



REPLACEMENT

**OPERATOR' S
MANUAL**

Model 12CF-154 (S)

Controlled Atmosphere
Conveyor Furnace

S/N: 3360

Created expressly for:

RGL Enterprises
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OPERATION, INSTALLATION AND MAINTENANCE MANUAL

NOTE

This manual has been prepared to cover a general line of MRL equipment, and in some cases reference may be made to items which are not included in your unit. Wherever variables that might cause operating difficulties occur, this manual should apply specifically to your unit.

Failure to maintain recommended spare parts can create problems involving unnecessary down-time. Parts used, other than those specified, can cause improper operation of the furnace.

Disclaimer

Although this manual has been validated and reviewed for its accuracy, it is subject to change without notice. Therefore **MRL INDUSTRIES** assumes no liability for damages incurred directly or indirectly from errors, omissions or discrepancies between this manual and the corresponding unit.

INTRODUCTION

MRL Industries is pleased to supply a replacement manual for a 12CF-154(S) Controlled Atmosphere Conveyor Furnace to RGL Enterprises. This manual is intended as a reference document to assist you with system installation, operation, maintenance. It also includes support system drawings and a spare parts list.

MRL Industries is a customer service-oriented organization dedicated to fulfilling specific end user requirements in the area of continuous heat processing. If you need any additional information or customer service for your MRL continuous heat processing equipment please contact your local Sales Agent. Service assistance may also be arranged directly through the factory at (209)533-1990, OR fax (209)533-4079. our SERVICE DEPARTMENT IS OPEN FROM 6:00 a.m. to 6:00 p.m. to aid you.

INTRODUCTION (Continued)

This MRL Industries 12CF-154(s) Conveyor Furnace utilizes a domed metallic muffle and a removable burnout exhaust plenum (educto) in order to properly maintain a clean, contamination free atmosphere. The muffle is heated by wire-wound heating elements embedded in a ceramic base. The heating elements are installed in segments around the muffle and each segment is independently connected to the power supply so that a maximum amount of zone control may be attained. All materials exposed to the interior of the hot zone, muffle, and belt are of a suitable high temperature alloy chosen for its long life at the zone temperature involved. A water-cooled exit chamber is provided in order to speed the cooling of parts emerging from the furnace.

A conveyor belt of flexible, link construction is supported throughout the entry, hot zone, and cool zone on the bottom of the muffle. The drive system is at the furnace exit end and the slack take-up occurs just beyond the drive pulley and beyond the unloading table.

A processing environment of air or nitrogen with doping is offered. Also, a multiple port sample system and an oxygen analyzer are options for customer monitoring of atmosphere throughout the muffle.

The temperature is accurately controlled by a multichannel microprocessor bases temperature controller.

IMPORTANT: Zones 1 and 14 have a maximum rated temperature of 600°C; zones 2-13 are rated to 1100°C.

INSTALLATION

CAUTION: MRL furnaces are prepared for shipment with extreme care in order to avoid handling damage. Be sure all shipping ties, etc., are removed when unit is being prepared for installation.

Normally, the first step in the installation of a MRL furnace is the setting in place and leveling of the unit. Leveling can be accomplished by use of the leveling blocks provided on each leg. Care should be taken to ensure that adequate clearance is provided on all sides sufficient to suit the nature of the intended operation. No minimum clearance other than that needed for access to the doors and to the control panel and other controls is necessary. Clearance in the rear of the unit for normal maintenance is also recommended. The heat and fumes developed by the unit are not excessive, but adequate ventilation is recommended, particularly where continuous use is anticipated.

NOTE: Due to the frame shipping break, follow the attached "Installation Addendum."

After the unit is located and leveled, the following connections, as required, must be made:

Back Top of Furnace near Exit End

1. **Water Inlet** - The furnace is provided with a 3/8 inch female pipe coupling. A supply of 80 gallons per hour at 60 psi is recommended.
2. **Water Outlet** - The furnace is provided with a 3/8 inch female pipe coupling. This outlet may be plumbed to a cooling tower, as no minimum back pressure is required.
3. **Atmosphere** - The furnace is provided with a 3/8 inch female pipe couplings. A maximum of 1440 scfh air or nitrogen and 3 scfh dopant gas is recommended. All input pressures should be 20 psig.

INSTALLATION (continued)

NOTE: Reference to the furnace wiring diagram for details of electrical connections should be made. It is recommended that the water line be thoroughly purged before connections are made to the furnace.

