tank is fitted with a float-operated level switch that is wired back to the OSEC control to shut down the electrolyzer should an overflow occur, as this points to a failure of the normal High (stop) level switch. The overflow pipework is fitted with an air vent to prevent syphonic effects from emptying the tank via the overflow.

Where full off-peak operation is specified, the tank contents level is transmitted to the OSEC controller from a hall effect pressure transducer as a 0 to 20mA signal. The Operator Terminal at the control panel is used to set the tank level parameters for both off-peak and daytime hours operation.

The tank’s High and Low level switches control the automatic operation of the electrolyzer, stopping hypochlorite generation when the High level is reached and starting it up again when the Low level is reached. These level switches are set so the maximum quantity of hypochlorite is generated during the low demand and thus reduced cost electricity hours.

The Low Storage level switch is set to operate and warn when the hypochlorite level has reached a very low point near which the hypochlorite dosing pumps would begin to pull air or hydrogen gas into the dosing pipeline. The PLC provides an inhibit signal to the dosing pump control to ensure that any dosing pump is shut down until the hypochlorite level has risen sufficiently.

1.7 OSEC Electrolyzer Type B2-200

The electrolyzer (shown in Dwg. 85.035.170.010) consists of a fabricated base skid of mild steel plate and channel construction on which is centrally mounted a vertical, channel section, mild steel column. Mounted on the top half of the column at the rear, and arranged horizontally, are the two 8-inch (200mm) diameter electrolyzer casings in which the electrolysis of the brine takes place. Mounted directly above the electrolyzer will be the heat exchanger, coupled to the hypochlorite output of the electrolyzer and to the dilution water supply, and arranged to warm the dilution water for efficient electrolysis. On the front face of the column is the hydraulic panel on which are mounted the various valves, flowmeters, and controls for the brine and dilution water feeds. An information plate attached to the panel shows the system schematically and details the various inputs and flows.

Incoming water from the softener connects directly to a manual 1-inch ball valve (A) at the base of the hydraulic panel. This incoming supply line is fitted with a solenoid or motorized valve prior to reaching the skid, the valve being under the control of the OSEC panel. From the main inlet valve, the water feeds to the dilution water flowmeter, a pressure gauge calibrated 0 to 10 bar being fitted to the line to monitor the water pressure.

After the flowmeter, the supply passes to a tee piece that splits the water supply into two feeds. One feed, from the side of the tee, passes through a Maric control valve and down the length of the hydraulic panel, to feed directly into the underside of the lower electrolyzer at its third cell position. This Maric valve is fitted with an internal orifice to regulate the flow through to the third cell to approximately 50% of the total electrolyzer water requirements.

The other dilution water branch feeds via a Maric control valve and three-way ‘L’ port valve into the lower electrolyzer at its first cell position, along with the brine supply. The three-way valve controls whether the dilution water is fed via the heat exchanger or directly to the electrolyzer. The heat exchanger is sized in accordance with the output capacity of the electrolyzer and thus the dilution water flow rate required to be warmed. The heat exchanger is also connected to the hypochlorite outlet of the electrolyzer and uses the heat of the hypochlorite as it is generated to warm the dilution water if its temperature is too low for optimum electrolysis (7° C minimum). Just prior to the electrolyzer inlet the dilution water is combined with the incoming brine supply and the solution feeds into the first cell of the electrolyzer.

Brine solution is drawn from the salt saturator by the action of the remote mounted brine pump. The brine pump, which is sized to suit the electrolyzer output capacity, is a diaphragm pump with a variable stroke control enabling the percentage of pump maximum stroke to be altered, and thus the output of the pump to be adjusted, to achieve the correct brine flow rate for the electrolyzer requirements.

From the pump discharge, the brine connects to the 1-inch inlet valve (C) on the hydraulic panel, then feeds to the brine flowmeter, and then to a back pressure valve. The back pressure valve ensures an accurate, consistent delivery from the pump. The flowmeter is also fitted with a presettable low flow switch wired to the OSEC panel to inhibit electrolyzer operation unless the flow is correct. Should the switch detect the failure of the duty pump, it will automatically start up the standby pump and raise a specific alarm. Should the standby pump fail, the system will be shut down. From the brine flowmeter, the brine supply feeds into a tee piece in the dilution supply feed to the first cell of the lower electrolyzer. This line, in which 50% of the dilution water combines with the brine, is fitted with a temperature gauge calibrated from 86 to +140°F (30 to +60°C), to monitor the temperature of the incoming solution.

NOTE: Under the terms of the warranty on the electrodes used in the electrolyzer, the minimum temperature of the incoming brine solution mix at which the electrolyzer is permitted to operate is 44.6°F (7°C), this temperature being registered at the gauge previously described. The number of occasions on which the unit may operate with incoming solution at this minimum temperature should not exceed two months in any 12-month period. The normal minimum solution temperature for continuous use is 50°F (10°C).

The 8-inch (200mm) diameter plastic electrolyzer casings mounted at the rear of the central column house the electrode assemblies (as shown in Dwg. 85.035.160.010). The electrodes are flat, rectangular metal plates, arranged as interleaved layers of alternate positive and negative electrodes, separated from each other by small Kynar spacers. The electrodes are arranged within the casing to form four cells. All the positive electrodes (anodes) in each cell are connected together in parallel. Similarly, all the negative electrodes (cathodes) in the cell are connected together in parallel. Each cell within the casing is connected in series to the next cell so that the anodes of one cell are connected to the cathodes of the next cell, etc., as in a battery. The cells are separated from each other by circular plastic discs that are pierced with a series of holes to allow the free passage of solution and gas.

The number of electrolyzers fitted to the electrolyzer, and the number of electrodes used in each electrolyzer, determine the hypochlorite production capacity of the unit. The B2-200 electrolyzer is equipped with two electrolyzers and has outputs ranging from 260 to 500 lbs/day (118 to 227 kg/day) of equivalent chlorine. Refer to the B2-200 operational data sheet (Table 1.1, located at the end of this section) for details of the various capacities available and the number of electrodes used. Where the output required falls between the outputs of the standard units quoted, the electrolyzer will be sized for the nearest higher capacity unit.

The anodes used are made from titanium and have precious metal oxide coatings. The cathodes are made from Hastelloy C. All other metalwork within the electrolyzer casing is titanium, which is one of the few metals that can resist hypochlorite attack. The plastic used for the electrolyzer casing is chlorinated polyvinyl chloride (cpvc), which is formulated to withstand any high temperatures the casing is likely to be subject to without risk of distortion.

The two ends of each four-cell electrolyzer assembly connect through the end flanges of the assembly casing to external bus bars. At the left-hand end of the casing, a bus bar connects the two electrolyzers together in series. At the right-hand end, the positive and negative terminals connect to the corresponding polarity terminals of the transformer/rectifier unit. This unit provides the low voltage/high current DC supply for the electrolysis of the brine. The usual arrangement is to locate the transformer/rectifier in an adjoining room to the electrolyzer (to avoid it being subject to any liquid splashes from the electrolyzer) and then have the interconnecting bus bars feed through clearance holes in the dividing wall.

The bus bars are made of large-section, high-conductivity copper strip, covered by an insulated shrink-fit sleeving. The transformer/rectifier provides a nominal 32V DC supply at the current required for the capacity of the electrolyzer (quoted on Table 1.1). The nominal voltage across each electrolyzer is 16V or 4V per cell.

As the brine solution passes through the lower casing, it is increasingly converted to sodium hypochlorite as it is electrolyzed in the four cells. The solution then feeds into the casing above to continue the process. The chemical reaction also generates hydrogen gas. To prevent the hydrogen in the lower electrolyzer from being transferred with the solution to the upper electrolyzer and degrading the electrolysis, the gas is bled from the top of the lower casing and separately piped to the outlet manifold on the upper casing. Here, it recombines with the emerging hypochlorite solution to be piped away to the storage tank, where the hydrogen is allowed to detrain from the solution and be vented to atmosphere.

Upon leaving the electrolyzer, the warm hypochlorite passes through the associated heat exchanger before feeding into the storage tank. As already described, the exchanger enables the dilution water temperature to be raised, if required. The hypochlorite outlet manifold is fitted with a float-operated reed switch to sense the solution level in the electrolyzers. This switch is wired back to the remote-mounted control panel to prevent the main electrolyzing DC supply from being applied to the electrodes unless both casings are full of electrolyte. The upper casing is also fitted with a temperature sensor wired to the control to shut down the electrolyzer should the solution temperature rise above 113°F (45°C).

The electrolyzer is also equipped with valves to enable acid cleaning equipment to be connected when required. The dilution water supply to the electrolyzer should have a hardness not exceeding 17 mg/l of $CaCO_3$ (calcium carbonate). This often entails the use of proprietary water softeners to remove the hardness elements. Without this provision, these elements would otherwise be deposited on the electrodes during electrolysis, leading to a gradual lowering of efficiency. In other instances, there may have been breakdowns in the softeners leading to deposits forming. These deposits can easily be removed without dismantling the electrolyzers by draining the units and then flushing through with a dilute hydrochloric acid solution using a packaged pump unit, which can be supplied.

The system used is a circulatory-type, where the output from the pump is connected to the ball valve at the brine/dilution water inlet to the lower electrolyzer casing and a return pipe from the ball valve at the hypochlorite outlet manifold on the upper casing is connected back to the tank. For full details, refer to the acid cleaning instructions in the Section 4 - Service. This service can be carried out by USF/W&T service personnel, if required.

1.8 Control Cabinet

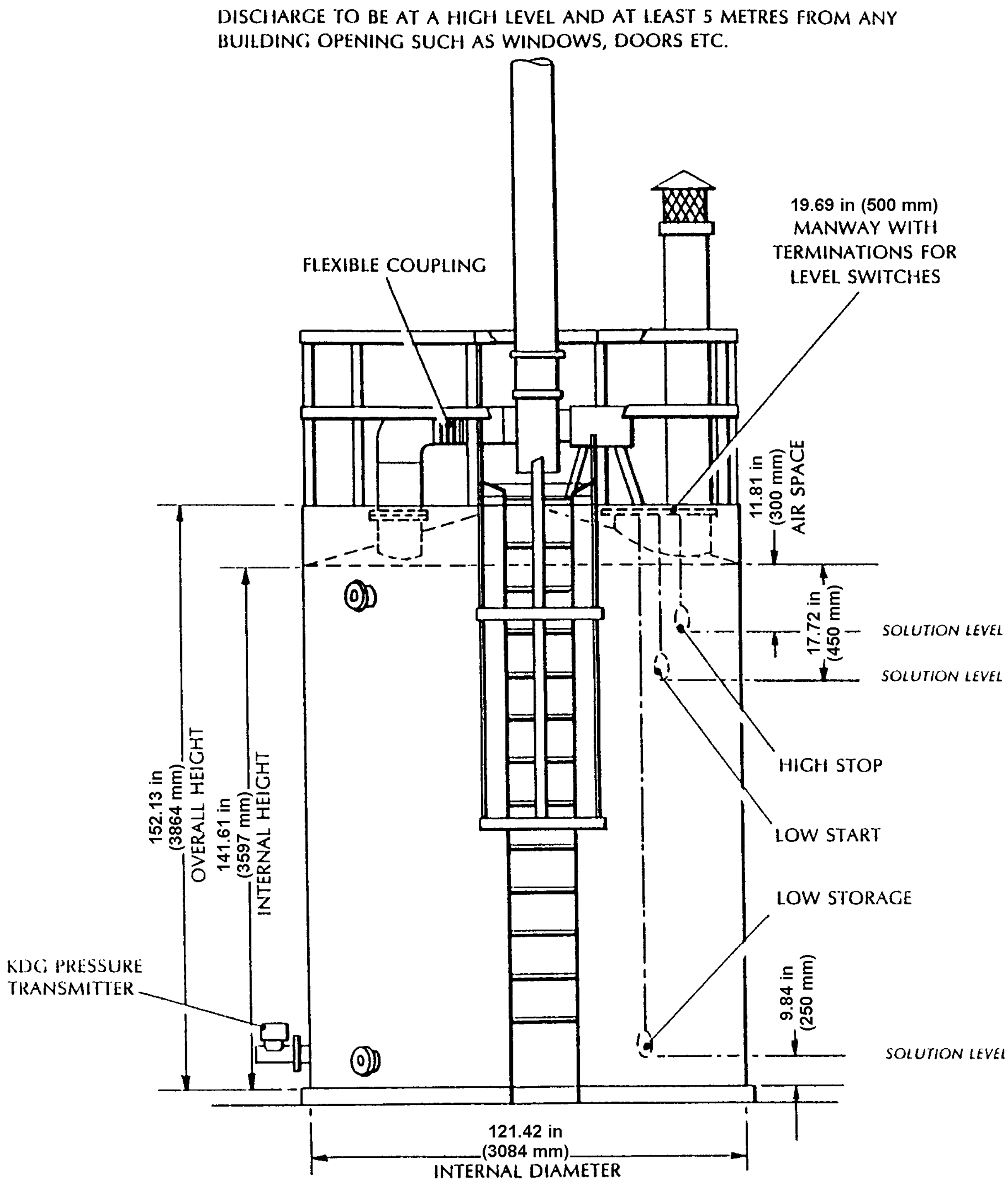
The electrolyzer is under the control of a wall-mounted control cabinet located remote from the electrolyzer, usually in the adjoining room that houses the transformer/rectifier unit. The cabinet is located remote from the electrolyzer for safety reasons, to avoid it incurring water or chemical splashes from the electrolyzer during any servicing. The control panel is described in detail in Supplement 1.

Table 1.1 - B4-200 OSEC - Operational Data

lbs/d (kg/d) Cl_2 *	Number of		Inlet Water Supply Pressure	Brine Supply Feedrate gal/hr (l/hr)			Nominal System Power			Water Requirements		Protective Current Amps
	Anodes	Cathodes		Saturated Brine	Dilution Water	Total	Electrolyzer Voltage V	Electrolyzer Current A	kW ac	Maric Valve for Saturator Water gal/min (l/min)	Peak Water Flow gal/hr (l/hr)	
260.15 (118.00)	112	128	40 to 80 psig (2.8 to 5.5 bar)	15.85 (60)	158.51 (600)	174.36 (660)	30	784	24.8	.66 (2.5)	226.67 (858)	0.70
277.78 (126.00)	120	136		16.91 (64)	174.36 (660)	191.27 (724)	30	840	26.6		239.35 (906)	0.75
295.42 (134.00)	128	144		18.23 (69)	187.04 (708)	205.27 (777)	30	896	28.3		250.44 (948)	0.80
315.26 (143.00)	136	152		19.29 (73)	199.72 (756)	219.01 (829)	30	952	30.1		266.29 (1008)	0.85
332.89 (151.00)	144	160		20.34 (77)	210.82 (798)	231.16 (875)	30	1008	31.9		277.39 (1050)	0.90
352.74 (160.00)	152	168		21.66 (82)	221.91 (840)	243.57 (922)	30	1064	33.6		293.24 (1110)	0.95
370.38 (168.00)	160	176		22.72 (86)	237.76 (900)	260.48 (986)	30	1120	35.4		309.09 (1170)	1.00
388.01 (176.00)	168	184		23.78 (90)	237.76 (900)	261.54 (990)	30	1176	37.2		324.94 (1230)	1.05
407.85 (185.00)	176	192		24.57 (93)	253.61 (960)	278.18 (1053)	30	1232	38.9		340.79 (1290)	1.10
425.49 (193.00)	184	200		26.15 (99)	269.46 (1020)	295.62 (1119)	30	1288	40.7		356.64 (1350)	1.15
445.33 (202.00)	192	208		27.21 (103)	285.31 (1080)	312.52 (1183)	30	1344	42.5		356.64 (1350)	1.20
462.97 (210.00)	200	216		28.27 (107)	285.31 (1080)	313.58 (1187)	30	1400	44.3		372.49 (1410)	1.25
480.61 (218.00)	208	224		29.59 (112)	301.17 (1140)	330.75 (1252)	30	1456	46.0		388.34 (1470)	1.30
500.45 (227.00)	216	232		30.64 (116)	317.02 (1200)	347.66 (1316)	30	1512	47.8		404.19 (1530)	1.35

Dilution water requirements based on 10:1 dilution ratio.

* These output figures are theoretical maximum values and may be subject to reductions due to vaviations in plant operating conditions.



Usable capacity of tank (between High Stop and Low Storage): Nominal 23,000 liters.

OSEC© SYSTEM - HYPOCHLORITE STORAGE TANKS

85.035.170.030A

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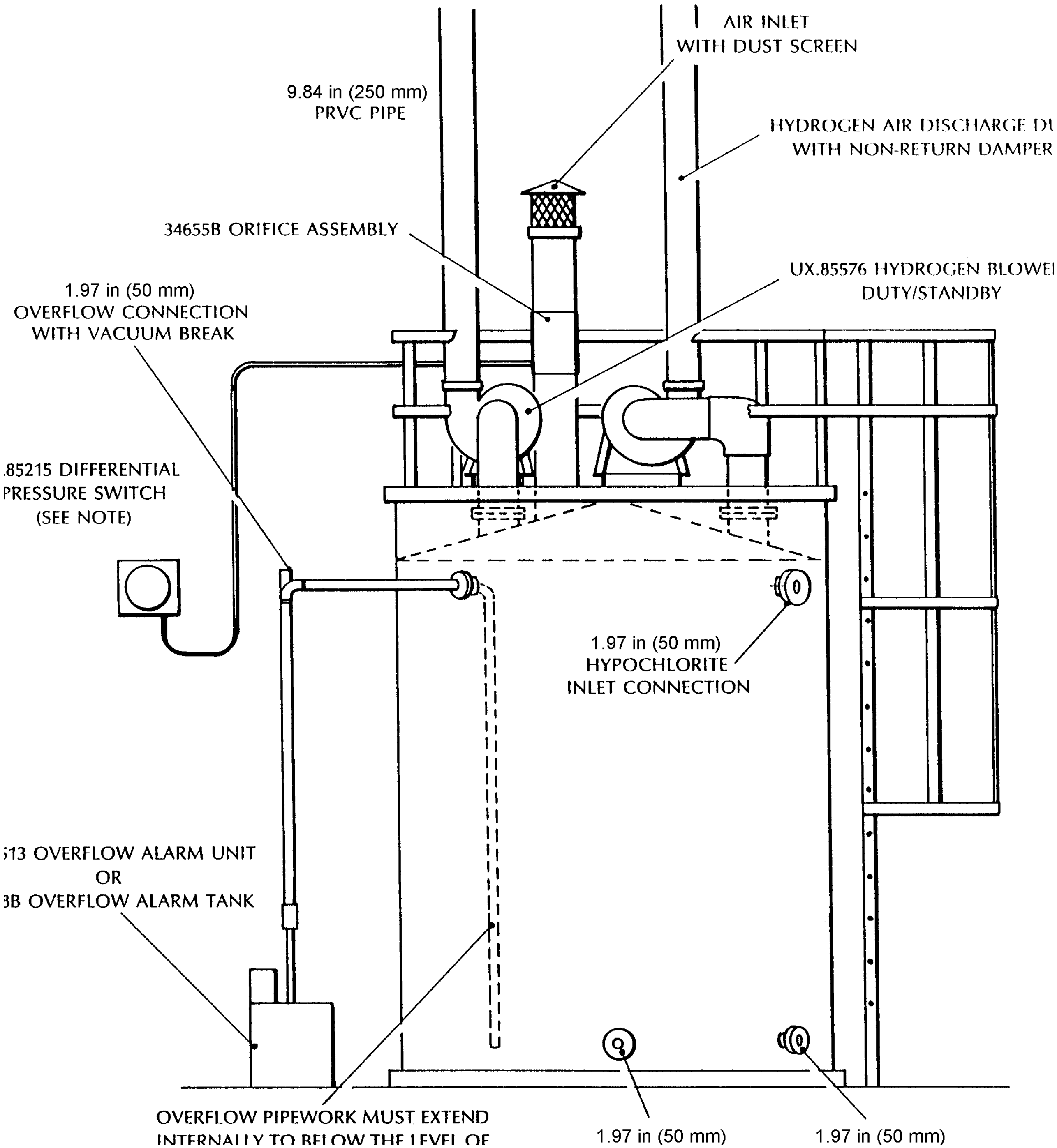

OSEC© SYSTEM - HYPOCHLORITE STORAGE TANKS

85.035.170.030B

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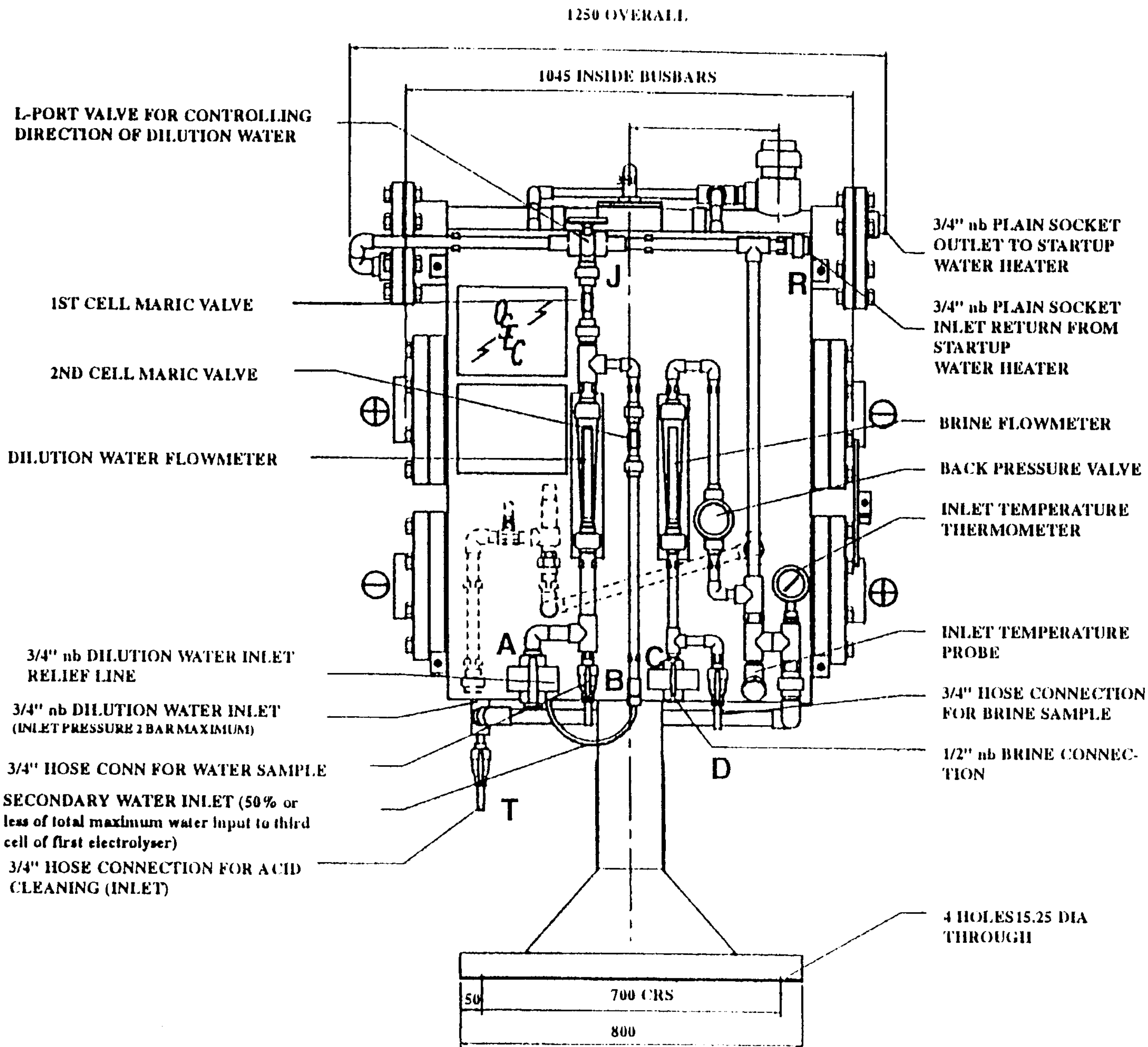

