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**New Technology Research & Development Program  
Grant Contract 582-5-70807-0010**

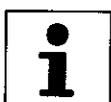
**Task 4 Deliverables  
Part 1 – Operating Manual**

The preparation of this report is based on work funded in part  
by the State of Texas through a Grant from the  
Texas Commission on Environmental Quality.

# MANUAL FOR

: Final Flue Gas Cleanig Unit

This manual is divided into the following sections:



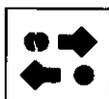
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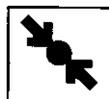
Function



Maintenance



Spare Parts



Drawings



Vendor's Information



Electrical Controls

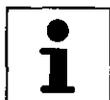


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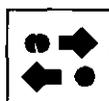
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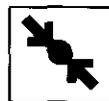
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## INTRODUCTION

The Wet Electrostatic Precipitator (WESP) - with high-voltage-plasma & Chemical Oxidation + Absorption and polishing sections – Pilot Unit System treats exhaust from the following process sources:

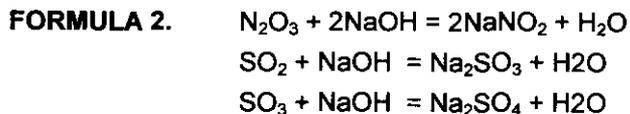
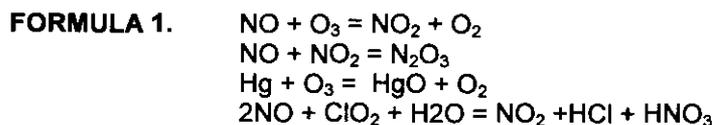
- Power Plant
- Industrial Boiler
- Incinerator
- Glass and Ceramic Manufacturing
- Steel, Primary Metal industry
- Diesel Generator

### PURPOSE

The Pilot Unit has been designed to provide an economical and environmentally acceptable way of NOx and Mercury removal from a variety of process. This system continuously oxidizes NOx and Mercury in the process exhaust by means of high-voltage-plasma and/or chemical treatment.

### OXIDATION PROCESS CHEMISTRY

Oxidation reactions are chemical changes, which are all classified as “electron-transfer” or oxidation-reduction reactions. Atoms, ions and molecules that have an unusually large affinity for electrons tend to be good oxidizing agents. For example, molecules such as O<sub>2</sub>, O<sub>3</sub>, Cl<sub>2</sub>, ClO<sub>2</sub> are strong oxidizers. Another place to look for strong oxidizer is among compounds with unusually high oxidation states, such as atoms, ions and radicals, for example O, O\*, OH\*, HO<sub>2</sub>\*. These compounds can be generated by high-voltage-plasma. The oxidized nitrogen oxides or mercury compounds can be removed by the WESP high-voltage-plasma Pilot Unit with scrubber (FFGC). Formula 1 illustrates some typical oxidation reactions. Formula 2 illustrates some typical absorption reactions in an FFGC.





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## **BENEFITS & LIMITATIONS**

Listed below are some of the benefits and limitations of high-voltage-plasma Technology.

### **Benefits:**

- High-voltage-plasma Pilot unit oxidizes and removes gas compounds in a safe, energy efficient way.
- Ease of operation
- Low maintenance

### **Limitations:**

- Accurate records must be maintained at all times.
- Systems must always be run within correct operating parameters & maintained appropriately.



## PROJECT CONTACTS

|   |  |
|---|--|
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## GENERAL INFORMATION

- 1. The FFGC High-Voltage-Plasma Oxidizer Pilot Unit – should only be used within its design parameters.**
- 2. WOW Energies is responsible for the proper operation and maintenance of this system in a manner to avoid personal injury, equipment and environmental damage.**

Special attention should be given to:

- Training of personnel to know general and specific sources of danger. For example, automatic starting sequences, as well as paying attention to safety signals such as, alarms, lights, etc.
- Checking mechanical, electrical, acoustical, and optical safety elements regularly for proper operation.
- Checking piping regularly for tightness, especially pressurized systems.
- Handling of hazardous materials for storage and use, such as caustic and chemical oxidizer.
- Safety precautions with regards to High Voltage
- Training of personnel in operating and maintaining the system.
- Adhering to company, OSHA and other applicable industry rules and regulations.

- 3. Use only qualified and skilled personnel for maintenance and repairs of the FFGC Pilot Unit.**

By doing so:

| <b>You Achieve:</b>  | <b>You Avoid:</b>  |
|--|--|
| <ul style="list-style-type: none"><li>• Longer system life</li></ul>   | <ul style="list-style-type: none"><li>• Reduced system life</li></ul>  |
| <ul style="list-style-type: none"><li>• Higher reliability</li></ul>   | <ul style="list-style-type: none"><li>• Production stops</li></ul>     |
| <ul style="list-style-type: none"><li>• Reduced repair costs</li></ul> | <ul style="list-style-type: none"><li>• High repair costs</li></ul>    |
| <ul style="list-style-type: none"><li>• Quality production</li></ul>   | <ul style="list-style-type: none"><li>• Defective production</li></ul> |
| <ul style="list-style-type: none"><li>• Warranty coverage</li></ul>    | <ul style="list-style-type: none"><li>• Loss of warranty</li></ul>     |





## SAFETY INFORMATION

### PREFACE TO OPERATING MANUAL

This Operating Manual will help you get to know your system and use it properly.

The Operating Manual contains important information on operating the system in a safe and proper manner.

Observing this manual will help you to:

| <b>You Achieve:</b>    | <b>You Avoid:</b>       |
|------------------------|-------------------------|
| • Longer system life   | • Reduced system life   |
| • Higher reliability   | • Production stops      |
| • Reduced repair costs | • High repair costs     |
| • Quality production   | • Defective production  |
| • Safer environment    | • Hazardous environment |

The Operating Manual must be supplemented by the system owner to include instructions arising from applicable national and local laws and regulations relating to industrial safety and environmental protection.

In addition to the Operating Manual and the applicable accident prevention regulations applying in the country and locality of use, generally accepted operating procedures must be followed for safe and proper operation.

The Operating Manual must be read by all persons who are responsible for working with or on the system, and it must be on hand for such persons at all times, in particular:

- when the system is in operation (including setup, correcting problems during the course of operation, removal of production waste, disposal of industrial substances and functional fluids);
- during maintenance (maintenance, inspection, repair).

### INFORMATION ON PROPER USE

The system has been designed to be a state-of-the-art installation, and to comply with safety regulations. However, its use may result in hazards to the life and limb of the user or third parties or the possibility of damage to the system and other physical assets.

The system must not be used unless it is in a technically flawless condition! It must always be used in accordance with its intended functions, and in full knowledge of safety considerations and in awareness of possible hazards associated with its use. The information contained in the Operating Manual must be observed. Any problems, which could affect safety, must be corrected without delay.



The operational safety and reliability of the system cannot be ensured unless the system is used as intended. Other uses beyond the intended use are not permissible. The limits stated in the technical data (see "Function" chapter) must never be exceeded.

The manufacturer is not responsible for any damage resulting from improper use. The user alone bears this risk.

Proper use also includes following the Operating Manual and observing inspection and maintenance requirements.

## **ORGANIZATIONAL MEASURES**

The Operating Manual must always be available and conveniently at hand for the appropriate technical personnel (operating, maintenance, repair personnel, etc.).

In addition to the Operating Manual, generally applicable legal or other applicable requirements pertaining to accident prevention and environmental protection must be observed and posted. Such requirements may also relate, for example, to handling hazardous substances or to the availability/wearing of personal protective equipment.

Add instructions (including supervisory and reporting duties) relating to specific operation concerns (for example, plant organization, operating procedures, personnel to be used, etc.).

Personnel assigned the responsibility of performing activities involving the system must have read the Operating Manual, in particular the section on "Safety Information," before beginning work on the system.

Upon hiring and at least once a year, operating personnel must be instructed regarding the accident prevention rules and regulations, proper operation of the system, any health hazards which may exist, actions to be taken in the event of a fire or potential fire, and proper operation of fire extinguishing equipment.

Operating personnel are to be specifically instructed in the hazards, which may be encountered in the area of the system. This applies mainly to working with the industrial and processing materials (paints, chemicals, corrosive mixtures, etc.), as well as working with sources of energy needed to operate the system — for example, electrical power, hot water, gas, etc.

From time to time, monitor personnel to be certain that they are working in a manner that is safe, that indicates their awareness of potential hazards, and that complies with the Operating Manual.

Whenever necessary or stipulated by specific requirements, personnel protective gear must be used.

All safety and hazard notifications and warnings on the system must be observed and must always be maintained in reasonable condition.

Safety equipment is to be inspected to confirm that it is operating correctly. Technical personnel must do this at regular intervals.

In the event of safety-related trouble in the system or changes in its operating behavior, shut down the system immediately and report the problem to the responsible department/person.



Do not undertake any modifications, additions or retrofitting of the system – in particular, those, which could have an adverse effect on safety – without the approval of the manufacturer. This requirement also applies to the installation and adjustment of the safety equipment and valves as well as to welding work on load-bearing parts.

Replacement parts must meet the technical specifications set by the manufacturer. For this reason, use only OEM replacement parts. If non-OEM replacement parts are used, liability, which would otherwise apply to the consequences of such use, may be voided.

Do not perform any changes in programs (software) on programmable control systems, without first consulting with the manufacturer.

Observe all scheduled times for recurring tests or inspections, as specified or as stated in the Operating Manual.

Shop equipment and facilities used to perform maintenance work must, without exception, be appropriate to the work being performed. If a special tool is required to perform work, this will be stated in the "Maintenance" chapter.

The location and operation of fire extinguishers, as well as fire alarm and fire-fighting equipment, must be made aware to personnel.

### **PERSONNEL SELECTION AND QUALIFICATIONS - BASIC RESPONSIBILITIES**

Only use trained or properly instructed personnel on the system. Clearly specify the responsibilities of personnel for operating, setting up, maintaining and repairing the system.

Ensure that only authorized personnel are used for work on the system.

Specify system supervisor responsibility and authorize the system supervisor to reject any unsafe instructions issued by third parties.

Do not allow personnel who are to be trained, familiarized, or instructed, or who are involved in a general training program to engage in activities on or about the system, unless they are under constant supervision by an experienced person.

Work on the system's electrical equipment may only be performed by an electrician or by trained persons under the direction and supervision of an electrician, in accordance with established standards and procedures for electrical work.

Work on gas equipment (gas-fired equipment) (if applicable) must only be performed by personnel trained for such work.

