Product User Manual

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EPRI Commercial Microwave Fabric Dryer

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WARRANTY

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This warranty supercedes all other warranties, expressed or implied. No warranty is given covering the product for any particular purpose other than as covered by the applicable product specifications. GAE assumes no liability in any event for incidental or consequential damages, financial losses, penalties or other losses incurred in conjunction with the use of GAE products.

DOCUMENT CONVENTIONS



NOTE: *Means the reader should take note. Notes contain helpful information, suggestions, or references to other sections, chapters, or documents.*



CAUTION: *Means the reader should be careful. You are doing something that might result in equipment damage or loss of data.*



WARNING: *Means danger. A situation exists that could cause bodily injury or death. All personnel must be aware of the hazards involved with high voltage electrical circuitry and high power microwave devices.*



WARNING

The microwave dryer described in this manual is capable of producing a microwave field that is potentially hazardous to operating personnel. The unit must never be connected or operated in a manner that allows a field in excess of 10 milliwatts per square centimeter to be generated in an area accessible to operating personnel. Contact GAE, Inc. for technical support prior to installation and/or operation of these units if there is any question or concern about microwave leakage.

All electrical cable connections must be secure prior to operation. Never operate the microwave dryer without a properly rated absorbing load inside the oven cavity. To ensure safe operation and prevent microwave leakage, the equipment must be periodically inspected and maintained as required or recommended.

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ATTACHMENTS:

Document Type	Number	Title
Drawing	910037	Outline Drawing
Drawing	910038	Block Diagram, Control System
Drawing	910048	Schematic Diagram, Comm Mw Fabric Dryer
Drawing	910049	Schematic Diagram, Microprocessor Interface
Drawing	910050	Line Power Distribution Diagram

INTRODUCTION

The EPRI Commercial Microwave Fabric Dryer ("CMFD") was designed and constructed by AGL, Inc. under contract from the Electric Power Research Institute for the purpose of on-site demonstration and evaluation of the microwave fabric drying process. However, prior to completion of construction of the CMFD the contract was terminated with AGL and funding for the dryer development program at EPRI was temporarily halted.

During its hiatus the dryer program was transferred to GAE, Inc. to await funding for completion of construction and general refurbishment of the CMFD. Renewed interest in the program focused around potential industrial applications in textiles manufacturing. A contract was awarded to GAE to complete the dryer's construction and deliver it for on-site installation and operation.

While most of the dryer's original functionality remains intact, certain functions and features have been altered or deleted from the original design specification due to discrepancies or conflicts in their operation. Some of these alterations were necessitated because of insufficient time and/or funding in the current program to adequately resolve the issues, while others are required in order to address inherent deficiencies in the original design. These changes are identified and discussed in detail within this Manual where applicable.



NOTE: *While GAE has made extensive efforts to ensure safe and reliable operation of the CMFD, Gerling Applied Engineering, Inc. hereby disclaims all responsibility or liability for poor reliability, unsatisfactory performance, unsafe operation or any other problem associated with the design and construction of the CMFD. Operators and end-users assume all risks associated with operation of the CMFD.*



WARNING: *Lethal voltages may exist inside the CMFD during operation and non-operation. All maintenance and service must be done by qualified technical personnel only. Under no circumstances should untrained or unskilled personnel be allowed access inside the CMFD.*

GENERAL DESCRIPTION

The EPRI Commercial Microwave Fabric Dryer (“CMFD”) is designed for field trials of the microwave fabric drying process in commercial establishments to dry fabric loads up to 12 pounds. It combines microwave energy with conventional hot air to dry almost any type of fabric load at faster rates and lower temperatures than conventional dryers using hot air alone. A microprocessor control system coordinates operation of the dryer by collecting data from a variety of sensors to optimize performance and ensure safety.

The microwave energy is supplied by three separate 1.8 kW generators for a total microwave power input of 5.4 kW. Hot air is provided by three separate 1.5 kW duct heaters. Energy efficiency is maximized by recycling the waste heat from the microwave generators and other heat producing electronics, providing a total hot air capacity of approximately 6.5 kW.