NOTE: Minimum withdrawal distance for electrolyser chassis is 1000mm either side

B2-200 OSEC© SYSTEM - ELECTROLYZER

85.035.170.010A

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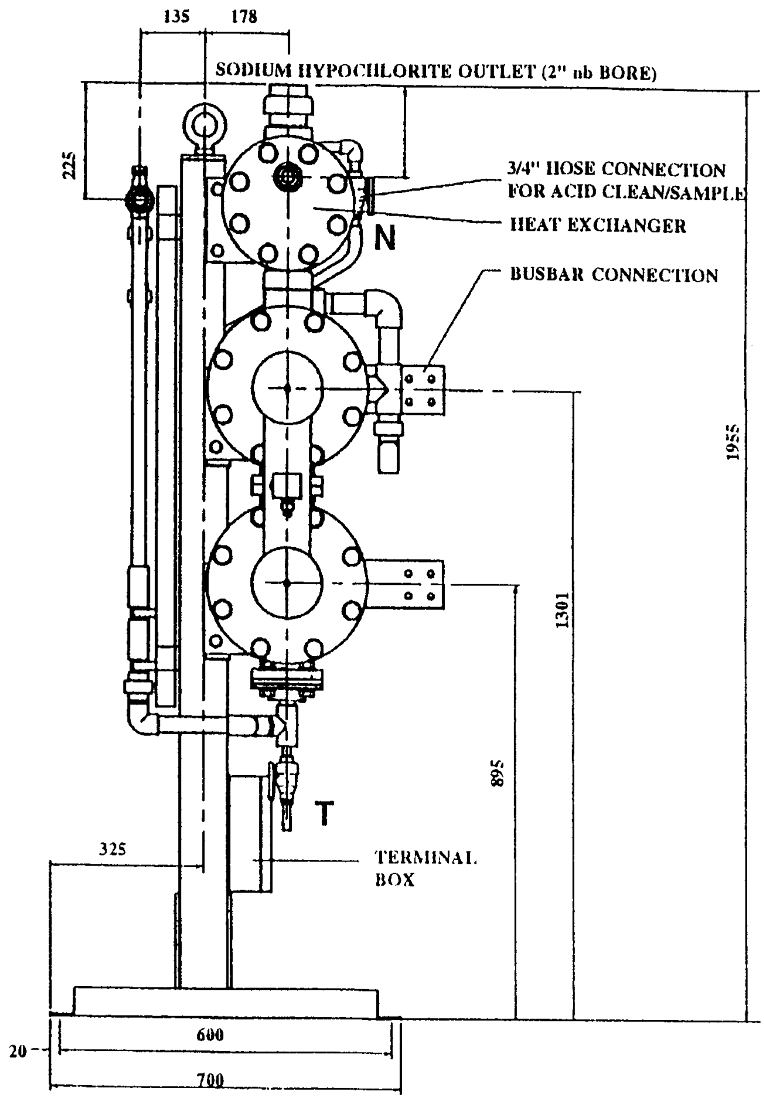

B2-200 OSEC© SYSTEM - ELECTROLYZER

85.035.170.010B

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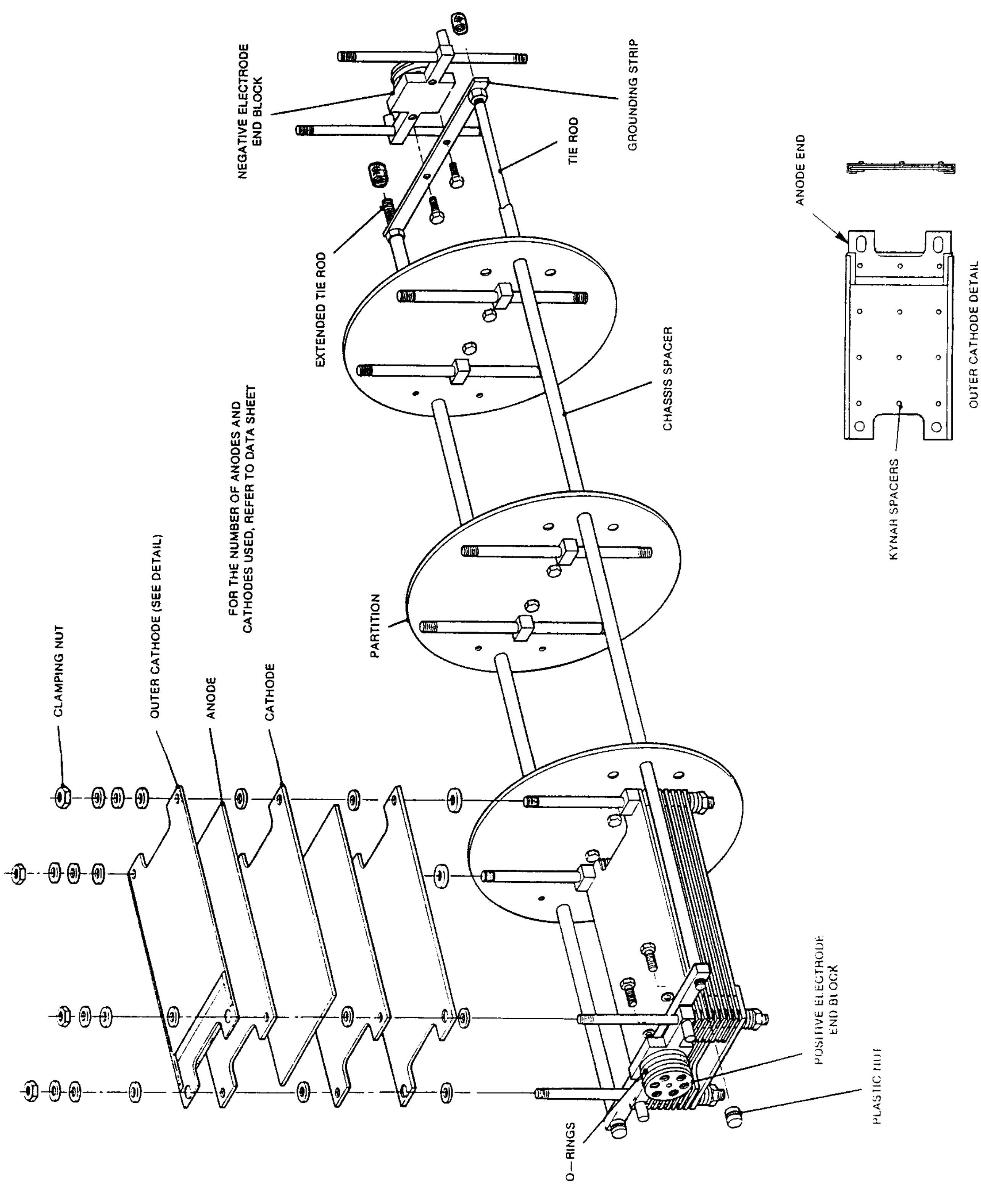


OSEC© SYSTEM - TYPICAL ELECTRODE ASSEMBLY

85.035.160.010

ISSUE 0 10-97

SECTION 2 - INSTALLATION

List of Contents

2.1 General

The electrolytic generation of sodium hypochlorite from brine results in the production of hydrogen gas, which detrains from the hypochlorite solution at the storage tank, therefore great care must be taken with the siting of the tank and the positioning of its associated electrical equipment. For installation recommendations, refer to the typical layout in Dwg. 85.035.110.010 and to any plant layout drawings specific to the contract that may be available. The air space within the tank above the solution naturally fills with hydrogen detraining from the solution and is classified as a Zone 0 (Division 1) area. The other hazardous zone is a radius of 5 feet (1.5 meters) around each tank exhaust, this area extending for 6.5 feet (2 meters) above and 3 feet (1 meter) below the outlet. This hazardous area is classified as a Zone 2 (Division 2) area. Refer to the zoning diagram included in this manual for details. Because the tank, by its function, creates the hazard, it must not be installed in any existing hazardous area or have any equipment installed in the area at a later date that can generate a hazard.

The electrolyzer should be sited in a location with good standards of high- and low-level ventilation. Whenever possible, the site chosen for the electrolyzer should be separate from all other electrical items, such as rectifiers, control panels, and pumps, so that there is no risk of such equipment being subjected to water or chemical splashing when servicing the electrolyzer.

All electrical cables between the various units must be installed in accordance with the latest edition of the NEC regulations for electrical installations, as well as with local electrical codes. The external connection diagram (Dwg. 85.035.140.010, located in Supplement 1) shows the cabling and stipulates the minimum sizes of cables to be used. Where any cables are designated Intrinsically Safe, such cables must be run separately from other mains cables and have a blue-colored outer sheath to signify their status. These cables must have 500V insulation and must be metal sheathed or armored where there is a risk of mechanical damage or if they are being run in the same ducting as other cables. Conduits that terminate in the hazardous area above the storage tank must employ approved glanding incorporating seals to prevent fumes or flames from traveling through the conduit.

All rigid pipework carrying liquids should be solvent welded, or threaded joints. This pipework should be installed to the pipe manufacturer's standards. Where making threaded connections on brine or hypochlorite lines, use a jointing compound. The gaskets, seals, and O-rings used on hypochlorite pipework must be fpm (Viton). Any pipework external to the plant rooms should be insulated and/or trace heated to prevent the possibility of freezing. Each pipe must be adequately supported and secured throughout its length, especially the hypochlorite piping from the electrolyzer to the tank as this solution is warm during generation periods. All pipes and valves must be clearly labeled as to their specific duty, contents, and flow.

2.2 Water Softener

The twin-cylinder water softener should be mounted on a flat, level base. Where several softeners are used, it is important to follow the piping arrangements shown in Figure 2.1. Two headers, one for the inlet and one for the outlet, are required, with the branch connections to the softeners being of equal diameter and length. This is to equalize any pressure drops in the pipework so that each softener provides an equal share of the load.

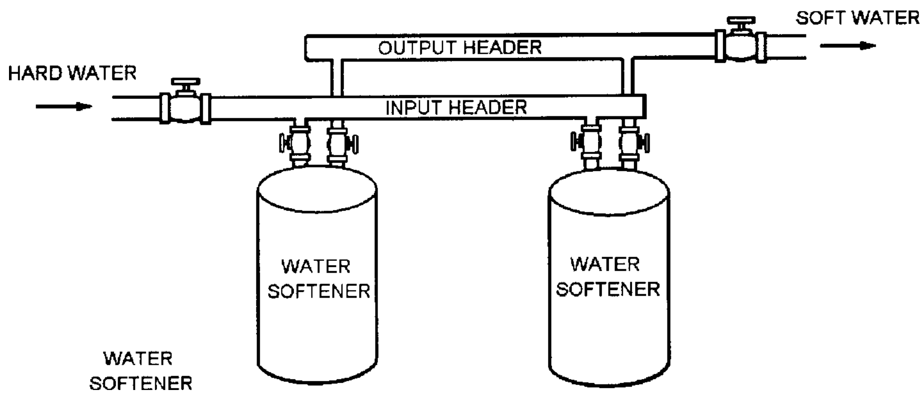


Figure 2.1 - Twin-Cylinder Water Softener

To comply with local regulations, connect a combined non-return/vacuum break valve in the incoming main to the softener. The purpose of this valve is to prevent possible back feeding of salt into the water main in the event of abnormal conditions, such as suction conditions within the mains.

The mains water inlet and the softened water outlet of the softener should be fitted with manual isolation valves. The connections at the softener are threaded R¾. The cold water supply should be clean and free from turbidity, at a pressure between 40 and 80 psig (2.8 and 5.5 bar), these being the pressure limits of the electrolyzer inlet. This supply should have a chlorine content not exceeding 1 mg/l, otherwise the resin bed could be adversely affected. If the chlorine content is in excess of this value, a carbon filter must be installed in the supply line to the softener.

In addition to the mains input and the outlet connections, another three pipes need to be run from the softener. These are the drain, the brine recharge line, and the overflow. The drain connection discharges the brine recharge residue and backwash water from the resin bed regeneration cycle. The overflow is fitted in case the internal brine piping develops a leak. These drain and overflow connections are piped to a common drain.

The brine recharge line connects via a manual isolation valve to the brine supply pipe from the saturator output strainer.

After installation and pipework is complete, the units will need to be charged with salt solution for their resin bed regeneration cycles, while the salt saturator is brought on-stream. The initial filling of the saturator will take some time as the maximum output from a single softener is 9.5 gallons/minute (36 liters/minute). The softeners will need to regenerate, on average, after each 264 gallons (1000 liters) of softened water has been supplied from each unit.

Until the saturator has been partially filled with softened water, it cannot provide the salt solution required for softener regeneration. Therefore, prepare some saturated brine solution in a container, adding 7 lbs (3.2 kg) of salt to 2.6 gallons (10 liters) of water and stirring until the salt has fully dissolved.

NOTE: The salt used must conform to the specifications in paragraph 2.3.

Check that the shut-off valve in the brine supply line from the saturator to the softener is fully closed and then reach into the softener drum and disconnect its brine suction line at the union, just inboard from where the brine line enters the drum. Allow the internally detached brine piping, complete with non-return valve, to rest on the internal grid of the drum. Pour in the prepared brine solution and check that the brine piping is fully covered. The salt saturator can then be commissioned as detailed in the following paragraph. Each regeneration of a softener will use approximately .37 gallons (1.4 liters) of brine. When the saturator has reached an operational state, the brine suction line is reconnected to its union and the valve in the brine supply line from the saturator to the softener opened.

The water softener has a water meter fitted to it that initiates a regeneration cycle after a certain quantity of softened water has been delivered. This quantity of water differs according to the hardness of the supply water—the harder the water, the more frequent the regeneration periods. A metering disc is fitted to the softener at the ordering stage by the manufacturer; therefore it is essential that the softener ordered for a particular site is not re-routed to another without first checking upon its suitability. Similarly, if the hardness of the supply water changes significantly, the water meter disc must be changed to suit the new supply.

2.3 Salt Saturator

Refer to the manufacturer's data sheets before installation. The saturator should rest on a firm, level foundation, which is flat to within 1/8 inch in

10 feet (3mm in 3 meters) in all directions. The base should be swept clear of stones or other debris before placement. When moving the tank, use only the lifting lugs fitted and move only when empty. Do not use slings.

Remember that the tank is relatively light for its size; the gravel bed should be loaded fairly soon after positioning the tank, otherwise it can easily be blown over by high winds. If necessary, it should be securely roped down so as to avoid any possibility of this happening.

The gravel filter bed is usually a bottom bed of 1/2- to 3/4-inch (14 to 20mm) diameter, washed, round gravel and another deeper bed on top of 1/8- to 1/4-inch (3 to 6mm) diameter, washed, round gravel. Care must be taken when adding the gravel not to damage the brine collection pipework in the bottom of the tank. The softened water supply to the saturator should be fitted with a Maric valve to control the water flow to .66 gallons (2.5 liters/minute).

Before finally connecting the brine outlet, the gravel in the saturator must be flushed through to ensure that all dust and dirt is removed. Continue to flush until clear water runs from the outlet. If the flushing is carried out by inserting a hose pipe through the top cover, take care to ensure that the gravel bed layers are not disturbed. Localized washing away of gravel could cause an area of low resistance, resulting in some particles of salt being drawn off when the saturator is brought into operation.

<u>NOTE</u>: If hard water is used for flushing the gravel, ensure that the unit is drained as far as possible before filling with soft water prior to charging with salt.

On large proprietary saturators, particular attention should be paid to the salt filling pipe, which usually takes the form of a large-diameter metal pipe, looping over so as to discharge the salt into the top of the saturator tank. This pipe has a union connection at its lower end to which is connected a flexible delivery pipe from the tanker during transfer of salt. It is essential that a good earth lead is properly bonded to this metal pipe on the saturator to ensure that any static electricity generated during deliveries of salt will be safely discharged.

After washing the gravel, the saturator can be charged with salt. Turn off the water supply and discharge the water to approximately 20 inches (500mm) above the gravel bed. The saturator will now accept its full charge and then the water supply can be turned on and allowed to fill to the normal level.

<u>NOTE</u>: The salt used must conform to the following specifications:

Water insolubles	**0.1 % maximum**
Calcium Sulfate	**0.14% maximum**
Magnesium Sulfate	**0.02% maximum**
Magnesium Chloride	**0.1 % maximum**
Sodium Chloride	**99.82% minimum**

Pure, vacuum-dried (food grade) salt or water softener salt is recommended.

NOTE: With a new installation, the brine initially drawn off will not be at the correct strength. At least 26 gallons (100 liters) should be drawn from the saturator before any attempt is made to calibrate the brine pump or brine flowmeter. The brine output should then be checked with a hydrometer or specific brine tester to ensure the specific gravity is 1.2.

2.4 Brine Pump

The brine pumps should be located close to the saturator to avoid long suction lines. The incoming brine supply from the saturator filter is fed in 1/2-inch NPT piping to the inlet port of the pump liquid end. This should be fitted with a manual isolation valve close to the pump to facilitate servicing.

The discharge from the pumps, via their pulsation dampers, are commoned together and piped in 1/2-inch NPT piping to the brine inlet valve at the electrolyzer. Each separate line should also be fitted with a manual isolation valve, as well as the non-return and pressure relief valves supplied. The discharges from the pumps' priming valves at the pulsation damper and pressure relief valves should be piped to waste.

For full details of pump installations refer to the separate publication supplied with the pump.

2.5 Electrolyzer

The electrolyzer should be positioned with respect to the transformer/rectifier unit to suit the bus bar layout required. Allow sufficient clearance around the units for subsequent servicing, in particular at one side of the unit to allow the electrode assemblies to be withdrawn from their casings. The electrode assembly is approximately 3 feet (1 meter) long and can be removed from either end of the casing. Refer to Dwg. 85.035.160.030 for overall dimensions and pipe sizes.

The unit is skid-mounted and should be bolted down on a flat, level surface, the hole centers for the mounting bolts being shown in Figure 2.2. A waterproof mastic compound should be used between the base skid and the floor to prevent any spillages of water or hypochlorite from running under the skid and causing unnecessary corrosion. Before connecting any discharge pipework to the outlet at the top of the upper electrolyzer casing, check that the electrolyzer casings are level, adjusting the mounting brackets as necessary. The electrolyzer may be dispatched with the electrode assemblies separately packed to avoid damage. For fitting details refer to paragraph 4.4.

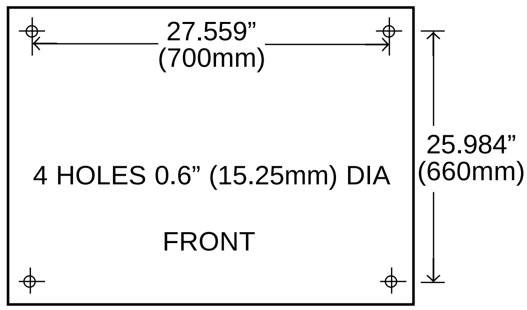


Figure 2.2 - Electrolyzer Mounting Diagram

The associated multi-leg heat exchanger unit can either be wall-mounted vertically behind and above the electrolyzers or ceiling-hung directly above the electrolyzer. The heat exchanger tubes are mounted on a support frame, which is provided with four 11.5mm diameter holes for mounting.

The electrolyzer requires five pipe connections to be made, as shown on the information plate attached to the unit. The dilution water supply from the softener connects to a manual water inlet valve (Dwg. 85.035.170.010 - Valve A) at the bottom left of the hydraulic panel. This incoming water supply is switched by an electric solenoid valve on the electrolyzer skid. The brine supply from the remote-mounted brine pumps connects to a manual inlet valve (C) at the bottom right of the hydraulic panel, located directly below the brine flowmeter.

A 2-inch socket union at the electrolyzer outlet manifold is used to connect the hypochlorite product line to the inlet union of the heat exchanger. The product line is fitted at the electrolyzer end with a clear upvc sight glass to check on the product delivery.

WARNING: TO AVOID OVER-PRESSURIZATION OF THE ELECTROLYZER SHOULD A SHUT-OFF VALVE BE ACCIDENTALLY CLOSED WITH THE ELECTROLYZER IN OPERATION, NO SUCH VALVES MUST BE FITTED IN THE PRODUCT PIPEWORK TO THE STORAGE TANK.

The hypochlorite outlet pipework should rise vertically for at least 20 inches (500mm) before turning horizontally, and should be fitted with swept bends. From the exchanger to the storage tank, the hypochlorite pipework should be run in an incline of approximately 1/2 inch per 3-foot (15mm per meter) run of pipe to the top of the tank. These requirements are to avoid the formation of any hydrogen gas traps in the pipework. The pipework must be adequately supported along its length as the product will be warm during production periods. Any pipework external to the plant room should be insulated and trace heated to prevent the possibility of freezing during low ambient temperatures.

The electrical connections between the electrolyzer and the associated remote-mounted control panel are shown on Dwg. 85.035.160.030. The connections are made to a terminal box located on the base skid. The signals from the high and low temperature sensors at the electrolyzer should be wired to the control panel using screened cable. The electrolyzer must be efficiently bonded to earth. The low cell level and low flow signals are intrinsically safe circuits and must be run separate to the other cables.

2.6 Control Panel

Information on the PLC-based OSEC Control Panel associated with the B2-200 electrolyzer is found in Supplement 1.

2.7 Transformer/Rectifier Unit

The transformer/rectifier unit is positioned to suit the bus bars supplied. The rectifier cabinet is mounted on two channel sections to raise it from the floor, each channel being drilled with two 14mm diameter holes for bolting the unit in position. The transformer/rectifier radiates heat, therefore, if the unit is located in a separate room, this room must have adequate ventilation. As a guide, a nominal 5 to 10% of rectifier power consumption will be given off as heat, which on larger units can be considerable. Due consideration should be given to forced ventilation using thermostatically controlled fans.

The DC electrolyzing voltage is brought out on two flat, aluminum terminals at the rear of the unit. These are connected to their corresponding polarity terminals at the right-hand end of the electrolyzer casing using the insulated bus bars supplied. Ensure that the correct polarities are maintained between the electrolyzer and the transformer/rectifier unit. When fitting the bus bars, ensure that the contact faces between individual bus bars, electrolyzer end terminals, and rectifier terminals are thoroughly clean and then coated with an electrical joint compound to ensure good conductivity and to prevent corrosion.

The bus bars connect to the connecting spacers at each end of the electrolyzer using three hexagon-headed bolts each, tightening to a torque of 17 ft-lb (23 Nm). At the transformer/rectifier end, the securing bolts between the bus bars and the transformer/rectifier terminals are also tightened to a torque of 70 ft-lb (95 Nm). Ensure that flat washers are placed under the heads of the bolts and spring washers are placed under the nuts.

The transformer/rectifier requires a 440V, 60 Hz, three-phase, power supply. The supply enters via a detachable panel at the lower front of the unit and is connected to terminals on the isolator. The supplies should be taken from a locally mounted fused isolator. The rectifier unit must be efficiently bonded to earth.

CAUTION: The unit has a nominal input current of between 54 amps and 86 amps, depending on the size of the electrolyzer (refer to transformer/rectifier manufacturer's data sheets). In view of the high inrush current to the rectifier at switch on, the use of a circuit breaker in the mains supply is not recommended, conventional HRC fuses being preferred.

In addition to the mains supply, the transformer/rectifier requires further connections with the OSEC control cabinet to provide the remote stop/start control, rectifier failure signal, improper voltage alarm, improper voltage sensing, and an electrolyzer running contact from the main contactor. The transformer/rectifier circuit diagram is included in the manufacturer's literature supplied with the equipment.

2.8 Hypochlorite Storage Tank

The product storage tank is suitable for 1% sodium hypochlorite at a temperature up to 104°F (40°C), and is manufactured from spirally wound, high-density, black polyethylene or premium resin FRP with nexus veil. The tank is usually located in an area capable of containing the full tank capacity in the event of a major leakage. This area should be fitted with an overflow switch assembly or an overflow tank to warn of any overflow. The overflow of the tank is to be internally piped to near the bottom of the tank so that the entry to the overflow is always submerged, preventing hydrogen gas from escaping via the overflow. The external overflow pipework to the overflow switch assembly must be fitted with a vacuum break to prevent syphonic action from emptying the tank should an overflow occur. The hypochlorite outlet and drain connections at the tank should be fitted with manual isolation valves, and the drain valve capped to prevent accidental draining of the tank.

The hydrogen venting arrangement at the tank consists of a pair of blowers, bolted to a slab at the base of the tank and configured for duty and standby operation. The blower outlet flanges are fitted with non-return dampers. Their ductwork is joined together to form a single connection to the plastic 10-inch (250mm) tank inlet flange. To ensure a gastight seal, a gasket is interposed between the two flanges.