Only personnel with special training and experience in hydraulic systems (if applicable) may be allowed to work on hydraulic equipment.



## **SAFETY INSTRUCTIONS FOR SPECIFIC OPERATING PHASES**

### **NORMAL OPERATION**

The system must not be operated unless all protective equipment and equipment required for safety (for example: removable protective equipment, emergency stop equipment, noise insulation, ventilation equipment, etc.) is present and is functioning properly.

Check the system at least once per shift for visible damage and problems. If any changes are noticed (including changes in operating behavior), notify the responsible person/office immediately. If necessary, shut down and secure the system.

Before turning on / starting up the system, be certain that starting the system does not create a hazard for any persons.

### **SPECIAL OPERATION**

The adjustment, maintenance and inspection activities required in the Operating Manual, as well as the replacement of parts and assemblies must always be carried out by skilled personnel.

Operating personnel must be informed before any special work or maintenance work is started. The name of the supervisor must be provided.

Power-on and power-off procedures and instructions for maintenance work must be observed for all work relating to production modifications, retrofitting or adjustment of the system or its safety-related equipment, as well as inspection, maintenance and repair.

If necessary, secure a large area around the maintenance area. If the system is completely powered off during maintenance and repair work, it must be protected from unexpected power-on conditions.

- Lockout the main switches.
- Place a warning sign on the main switch.

Individual components and larger assemblies must be carefully attached and secured to lifting equipment before being replaced, so as not to constitute any danger. Use only suitable lifting equipment, which is in 100% sound operating condition. Lifting equipment and load-bearing equipment must have adequate capacity ratings. Never stand or work under suspended loads!

When performing installation work at levels above body height, use only climbing aids and platforms, which have been provided for such use and which, are otherwise acceptable from the standpoint of safety. System parts must not be used as climbing aids! Always use safety belts, harnesses and similar equipment to prevent falls when working at relatively large heights.

All grips, steps, catwalks, pedestals, platforms, ladders, etc. must be kept free of dirt, snow and ice.

Remove oil, fuel, or cleaning agents and protective products from the system (especially from connections and threaded fittings) before beginning maintenance or repair work. Do not use any aggressive cleaning agents. Use lint-free cleaning cloths.



Before cleaning the system with water or steam (high-pressure cleaners) or other cleaning agents, cover or mask all openings, so that, for reasons of safety and/or proper functioning, no water, steam or cleaning agents can enter the system. Electrical motors and electrical control enclosures are at particular risk. After cleaning, remove all covering and masking completely.

When performing cleaning work, take care to ensure that the temperature sensors in the fire alarm and extinguishing systems do not come in contact with hot cleaning agents. Contact could cause the fire-extinguishing system to be triggered.

After cleaning all chemicals, motor oil, hydraulic fluid lines, inspect them for leaks, loose fittings, abraded areas, and damage. Immediately correct any problems that are detected.

Always tighten down any threaded fastenings which were loosened during maintenance and repair work.

If safety equipment must be removed during setup and repair work, such equipment must be reinstalled immediately after completion of the maintenance or repair work.

Industrial material and auxiliary substances, as well as replacement parts, must be disposed of safely, in an environmentally sound manner.



## **SPECIAL HAZARD CLASSES**

### **ELECTRICAL ENERGY**

Work on electrical systems or equipment must be performed only by electricians or trained persons under the direction and supervision of an electrician and in accordance with standard electrical procedures.

If specified, system parts on which inspection, maintenance and repair work is being performed must be switched to a voltage-free state. Parts which have been powered off in this way must first be checked to be certain that no voltage is present, then grounded, bypassed, and isolated from any adjacent parts which still are carrying electrical current.

The electrical equipment on the system must be inspected regularly. Any problems such as loose connections or melted areas on cable insulating must be corrected immediately.

If work must be performed on current-carrying parts, a second person must be present so that in the event of an emergency this person can operate the emergency stop switch or the main power switch to remove all power. Secure the area in which work is being performed using a red-and-white safety chain and warning sign. Use insulated tools only.

Use OEM fuses and circuit breakers conforming to the specified amperage. Shut off power to the system immediately, in the event of problems in the electrical power supply system.

### **ACTIONS TO BE TAKEN IN THE EVENT OF ACCIDENTS OCCURRING ON ELECTRICAL SYSTEMS**

1. Disconnect the power circuit by throwing switches to the off position, disconnecting the power connector, or pulling fuses.

If the electrical power cannot be disconnected immediately, the victim should be moved away from current-carrying parts using a nonconductive object, or the victim should be pulled away by grasping his/her clothing.

Rescuers should never stand on electrically conductive objects.

2. Never touch both the victim and metal objects or an electrically conducting floor (concrete floor) at the same time (use an insulating mat).
3. If the victim has stopped breathing, administer artificial respiration immediately and call for the paramedics.



## **IMPORTANT**

When electricity is involved, even the most minor accident must be taken seriously. Even though a victim appears to be feeling well after a relatively short time, the victim nevertheless must be placed in a physician's care.

**Caution must be Exercised at all Times when Working with Electrical Systems!**

### **GAS, DUST, STEAM, SMOKE**

Do not perform welding, flame cutting or grinding work on the system, unless such work has been expressly approved.

Clean away any dust and flammable substances, and ensure adequate ventilation before beginning welding, flame cutting, or grinding work on the system (fire and explosion hazards).

When working in small areas, it may be necessary to comply with applicable national safety regulations.

### **ACTION TO BE TAKEN IN THE EVENT OF A FIRE**

1. Remain calm.
2. In the event of a fire and when fire alarms are heard, leave the affected area immediately.
3. Call the fire department and safety personnel immediately.
4. Do not re-enter the protected area, until advised that it is safe to do so by the fire department.

For further information on action to be taken in the event of a fire, refer to your particular Fire Safety Instructions.

### **HYDRAULIC AND PNEUMATIC SYSTEMS (IF APPLICABLE)**

Work on hydraulic equipment may be performed only by persons having special training and experience in hydraulic systems.

All lines, hoses and fittings must be checked regularly for leaks and visible signs of damage. Correct any damage without delay. Leaking and spraying fluid can cause injuries and fires.

Be certain that pressure has been released completely from any system sections and pressurized lines (hydraulic system, compressed air), before beginning repair work.

Hydraulic and compressed air lines must be routed and installed in proper professional manner. Be certain that all connections are correctly made and that no mix-ups occur. Fittings, as well as the length and quality of hoses, must be to specification.



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## **NOISE**

Noise protection equipment used in the system must be in the protective position, when in operation. Required personal protection gear must be worn.

## **OIL, GREASE, AND OTHER CHEMICAL SUBSTANCES**

When working with oils, greases, and other chemical substances such as sodium chlorite and sodium hydroxide, all safety requirements applying to the product must be observed.

Exercise caution when working with hot industrial substances and auxiliaries (danger of burns and scalds).

our

**Confidential Portion Begins Here**



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## GENERAL INFORMATION

### INTRODUCTION

Make sure your FFGC and high-voltage-plasma Oxidizer System is maintained regularly by qualified personnel, according to our manual.

| By adhering to the following you achieve:                              | By adhering to the following you avoid:                              |
|--|--|
| <ul style="list-style-type: none"><li>• Longer life span</li></ul>     | <ul style="list-style-type: none"><li>• Production stops</li></ul>   |
| <ul style="list-style-type: none"><li>• Higher reliability</li></ul>   | <ul style="list-style-type: none"><li>• Loss of system use</li></ul> |
| <ul style="list-style-type: none"><li>• Reduced repair costs</li></ul> | <ul style="list-style-type: none"><li>• High repair costs</li></ul>  |
| <ul style="list-style-type: none"><li>• Quality parts</li></ul>        | <ul style="list-style-type: none"><li>• Defective Parts</li></ul>    |
| <ul style="list-style-type: none"><li>• Warranty coverage</li></ul>    | <ul style="list-style-type: none"><li>• Loss of warranty</li></ul>   |

Use only qualified and skilled personnel for maintenance and repairs.



## SYSTEM MAINTENANCE

To ensure the security of the system, the operator *must not do the following*, unless authorized by **WOW Energies** personnel:

1. Change anything in program sequence
2. Change anything in hardware wiring
3. Change any set points of controls or switches

If necessary, the following can be done by a trained operator:

1. Exchange modules, controls, switches, and/or relays by using equivalent parts and by taking all parameters and set points from the broken part.
2. When maintaining any rotating device, make sure that power is off & fuses have been taken out.

### SPARE PARTS

It is recommended that the listed spare parts be kept in stock to reduce shutdown times.

### SAFETY AND CONFINED SPACES, OSHA REGULATION

Some maintenance may require the entry into confined spaces. It is the owners responsibility to have all applicable equipment such as harnesses, life lines, air quality meter and temperature probe etc. on site and available prior to an entry.

#### **NOTE: SYSTEM MUST BE GROUNDED FOR MAINTENANCE:**

- BEFORE PERFORMING ANY MAINTENANCE ON THE SYSTEM MAKE SURE THAT THE SYSTEM IS PROPERLY GROUNDED.
- Make sure High Voltage System is locked out.
- Make sure that any lifts and metal ladders are grounded before performing maintenance.
- For further details see: High Voltage Safety Precautions, Key Lockout and Grounding Stick.



## SHIPPING - ASSEMBLY - DISASSEMBLY OF FFGC PILOT SYSTEM

### 0.1. Shipping:

[Click here for System Pictures](#)

- 0.1.1. OBSERVE ALL APPLICABLE OSHA, NEC AND OTHER CODES.
- 0.1.2. The Unit ships in the following main sections:
  - 0.1.2.1. Lower skid with Scrubber 1, 2, Pumps and piping, control panel and wiring.  
This loads onto 1 flatbed truck.
  - 0.1.2.2. WESP 1, WESP 2, Transformer Rectifier 1, T/R 2, Transformer Stands, Bus Duct, Exhaust Duct, miscellaneous parts ship on a second truck.
- 0.1.3. **USE SPREADER BAR FOR LOADING THE LOWER SKID SECTION.**
- 0.1.4. **Caution !!**
  - 0.1.4.1. The pH and ORP electrodes may not be subjected to freezing temperatures.  
After protecting them with a saline solution from drying out, they can either travel in the cab of the truck or be hand carried to a new site, if freezing temperatures might be expected.