INSTALLATION ADDENDUM

This furnace has been broken into two sections for shipping and will require reassembly before normal installation procedures can begin. The following steps should be followed.

1. Ensure leveling feet are installed in both sections.
2. Locate main heated section where desired and level this section with the leveling feet.
3. Remove sufficient side panels from each section to gain access to the frame and muffle connections.
4. Set the cooling section approximately 12 inches from the main frame.
5. Disconnect the wire that has been fed through the cooling section muffle and tie it securely to the end of the conveyor belt in the heated muffle.
6. Pull the belt from the heated muffle through the cooling section onto the unload table. Also, disconnect the belt from the return track on both sections.
7. Move the cooling section frame to mate with the main frame while keeping the conveyor belt tight in order for the two muffles to mate. The muffles have been set in the proper position to their related frame at the factory. The cooling section frame would be adjusted to match the two muffle flanges. When correctly

ADDENDUM - (Continued)

matched, the scribe marks on each flange should be in alignment.

8. Bolt the two muffle flanges with the bolts provided. No gaskets are used between these two flanges.
9. Bolt the frames together with the bolts provided.
10. Atmosphere plumbing and electrical connection between frame sections should now be made. All interconnecting wires are either numbered or color-coded.
11. Connect the conveyor belt on the unload table and connect the belt under the muffle at the return track frame junction with connecting links provided. No welding of these connections is required.

Normal installation procedures can now be followed.

DETAILS OF CONSTRUCTION

Power Control

Voltage is applied to the heating coils through SCR power controller activated by the temperature controller.

Temperature Control

The temperature is controlled by a Watkins-Johnson 988 Microprocessor Based Temperature Controller. Chromel/Alumel thermocouples installed under and against the muffle provide the input signal to the corresponding controller channel.

Heating Elements

The heating elements consist of a helical winding of Kanthal A1 alloy wire supported in ceramic plate. These plates are assembled around the muffle. The elements are installed in short segments and each is individually wired so that maximum zone control can be achieved.

Muffle Section

The muffle is a gas tight Inconel 601 tube constructed with a domed top for strength. the muffle design allows for easy removal and replacement.

Burnout Exhaust Plenum (Eductor)

An integral part of this furnace design is a removable assembly installed in the roof of the muffle and supported on slide rails. The assembly (eductor) extends from the muffle entry to the end of the burnout zones. It is divided into four chambers with each having individual exhaust and inlet ports. This design enables burnout contaminants (binders) a means of removal prior to the firing section as well as inlets for controlled atmosphere inputs (i.e., nitrogen and/or dopants). The atmosphere flows can be controlled through the variable speed exhauster which is integrated into this assembly. See Drawing No. 975390 for details.

DETAILS OF CONSTRUCTION - (Continued)

Work Exit Section

The exit chamber walls are enclosed in a water jacket to speed the cooling of parts emerging from the furnace.

Water Cooling System

The cooling system consists of clamp-on liquid-cooled plates, a Penn valve and flow switch. Water enters the cooling section through a flow control switch located on the back side, exit end of the furnace. The water then flows through the liquid-cooled plates and into the drain line. The flow control switch determines the adequacy of the water flow. Failure of the water flow will light the indicator light, sound an alarm and disconnect the furnace power. The water cooling section is also provided with a temperature/flow regulating valve and a panel-mounted thermometer. Turning the adjustment screw on the temperature/flow regulating valve in a counterclockwise direction will produce a higher water temperature. The valve is preset at the MRL plant for the coolest temperature.

Insulation

Suitably rated block-type insulation is provided around the heating chamber. This insulation is quite durable in service, but care must be exercised in its removal for routing maintenance to prevent its damage.

Furnace Environment

A connection for furnace inlet gas is provided at the exit end of the furnace. Nine atmosphere flowmeters are provided as well as six dopant gas flowmeters. The furnace has been provided with a variable speed venturi exhauster at the entry to the heated section. The exhauster is integrated into the eductor and enables "counter-to-belt" flow. See the "Atmosphere Flow Schematic" section of this manual for more complete information.

DETAILS OF CONSTRUCTION - (Continued)

Conveyor Belt and Drive System

The nominal 12-inch wide wire mesh conveyor belt is supported throughout the furnace by the muffle floor. The cham drive system incorporates a DC motor and a SCR speed controller. Belt tracking is adjusted with self-aligning bearings which support each pulley.