The discharges from the blowers should rise vertically and be ducted to outside the building in the case of internally located tanks, the discharge point being as high as practicable and at least 16 feet (5 meters) from any building opening such as doors or windows. The discharge ductwork comprises a transition piece and a cowl or bird screen.

Fitted in this discharge pipework is an orifice assembly that contains a small segmental obstruction to the bore. This creates a pressure drop across the obstruction when the blower is in operation and air is being drawn through the inlet pipe. From the tank side of the obstruction, a tube is connected to the low pressure inlet (LP) of a differential pressure switch, which must be mounted below the level of the top of the tank. The HP inlet of the switch is left open to atmosphere. The internal micro-switch of the pressure switch is connected by a two-wire cable back to the OSEC control panel. The normally open (N/O) contacts of the switch are utilized, the terminals to which the switch is wired at the control panel being shown in the external connection diagram (Dwg. 85.035.140.010, located in Supplement 1).

NOTE: The term ‘normal’ refers to the switch with equal pressures on both chambers—as would occur with no air flow.

The operational point of the switch is not set before shipment, but should be adjusted on-site to ensure that with the blower in operation and the vent pipework free of obstructions, the N/O contact should be closed. To increase the differential, rotate the spring bias adjuster screw in a clockwise direction, or vice versa to decrease the differential. Refer to Figure 2.3 for details. The blower assemblies require a 440V, 60 Hz, three-phase supply that should be taken from locally mounted isolators to the starters. The starters must be mounted below the top of the tank.

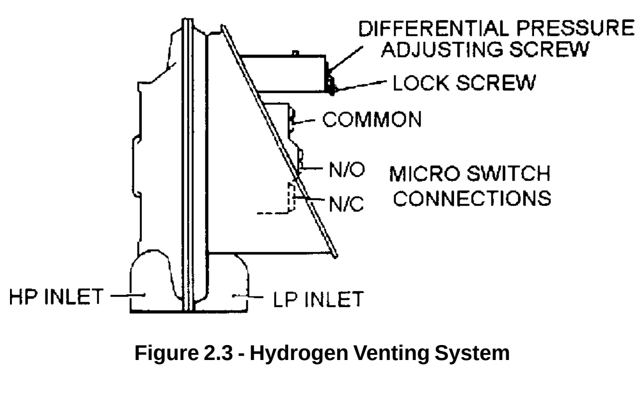
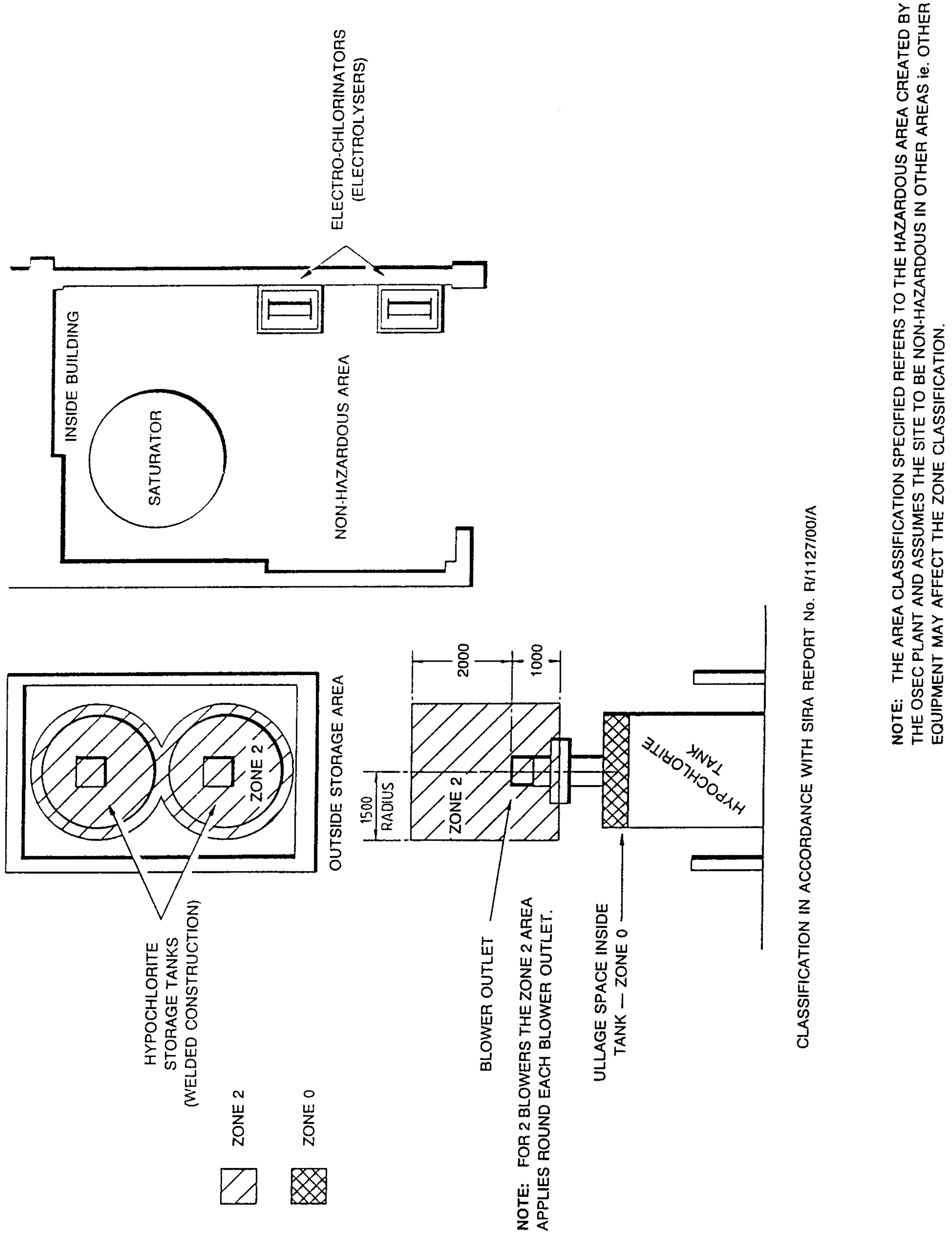


Figure 2.3 - Hydrogen Venting System



OSEC© SYSTEM - HAZARDOUS AREA ZONING

85.035.160.020

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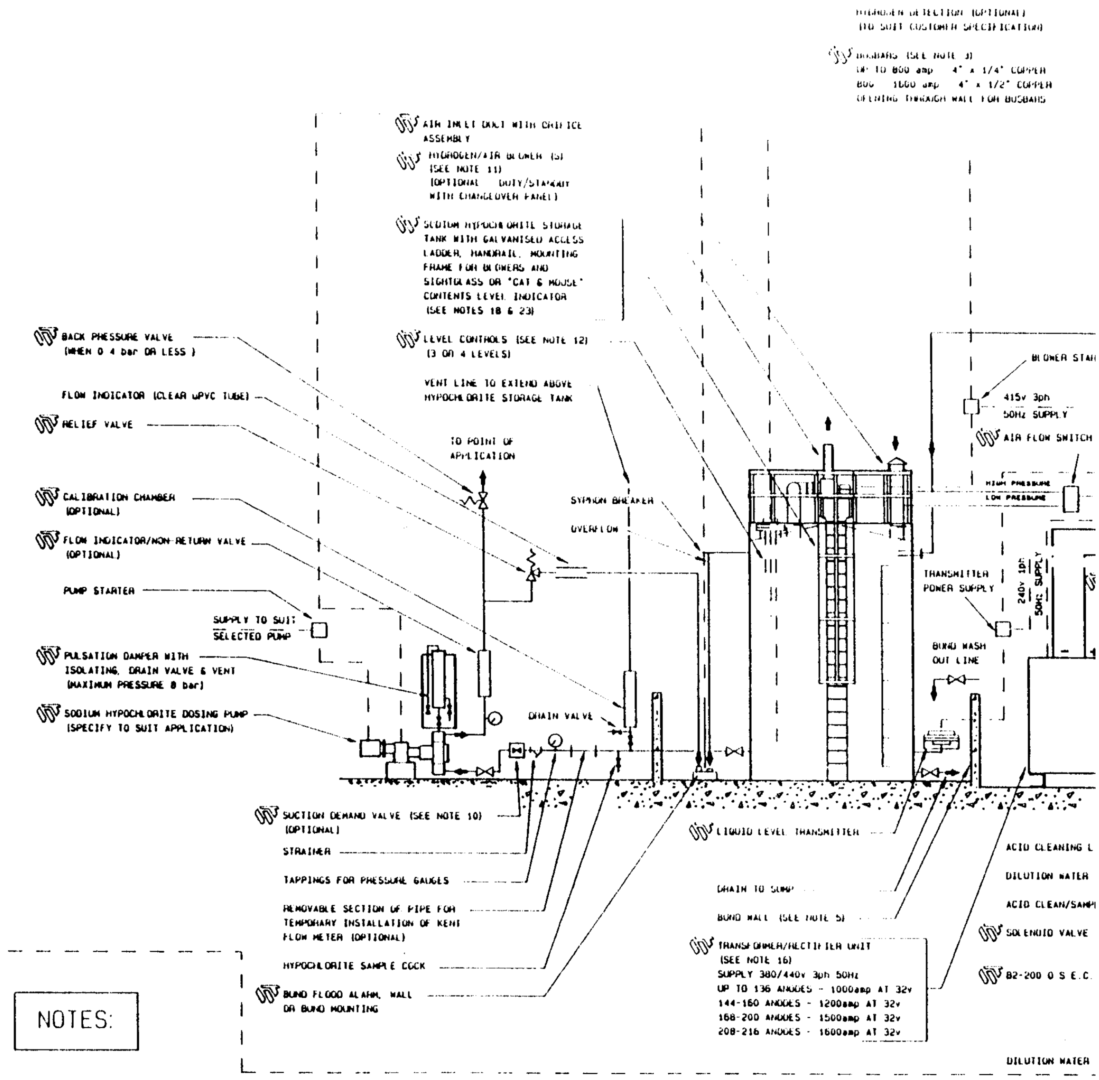


NOTES:

1. WATER PRESSURE REQUIREMENTS:
   3.5bar MINIMUM } AT SOFTENER INLET
   5.5bar MAXIMUM }
   2.0 bar MAXIMUM GENERATOR DISCHARGE PRESSURE

2. WATER SOFTENER/S SUPPLY TO SUIT APPLICATION AND SIZE OF PLANT. TO BE INSTALLED ACCORDING TO MANUFACTURERS INSTRUCTIONS.

3. WHERE THE BUSBARS PASS THROUGH A WALL THE OPENING SHOULD BE SEALED USING SUITABLE BUSBAR WALL PLATES. THE BUSBARS SHOULD BE SUPPORTED, INCLUDING SUPPORT ADJACENT TO O.S.E.C. UNIT, USING BUSBAR SUPPORTING BLOCKS. BUSBAR/RECTIFIER JOINTS TO BE INSULATED AND TAPED ON SITE. CLEAN AND APPLY E.80178 ELECTRICAL JOINTING COMPOUND TO COVER ALL METALLIC MATING SURFACES TO PREVENT DETERIORATION OF JOINT. OVERALL BUSBAR LENGTH TO BE KEPT TO A MINIMUM.

4. INTRINSICALLY SAFE CABLES FOR LEVEL SWITCHES. BUND FLOOD ALARM, CELL TEMPERATURE AND HYDROGEN DETECTORS (IF FITTED) MUST NOT BE RUN WITH MAINS CABLES. PREFERABLY THEY SHOULD BE ROUTED SEPARATELY FROM ALL OTHER CABLES, BUT MAY BE RUN WITH LOW TENSION SIGNAL CABLES, PROVIDED THAT THE INTRINSICALLY SAFE CABLES ARE GROUPED TOGETHER AND IDENTIFIED

5. THE BUND TO BE BUILT WITH ANY TYPE OF BRICK WHICH MUST BE KEYED AND SEALED TO THE FLOOR. INTERNAL SURFACES MUST BE CEMENT RENDERED 15 TO 20mm THICK AND FINISHED WITH CHEMICAL RESISTANT PAINT ONE WEEK AFTER RENDERING. DO NOT USE COMMON WALLS TO SEPARATE BUNDS

6. ALL RIGID PVC PIPEWORK TO BE INSTALLED TO 'DURAPIPE' STANDARD. RIGID P.V.C. PIPEWORK TO BE CLASS "E" FOR SOLVENT WELDED JOINTS, CLASS "T" FOR THREADED JOINTS, AND CLASS "C" THIN WALL FOR HYDROGEN BLOWER PIPEWORK. SWEPT BENDS ARE RECOMMENDED THROUGHOUT. EXPANSION JOINTS TO BE FITTED WHERE NECESSARY.

7. ALL RIGID PVC PIPE JOINTS SHOULD BE MADE USING EITHER SOLVENT WELD OR FLANGED METHOD. IF IT IS NECESSARY TO USE THREADED JOINTS THEN THESE SHOULD BE SEALED USING A SUITABLE JOINTING MATERIAL AS RECOMMENDED BY THE PIPE MANUFACTURERS.

8. ALL RUBBER SEALS ON HYPOCHLORITE LINES MUST BE F.P.M. (VITON)

9. ALL EXTERNAL PIPEWORK TO BE LAGGED OR TRACE HEATED AS REQUIRED, AND VALVES TO BE FITTED WITH EXTENDED SPINDLES.

10. SUCTION DEMAND VALVE TO BE FITTED WHEN THE SUCTION HEAD TO THE DOSING PUMP VARIES BY MORE THAN 3 METRES OR THE P.O.A. PRESSURE IS LESS THAN THE HEAD CREATED BY THE STORAGE TANK.

11. THE POINT OF DISCHARGE FOR HYDROGEN/AIR LINE MUST NOT BE LESS THAN 3 METRES FROM ANY BUILDING OPENING SUCH AS A DOOR OR WINDOW.

12. WHEN FITTING LEVEL PROBES ALLOW AT LEAST 1 METRE OF FLEXIBLE STEEL ARMOURED CONDUIT, REQUIRED TO ALLOW FOR MANLID REMOVAL.

13. PIPEWORK SHOULD BE COLOUR CODED FOR IDENTIFICATION WITH ARROWS SHOWING DIRECTION OF FLOW, AT LEAST TO B.S.1710

14. HAZARD WARNING LABEL

15. LIGHTING, HEATING

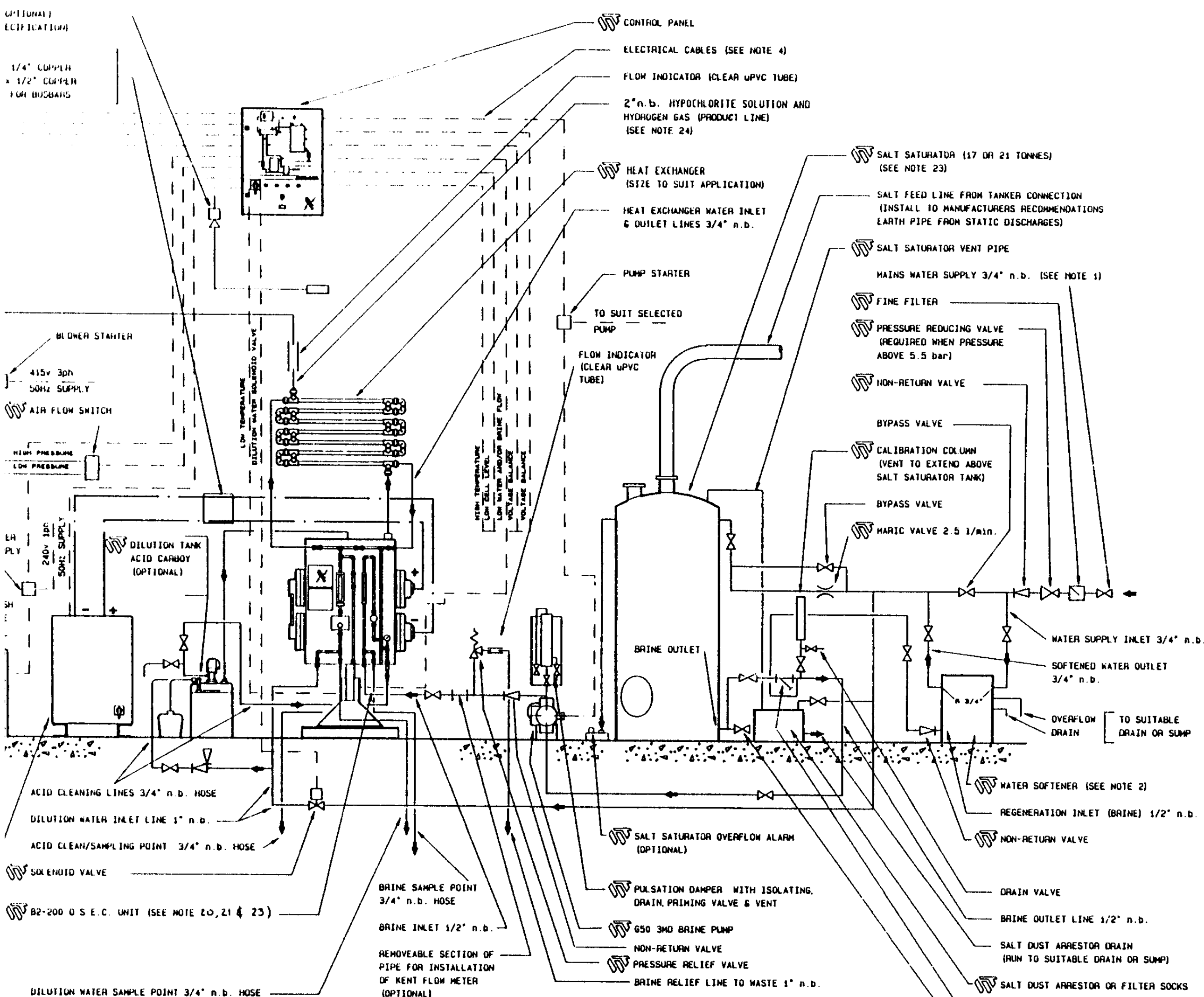
16. TRANSFORMER/RECTIFI
    A SEPARATE ROOM, VE
    SO THEN IT MUST BE
    GENERATOR.

17. ITEMS INDICATED TH

18. WHEN SODIUM HYPOCHL
    OPEN, ONLY BUNDFLOO
    BUND. IT IS RECOMME
    PUMP/S, PULSATION D
    BUILDING, IN THIS C
    EQUIPMENT.

19. HAZARDOUS AREAS:
    HYPOCHLORITE STORA
    ZONE 0 TANK ULL
    ZONE 2 SODIUM H
    FOR DETAILS SEE DR

20. THERE SHOULD BE SUF
    O.S.E.C. GENERATOR
    BE WITHDRAWN FROM
    1.5 METRES WHICH C



.HAZARD WARNING LABELS TO BE ATTACHED WHERE APPROPRIATE.

.LIGHTING, HEATING & VENTILATION TO BE TO LOCAL H.S.E. REQUIREMENTS.

.TRANSFORMER/RECTIFIER UNIT WHERE POSSIBLE TO BE SITED IN A SEPARATE ROOM, VENTILATED IF NECESSARY IF UNABLE TO DO SO THEN IT MUST BE AT LEAST 1.5 METRES AWAY FROM O.S.E.C. GENERATOR.

. ITEMS INDICATED THUS [logo] SUPPLIED BY WALLACE AND TIERNAN.

.WHEN SODIUM HYPOCHLORITE STORAGE TANK IS LOCATED IN THE OPEN, ONLY BUNDFLOOD ALARM NEED BE ACCOMMODATED IN THE BUND. IT IS RECOMMENDED THAT ALL OTHER EQUIPMENT: PUMP/S, PULSATION DAMPER/S etc. BE LOCATED IN THE O.S.E.C. BUILDING, IN THIS CASE NO BUND IS REQUIRED AROUND THIS EQUIPMENT.

.HAZARDOUS AREAS:
HYPOCHLORITE STORAGE TANK:
ZONE 0 TANK ULLAGE SPACE.
ZONE 2 SODIUM HYPOCHLORITE TANK VENT OUTLET
FOR DETAILS SEE DRG No 35022.D

.THERE SHOULD BE SUFFICIENT SPACE AT THE SIDE OF THE O S E C. GENERATOR TO ALLOW THE ELECTROLYSER(S) TO BE WITHDRAWN FROM THE OUTER CASING (APPROXIMATELY 1.5 METRES WHICH CAN BE AT EITHER SIDE).

21. WHEN FIXING THE O.S.E.C. SKID TO ITS FOUNDATION A WATERPROOF MASTIC COMPOUND, OR SIMILAR SHOULD BE USED IN ORDER TO PREVENT ANY SPILLAGE OF WATER OR HYPOCHLORITE FROM RUNNING UNDERNEATH THE SKID AND CAUSING UNNECESSARY CORROSION.

22. IF TWO OR MORE TANKS ARE USED ONLY ONE SET OF LEVEL SENSORS, BLOWER, OVERFLOW ALARM AND ANCILLARIES NEED BE FITTED.

23. PLINTH TO BE LEVEL, FLOAT FINISH WITH NO PROTRUSIONS.

24. HYPOCHLORITE SOLUTION & HYDROGEN GAS (PRODUCT LINE) MUST RISE WITHOUT TRAPS FROM ELECTROLYSER TO STORAGE TANK. ALL UNIONS IN LINE MUST BE IN VERTICAL POSTION.

B2-200 OSEC© SYSTEM - TYPICAL INSTALLATION

85.035.110.010
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SECTION 3 - OPERATION

List of Contents

PARA. NO.

3.1 Initial Start-Up (See Dwg. 85.035.170.010)

With all the equipment installed and connected, and the individual items such as the water softener, salt saturator, and brine pumps commissioned—as detailed in their respective data sheets or manuals—the electrolyzer can be brought into operation.

a. Ensure that any isolation valve on the mains water supply to any strainer in the supply to the softeners is open and the shut-off valve to the water softener is also fully open. Any softener bypass valve should be closed.

b. Check that the isolation valve on the softened water output line from the softener, and the valve on the softened water input to the salt saturator are both fully opened.

c. Check that the valve on the brine output from the saturator and the valve on the brine recharge line to the water softener are both open. The shut-off valves on the brine suction line to the electrolyzer duty/standby brine pumps or single pump (as appropriate) should be open, as should the brine pump discharge valves. Check that the brine pump manual stroke controls are set to approximately 80% of full stroke. These controls may need to be adjusted for correct flow rate when the electrolyzer starts up.

d. At the electrolyzer, check that the manual dilution water inlet valve (A) is fully open, and the dilution water 'L' port valve (J) is set in the position appropriate to the temperature of the incoming dilution water. If the incoming water temperature is below 59°F (15°C), the heat exchanger should be brought into use. Refer to paragraph 1.8.1 for the minimum solution temperatures permitted. Check also that the brine inlet valve (C) is fully open.

e. The acid clean/drain valve (T), the acid clean/sample valve (N), the dilution water sample valve (B), and the brine sample valve (D) should all be fully closed.

f. Any blanking plates for the hypochlorite output line from the electrolyzer into the storage tank are removed. (These plates are fitted to isolate the electrolyzer when acid cleaning is to be carried out.) Check that the tank drain valve is closed.

g. Check that the current level setting control at the transformer/rectifier unit is at minimum and then switch on the three-phase mains supply to the unit at its local isolator. Switch on the transformer/rectifier cabinet-mounted isolator, checking that its mains lamp lights, and then press the OFF/RESET button, followed by the ON button to reset its internal relays. Select AUTO on its AUTO/MAN switch.

h. Switch on the mains supplies to the duty/standby blowers starters and the duty/standby brine pump starters at their local isolators.

   Refer to Supplement 1 for details of control panel operation and the alarm and status indications.

i. With the control panel set and the unit in operation, check the water and brine flows at their respective flowmeters. The dilution water flow is already set to the flow rate appropriate to the size of the electrolyzer ordered. The appropriate flows are shown in Table 1.1 (located at the end of Section 1). This flow rate is set by the Maric valve in the line from the flowmeter.