### 0.2. Assembly:

[Click here for System Pictures](#)

#### Useful DWGs:

Flow Schematic: [A84-100-000-V1-WowWespFlowSchematic.pdf](#)

Flange Connections: [A84-100-000-V1-01-WowWespFlangeConnections.pdf](#)

- 0.2.1. OBSERVE ALL APPLICABLE OSHA, NEC AND OTHER CODES.
- 0.2.2. **USE SPREADER BAR FOR UNLOADING THE LOWER SKID SECTION.**
- 0.2.3. When unloading the unit make sure to check for hardware that may have fallen or come loose in the WESP. All hardware in the WESP is C276 and is very expensive. Collect hardware from the tarps or boards that are installed at the bottom of the WESPs and only then place them on the ground. Install the loose hardware as needed. Tighten all nuts and bolts.
- 0.2.4. Place the skid on a sturdy level surface and level the base frame. (1/8" across width - 1/4" across length) This is important for having the electrodes leveled properly later.
- 0.2.5. Tie-down base frame to ground to secure it in case of high winds or earthquakes.
- 0.2.6. Use Nickel Neverseize to assemble SS bolts.
- 0.2.7. Replace Insulator spacers in Top Section of WESPs with insulators. Keep the spacers for future shipments. Wipe the insulators down with Acetone to make them grease and dust free and make sure they have no cracks or scratches.
- 0.2.8. Install the WESP sections on top of the scrubber units.
- 0.2.9. Install the T/R set stands and the bus ducts.
- 0.2.10. Install T/R set. (Make sure to install the bottom gasket between the T/R and the bus duct)
- 0.2.11. Install insulators and threaded rods in the bus duct. Make sure they are clean and centered (+/- 1/4"). Be sure to remove all tags inside the bus ducts as they would create shorts once voltage is applied.
- 0.2.12. Make sure that all nuts and bolts in the HV frame and support system are tight before aligning the system. Check the high voltage frame for levelness. Adjust equipment levelness if needed. Key is that the electrodes are centered, due to the stiffness of the electrodes they can compensate for some out of levelness.
- 0.2.13. Before Installing the Scrubber Packing: Align the electrodes in WESP 1 and 2 with the tool provided to within +/- 1/8" (3 mm) or better from the center of the tube top and bottom. To do this it



- is necessary to have a person on top and at the bottom of the system at the same time. Access to WESP 2 is through the second packed scrubber section.
- 0.2.14. When done make sure to reinstall the access hole covers in the perforated sheets and to install the perforated sheets for the scrubber.
- 0.2.15. Before Installing Scrubber Packing: Run dry - no flow V-I curve and compare to original start-up test data. If the data is not the same or better, trouble shoot cause and remedy.  
See operational data. Note: Before starting High Voltage the system must be properly grounded. See grounding sheet on Electrical Schematics and verify that resistance to ground is less than 4  $\Omega$ .
- 0.2.16. Install all Instrumentation shipped loose and check against Flow Schematic.  
E.g. shipped loose are the pH and ORP electrodes, the outlet temperature gauge and the inlet temperature gauge which mounts into the inlet duct supplied by others.
- 0.2.17. Install scrubber packing. Note make sure to take out the scrubber top perforated cover sheets from the floor of the scrubber. When packing is in place locate those perforated sheets on top of the packing.
- 0.2.18. After 1 week of operation check for settling in scrubber packing and top of as needed.
- 0.2.19. If scrubber packing was already in place, make sure to inspect it before putting unit into service.
- 0.2.20. Before Startup:
- 0.2.20.1. Once all wires have been relanded check all connection for tightness.  
Also check control panel terminals and relay connections and especially all motor leads for terminal tightness.
- 0.2.20.2. Check Rotation of pumps once 480 V is on. If they run backwards switch 2 leads on the feed. Note only bump motors for seconds. Pumps may not run dry.
- 0.2.20.3. Check Rotation of the T/R set cooling fan on each system. If it runs backwards switch 2 leads on the feed.
- 0.2.20.4. Check all instruments for correct setup parameters. Setup parameters.
- 0.2.20.5. Perform daily, weekly, monthly and semi-annual maintenance.  
Check lubrication levels and lubricate Motors etc.
- 0.2.20.6. Run system with water for 24 hrs. See notes.
- 0.2.20.7. Before using chemicals in the system make sure that there is a functioning eye wash and shower station at the test site within 50 ft of the chemicals.
- 0.2.20.8. Check System for leaks and fix as needed. On threaded connections use pipe dope and Teflon tape. Do not over-tighten, especially not in cold weather.
- 0.2.20.9. Check spray nozzles and patterns.
- 0.2.21. Startup:
- 0.2.21.1. Check function of system against function description supplied.
- 0.2.22. Notes:
- 0.2.22.1. Use Nickel Neverseize for SS bolts.
- 0.2.22.2. Keep the blue electrode caps for future shipping.
- 0.2.22.3. After storing the pH and ORP Electrodes in a saline solution they will need about 24 hrs of operation with water before they are fully responsive to the new environment.
- 0.2.22.3.1. Make sure that the pH and ORP electrodes are clean.
- 0.2.22.3.2. Check pH and ORP electrodes with calibrating solution.
- 0.2.22.4. Keep tarps or boards from bottom of WESPs for future shipping.
- 0.2.22.5. Keep electrode spacers for future shipping.
- 0.2.22.6. Keep packaging material for future shipping.



0.2.22.7. Keep T/R wooden boxes for future shipping.

### 0.3. Disassembly:

[Click here for System Pictures](#)

- 0.3.1. OBSERVE ALL APPLICABLE OSHA, NEC AND OTHER CODES.
- 0.3.2. Before shutting down the system for the last time and before disassembly make sure to:
  - 0.3.2.1. Run intermittent flush water on both WESPs for min. 15 minutes with High Voltage off.
  - 0.3.2.2. Drain both scrubbers and refill with fresh water.
  - 0.3.2.3. Adjust pH in both scrubbers to 8-9 and run for 2 hrs in normal scrubber mode without HV and without the fan. Flush for 10 min. then shut down system.
  - 0.3.2.4. Inspect and clean scrubber packing as needed. Reflush if required.
- 0.3.3. Drain water from system. Perform internal inspections and pressure wash as needed.
- 0.3.4. Carefully label all parts when taking subassemblies apart. Make sure that all wires that have to be lifted have wire labels.
- 0.3.5. Take down T/R sets, bus ducts and WESP sections.
- 0.3.6. Tarp or board the bottom of the WESPs tightly to catch all hardware that may come loose during shipment.
- 0.3.7. Safely store insulators from bus ducts in the original shipping boxes.
- 0.3.8. Replace the insulators in the Top WESP sections with the shipping spacers and store insulators in the original shipping boxes.
- 0.3.9. For short trips the scrubber packing may stay in the scrubbers but must be checked after reinstallation of the system. Make sure the packing is clean and not broken or heavily compacted. If in doubt remove packing and replace with new packing upon reassembly.
- 0.3.10. **Caution !!**
  - 0.3.10.1. pH and ORP Electrodes are sensitive to drying up.
    - 0.3.10.1.1. For short distance shipments with no danger of being exposed to freezing temperatures, they can stay in place with water locked in at the electrode loop.
    - 0.3.10.1.2. For long distance shipments and the possibility of freezing temperatures, remove electrodes from system. Clean electrodes with clean drinking water. Fill blue protective caps with water and add a small amount of salt. Put caps on electrodes and tape up with electrical tape.
- 0.3.11. **Notes:**
  - 0.3.11.1. Make sure to pack the inlet temperature gauge that was installed in the customer duct.
  - 0.3.11.2. Make sure to remove and pack the outlet temperature gauge from the duct.
  - 0.3.11.3. Make sure to pack the Grounding Tool and the Electrode Adjustment Tool.
- 0.3.12. **USE SPREADER BAR FOR HANDLING THE LOWER SKID SECTION**



## 1. LOCKOUT PROCEDURES

Before servicing an Pilot Unit, always follow OSHA lockout/safety procedures.

- Avoid any action that would allow the combustion temperature to come up to the unit. Never have flow without the recycle liquid running. Never open the access doors if high voltage is on.
- Do not service any rotating devices, such as the pumps or fans without locking out the panel disconnect. Leave the WESPs on if possible without safety hazard and no service to the WESP is needed.
- When entering the vessel, observe OSHA rules for confined spaces if applicable.
- Note that the vessel is normally under negative pressure. Before entering vessel disconnect or isolate from process and make sure that there is sufficient oxygen in the unit before entering.
- If the Unit stops turning and the temperature is above ambient. it must be verified that no flow is moving through the unit. Monitor the temperatures in the inlet duct, first WESP outlet , outlet duct and purge air ducts.

## 2. PILOT UNIT SYSTEM PREVENTIVE MAINTENANCE

### **NOTE: SYSTEM MUST BE GROUNDED FOR MAINTENANCE:**

- BEFORE PERFORMING ANY MAINTENANCE ON THE SYSTEM MAKE SURE THAT THE SYSTEM IS PROPERLY GROUNDED.
- Make sure High Voltage System is locked out.
- Make sure that any lifts and metal ladders are grounded before performing maintenance.
- For further details see: High Voltage Safety Precautions, Key Lockout and Grounding Stick.

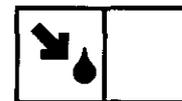
Air Pollution Control System components should be treated in the same manner as other facility process/production equipment in order to optimize equipment life and performance. The equipment should be physically inspected both internally as well as externally on a semi annual basis.

All items should be carefully examined for any evidence of physical damage, chemical attack, and/or wear due to abrasion. Furthermore equipment should be inspected to ensure that all parts and components are installed in the appropriate manner and position.

Following good general operating procedures decreases the frequency and duration of downtime and increases the overall system performance. It is important for the operator to be attentive, follow preventive maintenance procedures, and keep consistent records.

### **\*\* Temporary shut down:**

- If the system is to be shut down for less than 1 week: Adjust pH in both scrubbers to 8-9.
- If the system is to be shut down for more than 1 week:
  - Drain both scrubber, fill with fresh water, adjust pH to 8-9.
  - Turn scrubber sprays on without HV and without the fan and run for 15 min.  
Also perform intermittent washes.