Selectable drying cycles include Regular and Delicate (the Dryness selector has been disabled). The Regular drying cycle combines microwave energy with hot air and cuts the drying time to 1/3 that of conventional dryers. The Delicate cycle eliminates hot air altogether and uses only microwave to provide the lowest temperature drying.

The CMFD includes state-of-the-art safety features to protect both the dryer and operator from improper operation and use. A variety of sensors are provided to detect the presence of improper materials in the drying load and shut off the dryer. An indicator is provided on the control panel to warn the operator to check the load. Additional sensors are provided to monitor the dryer operation and performance and shut off the dryer in the event of malfunction.

Facilities requirements for the CMFD are the same as those for conventional commercial dryers. The input line power required is 208-220 VAC, single phase, 60 Amps, and the exhaust connection is to a standard 4” diameter duct. No cooling or gas connections are required.

Electrical Specifications

Microwave Power	5.4 kW (nominal) provided by three 1.8 kW generators
Magnetrons	Hitachi 2M130
Hot Air	6.5 kW (approx.) provided by three 1.5 kW duct heaters plus 2 kW from recycled waste heat
Line Power Input	208-220 VAC, Single Phase, 60 Amps (2-wire plus ground)

Mechanical Specifications

Basket Size	26” diameter x 20” deep
Basket Capacity	12 Pounds (dry weight, 100% moisture retention)
Door Opening	16” Wide x 10” High
Exhaust Duct	4” Diameter
Free Air Displacement	175 CFM (approximate)
Overall Dimensions	30” High x 36” Deep x 62” High
Weight (approx.)	700 lb. net; 960 lb. shipping

Controls

Cycle Start	Pushbutton
Cycle Stop	Pushbutton
Cycle Select	3-position rotary switch for “Regular” and “Delicate” settings (“Permanent Press” setting has been disabled)
Dryness	(Disabled)
Fault Indicators	“Check Load”, “Arc Detect”
Cycle Timer	Programmable timer initiates “End of cycle” routine upon time-out

Sensors

Dryer Operation	Exhaust air thermostat, exhaust air relative humidity, exhaust air temperature (Moisture contact sensor has been disabled)
Thermal Cut-outs	Magnetrons (3), duct heaters (3), exhaust air
Safety	Door interlock switches, microwave field strength detector, arc detector, exhaust gas sensors

INSTALLATION

Preliminary Inspection

Upon arrival at the installation site the CMFD should be thoroughly inspected for damage or wear caused during shipping. Any visible damage to the shipping crate or CMFD should be noted and reported immediately to the shipping company in accordance with standard claims procedures. Prior to connecting line power the outer covers should be removed and all electrical connections inspected for loose or disconnected wires. All mechanical components should also be inspected for any loose or broken hardware or other wear that may have been caused during shipping.

Facilities Requirements

- Line Power: 208-220 VAC, 60 Hz, single phase, 60 Amps, 2-wire plus ground. Proper earth ground must be provided. Please note that, while an internal line filter is provided, the CMFD has not been tested for immunity to noise, spikes or other line power conditions that may be present in typical industrial environments. A line conditioner and/or regulator may be required for satisfactory operation of the CMFD.
- Exhaust Duct: Standard 4” diameter dryer exhaust duct. Back pressure must be minimized.
- Environment: Indoors only, must be clean and dry. The allowable extremes of ambient temperature and humidity have not been tested and are thus unknown. Ambient conditions should be maintained as close to mid-range as possible to ensure reliable operation.

Location

The CMFD may be installed and operated on any level surface. Adequate clearance must be provided on the sides and front near the louvered ducts to allow sufficient intake of dryer air.