   The water flowmeter is calibrated from 29 to 290.5 gal/hour (110 to 1100 liters/hour) for electro-chlorinators with up to 295 lbs/day (134 kg/day) capacity and 46 to 462 gal/hour (175 to 1750 liters/hour) for units between 315 and 500 lbs/day (143 and 227 kg/day). The pressure of the incoming dilution water should not exceed 80 psig (5.5 bar) pressure on the gauge. The brine pumps stroke controls and the brine flowmeter scale are marked in percentage values only. Therefore the actual pump delivery rate and the flow rate at these percentage values must be determined to set the correct brine flow rate from the pump. Refer to paragraph 3.2 for details of pump calibration. The low flow alarm switches of the two flowmeters should be set to operate at 85% of correct flow.

   These flow figures are for a 10:1 dilution water/brine ratio, producing hypochlorite with a strength of approximately 0.8%. The electrolyzer can operate with a dilution water/brine ratio of 15:1, producing hypochlorite of approximately 0.6% strength, with an overall savings in cost of production. To effect this change in ratio, the orifice insert of the Maric valve in the dilution water feed line to the third cell will need to be changed. The alternative insert for this valve is supplied in a small bag tied to the unit. This insert is marked with its flow in liters/minute. Refer to Table 3.1 (located at the end of this section) for details of Maric valve sizes for the different electrolyzer capacities.

j. With the casing full, the level switch at the hypochlorite outlet manifold will have operated and signaled to the PLC to switch on the rectifier unit. After a nominal three minutes running time to ensure the casing is now full of brine, not just water, adjust the current at the transformer/rectifier to the current value shown on Table 1.1 using the current level control. The rectifier voltmeter alarm relay set points should not be set until after at least four hours of electrolyzer operation, thus allowing the equipment to reach normal operating temperature. The out of balance set points are typically +1V from the normal balanced condition. The set points are easily adjusted by two screws at the front of the meter.

k. The hypochlorite is now being generated and being fed to the storage tank. When the level in the tank passes the Low level, the ALARM RESET button can be pressed at the OSEC controller to cancel the associated alarm lamp. This action will also remove the inhibit on any associated dosing pump control.

l. The hypochlorite can be sampled for analysis at the electrolyzer from the acid clean/sample valve (N) on the hypochlorite outlet manifold. Refer to the Hydrogen Gas Warning at the beginning of the manual. Do not attempt to extract more than a small sample from this valve.

WARNING: ALTHOUGH IN A DILUTE FORM OF APPROXIMATELY 0.8% W/W, THE SODIUM HYPOCHLORITE PRODUCED BY THE ELECTROLYZER IS STILL CORROSIVE TO A DEGREE TO THE SKIN, EYES, CLOTHING, MOST METALS, AND PAINTED SURFACES. IT MUST NOT BE MIXED, OR COME INTO CONTACT, WITH ANY CHEMICAL OTHER THAN WATER. PERSONNEL HANDLING HYPOCHLORITE SHOULD WEAR CHEMICAL GOGGLES AND PROTECTIVE CLOTHING.

SPLASHES IN THE EYES SHOULD BE DEALT WITH IMMEDIATELY BY PROLONGED IRRIGATION WITH RUNNING WATER, AND MEDICAL ADVICE SHOULD BE SOUGHT AS SOON AS POSSIBLE. SIMILARLY, SPLASHES TO THE SKIN OR CLOTHING SHOULD IMMEDIATELY BE WASHED IN RUNNING WATER.

m. When the level of hypochlorite in the storage tank reaches the High (stop) level, the controller is signaled to shut down the electrolyzer and its associated equipment. The transformer/rectifier is disabled first, removing the main DC supply from the electrolyzer to stop the electrolysis. The brine pump continues to run and the water valve remains open for a further preset duration, so that the brine solution purges the remaining hypochlorite from the electrolyzer to prevent corrosion of the electrodes. The hydrogen venting blower continues to operate for 15 minutes after initial shut down to ensure that any hydrogen still detraining from the newly generated hypochlorite solution at the tank continues to be adequately diluted with air before discharge. The blower then shuts down. All the status lamps at the information panel should now be extinguished.

n. Now the tank is full and the electrolyzer is under the control of the off-peak or daytime level controls. The system remains on standby until the level in the tank falls to the Low (start) level (off-peak) or the low setting of the bargraph indicator (daytime hours), or the TANK TOP UP button is pressed.

3.2 Pump Calibration

As the brine pump stroke control and the brine flowmeter are marked in percentage values only, the actual pump output and the flow through the flowmeter at these percentages must be determined so that the brine flow can be set to the correct flow.

To facilitate calibration, the brine supply line is fitted with a graduated measuring tube assembly, usually adjacent to the salt saturator. The tube is always full of brine at a slightly lower level than the water level in the saturator. This is due to the difference in specific gravity of the two liquids. The graduations on the tube are at intervals to suit the pump delivery of the particular size of electrolyzer. The size of these graduations is marked on the tube scale. Before calibrating, check the brine output with a hydrometer to ensure that the specific gravity is 1.2. To calibrate, proceed as follows:

a. With the brine pump running, note the level in the brine calibration tube at the side of the salt saturator.

b. Now quickly close the shut-off valve on the saturator side of the tube and note the time in seconds that it takes the level to fall to the next convenient calibration mark. The exact quantity between the two calibrations is marked on the scale. Immediately after timing, re-open the shut-off valve.

To calculate the flow, use the following formula:

$$\text{Flow} = \frac{\text{Quantity Pumped}}{\text{Time in secs}} \times 60$$

Example:

$$\frac{1000\ \text{ml} \times 60}{48\ \text{secs}} = 1250\ \text{ml/min}$$

Multiply this answer by 60 to determine the flow in liters/hour:

Example:

1250 ml/min 60 = 75 liters/hour

If the pump rate is incorrect, adjust the pump stroke control in the appropriate direction and, after about 30 seconds to allow the pump to stabilize, repeat the check. Repeat this procedure until the flow rate is correct and note the percentage reading at the pump stroke control and at the brine flowmeter for future reference. Once the pump is set, the valve into the calibration tube should be closed.

3.3 Temporary Shut Down

Following normal operation, the electrolyzer will enter a standby condition where the casing(s) will have been flushed with fresh brine. The electrolyzer can subsequently be left for up to one week in this shut-down condition.

If the electrolyzer has ceased to operate following an alarm condition that does not initiate a refill cycle, then the electrolyzer must be drained of the partially electrolyzed product, in order to protect the electrodes from corrosive attack by hypochlorite.

3.4 Complete Shut Down

If the unit needs to be completely shut down for servicing purposes or due to the need for associated equipment to be serviced, proceed as follows:

If shutting down from a normal inactive state in which electrolysis is not taking place and the cell contains only brine solution, switch the main isolator at both the Transformer/rectifier and the Control Panel to OFF.

If it becomes necessary to shut the system down during a period of electrolysis, turn the mode selector to INHIBIT. Electrolysis will cease. The control panel and rectifier isolators should be turned off and the cell drained as previously described.

3.5 Failure of Power Supply

Should the mains supply to the OSEC Control fail while the casings are full of sodium hypochlorite, and it is obvious that it will not be restored within a short time (up to three hours), the electrolyzer casing of the electrolyzer must be drained. This is to prevent corrosion of the electrode assemblies due to reverse polarization occurring.

First, switch off the mains isolator on the control panel to prevent inadvertent start-up while draining, should the mains supply be suddenly restored. The casing of the electrolyzer can then be drained by connecting a hose to the acid clean/drain valve (T) on the underside of the lower casing and directing the hose to a suitable drain. Refer to the warning in paragraph 3.1 as to the handling of sodium hypochlorite. Open the drain valve and allow the casings and the hypochlorite product pipework to the storage tank to drain. Ideally, the casings should then be filled with clean water until such time as the unit can be brought back into operation. This can be effected by connecting the drain hose to a clean water supply and filling the casing. Close the drain valve after filling.

⚠ **CAUTION: If filling the casing from a mains water supply, ensure that the casing is not subjected to a greater pressure than 30 psig (2 bar).**

When the mains supply is restored after any outage, switch on the mains isolator. The OSEC control will automatically reset, but the transformer/rectifier internal relays must be manually reset by first pressing the unit OFF button, followed by the ON button.

3.6 Theory of Operation

With the electrolyzer casings full of brine and dilution water solution, the DC voltage from the associated transformer/rectifier unit can be applied via the respective bus bars to the casings' positive and negative terminals. The terminals convey the supply to the individual positive and negative electrodes within each electrolyzer casing, via internal connections. As brine is a good conductor of electricity, a current will flow between the individual positive and negative electrodes, electrolyzing the solution.

The electrolysis of brine results in chlorine gas (Cl_2) being produced at the positive electrodes (anodes), while sodium hydroxide (NaOH) and hydrogen gas (H_2) are produced at the negative electrodes (cathodes). The chlorine further reacts with the sodium hydroxide to form sodium hypochlorite (NaOCl). As the solution passes through the successive cells in the lower casing, the degree of conversion to sodium hypochlorite increases. The hydrogen forming during electrolysis separates out above the electrodes, gas ports in the cell separators producing separate gas and solution zones. The solution is arranged to pass through the lower casing and then into the upper casing, being progressively converted to hypochlorite as it passes through the total of eight cells.

To prevent the hydrogen gas in the lower casing from passing directly with the solution into the upper casing and degrading the reaction, the gas is separately tapped from the casing and piped to the hypochlorite outlet manifold on the upper casing. At the final cell of the upper casing, the gas and solution are combined at a common discharge port, the emerging solution being mainly sodium hypochlorite along with hydrogen and a small amount of unconverted brine. The output from the electrolyzer feeds via its associated heat exchanger into a pipeline to the hypochlorite storage tank complex where the hydrogen is allowed to gas off from solution and be diluted with air to below 25% of its LEL before being force-ventilated to outside atmosphere, safely away from any sources of ignition.

When the required amount of hypochlorite has been generated, the electrolyzer shuts down. The transformer/rectifier unit is first switched off, stopping the electrolysis, but the water and brine continue to flow for a short period to purge the hypochlorite from the casing as an aid to minimizing corrosion of the electrodes. The tank blower continues to operate for 15 minutes after shut down to ensure that the hydrogen gas continuing to detrain from the hypochlorite is safely diluted and exhausted to atmosphere.

Table 3.1 - B2-200 OSEC Maric Valve Sizes

NOMINAL OSEC CAPACITY	DILUTION RATIO NOMINAL	TOTAL WATER FLOW	WATER TO 2nd CELL MARIC VALVE PART No.	WATER TO 2nd CELL MARIC VALVE FLOW
260 lbs/day (118 kg/day)	10:1 12:1	159 gal/hr (600 l/hr) 187 gal/hr (708 l/hr)	UXF.85976 UXJ.85976	1.3 gal/min (5.0 l/min) 1.8 gal/min (7.0 l/min)
278 lbs/day (126 kg/day)	10:1 12:1	174 gal/hr (660 l/hr) 200 gal/hr (756 l/hr)	UXF.85976 UXK.85976	1.3 gal/min (5.0 l/min) 2.1 gal/min (8.0 l/min)
295 lbs/day (134 kg/day)	10:1 12:1	187 gal/hr (708 l/hr) 211 gal/hr (798 l/hr)	UXG.85976 UXK.85976	1.5 gal/min (5.5 l/min) 2.1 gal/min (8.0 l/min)
315 lbs/day (143 kg/day)	10:1 12:1	200 gal/hr (756 l/hr) 222 gal/hr (840 l/hr)	UXG.85976 UXL.85976	1.5 gal/min (5.5 l/min) 2.4 gal/min (9.0 l/min)
333 lbs/day (151 kg/day)	10:1 12:1	211 gal/hr (798 l/hr) 238 gal/hr (900 l/hr)	UXH.85976 UXL.85976	1.7 gal/min (6.3 l/min) 2.4 gal/min (9.0 l/min)
353 lbs/day (160 kg/day)	10:1 12:1	222 gal/hr (840 l/hr) 254 gal/hr (960 l/hr)	UXH.85976 UXM.85976	1.7 gal/min (6.3 l/min) 2.6 gal/min (10.0 l/min)
370 lbs/day (168 kg/day)	10:1 12:1	238 gal/hr (900 l/hr) 269 gal/hr (1020 l/hr)	UXJ.85976 UXM.85976	2.6 gal/min (10.0 l/min) 1.8 gal/min (7.0 l/min)
388 lbs/day (176 kg/day)	10:1 12:1	238 gal/hr (900 l/hr) 285 gal/hr (1080 l/hr)	UXJ.85976 UXN.85976	1.8 gal/min (7.0 l/min) 2.9 gal/min (11.0 l/min)
408 lbs/day (185 kg/day)	10:1 12:1	254 gal/hr (960 l/hr) 301 gal/hr (1140 l/hr)	UXJ.85976 UXN.85976	1.8 gal/min (7.0 l/min) 2.9 gal/min (11.0 l/min)
425 lbs/day (193 kg/day)	10:1 12:1	269 gal/hr (1020 l/hr) 317 gal/hr (1200 l/hr)	UXK.85976 UXP.85976	2.1 gal/min (8.0 l/min) 3.2 gal/min (12.0 l/min)
445 lbs/day (202 kg/day)	10:1 12:1	285 gal/hr (1080 l/hr) 317 gal/hr (1200 l/hr)	UXK.85976 UXR.85976	2.1 gal/min (8.0 l/min) 3.4 gal/min (13.0 l/min)
463 lbs/day (210 kg/day)	10:1 12:1	285 gal/hr (1080 l/hr) 333 gal/hr (1260 l/hr)	UXL.85976 UXR.85976	2.4 gal/min (9.0 l/min) 3.4 gal/min (13.0 l/min)
481 lbs/day (218 kg/day)	10:1 12:1	301 gal/hr (1140 l/hr) 349 gal/hr (1320 l/hr)	UXL.85976 UXR.85976	2.4 gal/min (9.0 l/min) 3.4 gal/min (13.0 l/min)
500 lbs/day (227 kg/day)	10:1 12:1	317 gal/hr (1200 l/hr) 365 gal/hr (1380 l/hr)	UXL.85976 UXR.85976	2.4 gal/min (9.0 l/min) 3.4 gal/min (13.0 l/min)

SECTION 4 - SERVICE

List of Contents

PARA./DWG. NO.

CAUTION: When servicing the individual items of equipment that form this complete system, only USF/W&T approved parts must be used for replacement purposes.

4.1 Routine Maintenance

Recommendations for the routine maintenance of the brine pumps will be found in the specific manual supplied with the pumps. This specific manual also contains the necessary information on servicing, together with illustrated parts lists for spares purposes.

The frequency of maintenanc to the electrolyzer cannot be accurately forecast due to the varying environments encountered and the degree of usage to which the plant is subject. Most of the maintenance required is minimal and consists mainly of good housekeeping.

It is essential that all items of equipment are kept clean of accumulations of salt, dust, and splashes of hypochlorite in order to minimize any corrosion. The equipment should also be regularly checked for leaks.

4.1.1 Water Softener

The water softener is designed to operate on an 'on-demand' basis and the regeneration of the resin beds is automatic when sufficient water has passed through the unit. Refer to the manual supplied with the unit for details of any routine maintenance or servicing required. The softener is preset to treat water with a maximum hardness of calcium carbonate ($CaCO_3$) stipulated at the time of ordering. A weekly check should be made on both the input supply and the output of the water softener to ensure the unit is functioning correctly. A test point is provided at the electrolyzer (valve B) to enable a test sample of softened water to be obtained. To check the hardness of the water, a hardness tester, such as a Hach, Model 5B Water Hardness Tester, should be used. Refer to the instruction manual supplied with the hardness tester for the proper procedure.

NOTE: Where the water supply is subject to high manganese levels, the resin bed media may need changing at long term intervals. Refer to the softener manufacturer for details.

4.1.2 Salt Saturator

The salt saturator is of a simple, foolproof design requiring little attention other than to maintain the permanent salt level at the lower limit quoted in the manufacturers information, if applicable. This is the maximum level at which the unit has the capacity to accept a full recharge of salt.

The action of the incoming water supply ball valve should be checked periodically to ensure that the water level is maintained to the manufacturer's figure. Check also any attached spray bar to ensure that the incoming water is evenly distributed across the top of the tank, and not concentrated in one particular spot, as this will create a clear path through the salt and lead to a weak brine solution being drawn off.

Weekly checks should be made on the strength of the brine emerging from the saturator. For this purpose, a sample tap is provided on the electrolyzer (Dwg. 85.035.170.010, valve D).

A measuring cylinder and a hydrometer specially calibrated in percent brine strength are provided for testing purposes. To make a check, half fill the measuring cylinder with brine and carefully place the hydrometer in the solution. With the brine at the correct strength, the liquid level should read 100% on the hydrometer scale.

4.1.3 Electrolyzer

Refer to the electrolyzer assembly drawing for details of individual components. The brine and dilution flowmeters should have their metering tubes and floats periodically cleaned of any deposits to ensure their optimum performance. The brine flowmeter will require more frequent cleaning.

4.1.3.1 Anode Warranty

The anodes used in the electrolyzer have a specific warranty period of five years, unless otherwise stated at the time of ordering the equipment. The anodes should perform satisfactorily for 60 continuous calendar months after initial commissioning, provided that the equipment has been operated in accordance with the conditions stated on the official warranty form, and in accordance with this manual. A check on the working hours can be obtained from the associated transformer/rectifier unit, which has a built-in hours run meter. Claims under the warranty must be accompanied by proof that the equipment has been operated correctly, therefore the OSEC Operational Log (OSEC-LOG), located at the end of this section, should be filled out on a regular basis of not less than once per month. A signature is required against every entry by a responsible person, such as a foreman, supervisor, or manager.

It is important that the plant is operated, maintained, and serviced in accordance with the recommendations contained in this instruction manual. Where, because of abnormal site conditions, a regular acid cleaning program is recommended (see below), this program must be adhered to otherwise permanent damage may be caused to the anode coatings.

4.1.3.2 Bus Bars

Regularly (at three-month intervals) check the surface temperature of the bus bars and the various bus bar joints using a thermocouple-type thermometer. The bus bar connections at each end of the electrolyzer are equipped with central pilot holes in which to insert the thermometer probe. These holes are accessible after removing the central knurled screws that retain the bus bar guards and then detaching the guards. The temperatures measured should not exceed 194°F (90°C). An excessive temperature at a joint area points to possible erosion within the joint causing resistance to current flow. This should be remedied by thoroughly cleaning and then remaking the joint.

Shut down the electrolyzer (as detailed in paragraph 3.4, Complete Shut Down) and isolate the three-phase mains supply to the transformer/rectifier unit. Dismantle the faulty joint, taking note of the arrangement of any spacers and washers used, and the positions and lengths of the securing bolts or screws. Degrease the mating surfaces of the joint and clean the surface of the bus bar with fine emery cloth until the surface is bright and free from any corrosion. Do not use emery on the circular connecting spacers fitted in the ends of the electrolyzer as these are silver-plated. After cleaning, coat the joint surfaces thinly with joint compound, as specified in Section 2 - Installation. Refit the bus bars, securing with the fixings previously removed, ensuring their correct orientation. Tighten the bolts to the correct torque—17 ft-lb (23 Nm) for bus bar-to-electrolyzer joints or 70 ft-lb (95 Nm) for bus bar-to-bus bar joints.

After remaking the joints, restore the supply to the OSEC Control and the transformer/rectifier unit. Press the ALARM RESET button at the OSEC panel to cancel any alarms. Press the OFF button at the transformer/rectifier, followed by the ON button, to reset its control relays.

4.1.3.3 Electrode Cleaning

The electrode assemblies must be acid cleaned at yearly intervals, or more frequently if a reduction in the efficiency of the electrolyzer is observed. The water supply from the softener should have had all the hardness elements removed, as these elements would otherwise be deposited on the electrodes during electrolysis; however, the water supply may be subject to varying levels of manganese. The water softener should be able to remove all traces of manganese but, if not, the electrolyzer may need to be acid cleaned after any periodic increase to remove any deposits from the electrodes. Also there may have been breakdowns in the associated plant during the year that may have effected the water supply and, in turn, the electrolyzer. The hypochlorite should be sampled regularly to be analyzed as part of a regular check on operational efficiency. A pointer to deposits having formed will be a lowering by about 10% of the normal working efficiency of the electrolyzer. The following formulae will enable the efficiency to be calculated. Should acid cleaning be required, either refer to USF/W&T to arrange for such a treatment to be carried out or, if an acid cleaning package is available, follow the procedure in paragraph 4.2.

- Hypochlorite strength — This is determined by conducting a titration (see paragraph 4.6) on a sample taken from the sample valve at the hypochlorite outlet manifold of the electrolyzer. The plant must be allowed to run for at least 30 minutes before taking the sample, and must be running while the sample is taken. Assuming that a 5 ml sample has been taken:

$$\text{mg/liter} = (\text{mls of titrate } 20\ 35.46)$$

- Chlorine per Hour — Having determined the strength in mg/liter, the chlorine per hour can be calculated.

$$\frac{(\text{Total flow (water and brine) l/hr x mg/l})}{10^6} = \text{kg/hr}$$

- Current Efficiency (derived from Faraday's Law) — For a multiple electrolyzer-type electrolyzer, the efficiency of the unit can be determined using the kg/hr figure previously calculated.

$$\frac{(\text{kg/hr } (Cl_2) \text{ x } 9449.1165)}{\text{D.C.Current}} = \%$$

A typical figure for current efficiency is 60 to 70% and depends on the temperature and water/brine dilution ratio.

- Salt Usage — Salt usage can be determined using the previous figures; it is expressed as kg of salt per kg of chlorine produced.

$$\text{Kg (NaCl) / kg } (Cl_2) = \frac{(318 \text{ x Brine flow l/hr})}{(1000 \text{ x kg } Cl_2\text{/hr})}$$

  A typical figure is 3 to 3.5

- Salt Conversion Efficiency — This is to establish how much of the salt is being converted to hypochlorite in the electrolyzer.

  Theoretically, it requires 1.6485 kg of salt to make 1 kg of chlorine.

Therefore salt conversion efficiency = $\frac{(1.6485 \times 100)}{(\text{Salt Usage — see above})}$

A typical figure = 50%

When replacement of the electrodes is required, it is not recommended that the electrode assemblies be dismantled on site, but be returned to USF/W&T for refurbishing. This is because some of the assembly procedures are critical and electrical shorts between plates could lead to serious damage. Refer to paragraph 4.3 and 4.4 for removal and replacement procedures.

4.1.4 Transformer/Rectifier Unit

There are no routine maintenance requirements for the unit other than to keep its cabinet clean and ensure that all connections are secure and tight. Before opening the unit to check on electrical items, ensure that the supply is isolated elsewhere. Periodically check the variable transformer track for wear or breakage, cleaning with a soft, damp cloth if necessary. Also check its brushes for wear. As the unit is air-cooled, ensure that any ventilation slots are not covered.

4.1.5 Control Cabinet

Refer to Supplement 1 for details of control panel maintenance and servicing.

4.1.6 Hypochlorite Storage Tank

There are no maintenance requirements for the storage tank other than routine checks on the integrity of the various pipe joints and flanges. Check also the terminations of the level switches for security and good contact. The action of the pressure differential switch that monitors the air flow into the tank is automatically checked by the OSEC PLC during its control sequence. The blower motors are fitted with sealed bearings and require no lubrication. Should the bearings become noisy, it will be necessary to either replace the motor or fit new bearings. Refer to the manufacturer's data for any servicing instructions. Ensure that the mains supply to the blower starters is isolated elsewhere before any servicing is attempted.

4.2 Acid Cleaning

Before acid cleaning, it is important that the electrolyzer is flushed through with water to remove any traces of sodium hypochlorite as this would react with the acid to form chlorine. Press the MAN FLUSH push button at the OSEC control. This will open the water valve alone, the WATER SUP-

PLY ON lamp being lit. Once initiated, the flushing sequence will operate long enough to ensure a complete purge of the hypochlorite in the casing and at the end of this period the water valve will automatically close. At the completion of the flushing sequence when the lamp is canceled, leave the control with FLUSH still selected. Switch off the mains supply to the transformer/rectifier at its local isolator. Close the manual dilution water inlet valve (Dwg. 85.035.170.010, valve A). Drain the electrolyzer casings and the hypochlorite output piping by first connecting a hose to the acid clean/drain valve (T) and directing the hose to a suitable drain. Open the valve and allow the complete contents to drain. Unscrew the union at the hypochlorite outlet connection on the top of the upper casing and fit the blanking disc supplied with the electrolyzer to the union and then refit the union and fully tighten. This disc is fitted to prevent any possibility of the acid reaching the hypochlorite storage tank during cleaning, as the acid would react with the hypochlorite to produce dangerous chlorine gas.