## 2.1 RECORD KEEPING

An Operator's Log should be kept of the following parameters:

See the attached operator log file: [A84-100-WESP-Operational-Records.xls](#)

Also see the instrument setup sheet: [A84-100-WESP-InstrumentSetup-WOW.xls](#)

- 1) Primary current and voltage,
  - 2) Secondary current and voltage,
  - 3) Spark rate
  - 4) Gas and liquid temperatures
  - 5) Flow rates.
  - 6) Process conditions which might affect Pilot Unit performance should be noted (i.e. materials, rates, temperatures, etc.) In addition, any start ups, shutdowns or unusual events should be noted.
  - 7) ORP and pH data.
  - 8) Gas analyzer data if applicable.
  - 9) Process conditions which might affect Pilot Unit performance should be noted (i.e. materials, rates, temperatures, etc.) In addition any start ups, shutdowns or unusual events should be noted.
- A. Written Reports - downtime reports, personnel schedules, P/M schedules, and parts inventory lists are helpful documents when running a WESP system.
- B. Preventive Maintenance - The WESP system is largely maintenance free, however it does require some periodic preventive maintenance. Table 1 is a suggested minimum P/M schedule. Continued observation plus operator and mechanic experience are the best sources when developing a P/M schedule that will fit your needs.



## 2.2 PREVENTIVE MAINTENANCE INSPECTION

The preventative maintenance activities are those recommended for routine use. The procedures and frequencies should be adjusted in accordance with hours of operation, operating environment, and revisions to manufacturer's literature

### 2.2.1. Daily:

- Check and record general process operation parameters of the Pilot Unit.
- Check and record high voltage parameters of the WESPs.
- Visually examine system (Fans, Flexes, Ducts, Valves, Doors). Listen for strange new noises
- Check for excess vibration on fan and pumps.
- Check pH and ORP Controllers (see Controllers maintenance)
- Check purge air system. Temperature shall be at least 20 °F above ambient but not more than 60 °F. If needed adjust the flow if temperature is too low and or check the purge blower for operation if too high.
- Check flue gas Analyzer.

### 2.2.2. Weekly:

- Check & record exhaust fan bearings and check for piping and pump leakage.
- Check observation tube conditions. Clean as needed.
- Drain liquid from differential pressure vessels.
- Check purge air inlet filter and replace as needed.
- Check Dosing pump oil level.

### 2.2.3. Monthly:

- Scrubber inspection.

### 2.2.4. Semi-annually:

- Lubricate Fan Motor and Pump motors every 3,000 operating hours or every 6 months. See vendor manual
- Perform Dosing pump maintenance per Vendor manual.



Table 1

| DESCRIPTION  | FREQUENCY  |
|--|--|
| Upper Frame Wash<br>(Using spray headers in top of WESP)<br>(The T/R set and controller must be de-energized before washing)   | Every time WESP is being turned - off.<br>Recommended daily for WESP 1.<br>After 1 hr wash WESP 2.<br>DO NOT WASH BOTH UNITS within 1 hr<br>as destruction efficiency will otherwise suffer. |
| Check the high voltage cabinet for dust and moisture contamination, and if necessary clean it  | Once a month   |
| Check high voltage connections for tightness of connections and any possible places of sparking and arcing.  | Once a month   |
| Visual Inspection of Spray Headers<br>(Check for: corrosion, nozzle plugging)  | Once a month   |
| Dry V-I Curve<br>Before Shutdown wash precipitators and run for 30 min without water spray.<br>Put GVC into manual mode and perform Dry, clean, no airflow V-I Curve as per examples | Once a month   |
| Visual Inspection of Support Insulators<br>(Check for: cleanliness, cracking, moisture)  | Once every 6 months  |
| Visual Inspection of Collector Tubes<br>(Check for: pollutant buildup, corrosion, electrode alignment, foreign matter)   | Once every 6 months  |

- A. **NOZZLES:** Remove each nozzle to check for foreign material, which may have built up on the spinner. In the case of ceramic nozzles, they should be removed by hand or with a cloth nylon strap wrench, and under no circumstances should any other device be used. Any buildup of foreign material in the nozzle will affect the spray pattern. The nozzle should also be check for wear in the area of the spinner and outlet orifice. This is especially true when brass, stainless steel, or cast iron nozzles are used.
- B. **ACCESS DOORS:** Inspect periodically for integrity and condition of door gasket, and key interlocks and repairs or replace as needed.





### 3. FFGC TROUBLESHOOTING

If a unit that has functioned normally in the past begins to operate unsatisfactorily, then a preliminary fault diagnosis should be conducted.

Table 3 of these instructions describes common problems, which may occur and lists possible causes. Well-kept operating records are invaluable when determining probable causes of a malfunction. Other factors such as process changes and operator error must be taken into account. A preliminary analysis that considers these points will most likely save time and expense.

It is important that a log be kept that can easily link process changes that might be important, (such as raw materials, temperatures, process flow rates, product specifications, and length of operation, et. al.) Many times precipitator malfunctions are solely attributable to process parameters that have been modified. Provisions have been made to allow the WESP system to compensate for moderate process changes. If it is suspected that a modification of process variables is the source of the problem a representative should be contacted to make the required adjustments.

If a malfunction in the electrical equipment is suspected, then consult the T/R control manuals for guidelines.



**TABLE 3  
FFGC UNITS TROUBLESHOOTING**

| PARAMETER               | CONDITION                                  | POSSIBLE CAUSES   |
|-------------------------|--|---|
| Recycle liquid Pressure | High                                       | Clogged spray nozzles   |
|                         | Low  | Missing spray nozzles<br>Pump malfunction<br>Pipe failure   |
| Output Current          | High                                       | Foreign object in collector.<br>Excess buildup in collector.<br>Rod misalignment.   |
|                         | Low  | Wet insulators.   |
| Output Voltage          | High                                       | T/R malfunction   |
|                         | Low  | Foreign object in collector.<br>Excess buildup in collector.<br>Rod misalignment.<br>Controller set improperly.<br>Wet insulators.  |
| Spark Rate              | High (above 60-80 Sparks per minute (SPM)) | Foreign object in collector.<br>Excess buildup in collector.<br>Rod misalignment.<br>Controller set improperly.<br>Wet or greasy insulators.<br>Wash headers on or leaking. |

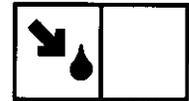
NOTE – CONSULT THE T/R AND CONTROLLER MANUALS IN THE CASE OF SUSPECTED ELECTRICAL MALFUNCTION. ALARM LIGHTS SHOULD BE NOTED AND REPORTED IMMEDIATELY.



#### 4. PILOT UNIT MAIN OPERATING PARAMETERS

Table 4.

| <u>Description</u>                                      | <u>Parameters</u>                       |                 |
|---|---|-----------------|
| Minimum Fan Gas Flow Rate                               | 500                                     | ACFM            |
| Design Fan Gas Flow Rate                                | 2,000                                   | ACFM            |
| Maximum Fan Gas Flow Rate                               | 4,000                                   | ACFM            |
| Design Inlet Gas Temperature                            | 354                                     | F               |
| Design Inlet Gas Pressure                               | -10                                     | " WC            |
| Max. Gas inlet pressure                                 | -15                                     | " WC            |
| Design Sulfur Dioxide (SO <sub>2</sub> ) concentration  | 317                                     | ppm             |
| Design Sulfur Trioxide (SO <sub>3</sub> ) concentration | 309                                     | ppm             |
| Design Hydrogen Chloride (HCl) concentration            | 5.2                                     | ppm             |
| Design Nitrogen Oxides (NO <sub>x</sub> ) concentration | 250                                     | ppm (estimated) |
| Design Particulate Loading                              | 0.009                                   | gr/acf          |
| Saturation Temperature (calculated)                     | 123                                     | ° F             |
| Maximum Scrubber Inlet Operating Temperature            | 180                                     | ° F             |
| Primary T/R set Voltage                                 | 460                                     | V               |
| Secondary T/R set Voltage (estimated)                   | 40                                      | kV              |
| Max. T/R set secondary voltage                          | 70                                      | kV              |
| Max. T/R set secondary current                          | 400                                     | mA              |
| Max T/R set power                                       | 28                                      | kW              |
| Recycle Pump Liquid Rate                                | 250                                     | gpm             |
| Recycle Pipe Maximum Pressure                           | 80                                      | PSI             |
| Fresh Water Makeup (approx.)                            | 1.8                                     | gpm             |
| First Scrubber (Oxidizer) expected pH range             | 4.5 (minimum)<br>6.5 (maximum)          |                 |
| First Scrubber expected ORP range                       | 1,200mV (minimum)<br>1,700 mV (maximum) |                 |
| Second Scrubber (Reducing) expected pH range            | 6.5 (minimum)<br>10.0 (maximum)         |                 |



### 4.1 Utility & Chemical Requirements

#### Electrical:

- 1x 100 A Feed to Panel: 480 V - 60 Hz - 3-Phase
- 2x 60 A Feed to T/R sets WESP 1 & 2: 480 V - 60 Hz - 3-Phase

#### Water:

- 1x 1" line Pressure min. 40 PSIG max. 100 PSIG ideal 60 PSIG at 10 GPM flow.
- 1x Tee on 1" line with connection to Owner supplied eyewash and shower station

#### Waste Water bleed drain:

- 1x 3" line PVC to plant waste water treatment. For expected chemical composition see Flow Schematic. Actual composition will depend on flue gas composition.

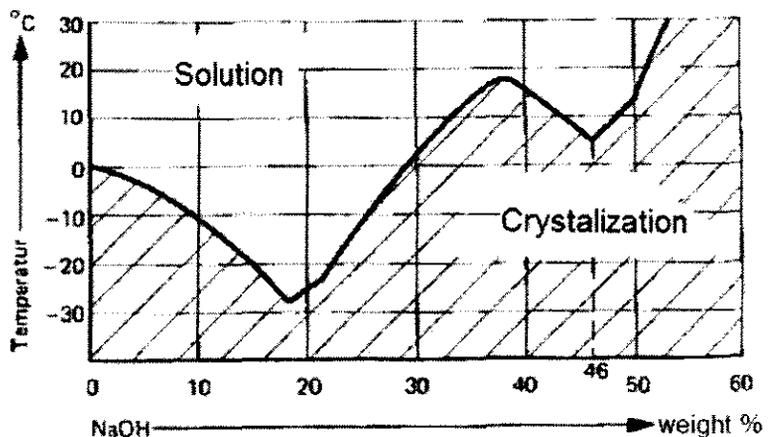
#### Chemicals:

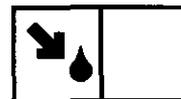
- 1x Tote 100 gal NaClO<sub>2</sub> 10-20% installed.  
Usage 4 totes max. / 8 hr shift  
Recommended stock: 20 totes, reorder at 10 totes  
MSDS: [MSDS\NaClO2-MSDS.doc](#)

- 1x Tote 100 gal NaOH 25% installed.  
Usage 2.4 totes 25% max. / 8 hr shift  
Recommended stock of 50% NaOH: 10 totes, reorder at 6 totes  
MSDS: [MSDS\MSDS-NaOH.pdf](#)

\* Note for NaOH:  
For outside use dilute commercial NaOH 50% to 25% to avoid crystallization during cool weather.  
To dilute fill tote 50% with water and top off with NaOH 50% to achieve NaOH 25%.