Safety Circuits

1. Water Failure - Failure of the water flow will cause the indicator light to light, sound an alarm and shut off power to the elements and conveyor.
2. Thermocouple Break Protection - Thermocouple break protection is provided in the WJ-988 controller to shut off zone power in the event of a thermocouple open circuit.
3. Overtemperature Protection - Thermoguard overtemperature protection is provided. A thermocouple is located in the center of each zone. In the event of an overtemperature condition, the element circuit breaker will open, shutting down the heating element power.

CF FURNACE SAFETY SYSTEMS

Element Power

Primary power at 460V is first applied through a contactor and then a transformer and converted to a secondary power at 230V to the elements.

DETAILS OF CONSTRUCTION (Continued)

In order for the contacts to be closed, the following conditions must exist:

1. Water flow must be normal
2. Temperature sensed by the overtemperature controller must be below setpoint.
3. Control power switch must be closed. (This is the master switch for all control and alarm functions in the furnace.)

Failure of cooling water flow will energize the shunt trip coil, tripping the circuit breaker and removing power from the heating elements. It will also stop the conveyor belt so that heat is not continuously carried out of the furnace into the cooling section. At the same time, visual and audible alarms will be activated. Upon restoration of normal water flow, power may be reapplied to the heating elements by resetting the element power.

An overtemperature condition in the furnace will also remove power from the heating elements and activate visual and audible alarms. Following correction of the fault causing the overtemperature condition, it will be necessary to reset the particular overtemperature controller by pushing the appropriate reset button. The power may then be reapplied to the heating elements after resetting the element power.

INITIAL STARTUP

1. Turn on cooling water valves and check for adequate flow.
Check also for the possibility of leaks which may have occurred during shipment.
2. Connect atmosphere lines.
3. Open damper on atmosphere exhauster.
4. Set atmosphere system to desired configuration (see Atmosphere Flow Diagram). IMPORTANT: Set nitrogen supply regulator at 20 psi.
5. Set flowmeters at desired settings. Typical copper firing startup settings are: entry curtains - 80 cfh; burnout atmosphere(s) - 40 cfh; no dopant or prefiring; firing - 4 cfm; exit curtain - 4 cfm; total approximately 800 cfh.
6. Turn on conveyor power. Check to ensure the belt tracks properly. The belt alignment has been set at the factory and should not be adjusted unless grossly misaligned.
7. Refer to WJ-988 instruction manual and set zone temperatures at 600°C and maximum power level at 99%.
Set rise rate at 1.6 which will allow the furnace temperature to increase approximately 100°C per hour and allow to run for 24 hours to oxidize the elements. Raise the temperature to 930°C, following the same

INITIAL STARTUP - (Continued)

incremental procedure, and allow the run for 24 hours or until each part of the belt has been at 930°C for one hour of annealing time.

8. Set to desired profile.

OPERATING INSTRUCTIONS

The following steps should be followed each time the furnace is used. Detail under each item are omitted if they have previously been covered in the paragraphs under "Initial Startup."

1. Turn on cooling water and open master gas valves. Close main disconnect switch.
2. Switch on furnace. Check zone control settings. Check parameters for proper settings. Check for proper zone temperature settings.
3. Turn on atmosphere system and set to desired flow.
4. Turn on belt drive system and set to desired speed.
5. When furnace reaches operating temperature, parts may be inserted. The furnace should be brought up to temperature as stated in "Initial Startup."

Shut off furnace. Unless unit is to be used again shortly, all master valves should be closed and switches should be opened. Do not, however, open the conveyor switch until temperature throughout the furnace is less

OPERATING INSTRUCTIONS - (Continued)

than 300°C. Also, use reduced N2 flow (approximately 1/4 normal setting) until furnace temperature is below 600°C.

ATMOSPHERE SYSTEM

(Refer to Dwg. No. 973556)

The atmosphere in the muffle is controlled through suitable flowmeters depending on input location. The supply atmosphere couplings are located near the exit end along the back side. The supply gases are nitrogen, air, and/or dopant gases. All gases for this type of furnace are noncombustible. Also, as an option, all or some of the input locations can have dopant gas capability if needed. The following locations are input areas and, depending on the process, have been selected as the best areas for atmosphere control.

1. Entry and exit curtains to shield from unnecessary oxygen inputs.
2. The burnout exhaust plenum (eductor) is a removable assembly and has four atmosphere inputs for burnout control. The eductor also has the upper entry curtain input. The four inputs are spaced eight inches apart, and for each input there is an exhaust port. The exhaust ports also spaced eight inches apart. The positive pressure generated by the inputs enables a venturi type exhaust system to develop. This flow pattern is a vehicle for removing the burnout contaminants and exhausting the firing atmosphere.