WARNING: THE FOLLOWING PROCEDURE INVOLVES THE HANDLING OF BOTH CONCENTRATED AND DILUTE HYDROCHLORIC ACID. PERSONNEL SHOULD REFER TO THE SAFETY WARNINGS AT THE START OF THIS MANUAL AND TO THE ACID SUPPLIER'S INFORMATION TO BE MADE AWARE OF THE POSSIBLE HAZARDS INVOLVED AND THE PRECAUTIONS TO BE TAKEN.

a. Check that the acid dilutor is fitted with a 2.2mm orifice in the acid inlet connection at the side of the dilutor. This orifice enables the dilutor to give a nominal dilution ratio of 10:1 (water:acid). Taking note of the acid warnings, connect the hose from a carboy of 36% strength concentrated hydrochloric acid to the acid inlet collet. Ensure that the hose connection is secure both at the dilutor and at the acid carboy.

b. Connect a fresh water supply (not towns mains) of minimum pressure 1.5 bar to the hose spigot at the end of the dilutor and check the connection is secure.

c. Unlock the float level indicator at the dilute acid tank by turning the central knob until the float is free to rise.

d. Turn on the water supply to the dilutor and allow the dilute acid to fill the 52-gallon (200-liter) tank approximately 40% full, then turn off the water supply. Disconnect the water supply hose and also the acid carboy hose, taking heed of the acid warnings.

<u>NOTE</u>: With a concentrated acid strength of 36% and a 10:1 dilution ratio, the strength of the dilute acid produced will be a nominal 4%, and 1.9 gallons (7.3 liters) of concentrated acid will be used to create 21 gallons (80 liters) of dilute solution.

e. Connect a hose from the outlet of the tank-mounted barrel pump to the hose spigot at the acid clean/drain valve (T) on the underside of the lower electrolyzer casing. Also connect a hose from the acid clean/ sample valve (N) at the hypochlorite outlet manifold back to the return tank connection on the top of the dilute acid tank. Check that all hose connections are secure.

<u>NOTE</u>: The acid clean/sample valve (N) is already fitted with a length of clear PVC hose that runs down the side of the column to the base. Either this hose can be temporarily disconnected from the valve to enable the acid return hose to be connected direct, or the acid return hose can be connected to the end of the existing hose.

f. Adjust the valves on the dilution water feed line to the heat exchanger so that the heat exchanger is by-passed, preventing any acid flow through the exchanger.

g. Fully open both acid clean valves (T and N).

h. Connect the pump to the electricity supply and switch on at the pump-mounted switch.

i. Allow the dilute acid solution to circulate through the casing for 30 minutes or longer, depending on the amount of scaling. The presence of carbon dioxide gas bubbles in the acid return line indicates that descaling is still in process.

j. Switch off the pump and allow the acid solution to flow back into the tank as much as possible.

k. Open the manual dilution water inlet valve (A). Press the AUTO button at the OSEC control and then almost immediately press the MAN FLUSH button to initiate a new flush sequence. Allow the water to fill the casing and then flow into the acid tank. Check the increasing solution level in the dilute acid tank and press the INHIBIT button when the level reaches 80% full to stop the flush cycle.

l. At the end of the last flushing sequence, leave the selector in the FLUSH mode and allow the water in the electrolyzer to drain back into the dilute acid tank. Disconnect the tubing of the acid return line from the acid clean/sample valve (N) to allow air into the electrolyzer casing to assist draining.

m. Fully close both acid clean valves (T and N) and remove the plastic tubing.

n. If the electrode assembly is to be visually examined or serviced, proceed directly to paragraph 4.3.

o. If the electrolyzer is to be brought back into operation, remove the blanking disc previously inserted in the union at the hypochlorite outlet on the upper casing. Ensure the union nut is fully tightened when refitted. Re-select the heat exchanger by turning valve J to the desired setting.

p. Switch on the transformer/rectifier unit at its local isolator and press the OFF/RESET button, followed by the ON button. Turn the current control to minimum.

q. Press the AUTO button, followed by the MAN FLUSH button to initiate the filling of the electrolyzer casing with water. At the completion of the flush cycle, reselect AUTO, allowing the electrolyzer to start up again. After a nominal three minutes running time, to ensure the casing now contains brine rather than plain water, increase the current control at the transformer/rectifier to the normal running current, as shown on Table 1.1 (located at the end of Section 1).

r. Neutralize the spent dilute acid in the tank by slowly adding soda ash or sodium bicarbonate to the solution until it ceases to effervesce. Ensure that the room is well ventilated to dissipate the carbon dioxide gas produced. Check that the solution is neutralized by testing with pH indicator paper. The paper should register a value of pH7 or above (a yellow indication, not red). The solution should then be disposed of in a safe manner. To empty the tank, redirect the outlet hose from the acid pump to the drain or a suitably sized container ready to receive the solution and then switch on the pump again. When empty, flush the tank and pump with clean water to purge them of any residue. Switch off the pump and isolate its supply.

4.3 Removing the Electrode Assembly

WARNING: DO NOT USE METAL TOOLS IN CLOSE PROXIMITY TO THE ELECTROLYZER CASING AND TO THE BUS BARS WHILE POWER IS BEING APPLIED TO THE CASING. ALTHOUGH THE VOLTAGE IS LOW (NOMINAL 32V), THE CUR-

RENT BEING APPLIED IS HIGH (BETWEEN 780A AND 1500A DEPENDING ON THE CAPACITY OF THE ELECTROLYZER—REFER TO TRANSFORMER MANUFACTURER'S DATA SHEET) AND SERIOUS INJURY COULD RESULT FROM SHORTING OUT THE BUS BARS. ENSURE THAT THE SYSTEM IS FULLY SHUT DOWN AND THE TRANSFORMER/RECTIFIER ISOLATED BEFORE SERVICING STARTS.

a. If performing this service without any prior acid cleaning, shut down the electrolyzer (as detailed in paragraph 3.4, Complete Shut Down) and then close the main dilution water inlet valve (A) (see Dwg. 85.035.160.030).

b. Drain the electrolyzer casing and the hypochlorite output piping by connecting a hose to the nipple of the acid clean/drain valve (T) and directing the hose to a suitable drain. Open the valve and ensure the casing and pipework fully drain.

NOTE: For the purpose of this description it is assumed that both electrode assemblies are to be checked over and possibly replaced. Service only one casing at a time so that the electrode assemblies cannot be intermixed and the orientation accidentally reversed when replaced. Refer to Dwg. 85.035.110.010 for details of the bus bars, their connections, and respective polarity orientation.

c. Disconnect the fuse holder, complete with voltage balance cable, and the two cover guards from the ends of the jumper bus bar at the left-hand end of the casing.

d. Remove the three long bolts at each end of the jumper bus bar and then detach the bus bar from the end of the casings.

e. Depending upon the particular casing to be serviced, remove the three hexagon-headed bolts recessed in its connecting spacer at the left-hand end, and detach the spacer.

f. Remove the bus bar guard from the right-hand end of the casing and then disconnect the short horizontal bus bar that connects that electrolyzer to the main bus bar assembly. This short bus bar is secured at the electrolyzer end by three long hexagon-headed bolts, and to the main bus bar assembly by four hexagon-headed screws, nuts, and washers.

g. Now remove the eight bolts and nuts that secure the right-hand end flange to the particular casing. Insert two wide-bladed screwdrivers, or flat-ended levers, in the gap between the casing and flange from which the bolts have been removed, and ease the electrode assembly out of the casing by about 20mm.

h. Remove the complete electrode assembly by grasping its end flange and tie rod spacers as the assembly emerges from the casing. If the electrode assembly seems tight in the casing, check that the casing mounting straps are not too tight, distorting the casing. The straps' securing screws should be just over finger-tight.

⚠ **WARNING: ELECTRODE PLATE EDGES MAY BE SHARP. AVOID HANDLING BY THE ELECTRODE STACKS AS INJURY MAY RESULT.**

i. The end flange can be removed from the detached electrode assembly, if required, by removing the screws recessed in the connecting spacer in the center of the flange and lifting the flange and spacer from the assembly.

j. The left-hand end flange still attached to the electrolyzer casing can now be removed, if desired, though this is not strictly necessary.

⚠ **CAUTION: It is not recommended for unauthorized personnel to attempt to dismantle the electrode assemblies to replace individual electrodes, as some of the assembly procedures are critical and electrical shorts between plates could lead to serious damage.**

4.4 Replacing the Electrode Assembly

The electrode assembly end blocks are marked with their respective polarities, as well as an arrowhead indicating which way up the electrode assembly is placed within the casing. The negative end of the electrode assembly also has an extended upper tie rod (Dwg. 85.035.160.010), which locates in a hole on the inner face of a negative end flange.

a. Refit the left-hand end flange to the casing, if previously removed, first smearing its gasket with a little silicone grease and checking on Dwg. 85.035.160.030 that it has the correct polarity engraved on it and that it is being fitted in the correct orientation. Secure with the eight bolts and nuts, tightening to a torque of 25 ft-lb (34 Nm).

b. Ensure that the two O-rings fitted to the end blocks at each end of the electrode assembly are correctly located and undamaged. Lightly smear each O-ring with silicone grease.

c. Observing the correct polarity and orientation for the particular assembly being refitted, insert the assembly so that the end block locates in the central hole in the left-hand end flange and the extended tie rod locates in its specific hole on the inner face of the end flange (if the upper electrode assembly is being replaced).

d. Using the palm of the hand, firmly push the electrode assembly—complete with its end flange and gasket, if not previously removed—into the casing in order to seat the two O-rings of the end block into the bore of the left-hand refitted end flange.

e. Refit the right-hand end flange and gasket to the casing, smearing the gasket with a little silicone grease. Check that the flange is correctly orientated and that its central hole locates on the electrode end block. If the flange had been removed from the electrode assembly, also check on the lower assembly that the extended tie rod at the right-hand end (negative) locates in its hole in the end flange. Secure with the eight bolts and nuts, tightening to a torque of 25 ft-lb (34 Nm).

f. Refit the circular connecting spacers in the recesses at the end flanges, having first coated their joint faces with jointing compound, and secure each with its three screws in the recessed holes, tightening to a torque of 17 ft-lb (23 Nm).

g. If the adjacent electrolyzer casing—to which the just-serviced electrolyzer is linked at the left-hand end—has not been serviced yet, do not refit the jumper bus bar until both units have been refitted to their casings.

h. With both electrolyzers refitted and their connecting spacers at each end secured, refit the short connecting bus bars at the right-hand end of the electrolyzer, securing at each end with three 65mm-long hexagon-headed bolts, tightening to a torque of 17 ft-lb (23 Nm).

NOTE: All metal-to-metal joint faces at the electrolyzer between the various end spacers and all bus bars should have a thin coating of electrical jointing compound, as previously described in the Section 2 - Installation.

i. Secure the bus bars to the main transformer/rectifier bus bars using four bolts, washers, and nuts each. Fit the plain washers under the heads of the bolts and spring washers under the nuts, tightening to a torque of 70 ft-lb (95 Nm).

j. Refit the jumper bus bar to the left-hand end of the two casings, securing at each end with the 65mm-long, hexagon-headed bolts, tightening to a torque of 17 ft-lb (23 Nm).

k. Reconnect the fuse holder and balance cable to the jumper bus bar and refit the guards to each end of the two casings, securing with their central knurled-headed screws.

l. Bring the electrolyzer unit back into service, if required, by first checking that all drain valves are closed. Remove the blanking disc previously inserted in the hypochlorite outlet unit on the upper casing. When replacing the union nut, ensure that it is fully tightened. Open the dilution water inlet valve (A) and select the heat exchanger, if required.

m. Switch on the transformer/rectifier at its local isolator and press its OFF/RESET button, followed by the ON button. Turn the current control to minimum.

n. Press the AUTO button at the OSEC control, followed by the MAN FLUSH button to initiate the filling of the two casings with water. At the completion of the flush cycle, reselect AUTO to start up the electrolyzer. After approximately five minutes, to ensure the casings contain brine rather than plain water, increase the current control at the transformer/rectifier unit so that the normal running current is registered. Refer to Table 1.1 (located at the end of Section 1) for actual values.

4.5 Flowmeter Servicing

The two flowmeters on the electrolyzer can be stripped down on site for cleaning, without the need to disturb the piping. Temporarily shut down the electrolyzer, if not already shut down for previous service procedures (as detailed in paragraph 3.3, Temporary Shut Down), and then close the dilution water inlet valve (A).

NOTE: The flowmeters cannot be drained due to the non-return action of their floats. Have an absorbent cloth on hand to catch any liquid released when removing the flowmeters.

a. Unscrew the large union nuts at each end of the flowmeter and carefully lift the tube clear, taking care not to strain the still-attached cable of its minimum flow switch.

b. Mark the relative position of the flow switch on the back of the flowmeter tube and then slacken its clamping screw to enable the switch assembly to be slid from the tube. Do not disconnect the cable from the switch.

c. Clean all the parts in warm, soapy water and inspect for damage or wear. Do not use solvents or abrasive cleaners on any of the parts. Check the O-rings in the recesses at each end of the tube and replace, if necessary, with new Viton or ptfe O-rings.

d. Replacement is the reverse order, making sure the float is inserted with its point facing downwards, and that the O-rings are lightly lubricated with silicone grease.

e. After tightening the union nuts at either end of the flowmeter, reset the minimum flow switch to the previously marked setting, and then tighten its clamp screw. These settings are usually 85% of normal flow.

f. After servicing is complete, check that the flowmeter union nuts are tight. Open the dilution water inlet valve (A). Switch on the OSEC controller and press the ALARM RESET button, if necessary, to clear the alarms. Re-select AUTO mode—if previously selected—to start up the system again, level switches permitting.

4.6 Titration Procedure

To enable the product strength of the generated hypochlorite to be calculated, a sample must be taken from the sample valve (N) at the outlet manifold. Refer to the Sodium Hypochlorite and Hydrogen Gas warnings at the start of this manual.

NOTE: The chemical reagents required for the following titration are include, potassium iodide, sodium thiosulphate solution (0.1N), and acetic acid (50%) or citric acid crystals.

a. Place approximately 50 ml of distilled water in a flask.

b. Add 1 gram of potassium iodide.

c. Add 20 ml of 50% acetic acid, or approximately 10 grams of citric acid crystals, to the flask.

d. Using a pipette, take 5 ml of OSEC product sample and place the sample in the flask.

e. Titrate with the sodium thiosulphate solution, slowly adding the solution in small measured doses until all the color has cleared. Note the quantity of solution used in ml. For a more accurate end-point determination, add starch or a similar indicator to the cleared solution and then add more thiosulphate until the solution clears again, noting the amount of thiosulphate used.

f. Calculate the product strength as follows:

$$\frac{T \times 3.546 \times 1000}{V} = \text{mg/l chlorine}$$

Where T = the titration result in ml,
and V = volume of sample in ml.

4.7 Troubleshooting

Refer to Supplement 1 for details of the various fault alarms that may register at the control panel, together with their possible causes and remedies.

OSEC Operational Log

OSEC MODEL NO.:... **SITE:..................................** **DATE COMMISSIONED:......................................**

CAPACITY:.............................. **kg(lb)/day**

SETTING FOR NORMAL RUNNING:.. WATER FLOW RATE:...gal(l)/hr

BRINE FLOW RATE:..gal(l)/hr

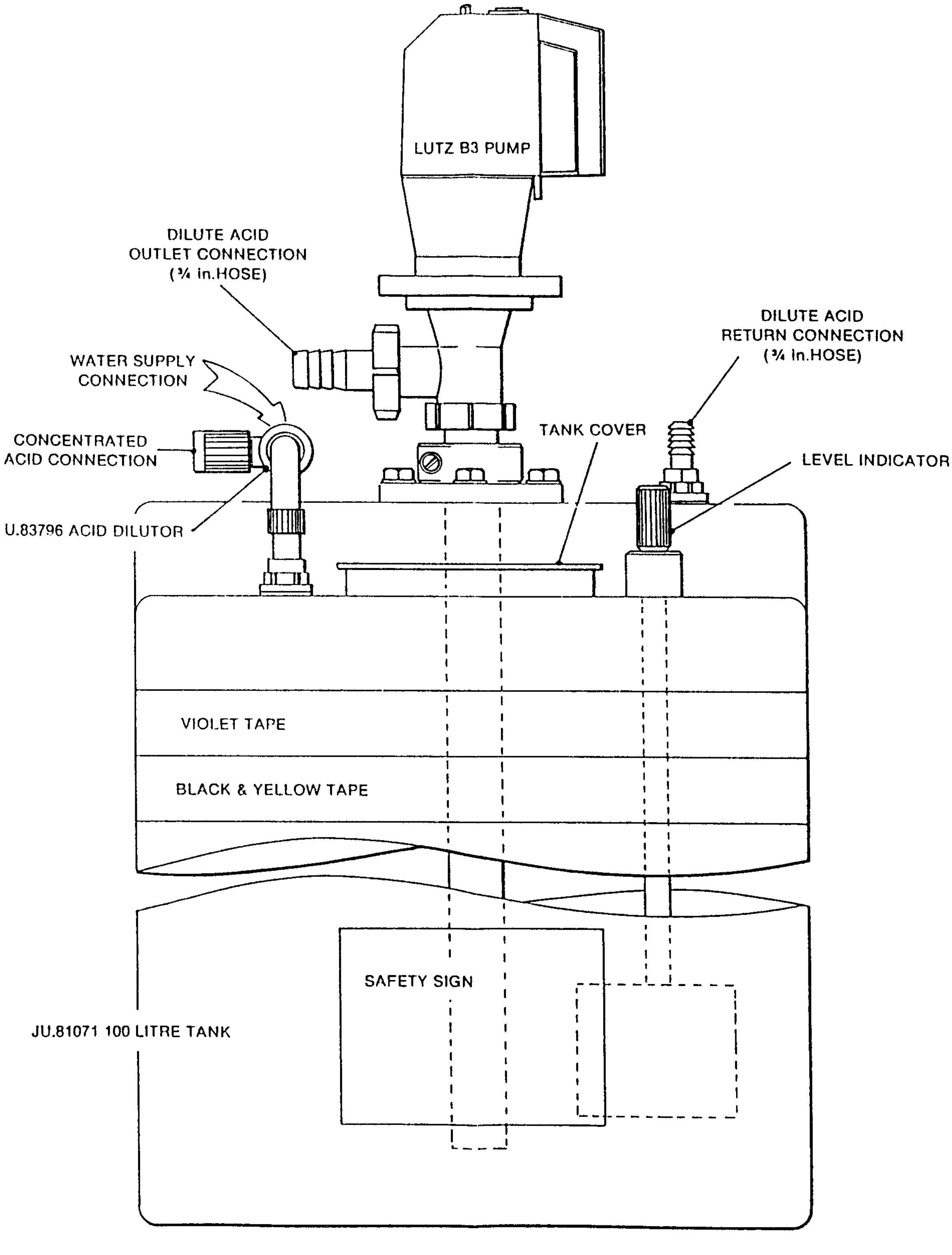
HEAT EXCHANGER FITTED? YES/NO AMPERES:..

VOLTS:...

RECOMMENDED ACID CLEANING FREQUENCY:..

NOTE: THE TABLE BELOW MUST BE COMPLETED AT LEAST EVERY MONTH

DATE	WATER FLOW gal(l)/hour	BRINE FLOW gal(l)/hr	INLET WATER TEMP°F (°C)	AMPS	VOLTS	SIGNATURE	POSITION



OSEC© SYSTEM - ACID CLEANING UNIT

85.035.150.010
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SECTION 5 - ILLUSTRATIONS

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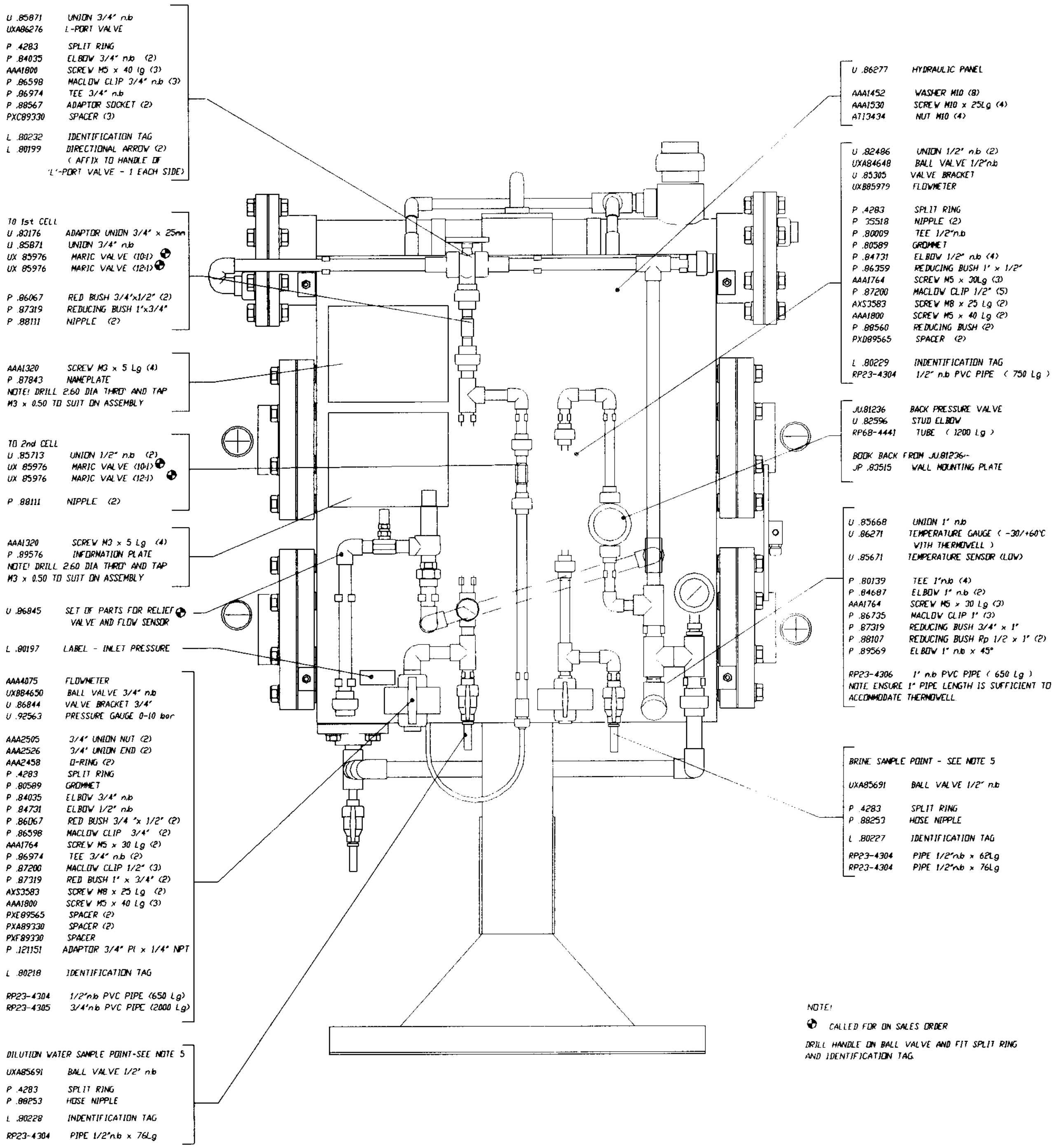