For reference see attached graph.





## 5. SAFETY INSTRUCTIONS

All personnel working with a WESP should follow all OSHA or Local Codes guidelines for maintenance of high voltage equipment. The following is suggests as guidelines as a minimum Safety Program when working in or around a WESP System. Where these guidelines and OSHA guidelines or Local Codes differ the more rigorous guideline should apply.

**DANGER: THE WESP SYSTEM USES HIGH VOLTAGE ELECTRICITY WHICH CAN BE LETHAL IF SAFETY PRECAUTIONS ARE NOT FOLLOWED.**

### 5.1 HOUSING ENTRY SAFETY PRECAUTIONS

Entering the housing without safety precautions can be very dangerous. Certain gases contain constituents, which may be harmful to personnel. To decrease the likelihood of harm to personnel, take the following precautions:

Make sure all high voltage systems are grounded and locked out.

- a) Any mechanical devices such as pumps, sump heaters, agitators, etc. should be locked out or disconnected electrically prior to entry.
- b) Any pipe lines connected to the system containing hazardous or potentially dangerous materials should be drained and broken prior to entry.
- c) The System should be purged with clean ambient air and vented prior to entering.
- d) The System should be cleaned of any hazardous material residue using appropriate material handling procedures prior to entry.
- e) Air quality should be checked using appropriate methods prior to entering.
- f) It is recommended using a Buddy System, where one person acts as an observer to ensure the safety of persons inside a vessel.

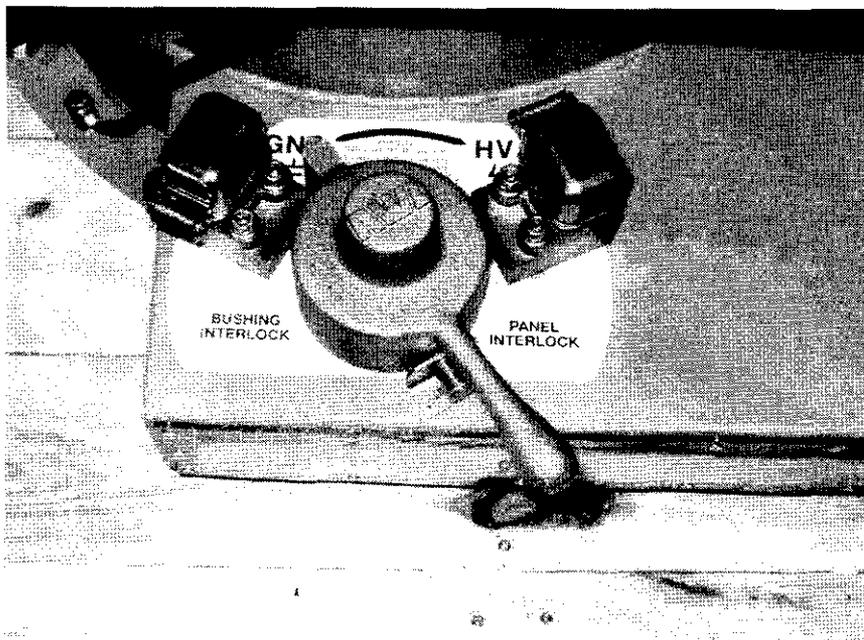




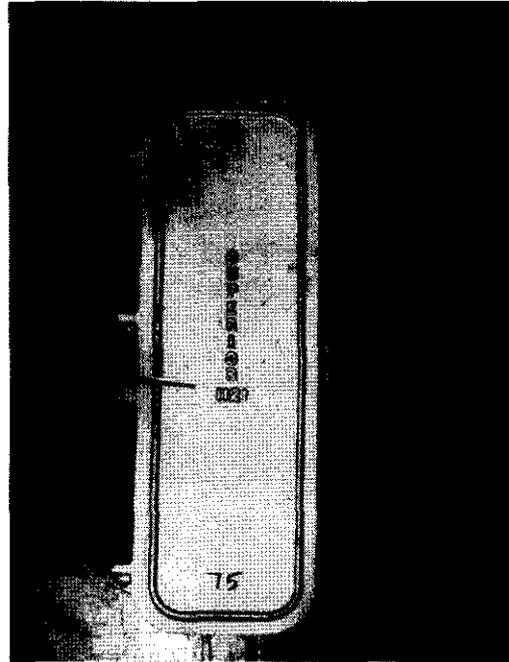
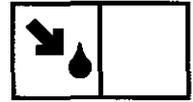
- a) E.G. for WESP 2 Lock "74" is located at the main circuit breaker of the WESP high voltage control panel.



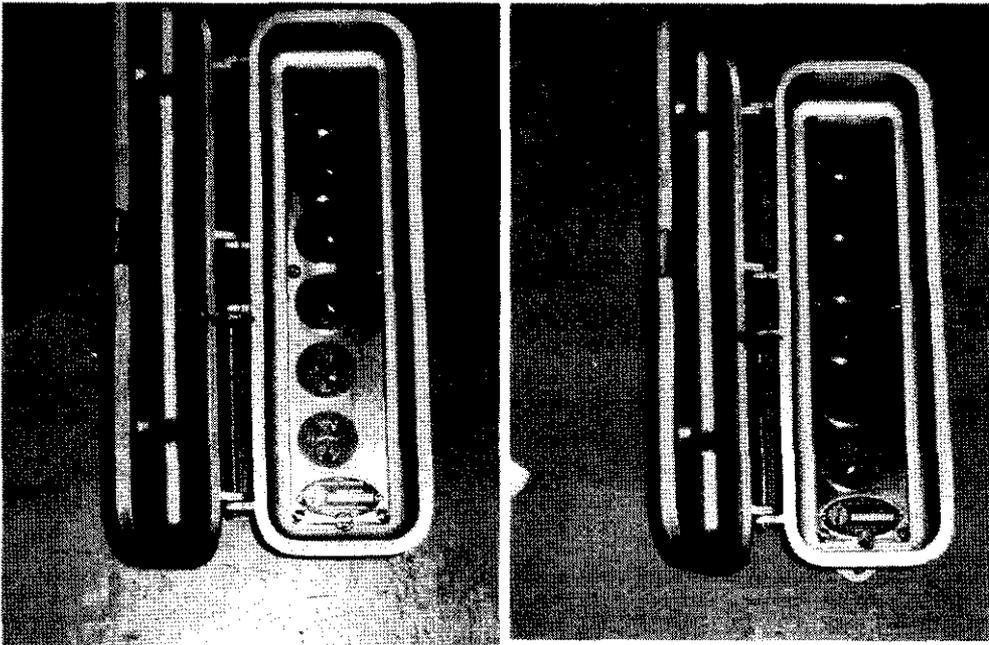
- b) The second Lock "74" is located at the Ground-HV switch of the transformer/rectifier (T/R set) at the high voltage (HV) position.  
c) Lock "75" is located at the Ground-HV switch of the T/R set at the ground (GRD) position.



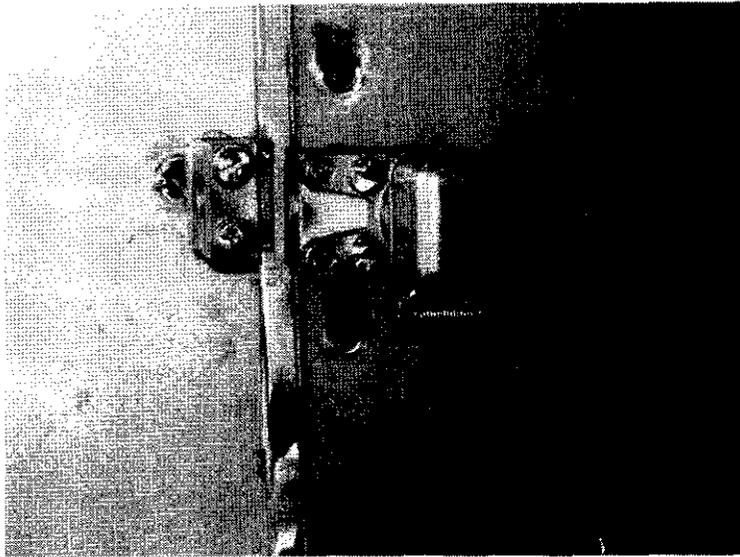
- d) The interlock containing the release key "75" and access keys "03" is located underneath the main control panel. transfer box



- e) The Number of locks "03" is equal to number of access main access openings. These are the insulator compartment doors and the man door ways.  
For the main access doors to the bus duct use keys for doors that are not in use.  
**DO NOT DUPLICATE KEYS!!**



- f) **Opening of Locks:**  
After the access keys have been release from the interlock transfer boxes you can open the associated doors e.g. 03. All locks are number marked and stamped internally.



### 5.2.3. WHEN THE WESP IS RUNNING:

- a) Lock "74" is unlocked with the key captive on the main circuit breaker of the WESP high voltage control panel and is in the "ON" position.
- b) The high voltage ground switch on the T/R Set (Transformer/Rectifier Set) is in the "HV" position and Lock "74" is locked with no key.
- c) The "GRD" position has lock "75" with key captive in the unlocked position.
- d) The interlock transfer box has Lock "04" cylinders for each access with keys captive and one cylinder for Lock "75" has no key.

### 5.2.4. WHEN THE WESP IS TO BE LOCKED OUT:

To open the WESP access doors; the Operator must use the following procedure:

- a) Press the high voltage "OFF" push button of the control panel display unit.
- b) Turn the T/R set main circuit breaker to the "OFF" position.
- c) Remove key from Lock "74" (circuit breaker will now be locked in the off position).
- d) Insert key (74) into Lock "74", located at the T/R set ground switch "HV" position, and unlock Lock "74".
- e) Move the ground switch from "HV" to the "GRD" position. Lock "75" lock.
- f) Remove key (75) from Lock "B". Use key (75) in the interlock transfer box to unlock all the keys (04). Only remove the number of (04) keys needed for the doors to be opened.