OPERATING INSTRUCTIONS - (Continued)

3. The last two atmosphere inputs after the burnout zone(s) are the prefiring and firing. These are responsible for the environment before and during the firing process. The prefiring input is located between the burnout and firing sections. The firing inputs are located in the center of the cooling section on either side and are high volume inputs.
4. Atmosphere gas flows in all cases are counter to belt travel

The last system that is an integral part of the atmosphere system is the exhaust system. This system utilizes a variable speed exhauster that must be adjusted in conjunction with the atmosphere inputs to obtain the desired working atmosphere for each process. The burnout and firing atmospheres. It is located toward the entry of the muffle. A discussion on its use in conjunction with the atmosphere flows follows this section of the manual.

NITROGEN FIRING - EXHAUST SETUP

In order to achieve the maximum exhausting of the burnout products while maintaining the necessary oxygen level within the muffle, methods must be provided to accurately control the gas input and output. The exhaust plenum assembly provided in this furnace will accomplish this task. With flow meter settings as established in "Initial Startup, : turn on atmosphere sample system and

OPERATING INSTRUCTIONS - (Continued)

select the "cooling section" sample port. It may require several hours on this initial turn-on for the complete system to reach levels below 10ppm. When the analyzer indicates 10ppm or below, shift to the "entry sample" port and ensure no air is entering the muffle from entry end. Now increase the exhauster speed until the O2 level begins to increase, indicating air is being drawn in from the entry. Slowly decrease the exhauster speed until the O2 level again drops below 10ppm. At this time check the "cooling section" sample port to insure no air is entering there. If so, then increase exit curtain flow or repeat above procedure. Under these conditions maximum exhaust is being accomplished. As flow rates are changed to optimize performance, repeat the above procedures.

SAMPLING SYSTEM OPERATION

(Refer to Dwg. Nos. 975653 and 975840)

Prior to using the sampling system consult the Thermox Model TM-1A oxygen analyzer instruction manual to become familiar with the analyzer's operation. MRL recommends a thorough reading of this manual prior to using the sampling system.

NOTE: O2 analyzer is to be used in N2 mode only. Set sample system supply nitrogen regulator at 2 psi.

Prior to Sampling:

1. For the initial sample, when having changed from the air to n2, purge muffle with nitrogen for one hour.

To Sample:

1. Open desired sample valve. Open only one valve at a time to prevent sample mixing.

When sampling the nitrogen supply, turn pump motor off, open TM-1A flowmeter completely, use needle valve which samples the nitrogen supply to obtain recommended

SAMPLING SYSTEM OPERATION - (Continued)

2. height in TM-1A flowmeter. This precaution will eliminate the possibility of adversely affecting the unit's internal pump.
3. Operate oxygen analyzer in accordance with its instruction manual.

NOTE: Since the sample tubes are fairly long, it may take a significant amount of time for the readings to stabilize when changing sample points.

MAINTENANCE SCHEDULE

The following maintenance steps should be accomplished every three months when a furnace is in normal use. Experience may dictate a different frequency depending on usage, especially with the removable eductor assembly.