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85.035.160.030A

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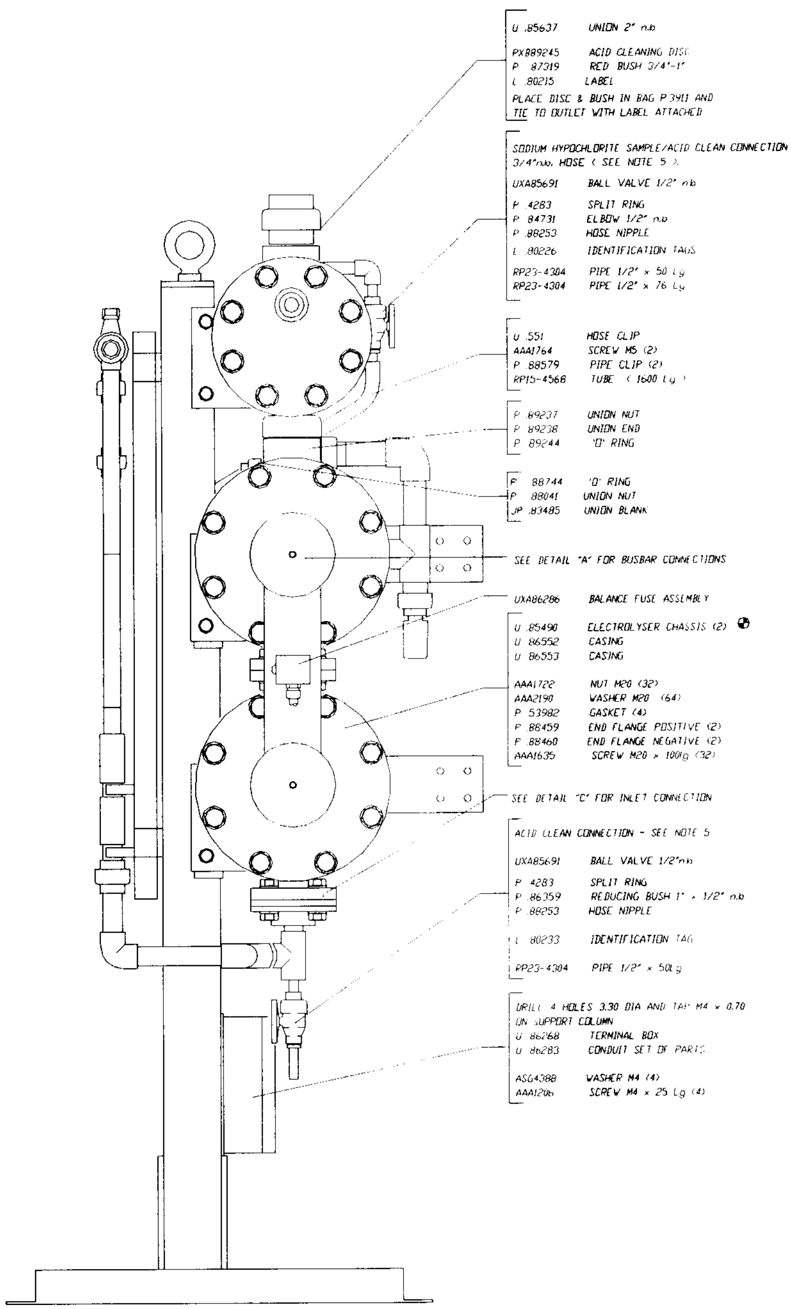

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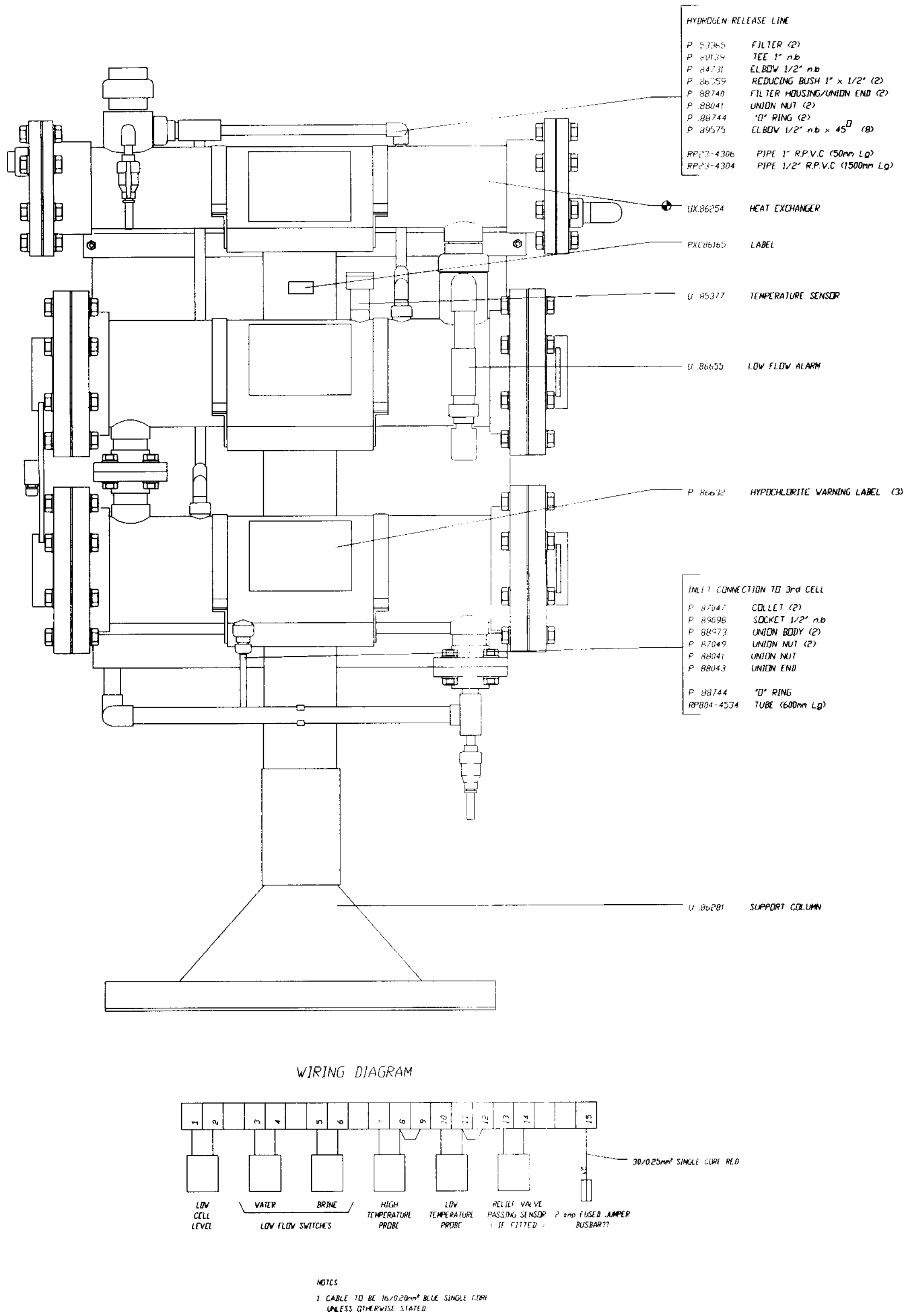

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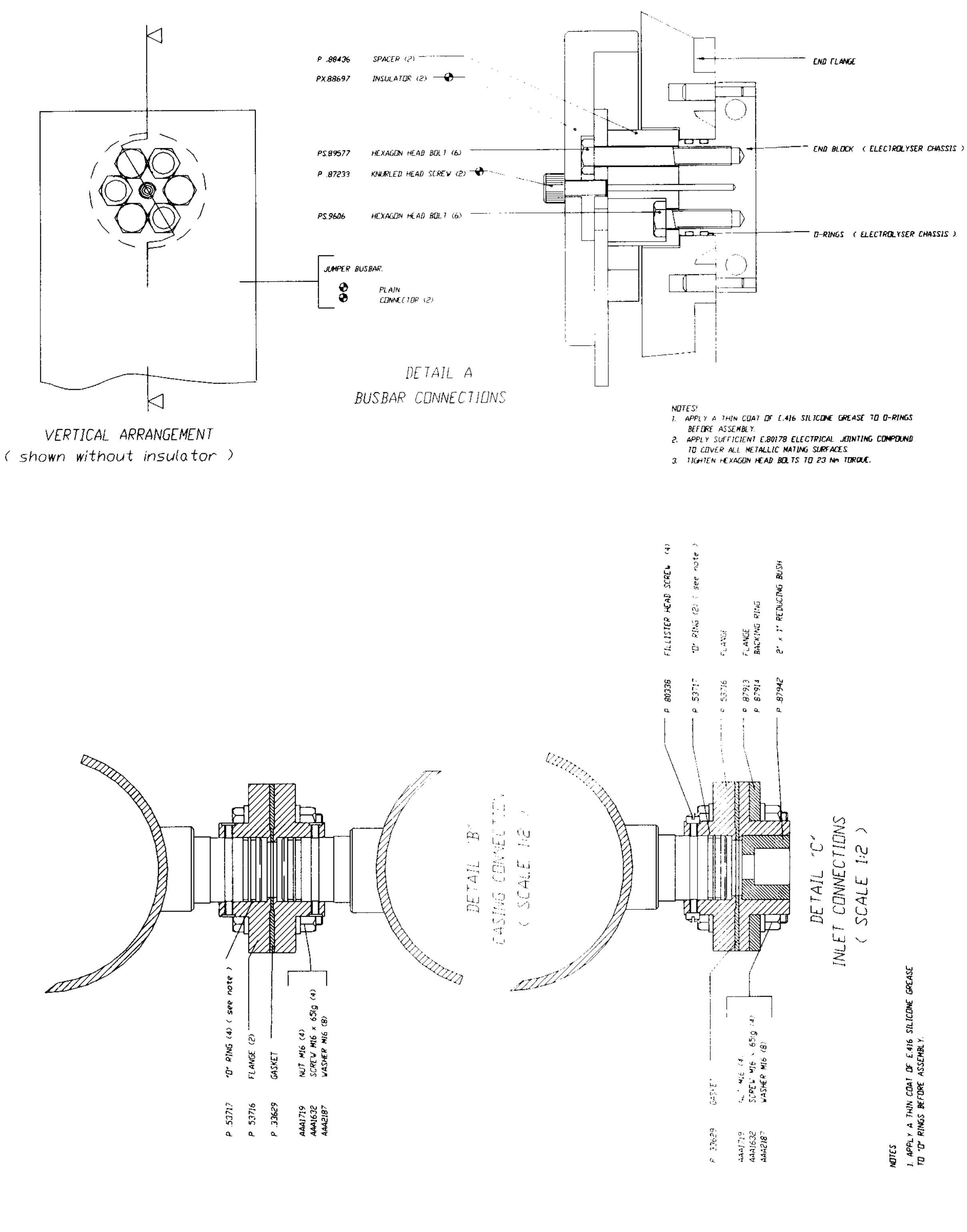

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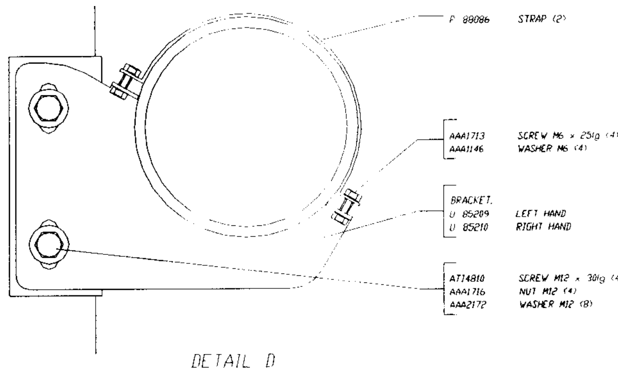

DETAIL D
HEAT EXCHANGER SUPPORT
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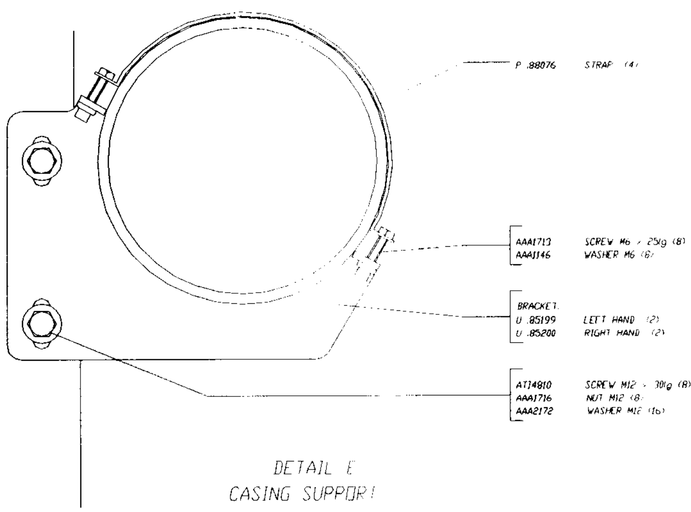

DETAIL E
CASING SUPPORT
(scale 1:2)

B2-200© OSEC - GENERAL ASSEMBLY

85.035.160.035C
ISSUE 0 1-00

SECTION 6 - SPARE PARTS LIST

QTY.	DESCRIPTION	PART NO.
1	Electrical Jointing Compound	U 85553
2	Gasket	P 33629
1	Filter	P 53365
8	O-ring	P 53717
4	Gasket	P 53982
8	O-ring	P 55253
1	O-ring	PXC 82206
2	2 Fuse	P 85259
1	Gasket	P 88081
11	O-ring	P 88744
6	O-ring	P 88873
6	O-ring	P 89299
1	O-ring	P 89382
1	Gasket	JPXQ 81423
1	Diaphragm	JP 82415
60 cm	Tube	RP1-446

OSEC® CONTROL PANEL

INTRODUCTION

The OSEC® system described in the main part of this manual is under the control of an integral panel that is mounted above the transformer/rectifier unit. This supplement fully describes this control panel, including its connection details, operation, and troubleshooting, should an alarm condition occur.

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SECTION 1 - TECHNICAL DATA

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1.1 General Description

The OSEC Control Panel monitors and supervises the On Site Electro Chlorination process described in the main electrolyzer manual. Housed in a wall-mounted, sheet metal cabinet, the OSEC Control Panel utilizes a FX-32MR PLC (programmable logic controller) to manage the system. An operator terminal fitted to the front door of the control panel allows access to system data and control parameters via a keypad interface. Using the level transmission signal from the hypochlorite storage tank(s), the Controller ensures the hypochlorite product is always available for dosing purposes.

Associated with the FX-32MR processor unit—which also incorporates the memory module—are two expansion units for input and output signal interfacing. The input interface provides the connections between the various plant process monitors, switches, sensors, and relays, and converts these inputs into logic signals for the processor unit. The output interface converts the digital output signals from the processor into a form capable of driving the various contactors, solenoids, motorized valves, etc.

As the input signals are received, the processor examines their logic status and compares this information with the user program stored in its memory. It then determines whether any control action is required and, if necessary, provides the requisite signals to the output interface. It then re-examines the status levels of the input signals again and repeats the control process.

1.2 OSEC System Control Sequence

Under normal operating conditions, the OSEC system is set to OSEC AUTO and the control sequence begins with a low-level signal from the storage tank. This signals the PLC to switch on the brine pump and open the dilution water inlet valve. After a short delay, the transformer/rectifier output is switched on and the storage tank venting blower is started.

The hypochlorite is now being generated and fed to the storage tank where the hydrogen is detrained and vented by the blower.

When the level in the tank reaches the high level setting, the transformer/rectifier is switched off, stopping any further electrolysis. The brine pump continues to run and the water valve remains open for a preset period to purge the remaining hypochlorite from the electrolyzer casing to minimize corrosion of the electrodes.

The length of time that the brine and water remain flowing is programmed into the PLC to match the normal brine and water flows for the particular capacity electrolyzer so that the electrolyzer has a complete change of fluid. The hydrogen venting blower continues to operate for 15 minutes after shut down so that any hydrogen still detraining from the newly generated hypochlorite in the tank continues to be diluted and vented.

1.3 Status and Alarm Indications

When an alarm condition is detected, the word ALARM appears in the top right-hand corner of the Operator Terminal display and the audible alarm is turned on. When appropriate, the system is shut down.

The alarm condition is written to the ALARM LIST with a date and time record. When the ALARM LIST key is pressed, the list is displayed and the audible is silenced. At the display the alarm status is ascertained by reference to the symbol preceding the alarm name, these are:

*	-	Not accepted or reset
-	-	Accepted but not reset
$	-	Reset but not accepted
	-	Accepted and reset

Exit the ALARM LIST by using either the ALARM LIST or MAIN MENU keys. The ALARM LIST is cleared when power is removed from the operator terminal or the operator terminal program is restarted.

Alarms can only be reset (by pressing the ALARM ACK key after clearing the alarm condition) while the ALARM LIST is displayed.

- **BRINE PUMP FAULT:** Derived from the brine flow switch contact that opens under the no-flow condition, this alarms is inhibited when the brine pump is not running and for a configurable time of up to 300 seconds after brine pump start-up. There is also a two-second transient time to accommodate fluctuations in the brine flow.

- **BRINE PUMP FAILED:** This alarm is generated if the brine flow switch contact opens when the system is configured for single pump operation. The priority alarm relay is de-energized. The electrolyzer is shut down, but the hydrogen blower remains on for 15 minutes.

- **DUTY BRINE FAILED:** An alarm generated if the brine flow switch contact opens when the system is configured for two-pump operation and the duty pump is running. The minor alarm relay is de-energized and the standby brine pump is started.

- **STANDBY BRINE FAIL:** This alarm is generated if the brine flow switch contact opens while the standby pump is running. The priority alarm relay is de-energized. The electrolyzer is shut down, but the hydrogen blower remains on for 15 minutes.

- **LOW WATER FLOW:** Derived from the contact of the water flow switch that opens under the no-flow condition. The alarm is inhibited when the water solenoid valve is closed and for 30 seconds after the valve is opened. There is also a two-second transient time to accommodate fluctuations in the water flow.

  When this alarm is generated, the priority alarm relay is de-energized, the electrolyzer is shut down, and the hydrogen blower remains on for 15 minutes.

- **LOW ELECT TEMP:** Derived from a temperature sensor mounted in the inlet pipework of the electrolyzer and connected to a signal convertor within the control panel. The 4 to 20 mA output from the signal convertor is applied to an analog input on the PLC. A trip level equivalent to 50°F (10°C) is set in the software. This alarm is inhibited when the electrolyzer is off and for 20 minutes after the electrolyzer is started. There is a 10-second transient time before the alarm is generated.

If this alarm is generated, the priority alarm relay is de-energized, the electrolyzer is shut down, and the hydrogen blower continues to run for 15 minutes.

- **HIGH ELECT TEMP:** Derived from a temperature sensor that is mounted in the electrolyzer outlet pipework and connected to a signal convertor within the control panel. The 4 to 20 mA output from the signal convertor is applied to an analog input on the PLC. A trip level equivalent to 113°F (45°C) is set in the software. There is a 10-second transient time before the alarm is generated.

  If this alarm is generated, the priority alarm relay is de-energized, the electrolyzer is shut down, and the hydrogen blower continues to run for 15 minutes.

- **LOW ELECT LEVEL:** Generated by a level switch located on the electrolyzer cell. Alarm initiation is dependant on the control mode of the electrolyzer when the condition occurs.

  † In the FLUSH mode, the alarm is inhibited.

  † In the INHIBIT mode, the electrolyte level is continuously monitored. If the level switch contact opens, this alarm is generated and the minor alarm relay is de-energized.

  † In the AUTO mode, the control action is further dependant on whether the electrolyzer is RUNNING or WAITING for the next fill request, e.g.:

    ‡ ELECTROLYZER RUNNING: There is a four-second transient time before any action is taken, after which the Low Elect Level alarm is generated and the priority alarm relay is de-energized. The electrolyzer is shut down and the hydrogen blower continues to run for 15 minutes.

    ‡ ELECTROLYZER WAITING: An automatic top-up is started, meaning the brine pump is started and, once flow is established, the water valve is opened. These flows continue until the alarm condition clears and then remain on for a further 20 seconds. The maximum run time for any top-up cycle is limited to two minutes and the top-up may only be performed once in any ‘waiting’ period. If the top-up cycle is exceeded or a second low level condition occurs, the Low Elect Level alarm is generated and the minor alarm relay is de-energized.

When the system is selected for AUTO but has not yet run, the Low Elect Level alarm is inhibited. In this case, when the electrolyzer is required to start, the normal control sequence is entered but the rectifier is not started until the cell level switch closes. The system has the start-up inhibit time to achieve this before automatic shut down occurs. This method enables an empty electrolyzer to fill with brine and water and to start without generating alarms.

- **RECTIFIER FAILED:** The rectifier alarm is derived from a contact (closed when healthy) that is located in the transformer/rectifier. This alarm is inhibited when the rectifier is switched off and for 120 seconds after it is switched on.

  If this alarm is generated, the priority alarm relay is de-energized. The electrolyzer is shut down and primed 0 and the hydrogen blower is run for a further 15 minutes.

- **IMPROPER VOLTAGE:** Derived from a contact (closed when healthy) situated in the transformer/rectifier. Inhibited when the rectifier is switched off, the alarm is also inhibited for 120 seconds after the unit is switched on.

  If this alarm is generated, the priority alarm relay is de-energized, the electrolyzer is shut down and primed, and the hydrogen blower is run for a further 15 minutes.

- **HYDROGEN BLOWER FAILED:** Derived from an air flow switch mounted in the blower ductwork. The switch contact (open in the no-flow state) is used to initiate a changeover to the standby blower if the duty unit fails. The switch itself is monitored for correct operation.

  The alarm is inhibited when the blower is off and for 60 seconds after the blower is started. A five-second transient time is allowed for variations in the air flow.

- **BLOWER FAILED:** If this alarm is generated when the system is configured for a single hydrogen blower, the priority alarm relay is de-energized and the electrolyzer is shut down and primed.

- **DUTY BLOWER FAILED:** If this alarm is generated when the system is configured for two blowers and the duty unit is running, the minor alarm relay is de-energized and the standby blower started.

- **STANDBY BLOW FAILED:** If this alarm is generated when the standby blower is running, the priority alarm relay is de-energized and the electrolyzer is shut down and primed.

- **AIR SWITCH FAIL:** When a blower is stopped, the air flow switch is checked to see that it returns to the open, no-flow condition. If the switch does not return within 120 seconds, this alarm is generated and the minor alarm relay is de-energized.

- **PRODUCT TANK OVER:** Derived from an overflow container in the storage tank bund, this alarm is triggered by the container's float switch contact, which is normally closed.

  If this alarm is generated, the priority alarm relay is de-energized and, if the electrolyzer is running, the unit is shut down, but the hydrogen blower continues running for a further 15 minutes.

- **PRODUCT TANK LOW:** This alarm is generated if the product in the storage tank falls below the low storage trip level set in the storage levels menu. If initiated, the minor alarm relay is de-energized.

- **TANK SIGNAL LOST:** If the input signal from the product tank level monitoring system should fall below 2 mA, this alarm is generated and the priority alarm relay is de-energized. If the electrolyzer is running, it is shut down and primed and the hydrogen blower continues to run for 15 minutes. While this alarm is present, the electrolyzer is prevented from running.

- **IN TEMP SIG LOST/OUT TEMP SIG LOST:** If the signal from either temperature monitoring system should fall below 2 mA, the respective alarm is generated and the priority alarm relay de-energized. If the electrolyzer is running, it is shut down and primed. The hydrogen blower remains running for 15 minutes. While either of these alarms remains active, the electrolyzer is prevented from starting.

- **PLC ———:** If the software detects a PLC fault, an alarm is generated in the alarm list with the text prefixed 'PLC' and followed by the fault type.

- **HYDROGEN LEAK:** If the leak detector contact opens, this alarm is generated and the priority alarm relay is de-energized. If the electrolyzer is running, all run signals are removed (shut-down having been achieved through the hard-wired circuits).

This alarm is derived from a separate hydrogen detector (if used), the contact from which should be closed when healthy and open on alarm. Located in a hard-wired circuit, the contact is used to stop the rectifier, close the water supply valve, stop the brine pump, and stop the hydrogen blower. It is also taken as an input to the PLC.

- **ROOM VENT FAULT:** If this alarm is generated, the priority alarm relay is de-energized and, if running, the electrolyzer is shut down and primed. The hydrogen blower continues to run for 15 minutes.

  The way the room ventilation alarm condition is monitored depends on how the room ventilation system is configured (see paragraph 1.9).

- **EMERGENCY STOP:** If this alarm is generated, the priority alarm relay is de-energized; if the electrolyzer is running, all the run signals are removed (shut-down having been achieved through the hard-wired circuits).

  The emergency stop push button forms part of the hard-wired shut-down circuit; the contacts should be closed when healthy. This push button is also monitored by the software.