Electrical Connections

- Line Power: A 4-conductor Hubbell ‘Twist-lock’ type connector is provided at the back of the CMFD. Connections are to two phases plus ground with no neutral connection. A mating connector and power cord is also provided. Pinouts are as follows:
  X Phase A (any of three phases)
  Y Phase B (either of remaining two phases)

G	Ground
W	No connection (normally used for neutral)

- Line Current Monitoring: An 11-pin ‘MS’ style circular connector (J1) located on the back of the CMFD provides three separate analog voltage signals that are proportional (10VDC = 100A) to the line current drawn by corresponding subsystems within the CMFD. A mating connector is also provided. Pinouts are as follows:

Pins A (+) and B (-)	Microwave power supply current
Pins C (+) and D (-)	Basket and blower drive motors current
Pins D (+) and E (-)	Duct heaters current (output disabled)
Pins F and H	Not used (reserved for later use)
Pins K, L and M	No connection

BASIC OPERATION

Operation of the CMFD is very similar to that of a conventional residential clothes dryer. A typical sequence of events is as follows:

- Load fabrics to be dried and close door
- Select drying cycle
- Press ‘Start’ button to begin drying
- Wait for buzzer signaling end of drying cycle
- Open door and remove dried fabrics

While this operation sequence appears to be relatively simple, there are many subtle aspects of the CMFD’s operation as explained below that should be fully understood by the operator.

Initial Power-Up

After connecting line power as described in the “Installation” section of this manual, power is applied to the CMFD by lifting the circuit breaker handle located near the line power connector on the back panel. This applies power to various low voltage power supplies which in turn supply power to the microprocessor and other controls.



NOTE: *One of the subsystems to which initial power is applied is the suite of four separate gas sensors. These sensors require a warm-up period of approximately one hour for stable performance.*

Line power can remain on indefinitely, so there is no need to turn off and disconnect line power between daily periods of operation. However, as a safety precaution it is recommended that line power be disconnected during extended periods of non-operation.

Dryer Loads

The CMFD is designed to accommodate most typical fabrics used in clothing or other standard textile products. However, it should be noted that some fabrics may contain certain materials that will result in fault conditions during the drying process. While the CMFD is designed to protect itself and the operator from such loads, the operator should take necessary precautions to avoid loads containing the following materials:

- Metallic fabrics such as woven metal screens
- Metallic or metalized threads
- Heavily studded, sequined or ornamented fabrics (a few metal studs or metal zippers are generally OK)

- Non-fabric objects such as pencils, cigarette lighters, coins, hair pins, etc.

The CMFD generally performs better and more reliably with full loads than with lighter loads. Also, loads should be evenly wetted as would be typical following a standard wash cycle with spin drying.



CAUTION: *Loads must not contain excessive amounts of moisture such that water is allowed to accumulate inside the dryer cavity and/or drip down from the dryer basket. Failure to prevent water accumulation and dripping may result in electrical damage to the CMFD. Spin drying of all loads prior to microwave drying is highly recommended.*

Drying Cycle Setting

Any one of three drying cycles can be selected depending on the type of fabric load.

- Regular: This cycle combines microwave energy with conventional hot air. During the drying stage all three microwave power supplies are on while two of the three duct heaters are on. The final stage of the drying cycle is a three minute cool-down period during which the microwave supplies and duct heaters are all turned off.
- Delicate: This cycle utilizes only microwave energy to provide the lowest temperature drying of the three cycles. Heated air is provided only by the waste energy that is dissipated by and salvaged from the microwave power supplies. As with the other cycles, the final stage is a three minute cool-down period during which all microwave supplies and duct heaters are turned off.

Cycle Start

Close the dryer door and press the ‘Start’ button to begin the drying cycle. The basket will immediately begin to rotate and the main blower will operate. Approximately five seconds later the microwave power supplies will be turned on as can be verified by the ‘clack’ of the associates contactors.

Failure to start properly will usually be due to one the following:

- An interlock is not satisfied, in which case the buzzer will immediately sound for ten seconds (see general fault cycle described below). Check to be sure the door is closed tightly and all covers are in place, then try again.
- One or more gas sensors have caused a fault condition, in which case the basket and blower will operate but the ‘clack’ of

the microwave power supply contactors will not be heard (see gas sensor fault cycle described below). Try starting again after the end of the fault sequence (ten-second buzzer turns off), but discontinue starting and check the load if the fault cycle is repeated.