**IMPORTANT: IF ANY KEYS ARE LOST OR MISPLACED THE HIGH VOLTAGE WILL NOT BE ABLE TO BE RESTORED. THE KEY INTERLOCK SYSTEM MUST BE FOLLOWED BEFORE THE CONTROLLER WILL OPERATE.**

- g) Each access cover has a Lock "04" bolted to the WESP frame and the door. When the lock is unlocked, key (04) is captive and the bolt releases allowing the cover to be opened.



### 5.3. GROUNDING STICK

#### Back to Note on Grounding

1. Connect the high voltage ground stick to any ground located on the outside shell of the WESP sections or the ground grid surrounding the housing.
2. Holding the ground stick at the insulating end without touching the wire, hook the ground stick's metallic end to the WESP high voltage frame and leave the ground stick in place while working in the WESP.
3. The WESP is now grounded.

## IMPORTANT

**THE HIGH VOLTAGE TRANSFORMER / RECTIFIER AND THE CONTROLLER INSTRUCTION MANUALS INCLUDED IN THIS INSTRUCTION MANUAL MUST BE READ BY ALL PERSONNEL WHO WILL BE OPERATING THE WESP SYSTEM.**

**ALL NON ESSENTIAL PERSONNEL MUST BE KEPT AWAY FROM THIS EQUIPMENT.**

**AN OBSERVER FAMILIAR WITH THE WESP AND IT'S OPERATION MUST BE PRESENT OUTSIDE THE ACCESS DOOR ANYTIME SOMEONE IS WORKING INSIDE THE WESP**



## 6. MAINTENANCE INSTRUCTIONS FOR TURBO-GRID AND PACKED SECTIONS

### 6.1. INTEGRAL RECYCLE TANKS

The object of the integral recycle tanks for first and second scrubbers is to minimize the introduction of fresh liquid - needed to maintain a constant scrubbing liquid flow and to maintain a constant percentage of solids concentration in the scrubbing liquid.

The rate of fresh liquid added to the integral recycle tank to maintain a constant scrubbing liquid level is called the "makeup" rate. The rate of scrubbing liquid discharged in order to maintain a constant allowable percentage of solids concentration in the scrubbing liquid, is called the "bleed-off" rate.

Should the solids concentration in the scrubbing liquid increase beyond the maximum percentage of solids concentration allowed (max. 2%) during the operation of the scrubber system, the "bleed-off" and "make-up" rate should be raised accordingly, so as to maintain the allowable percentage of solids concentration in the scrubbing liquid and to minimize abrasion and salt sedimentation within the scrubber system. The bleed composition of each sections is shown in the Flow Schematic.

### 6.2. PRESTART UP:

Thoroughly flush out all liquid piping for at least 20 minutes at full line pressure. The precaution is necessary to clean slag and trash from piping system.

Conduct a thorough inspection of the interior of the unit making sure of the following points:

All internals are secured in place.

The internal sections of the tower are free from debris.

After the flush run with water clean out the strainers.

### 6.3. START-UP PROCEDURE:

The scrubbing liquid supply will be turned on first to ensure adequate liquid flow and pre-wetting of the packing media. Then the high voltage systems of the WESP are turned on (see WESP procedure). Next the fan system is turned on and dampers are opened. This will cause the gas to flow through the scrubbers. All pressure gauges, temperature and flow measuring devices should be checked and adjusted for proper flow quantities.

Should any malfunctions arise, turn the fan off first, high voltage and then the pumps. Recheck the entire system for mechanical or electrical mistakes.

### 6.4. SHUTTING SCRUBBING SECTIONS DOWN:

The system fan should be turned off first, high voltage and the scrubbing liquid should remain on for 2 (two) minutes after fan has stopped rotating. Scrubbing sections self drain after liquid flow has been turned off.



Following any extended shut-down, it is recommended that the liquid supply piping be flushed and scrubber internals checked for blockage before proceeding with standard start-up procedures.

#### 6.5. INSPECTION & INITIAL MAINTENANCE:

Re-tighten all flange bolts after 48 hours of continuous operation and again after two (2) weeks of continuous operation.

Frequent inspection is recommended, especially during the first week of operation. An inspection and cleaning schedule should be based on actual operating experience and necessity. The inside of the collector must be kept free of accumulation which may impair operation.

#### 6.6. SCRUBBING INTERNALS INSTALLATION:

The Oxidizer turbo grid section is completely preinstalled in the shop. In the second reducing packed section the packing support grid, internal liquid spray piping, and all packing supports are also preinstalled in the shop, but the packing material is shipped loose and **MUST BE** loaded after pilot unit installation on the testing site.

##### 6.6.1. Packing shipment, storage and handling.

Jaeger Tri-Packs@ packing containers are corrugated cardboard boxes containing 10 cubic feet of packing each which are not designed for outside storage. Care should be taken when handling boxes to prevent boxes from tearing open or corners becoming crushed. Stack boxes on wooden pallets or on level floor so that there is no danger of water or condensation. Make sure the entire bottom of each box is fully supported.

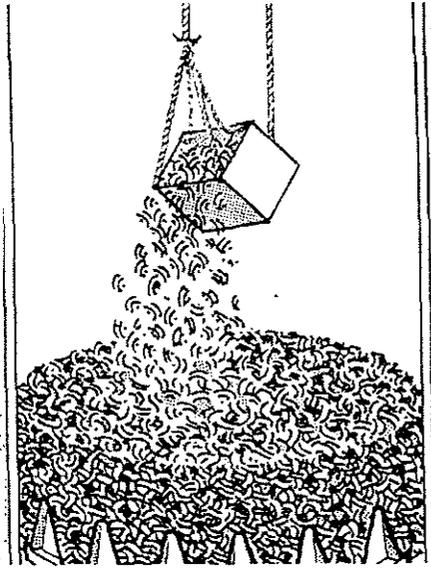
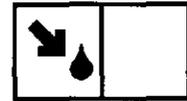
Do not stack boxes more than three high and tape boxes together as a group. If the packing is to be stored in a climate with high humidity (90% or more) for extended periods of time, then reduce stacked height to two boxes. Do not put any load on top of stacked boxes. Never allow any person to climb on or store other equipment on top of any of the boxes.

##### 6.6.2. Random Packing Installation.

For Pilot Unit cross-flow packed section the packing material should be loaded through the top level scrubber nozzle plates. Distribute packing pieces in a random manner and never let them free fall more than four (4-6) feet. In cold weather (temperature below 45°F) particular care must be taken in handling and installing plastic packing since the ductility of the plastic resin will be greatly reduced. Make sure the packing fills all the space in the packed bed section. Pay particular attention to the manway and irregular spaces.

Be careful not to leave any foreign materials in the packed bed section. Make sure all plywood, boxes, and bags are removed.

Packing may be loaded directly from their shipping cartons by lowering the carton to the proper heights above the surface of the bed and dumping the packing slowly by means of a tripping rope.



If procedures are not clearly understood by the personnel installing the packing, they should call the packing manufacturer for additional information required.

**IOTE:**

The packing material must be filled to its designated full depth.  
Make sure that there is no unobstructed air passage below or above the packing material.

6.7. Instrumentation is provided to:

- 1) Control the liquid supply.
- 2) Measure the liquid flow rate.
- 3) Monitor the pressure drops across the scrubbing section.
- 4) Monitor the temperature across the system.
- 5) Monitor the pH and ORP across the system.

**6.8.MAINTENANCE:**

The Turbo-Grid first scrubbing section requires little maintenance. The scrubbing elements resist buildup and scaling much better than other scrubbing devices. Even if buildup or scaling should occur or the elements eventually wear and do need replacement, they can be replaced quickly at a small cost.

The main concern with the packed section would be a potential buildup due to an upset in the process and/or a malfunction of the first WESP and Turbo-grid scrubber stage and the interruption of the liquid supply to the packed section.

It is therefore suggested the following sequence of steps be used.

At the end of the first process test operation when the unit should be shut down all access doors in the turbo-grid and packed sections should be opened for inspection:



- The packing support perforated plates should be checked for the presence of build-up.
- The floor and drain at the bottom of the scrubbing sections should be checked for sludge build-up.
- The liquid distribution manifold spray piping should be checked for plugged holes. Water should be run through the manifold spray piping at this time to confirm the presence of free liquid flow through all openings in the manifold pipe.

Inspection of the packing should be done on a regularly scheduled basis. Maintenance of the packing is determined by the amount of fouling (collection of deposits such as iron, carbonate, and bacteria) that has accumulated on the packing. Past experience indicates a minimum inspection period of six (6) months to check for excess fouling. The optimum inspection time will vary from area to area depending on the concentration of contaminants of deposits from the water and gas source. The packing can be removed and cleaned if fouling is not permitted to get excessive. The packing should always be kept wet until cleaning can be done to prevent the solidification of deposits which makes them much more difficult to remove.

Packing can be cleaned using different methods and is often a combination of common sense and effort depending on labor and equipment available. A regularly scheduled maintenance program can reduce or eliminate difficult cleaning efforts.

There are many chemicals and acids that can be used in the cleaning of packed towers. Good results have been evident using 3-5% HCl or citric acid. The approval and recommended use of any specific chemical or acid should be indicated by the manufacturer of all components of the vessel or system including the packing and internals.

If the packing is not severely fouled, the cleaning can be done without removing it from the scrubber and basically involves circulation and recirculation of the cleaning agent through the packed bed. The circulation rate should be at the maximum that can be achieved through the process equipment. The recirculated solution should be filtered or drained to minimize solids concentration as they become dislodged from the packing. The length of time required to clean the packing will depend on the amount of fouling present, the effectiveness of the cleaning agent chosen and the quality of the liquid distribution. If acids are used, the solution may require neutralization before proper disposal.

If the packing is severely fouled and distribution of the cleaning agent is difficult, the packing is typically removed and cleaned using similar techniques, but in baskets or wash basins. The packing can be soaked longer with this method and agitated to aid in the removal of the fouled matter. However, this method will most likely result in more broken packing elements and the need for replacement of some media. Consideration should be given to the cost effectiveness of this method versus total packing replacement.

Should it become evident that the packing cannot be cleaned and is to be replaced, one must dispose of the packing properly. Usually disposal of "spent" packing is done at regional landfills. The packing itself does not pose an environmental problem to the landfill, however the solids present with the fouling may be considered hazardous depending on your application. Disposal of "spent" packing will usually require a test at the request of the landfill to determine toxicity or presence of contaminants that may leach over time. Based on their test, the landfill will then assign the proper landfill classification suitable for disposal.

## 10. Troubleshooting packed scrubber



When a packed scrubber develops difficulties in achieving good removal efficiency or can not achieve rated capacity, the problem may be related to the process, hydraulic problems, mechanical problems or a combination of the above.