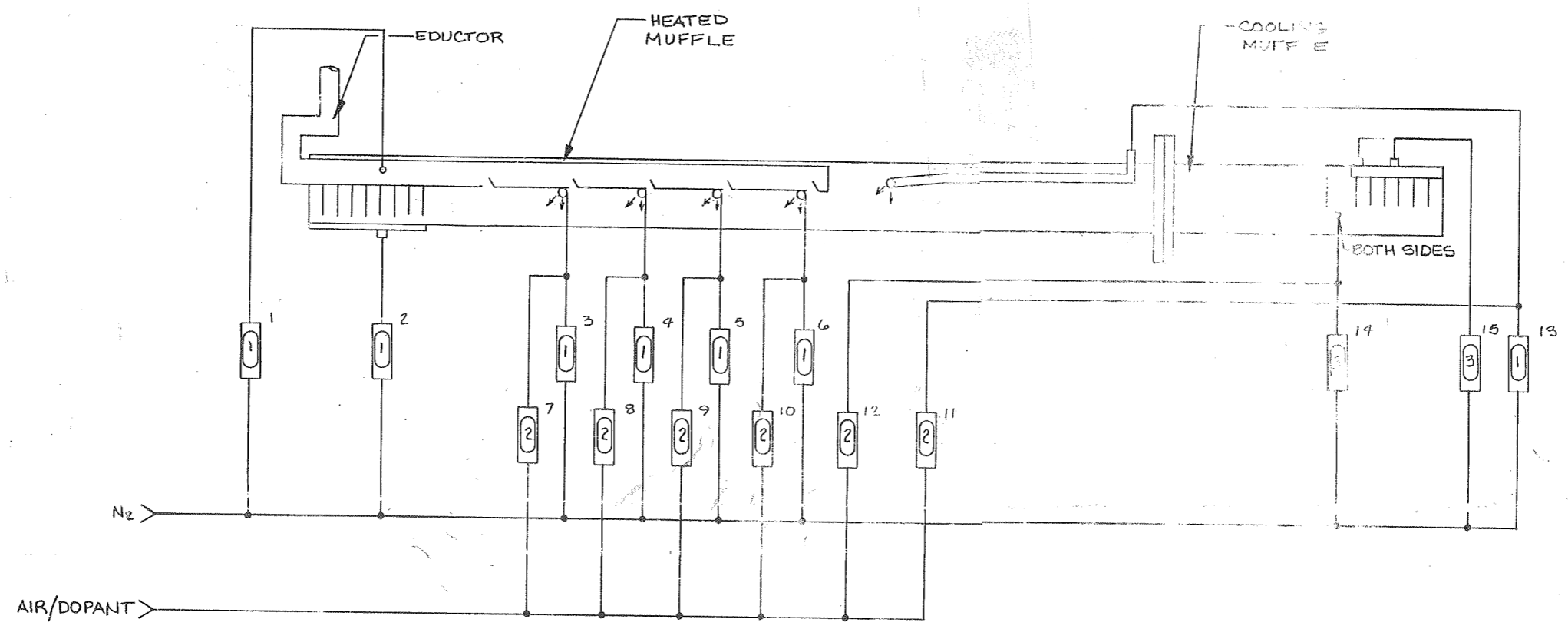
1. Remove and clean.
2. Remove and clean eductor with steam or water.
3. Clean inside of muffle with coarse fiber brush.
4. Blow out muffle with air hose.
5. Wipe down inside of muffle with clean, moist rags.
6. Check lubrication in the drive motor gear reducer every six months.
7. Operate furnace through normal cycle. Check operation of controller.
8. Check operation of water flow switch. A water flow below 30 gph will actuate the switch, resulting in the

SAMPLING SYSTEM OPERATION - (Continued)

shutdown of the unit and activation of the alarm circuit.

9. Check operation of overtemperature system.
10. Remove and clean belt cleaner tray.
11. Adjust brush position on belt cleaner.

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED



- | | |
|----------------------|------------------|
| 1 ENTRY TOP | 12 FIRING DOPANT |
| 2 ENTRY BOTTOM | 13 PRE-FIRING |
| 3 BURNOUT (Bo) # 1 | 14 FIRING |
| 4 Bo # 2 | 15 EXIT CURTAIN |
| 5 Bo # 3 | |
| 6 Bo # 4 | |
| 7 Bo # 1 DOPANT | |
| 8 Bo # 2 DOPANT | |
| 9 Bo # 3 DOPANT | |
| 10 Bo # 4 DOPANT | |
| 11 PRE-FIRING DOPANT | |

45 1728
 19 FT Heated
 40 cu in
 40 FT
 4704
 27 cu FT
 3

QTY PER DASH NO.	FSCM NO.	PART OR IDENTIFICATION NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION	ITEM NO.
2	081005		FLOWMETER, AIR, 0.5-6.0 SCFM		3
6	082144		FLOWMETER, 0-.5 SCFH		2
7	081931		FLOWMETER, N ₂ , 0-120 SCFH		1

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS DECIMALS ANGLES ± 1/32 ± .02 ± .XXX ± .005		CONTRACT NO.		WATKINS-JOHNSON COMPANY MICROWAVE DEVICES, PRODUCTION EQUIPMENT SCOTTS VALLEY, CALIFORNIA
MATERIAL		APPROVALS	DATE	
FINISH		CHECKED		ATMOSPHERE SCHEMATIC
APPLICATION		ENGR.		
DASH NO.	12CF-135(S)	MFG. ENGR.		SIZE FSCM NO. DWG. NO. REV. C 05783 973556
DO NOT SCALE DRAWING		P.A.		SCALE - DIV 25 SHEET 1 OF 1

NOTES (UNLESS OTHERWISE SPECIFIED):

DWG. NO. SH REV

A