NOTE: *When starting the drying cycle for the first time following initial power-up (see above), the gas sensor fault cycle (see below) may be initiated due to insufficient warm-up of the gas sensors. This should not occur during subsequent starts unless line power is turned off and then back on again.*

Cycle Stop

Once started, the drying cycle will continue until one of the following occurs:

- The cycle ends normally when moisture has been sufficiently removed. The buzzer will sound for two seconds to indicate the normal end of cycle.
- The 'Stop' button or the door switch may be pressed to stop the drying cycle at any time and for any reason. This action initiates the fault cycle during which the buzzer will sound for ten seconds.
- A fault condition as explain below will stop the drying cycle automatically.

The drying cycle can be restarted following any of the above stop events once the buzzer has sounded.

WARNING: *Fabrics may be hot due to heated moisture during the drying cycle and can cause severe burns if improperly handled. The operator must exercise extreme caution when opening the cavity door and handling fabrics during the middle of a drying cycle.*

Sensor Lint Screen Burn-off

The final stage of the drying cycle following the end-of-cycle buzzer is a ten-second period during which the sensor lint screen burn-off occurs (see related discussion in Theory of Operation section). The operator is typically unaware that this burn-off is occurring. However, if the cavity door is opened during this period then the general fault cycle will be initiated (see below).

Fault Cycles

Any of the following fault cycles may be initiated during the drying cycle due to abnormal operating conditions.

- General Fault Cycle: This cycle occurs when any one of several interlock devices (covers, lint screen door, cavity door, thermal cutouts) becomes dissatisfied or the microwave field strength exceeds specified limits. During this cycle the 'Check Load' lamp immediately lights up, the basket and blower both stop and the buzzer sounds for ten seconds. The load must be checked prior to restarting.
- Gas Sensor Fault Cycle: This cycle is similar to the general fault cycle except that it begins with a thirty second period during which the microwave power supplies and heaters are turned off (as evidenced by the 'clack' of the contactors turning off) but the basket and blower continue to operate. This first stage is immediately followed by a stage identical to the general fault cycle described above. Aside from the clack of the contactors, the operator may be completely unaware that this fault cycle has been initiated until the second stage begins. Checking the load will usual provide clues to help differentiate between gas sensor and general faults.
- Arc Detect Fault Cycle: The presence of metallic fabric or objects can, when combined with light loads and high field strengths, cause arcing to occur inside the dryer cavity. Arcs are detected by a photo diode which sends a voltage signal to sensitive electronic circuitry that initiates the fault cycle. During an arc detect fault cycle the 'Arc Detect' lamp is turned on and the drying cycle is immediately stopped. The 'Stop' button must be pressed to clear the fault condition and reset the dryer for normal operation.



NOTE: *Due to unresolved difficulties associated with nuisance tripping of the arc detect circuit, this feature has been temporarily disabled. However, other protection devices remain in place (such as the gas sensors) which will adequately protect the dryer and operators from harm in the event of conditions that could cause arcing in the dryer cavity.*

Lint Screen Cleaning

The lint screen, located inside the panel beneath the cavity door, should be inspected regularly and cleaned as necessary. Failure to properly clean the lint screen may result in inadequate air flow and faulty operation of the CMFD.

THEORY OF OPERATION

This section explains in detail the various functions, features and control sequences of the CMFD. Knowledge of these details will assist the operator and service personnel to understand how the functions interact, interpret process results and diagnose operational difficulties. Refer to the attached schematic drawings for further details in conjunction with the discussion below.

Dielectric Heating

Microwave, or dielectric heating occurs when electromagnetic fields oscillating at a specific frequency (2450 MHz) interact with certain kinds of molecules (having a high dipole moment). These molecules try to align themselves with the electric fields as they rapidly reverse polarity at the oscillating frequency, causing them to vibrate. The resulting friction between adjacent molecules generates heat.

Materials containing highly polar molecules are said to be “lossy” because they readily absorb microwave energy. A measure of this lossiness is a property of the material known as its dielectric loss or loss tangent. Water is a good example of a lossy material because its molecules have a high dipole moment. Most fabrics are made of materials having a relatively low dielectric loss, far lower than that of water.