It can also be caused by the following:

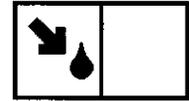
- A sudden pressure surge (often due to the sudden flashing and expansion of water to steam), resulting in damage of the packing;
- Destruction of packing by corrosion, excessive temperature, and prolonged flooding;
- Plugging of packing material;
- Foaming, resulting in a reduced absorption capacity.

#### 6.11. OPERATION INTERLOCKS:

The following electrical interlocks of the scrubbing sections are intended to insure safety in operation and protection of the scrubbing sections mechanical equipment.

- RECYCLE PUMPS, METERING PUMPS AND FAN WILL NOT OPERATE UNLESS THERE IS ENOUGH SCRUBBING LIQUID IN SCRUBBER INTEGRAL RECYCLE TANKS.
- NORMALLY CLOSED WATER MAKEUP SOLENOID VALVES WILL ENERGIZE IF THE LEVEL IS BELOW LOW LEVEL.

#### 6.12. SCRUBBING SECTIONS ALARM CONDITIONS: (See function description)

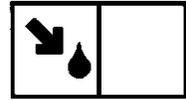


## 7. EMERGENCY SHUT-DOWN

### IN EMERGENCY SITUATIONS SHUT OFF THE MAIN DISCONNECT AT THE CONTROL PANEL:

For minor problems conditions please follow the below mentioned sequence:

- Shut the fan down first then enter into bypass mode.
- Turn the high voltage off
- Shut down all metering pumps.
- Shut down all recycle pumps.
- Reset all alarms.



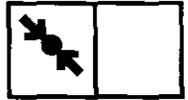
| D:\X-Manuals\SpareParts\A84-100-WESP-SpareParts-MASTER.xls\A84-100 WOW-Energies SpareParts |                         |                        |   |           |           |              | Update Veit, 10-12-05 |           |            |
|--|-------------------------|------------------------|---|-----------|-----------|--------------|-----------------------|-----------|------------|
| A84-100-001  |                         | WESP #1 SYSTEM         |   |           |           |              |                       |           |            |
| Level  | Drawing Number          | Code                   | Description   | Total Qty | Rec Stock | Delv (Weeks) | ID #                  | Article # | Unit Price |
| ~1~  |                         | 005594                 | WESP # 1 SYSTEM METALINE<br>SEE VENDOR MANUAL FOR SPARE PARTS   | 1.0       | 4.0       |              | 103359-00             |           |            |
| ~3~  |                         | 001547                 | BUS BAR WALL INSULATOR #Q37768-70<br>LAPP INSULATOR   | 4.0       | 0.0       |              | 103933-01             |           |            |
| A84-100-003  |                         | SCRUBBING SECTION      |   |           |           |              |                       |           |            |
| ~1~  |                         | 005594                 | SCRUBBING SECTION METALINE  | 1.0       | 0.0       |              | 103361-00             |           |            |
| ~3~  |                         | 005594                 | MIST ELIMINATOR METALLINE   | 1.0       | 0.0       |              | 104542-01             |           |            |
| ~3~  |                         | 005594                 | SKID METALLINE  | 1.0       | 0.0       |              | 104542-02             |           |            |
| A84-100-004  |                         | HIGH VOLTAGE EQUIPMENT |   |           |           |              |                       |           |            |
| ~3~  |                         | 006147                 | HIGH-FREQUENCY POWER SUPPLY POWER+ 28 kW<br>INCLUDING:<br>HV GROUND SWITCH, BOTTOM EXIT<br>INPUT: 480 VAC / 60HZ / 39A<br>OUTPUT: Max. 70KVDC / 400MILLIAMPS DC | 2.0       | 0.0       |              | 103380-01             |           |            |
|  |                         |                        | GVC for Power +28 kW  | 2.0       | 1.0       |              |                       |           |            |
|  |                         |                        | Remote Power Supply for GVC   | 2.0       | 1.0       |              |                       |           |            |
|  | Vendor Spare Parts List |                        | NWL Spare Parts List  |           |           |              |                       |           |            |
| ~4~  |                         |                        | Fuse, Input Power P38131  | 3.0       | 4.0       |              |                       |           | \$71.00    |
| ~4~  |                         |                        | Gate Driver Board, IGBT, D25116-01  | 4.0       | 2.0       |              |                       |           | \$614.00   |
| ~4~  |                         |                        | MOV, DC Bus, H16916   | 1.0       | 1.0       |              |                       |           | \$224.00   |
| ~4~  |                         |                        | MOV, Rectifier, H16912  | 3.0       | 3.0       |              |                       |           | \$166.00   |
| ~4~  |                         |                        | IGBT Module, 116223S  | 2.0       | 2.0       |              |                       |           | \$986.00   |
| ~4~  |                         |                        | IGBT Thermal Pad H99735   | 2.0       | 2.0       |              |                       |           | \$12.00    |
| ~4~  |                         |                        | Rectifier, H Voltage 70kV 4 bridge, D25109-01   | 1.0       | 1.0       |              |                       |           | \$782.00   |
| ~4~  |                         |                        | Control Electronics Assembly, G20830-02   | 1.0       | 1.0       |              |                       |           | \$3,284.00 |
| ~4~  |                         |                        | Fuse, Control, 120V, H11115   | 1.0       | 1.0       |              |                       |           | \$32.00    |
| ~4~  |                         |                        | Fuse, Control, 480V, H11158   | 2.0       | 2.0       |              |                       |           | \$30.00    |
| A84-100-005  |                         | PUMPS                  |   |           |           |              |                       |           |            |
| ~3~  |                         | 006943                 | RECYCLE PUMP SETHCO MODEL 2X3-6<br>FIBERGLAS CONSTRUCTION<br>15 HP MOTOR  | 2.0       | 1.0       | 6.00         | 103517-01             |           | \$8,112.00 |
| ~3~  |                         | 007760                 | METERING PUMP 2.5 GPM SERIES SG63-88P<br>PP/PVC/PTFE CONSTRUCTION MILTON ROY  | 2.0       | 1.0       | 4.00         | 103517-02             |           | \$3,196.00 |

| Level | Drawing Number     | Code   | Description  | Total Qty | Rec Stock | Delv (Weeks) | ID #      | Article # | Unit Price |
|-------|--------------------|--------|--|-----------|-----------|--------------|-----------|-----------|------------|
|       |                    |        | METERING PUMP Motor<br>WEG MOTOR 1 HP, 1730RPM230//460VAC, 3 PHASE, 60<br>HZNEMA 56 C FRAME P/N 00118ES3ED56CFL                      | 2.0       | 0.0       | 2.00         |           |           |            |
|       | <b>A84-100-006</b> |        | <b>EXHAUST FAN</b>   |           |           |              |           |           |            |
| ~3~   |                    | 009186 | EXHAUST FAN TWIN CITY FAN  | 1.0       | 0.0       |              | 103518-01 |           |            |
|       |                    |        | STRIP HEATER 240 V - 725 W - FINNED GRAINGER #: 4E265<br>240 VAC - 725 WATT - 33 W/IN2   | 4.0       | 2.0       | 2.00         |           |           |            |
|       |                    |        | PURGE BLOWER: Dayton 4C006 Blower (Grainger 4C006)   | 2.0       | 0.0       | 2.00         |           |           |            |
|       | <b>A84-100-007</b> |        | <b>EXTERNAL PIPING</b>   |           |           |              |           |           |            |
| ~3~   |                    | 001500 | ATOMIZING SPRAY NOZZLE<br>2 GPM, 20 PSIG, 1/4 IN. MALE PIPE THREAD<br>MATERIAL: HASTELLOY C<br>#P120 BETE FOG                        | 1.0       | 1.0       | 4.00         | 104547-02 |           | \$505.00   |
| ~3~   |                    | 001500 | TOP WESP SPRAY NOZZLE<br>62.5 GPM, 1 IN. MALE PIPE THREAD<br>MATERIAL: PVC<br>#TF48NN BETE FOG                                       | 4.0       | 1.0       | 4.00         | 104547-03 |           | \$69.00    |
| ~3~   |                    | 001500 | TOP WESP SPRAY NOZZLE<br>62.5 GPM, 1 IN. MALE PIPE THREAD<br>MATERIAL: TEFLON<br>#TF48NN BETE FOG<br>(REPLACE MATERIAL WITH TEFLON)  | 4.0       | 1.0       | 4.00         | 104547-04 |           | \$69.00    |
| ~3~   |                    | 001500 | ROD SPRAY NOZZLE<br>27.8 GPM, 3/4 IN. MALE PIPE THREAD<br>MATERIAL: PVC<br>#TF32FCN BETE FOG   | 9.0       | 1.0       | 4.00         | 104547-05 |           | \$45.00    |
| ~3~   |                    | 001500 | DEMISTER SPRAY NOZZLE<br>7 GPM, 3/8 IN. MALE PIPE THREAD<br>MATERIAL: PVC<br>#TF16FCN BETE FOG                                       | 6.0       | 1.0       | 4.00         | 104547-06 |           | \$22.00    |
| ~3~   |                    | 001500 | SCRUBBER TOP SPRAY NOZZLE CO. BETE FOG NOZZLE<br>INC.<br>12.8 GPM<br>1/2 IN. MALE PIPE THREAD<br>MATERIAL: PVC<br>BETE FOG # TF24FCN | 18.0      | 1.0       | 4.00         | 104547-07 |           | \$22.00    |