1.4 Alarm Relays

Three relays, each with a single, volt-free contact are provided for alarm monitoring. These operate in a fail safe mode, i.e., the relays are energized when the system is healthy.

- HYDROGEN LEAK - This alarm is derived from the hydrogen leak detector alarm input
- MINOR ALARM - This relay is controlled by those alarms that do not initiate electrolyzer shut down procedure
- PRIORITY ALARM - This relay is controlled by those alarms that do initiate the electrolyzer shut down procedure

1.5 Programmable Input Alarms

There are three programmable input alarms. Each is set when the system is configured. Selection of the alarms is made from the following list:

Off	Water softener failed
Relief valve passing	Aux. alarm (1, 2, or 3)
Salt saturator overflow	Remote Inhibit - (programmable input 1 only)

- **RELIEF VALVE:** If the volt-free contact associated with the relief valve is connected to the input, when the contact opens, this alarm is generated and the priority alarm relay de-energized. The electrolyzer is shut down, but the hydrogen blower is left running for a further 15 minutes.

- **SATURATOR OVERFLOW:** If the volt-free contact associated with the salt saturator overflow switch is connected to the input, should the contact open this alarm is generated. The minor alarm relay is de-energized; the electrolyzer (if on) remains running.

- **SOFTENER FAILED:** If the volt free contact associated with the water softener failure is connected to the input, this alarm is generated should the contact open. The minor alarm relay is de-energized and, if the electrolyzer is running, it continues to run.

- **AUX ALARM (1, 2 or 3):** If this alarm is selected during configuration, the action taken when the associated contact opens is dependant on other parameters that also need to be set during configuration, i.e., inhibit time and control action. The alarm is generated if the contact opens and either the minor or the priority alarm relay is de-energized. The electrolyzer is shut down and primed if the action has been set to priority.

- **REMOTE INHIBIT - (programmable input 1 only):** The volt-free contact to this input has to be closed to allow the electrolyzer to run. If the contact opens, the electrolyzer is inhibited and, if currently running, it is shut down and primed.

1.6 Operator Terminal

An operator terminal (see paragraph 3.2) allows operator access to the PLC. Fitted to the front door panel, the terminal is equipped with a keypad and a four-line display screen. The keypad is arranged in three groups of keys, two on the left-hand side of the terminal and a group of mostly number keys on the right-hand side. These key groups are used as follows:

1.6.1 Function Keys

At the top left-hand side of the operator terminal keypad are six function keys that are used to control the generation of sodium hypochlorite. These keys are labeled:

- **TOP-UP/NEXT -** One function of this key is to initiate a tank top-up cycle. The PLC will start a fill before the low start level is reached and fill the tank to the stop level or until the TOP-UP key is pressed again. ‘TOP-UP’ appears in the overview display instead of ‘GENERAT-ING’. A second function is to move the display on to show the next event in the log.

The TOP-UP function is not available while the Event Log menu is selected at the terminal. The NEXT function key operates only when the Event Log menu is selected at the terminal display.

- **RESET** - Press this key to reset the OSEC system after an alarm condition is cleared and restart the system (subject to tank level).

NOTE: The RESET key is active only after the ALARMS LIST key is pressed and the list is displayed.

- **BACK** - This key is used to return the display to the previous level and will function in all menus.

- **AUTO/PREV** - This is a dual-function key that operates in the following way:

  Pressing the AUTO function key will set the OSEC system for automatic start/stop operation as determined by the storage tank level transmitters.

  In the overview display, the word ‘AUTO’ is displayed when the electrolyzer is not running and ‘STARTING’, ‘GENERATE’, ‘TOP-UP’, ‘PRIMING’, or ‘PURGING’ when the appropriate cycle is in progress. This key will not function in the Event Log menu.

  The PREV function will operate only in the Event Log menu where, by pressing this key, the present event shown at the display will move backward to show the previous event in the log.

- **INHIBIT** - This key is pressed in any menu to prevent the OSEC from generating hypochlorite. The word ‘INHIBIT’ appears in the overview display. The alarm system remains active.

- **FLUSH** - Pressing this key, in any menu, will turn on the water supply and leave it on until two complete changes of water have passed through the electrolyzer. The time this will take is determined from the parameters entered during the configuration procedure. The word ‘FLUSH’ appears in the overview menu when selected, ‘FLUSHING’ appears while running, and ‘FLUSHED’ appears when the cycle is complete.

A flush terminates immediately if the storage tank high level contact operates, if a tank overflow is detected, or if there is a low water flow alarm. The flush is also terminated if INHIBIT is selected. In this mode, alarms are monitored as in the inhibit mode.

1.6.2 Display Keys

The lower six keys of the left-hand section of the operator terminal keypad are associated with the display itself and are used to select the following:

- **ALARM LIST** - As soon as it occurs, every alarm condition is written to the ALARM LIST, along with the date and time. Pressing this key silences the audible and displays the LIST for the alarm to be identified

- **MAIN MENU** - Comprises the system's two basic displays (see Dwg. 85.030.190.010, located in Section 3). Whenever this key is pressed, regardless of the menu displayed, the Main menu is displayed:

  Main Menu
  ➔ Status Display
  ➔ Other Functions

  The four remaining keys (←→↑↓) are used to move the display cursor in the appropriate direction to select the required item, i.e., to scroll through the Alarm List.

Refer to paragraph 3.2 for further information on the operator terminal.

1.7 Tank Level

Product level in the storage tank is transmitted to the control panel from a hall effect pressure transducer as a 0 to 20 mA signal. At the panel, this signal is applied to an analog input of the PLC and also to a signal isolator for re-transmission purposes.

Day start, day stop, night start, night stop, and low storage level are all set in the 'storage levels' menu at the operator terminal display.

The current storage tank level is indicated at the 'overview' display.

1.8 Event Log

Every event (e.g., electrolyzer start-up, shut down, alarm, etc.) is stored in the event log along with the date and time record of when it occurred.

The event log is viewed by accessing the ‘event log’ menu and selecting ‘view event log’.

The storage area for the event log is limited to 200 entries and, once full, the oldest entries are replaced by the new records.

To clear and reset the event log, access the ‘event log’ menu and select ‘clear event log’. A password is needed to carry out this action.

1.9 Room Ventilation

Two types of room ventilation monitoring are available, one of the two is selected during the configuration procedure.

- **ROOM VENTILATION AVAILABLE:** A volt-free contact within the customer’s ventilation control system is monitored for system availability. This contact should be closed when the ventilation system is available and healthy. The contact is checked prior to electrolyzer start-up and, if open, start-up is inhibited. It is also checked while the electrolyzer is running and, if open, the electrolyzer is shut down and primed.

- **ROOM VENTILATION RUNNING:** A volt-free contact from the customer’s ventilation control system is monitored for correct operation. It has one minute to reach the closed state on start-up. If this contact should fail to close or should open while the electrolyzer is running, the electrolyzer is shut down and primed.

1.10 Tandem Link

The control panel has a facility that enables two control panels to be linked together (four wires) to allow a common start. This is used when two separate OSEC systems are installed and the two product tanks are joined together by either a balance pipe or a bus main for the dosing pumps.

When one OSEC system reaches the active start level, it starts its own electrolyzer and sets its ‘system filling’ output high. Each panel monitors an ‘other system filling’ input and, if it detects that the other system has started (input going high), it waits five seconds (ignoring its own start level) before going into its own start sequence. Whichever way an electrolyzer is started, it is stopped by reaching its own active stop level.

Each OSEC will start its rectifier only on its 10-second synchronization pulse (this being started by reaching the start level) and, as the link start is delayed by five seconds, there will always be at least a five-second delay between the start-up of two rectifiers on a linked system.

1.11 Dosing Pump Enable

The ‘dosing pump enable’ relay is continuously energized while the product level in the hypochlorite storage tank is above the set low storage level.

1.12 Electrolyzer Running Relay

An ‘electrolyzer running’ relay is energized whenever the electrolyzer is generating sodium hypochlorite. This provides a volt-free contact for customer telemetry.

1.13 Monitor

Accessed by entering the ‘Monitor’ menu of the operator terminal and selecting the parameter type that you wish to view, the monitor allows the operator to see what is happening within the PLC software by examining the state of the data registers, auxiliary relays, timers, and counters. This is a ‘view only’ facility.

1.14 Information

The information menu allows the operator to view certain information about the current status of the system and its history.

In the ‘Process times’ menu, the current status of various processes is displayed enabling the operator to see, for example, how long the current generation has been running, how long since the last generation ended, or how much time remains for the prime or purge cycles to run.

The ‘Hours run’ menu displays in hours and minutes the total run time for the brine pumps, blowers, and transformer/rectifier. These can be reset from a password-protected reset menu.

1.15 Help

The ‘Help’ menu provides access to various text-based help screens.

1.16 Hydrogen Detection (Optional)

A set of hydrogen detection equipment can be fitted to monitor the atmosphere in the vicinity of the electrolyzer and provide alarms should the hydrogen concentration exceed a preset level, signifying that a leakage has occurred. The detection unit supplied comprises a control box and a separate gas sensor unit. The control box is located in the OSEC control room and the sensor is mounted close to and above the electrolyzer. The control unit is powered from a 110/240V, 60 Hz, single-phase mains supply and is fitted with a three-digit liquid crystal display. This is calibrated in percent LEL (Lower Explosive Limit) and ranges from 0 to 100% to continuously indicate the concentration of any gas detected.

The unit provides two alarm outputs for high and low alarms, and the set points are individually adjustable in the range of 5% to 65% of full scale. An equipment fault alarm output is also provided for customer use.

In the event of a low-level alarm occurring, an audible alarm is sounded and an alarm lamp is lit at the control unit. Together with these local alarm indications, a signal is provided to the OSEC control cabinet to light the Hydrogen Leak alarm lamp and to shut down the electrolyzer system. For full details, refer to the manufacturer's information supplied with the equipment.

SECTION 2 - INSTALLATION

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PARA. NO.

2.1 General

It is recommended that the control panel is wall-mounted remote from the electrolyzer in an area where it will not be subject to any water or chemical splashes and where the temperature is between 41°F (5°C) and 105.8°F (40°C). The enclosure is secured to the wall by four screws in adjustable brackets fitted to the rear of the case at the corners. These brackets can be positioned so that they extend vertically at the top and bottom edges of the enclosure, or alternatively, extend horizontally at the left- and right-hand sides of the case.

2.2 Connection Details

The control requires a 110V or 240V, 60 Hz, single-phase mains supply, depending upon customer stipulation at time of ordering. The control voltage is not selectable on site. The mains supply to the control must be taken from a fused switch unit mounted within 6.5 feet (2 meters) of the control. The switch should be fused at 10A for the 110V supply or 5A for 240V supplies.

WARNING: MAINS VOLTAGES CAN KILL. ENSURE THAT THE SUPPLY IS ISOLATED ELSEWHERE BEFORE MAKING THE CONNECTIONS.

The control connects directly to the electrolyzer by a six-wire intrinsically safe cable and two three-wire screened cables, one for the high-temperature sensor and one for the low-temperature sensor. The dilution water inlet solenoid valve for the electrolyzer is also connected by a three-wire cable to the control.

In addition to the connections with the electrolyzer, the control panel requires further connections with the other items of the plant that form the electrolyzer system:

- Starters of the remote mounted duty/standby brine pumps for the stop/ start signals;

- The storage tank equipment of level switches, level transmitter, hydrogen blowers local starters for duty/standby blowers, low air flow, and the tank overflow alarm switch.

The tank level switch circuits are designated intrinsically safe and should be run separately from other cables.

All electrical cables between the panel and the various units must be installed in accordance with the latest edition of the I.E.E. regulations for electrical installations and must conform to local electrical codes. The external connection diagram (Dwg. 85.035.140.010) shows the cabling and stipulates the minimum sizes of cables to be used. Where any cables are designated intrinsically safe, such cables must be run separately from other mains cables and have a blue-colored outer sheath to signify their status. These cables must have 500V insulation and must be metal-sheathed or armored where there is a risk of mechanical damage, or if they are being run in the same ducting as other cables.

Conduits that terminate in the hazardous area above the tank must employ approved glanding incorporating seals to prevent fumes or flames from travelling through the conduit.

2.3 Configuration

Prior to operation, the control software is configured to suit the system being installed and the following information must be entered or selected:

- OSEC type (B1-150, B1-200, B2-200, or B4-200) and its anode quantity must be entered in order to set the prime, flush, and cell fill times.

- Storage tank capacity (liters at 20 mA input) along with the fill start/ stop levels and their corresponding alarm levels.

- The number of storage tank blower units available to the controller must be selected between one or duty and standby operation.

- Room ventilation monitoring must be selected, e.g., between ‘available’ and ‘running’.

- The number of brine pumps available to the controller must be selected between one or duty and standby operation.

- The brine pump start-up inhibit time (between 30 and 300 seconds).
- The three programmable alarm inputs.
- The use of low-cost electricity (see paragraph 2.4) and the time during which that applies.

2.4 Low-Cost Electricity

The system can be configured to use electricity on the during low-usage, and thus low-cost, periods. If this option is set, a large fill is performed overnight and small fills, if required, are allowed during the day.

The PLC clock is used to determine whether the low-cost period is currently applicable by referring to the low-cost electricity start and end times set by the user.

If the low-cost electricity option is set and the system is still running at the end of the low-cost period, the system will continue to run until the daytime stop level is reached. Should that level have been reached already, the system is stopped.

At the beginning of the low-cost electricity period, the system is started regardless of the storage tank level, stopping when the nighttime stop level is reached.

SECTION 3 - OPERATION

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3.1 Initial Start-Up

With the initial start-up procedure of the electrolyzer fully completed (as detailed in paragraph 3.1, steps a through h, of the main instruction manual), the control panel can be brought into operation.

a. Before start-up, check that all ventilators in the plant room are open.

b. Check that the sample/drain valve on the electrolyzer is closed and that the storage tank drain valve is closed.

c. Ensure the valve on the water supply to the water softener is open.

d. At the Control Cabinet, set the Main Incomer supply selector switch to ON and check that its SUPPLY ON lamp illuminates. Set the mains isolator for the transformer/rectifier to the ON position and check that its SUPPLY ON lamp lights.

e. At the operator terminal, the Main menu is displayed.

3.2 Operator Terminal Displays (See Dwg. 85.030.190.010)

After power-up, the operator terminal screen displays the Main menu. This display is returned to the screen from any other display by pressing the MAIN MENU key. The display allows the operator to scroll through the complete range of menus. The Main menu comprises:

➔ Status Display
➔ Other Functions

At the display, only four lines of information are seen at any one time and where there are more lines the '+' sign is used to show this. The lines appear as the cursor is scrolled down and then up again.

3.3 Status Display

Ensure the flashing cursor is level with the words 'Status Display', then press the Enter key. The following display appears on the screen:

Product:	# # # # #L # # #%
In: # # °C	Water : # # #
Out: # # °C	Brine : # # #
(state)	Blow : # # # #

This display remains on the screen during normal working conditions and shows, in liters, how much sodium hypochlorite the storage tank contains and what percentage of the tank this amount fills.

Also displayed is the temperature of the water at the electrolyzer inlet; the temperature of the product at the OSEC outlet; the status of the water supply (on or off); the status of the brine supply (on or off); and the status of the blower (on or off). This display gives the current operating mode of the OSEC unit (purging, etc.). The screen is read-only and does not have a cursor.

Press the BACK key, or the MAIN MENU key, to go back to the Main menu display. Set the cursor level with the 'Other Functions' line and press the Enter key.

3.4 Other Functions Display

The Other Functions display provides access to all other functions of the OSEC control system, which comprise the following menus:

- ➔ Help
- ➔ Duty Select
- ➔ Storage Levels +
- ➔ Time/Date
- ➔ Configuration
- ➔ Information
- ➔ Event Log
- ➔ Monitor

3.4.1 Help Display

With the cursor on the arrow next to the 'Help' line, press the Enter key. The following menu appears:

- ➔ Number of Anodes
- ➔ Cheap Rate Power
- ➔ Alarms
- ➔ Prog. Inputs +
- ➔ Information
- ➔ Event Log
- ➔ Monitor

This menu enables the operator to obtain help about the associated OSEC and its control system. It cannot be used to make changes to any of the control settings.

3.4.2 Duty Select Menu

When dispatched, the control parameters may already be selected and set into the controller, requiring no changes; however, if any changes are required regarding the selection of the duty/standby status of the brine pump or hydrogen blower, this menu is used. Select which brine pump shall operate as the No.1 (duty) unit and which hydrogen blower shall serve as the No.1 (duty) unit by placing the cursor against the desired pump or blower and pressing the Enter key. The display will show the change from the present No.1 to No.2 or back again.

3.4.3 Storage Levels Menu

This menu allows changes to be made to the existing control settings with respect to the tank fill START and STOP levels. The START levels for both the daytime fill and the nighttime fill are shown as a percentage of the storage tank volume. The STOP levels for both the daytime fill and the nighttime fill are also shown as a percentage of the storage tank volume. The storage tank low-level alarm is also set in this menu.

3.4.4 Time/Date Menu

The time and date are set in the PLC prior to dispatch from the factory, but if a change is needed this menu is used. To alter the existing time/date settings, use the arrow keys to position the cursor over the figures to be changed and type in the new settings.

3.4.5 Configuration Menu

When the OSEC system is dispatched, the control parameters associated with the system will already have been entered in the PLC; however, the final operating data may be entered during the commissioning stage. When this is the situation, the changes are made in this menu, which comprises the following sub-menus:

- **OSEC type:** Type of electrolyzer, i.e., B1-200. This selection is made prior to dispatch by the manufacturer; however, if it is necessary to select the appropriate OSEC type, press the Enter key when this display appears—do not move the cursor. A list of OSEC types will appear. Move the cursor to the required type and press the Enter key to accept the new selection.

- **No. of Anodes:** This data is also set before dispatch, but this figure can be altered by using the number keys and then entering the new figure.

- **Tank cap.:** This figure can be altered by using the number keys and then pressing Enter to save the figure.

- **No. Blower:** Either a single hydrogen blower is used in the OSEC system or two blowers are arranged for duty and standby operation.

- **Room Vent:** A selection is made between AVAILABLE and RUNNING using the Enter key to toggle between either of these remote customer contacts.

- **No. Brine:** This menu allows selection between SINGLE and DUTY/STANDBY operation using the Enter key to toggle between the single or duty/standby configuration.

- **Brine start:** This menu relates to the number of seconds the brine flow alarm start-up inhibit will last. Use the number keys and then press the Enter key to save the figure.

- **Cheap rate:** Provides the operator with the option of making use of low-cost electricity, if desired. If NO is already selected, press the down arrow key to skip this and the next item on the menu. If selecting YES (the Enter key is used to toggle between YES and NO), the following item is also selected.

- **Cheap rate period:** Access the cheap rate START time by pressing Enter. First use the number keys to select the hour and press the Enter key to select it, then select the minutes and press the Enter key to select them. Repeat the procedure for the END time and then press the BACK key to return to the Configuration menu and the next item.

- **Set-up prog inputs:** Three programmable inputs are provided that may be used to feed signals into the OSEC controller. Each input is connected to a selected contact in the OSEC system. Press the Enter key to move to the Set Type menu and press the key again to display the input list.

  With the cursor against No.1, press the Enter key and a list of items will appear at the left side of the menu. From this list, select one of the following choices and press the Enter key to select it:

OFF	-	Not used
RELIEF	-	Relief valve operating
SATOVER	-	Saturator overflow
SOFTENER	-	Softener has failed
AUX. 1	-	Aux. alarm No. 1 has operated
INHIBIT	-	Used to inhibit OSEC control

NOTE: The choice of INHIBIT is available only in 'Programmable Input No.1' and must therefore be selected here if it is required.

Repeat the procedure with input No.2 and input No.3. If the Auxiliary Alarms associated with the inputs are not selected, skip the next item on the menu and return to the Main menu.

If an Auxiliary Alarm is selected in the inputs menu, press the BACK key and the Enter key to select the next menu.

- **Configure Aux.:** The OSEC control has three auxiliary alarms that are configured to operate when a customer-specified alarm condition occurs. To set the alarm, use the number keys to select the alarm delay time (time lapse between the alarm occurring and its display) and press the Enter key.

  Next use the Enter key—which will toggle between CONTINUE (i.e., continue generating) and STOP (i.e., stop generating)—to set the desired control action in the event of this alarm. Press the BACK key until the Information menu appears in the display.

3.4.6 Information Menu

Press the Enter key to obtain the PROCESS TIMES menu.

NOTE: This menu can only provide the operator with information about the current status of the electrolyzer unit, it cannot be used to make changes to the unit's control settings. Pressing either the Enter key or the down arrow key will allow the operator to scroll through the following information:

- **This Gen:** If the electrolyzer is running, the time it has been running is shown here.
- **Since Gen:** Providing the electrolyzer is not running, this display will show how much time has elapsed since it last ran, otherwise this display will show zero.
- **End Prime:** If the prime cycle is active, this display shows how much time remains until the cycle ends; otherwise this display will show zero.
- **End Purge:** This display shows how much time remains until the purge cycle will end if it is active; otherwise this display will show zero.
- **Prime Time:** This display shows the time—set by the system—that it takes to complete the prime cycle.
- **Flush Time:** This display shows the time—set by the system—that it takes to complete the flush cycle.
- **Cell Fill Time:** This display shows the time—set by the system—that it takes to complete the cell fill cycle.

At the bottom of the menu press BACK to return to the Information menu and the next sub-menu.

- **Hour Run Meters:** This sub-menu tells the operator how much 'run' time has accrued on the following items of equipment:

  Brine Pump No.1
  Brine Pump No.2
  Blower No.1
  Blower No.2
  Transformer/rectifier

  The operator can check these times by scrolling through the list, using either the Enter or the down arrow key. At the bottom of the menu, press BACK to return to the Information menu and the next sub-menu.

- **Reset Hour Run:** When this menu is selected (by pressing the Enter key at the Information menu), the word 'PASSWORD' is displayed. If the password is not known, press the Enter key to return to the previous menu, then press BACK to go on to the next menu.

3.4.7 Event Log Menu

- **Event Log:** Events that occur during the OSEC operating cycle are recorded by the PLC, which gives each event a number, notes the date and time, and describes the event. Use the arrow key to scroll through the list and press LAST to pass on to the next display.

- **Clear Event Log:** When this menu is selected (by pressing the Enter key at the 'Event Log' display), the word 'PASSWORD' appears. If the password is not known, press the Enter key to return to the previous menu, then press BACK to go on to the next menu.

3.4.8 Monitor Menu

The Monitor menu provides a facility similar to a diagnostics-type tool and is provided essentially for use by USF/W&T service engineers. The menu allows access to four types of data, each of which is denoted by a letter (i.e., 'D' for Data Register, 'M' for Aux Relays, 'T' for Timers, and 'C' for Counters). Press the Enter key to reach the next display.

- **Data Reg's:** The letter 'D' is used to identify the Data Register menu, where two identical columns are displayed. Each column represents two separate addresses where data is registered. Each address is headed by the letter 'D' and contains two consecutive data registers.

  Alongside the letter 'D', type in the address of the data to be monitored and press the Enter key. Typically, the following information will appear in the display:

  Example:

D235	(the address of the data register)
+ 0 = 2522	(the data registered at address box 235)
+ 1 = 27	(the data registered at the next consecutive address box, i.e., address box 236)

  The second column allows a second address to be accessed.

- **Aux Relay:** Identified by the letter 'M', the Aux. Relay menu displays two lines of places, one above the other. Each line allows access to the address of an auxiliary relay. On each line, the first four places to the left of the colon (:) are used to key-in the address of the auxiliary relay to be monitored.

The first place to the right of the colon shows the state of the relay at the address selected, while the next seven places show the state of the relays at the next seven consecutive addresses.

The following example shows that the auxiliary alarm at address 362 (underlined) is ‘off’ and shows the state of the relays at the consecutive addresses as: 363 is ‘off’, 364 is ‘off’, 365 is ‘on’, 366 is ‘on’, 367 is ‘off’, 368 is ‘on’ and 369 is ‘on’.