In the microwave fabric dryer microwave energy is absorbed primarily in the water rather than the fabric, resulting in heating and vaporizing of the moisture. The fabric tends to stay relatively cool because it is not being heating directly. By contrast, the hot air used in conventional dryers heats the fabric and the moisture simultaneously, resulting in higher overall drying temperatures.

However, as moisture is vaporized and leaves the microwave dryer the tendency to heat the fabric directly becomes greater. If microwave energy remains on after the moisture has been removed then damage to the fabric from burning could result.

Microwave Power Generators

The microwave power generators used in the CMFD consist of three main elements, a magnetron oscillator, a high voltage power supply and a filament power supply. The magnetron is a vacuum tube oscillator that is designed operate at the desired frequency (2450 MHz). Like other types of vacuum tubes it contains an anode, a cathode and a filament (heater) and operates when the filament is hot and a sufficiently high voltage is present across the anode and cathode.

The high voltage, also referred to as the “plate” voltage, is generated in the CMFD using a “full wave voltage doubler” power supply. This power supply consists of two separate power supply sections operating on alternate phases of the line cycle. Each section, also referred to as a “half wave voltage doubler” and known for its output voltage regulating characteristics, is similar to power supplies used in conventional microwave ovens. A diode network combines the outputs of these two sections to deliver a fixed voltage to the magnetron which in turn delivers fixed output microwave power to the dryer.

The filament power supplies consist simply of a high current isolation transformer and a network of variable resistors to control the voltage delivered to the transformer primary winding. Because of backheating inside the magnetron, the voltage required during operation is lower than during idle periods. A relay whose contacts are used to change the amount of resistance in the primary line is energized whenever line voltage is applied to the plate voltage power supply. To provide a short warm-up period prior to application of plate voltage, the filament power supplies are turned on approximately five seconds before the plate voltage supplies.

Field Strength Sensor

The field strength sensor monitors the electric field strength inside the dryer cavity. It operates by sensing the microwave field using a small wire probe and converting the signal to a DC voltage using a crystal diode. The microprocessor monitors the field strength signal and controls the amount of microwave power as required to prevent damage.

The field strength varies with the level of microwave power delivered to the cavity and the amount of moisture (and fabric) inside the cavity. If the field strength is too high then damage could result to the fabrics and/or dryer.

At the beginning of the drying process moisture content is generally high, thus the field strength is relatively low. As the drying process progresses and moisture is removed from the dryer cavity the field strength gradually climbs. If the field strength signal reaches or exceeds a setpoint value roughly equal to 80% of the maximum allowable field the microprocessor shuts off one of the magnetrons by de-energizing a relay, thus lowering the field strength to within acceptable limits and allow the drying process to continue. As drying progresses and the moisture content continues to drop, field strength will again reach a the setpoint value. At this point the microprocessor will turn off a second magnetron to further reduce the field strength. The drying process will then continue with only one magnetron operating until the field strength setpoint is reached.

This time the microprocessor will turn off all magnetrons and initiate the “End of Cycle” routine.

By this discussion it can be understood that full loads are preferred to light loads so as to maintain the electric field strength at relatively low levels throughout the drying process.

As the basket rotates and the fabrics tumble inside the dryer cavity the electric field pattern is constantly changing. Thus, the electric field seen by the field strength sensor is constantly changing and results in wide variations of the output signal. The peak values typically remain well below the setpoint values at the beginning of the drying cycle, but towards the end of the cycle they can easily exceed the setpoint values while the more important time averaged value is still below the setpoint. To help compensate for these variations the microprocessor calculates the average value of the 25 most recent field strength readings and uses the result for the interlock function.

Arc Detector

Electrical arcing can occur inside the dryer cavity under certain conditions, typically when loose metal objects are present and the electric field strength is high. Arcs can result in scorching of fabrics and possibly an open flame if allowed to continue unchecked.

Arcs are detected using a photo diode that generates a small voltage proportional to the amount of light inside the dryer cavity. The duration of an arc is usually very short, so the detector circuitry amplifies the signal pulse and “stretches” it sufficiently to energize a relay and shut down the CMFD. When this occurs the ‘Arc Detect’ lamp on the front panel turns on to notify the operator of the event. The operator must then reset the CMFD by pressing the ‘Stop’ button.