| Level              | Drawing Number | Code   | Description  | Total Qty | Rec Stock | Delv (Weeks) | ID #      | Article # | Unit Price |
|--------------------|----------------|--------|--|-----------|-----------|--------------|-----------|-----------|------------|
| ~3~                |                | 004706 | SCRUBBER PACKING TOTAL 150 FT ^3, 2" PP<br>JAEGER PRODUCTS   | 1.0       | 0.0       |              | 104547-08 |           |            |
| ~3~                |                | 007760 | SAFETY VALVE<br>0-250 PSI, MATERIAL: PVC, 1" DIA. CONNECTION<br># 5423.010 RYAN HERCO  | 2.0       | 1.0       | 4.00         | 104547-09 |           | \$482.00   |
| <b>A84-100-008</b> |                |        | <b>INSTRUMENTATION</b>   |           |           |              |           |           |            |
| ~3~                |                | 007760 | FLOW INDICATOR<br>ROTAMETER NO SWITCH, 0.6-7.6 GPM, 1 IN. DIA.<br>MATERIAL: PVC, POLYSULFONE<br>#5836-130 RYAN HERCO   | 4.0       | 1.0       | 4.00         | 103893-01 |           | \$199.00   |
| ~3~                |                | 007760 | FLOW INDICATOR<br>ROTAMETER NO SWITCH, 10-100 GPM, 2 IN. DIA.<br>MATERIAL: PVC, POLYSULFONE<br>#5836-153 RYAN HERCO  | 6.0       | 1.0       | 4.00         | 103893-02 |           | \$199.00   |
| ~3~                |                | 005530 | PRESSURE INDICATOR 0-30 PSI #4007K8 MCMASTER-<br>CARR  | 1.0       | 0.0       |              | 103893-03 |           |            |
| ~3~                |                | 007760 | FLOWMETER<br>ROTAMETER, 0.5-5.0 GPM, 1/2 IN. FNPT<br>MATERIAL: ACRYLIC, FLOT-316 SS<br>#5801-0-05 RYAN HERCO   | 1.0       | 1.0       | 4.00         | 103893-04 |           | \$131.00   |
| ~3~                |                | 007760 | PRESSURE INDICATOR W/GAUGE ISOLATOR<br>0-200 PSI, 1/2 IN., MATERIAL: PVC<br>#5345-030 RYAN HERCO   | 2.0       | 1.0       | 4.00         | 103893-05 |           | \$99.00    |
| ~3~                |                | 008974 | INTERLOCK SYSTEM SUPERIOR INTERLOCK<br><i>SEE VENDOR MANUAL FOR SPARE PARTS</i>  | 4.0       | 0.0       |              | 103893-06 |           |            |
| ~3~                |                | 009728 | THERMOCOUPLE W.THERMOWELL<br>TYPE K, 0-250 DEG. F<br>THERMOWELL DIMENSIONS:<br>1/2 IN. NPT<br>OVERALL L = 9 IN.<br>INSERTION L = 7.5 IN.<br>SHANK DIA. = 5/8 IN.<br>THERMOWELL MAT: HASTELLOY OR FULLY COATED<br>(INCLUDING THREADS) WITH TEFLON, TO INCLUDE<br>ALUMINUM HEAD FOR TRANSMITTER MOUNTING<br>WATLOW WEED INST.<br>4-20 mA transmitter in Head | 1.0       | 1.0       | 4.00         | 103893-07 |           | \$772.00   |

| Level | Drawing Number | Code   | Description   | Total Qty | Rec Stock | Delv (Weeks) | ID #      | Article # | Unit Price |
|-------|----------------|--------|---|-----------|-----------|--------------|-----------|-----------|------------|
| ~3~   |                | 004688 | THERMOMETER WITHOUT THERMAL VALVE<br>50-500 DEG. F<br>4 IN STEM<br>3 IN DIAL<br># AA-040-1-F67-SS REOTEMP INSTRUMENTS   | 1.0       | 1.0       | 4.00         | 103893-08 |           | \$80.00    |
| ~3~   |                | 004688 | THERMOMETER WITHOUT THERMAL VALVE<br>0-250 DEG. F<br>4 IN STEM<br>3 IN DIAL<br># AA-040-1-F47-SS REOTEMP INSTRUMENTS    | 1.0       | 1.0       | 4.00         | 103893-09 |           | \$80.00    |
| ~3~   |                | 006420 | PH TRANSMITTER # 3-8750-2P SIGNET   | 2.0       | 1.0       | 3.00         | 103893-11 |           | \$705.00   |
| ~3~   |                | 006420 | PH ELECTRODE # 3-2714 SIGNET  | 2.0       | 1.0       | 3.00         | 103893-12 |           | \$380.00   |
| ~3~   |                | 006420 | ORP TRANSMITTER #3-8750-2P SIGNET   | 1.0       | 1.0       | 3.00         | 103893-13 |           | \$705.00   |
| ~3~   |                | 006420 | ORP ELECTRODE # 3-2715 SIGNET   | 1.0       | 1.0       | 3.00         | 103893-14 |           | \$404.00   |
| ~3~   |                | 006420 | PREAMPLIFIER TWIST-LOCK #2720 SIGNET  | 3.0       | 1.0       | 3.00         | 103893-15 |           | \$214.00   |
| ~3~   |                | 002920 | DIFFERENTIAL PRESSURE GAGE 0-10" W.C.<br># 2010 WITH ACC. A-432 DWYER   | 2.0       | 1.0       | 3.00         | 103893-16 |           | \$224.00   |
| ~3~   |                | 007760 | AUTOMATED TRUE UNION VALVE #5061H-410<br>RYAN HERCO   | 3.0       | 1.0       | 3.00         | 104019-01 |           | \$381.00   |
| ~3~   |                | 005530 | SOLENOID VALVE #7944K24 MCMaster-CARR   | 2.0       | 1.0       | 2.00         | 104019-02 |           | \$165.00   |
| ~3~   |                | 006802 | CONDUCTIVE LEVEL SWITCH HOLDER #6012-KF3-5-RC<br>AMETEK   | 2.0       | 1.0       | 4.00         | 104019-03 |           | \$428.00   |
| ~3~   |                | 006802 | CONDUCTIVE RODS LEVEL SWITCH #6013-HC-T-C-3<br>AMETEK   | 4.0       | 1.0       | 4.00         | 104019-04 |           | \$318.00   |
| ~3~   |                | 006802 | CONDUCTIVE RODS FOR SWITCH #6013-HC-T-C-2<br>AMETEK   | 6.0       | 1.0       | 4.00         | 104019-05 |           | \$212.00   |
| ~3~   |                | 000008 | ELECTRO-STATIC PRECIPITATOR GROUNDING TOOL SET<br>#T600-0891 HUBBEL/CHANCE  | 1.0       | 0.0       |              | 104318-01 |           |            |
| ~3~   |                | 005070 | PRESSURE SWITCH #J120-191 ARCO  | 3.0       | 1.0       | 3.00         | 104318-02 |           | \$450.00   |
| ~3~   |                | 007760 | PRESSURE GAUGE ISOLATOR- NO GAUGE<br>0-200 PSI<br>MATERIAL: PVC<br>1/2 IN. NPT INLET CONNECTION<br>#5345-030 RYAN HERCO | 2.0       | 1.0       | 3.00         | 104318-03 |           | \$99.00    |
| ~3~   |                | 007760 | FLOW INDICATOR<br>1 IN NPT PIPE SIZE, L=5.25 IN. , D=3 IN.<br>MATERIAL: PVC<br># 5360-010 RYAN HERCO                    | 2.0       | 0.0       |              | 104318-04 |           |            |

| Level              | Drawing Number   | Code   | Description  | Total Qty | Rec Stock | Delv (Weeks) | ID #      | Article # | Unit Price |
|--------------------|------------------|--------|--|-----------|-----------|--------------|-----------|-----------|------------|
| ~3~                |                  | 005530 | TUBE FLOWMETER 0.5-5 GPM #4350K42 MCMaster-CARR  | 1.0       | 0.0       |              | 104448-17 |           |            |
| ~3~                |                  | 007760 | FLOW INDICATOR<br>ROTAMETER NO SWITCH, 0.6-7.6 GPM<br>1 IN. DIA.<br>MATERIAL: PVC, POLYSULFONE<br>#5836-130 RYAN HERCO | 1.0       | 0.0       |              | 104807-01 |           |            |
| ~3~                |                  | 007760 | FLOW INDICATOR<br>ROTAMETER NO SWITCH, 10-100 GPM, 2 IN. DIA.<br>MATERIAL: PVC, POLYSULFONE<br>#5836-153 RYAN HERCO    | 1.0       | 0.0       |              | 104807-02 |           |            |
| ~3~                |                  | 006420 | SADDLE CLAMP PH-ORP PROBE 2-1/2"<br>#PV8S025 SIGNET  | 3.0       | 0.0       |              | 105807-01 |           |            |
| ~3~                |                  | 006420 | SENSOR CAP PH-ORP PROBE<br>#P31542 SIGNET  | 3.0       | 0.0       |              | 105807-02 |           |            |
| <b>A84-100-009</b> |                  |        | <b>CONTROL PANEL</b>   |           |           |              |           |           |            |
| ~3~                | A84-100-E-1\$\$6 | 002700 | CONTROL PANEL CONTROL PANELS INC.<br>SEE ELECTRICAL MANUAL FOR SPARE PARTS   | 1.0       | 0.0       |              | 105945-01 |           |            |
|                    |                  |        | DWYER/LOVE TEMPERATURE INDICATOR FOR PROCESS<br>INPUT 4-20MA, 120 VAC INPUT POWER LC1108-0-0                           | 1.0       | 0.0       |              |           |           |            |
| ~4~                |                  | 2920   | RELAY CARD FOR TEMP. INDICATOR #LCIA-01 DWYER  | 1.0       | 0.0       |              | 105946-02 |           |            |
| ~4~                |                  | 7365   | POWER FLEX 70 VFD #20AD027A2AYANN A-B  | 1.0       | 0.0       |              | 105946-03 |           |            |
| ~4~                |                  | 6802   | LEVEL CONTROL RELAY #5200-LF1-OC B/W CONTROLS  | 8.0       | 0.0       |              | 105946-04 |           |            |



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| <b><u>A84-100-Electrical-D-xx</u></b> .....                    | <b>WESP-2F Electrical Wiring Schematics</b> |
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## **ELECTRICAL CONTROLS**

### **CONTROL SYSTEM/ OPERATION**

The Wet Electrostatic Precipitator has one Main Control Panel with a Variable Frequency Drive that controls and monitors the system.

The system is wired with relay logic and controlled by stand alone controllers.

### **INSTALLED ELECTRICAL EQUIPMENT**

Main control panel containing the following:

- 1 - NEMA 4 cabinet with main disconnect.
- 1 - 460/120 volts AC step-down control transformer
- 1 - 120 volts AC/24 volts DC power supply
- 1 - High limit temperature controller
- 2 - pH controller
- 1 - ORP controller
- 2 - Level controller
- 1 - Allen-Bradley VFD



## PROCESS CONTROL CONSIDERATIONS

- See function description reference in Drawing List section.
- [Electrical\A84-100-000-W-01-WowWespFunction.doc](#)

## ELECTRICAL SCHEMATIC DRAWINGS

- See Electrical Wiring Schematics in Drawing List section.
- [Wiring Schematics as PDF](#)
- [Wiring Schematics as DWG in ZIP](#)

## ELECTRICAL EQUIPMENT LIST

- [A84-100-000-E-List-WowWespElecEquipList.xls](#)