M
<u>0362 : 0</u> 0 0 1 1 0 1 1

- **Timer:** This menu, identified by the letter ‘T’, displays two lines of places, either of which can be used to key-in the address of a timer. The address is keyed-in on the left-hand side of the ‘=’ sign and the Enter key is pressed to accept it. On the right of the ‘=’ sign, the content of the selected address is displayed. If the timer is running, it is shown—in operation—at the display. If the timer is not running, the display will show a zero.

- **Counter:** This menu, identified by the letter ‘C’, displays two lines of places, either of which can be used to key-in the address of a counter. The address is keyed-in on the left-hand side of the ‘=’ sign and the Enter key is pressed to accept it. On the right of the ‘=’ sign, the content of the selected address is displayed. If the counter is running, it is shown—in operation—at the display. If the counter is not running, the display will show zero.

- **A/D Channel:** Identified by the letter ‘D’, this menu is used to display the value of three 0 to 20 mA analogue inputs. One input comes from the tank contents-level transmitter, one from the water temperature sensor fitted to the OSEC inlet, and one from the product temperature sensor fitted to the OSEC outlet.

3.5 Electrolyzer System Malfunction

If a malfunction occurs on the electrolyzer or its associated equipment, an audible alarm will sound at the OSEC Control. The audible alarm can be silenced by pressing the ‘ALARM LIST’ key, which will indicate the source of the alarm, followed by the ‘ALARM ACK’ key. The alarm will remain until the fault condition is cleared and the ‘RESET’ button is pressed.

This action will start-up the system again, level transmitter at the storage tank permitting.

Certain alarm conditions result in a total system shut down, while others only activate the associated alarm contacts and the audible alarm. Refer to paragraphs 1.4 to 1.6 for details of alarms and their functions.

3.6 Temporary Shut Down

Following normal operation, the electrolyzer will enter a standby condition where the casing(s) will have been flushed with fresh brine. The electrolyzer can subsequently be left for up to one week in this shut-down condition.

If the electrolyzer has ceased to operate following an alarm condition that does not initiate a refill cycle, the electrolyzer must be drained of the partially electrolyzed product in order to protect the electrodes from corrosive attack by hypochlorite.

3.7 Complete Shut Down

If the unit needs to be completely shut down for servicing purposes or due to the need for associated equipment to be serviced, proceed as follows:

If shutting down from a normal inactive state in which electrolysis is not taking place and the cell contains only brine solution, switch the mains isolator at both the transformer/rectifier and the Control Panel to OFF.

Connect a hose to the sample/drain valve on the cell outlet and open the valve to fully drain the casing(s). Close the valve when draining is complete.

If the need arises to shut the system down during a period of electrolysis, turn the mode selector to INHIBIT. Electrolysis will cease. The control panel and rectifier isolators should be turned off and the cell drained as previously described.

3.8 Failure of Electrical Power

Should a failure occur in the electrical power supply to the OSEC system while it is generating sodium hypochlorite, and it is apparent the power will not be restored within a **maximum** of three hours, the following procedure MUST be carried out:

a. Switch off the OSEC control panel at its local electrical isolator to ensure that, when power is restored, the OSEC control does not try to continue where it left off, not knowing the cell casings are empty.

b. Fully drain the electrolyzed product from the electrolyzer cells. This action is necessary to prevent corrosion of the electrode assemblies due to reverse polarization occurring in the presence of hypochlorite.

c. On restoration of power, switch on the electrical supply to the OSEC control panel and press the INHIBIT key at the operator terminal.

d. After a few seconds, press the AUTO key. The OSEC control will automatically start a new cycle by filling the electrolyzer cells with water and brine.

CAUTION: If filling the casing from a mains water supply, ensure that the casing is not subjected to a greater pressure than 2 bar.

SECTION 4 - SERVICE

List of Contents

PARA. NO.

4.1 Routine Maintenance

There are no routine maintenance requirements for the control cabinet, other than to check the terminations. Ensure that the mains supply to the cabinet is isolated elsewhere before opening the control panel.

4.2 Troubleshooting

Table 4.1 details the alarms that may occur at the OSEC control, together with their possible causes and remedies.

Table 4.1 - Troubleshooting

FAULT CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
High current - Rectifier Failure alarm triggered, electrolyzer shut down.	Short in electrolyzer or electrical connections from rectifier.	Check for shorts but do not dismantle electrode assembly. Return for servicing.
	Operating on two phases only.	Renew fuse in failed line.
	Failure in rectifier unit.	Check and repair or replace.
Low current/high cell voltage - Improper Voltage alarm triggered and electrolyzer shut down.	Low brine concentration.	Check brine flowrate on flowmeter and adjust brine pump stroke, if necessary.
	Salt saturator water level low.	Check and adjust ball valve.
Low current/high cell voltage - Improper Voltage alarm triggered a electrolyzer shut down.	Salt level low.	Fill to at least the minimum level marked on the saturator.
	Salt saturator discharge blocked.	Empty saturator and flush through tank and delivery lines.
	Rectifier failure.	Check and repair or replace.
	Electrodes require replacement.	Electrodes have an operating life of approximately five years.
	Poor bus bar connection.	Test voltage drop across terminals and repair poor joints.
Low cell voltage - Improper Voltage alarm is triggered and electrolyzer shut down.	High brine concentration.	Check brine flowrate on flow-meter and adjust brine pump, if necessary.
	Insufficient dilution water.	Check dilution water flowrate and adjust.
	Short circuit in electrode assembly.	Drain electrolyzer and replace electrode assembly. Return old unit to USF/W&T for servicing.
High temperature - High Electrolyte Temperature alarm triggered and electrolyzer shut down.	Dilution water flow incorrect.	Readjust flow regulator valve.
	Water flowmeter or line blocked.	Clean meter and lines.
	Strainer blocked.	Clean strainer.
	Solenoid valve failure.	Repair or replace.

Table 4.1 - Troubleshooting (Cont'd)

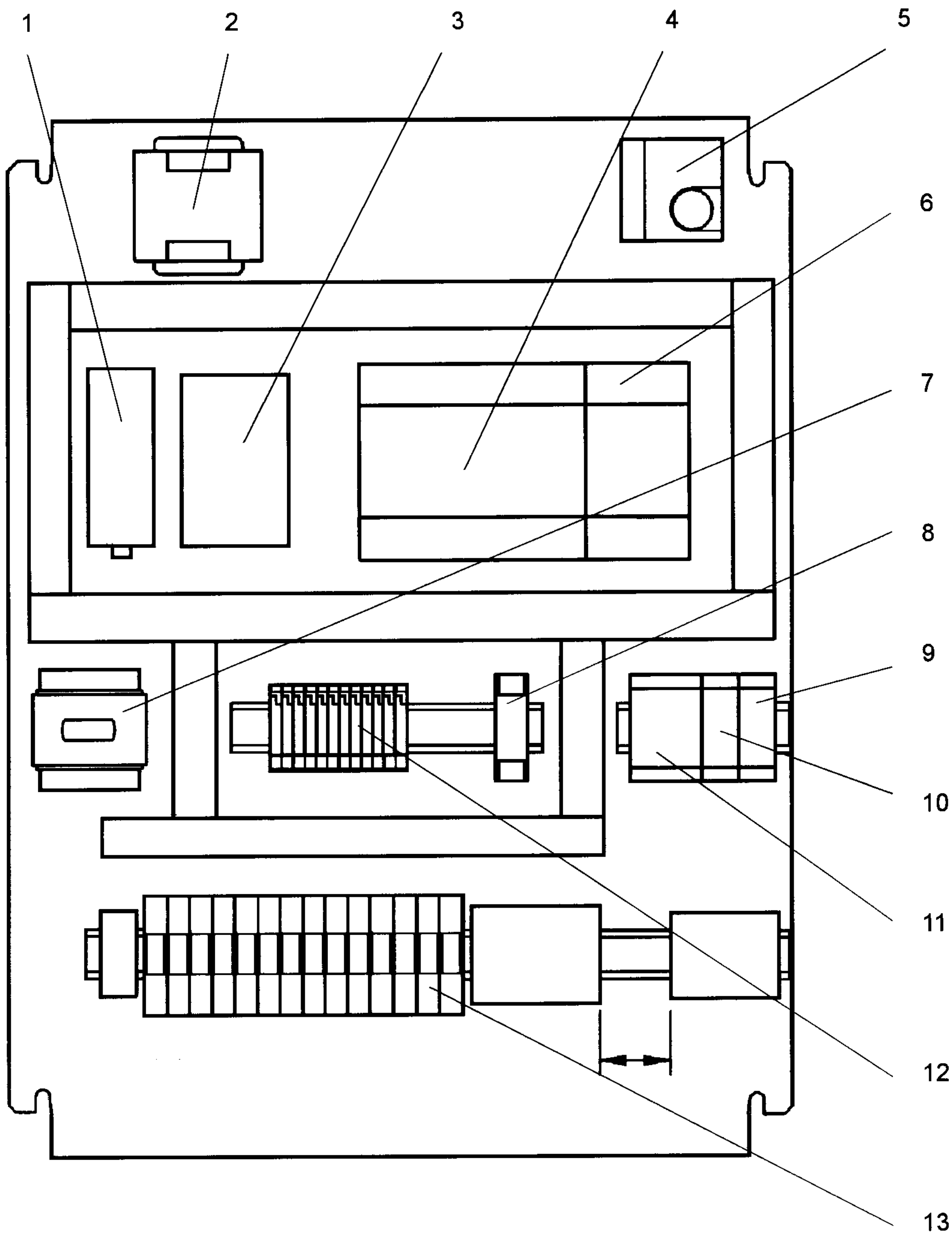
FAULT CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Low dilution water flow - Low Water Flow alarm triggered and electrolyzer shut down.	Failure of supply.	Check and remedy.
	Incorrect setting of pressure regulator.	Check setting. Refer to Section 3 in the main manual.
	Failure of pressure regulator.	Service or replace.
	Failure of solenoid valve in inlet line.	Service or replace.
	Jammed float in flowmeter.	Clean flowmeter. Refer to Section 4 in the main manual.
	Incorrect setting of minimum flow switch.	Check and adjust - set to a 15% lower figure than correct flow. Refer to Table 3.1 in the main manual.
	Failure of switch.	Service or replace.
Low brine solution flow - Low Brine Flow alarm triggered and electrolyzer shut down.	Incorrect setting of brine pump.	Adjust stroke. Refer to Table 3.1 in the main manual.
	Incorrect setting of minimum flow switch.	Check and adjust - set to a 15% lower figure than correct flow (see Table 3.1).
	Jammed float in flowmeter.	Clean flowmeter. Refer to Section 4 in the main manual.
	Failure of switch.	Service or replace.
	Failure of supply to brine pump.	Check and restore.
	Failure of pump.	Service or replace.
Low solution level in electrolyzer - Low Electrolyte Level alarm triggered.	Faulty reed switch in hypochlorite.	Replace manifold.
	Faulty connection.	Check and repair.
Low temperature - Low Water Temperature (50°F (10°C)) alarm triggered with no further response, or (49.1°F (9.5°C)) alarm triggered and unit shut down.	Heat exchanger not in use.	Open exchanger feed and return valves on electrolyzer.
	Heat exchanger bypass valve open.	Close valve.
	Site mains water excessively low temperature.	Investigate causes. Refer to the main manual for temperature requirements.

Table 4.1 - Troubleshooting (Cont'd)

FAULT CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Incorrect airflow into tank - duty blower fails, standby blower starts-up.	Blower supply failed.	Check and restore.
	Operating on two phases.	Renew fuse in failed line.
	Blower faulty.	Service or replace.
Incorrect air flow into tank - standby blower failed alarm, electrolyzer shuts down.	General supply failure.	Check and restore.
	Piping to air flow switch disconnected.	Check and repair.
	Blockage in air intake.	Check and remedy.
	Faulty wiring.	Check and restore.
Faulty airflow switch - Air Flow Switch Failed alarm triggered - electrolyzer not in operation.	Faulty switch - contacts not opening.	Service or replace.
	Short in wiring.	Check and repair.
Extra high level or discharge from tank - Overflow Alarm triggered and electrolyzer shut down.	Failure of High Stop.	Check and replace.
	Fault in control.	Check and repair.
	Mechanical damage to tank causing leak.	Check and repair.
Low level in tank - Low Level Alarm triggered and associated dosing pump inhibited.	Control panel off.	Switch on.
	Control in inhibit mode.	Switch to Auto.
	Faulty low start.	Service or replace.

SECTION 5 - ILLUSTRATIONS

DWG. NO



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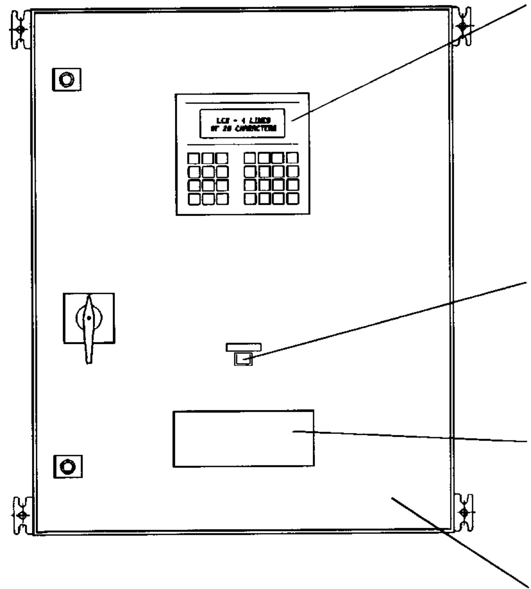

KEY	PART NO.	QTY	DESCRIPTION
1	AUK.3181	1	Panel heater (20W)
	AQA.3663	2	Screw, M4 x 8
	ASG.4388	2	Washer, M4
2	AAA.3685	1	Transformer, 230/110V
	AXS.4368	4	Screw, M4 x 8
	ASG.4388	4	Washer, M4
3	AXQ.4252	1	Power supply unit, 24V DC 24A
	AQA.3663	4	Screw, M4 x 8
	ASG.4388	4	Washer, M4
4	AAA.1174	1	Programmable Logic Contllr, FX-32MR
	AUK.3691	4	Screw, M4 x 16
	ASG.4388	4	Washer, m4
5	AAA.1156	1	Thermostat, +5 to +55°C
	AAA.2241	2	Screw, M4 x 12
	ASG.4388	2	Washer, M4
6	AAA.3673	1	Analog input 4 channel FX-4AD
	AUK.3691	2	Screws, M4 x 16
	ASG.4388	2	Washer, M4
7	AUK.4146	1	Mains isolator switch
	AAA.1314	4	Screw, M4 x 12
	ASG.4388	4	Washer, M4

KEY	PART NO.	QTY	DESCRIPTION
8	AUK.5788	1	Signal convertor, 4-20mA/4-20mA
9	AAA.3679	1	Temperature convertor, RTD/mA
10	AAA.3679	1	Temperature convertor, RTD/mA
11	AQA.4210	1	Interface unit, 3 channel
12	AAA.1132	1	Fuse 2A, F1, F3 and F6
	AAA.1144		Fuse 5A, F2
	AAA.1123	1	Fuse 1A, F4
	AAA.1129	1	Fuse 1.6A, F5
13	AWO.4046	14	Relay, 1 pole c/o 24 VDC
	ATI.3989	14	Rela
14	AAA.3676	1	Operator terminal, MAC50/ML
	AXS.4261	4	Nut, M4
	ASG.4388	4	Washer, M4
15	AWO.3817	1	Audible alarm
16	ARE.3983	1	Indicator
	ARE.3995	1	Screen, flat white
	ATI.4276	1	Lamp, 28V T1-3/4 1.12W
	AAA.2718	1	Label (MAINS ON)
17	AAA.2625	1	Enclosure
	AAA.7759	4	Enclosure bracket
	AAA.2715	1	Label (OSEC CONTROL PANEL)

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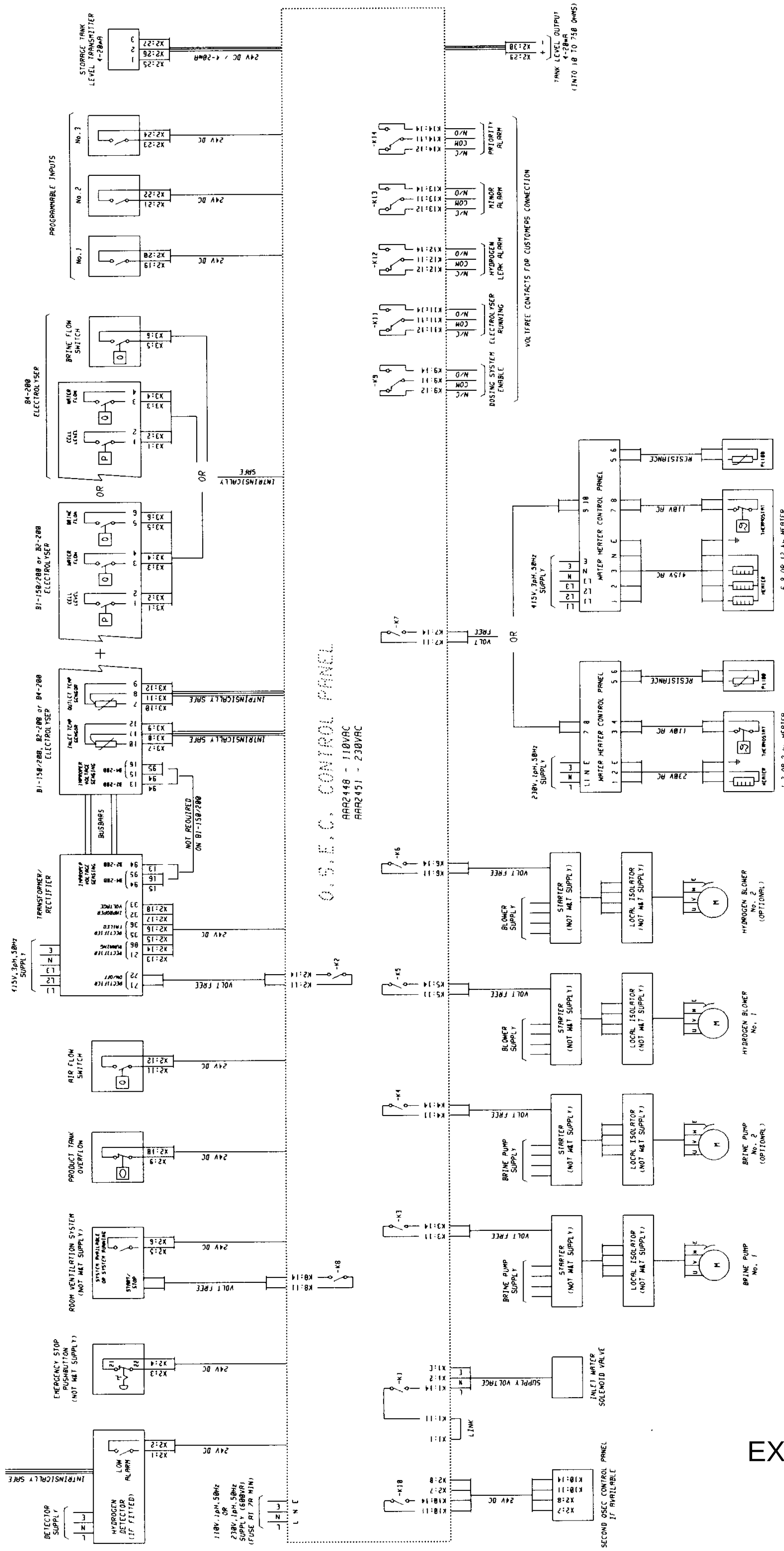

OSEC® SYSTEM -
EXTERNAL CONNECTION

85.035.140.010

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MAIN MENU	SUB-MENUS					
---MAIN MENU---+ » Status Display |	Product:#####L ###% In:##°C Water:### Out:##°C Brine:#### (state) Blow:####					Current storage tank level in liters & percent Inlet temperature and water solenoid valve status Outlet temperature and brine pump status Current system state and blower status
» Other Functions | -----------------------+	» Help	HELP: » Number of Anodes » Cheap Rate Power » Alarms » Prog. Inputs » Information » Event Log » Monitor				Display help text on the number of anodes fitted Display help text on the cheap rate electric option Display help text on the alarm system Display help text on the programmable inputs Display help text on the information displays Display help text on the event logger Display help text on the monitor
	» Duty select	Selected for DUTY Brine pump : ???? Blower : ????				Brine pump selected for duty - Toggle No.1/No.2 Blower selected for duty - Toggle No.1/No.2
	» Storage levels	Day Night Start: ??% ??% Stop: ??% ??% Low alarm: ??%				Storage tank fill start levels for day & night Storage tank fill stop levels for day & night Storage tank low alarm level
	» Time / Date	Time : ##:##:## Date : ##/##/##				Current time - Overtype to change Current date - Overtype to change

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	» Configuration	OSEC type : ?????? No. Anodes : ??? Tank Cap. : ?????L No. Blower : ??????? Room Vent : ??????? No. Brine : ??????? Brine Start : ???sec Cheap rate : ???				Type of electrolyzer - Select from list Number of Anodes fitted in the electrolyzer Storage tank capacity in liters Number of storage tank Blowers - Toggle SINGLE / DUTY/STANDBY Type of room vent monitoring - Toggle AVAILABLE / RUNNING Number of Brine pumps - Toggle SINGLE / DUTY/STANDBY Brine flow alarm start-up inhibit time Use cheap rate electric option - Toggle YES / NO
		» Cheap rate period	Cheap Rate Period Start - ??:?? End - ??:?? (24-hour clock)			Set start of cheap rate electricity period Set end of cheap rate electricity period
		» Set-up prog inputs	Programmable input » Set Type	Prog. input type No.1 : ??????? No.2 : ??????? No.3 : ???????		Definition of input No.1 - Select from list Definition of input No.2 - Select from list Definition of input No.3 - Select from list
			» Configure Aux	Auxiliary Alarm » Configure No. 1 » Configure No. 2 » Configure No. 3	Auxiliary Alarm No.1 Delay : ??? sec Action : ??????? Auxiliary Alarm No.2 Delay : ??? sec Action : ??????? Auxiliary Alarm No.3 Delay : ??? sec Action : ???????	Delay before alarm No.1 is displayed & actioned Choice of CONTINUE or STOP on alarm Delay before alarm No.2 is displayed & actioned Choice of CONTINUE or STOP on alarm Delay before alarm No.3 is displayed & actioned Choice of CONTINUE or STOP on alarm

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		INFORMATION » Process Times	PROCESS TIMES This Gen. ###:##:## Since Gen ###:##:## End Prime ##:## End Purge ##:## Prime Time ##:## Flush Time ##:## Cell Time ##:##			Time unit has been running (if on) Time since unit last ran (unless running) Time until end of prime cycle (if active) Time until end of purge cycle (if active) Prime time (set by the system) Flush time (set by the system) Cell fill time (set by the system)
		» Hours Run Meters	HOURS RUN METERS Brine 1 Brine 2 Blower 1 Blower 2 Trans/Rect			Brine pump No.1 run time - hrs:mins Brine pump No.2 run time - hs:mins Blower No.1 run time - hrs:mins Blower No.2 run time - hrs:mins Transformer/Rectifier run time -hrs:mins
		» Reset Hour	Run HOURS RUN RESET Meter = ??????? Reset = ???			Meter to reset - Select from list Confirm reset
	» Event log	EVENT LOG (### entries) » View Event Log	### ##/## ## : ## : ## ################ ### ##/## ## : ## : ## ################			Record number - Date - Time Event description Record number - Date - Time Event description
		» Clear Event Log	Event log last clear at ##:## on ##/##/## Clear Log now? ???			Last event log clear time & date Confirm log clear
	» Monitor	» Data register (D)	Monitor - Data Reg's D???? D???? +0=##### +0=##### +1=##### +1=#####			Data register addresses to view Data at specified register addresses Data at specified register addresses+1
		» Aux Relay (M)	Monitor - Aux Relays 'M' : next 7 values ####:# # # # # # # # ####:# # # # # # # #			Address : State of 8 Auxiliary relays from addresses Address : State of 8 Auxiliary relays from addresses
		» Timer (T)	Monitor - Timers T??? = ##### T??? = #####			Timer address & current value Timer address & current value
		» Counter (C)	Monitor - Counters C??? = ##### C??? = #####			Counter address & current value Counter address & current value
		» A/D Channel	Monitor - A to D Channel : ??????? Value : ####			Channel to view - Select from list Current value of selected channel

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