NOTE: *During testing of the CMFD the arc detector was causing numerous false shut-downs due to electrical interference from other circuitry within the CMFD. A significant amount of time was spent trying to isolate and correct the problem, but no solution was found the would prevent such nuisance tripping. As a result, the arc detect circuit was temporarily disabled. However, it was decided that the presence of the field strength and gas sensors will adequately protect the operator from harm and CMFD from damage in the event that arcing occurs inside the dryer cavity.*

Exhaust Humidity Sensor

The relative humidity of the exhaust air is measured using a sensor whose output voltage is proportional to relative humidity and calibrated in percent RH. This signal currently is not used actively

by the microprocessor for control of the CMFD, but rather it is provided only for data acquisition purposes.

Exhaust Gas Sensors

A series of four sensors monitor the exhaust air for the presence of specific compounds commonly found in smoke or other products of combustion. Each sensor is designed to detect a different set of compounds as defined in the following chart:

Gas Sensor Compound Sensitivity		
Sensor Number	Figaro Type	Compounds Detected
1	822	Toluene
2	825	Hydrogen Sulfide
3	842	Methane, Propane, Butane
4	882	Alcohol

The sensors operate by passing a current through a selective adsorbent element whose resistance varies as compounds are adsorbed. The output voltage varies with this resistance and increases as compounds are adsorbed. The microprocessor monitors the output voltage and triggers the gas sensor fault cycle (see Basic Operation section) when its slope exceeds a preset value.

The sensor elements operate most effectively at an elevated temperature, thus a heater voltage (+5 VDC) is supplied in addition to an instrument voltage (+10 VDC). These voltages are supplied whenever line power is connected to the CMFD and the main circuit breaker is turned on. A warm-up period of up to one hour is required for stable and reliable operation of the sensors.

Magnetron Thermal Cutouts

Each magnetron is protected from overheating by a thermal cutout switch device mounted to its side. Each thermal cutout is connected in series with the coil of the contactor that turns on the respective magnetron power supply. If a magnetron overheats then its associated cutout opens and turns off only the power supply to that magnetron. Since the blower continues to operate, the magnetron will cool down until the thermal cutout resets and turns the power supply back on.

Sensor Lint Screen Burn-off

To protect the exhaust gas sensors from fouling due to lint accumulation, a lint screen separates the sensors from the flow of air in the exhaust duct. But if lint is allowed to accumulate on this

screen then it will gradually reduce the flow of exhaust air to the sensors, thus reducing their sensitivity.

To prevent continual accumulation of lint on the sensor screen the lint is burned off at the end of every drying cycle by applying an electrical current through the screen. This current is high enough to cause the lint to smolder but not ignite into an open flame. The burn-off period occurs after the blower stops so that the flow of air does not prevent the burn-off temperature from being reached. The lint ash is then carried away by the exhaust air at the start of the next drying cycle.

Low Voltage Power Supplies

Several low voltage power supplies provide power to various control circuits. These power supplies are on whenever line power is connected to the CMFD and the main circuit breaker is turned on. Their functions are described as follows:

- 24 VDC Power Supply – This power supply is the primary source of control power to the CMFD. Several devices are powered by this supply directly while others are powered through additional circuitry. Devices connected to the output of this power supply are protected by a 5 Amp fuse.
- Gas Sensor Power Supply – This power supply is dedicated to only the gas sensors to provide +5 VDC for heater power and +10 VDC for signal power. This dedication is necessary to maintain stability of the supply voltages to help prevent erratic performance of the sensors.
- Voltage Regulators – Two voltage regulators provide +15 VDC to the humidity sensor and +5 VDC to the microprocessor and various other devices and circuitry.

Drive Motors

Two different electric motors are used to drive the blower and dryer basket. Both motors operate simultaneously during all periods of dryer operation except when the buzzer is on (fault or end-of-cycle) and during the sensor lint screen burn-off.

The blower is driven by a fixed speed AC motor while the basket is driven by a variable speed DC motor. The speed of the basket motor, and thus the basket rotation speed, can be varied by adjusting a trimming potentiometer (R10) located near the bottom edge of the microprocessor interface PC board.



CAUTION: *Excessive basket rotation speed can cause damage to the internal basket support rollers and drive mechanism. The basket speed should be such that the fabrics are allowed to fall*

freely through the center of the cavity as they tumble. In any case, the maximum allowable basket rotation speed is 60 rpm.

USER MAINTENANCE

The CMFD is designed to relatively maintenance free. With the exception of the lint screen, there are no operator serviceable parts or subassemblies inside the CMFD.



WARNING: *Lethal voltages may exist inside the CMFD even during periods of non-operation. All service personnel must be aware of the hazards involved with high voltage electrical circuitry and high power microwave devices. In the event service becomes necessary, all repairs should be performed by a qualified service technician.*

Lint Screen Cleaning

The lint screen, located inside the panel beneath the cavity door, should be inspected regularly and cleaned as necessary. Failure to properly clean the lint screen may result in inadequate air flow and faulty operation of the CMFD.

PROCESS DATA COLLECTION

The microprocessor controlling the CMFD is provided with a dedicated serial port B which can be used to send information processed by the microprocessor to a remote data acquisition system. A ribbon cable terminated with a 9-pin subminiature “D” type connector is provided at the back of the CMFD for this purpose.

The microprocessor control software is designed to deliver the following parameters through this serial port:

- Exhaust Temperature
- Exhaust Relative Humidity
- Microwave Field Strength

A typical IBM compatible personal computer can be used to collect the data delivered by the microprocessor. The serial port on the computer is used to collect the data and should be setup as follows:

COM 1
19,200 baud
No parity
8 data bits
1 stop bit
No handshaking

Terminal Emulator Data Logging

Any terminal emulation program (such as HyperTerminal provided with MS Windows 95) can be used to directly read the last values sent by the microwave dryer CPU. The serial string received will be a comma-delimited ASCII string currently configured to send the last sampled temperature, humidity, and field strength values. The typical string will be formatted as follows:

TEMP,<temp_value>,F,HUMID,<humid_value>,%,FLDSTR,<fldstr_value>,%

The temperature value will be an integer between ambient and 250 degrees F. The humidity value will be a floating point between 0.0 and 100.0 %. The field strength value will be a running average of the last twenty five values sampled and will be a floating point between 0.0 and 100.0 %. If any of the fields contain {****} it represents an over-range value.

MS Excel Spread Sheet Data Logging

An Excel spread sheet application (UWAVE.XLS) has been developed which, in conjunction with WinWedge application

software, will collect the serial data directly and log all of the samples in sequential order. The spread sheet then continuously calculates and displays statistics for each of the three data values.

The Excel spread sheet can be opened from either Windows 95 or Windows NT. However, Windows NT is highly recommended due to the enhanced speed of the transmitted data.

After opening the spread sheet any residual values in the cells should be cleared using the [CLEAR] button in the upper left hand corner. After the spread sheet is cleared the WinWedge software program must be initiated one time by clicking on the respective button. This program will link the serial data received to the Excel spread sheet using the windows DDE communication. The program can also be started using the shortcut keys {CTRL-SHIFT-W} but care must be taken to ensure that only one program is running at any given time.

After the WinWedge software has successfully started the ribbon cable from the CMFD can be connected to the remote computer's COM1 serial port to begin logging data. The number of samples collected will be indicated in the upper left hand corner of the spread sheet. After the dryer cycle the cable should be removed to stop collection and charts can be automatically generated using the special buttons provided. The spread sheet should then be saved to a unique file name so that the template spreadsheet file UWAVE.XLS can be used repeatedly. After the spread sheet has been saved, close and then reopen the UWAVE.XLS spreadsheet in order to start from the top of the sheet.



NOTE: *The UWAVE.XLS spreadsheet must reside in the [c:\uwave] subdirectory, and the WinWedge software and associated configuration file (uwave.sw3) must reside in the [c:\Program Files\winwedge] subdirectory so they can be located by the Excel spread sheet.*